2010 SALMON METHODOLOGY REVIEW

Each year, the Scientific and Statistical Committee (SSC) completes a methodology review to help assure new or significantly modified methodologies employed to estimate impacts of the Council's salmon management use the best available science. This review is preparatory to the Council's adoption, at the November meeting, of all proposed changes to be implemented in the coming season, or, in certain limited cases, of providing directions for handling any unresolved methodology problems prior to the formulation of salmon management options the following March. Because there is insufficient time to review new or modified methods at the March meeting, the Council may reject their use if they have not been approved the preceding November.

The Methodology Review is also used as a forum to review updated stock conservation objective proposals, which allows the Council to approve updates at the November meeting and allows adequate time for planning fisheries in the subsequent year. The Salmon Fishery Management Plan (FMP) allows conservation objectives to be updated without a formal FMP amendment, provided a comprehensive technical review of the best scientific information available provides conclusive evidence that, in the view of the Salmon Technical Team (STT), SSC, and the Council, justifies a modification. An exception is the 35,000 natural spawner floor for Klamath River fall Chinook, which may only be changed by FMP amendment.

At its April 2010 meeting, the Council identified a list of potential subjects for the methodology review. These subjects and the responsible agencies were identified in a reminder email dated July 21, 2010, which requested agencies prepare to speak to the status of the subjects in terms of completeness and priority (Agenda Item C.1.a, Attachment 1). The reminder email also noted the possibility of including proposed conservation objective updates in the process, two of which had been brought to Council staff's attention: Oregon Coast Natural coho and Oregon Coast Chinook.

Other review topics or conservation objective updates may be considered for review at this meeting, provided responsible agencies or individuals are prepared to justify their inclusion. All materials for review are to be received at the Council office at least two weeks prior to the scheduled review meeting of the SSC Salmon Subcommittee and Salmon Technical Team (STT), which is scheduled for October 19-20, 2010.

Council Action:

1. **Determine if topics identified for review will be ready for the joint SSC Salmon Subcommittee - STT meeting in October.**
2. **Set priorities for review of methodologies and/or conservation objective update proposals**.

Reference Materials:

1. Agenda Item C.1.a, Attachment 1: Email to the agencies from Chuck Tracy dated July 21, 2010.
2. Agenda Item C.1.b, NMFS Report: Letter from Will Stelle to Mark Cedergreen.

Agenda Order:

a. Agenda Item Overview **Chuck Tracy**
b. Reports and Comments of Advisory Bodies and Management Entities
c. Public Comment
d. **Council Action**: Adopt Final Review Priorities

PFMC
08/25/10

Agenda Item C.1.a
Attachment 1
September 2010

Hi All:
>>
>> This is just a reminder to agencies and involved individuals that the
>> Council will be establishing priorities for salmon methodology review
>> by the SSC and STT at the September Council meeting. The review
>> itself will be scheduled for the last week in September or the second
>> week in October.
>>
>> A list of potential subjects was considered at the April Council
>> meeting (see below), and it will be useful to have updates on the
>> priorities and whether some of the projects are suitably complete for
>> review.
>>
>> The Council adopted the following priority candidate items that the
>> Scientific and Statistical Committee (SSC) may consider for the 2010
>> Salmon Methodology Review. Source entities to deliver detailed
>> reports for review are included in parentheses with each candidate item.

Examination of the potential bias in Coho and Chinook Fishery Regulation Assessment Model (FRAM) of fishery‐related mortality introduced by mark‐selective fisheries – (Model Evaluation Workgroup)
1. Continued sensitivity analysis of FRAM to key parameter – (Model Evaluation Workgroup)
2. Oregon coastal natural (OCN) coho abundance predictor – (National Marine Fisheries Service)
3. Evaluation of indicator stock tag groups for Columbia River summer Chinook for incorporation into FRAM – (Salmon Technical Team)
4. Incorporation of additional Chinook stocks into the FRAM for improved accounting and better overall stock representation – (Salmon Technical Team)
5. Revisions to Amendment 13 matrix control rules for OCN coho stocks – (Oregon Department of Fish and Wildlife)
6. Abundance‐based management framework for Lower Columbia River tule fall Chinook –Tule Chinook Workgroup)
7. Update and revision of natural production information in the Lower Columbia River natural coho harvest management matrix – (Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife)
8. Review and evaluation of mark‐selective fishery reports – (Salmon Technical Team)

In addition to the above potential methodology changes, the review
> process will also consider updated stock conservation objectives.
> There have been indications that updates were being considered for
> Oregon coast Chinook and OCN coho. The process will be similar to
> proposed methodology changes, with write-ups of the proposed
> objectives, rationale, and scientific basis due to the Council office
> at least 2 weeks prior to the October review meeting.
>
> Please discuss these projects with appropriate parties and have
> recommendations ready for the September Council meeting as to whether
> they will be sufficiently complete in time for the October review
> meeting.
>
> Thanks.
>
--

-------- Original Message --------

Subject: Re: Salmon Methodology/Cons. Obj Review
Date: Wed, 21 Jul 2010 15:57:39 -0700
From: Chuck Tracy <Chuck.Tracy@noaa.gov>
To: Chuck Tracy <Chuck.Tracy@noaa.gov>, Larrie LaVoy <Larrie.LaVoy@noaa.gov>, Ray Beamesderfer <Beamesderfer@fishsciences.net>, Cindy LeFleur <LEFLECML@DFW.WA.GOV>, Stuart Ellis <ells@critfc.org>, Hap Leon <hapleon@earthlink.net>, Peter Dygert <Peter.Dygert@noaa.gov>, Guy Norman <normagrn@DFW.WA.GOV>, Tom Stahl <thomas.stahl@state.or.us>, John North <john.a.north@state.or.us>, Dan Rawding <daniel.rawding@dfw.wa.gov>, Mark Scheuerell <Mark.Scheuerell@noaa.gov>
CC: Sandy Zeiner <szeiner@nwifc.org>, Keith Lutz <lutz@nwifc.org>, Robert Kope <Robert.Kope@noaa.gov>, Mike O'Farrell <Michael.OFarrell@noaa.gov>, Doug Milward <milwadam@dfw.wa.gov>, Craig Foster <Craig.A.Foster@state.or.us>, Henry Yuen <henry_yuen@fws.gov>, Eric Schindler <Eric.D.Schindler@state.or.us>, Melodie Palmer-Zwahlen <mpalmer@dfg.ca.gov>, Wendy Beeghley <BeeghWLB@dfw.wa.gov>, Hap Leon <hapleon@earthlink.net>, Joe Dazey <jdazey@centurytel.net>, Larrie LaVoy <Larrie.LaVoy@noaa.gov>, Jim Packer <PackeJFP@dfw.wa.gov>, Ethan Clemons <Ethan.R.Clemons@state.or.us>, Andy Rankis <ARankis@nwifc.org>, Rishi Sharma <ShaR@CRITFC.org>, Bob Conrad <bconrad@nwifc.org>, Angelika Hagen-breaux <hagenafh@dfw.wa.gov>, Ron Boyce <ron.boyce@state.or.us>, Marci Yaremko <myaremko@dfg.ca.gov>, Pat Pattillo <pattiplp@dfw.wa.gov>, Craig Bowhay <cbowhay@nwifc.org>, Peter Lawson <Peter.W.Lawson@noaa.gov>, Charlie Petrosky <cpetrosky@idfg.idaho.gov>, Owen Hamel <Owen.Hamel@noaa.gov>, David Sones <ddavid160@centurytel.net>, Stephen Williams ODFW <Stephen.H.Williams@state.or.us>, Jennifer Hogan <Jennifer.Hogan@noaa.gov>, Marija Vojkovich <mvojkovich@dfg.ca.gov>, Peggy Busby <Peggy.Busby@noaa.gov>, Peter Dygert <Peter.Dygert@noaa.gov>, Michael Mohr <Michael.Mohr@noaa.gov>, Tom Welsh <MWelsh9538@aol.com>, Jim Olson <jaocto@juno.com>, Duncan MacLean <b-faye@pacbell.net>, Steve Watrous <BRANCHOFIC@aol.com>, Butch Smith <coho@willapabay.org>, Mike Sorenson <fvmissraven@hotmail.com>, Kent Martin <imartin@iinet.com>, Craig Stone <emvlsport@aol.com>, Paul Pierce <sdad111@aol.com>, Jim Hie <jnahie@att.net>, Richard Heap <fiskare@charter.net>, Paul Heikkila <PHeikkila@mycomspan.com>, Dave Hillemeier <dhillemeier@yuroktribe.nsn.us>, Gerry Reinholdt <reinholdtfish@hotmail.com>

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northwest Region
7600 Sand Point Way N.E., Bldg. 1
Seattle, WA 98115

August 23, 2010

Mr. Mark Cedergreen, Chairman
Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 101
Portland, Oregon 97220-1384

Dear Mr. Cedergreen:

I am writing to update the Pacific Fishery Management Council (Council) about ongoing efforts to address the tasks described in the 2010 biological opinion on Lower Columbia River Chinook. Recall that the 2010 opinion covered Council area fisheries in 2010 and 2011. The opinion limited the total exploitation rate on Lower Columbia River tule Chinook to 0.38 in 2010 and 0.36 in 2011. However, the opinion included a contingency that allowed for an exploitation rate limit of 0.37 in 2011 if certain tasks were addressed satisfactorily. The opinion described a set of tasks designed to accelerate the recovery process by completing actions with immediate benefit to tule populations. If the tasks are addressed adequately, the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries) would indicate through its annual guidance letter to the Council that the higher exploitation rate was acceptable.

I know the Council has a keen interest in ensuring completion of the tasks and thought it would be useful to update the Council on progress at this time. Staff from Oregon and Washington, the Council, recovery planning groups, and NOAA Fisheries is involved. The Lower Columbia Steering Committee is helping to coordinate the work assignments and met on June 2, 2010 to form working groups with convening leads assigned to each task. NOAA Fisheries appreciates the work of the Steering Committee and all involved, including the Council staff, but wants to underscore the need to follow through to complete the work. The tasks were designed to advance the recovery planning process and so are important to progressively reduce the risks to Columbia River fall chinook. That is why satisfactory completion of the work is necessary to take advantage of the opportunity presented in the biological opinion.

NOAA Fisheries will provide a progress report related to the tasks at the November Council meeting. The report will allow the Council to assess the prospects for successfully completing the tasks, and highlight areas that may require immediate attention.

Council members should recognize, however, that by November little time will be remaining to complete any remaining work prior to formulation of NOAA's guidance on the 2011 harvest rate. NOAA Fisheries therefore asks that the Council and it members continue to support the ongoing effort and encourage all involved parties to set priorities accordingly.

I appreciate your support and look forward to our collective success in this endeavor.

Sincerely,

William W. Stelle, Jr.
Regional Administrator

MODEL EVALUATION WORKGROUP REPORT ON 2010 SALMON METHODOLOGY REVIEW

A list of priority candidate items that the Scientific and Statistical Committee (SSC) may consider for the 2010 Salmon Methodology Review was adopted by the Council at the April meeting. The current status of items the Model Evaluation Workgroup (MEW) has worked on are as follows:

1. Sensitivity analysis of Chinook and Coho Fishery Regulation Assessment Models (FRAM) to major assumptions, including sensitivity to parameters related to mark-selective fisheries.
   - The MEW has not made any further progress on this topic and will not have a report available for the review meeting.

2. Bias-correction methods for estimates of unmarked and marked fish mortalities when both mark-selective and non-selective fisheries are operating during a FRAM time step that would be applicable to Coho FRAM.
   - A completed report will be ready for review at the methodology review meeting.

3. Analysis of potential FRAM bias which examines the relative contribution to bias of various FRAM model parameters.
   - A completed report will be ready for review at the methodology review meeting.

4. Adding additional coded-wire-tag (CWT) groups to Chinook FRAM for better representation of the upper Columbia River summer Chinook stock.
   - Six new CWT groups for this stock, from three additional brood years, have been incorporated into a version of the Chinook FRAM Base Period. The current state of the analyses is sufficient for evaluation at the methodology review meeting, for potential use during 2011 pre-season modeling.

PFMC
9/7/10

Agenda Item C.1.b
Supplemental SSC Report
September 2010

SCIENTIFIC AND STATISTICAL COMMITTEE REPORT ON 2010 SALMON METHODOLOGY REVIEW

At the April meeting, the Council identified the following nine priority items that the Scientific and Statistical Committee (SSC) should consider for the 2010 Salmon Methodology Review.

1. Examination of the potential bias in Coho and Chinook Fishery Regulation Assessment Model (FRAM) of fishery-related mortality introduced by mark-selective fisheries – Model Evaluation Workgroup.

2. Continued sensitivity analysis of FRAM to key parameter – Model Evaluation Workgroup.

3. Oregon coastal natural (OCN) coho abundance predictor – National Marine Fisheries Service.

4. Evaluation of indicator stock tag groups for Columbia River summer Chinook for incorporation into FRAM – Salmon Technical Team.

5. Incorporation of additional Chinook stocks into the FRAM for improved accounting and better overall stock representation – Salmon Technical Team.

6. Revisions to Amendment 13 matrix control rules for OCN coho stocks – Oregon Department of Fish and Wildlife.

7. Abundance-based management framework for Lower Columbia River tule fall Chinook – To Be Determined.

8. Update and revision of natural production information in the Lower Columbia River natural coho harvest management matrix – Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife.

9. Review and evaluation of mark-selective fishery reports – Salmon Technical Team.

Reports on the following three items will be ready for review at the methodology meeting:

- Examination of potential bias and bias-correction methods for estimates of unmarked and marked fish mortalities when both mark-selective and non-selective fisheries are operating during a single FRAM time step. This analysis is focused on coho FRAM but will also have relevance to the Chinook FRAM (item 1.) – Model Evaluation Workgroup.

- Addition of new coded-wire-tag (CWT) groups to Chinook FRAM for better representation of the upper Columbia River summer Chinook stock (Item 4.) – Model Evaluation Workgroup and Salmon Technical Team.

- Oregon coastal natural coho salmon abundance predictor (Item 3.) – National Marine Fisheries Service and Oregon Production Index Technical Team.

A memo dated August 23, 2010 from Will Stelle, NMFS Northwest Regional Administrator to Mark Cedergreen indicated that NMFS is working to complete certain, unspecified, tasks "designed to accelerate the recovery process" for Lower Columbia River tule Chinook. NMFS will provide a progress report to the Council in November, in the hopes of having work products for implementation in 2011 fisheries. There will be no opportunity for SSC or Council review of this work prior to March 2011.

While considering Amendment 16 it became apparent that, depending on which alternative is adopted by the Council, there would be methodology and stock classification changes that will warrant review in 2011 and future years.

The SSC looks forward to reviewing reports on these topics at the November meeting. The SSC Salmon Subcommittee and Salmon Technical Team (STT) will hold a joint meeting on October 19 and 20 in Portland to review these issues. As always, the SSC requires good documentation and ample review time to make efficient use of the SSC Salmon Subcommittee's time. Materials for review should be submitted at least two weeks prior to the scheduled review. Agencies should be responsible for ensuring that materials submitted to the SSC are technically sound, comprehensive, clearly documented, and identified by author.

PFMC
09/11/10

SALMON TECHNICAL TEAM REPORT ON 2010 SALMON METHODOLOGY REVIEW

Of the potential topics for consideration at the 2010 SSC/STT salmon methodology review, the STT understands that analyses will be completed for the following three items:

1. Evaluation of and correction for potential mark selective fishery bias in the coho FRAM
2. Oregon coastal natural coho abundance predictor
3. Evaluation of indicator stock tag groups for Columbia River summer Chinook

The STT recommends that these items be included in the agenda for the methodology review.

PFMC
9/11/2010

Salmon Methodology Review

The Tribes are concerned about mark-selective fisheries and the ability of FRAM to project the impacts of any mark-selective fisheries. Work on suitable methodologies of sensitivity analysis for key model parameters needs to continue. The Council must be confident that this tool is adequate for assessing fishery impacts from the suite of fisheries that we ultimately recommend for adoption.

The Tribes encourage the MEW, STT and SSC to continue working on the bias correction equations, provide the Council with their recommendations on what metric should be utilized to monitor the impact or intensity levels of mark-selective fisheries, and identify at what impact levels the bias resulting from mark-selective fisheries becomes a conservation concern.

The Tribes have requested a multi-year assessment report be prepared on the ocean mark-selective fishery for **coho** that is ongoing in Areas 1-4 for the last ten plus years. The State of Washington has said that these reports already exist. So why hasn't the Council or its advisory bodies seen them? The tribes have review the Chinook Encounter Study progress reports recently submitted by WDFW and are disturbed by the information contained within them pertaining to the ocean mark-selective fishery for coho. The Tribes would like to think that the ocean fishery responsible for the largest source of impacts on coho under PFMC jurisdiction would be monitored a little bit closer than this. The reports for the fishery do not provide coverage of all years and all management areas. No variances were provided with the estimates to allow for the assessment of the precision of the sampling methodology to estimate key parameters. The reported mark rates show a consistent bias, for all years and all management areas, for overestimating hatchery contributions and, therefore, underestimating impacts on natural stocks. We believe the Council must establish a better reporting process for this style of fishing before consideration is given to further apply this approach to Chinook.

The Tribes request that the Salmon Technical Team look over the existing reports especially regarding the concerns mentioned above. The STT needs to review and evaluate all WDFW ocean mark selective fisheries reports developed and present their finding to Council and its Advisory Bodies prior to the preseason planning cycle for salmon.

The Tribes are committed to participate in any of the technical processes required to develop and evaluate the tools needed for any of the analyses.

Completion of this work is essential, if the Council is to continue to fulfill its obligation to constrain fishery impacts to sustainable levels on stocks of concern.

FISHERY MANAGEMENT PLAN AMENDMENT 16, ANNUAL CATCH LIMITS AND ACCOUNTABILITY MEASURES

The reauthorization of the Magnuson-Stevens Act (MSA) in 2007 established new requirements to end and prevent overfishing through the use of annual catch limits (ACLs) and accountability measures (AMs). The reauthorization also contained new requirements for the Scientific and Statistical Committee (SSC) to recommend acceptable biological catch (ABC) levels to the Council that account for scientific uncertainty. Federal fishery management plans (FMPs) must establish mechanisms for ACLs and AMs by 2010 for stocks subject to overfishing and by 2011 for all others, with the exception of stocks managed under an international agreement or stocks with a life cycle of approximately one year. On January 16, 2009, National Marine Fisheries Service published amended guidelines for National Standard 1 (NS1Gs) to provide guidance on how to comply with new provisions of the MSA (Agenda Item C.2.a, Attachment 1).

The Council is tentatively scheduled to adopt alternatives for public review at the September 2010 meeting and take final action at the November 2010 meeting. Final action in November would allow the Council to implement the amendment during the preseason planning process, and should provide adequate time to complete the administrative process prior to the beginning of the next salmon regulation cycle on May 1, 2011.

At its September 2009 meeting, the Council identified several issues to be considered in the amendment process including: stock classification, status determination criteria, overfishing limit (OFL)/ acceptable biological catch (ABC)/annual catch limit (ACL) reference point framework, AMs, and *de minimis* fishery provisions. Since that time, the ad hoc salmon amendment committee (SAC) has met several times to develop alternatives for these issues and draft a report for Council consideration (Agenda Item C.2.b, SAC Report).

The SAC Report contains proposed alternatives and analyses for consideration by the Council. The alternatives are organized around five topics:

1) <u>Classifying stocks in the FMP</u> as in the fishery, out of the fishery, or ecosystem component (EC) stocks.
2) <u>Applying the MSA international exception</u> to specifying ABC, ACLs, and AMs for stocks managed under the Pacific Salmon Treaty (PST).
3) <u>Establishing objective and measurable status determination criteria (SDC)</u> for all relevant stocks in the FMP.
4) <u>Establishing a framework for application of OFL/ABC/ACL</u> reference points.
5) <u>Determining appropriate accountability measures</u> necessary to prevent ACLs from being exceeded, and to mitigate any overages that may occur.
6) <u>Establishing *de minimis* fishing provisions</u> for stocks that don't have existing mechanisms absent an emergency rule when a conservation alert is triggered.

The SAC Report is a draft Environmental Assessment (EA) analyzing the alternatives and providing a record for the FMP amendment process. The analyses of some issues are still incomplete; however, alternatives for stock classification, status determination criteria, ACLs, AMs, and *de minimis* fisheries are sufficiently complete for the Council to adopt a range of alternatives, and if appropriate, to identify preliminary preferred alternatives, to release for public review.

Council Task:

1. **Adopt alternatives for public review.**
2. **As appropriate, identify preliminary preferred alternatives**
3. **Provide additional guidance on development and analysis of alternatives.**

Reference Materials:

1 Agenda Item C.2.a, Attachment 1: National Standard 1 Guidelines.
2. Agenda Item C.2.b, SAC Report: Draft Environmental Assessment for Pacific Coast Salmon Plan Amendment 16: Classifying Stocks, Revising Status Determination Criteria, Establishing Annual Catch Limits and Accountability Measures, and *De Minimis* Fishing Provisions.

Agenda Order:

a. Agenda Item Overview **Chuck Tracy**
b. Reports and Comments of Advisory Bodies and Management Entities
c. Public Comment
d. **Council Action:** Adopt Proposed Alternatives for Public Review

PFMC
08/23/10

§ 600.310 National Standard 1—Optimum Yield.

(a) *Standard 1.* Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield (OY) from each fishery for the U.S. fishing industry.

(b) *General.*

(1) The guidelines set forth in this section describe fishery management approaches to meet the objectives of National Standard 1 (NS1), and include guidance on:

(i) Specifying maximum sustainable yield (MSY) and OY;

(ii) Specifying status determination criteria (SDC) so that overfishing and overfished determinations can be made for stocks and stock complexes that are part of a fishery;

(iii) Preventing overfishing and achieving OY, incorporation of scientific and management uncertainty in control rules, and adaptive management using annual catch limits (ACL) and measures to ensure accountability (AM); and

(iv) Rebuilding stocks and stock complexes.

(2) *Overview of Magnuson-Stevens Act concepts and provisions related to NS1*

(i) *MSY.* The Magnuson-Stevens Act establishes MSY as the basis for fishery management and requires that: The fishing mortality rate does not jeopardize the capacity of a stock or stock complex to produce MSY; the abundance of an overfished stock or stock complex be rebuilt to a level that is capable of producing MSY; and OY not exceed MSY.

(ii) *OY.* The determination of OY is a decisional mechanism for resolving the Magnuson-Stevens Act's conservation and management objectives, achieving a fishery management plan's (FMP) objectives, and balancing the various interests that comprise the greatest overall benefits to the Nation. OY is based on MSY as reduced under paragraphs (e)(3)(iii) and (iv) of this section. The most important limitation on the specification of OY is that the choice of OY and the conservation and management measures proposed to achieve it must prevent overfishing.

(iii) *ACLs and AMs.* Any FMP which is prepared by any Council shall establish a mechanism for specifying ACLs in the FMP (including a multiyear plan), implementing regulations, or annual specifications, at a level such that overfishing does not occur in the fishery, including measures to ensure accountability (Magnuson-Stevens Act section 303(a)(15)). Subject to certain exceptions and circumstances described in paragraph (h) of this section, this requirement takes effect in fishing year 2010, for fisheries determined subject to overfishing, and in fishing year 2011, for all other fisheries (Magnuson-Stevens Act section 303 note). ''Council'' includes the Regional Fishery Management Councils and the Secretary of Commerce, as appropriate (*see* § 600.305(c)(11)).

(iv) *Reference points.* SDC, MSY, acceptable biological catch (ABC), and ACL, which are described further in paragraphs (e) and (f) of this section, are collectively referred to as ''reference points.''

(v) *Scientific advice.* The Magnuson-Stevens Act has requirements regarding scientific and statistical committees (SSC) of the Regional Fishery Management Councils, including but not limited to, the following provisions:

(A) Each Regional Fishery Management Council shall establish an SSC as described in section 302(g)(1)(A) of the Magnuson-Stevens Act.

(B) Each SSC shall provide its Regional Fishery Management Council recommendations for ABC as well as other scientific advice, as described in Magnuson-Stevens Act section 302(g)(1)(B).

(C) The Secretary and each Regional Fishery Management Council may establish a peer review process for that Council for scientific information used to advise the Council about the conservation and management of a fishery (see Magnuson-Stevens Act section 302(g)(1)(E)). If a peer review process is established, it should investigate the technical merits of stock assessments and other scientific information used by the SSC or agency or international scientists, as appropriate. For Regional Fishery Management Councils, the peer review process is not a substitute for the SSC and should work in conjunction with the SSC. For the Secretary, which does not have an SSC, the peer review process should provide the scientific information necessary.

(D) Each Council shall develop ACLs for each of its managed fisheries that may not exceed the ''fishing level recommendations'' of its SSC or peer review process (Magnuson-Stevens Act section 302(h)(6)). The SSC recommendation that is the most relevant to ACLs is ABC, as both ACL and ABC are levels of annual catch.

(3) *Approach for setting limits and accountability measures, including targets, for consistency with NS1.* In general, when specifying limits and accountability measures intended to avoid overfishing and achieve sustainable fisheries, Councils must take an approach that considers uncertainty in scientific information and management control of the fishery. These guidelines describe how to address uncertainty such that there is a low risk that limits are exceeded as described in paragraphs (f)(4) and (f)(6) of this section.

(c) *Summary of items to include in FMPs related to NS1.* This section provides a summary of items that Councils must include in their FMPs and FMP amendments in order to address ACL, AM, and other aspects of the NS1 guidelines. As described in further detail in paragraph (d) of this section, Councils may review their FMPs to decide if all stocks are ''in the fishery'' or whether some fit the category of ''ecosystem component species.'' Councils must also describe fisheries data for the stocks, stock complexes, and ecosystem component species in their FMPs, or associated public documents such as Stock Assessment and Fishery Evaluation (SAFE) Reports. For all stocks and stock complexes that are ''in the fishery'' (see paragraph (d)(2) of this section), the Councils must evaluate and describe the following items in their FMPs and amend the FMPs, if necessary, to align their management objectives to end or prevent overfishing:

(1) MSY and SDC (see paragraphs (e)(1) and (2) of this section).

(2) OY at the stock, stock complex, or fishery level and provide the OY specification analysis (see paragraph (e)(3) of this section).

(3) ABC control rule (see paragraph (f)(4) of this section).

(4) Mechanisms for specifying ACLs and possible sector-specific ACLs in relationship to the ABC (see paragraphs (f)(5) and (h) of this section).

(5) AMs (see paragraphs (g) and (h)(1) of this section).

(6) Stocks and stock complexes that have statutory exceptions from ACLs (see paragraph (h)(2) of this section) or which fall under limited circumstances which require different approaches to meet the ACL requirements (see paragraph (h)(3) of this section).

(d) *Classifying stocks in an FMP*

(1) *Introduction.* Magnuson-Stevens Act section 303(a)(2) requires that an FMP contain, among other things, a description of the species of fish involved in the fishery. The relevant Council determines which specific target stocks and/or non-target stocks to include in a fishery. This section provides that a Council may, but is not required to, use an ''ecosystem component (EC)'' species classification. As a default, all stocks in an FMP are considered to be ''in the fishery,'' unless they are identified as EC species (see § 600.310(d)(5)) through an FMP amendment process.

(2) *Stocks in a fishery.* Stocks in a fishery may be grouped into stock complexes, as appropriate. Requirements for reference points and management measures for these stocks are described throughout these guidelines.

(3) ''Target stocks'' are stocks that fishers seek to catch for sale or personal use, including ''economic discards'' as defined under Magnuson-Stevens Act section 3(9).

(4) ''Non-target species'' and ''non-target stocks'' are fish caught incidentally during the pursuit of target stocks in a fishery, including ''regulatory discards'' as defined under Magnuson-Stevens Act section 3(38). They may or may not be retained for sale or personal use. Non-target species may be included in a fishery and, if so, they should be identified at the stock level. Some non-target species may be identified in an FMP as ecosystem component (EC) species or stocks.

(5) *Ecosystem component (EC) species.*

(i) To be considered for possible classification as an EC species, the species should:

(A) Be a non-target species or non-target stock;

(B) Not be determined to be subject to overfishing, approaching overfished, or overfished;

(C) Not be likely to become subject to overfishing or overfished, according to the best available information, in the absence of conservation and management measures; and

(D) Not generally be retained for sale or personal use.

(ii) Occasional retention of the species would not, in and of itself, preclude consideration of the species under the EC classification. In addition to the general factors noted in paragraphs (d)(5)(i)(A)–(D) of this section, it is important to consider whether use of the EC species classification in a given instance is consistent with MSA conservation and management requirements.

(iii) EC species may be identified at the species or stock level, and may be grouped into complexes. EC species may, but are not required to, be included in an FMP or FMP amendment for any of the following reasons: For data collection purposes; for ecosystem considerations related to specification of OY for the associated fishery; as considerations in the development of conservation and management measures for the associated fishery; and/or to address other ecosystem issues. While EC species are not considered to be ''in the fishery,'' a Council should consider measures for the fishery to minimize bycatch and bycatch mortality of EC species consistent with National Standard 9, and to protect their associated role in the ecosystem. EC species do not require specification of reference points but should be monitored to the extent that any new pertinent scientific information becomes available (e.g., catch trends, vulnerability, etc.) to determine changes in their status or their vulnerability to the fishery. If necessary, they should be reclassified as ''in the fishery.''

(6) *Reclassification.* A Council should monitor the catch resulting from a fishery on a regular basis to determine if the stocks and species are appropriately classified in the FMP. If the criteria previously used to classify a stock or species is no longer valid, the Council should reclassify it through an FMP amendment, which documents rationale for the decision.

(7) *Stocks or species identified in more than one FMP.* If a stock is identified in more than one fishery, Councils should choose which FMP will be the primary FMP in which management objectives, SDC, the stock's overall ACL and other reference points for the stock are established. Conservation and management measures in other FMPs in which the stock is identified as part of a fishery should be consistent with the primary FMP's management objectives for the stock.

(8) *Stock complex.* ''Stock complex'' means a group of stocks that are sufficiently similar in geographic distribution, life history, and vulnerabilities to the fishery such that the impact of management actions on the stocks is similar. At the time a stock complex is established, the FMP should provide a full and explicit description of the proportional composition of each stock in the stock complex, to the extent possible. Stocks may be grouped into complexes for various reasons, including where stocks in a multispecies fishery cannot be targeted independent of one another and MSY can not be defined on a stock-by-stock basis (*see* paragraph (e)(1)(iii) of this section); where there is insufficient data to measure their status relative to SDC; or when it is not feasible for fishermen to distinguish individual stocks among their catch. The vulnerability of stocks to the fishery should be evaluated when determining if a particular stock complex should be established or reorganized, or if a particular stock should be included in a complex. Stock complexes may be comprised of: one or more indicator stocks, each of which has SDC and ACLs, and several other stocks; several stocks without an

indicator stock, with SDC and an ACL for the complex as a whole; or one of more indicator stocks, each of which has SDC and management objectives, with an ACL for the complex as a whole (this situation might be applicable to some salmon species).

(9) *Indicator stocks.* An indicator stock is a stock with measurable SDC that can be used to help manage and evaluate more poorly known stocks that are in a stock complex. If an indicator stock is used to evaluate the status of a complex, it should be representative of the typical status of each stock within the complex, due to similarity in vulnerability. If the stocks within a stock complex have a wide range of vulnerability, they should be reorganized into different stock complexes that have similar vulnerabilities; otherwise the indicator stock should be chosen to represent the more vulnerable stocks within the complex. In instances where an indicator stock is less vulnerable than other members of the complex, management measures need to be more conservative so that the more vulnerable members of the complex are not at risk from the fishery. More than one indicator stock can be selected to provide more information about the status of the complex. When indicator stock(s) are used, periodic re-evaluation of available quantitative or qualitative information (e.g., catch trends, changes in vulnerability, fish health indices, etc.) is needed to determine whether a stock is subject to overfishing, or is approaching (or in) an overfished condition.

(10) *Vulnerability.* A stock's vulnerability is a combination of its productivity, which depends upon its life history characteristics, and its susceptibility to the fishery. Productivity refers to the capacity of the stock to produce MSY and to recover if the population is depleted, and susceptibility is the potential for the stock to be impacted by the fishery, which includes direct captures, as well as indirect impacts to the fishery (e.g., loss of habitat quality). Councils in consultation with their SSC, should analyze the vulnerability of stocks in stock complexes where possible.

(e) *Features of MSY, SDC, and OY.*

(1) *MSY.* Each FMP must include an estimate of MSY for the stocks and stock complexes in the fishery, as described in paragraph (d)(2) of this section).

(i) *Definitions.*

(A) *MSY* is the largest long-term average catch or yield that can be taken from a stock or stock complex under prevailing ecological, environmental conditions and fishery technological characteristics (e.g., gear selectivity), and the distribution of catch among fleets.

(B) *MSY fishing mortality rate (Fmsy)* is the fishing mortality rate that, if applied over the long term, would result in MSY.

(C) *MSY stock size (Bmsy)* means the long-term average size of the stock or stock complex, measured in terms of spawning biomass or other appropriate measure of the stock's reproductive potential that would be achieved by fishing at Fmsy.

(ii) *MSY for stocks.* MSY should be estimated for each stock based on the best scientific information available (see § 600.315).

(iii) *MSY for stock complexes.* MSY should be estimated on a stock-by-stock basis whenever possible. However, where MSY cannot be estimated for each stock in a stock complex, then MSY may be estimated for one or more indicator stocks for the complex or for the complex as a whole. When indicator stocks are used, the stock complex's MSY could be listed as ''unknown,'' while noting that the complex is managed on the basis of one or more indicator stocks that do have known stock-specific MSYs, or suitable proxies, as described in paragraph (e)(1)(iv) of this section. When indicator stocks are not used, MSY, or a suitable proxy, should be calculated for the stock complex as a whole.

(iv) *Specifying MSY.* Because MSY is a long-term average, it need not be estimated annually, but it must be based on the best scientific information available (*see* § 600.315), and should be re-estimated as required by changes in long-term environmental or ecological conditions, fishery technological characteristics, or new scientific information. When data are insufficient to estimate MSY directly, Councils should adopt other measures of reproductive potential, based on the best scientific information available, that can serve as reasonable proxies for MSY, Fmsy, and Bmsy, to the extent possible. The MSY for a stock is influenced by its interactions with other stocks in its ecosystem and these interactions may shift as multiple stocks in an ecosystem are fished. These ecological conditions should be taken into account, to the extent possible, when specifying MSY. Ecological conditions not directly accounted for in the specification of MSY can be among the ecological factors considered when setting OY below MSY. As MSY values are estimates or are based on proxies, they will have some level of uncertainty associated with them. The degree of uncertainty in the estimates should be identified, when possible, through the stock assessment process and peer review (*see* § 600.335), and should be taken into account when specifying the ABC Control rule. Where this uncertainty cannot be directly calculated, such as when proxies are used, then a proxy for the uncertainty itself should be established based on the best scientific information, including comparison to other stocks.

(2) *Status determination criteria*

(i) *Definitions.*

(A) *Status determination criteria (SDC)* mean the quantifiable factors, MFMT, OFL, and MSST, or their proxies, that are used to determine if overfishing has occurred, or if the stock or stock complex is overfished. Magnuson-Stevens Act (section 3(34)) defines both ''overfishing'' and ''overfished'' to mean a rate or level of fishing mortality that jeopardizes the capacity of a fishery to produce the MSY on a continuing basis. To avoid confusion, this section clarifies that ''overfished'' relates to biomass of a stock or stock complex, and ''overfishing'' pertains to a rate or level of removal of fish from a stock or stock complex.

(B) *Overfishing* (to overfish) occurs whenever a stock or stock complex is subjected to a level of fishing mortality or annual total catch that jeopardizes the capacity of a stock or stock complex to produce MSY on a continuing basis.

(C) *Maximum fishing mortality threshold (MFMT)* means the level of fishing mortality (F), on an annual basis, above which overfishing is occurring. The MFMT or reasonable proxy may be expressed either as a single number (a fishing mortality rate or F value), or as a function of spawning biomass or other measure of reproductive potential.

(D) *Overfishing limit (OFL)* means the annual amount of catch that corresponds to the estimate of MFMT applied to a stock or stock complex's abundance and is expressed in terms of numbers or weight of fish. The OFL is an estimate of the catch level above which overfishing is occurring.

(E) *Overfished.* A stock or stock complex is considered ''overfished'' when its biomass has declined below a level that jeopardizes the capacity of the stock or stock complex to produce MSY on a continuing basis.

(F) *Minimum stock size threshold (MSST)* means the level of biomass below which the stock or stock complex is considered to be overfished.

(G) *Approaching an overfished condition.* A stock or stock complex is approaching an overfished condition when it is projected that there is more than a 50 percent chance that the biomass of the stock or stock complex will decline below the MSST within two years.

(ii) *Specification of SDC and overfishing and overfished determinations.* SDC must be expressed in a way that enables the Council to monitor each stock or stock complex in the FMP, and determine annually, if possible, whether overfishing is occurring and whether the stock or stock complex is overfished. In specifying SDC, a Council must provide an analysis of how the SDC were chosen and how they relate to reproductive potential. Each FMP must specify, to the extent possible, objective and measurable SDC as follows (*see* paragraphs (e)(2)(ii)(A) and (B) of this section):

(A) *SDC to determine overfishing status.* Each FMP must describe which of the following two methods will be used for each stock or stock complex to determine an overfishing status.

(*1*) *Fishing mortality rate exceeds MFMT.* Exceeding the MFMT for a period of 1 year or more constitutes overfishing. The MFMT or reasonable proxy may be expressed either as a single number (a fishing mortality rate or F value), or as a function of spawning biomass or other measure of reproductive potential.

(*2*) *Catch exceeds the OFL.* Should the annual catch exceed the annual OFL for 1 year or more, the stock or stock complex is considered subject to overfishing.

(B) *SDC to determine overfished status.* The MSST or reasonable proxy must be expressed in terms of spawning biomass or other measure of reproductive potential. To the extent possible, the MSST should equal whichever of the following is greater: One-half the MSY stock size, or the minimum stock size at which rebuilding to the MSY level would be expected to occur within 10 years, if the stock or stock complex were exploited at the MFMT specified under paragraph (e)(2)(ii)(A)(1) of this section. Should the estimated size of the stock or stock complex in a given year fall below this threshold, the stock or stock complex is considered overfished.

(iii) *Relationship of SDC to environmental change.* Some short-term environmental changes can alter the size of a stock or stock complex without affecting its long-term reproductive potential. Long-term environmental changes affect both the short-term size of the stock or stock complex and the long-term reproductive potential of the stock or stock complex.

(A) If environmental changes cause a stock or stock complex to fall below its MSST without affecting its long-term reproductive potential, fishing mortality must be constrained sufficiently to allow rebuilding within an acceptable time frame (*also see* paragraph (j)(3)(ii) of this section). SDC should not be respecified.

(B) If environmental changes affect the long-term reproductive potential of the stock or stock complex, one or more components of the SDC must be respecified. Once SDC have been respecified, fishing mortality may or may not have to be reduced, depending on the status of the stock or stock complex with respect to the new criteria.

(C) If manmade environmental changes are partially responsible for a stock or stock complex being in an overfished condition, in addition to controlling fishing mortality, Councils should recommend restoration of habitat and other ameliorative programs, to the extent possible (see also the guidelines issued pursuant to section 305(b) of the Magnuson-Stevens Act for Council actions concerning essential fish habitat).

(iv) *Secretarial approval of SDC.* Secretarial approval or disapproval of proposed SDC will be based on consideration of whether the proposal:

(A) Has sufficient scientific merit;

(B) Contains the elements described in paragraph (e)(2)(ii) of this section;

(C) Provides a basis for objective measurement of the status of the stock or stock complex against the criteria; and

(D) is operationally feasible.

(3) *Optimum yield*

(i) *Definitions*

(A) *Optimum yield (OY).* Magnuson-Stevens Act section (3)(33) defines ''optimum,'' with respect to the yield from a fishery, as the amount of fish that will provide the greatest overall benefit to the Nation, particularly with respect to food production and recreational opportunities and taking into account the protection of marine ecosystems; that is prescribed on the basis of the MSY from the fishery, as reduced by any relevant economic, social, or ecological factor; and, in the case of an overfished fishery, that provides for rebuilding to a level consistent with producing the MSY in such fishery. OY may be established at the stock or stock complex level, or at the fishery level.

(B) In NS1, use of the phrase ''achieving, on a continuing basis, the optimum yield from each fishery'' means producing, from each stock, stock complex, or fishery: a long-term series of catches such that the average catch is equal to the OY, overfishing is prevented, the long term average biomass is near or above Bmsy, and overfished stocks and stock complexes are rebuilt consistent with timing and other requirements of section 304(e)(4) of the Magnuson-Stevens Act and paragraph (j) of this section.

(ii) *General.* OY is a long-term average amount of desired yield from a stock, stock complex, or fishery. An FMP must contain conservation and management measures, including ACLs and AMs, to achieve OY on a continuing basis, and provisions for information collection that are designed to determine the degree to which OY is achieved. These measures should allow for practical and effective implementation and enforcement of the management regime. The Secretary has an obligation to implement and enforce the FMP. If management measures prove unenforceable—or too restrictive, or not rigorous enough to prevent overfishing while achieving OY—they should be modified; an alternative is to reexamine the adequacy of the OY specification. Exceeding OY does not necessarily constitute overfishing. However, even if no overfishing resulted from exceeding OY, continual harvest at a level above OY would violate NS1, because OY was not achieved on a continuing basis. An FMP must contain an assessment and specification of OY, including a summary of information utilized in making such specification, consistent with requirements of section 303(a)(3) of the Magnuson-Stevens Act. A Council must identify those economic, social, and ecological factors relevant to management of a particular stock, stock complex, or fishery, and then evaluate them to determine the OY. The choice of a particular OY must be carefully documented to show that the OY selected will produce the greatest benefit to the Nation and prevent overfishing.

(iii) *Determining the greatest benefit to the Nation.* In determining the greatest benefit to the Nation, the values that should be weighed and receive serious attention when considering the economic, social, or ecological factors used in reducing MSY to obtain OY are:

(A) The benefits of food production are derived from providing seafood to consumers; maintaining an economically viable fishery together with its attendant contributions to the national, regional, and local economies; and utilizing the capacity of the Nation's fishery resources to meet nutritional needs.

(B) The benefits of recreational opportunities reflect the quality of both the recreational fishing experience and non-consumptive fishery uses such as ecotourism, fish watching, and recreational diving. Benefits also include the contribution of recreational fishing to the national, regional, and local economies and food supplies.

(C) The benefits of protection afforded to marine ecosystems are those resulting from maintaining viable populations (including those of unexploited species), maintaining adequate forage for all components of the ecosystem, maintaining evolutionary and ecological processes (e.g., disturbance regimes, hydrological processes, nutrient cycles), maintaining the evolutionary potential of species and ecosystems, and accommodating human use.

(iv) *Factors to consider in OY specification.* Because fisheries have limited capacities, any attempt to maximize the measures of benefits described in paragraph (e)(3)(iii) of this section will inevitably encounter practical constraints. OY cannot exceed MSY in any circumstance, and must take into account the need to prevent overfishing and rebuild overfished stocks and stock complexes. OY is prescribed on the basis of MSY as reduced by social, economic, and ecological factors. To the extent possible, the relevant social, economic, and ecological factors used to establish OY for a stock, stock complex, or fishery should be quantified and reviewed in historical, short-term, and long-term contexts. Even where quantification of social, economic, and ecological factors is not possible, the FMP still must address them in its OY specification. The following is a non-exhaustive list of potential considerations for each factor. An FMP must address each factor but not necessarily each example.

(A) *Social factors.* Examples are enjoyment gained from recreational fishing, avoidance of gear conflicts and resulting disputes, preservation of a way of life for fishermen and their families, and dependence of local communities on a fishery (e.g., involvement in fisheries and ability to adapt to change). Consideration may be given to fishery-related indicators (e.g., number of fishery permits, number of commercial fishing vessels, number of party and charter trips, landings, ex-vessel revenues etc.) and non-fishery related indicators (e.g., unemployment rates, percent of population below the poverty level, population density, etc.). Other factors that may be considered include the effects that past harvest levels have had on fishing communities, the cultural place of subsistence fishing, obligations under Indian treaties, proportions of affected minority and low-income groups, and worldwide nutritional needs.

(B) *Economic factors.* Examples are prudent consideration of the risk of overharvesting when a stock's size or reproductive potential is uncertain (*see* § 600.335(c)(2)(i)), satisfaction of consumer and recreational needs, and encouragement of domestic and export markets for U.S. harvested fish. Other factors that may be considered include: The value of fisheries, the level of capitalization, the decrease in cost per unit of catch afforded by an increase in stock size, the attendant increase in catch per unit of effort, alternate employment opportunities, and economic contribution to fishing communities, coastal areas, affected states, and the nation.

(C) *Ecological factors.* Examples include impacts on ecosystem component species, forage fish stocks, other fisheries, predator-prey or competitive interactions, marine mammals, threatened or endangered species, and birds. Species interactions that have not been explicitly taken into account when calculating MSY should be considered as relevant factors for setting OY below MSY. In addition, consideration should be given to managing forage stocks for higher biomass than Bmsy to enhance and protect the marine ecosystem. Also important are ecological or environmental conditions that stress marine organisms, such as natural and manmade changes in wetlands or nursery grounds, and effects of pollutants on habitat and stocks.

(v) *Specification of OY.* The specification of OY must be consistent with paragraphs (e)(3)(i)–(iv) of this section. If the estimates of MFMT and current biomass are known with a high level of certainty and management controls can accurately limit catch then OY could be set very close to MSY, assuming no other reductions are necessary for social, economic, or ecological factors. To the degree that such MSY estimates and management controls are lacking or unavailable, OY should be set farther from MSY. If management measures cannot adequately control fishing mortality so that the specified OY can be achieved without overfishing, the Council should reevaluate the management measures and specification of OY so that the dual requirements of NS1 (preventing overfishing while achieving, on a continuing basis, OY) are met.

(A) The amount of fish that constitutes the OY should be expressed in terms of numbers or weight of fish.

(B) Either a range or a single value may be specified for OY.

(C) All catch must be counted against OY, including that resulting from bycatch, scientific research, and all fishing activities.

(D) The OY specification should be translatable into an annual numerical estimate for the purposes of establishing any total allowable level of foreign fishing (TALFF) and analyzing impacts of the management regime.

(E) The determination of OY is based on MSY, directly or through proxy. However, even where sufficient scientific data as to the biological characteristics of the stock do not exist, or where the period of exploitation or investigation has not been long enough for adequate understanding of stock dynamics, or where frequent large-scale fluctuations in stock size diminish the meaningfulness of the MSY concept, OY must still be established based on the best scientific information available.

(F) An OY established at a fishery level may not exceed the sum of the MSY values for each of the stocks or stock complexes within the fishery.

(G) There should be a mechanism in the FMP for periodic reassessment of the OY specification, so that it is responsive to changing circumstances in the fishery.

(H) Part of the OY may be held as a reserve to allow for factors such as uncertainties in estimates of stock size and domestic annual harvest (DAH). If an OY reserve is established, an adequate mechanism should be included in the FMP to permit timely release of the reserve to domestic or foreign fishermen, if necessary.

(vi) *OY and foreign fishing.* Section 201(d) of the Magnuson-Stevens Act provides that fishing by foreign nations is limited to that portion of the OY that will not be harvested by vessels of the United States. The FMP must include an assessment to address the following, as required by section 303(a)(4) of the Magnuson-Stevens Act:

(A) *DAH.* Councils and/or the Secretary must consider the capacity of, and the extent to which, U.S. vessels will harvest the OY on an annual basis. Estimating the amount that U.S. fishing vessels will actually harvest is required to determine the surplus.

(B) *Domestic annual processing (DAP).* Each FMP must assess the capacity of U.S. processors. It must also assess the amount of DAP, which is the sum of two estimates: The estimated amount of U.S. harvest that domestic processors will process, which may be based on historical performance or on surveys of the expressed intention of manufacturers to process, supported by evidence of contracts, plant expansion, or other relevant information; and the estimated amount of fish that will be harvested by domestic vessels, but not processed (*e.g.*, marketed as fresh whole fish, used for private consumption, or used for bait).

(C) *Joint venture processing (JVP).* When DAH exceeds DAP, the surplus is available for JVP.

(f) *Acceptable biological catch, annual catch limits, and annual catch targets.* The following features (see paragraphs (f)(1) through (f)(5) of this section) of acceptable biological catch and annual catch limits apply to stocks and stock complexes in the fishery (see paragraph (d)(2) of this section).

(1) *Introduction.* A control rule is a policy for establishing a limit or target fishing level that is based on the best available scientific information and is established by fishery managers in consultation with fisheries scientists. Control rules should be designed so that management actions become more conservative as biomass estimates, or other proxies, for a stock or stock complex decline and as science and management uncertainty increases. Examples of scientific uncertainty include uncertainty in the estimates of MFMT and biomass. Management uncertainty may include late catch reporting, misreporting, and underreporting of catches and is affected by a fishery’s ability to control actual catch. For example, a fishery that has inseason catch data available and inseason closure authority has better management control and precision than a fishery that does not have these features.

(2) *Definitions.*

(i) *Catch* is the total quantity of fish, measured in weight or numbers of fish, taken in commercial, recreational, subsistence, tribal, and other fisheries. Catch includes fish that are retained for any purpose, as well as mortality of fish that are discarded.

(ii) *Acceptable biological catch (ABC)* is a level of a stock or stock complex’s annual catch that accounts for the scientific uncertainty in the estimate of OFL and any other scientific uncertainty (see paragraph (f)(3) of this section), and should be specified based on the ABC control rule.

(iii) *ABC control rule* means a specified approach to setting the ABC for a stock or stock complex as a function of the scientific uncertainty in the estimate of OFL and any other scientific uncertainty (*see* paragraph (f)(4) of this section).

(iv) *Annual catch limit (ACL)* is the level of annual catch of a stock or stock complex that serves as the basis for invoking AMs. ACL cannot exceed the ABC, but may be divided into sector-ACLs (*see* paragraph (f)(5) of this section).

(v) *Annual catch target (ACT)* is an amount of annual catch of a stock or stock complex that is the management target of the fishery, and accounts for management uncertainty in controlling the actual catch at or below the ACL. ACTs are recommended in the system of accountability measures so that ACL is not exceeded.

(vi) *ACT control rule* means a specified approach to setting the ACT for a stock or stock complex such that the risk of exceeding the ACL due to management uncertainty is at an acceptably low level.

(3) *Specification of ABC.* ABC may not exceed OFL (see paragraph (e)(2)(i)(D) of this section). Councils should develop a process for receiving scientific information and advice used to establish ABC. This process should: Identify the body that will apply the ABC control rule (*i.e.* , calculates the ABC), and identify the review process that will evaluate the resulting ABC. The SSC must recommend the ABC to the Council. An SSC may recommend an ABC that differs from the result of the ABC control rule calculation, based on factors such as data uncertainty, recruitment variability, declining trends in population variables, and other factors, but must explain why. For Secretarial FMPs or FMP amendments, agency scientists or a peer review process would provide the scientific advice to establish ABC. For internationally-assessed stocks, an ABC as defined in these guidelines is not required if they meet the international exception (*see* paragraph (h)(2)(ii)). While the ABC is allowed to equal OFL, NMFS expects that in most cases ABC will be reduced from OFL to reduce the probability that overfishing might occur in a year. Also, *see* paragraph (f)(5) of this section for cases where a Council recommends that ACL is equal to ABC, and ABC is equal to OFL.

(i) *Expression of ABC.* ABC should be expressed in terms of catch, but may be expressed in terms of landings as long as estimates of bycatch and any other fishing mortality not accounted for in the landings are incorporated into the determination of ABC.

(ii) *ABC for overfished stocks.* For overfished stocks and stock complexes, a rebuilding ABC must be set to reflect the annual catch that is consistent with the schedule of fishing mortality rates in the rebuilding plan.

(4) *ABC control rule.* For stocks and stock complexes required to have an ABC, each Council must establish an ABC control rule based on scientific advice from its SSC. The determination of ABC should be based, when possible, on the probability that an actual catch equal to the stock's ABC would result in overfishing. This probability that overfishing will occur cannot exceed 50 percent and should be a lower value. The ABC control rule should consider reducing fishing mortality as stock size declines and may establish a stock abundance level below which fishing would not be allowed. The process of establishing an ABC control rule could also involve science advisors or the peer review process established under Magnuson-Stevens Act section 302(g)(1)(E). The ABC control rule must articulate how ABC will be set compared to the OFL based on the scientific knowledge about the stock or stock complex and the scientific uncertainty in the estimate of OFL and any other scientific uncertainty. The ABC control rule should consider uncertainty in factors such as stock assessment results, time lags in updating assessments, the degree of retrospective revision of assessment results, and projections. The control rule may be used in a tiered approach to address different levels of scientific uncertainty.

(5) *Setting the annual catch limit*

(i) *General.* ACL cannot exceed the ABC and may be set annually or on a multiyear plan basis. ACLs in coordination with AMs must prevent overfishing (see MSA section 303(a)(15)). If a Council recommends an ACL which equals ABC, and the ABC is equal to OFL, the Secretary may presume that the proposal would not prevent overfishing, in the absence of sufficient analysis and justification for the approach. A ''multiyear plan'' as referenced in section 303(a)(15) of the Magnuson-Stevens Act is a plan that establishes harvest specifications or harvest guidelines for each year of a time period greater than 1 year. A multiyear plan must include a mechanism for specifying ACLs for each year with appropriate AMs to prevent overfishing and maintain an appropriate rate of rebuilding if the stock or stock complex is in a rebuilding plan. A multiyear plan must provide that, if an ACL is exceeded for a year, then AMs are triggered for the next year consistent with paragraph (g)(3) of this section.

(ii) *Sector-ACLs.* A Council may, but is not required to, divide an ACL into sector-ACLs. ''Sector,'' for purposes of this section, means a distinct user group to which separate management strategies and separate catch quotas apply. Examples of sectors include the commercial sector, recreational sector, or various gear groups within a fishery. If the management measures for different sectors differ in the degree of management uncertainty, then sector ACLs may be necessary so that appropriate AMs can be developed for each sector. If a Council chooses to use sector ACLs, the sum of sector ACLs must not exceed the stock or stock complex level ACL. The system of ACLs and AMs designed must be effective in protecting the stock or stock complex as a whole. Even if sector-ACLs and AMs are established, additional AMs at the stock or stock complex level may be necessary.

(iii) *ACLs for State-Federal Fisheries.* For stocks or stock complexes that have harvest in state or territorial waters, FMPs and FMP amendments should include an ACL for the overall stock that may be further divided. For example, the overall ACL could be divided into a Federal-ACL and state-ACL. However, NMFS recognizes that Federal management is limited to the portion of the fishery under Federal authority (*see* paragraph (g)(5) of this section). When stocks are co-managed by Federal, state, tribal, and/or territorial fishery managers, the goal should be to develop collaborative conservation and management strategies, and scientific capacity to support such strategies (including AMs for state or territorial and Federal waters), to prevent overfishing of shared stocks and ensure their sustainability.

(6) *ACT control rule.* If ACT is specified as part of the AMs for a fishery, an ACT control rule is utilized for setting the ACT. The ACT control rule should clearly articulate how management uncertainty in the amount of catch in the fishery is accounted for in setting ACT. The objective for establishing the ACT and related AMs is that the ACL not be exceeded.

(i) *Determining management uncertainty.* Two sources of management uncertainty should be accounted for in establishing the AMs for a fishery, including the ACT control rule if utilized: Uncertainty in the ability of managers to constrain catch so the ACL is not exceeded, and uncertainty in quantifying the true catch amounts (*i.e.,* estimation errors). To determine the level of management uncertainty in controlling catch, analyses need to consider past management performance in the fishery and factors such as time lags in reported catch. Such analyses must be based on the best available scientific information from an SSC, agency scientists, or peer review process as appropriate.

(ii) *Establishing tiers and corresponding ACT control rules.* Tiers can be established based on levels of management uncertainty associated with the fishery, frequency and accuracy of catch monitoring data available, and risks of exceeding the limit. An ACT control rule could be established for each tier and have, as appropriate, different formulas and standards used to establish the ACT.

(7) A Council may choose to use a single control rule that combines both scientific and management uncertainty and supports the ABC recommendation and establishment of ACL and if used ACT.

(g) *Accountability measures.* The following features (see paragraphs (g)(1) through (5) of this section) of accountability measures apply to those stocks and stock complexes in the fishery.

(1) *Introduction*. AMs are management controls to prevent ACLs, including sector-ACLs, from being exceeded, and to correct or mitigate overages of the ACL if they occur. AMs should address and minimize both the frequency and magnitude of overages and correct the problems that caused the overage in as short a time as possible. NMFS identifies two categories of AMs, inseason AMs and AMs for when the ACL is exceeded.

(2) *Inseason AMs*. Whenever possible, FMPs should include inseason monitoring and management measures to prevent catch from exceeding ACLs. Inseason AMs could include, but are not limited to: ACT; closure of a fishery; closure of specific areas; changes in gear; changes in trip size or bag limits; reductions in effort; or other appropriate management controls for the fishery. If final data or data components of catch are delayed, Councils should make appropriate use of preliminary data, such as landed catch, in implementing inseason AMs. FMPs should contain inseason closure authority giving NMFS the ability to close fisheries if it determines, based on data that it deems sufficiently reliable, that an ACL has been exceeded or is projected to be reached, and that closure of the fishery is necessary to prevent overfishing. For fisheries without inseason management control to prevent the ACL from being exceeded, AMs should utilize ACTs that are set below ACLs so that catches do not exceed the ACL.

(3) *AMs for when the ACL is exceeded*. On an annual basis, the Council must determine as soon as possible after the fishing year if an ACL was exceeded. If an ACL was exceeded, AMs must be triggered and implemented as soon as possible to correct the operational issue that caused the ACL overage, as well as any biological consequences to the stock or stock complex resulting from the overage when it is known. These AMs could include, among other things, modifications of inseason AMs or overage adjustments. For stocks and stock complexes in rebuilding plans, the AMs should include overage adjustments that reduce the ACLs in the next fishing year by the full amount of the overages, unless the best scientific information available shows that a reduced overage adjustment, or no adjustment, is needed to mitigate the effects of the overages. If catch exceeds the ACL for a given stock or stock complex more than once in the last four years, the system of ACLs and AMs should be re-evaluated, and modified if necessary, to improve its performance and effectiveness. A Council could choose a higher performance standard (e.g., a stock's catch should not exceed its ACL more often than once every five or six years) for a stock that is particularly vulnerable to the effects of overfishing, if the vulnerability of the stock has not already been accounted for in the ABC control rule.

(4) *AMs based on multi-year average data*. Some fisheries have highly variable annual catches and lack reliable inseason or annual data on which to base AMs. If there are insufficient data upon which to compare catch to ACL, either inseason or on an annual basis, AMs could be based on comparisons of average catch to average ACL over a three-year moving average period or, if supported by analysis, some other appropriate multi-year period. Councils should explain why basing AMs on a multi-year period is appropriate. Evaluation of the moving average catch to the average ACL must be conducted annually and AMs should be implemented if the average catch exceeds the average ACL. As a performance standard, if the average catch exceeds the average ACL for a stock or stock complex more than once in the last four years, then the system of ACLs and AMs should be re-evaluated and modified if necessary to improve its performance and effectiveness. The initial ACL and management measures may incorporate information from previous years so that AMs based on average ACLs can be applied from the first year. Alternatively, a Council could use a stepped approach where in year-1, catch is compared to the ACL for year-1; in year-2 the average catch for the past 2 years is compared to the average ACL; then in year 3 and beyond, the most recent 3 years of catch are compared to the corresponding ACLs for those years.

(5) *AMs for State-Federal Fisheries*. For stocks or stock complexes that have harvest in state or territorial waters, FMPs and FMP amendments must, at a minimum, have AMs for the portion of the fishery under Federal authority. Such AMs could include closing the EEZ when the Federal portion of the ACL is reached, or the overall stock's ACL is reached, or other measures.

(h) *Establishing ACL mechanisms and AMs in FMPs*. FMPs or FMP amendments must establish ACL mechanisms and AMs for all stocks and stock complexes in the fishery, unless paragraph (h)(2) of this section is applicable. These mechanisms should describe the annual or multiyear process by which specific ACLs, AMs, and other reference points such as OFL, and ABC will be established. If a complex has multiple indicator stocks, each indicator stock must have its own ACL; an additional ACL for the stock complex as a whole is optional. In cases where fisheries (e.g., Pacific salmon) harvest multiple indicator stocks of a single species that cannot be distinguished at the time of capture, separate ACLs for the indicator stocks are not required and the ACL can be established for the complex as a whole.

(1) In establishing ACL mechanisms and AMs, FMPs should describe:

(i) Timeframes for setting ACLs (e.g., annually or multi-year periods);

(ii) Sector-ACLs, if any (including set-asides for research or bycatch);

(iii) AMs and how AMs are triggered and what sources of data will be used (e.g., inseason data, annual catch compared to the ACL, or multi-year averaging approach); and

(iv) Sector-AMs, if there are sector-ACLs.

(2) *Exceptions from ACL and AM requirements*

(i) *Life cycle*. Section 303(a)(15) of the Magnuson-Stevens Act ''shall not apply to a fishery for species that has a life cycle of approximately 1 year unless the Secretary has determined the fishery is subject to overfishing of that species'' (as described in Magnuson-Stevens Act section 303 note). This exception applies to a stock for which the average length of time it takes for an individual to produce a reproductively active offspring is approximately 1 year and that the individual has only one breeding season in its lifetime. While exempt from the ACL and AM requirements, FMPs or FMP amendments for these stocks must have SDC, MSY, OY, ABC, and an ABC control rule.

(ii) *International fishery agreements*. Section 303(a)(15) of the Magnuson-Stevens Act applies ''unless otherwise provided for under an international agreement in which the United States participates'' (Magnuson-Stevens Act section 303 note). This exception applies to stocks or stock complexes subject to management under an international agreement, which is defined as ‘‘any bilateral or multilateral treaty, convention, or agreement which relates to fishing and to which the United States is a party’’ (see Magnuson-Stevens Act section 3(24)). These stocks would still need to have SDC and MSY.

(3) *Flexibility in application of NS1 guidelines*. There are limited circumstances that may not fit the standard approaches to specification of reference points and management measures set forth in these guidelines. These include, among other things, conservation and management of Endangered Species Act listed species, harvests from aquaculture operations, and stocks with unusual life history characteristics (e.g., Pacific salmon, where the spawning potential for a stock is spread over a multi-year period). In these circumstances, Councils may propose alternative approaches for satisfying the NS1 requirements of the Magnuson-Stevens Act than those set forth in these guidelines. Councils must document their rationale for any alternative approaches for these limited circumstances in an FMP or FMP amendment, which will be reviewed for consistency with the Magnuson-Stevens Act.

(i) *Fisheries data*. In their FMPs, or associated public documents such as SAFE reports as appropriate, Councils must describe general data collection methods, as well as any specific data collection methods used for all stocks in the fishery, and EC species, including:

(1) Sources of fishing mortality (both landed and discarded), including commercial and recreational catch and bycatch in other fisheries;

(2) Description of the data collection and estimation methods used to quantify total catch mortality in each fishery, including information on the management tools used (i.e., logbooks, vessel monitoring systems, observer programs, landings reports, fish tickets, processor reports, dealer reports, recreational angler surveys, or other methods); the frequency with which data are collected and updated; and the scope of sampling coverage for each fishery; and

(3) Description of the methods used to compile catch data from various catch data collection methods and how those data are used to determine the relationship between total catch at a given point in time and the ACL for stocks and stock complexes that are part of a fishery.

(j) *Council actions to address overfishing and rebuilding for stocks and stock complexes in the fishery*

(1) *Notification*. The Secretary will immediately notify in writing a Regional Fishery Management Council whenever it is determined that:

(i) Overfishing is occurring;

(ii) A stock or stock complex is overfished;

(iii) A stock or stock complex is approaching an overfished condition; or

(iv) Existing remedial action taken for the purpose of ending previously identified overfishing or rebuilding a previously identified overfished stock or stock complex has not resulted in adequate progress.

(2) *Timing of actions*

(i) *If a stock or stock complex is undergoing overfishing*. FMPs or FMP amendments must establish ACL and AM mechanisms in 2010, for stocks and stock complexes determined to be subject to overfishing, and in 2011, for all other stocks and stock complexes (*see* paragraph (b)(2)(iii) of this section). To address practical implementation aspects of the FMP and FMP amendment process, paragraphs (j)(2)(i)(A) through (C) of this section clarifies the expected timing of actions.

(A) In addition to establishing ACL and AM mechanisms, the ACLs and AMs themselves must be specified in FMPs, FMP amendments, implementing regulations, or annual specifications beginning in 2010 or 2011, as appropriate.

(B) For stocks and stock complexes still determined to be subject to overfishing at the end of 2008, ACL and AM mechanisms and the ACLs and AMs themselves must be effective in fishing year 2010.

(C) For stocks and stock complexes determined to be subject to overfishing during 2009, ACL and AM mechanisms and ACLs and AMs themselves should be effective in fishing year 2010, if possible, or in fishing year 2011, at the latest.

(ii) *If a stock or stock complex is overfished or approaching an overfished condition*.

(A) For notifications that a stock or stock complex is overfished or approaching an overfished condition made before July 12, 2009, a Council must prepare an FMP, FMP amendment, or proposed regulations within one year of notification. If the stock or stock complex is overfished, the purpose of the action is to specify a time period for ending overfishing and rebuilding the stock or stock complex that will be as short as possible as described under section 304(e)(4) of the Magnuson-Stevens Act. If the stock or stock complex is approaching an overfished condition, the purpose of the action is to prevent the biomass from declining below the MSST.

(B) For notifications that a stock or stock complex is overfished or approaching an overfished condition made after July 12, 2009, a Council must prepare and implement an FMP, FMP amendment, or proposed regulations within two years of notification, consistent with the requirements of section 304(e)(3) of the Magnuson-Stevens Act. Council actions should be submitted to NMFS within 15 months of notification to ensure sufficient time for the Secretary to implement the measures, if approved. If the stock or stock complex is overfished and overfishing is occurring, the rebuilding plan must end overfishing immediately and be consistent with ACL and AM requirements of the Magnuson-Stevens Act.

(3) *Overfished fishery*.

(i) Where a stock or stock complex is overfished, a Council must specify a time period for rebuilding the stock or stock complex based on factors specified in Magnuson-Stevens Act section 304(e)(4). This target time for rebuilding (Ttarget) shall be as short as possible, taking into account: The status and biology of any overfished stock, the needs of fishing communities, recommendations by international organizations in which the U.S. participates, and interaction of the stock within the marine ecosystem. In addition, the time period shall not exceed 10 years, except where biology of the stock, other environmental conditions, or management measures under an international agreement to which the U.S. participates, dictate otherwise. SSCs (or agency scientists or peer review processes in the case of Secretarial actions) shall provide recommendations for achieving rebuilding targets (*see* Magnuson-Stevens Act section 302(g)(1)(B)). The above factors enter into the specification of Ttarget as follows:

(A) The ''minimum time for rebuilding a stock'' (Tmin) means the amount of time the stock or stock complex is expected to take to rebuild to its MSY biomass level in the absence of any fishing mortality. In this context, the term ''expected'' means to have at least a 50 percent probability of attaining the Bmsy.

(B) For scenarios under paragraph (j)(2)(ii)(A) of this section, the starting year for the Tmin calculation is the first year that a rebuilding plan is implemented. For scenarios under paragraph (j)(2)(ii)(B) of this section, the starting year for the Tmin calculation is 2 years after notification that a stock or stock complex is overfished or the first year that a rebuilding plan is implemented, whichever is sooner.

(C) If Tmin for the stock or stock complex is 10 years or less, then the maximum time allowable for rebuilding (Tmax) that stock to its Bmsy is 10 years.

(D) If Tmin for the stock or stock complex exceeds 10 years, then the maximum time allowable for rebuilding a stock or stock complex to its Bmsy is Tmin plus the length of time associated with one generation time for that stock or stock complex. ''Generation time'' is the average length of time between when an individual is born and the birth of its offspring.

(E) Ttarget shall not exceed Tmax, and should be calculated based on the factors described in this paragraph (j)(3).

(ii) If a stock or stock complex reached the end of its rebuilding plan period and has not yet been determined to be rebuilt, then the rebuilding F should not be increased until the stock or stock complex has been demonstrated to be rebuilt. If the rebuilding plan was based on a Ttarget that was less than Tmax, and the stock or stock complex is not rebuilt by Ttarget, rebuilding measures should be revised, if necessary, such that the stock or stock complex will be rebuilt by Tmax. If the stock or stock complex has not rebuilt by Tmax, then the fishing mortality rate should be maintained at Frebuild or 75 percent of the MFMT, whichever is less.

(iii) Council action addressing an overfished fishery must allocate both overfishing restrictions and recovery benefits fairly and equitably among sectors of the fishery.

(iv) For fisheries managed under an international agreement, Council action addressing an overfished fishery must reflect traditional participation in the fishery, relative to other nations, by fishermen of the United States.

(4) *Emergency actions and interim measures.* The Secretary, on his/her own initiative or in response to a Council request, may implement interim measures to reduce overfishing or promulgate regulations to address an emergency (Magnuson-Stevens Act section 304(e)(6) or 305(c)). In considering a Council request for action, the Secretary would consider, among other things, the need for and urgency of the action and public interest considerations, such as benefits to the stock or stock complex and impacts on participants in the fishery.

(i) These measures may remain in effect for not more than 180 days, but may be extended for an additional 186 days if the public has had an opportunity to comment on the measures and, in the case of Council-recommended measures, the Council is actively preparing an FMP, FMP amendment, or proposed regulations to address the emergency or overfishing on a permanent basis.

(ii) Often, these measures need to be implemented without prior notice and an opportunity for public comment, as it would be impracticable to provide for such processes given the need to act quickly and also contrary to the public interest to delay action. However, emergency regulations and interim measures that do not qualify for waivers or exceptions under the Administrative Procedure Act would need to follow proposed notice and comment rulemaking procedures.

(k) *International overfishing.* If the Secretary determines that a fishery is overfished or approaching a condition of being overfished due to excessive international fishing pressure, and for which there are no management measures (or no effective measures) to end overfishing under an international agreement to which the United States is a party, then the Secretary and/or the appropriate Council shall take certain actions as provided under Magnuson-Stevens Act section 304(i). The Secretary, in cooperation with the Secretary of State, must immediately take appropriate action at the international level to end the overfishing. In addition, within one year after the determination, the Secretary and/or appropriate Council shall:

(1) Develop recommendations for domestic regulations to address the relative impact of the U.S. fishing vessels on the stock. Council recommendations should be submitted to the Secretary.

(2) Develop and submit recommendations to the Secretary of State, and to the Congress, for international actions that will end overfishing in the fishery and rebuild the affected stocks, taking into account the relative impact of vessels of other nations and vessels of the United States on the relevant stock. Councils should, in consultation with the Secretary, develop recommendations that take into consideration relevant provisions of the Magnuson-Stevens Act and NS1 guidelines, including section 304(e) of the Magnuson-Stevens Act and paragraph (j)(3)(iv) of this section, and other applicable laws. For highly migratory species in the Pacific, recommendations from the Western Pacific, North Pacific, or Pacific Councils must be developed and submitted consistent with Magnuson-Stevens Reauthorization Act section 503(f), as appropriate.

(3) *Considerations for assessing ''relative impact.''* ''Relative impact'' under paragraphs (k)(1) and (2) of this section may include consideration of factors that include, but are not limited to: Domestic and international management measures already in place, management history of a given nation, estimates of a nation's landings or catch (including bycatch) in a given fishery, and estimates of a nation's mortality contributions in a given fishery. Information used to determine relative impact must be based upon the best available scientific information.

(l) *Relationship of National Standard 1 to other national standards—General.* National Standards 2 through 10 provide further requirements for conservation and management measures in FMPs, but do not alter the requirement of NS1 to prevent overfishing and rebuild overfished stocks.

(1) *National Standard 2 (see § 600.315).* Management measures and reference points to implement NS1 must be based on the best scientific information available. When data are insufficient to estimate reference points directly, Councils should develop reasonable proxies to the extent possible (*also see* paragraph (e)(1)(iv) of this section). In cases where scientific data are severely limited, effort should also be directed to identifying and gathering the needed data. SSCs should advise their Councils regarding the best scientific information available for fishery management decisions.

(2) *National Standard 3 (see § 600.320).* Reference points should generally be specified in terms of the level of stock aggregation for which the best scientific information is available (*also see* paragraph (e)(1)(iii) of this section). Also, scientific assessments must be based on the best information about the total range of the stock and potential biological structuring of the stock into biological sub-units, which may differ from the geographic units on which management is feasible.

(3) *National Standard 6 (see § 600.335).* Councils must build into the reference points and control rules appropriate consideration of risk, taking into account uncertainties in estimating harvest, stock conditions, life history parameters, or the effects of environmental factors.

(4) *National Standard 8 (see § 600.345).* National Standard 8 directs the Councils to apply economic and social factors towards sustained participation of fishing communities and to the extent practicable, minimize adverse economic impacts on such communities within the context of preventing overfishing and rebuilding overfished stocks as required under National Standard 1. Therefore, calculation of OY as reduced from MSY should include economic and social factors, but the combination of management measures chosen to achieve the OY must principally be designed to prevent overfishing and rebuild overfished stocks.

(5) *National Standard 9 (see § 600.350).* Evaluation of stock status with respect to reference points must take into account mortality caused by bycatch. In addition, the estimation of catch should include the mortality of fish that are discarded.

(m) *Exceptions to requirements to prevent overfishing.* Exceptions to the requirement to prevent overfishing could apply under certain limited circumstances. Harvesting one stock at its optimum level may result in overfishing of another stock when the two stocks tend to be caught together (This can occur when the two stocks are part of the same fishery or if one is bycatch in the other's fishery). Before a Council may decide to allow this type of overfishing, an analysis must be performed and the analysis must contain a justification in terms of overall benefits, including a comparison of benefits under alternative management measures, and an analysis of the risk of any stock or stock complex falling below its MSST. The Council may decide to allow this type of overfishing if the fishery is not overfished and the analysis demonstrates that all of the following conditions are satisfied:

(1) Such action will result in long-term net benefits to the Nation;

(2) Mitigating measures have been considered and it has been demonstrated that a similar level of long-term net benefits cannot be achieved by modifying fleet behavior, gear selection/configuration, or other technical characteristic in a manner such that no overfishing would occur; and

(3) The resulting rate of fishing mortality will not cause any stock or stock complex to fall below its MSST more than 50 percent of the time in the long term, although it is recognized that persistent overfishing is expected to cause the affected stock to fall below its Bmsy more than 50 percent of the time in the long term.

[FR Doc. E9–636 Filed 1–15–09; 8:45 am]
BILLING CODE 3510–22–P

Agenda Item C.2.b
SAC Report
September 2010

DRAFT ENVIRONMENTAL ASSESSMENT
FOR
PACIFIC COAST SALMON PLAN AMENDMENT 16: CLASSIFYING STOCKS, REVISING STATUS DETERMINATION CRITERIA, ESTABLISHING ANNUAL CATCH LIMITS AND ACCOUNTABILITY MEASURES, AND DE MINIMIS FISHING PROVISIONS

PREPARED BY
THE AD HOC SALMON AMENDMENT COMMITTEE

AUGUST 2010

Table of Contents

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

Table of Contents (continued)

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

List of Tables

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

List of Figures

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

List of Acronyms

ABC	acceptable biological catch
ACL	annual catch limit
AEQ	adult equivalent (exploitation rate [ER])
AM	accountability measure
ACT	annual catch target
C	catch (based reference points)
CA ESA	California (salmon stocks listed under the) Endangered Species Act
CAN	Canadian (coho, Chinook, or pink salmon)
CA/S OR C	California/Southern Oregon Coast (Chinook)
CFR	Code of Federal Regulations
CR ESA	Columbia River (salmon stocks listed under the) Endangered Species Act
CR F	Columbia River fall (upper river bright Chinook)
CR S	Columbia River summer (Chinook)
CVF	Central Valley fall (Chinook complex)
EA	Environmental Assessment
EC	Ecosystem Component
EFH	Essential Fish Habitat
ER	exploitation rate
ESU	evolutionarily significant unit
F	fishing mortality rate (instantaneous)
FMP	Fisheries Management Plan
FNM	far-north migrating
FNMSS	far-north migrating spring/summer (Chinook complex)
FONSI	Finding Of No Significant Impacts
GM	geometric mean
HAT	Hatchery (origin salmon stocks)
HC	Habitat Committee
IRFA	Initial Regulatory Flexibility Analysis
KOHM	Klamath Ocean Harvest Model
KRFC	Klamath River fall Chinook
MSA	Magnuson Stevens Act
MFMT	maximum fishery mortality threshold
MSST	minimum stock size threshold
MSY	maximum sustainable yield
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NS1Gs	National Standard 1 Guidelines
ODFW	Oregon Department of Fish and Wildlife
OFL	overfishing limit
OR C	Oregon Coast
OY	optimum yield
PFMC	Pacific Fishery Management Council (Council)
PS	Puget Sound
PS ESA	Puget Sound (salmon stocks listed under the) Endangered Species Act
PST	Pacific Salmon Treaty
RIR	Regulatory Impact Review

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

List of Acronyms (continued)

S	spawning escapement
SAC	(Ad Hoc) Salmon Amendment Committee
SAS	Salmon Advisory Subpanel
SDC	status determination criteria
SHM	Sacramento Harvest Model
SI	Sacramento Index (of abundance)
SONC	Southern Oregon-Northern California (Chinook Complex)
SONCC	Southern Oregon-Northern California Coastal (coho ESU)
SRFC	Sacramento River fall Chinook
SSC	Scientific and Statistical Committee
STT	Salmon Technical Team
VEWG	Vulnerability Evaluation Work Group
WA C	Washington Coast (coho)
WA/CR Sp/S	Washington/Oregon spring/summer (Chinook)
WA/OR S/F	Washington/Oregon summer/fall (Chinook)

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

EXECUTIVE SUMMARY

Table ES-1. Alternatives for stock classification, stock complexes, and application of the international exception for specifying annual catch limit and accountability measures.

Classification	Stock Category	Alternative 1: Status Quo	Alternative 2	Alternative 3
In the Fishery	Individual Stocks	45 Chinook stocks, 21 coho stocks, and 2 pink stocks currently identified in Table 3-1 of the FMP	46 Chinook stocks, 21 coho stocks, and 2 pink stocks separating Smith River Chinook from Eel, Mattole, Mad Rivers (California Coastal ESU	32 Chinook stocks, 21 coho stocks, and 2 pink stocks: separating Smith River Chinook from Eel, Mattole, Mad Rivers (California Coastal ESU)
	Stock Complexes	7 Chinook and 4 coho complexes currently identified in Table 3-1 of the FMP	3 Chinook complexes: • Central Valley Fall • Southern Oregon/Northern California • Far North Migrating Spring/Summer	2 Chinook complexes: • Central Valley Fall • Southern Oregon/Northern California
	ESA Listed	9 Chinook and 4 coho ESUs currently identified in Table 3-1 of the FMP	9 Chinook and 4 coho ESUs currently identified in Table 3-1 of the FMP	9 Chinook and 4 coho ESUs currently identified in Table 3-1 of the FMP
	Hatchery Stocks	5 Chinook and 6 coho stocks currently identified in Table 3-1 of the FMP	5 Chinook and 6 coho stocks currently identified in Table 3-1 of the FMP	5 Chinook and 6 coho stocks currently identified in Table 3-1 of the FMP
	Exploitation Rate Exceptions	14 Chinook stocks (not ESA listed or hatchery) currently identified in Table 3-1 of the FMP	NA	NA
	International Exceptions to ACLs and AMs	NA	14 Chinook and 11 coho stocks (not ESA listed or hatchery) identified in the Pacific Salmon Treaty	1 Chinook and 11 coho stocks (not ESA listed or hatchery) identified in the Pacific Salmon Treaty
Not In The Fishery	Ecosystem Component Stocks	NA	None	14 Chinook stocks (FNM) and 2 pink stocks (not ESA listed or hatchery)

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

Table ES-2: Overview of SDC alternatives for overfishing, overfished, approaching overfished, and rebuilt (S ≡ Spawning Escapement; C ≡ catch; t ≡ year; GM ≡ Geometric mean)

Status Category	Alternative 1: Status Quo Determination Based on Three Consecutive Years: MSST = S_{MSY}	Alternative 2 Determination Based on a Single Year: MSST = 0.5*S_{MSY}	Alternative 3 Determination Based on 3-Year Geometric Mean: MSST = 0.5*S_{MSY}	Alternative 4 Determination Based on a Single Year: MSST = 0.75*S_{MSY}	Alternative 5 Determination Based on 3-Year Geometric Mean: MSST = 0.75*S_{MSY}
Overfishing	S(t,t-1,t-2)<MSST and C(t,t-1,t-2) > MSST-S(t,t-I,t-2) i.e. fishing contributed to triggering Overfishing Concern	F > MFMT in one year, with MFMT = F_{MSY}. F used is most recently available postseason value.	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
Overfished	S(t,t-1,t-2)<MSST Current NMFS interpretation of Overfishing Concern as defined in FMP.	S < MSST in one year, with MSST = 0.5*S_{MSY}. S used is most recently available postseason value.	GM(S) < MSST over three year period, with MSST = 0.5*S_{MSY}. S used are 3 most recently available postseason values.	S < MSST in one year, with MSST = 0.75*S_{MSY}. S used is most recently available postseason value.	GM(S) < MSST over three year period, with MSST = 0.75*S_{MSY}. S used are 3 most recently available postseason values.
Approaching overfished	S(t-1,t-2)<MSST and S(t) forecast < MSST	S < MSST in one year, with MSST = 0.5*S_{MSY}. S used is current preseason forecast.	GM(S) < MSST over three year period, with MSST = 0.5*S_{MSY}. S used are 2 most recently available postseason values and current preseason forecast.	S < MSST in one year, with MSST = 0.75*S_{MSY}. S used is current preseason forecast.	GM(S) < MSST over three year period, with MSST = 0.75*S_{MSY}. S used are 2 most recently available postseason values and current preseason forecast.
Rebuilt	S > S_{MSY} in one year or as otherwise determined in rebuilding plan. S used is most recently available postseason value.	S ≥ S_{MSY} in one year. S used is most recently available postseason value.	GM(S) ≥ S_{MSY} over three year period. S used are 3 most recently available postseason values.	Same as Alternative 2	Same as Alternative 3

The status categories for overfished, approaching overfished, and rebuilt within each alternative should be considered together, given the need to have comparable metrics among these abundance-based SDC.

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

Table ES-3. Status determination criteria reference points, assumptions and issues for coho stocks.

Coho Stock	S_{MSY} Est	S_{MSY} Basis	MFMT (F_{MSY}) Est	MFMT (F_{MSY}) Basis	MSST Alt 1 Status Quo Cons Obj	MSST Alt 2 & 3 $0.5*S_{MSY}$	MSST Alt 4 & 5 $0.75*S_{MSY}$	Assumptions/Issues
CCC – ESA Endangered	Unk	NA	Unk	NA	0.0 HR in CA ESA BO	Unk	Unk	While these stocks remain listed and managed under the ESA, MSA SDC are not applicable and remain undefined. If a stock becomes de-listed, MSA SDC will be defined as possible.
SONCC – ESA Threatened	Unk	NA	Unk	NA	0.13 Ocean ER ESA BO	Unk	Unk	
OCN – ESA Threatened	Unk	NA	Unk	NA	0.08-0.45 ER ESA BO	Unk	Unk	
LRN – ESA Threatened	Unk	NA	Unk	NA	Council & MS CR ER ESA BO	Unk	Unk	
Columbia River Late - Hatchery	14,100	TAC	<1.0	ER		NA	NA	Hatchery egg take goals satisfy SDC (pursuant to NS1Gs' flexibility provision)
Columbia River Early - Hatchery	7,100	TAC	<1.0	ER	7,100	NA	NA	
Willapa Bay - Hatchery	6,100	WDFW	<1.0	ER	6,100	NA	NA	
Quinault - Hatchery	??	QIN?	<1.0	ER	??	NA	NA	
Quillayute Summer - Hatchery	300	WDFW	<1.0	ER	300	NA	NA	
S. Puget Sound - Hatchery	52,000	WDFW	<1.0	ER	52,000	NA	NA	
Grays Harbor	24,426	S_{MSP} (FMP) $*F_{SMY}$ (App C	0.69	App C	35,400	12,213	18,320	App E Est's need review.
Queets	5,500 10,150 5,800	App E Mid Pt Low	0.68	App C	5,800-14,500	5,075	7,163	App E Est's need review. Need to decide if S_{MSY} (App E), lower or mid-point of FMP range used to calculate MSST: Assume midpoint for now, used in PST.
Hoh	2,250 3,500 2,000	App E Mid Pt Low	0.69	App C	2,000-5,000	1,750	2,625	
Quillayute Fall	5,873 11,050 6,300	App E Mid Pt Low	0.59	App C	6,300-15,800	5,525	8,826	
Strait of JdF	10,978	FMP	0.60	FMP	7,007	5,489	8,234	Need to decide if S_{MSY} (FMP), low/critical abundance breakpoint, or App E used to calculate MSST. Assume S_{MSY} (FMP)
Hood Canal	14,350	FMP	0.65	FMP	10,750	7,175	10,762	
Skagit	25,000	FMP	0.60	FMP	14,875	12,500	18,750	
Stillaguamish	10,000	FMP	0.50	FMP	6,100	5,000	7,500	
Snohomish	50,000	FMP	0.60	FMP	31,000	25,000	37,500	
Coastal Stocks	UnDef	FMP	UnDef	FMP	UnDef	NA	NA	Canadian manages stock components
Fraser River	UnDef	FMP	UnDef	FMP	UnDef	NA	NA	

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

Table ES 4. Status determination criteria reference points, assumptions and issues for Chinook stocks. Sp/Su = Spring/Summer, Su/F = Summer/Fall.

Chinook Stock	S_{MSY} Est	S_{MSY} Basis	MFMT (F_{MSY}) Est	MFMT (F_{MSY}) Basis	MSST Alt 1 Status Quo Cons Obj	MSST Alt 2 & 3 0.5*S_{MSY}	MSST Alt 4 & 5 0.75*S_{MSY}	Assumptions/Issues
Sacramento River Winter – ESA Endangered	Unk	NA	Unk	NA	Time/Area restrictions in CA ESA BO	Unk	Unk	While these stocks remain listed and managed under the ESA, MSA SDC are not applicable and remain undefined. If a stock becomes de-listed, MSA SDC will be defined as possible.
Sacramento River Spring – ESA Threatened	Unk	NA	Unk	NA	Time/Area restrictions in CA ESA BO	Unk	Unk	
Northern California Coast (Eel, Mattole, Mad Rivers) - ESA Threatened	Unk	NA	Unk	NA	≤ 0.16 Ocean Age-4 KRFC ER ESA BO	Unk	Unk	
Upper Willamette Spring – ESA Threatened	Unk	NA	Unk	NA	≤ 0.15 FW ER ESA BO	Unk	Unk	
Lower Columbia River (LCR) Chinook – ESA Threatened	Unk	NA	Unk	NA	≤ 0.39 Wild Tule ER ESA BO	Unk	Unk	
North Fork Lewis Fall – Part of LCR ESU	5,700 5,791	FMP CTC	0.76	CTC	5,700 ESA BO	Unk	Unk	
Snake River Fall Chinook – ESA Threatened	Unk	NA	Unk	NA	≤ 0.70 Base Period ER ESA BO	Unk	Unk	
Snake River Sp/Su Chinook – ESA Threatened	Unk	NA	Unk	NA	≤ 0.055 to 0.17 FW ER ESA BO	Unk	Unk	
Upper Columbia River Spring Chinook – ESA Endangered	Unk	NA	Unk	NA	≤ 0.055 to 0.17 FW ER ESA BO	Unk	Unk	
Eastern Strait of Juan de Fuca Su/F – ESA Threatened	Unk	NA	Unk	NA	Comp. Chinook ER ESA 4(d) Rule	Unk	Unk	
Skokomish Su/F – ESA Threatened	Unk	NA	Unk	NA	Comp. Chinook ER ESA 4(d) Rule	Unk	Unk	
Nooksack Sp/early Fall – ESA Threatened	Unk	NA	Unk	NA	Comp. Chinook ER ESA 4(d) Rule	Unk	Unk	

Chinook Stock	S_{MSY}		MFMT (F_{MSY})		MSST			Assumptions/Issues
	Est	Basis	Est	Basis	Alt 1 Status Quo Cons Obj	Alt 2 & 3 $0.5*S_{MSY}$	Alt 4 & 5 $0.75*S_{MSY}$	
Skagit - Su/F – ESA Threatened	Unk	NA	Unk	NA	Comp. Chinook ER ESA 4(d) Rule	Unk	Unk	While these stocks remain listed and managed under the ESA, MSA SDC are not applicable and remain undefined. If a stock becomes de-listed, MSA SDC will be defined as possible.
Skagit Sp – ESA Threatened	Unk	NA	Unk	NA	Comp. Chinook ER ESA 4(d) Rule	Unk	Unk	
Stillaguamish Su/F – ESA Threatened	Unk	NA	Unk	NA	Comp. Chinook ER ESA 4(d) Rule	Unk	Unk	
Snohomish Su/F – ESA Threatened	Unk	NA	Unk	NA	Comp. Chinook ER ESA 4(d) Rule	Unk	Unk	
Cedar River Su/F – ESA Threatened	Unk	NA	Unk	NA	Comp. Chinook ER ESA 4(d) Rule	Unk	Unk	
White River Spring – ESA Threatened	Unk	NA	Unk	NA	Comp. Chinook ER - ESA 4(d) Rule	Unk	Unk	
Green River Su/F – ESA Threatened	Unk	NA	Unk	NA	Comp. Chinook ER - ESA 4(d) Rule	Unk	Unk	
Nisqually River Su/F – ESA Threatened	Unk	NA	Unk	NA	1,100 - ESA 4(d) Rule	Unk	Unk	
Lower Columbia River Fall - Hatchery	15,400	TAC	<1.0	ER	15,400	NA	NA	Hatchery egg take goals satisfy SDC (pursuant to NS1Gs' flexibility provision)
Lower Columbia River Spring - Hatchery	2,700	TAC	<1.0	ER	2,700	NA	NA	
Mid-Columbia River Bright Fall - Hatchery	?	TAC	<1.0	ER	Hatchery Egg Take	NA	NA	
Spring Creek Fall- Hatchery	7,000	TAC	<1.0	ER	7,000	NA	NA	
Willapa Bay Fall- Hatchery	8,200	WDFW	<1.0	ER	8,200	NA	NA	
Quinault Fall– Hatchery	?	QIN	<1.0	ER	Hatchery Egg Take	NA	NA	

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

	S_{MSY}		MFMT (F_{MSY})		MSST			
Chinook Stock	Est	Basis	Est	Basis	Alt 1 Status Quo Cons Obj	Alt 2 & 3 $0.5*S_{MSY}$	Alt 4 & 5 $0.75*S_{MSY}$	Assumptions/Issues
Sacramento Fall	122,000 151,000	Lower Mid Pt Of FMP range	0.78	App C	122,000	61,000	91,500	Need to decide if lower or mid-point of FMP range used to calculate MSST Assume lower for now
Klamath River Fall	40,700	STT	0.71	STT	35,000 FMP floor	20,350	30,525	Need to decide if STT or FMP floor used to calculate MSST Assume STT for now
Smith River Fall	UnDef	NA	0.78	App C	UnDef	UnDef	UnDef	Currently part of CA coastal, proposed alternatives would include with SONC complex
Southern Oregon	150,000 to 200,000	FMP	0.78	App C	>60 spawners/ mi	UnDef	UnDef	May have additional indicator stocks in future
Central and Northern Oregon		FMP	0.78	App C		UnDef	UnDef	
Klickitat, Warms Springs, John Day and Yakima River - Spring	Unk	FMP	Unk	NA	<1% ocean impact rate	Unk	Unk	Far North Migrating stocks (Alt 2) or EC (Alt 3) Upper River Summers might not fall into these categories
Upper River Bright - Fall	39,625	CTC	0.86	CTC	<4% ocean impact rate	Unk	Unk	
Upper River - Summer	37,041	CTC	0.75	CTC	<2% ocean impact rate	Unk (18,521)	Unk (27,781)	
Willapa Bay - Fall	4,350 (MSP)	WDFW	Unk	FMP	4,350 (MSP)	Unk	Unk	
Grays Harbor Fall	14,600 (MSP)	WDFW	Unk	FMP	14,600 (MSP)	Unk	Unk	
Grays Harbor Spring	1,400 (MSP)	FMP	Unk	FMP	1,400 (MSP)	Unk	Unk	
Queets - Fall	2,500	FMP	Unk	FMP	Unk	Unk	Unk	
Queets – Sp/Sur	700	FMP	Unk	FMP	Unk	Unk	Unk	
Hoh - Fall	1,200	FMP	Unk	FMP	Unk	Unk	Unk	
Hoh Sp/Su	900	FMP	Unk	FMP	Unk	Unk	Unk	
Quillayute - Fall	3,000	FMP	Unk	FMP	Unk	Unk	Unk	
Quillayute - Sp/Su	1,200	FMP	Unk	FMP	Unk	Unk	Unk	
Hoko -Su/F	850	FMP	Unk	FMP	Unk	Unk	Unk	
Coastal Stocks	UnDef	FMP	UnDef	FMP	UnDef	NA	NA	Canada manages stock components
Fraser River	UnDef	FMP	UnDef	FMP	UnDef	NA	NA	

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

Table ES-5. Overview of alternatives for OFL, ABC, ACL, ACT, and the associated framework.

Alternatives	OFL	ABC	ACL	ACT[a/]	Framework
1) Status Quo	Not identified	Not identified	Not identified	Not identified	--NA— Current conservation objectives specified not to exceed (S_{MSY})
2) Catch (C) Based	C_{OFL}	C_{ABC}	C_{ACL}	C_{ACT} [a/]	$C_{OFL} > C_{ABC} = C_{ACL} > C_{ACT}$ $C_{OFL}(t) = N(t) \times F_{MSY}$ $C_{ABC}(t) = N(t) \times F_{ABC}$ F_{ABC} = 95% or 90% F_{MSY} [b/]
3) Spawning Escapement (S) Based	S_{OFL}	S_{ABC}	S_{ACL}	S_{ACT} [a/]	$S_{OFL} < S_{ABC} = S_{ACL} < S_{ACT}$ $S_{OFL}(t) = N(t) \times (1-F_{MSY})$ $S_{ABC}(t) = N(t) \times (1-F_{ABC})$ F_{ABC} = 95% or 90% F_{MSY} [b/]

a/ ACT could be used, as needed, but is undefined at this time.
b/ The buffer to account for scientific uncertainty is either 95% or 90% of F_{MSY}, depending on whether the F_{MSY} value represents a stock-specific estimate (Tier 1) or proxy value (Tier 2), respectively.

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

1.0 INTRODUCTION

The reauthorization of the Magnuson-Stevens Act (MSA) in 2006 established new requirements to end and prevent overfishing through the use of annual catch limits (ACLs) and accountability measures (AMs). The reauthorization also contained new requirements for the Scientific and Statistical Committee (SSC) to recommend acceptable biological catch (ABC) levels to the Council. On January 16, 2009, National Marine Fisheries Service (NMFS) published amended guidelines for National Standard 1 (NS1Gs) to provide guidance on how to comply with new provisions of the MSA. In order to comply with these new requirements and guidelines, the Salmon Fishery Management Plan (FMP) would have to be amended.

This process began in March 2009 for the purpose of initiating scoping of an FMP amendment to address the new MSA requirements and NS1Gss. At that time the Council also identified some related issues that should be considered in the amendment process, including *de minimis* fishing provisions and updates to stock conservation objectives. The Council was interested in alternatives to complete fishery closures when stock projections were below objectives. Most salmon stocks had some form of allowance for these circumstances, but a few did not, resulting in situations like 2008-2009 (fishery closures) and 2006 (emergency rule promulgation).

1.1 Document Organization

This is an integrated document in regard to the assessments required for an FMP amendment. The Council decision process for this initiative is outlined in Section 1.3. The description of the proposed amendment and impacts in Sections 2.0, 4.0 and 5.0 contain key elements necessary for a Regulatory Impact Review/Initial Regulatory Flexibility Analysis (RIR/IRFA) and EA. Section 5.0 summarizes the relationship of this amendment to other existing laws and policies. Section 5.5 contains or references the information required for a structurally complete RIR/IRFA. The proposed FMP wording changes necessary to implement the amendment appears in Section 6.0.

1.2 Purpose and Need for Action

The purpose of the proposed action is to provide a framework for specifying biological and management reference points and AMs that will meet the requirements of the revised MSA and NS1Gs to account for uncertainty in the fishery management process, reduce the probability of overfishing, and include clear and objective status determination criteria (SDC), while integrating with existing management processes and capabilities to the degree possible.

This action is needed to bring the Salmon FMP into compliance with new requirements to end and prevent overfishing in the MSA, as amended in 2007, and to address the corresponding 2009 revised National Standard 1 Guidelines (NS1Gs) (CFR § 600.310). The MSA now requires specification of ABC, ACLs, and AMs. The NS1Gs establish a detailed framework that integrates the existing and new biological reference points and AMs. In addition, the proposed action needs to revise SDC and associated actions of the current SDC in the Salmon FMP to make them consistent with the NS1Gs and to address issues with ambiguity, timeliness, and implementation of annual management measures.

Specifically the proposed action needs to:

- Classify salmon stocks in the FMP as “in the fishery” or as “ecosystem components”;
- Identify the salmon stocks for which the international exception to MSA 303(a)(15) (specification of ACLs and AMs) will apply;
- Revise the SDC for overfishing, overfished, approaching overfished, and rebuilt to be “measurable and objective” as required by the MSA, and establish maximum fishing mortality threshold (MFMT) and minimum stock size threshold (MSST) reference points used for status determinations;

- Establish a framework for the specification of the following reference points: overfishing limit (OFL), ABC (with a corresponding ABC control rule), ACL, and possibly annual catch target (ACT);
- Establish AMs to prevent the ACL from being exceeded, where possible, and establish AMs to address overages of the ACL;
- Explain how and why “flexibility” in the application of the NS1Gs will be applied in the Salmon FMP;
- Clarify any discrepancies with current “exceptions” as identified in the Salmon FMP with new terminology of the MSA; and
- Integrate, to the extent possible, existing management processes and capabilities.

1.3 Plan Development Schedule and Council Advisory Committee Participation

The expectation for this action was that the Council would recommend to the Secretary of Commerce (Secretary) adoption of an amended Salmon FMP in time for implementation of regulations affecting ocean salmon fisheries commencing May 1, 2011. However, the exact form and wording of the final recommendations depended on the results of the analyses and findings that are presented in this document. To facilitate this effort an *ad hoc* Salmon Amendment Committee (SAC) was appointed to develop and analyze alternatives and to report to the Council on the progress of the overall initiative.

The committee structure included representatives from NMFS NWR, SWR, NWFSC, SWFSC, and General Council, plus members of the Salmon Technical Team (STT) representing state and tribal agencies, and a member of the Scientific and Statistical Committee (SSC). The committee was responsible for preparing the draft amendment and Council/public review documents, including modeling and analytical components and written narratives, and for Federal regulatory streamlining responsibilities, including the Council/NMFS interface and Federal internal policies to allow for timely Secretarial review and an approval/disapproval decision of the final Council action at the November 2010 meeting. Individual SAC members were called upon to prepare or submit report sections depending on their particular area of expertise and availability to assist in Council activities. The names of committee members and their affiliations appear in Appendix A.

1.3.1 Council Decision Process

The Council recommendations for amending the FMP were based on findings using a stepwise process, as follows:

1. Thorough review of the history, management framework, scientific literature, pertinent regulatory documents and administrative orders, and social and economic data as they relate to the management of Pacific Coast Chinook, coho, and pink salmon stocks;
2. Development of a set of alternatives using the Council meeting process to solicit input from the public and Council advisory groups;
3. Analysis and evaluation of alternatives relative to i) NOAA Environmental Review Procedures, ii) the National Standards of the MSA, iii) the long-term productivity of the stock, iv) protection of ESA listed species, v) community economic impacts, and vi) other applicable law; and
4. Establishment of the biological conditions, regulatory timeframe, and associated regulatory considerations for implementation of regulations as part of the Council’s annual ocean salmon management process.

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

1.4 Background and Related Documents

1.4.1 Scoping Summary

The Council initiated the FMP amendment process in March 2009, after NMFS had published the final rule for NS1Gs. The Council initially identified the following topics for tentative inclusion in the amendment process:

- ACL and AM;
- Revised SDC for overfishing and overfished designations;
- Revising stock conservation objectives to include updated MSY values, exploitation rate approaches and *de minimis* fishing provisions for stocks without such measures,
- Exceptions for stocks managed under the Pacific Salmon Treaty, and ;
- Sector ACL/AM for multi-jurisdictional fisheries

The Council directed that preliminary alternatives be developed to facilitate further scoping of issues at the September 2009 meeting. The SAC held a meeting in August 2009, which was open to the public, to discuss and further develop issues for Council consideration, and to consider possible alternatives that could exemplify approaches to those issues.

At the September 2009 Council meeting, the SAC presented its scoping summary to the Council and its advisory bodies (SSC, STT, and SAS). After receiving the SAC report, statements from the advisory bodies, and providing an opportunity for public comment, the Council directed that the amendment process focus on issues directly related to the MSA requirements and NS1Gs related to ACL/AM and SDC, including:

- Determine which stocks or stock complexes would be subject to ACLs and AMs;
- Establish ACLs and AMs for appropriate stocks or stock complexes;
- Revising SDC for Overfishing and Overfished designations;
- Characterization of stock conservation objectives relative to specified reference points (MSY, ABC, ACL, and ACT), and;
- Council action required under the FMP overfishing criteria relating to *de minimis* fishery provisions and fishery closures.

The Council directed the SAC to develop suites of alternatives that would encompass the range of options for the above topics. Alternatives were to include formation of stock complexes with indicator stocks to facilitate setting ACL/AM, with options for quota management in salmon fisheries south of Cape Falcon, and options for using buffers to facilitate traditional time/area salmon fisheries south of Cape Falcon.

The SAC met several times between the September 2009 and June 2010 Council meetings to develop alternatives for presentation to the Council at its June 2010. All meetings of the SAC were noticed in the Federal Register, were open to the public, and provided formal opportunity for public comment.

At the June 2010 Council meeting, the Council recommended preliminary preferred alternatives for stock classification and application of the international exception to the ACL and AM requirements for salmon stocks currently identified in the Salmon FMP. The Council also recommended including the alternatives presented in the SAC Progress Report (PFMC 2010e) for SDC, OFL/ABC/AC frameworks, and *de minimis* fishery provision the range of alternatives analyzed during preparation of this EA. The Council also recommended a variation on the SDC alternatives be developed, and directed the SAC to structure *de minimis* fishing provisions decrease fishing mortality rates to zero before stock abundance approached zero.

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

1.4.2 Related Documents

There are numerous documents available related to Council area salmon management, which have been used in the analyses in this EIS and support the decision at hand. These documents are briefly described below and their relevance to the analysis is explained.

1.4.2.1 Pacific Coast Salmon Plan (Salmon FMP)

The Salmon FMP (PFMC 2007) establishes conservation and allocation guidelines for annual management. This framework allows the Council to develop measures responsive to stock status in a given year. Section 3 of the current Salmon FMP describes the conservation objectives for Salmon FMP stocks necessary to meet the dual MSA objectives of obtaining optimum yield (OY) from a fishery while preventing overfishing. Each stock has a specific objective, generally designed to achieve maximum sustained yield (MSY), maximum sustained production (MSP), or in some cases, an exploitation rate to serve as an MSY proxy. The Salmon FMP also specifies criteria to determine when overfishing may be occurring and when a stock may have become overfished. These conditions are referred to as a Conservation Alert and an Overfishing Concern, respectively. In addition, the Salmon FMP also specifies required actions when these conditions are triggered. The alternatives described in Section 2 are structured around the actions required when a Conservation Alert is triggered.

The annual management regime has been subject to several previous environmental impact analyses. From 1976 through 1983, the Council prepared an environmental impact statement (EIS) or supplemental EIS (SEIS) for each year’s salmon fishing season. In 1984 an EIS was prepared when the Salmon FMP was comprehensively amended to implement the framework process for annual management. This resulted in a much more efficient management process and obviated the substantial staff burden of preparing an EIS or SEIS annually. A still more recent 2000 SEIS accompanied Amendment 14, implemented in 2001, which set the current Salmon FMP conservation objectives, and described the criteria and actions for a Conservation Alert and an Overfishing Concern. These EISs also represent information and analytical resources that, as appropriate, are incorporated into this document.

1.4.2.2 Review of Ocean Salmon Fisheries

This Stock Assessment and Fishery Evaluation (SAFE) document is the first in a series of annual documents prepared by the STT. It provides an historical context for fishery impacts, spawning escapement, and management performance for Salmon FMP stocks, annual regulations governing Council-area salmon fisheries, and economic factors associated with Council-area salmon fisheries. Information on inland marine and freshwater fisheries, as well as ocean fisheries in Canada and Alaska, are also presented. The Review of 2009 Ocean Salmon Fisheries (PFMC 2010a) SAFE document provides a baseline for fishery impacts and economic assessments used in this EA. The most recent version of the review report for the previous year is available from the Council office beginning in late February.

1.4.2.3 Preseason Reports I, II, and III

Preseason Report I is the second in the series prepared by the STT and presents projected stock abundances for Salmon FMP stocks, including the methodology and performance of predictors. The most recent version of the report is available from the Council office beginning in late February (PFMC 2010b).

Preseason Report II presents the range of regulatory ocean fishery alternatives that the Council was considering for the coming salmon season. It is distributed to the public and reviewed in public hearings to solicit public input of preferred management measures. The most recent version of the report is available from the Council office beginning in late March (PFMC 2010c).

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

Preseason Report III is the final document in the series prepared by the STT. It details the final management measures adopted by the Council for recommendation to NMFS for the coming season's regulations. It includes an analysis of the effects of the management measures on conservation objectives for key salmon stocks. The most recent version of the report is available from the Council office beginning in late April. (PFMC 2010d)

1.4.2.4 2006 Ocean Salmon Regulations EA (2006 Regulations EA)

The 2006 regulations EA analyzes the environmental and socioeconomic impacts of proposed management measures for ocean salmon fisheries occurring off the coasts of Washington, Oregon, and California. The document evaluated the 2006 annual salmon ocean harvest management measures with respect to compliance with the terms of the Salmon FMP, obligations under the Pacific Salmon Treaty (PST), and the level of protection required by all consultation standards for salmon species listed under the ESA. The range of alternatives analyzed in the 2006 Regulations EA included the effects of three levels of *de minimis* fishing strategies on KRFC when the stock was projected to fall below the 35,000 natural spawner floor for the third consecutive year. The 2006 EA supported NMFS' Finding of No Significant Impacts (FONSI) for the 2006 ocean salmon regulations. The affected environment section and socioeconomic analysis of the 2006 Regulations EA represent the current environmental baseline and a reasonable expectation of economic impacts for recent years, and are incorporated by reference in this EA.

1.5 Relevant Issues

The alternatives in this EA were initially screened to determine if they deserved further consideration and analysis. The criteria used for the initial screening were based on meeting the purpose and need statement, including requirements of MSA and NS1Gs. Specific criteria evaluated included:

- OFL/ABC/ACL framework includes catch (C) or spawning escapement (S) based reference points such that OFL>ABC≥ACL, or escapement based reference points such that OFL<ABC≤ACL
- SDC are measurable and objective
- The probability of overfishing is less than 50 percent

Viable alternatives were then analyzed to provide a basis for comparing and contrasting alternatives and selecting a preferred alternative. In addition to the above criteria, the analysis consisted of evaluating the following:

A*dministrative implementation feasibility.* Factors affecting administrative implementation include the ability of management agencies to:

- Monitor fisheries inseason
- Take inseason action to close fisheries
- Take inseason action to modify management measures necessary to meet preseason objectives
- Assess fisheries and compliance with objectives and standards

Scientific assessment capability. Factors affecting scientific assessment include:

- Preseason forecasting of exploitation rates, abundance, and harvest impacts used to develop annual management measures
- Postseason assessment of those factors to determine compliance with achieving reference points
- Relative uncertainty of methods for estimating reference points

In order to analyze the environmental impacts of the alternatives (Chapter 4 of this EA), the following criteria were evaluated:

The relative short and long-term economic effects on the fishery. Factors affecting economic impacts include:

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

- Coastal community impacts
- Angler Trips
- Foregone opportunity
- Allocation of resources among fishing sectors

The effects on cultural resources and activities. Factors affecting cultural resources include:
- Tribal access to harvestable surplus
- Potential for full utilization

The relative effects on biological factors. Biological factors include:
- Risk of overfishing
- Risk to long-term stock productivity

Section 6.02 of the NOAA Administrative Order 216-6 also enumerates a specific set of guidelines for identifying potentially significant environmental impacts resulting from a fishery management action. During the scoping process several of the factors were dropped from further consideration based on the conclusion that they would not be affected by the action. The remaining factors for this EA are:
- The relative effects of the Alternatives to jeopardize the sustainability of any target species that may be affected by the action.
- The relative effects of the Alternatives to jeopardize the sustainability of any non-target species.
- The proposed action may be reasonably expected to cause substantial damage to the ocean and coastal habitats and/or essential fish habitat as defined under the MSA and identified in FMPs.
- The relative effects of the Alternatives to have a substantial adverse impact on public health or safety.
- The relative effects of the Alternatives to adversely affect endangered or threatened species, marine mammals, or critical habitat of these species.
- The relative effects of the Alternatives to result in cumulative adverse effects that could have a substantial effect on the target species or non-target species.

2.0 DESCRIPTION OF ALTERNATIVES

This section provides a description of the alternatives considered under this EA. This section is not intended to include a description of the baseline environment or an analysis of the alternatives. The reader is referred to Sections 3 and 4 (respectively) of this EA for that information.

2.1 Stock Classification

The MSA requires that an FMP describe the stocks of fish involved in the fishery. The NS1Gs provide a structure for classifying stocks in and around the fishery, and organizing stock complexes. These organizing principles are an important first step in developing an FMP that is consistent with the NS1Gs since they affect how other key provisions of the MSA and NS1Gs may be applied including, for example, SDC, and ACLs and AMs. The NS1Gs recommend that stocks identified in an FMP be classified as in or out of the fishery. Target stocks are in the fishery and some non-target stocks could also be in the fishery; ecosystem components (ECs) stocks are not. Individual stocks can also be formed in to stock complexes so that, for example, data poor stocks can be managed in association with data rich stocks with similar characteristics. This classification scheme helps conceptualize how the fishery operates, which stocks are affected by various fishery sectors, and how SDC and ACL provisions, among other MSA Section 303(a) provisions, may be applied.

This section identifies alternatives for how salmon stocks currently listed in the FMP could be classified in the FMP consistent with the NS1Gs § 600.310(d). It includes alternatives for designating several Chinook and pink stocks as ecosystem components and establishing complexes for some Chinook stocks. The section also provides alternatives for application of the international exception to MSA Section 303(a)(15) (i.e., ACLs and AMs).

2.1.1 Classification Issues

The first step in the classification process is to review the stocks currently listed in the FMP and determine which stocks are still in need of conservation and management measures in Council area fisheries; these stocks will be classified as "in the fishery" (i.e., for which MSA Section 303(a) requirements apply), consistent with the NS1Gs § 600.310(d). Stocks "in the fishery" will include target stocks (stocks that fishers seek to catch for sale or personal use, including "economic discards"), and non-target stocks (fish caught incidentally during the pursuit of target stocks in a fishery, including "regulatory discards") in need of conservation and management. Examples of target stocks in Council area fisheries are hatchery stocks and productive natural stocks with ocean distributions primarily within the Council area. Non-target salmon stocks include ESA-listed stocks or depressed natural stocks (e.g., Strait of Juan de Fuca coho).

Stocks currently in the FMP that are not recommended to be classified as "in the fishery" can either be omitted altogether, if determined not to be in need of conservation and management measures; or can be classified as ECs (see NS1Gs § 600.310(d)(5)). If classified as an EC, they would be assessed as to their vulnerability to the fishery and monitored, but not actively managed in Council area fisheries under the Pacific Salmon FMP. ECs do not require specification of reference points.

The NS1Gs suggests that stock complexes may be identified, but they have a particular purpose. Stock complexes are groups of stocks that are sufficiently similar in geographic distribution, life history, and vulnerabilities to the fishery such that the impacts of management actions on the stocks are similar. Stock complexes may be formed to facilitate management requirements such as setting ACL, or assessing stock status.

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

Although the international exception to ACLs and AMs is not directly related to how the fishery is classified, addressing it in this section helps simplify the subsequent consideration of alternatives for reference points. Stocks that are subject to an international agreement may be excepted from ACL and AM requirements, but still must have all other MSA Section 303(a) requirements, including specification of SDC and MSY.

2.1.3 Alternatives for Stock Classification

In this section, the following alternatives are described:

- Alternatives for stocks currently included in the FMP that will be classified as "in the fishery"
- Alternatives for stocks currently included in the FMP that will be classified as ECs
- Alternative for designating stock complexes and indicator stocks to facilitate management of data poor stocks
- Alternatives for application of the international exception to the ACL requirements.

The proposed alternatives are broken out separately for coho, Chinook, and pink stocks. To simplify the presentation of the proposed alternatives for stock classification, current stocks listed in the FMP have been organized into groups based on the following characteristics: similar geographic area, life history, ESA-listed, and hatchery produced (Table 2-1). Some of these stock groupings correspond to complexes identified in the current FMP, although the intent of displaying these stock groupings here is not to reference or establish stock complexes; only to simplify the presentation of alternatives. There are only two pink stocks so no further simplification was required.

Table 2-1. Coho and Chinook stock groups and abbreviations used in classification alternative descriptions.

Coho			**Chinook**		
Stock Group	**Abbreviation**	**# Stocks**	**Stock Group**	**Abbreviation**	**# Stocks**
Endangered Species Act	ESA	4	Endangered Species Act – California origin	CA ESA	3
Hatchery	HAT	6	Endangered Species Act – Columbia River origin	CR ESA	5
Puget Sound	PS	5	Endangered Species Act – Puget Sound origin	PS ESA	11
Washington Coastal	WA C	4	Hatchery	HAT	5
Canadian	CAN	2	Columbia River Summer	CR S	1
			Columbia River Fall	CR F	1
			Washington Coastal/ Columbia River Far-North Migrating Spring/Summer (non ESA listed)	FNMSS	5
			Washington Coastal/ Northern Oregon Far-North Migrating Summer/Fall (non-ESA listed)	WA/OR S/F	8
			S. Oregon/N. California	SONC	3(4)[a/]
			California Central Valley Fall	CVF	1
			Canadian	CAN	2
Totals		21			45

a/ The three stocks currently listed in the FMP are South Oregon Coast, Klamath River fall and Klamath River spring. Under Classification Alternatives 2 and 3, Smith River (CA) Chinook would be moved to the SONC stock group from the Eel, Mad, Mattole, and Smith rivers stock group.

Alternative 1 in the Tables 2-2, 2-3, and 2-4 generally represents status quo, or an adaptation of status quo to conform as closely as possible to the new MSA requirements and NS1Gs.

2.1.3.1 Classification Alternatives for Coho Stocks

All of the U.S. origin coho stocks have ocean distributions primarily in Council waters and are substantially affected by Council area fisheries. Canadian coho stocks are also affected by U.S fisheries. All coho stocks currently listed in the FMP would remain in the fishery and no EC stocks are proposed. Alternative 2 would, however, move the Southern OCN stock component to the Northern California coho stock and rename that stock to the Southern Oregon Northern California Coastal (SONCC) coho stock, consistent with the ESU designation (Table 2-2). The OCN fishery impact matrix could then be modified to use only the Northern, North Central and South Central OCN stock components. Approval of a modified OCN matrix may initiate ESA reconsultation for OCN coho, and possibly a new Biological Opinion; however, the modified matrix would be consistent with the ESU designation for coho stocks along the Oregon Coast. The FMP classification would be consistent with the current ESA consultation standard for SONCC coho, which uses Rogue/Klamath hatchery coho as a surrogate for that ESU.

Table 2-2. Alternatives for classification of coho stocks.

Classification	Alternative 1 – Status Quo	Alternative 2
In the Fishery	HAT – 6 ESA – 4 WA C – 4 PS – 5 CAN – 2	HAT – 6[a/] ESA– 4[a/b/] WA C – 4[c/] PS – 5[c/] CAN – 2[c/]
Ecosystem Component Stocks	None	None

a/ Reference points would be based on hatchery goals and ESA consultation standards. (50 CFR 600.310(h)(3)).
b/ Places the Southern OCN stock component with the Northern California stock to conform with current ESU designations.
c/ Stocks to which the MSA international exception to specification of ACL will be applied. Specification of ABC will also not be required, but specifications of SDC reference points are required.

2.1.3.2 Classification Alternatives for Chinook Stocks

Chinook stocks have more diverse ocean distribution and life history characteristics than coho, and therefore require different management approaches. While all coho stocks in the FMP are available to Council area fisheries, many Chinook stocks originating in the Southern U.S. are largely unavailable due to a combination of ocean migration patterns and run timing. Therefore, Chinook stocks can be classified to reflect the management capability and characteristics of the stocks.

Alternative 1 reflects status quo and all stocks currently identified in the FMP remain in the fishery. Alternatives 2 and 3 would identify Smith River Chinook as a separate stock, rather than associating it with the ESA listed Eel, Mattole, and Mad rivers stock group as it is currently represented in the FMP (Table 2-3). Alternative 3 classifies non-ESA listed FNM Chinook stocks as ecosystem component stocks (not in the fishery) because they are non-target stocks of the fishery, have low vulnerability to Council area fisheries (see Appendix B); exploitation rates in Council area fisheries are less than 5 percent and do not affect stock status.

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

Table 2-3. Alternatives for classification of Chinook stocks.

Classification	Alternative 1 – Status Quo	Alternative 2	Alternative 3
In the Fishery	CVF – 1 SONC - 3 HAT – 5 CA ESA – 3 CR ESA – 5 PS ESA – 11 CR S – 1 CR F[a/] – 1 WA/OR S/F[a/] – 8 FNMSS [a/] – 5 CAN – 2	CVF – 1 SONC - 4[b/] HAT – 5 CA ESA – 3 CR ESA – 5 PS ESA – 11 CR S – 1 CR F[a/] – 1 WA/OR S/F[a/] – 8 FNMSS [a/] – 5 CAN – 2	CVF – 1 SONC – 4[b/] HAT – 5 CA ESA – 3 CR ESA – 5 PS ESA – 11 CR S – 1 CAN – 2
Ecosystem Component Stocks	None	None	WA/OR S/F [a/] – 8 CR F [a/] – 1 FNMSS [a/] – 5

a/ Far north migrating (FNM) stocks.
b/ Includes Smith River Chinook, which was included with the ESA listed Eel, Mattole, and Mad rivers group in the status quo alternative.

2.1.3.3 Classification Alternatives for Pink Stocks

Pink salmon are generally abundant in odd numbered years only. Council area fisheries frequently provide additional opportunity to retain pink salmon (e.g., increased bag limits), but overall impacts are negligible, generally fractions of 1 percent over the last 20 years, and occur only in the northern part of the Washington coastal fishery.

Alternative 1 reflects status quo including both pink stocks as in the fishery as they are in the current FMP. Alternative 2 reflects the low vulnerability of pink stocks to Council area fisheries (see Appendix B), and classifies them as ecosystem components because they are non-target stocks and retention in Council area fisheries does not affect stock status (Table 2-4).

Table 2-4. Alternatives for classification of pink salmon stocks.

Classification	Alternative 1-Status Quo	Alternative 2
In the Fishery	PS Fraser (CAN)	None
Ecosystem Component Species	None	PS Fraser (CAN)

2.1.3.4 Rationale for Ecosystem Components

Ecosystem component stocks are not considered to be "in the fishery," and do not require specification of reference points. Section (d)(5) of the NS1Gs provides criteria for classification of EC stocks. Such stocks should:

- Be a non-target species or non-target stock;
- Not be determined to be subject to overfishing, approaching overfished, or overfished;
- Not be likely to become subject to overfishing or overfished, according to the best available information, in the absence of conservation and management measures; and
- Not generally be retained for sale or personal use.

However, The NS1Gs also indicate that occasional retention of the stock would not, in and of itself, preclude consideration of the species under the EC classification. A stock's vulnerability to fisheries is

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

also an important consideration when designating EC stocks; stocks that are highly vulnerable to the ocean salmon fisheries would not be good candidates for EC classification under the Salmon FMP.

For this FMP amendment, Stock Classification Alternative 3 includes designating 14 of the FNM Chinook stocks and both pink stocks as ecosystem components. Unique circumstances related to salmon are such that there are some ambiguities related to criteria for classifying EC stocks, but their classification as ECs is consistent with the intent of the NS1Gs and the overall MSA conservation and management requirements related to preventing overfishing and achieving optimum yield (OY).

Individual salmon caught during the ocean fishery can be distinguished at the species level (e.g., Chinook can be distinguished from coho), but stocks within a species cannot otherwise be identified and selectively released. FNM Chinook stocks are distinguished from other Chinook stocks in the fishery by their low contribution to the fishery. In the current Salmon FMP these FNM stocks were identified as having minimal harvest impacts if the cumulative exploitation rate in Council fisheries during the 1979-1982 base period was less than five percent. Fisheries are now much reduced relative to what they were thirty years ago so Council fishery exploitation rates on these stocks are generally at the low end of the zero to five percent range. A more contemporary analysis of the vulnerability of the FNM stocks is provided in Appendix B. The vulnerability analysis shows that these stocks have low vulnerability relative to other Chinook stocks that are in the fishery, and are very low on the vulnerability scale relative to all stocks and species considered in that overall vulnerability analysis.

Another consideration for an EC designation relates to whether they are retained in the fishery. The near absence of FNM stocks in the fishery is such that they cannot be targeted. Far north migrating Chinook are instead caught incidentally while targeting the abundant hatchery and natural-origin stocks that drive the fishery. Although these stocks are retained, the NS1Gs provides that occasional retention does not itself preclude consideration of the species for EC classification.

Although Council fisheries have little impact on the FNM stocks, they are subject to management and related protections by other management jurisdictions. Some of the FNM stocks are substantially impacted in fisheries north of the U.S. Canadian border and are managed under the Pacific Salmon Treaty. All of these FNM stocks are caught in inland fisheries and are thus subject to management controls provided by the states of Washington and Oregon and treaty tribes. However, these stocks would not be subject to determinations for overfishing, overfished, or approaching an overfished condition if designated as EC stocks. Impacts are such that the reduced attention to stock specific conservation and management measures in Council fisheries associated with an EC designation would have no material effect on whether the stocks become overfished or subject to overfishing in the future.

For similar reasons, Alternative 2 designates the Fraser River and Puget Sound pink stocks as ECs. Pink salmon have a two year life cycle and are abundant only in odd numbered years. Because the pink stocks are returning to Puget Sound and the Fraser River they are only caught in Council fisheries in the northern catch areas off Washington. The catch in Council fisheries in odd numbered years totals a few hundred or at most a few thousand fish relative to run sizes of hundreds of thousands or millions. Exploitation rates in Council area fisheries are therefore fractions of one percent. The vulnerability analysis indicates that pink salmon are one of the least vulnerable species of all the species and stocks in the overall analysis (Appendix B).

Pink salmon are caught incidentally in the fisheries directed at other species and retention is allowed because of the absence of any conservation constraints. As indicated above retention of a stock does not necessarily preclude consideration of an EC designation. Pink salmon are not targeted in the fishery. Recreational fishermen target Chinook and coho salmon which are larger and greatly preferred in terms of

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

table fare. Pink salmon are also not targeted in the Council area commercial fishery because of their low value (cents per pound). Commercial pink salmon fisheries are viable only in cases where there is localized, high volume opportunity. The inland fisheries where these stocks are caught are managed under the Pacific Salmon Treaty. The pink salmon stocks are also not subject to overfishing, and are not overfished or approaching an overfished condition. Impacts are such that the reduced attention to stock specific conservation and management measures in Council fisheries associated with an EC designation would have no material effect on whether the stocks become overfished or subject to overfishing in the future.

The overriding consideration when making a EC designation is whether they are in need of conservation and management under the MSA, a consideration of which is if conservation and management is necessary to prevent overfishing. Designating the FNM Chinook and pink stocks as proposed is consistent with these requirements. The fisheries that do affect these stocks to the north and in inland areas are managed responsibly. The state, tribal, and federal entities involved with Council area management are also directly involved in the Pacific Salmon Treaty and inland management processes. Since all of these stocks return to Washington and Oregon, except Fraser pinks, the interest in protecting them is clear. Impacts to these stocks in Council fisheries are low, to the point where Council fisheries have no material effect on the status of pink stocks or to achieving OY for the other stocks in the fishery. Impacts are too low to cause overfishing or contribute to rebuilding if needed. Designating these stocks as ECs does not diminish their protection, it simply defers it to those with the ability and responsibility for their direct management. Because the EC stocks would remain in the FMP, they would continue to be monitored in order to evaluate their status. If circumstances change, their classification as ECs can be reconsidered.

2.1.4 Alternatives for Stock Complexes and Indicator Stocks

The MSA requires ACLs be specified for each stock or stock complex in the fishery, unless subject to the international exception to MSA Section 303(a)(15). Some stocks currently listed in the FMP have insufficient information to develop individual catch based ACLs, such as Klamath River spring Chinook; therefore, formation of stock complexes may be necessary to address the intent of the NS1Gs and prevent overfishing of these data poor stocks. Each stock complex would need one or more indicator stocks to establish annual harvest constraints (e.g., ACLs) based on status of those indicator stocks.

As mentioned above, stock complexes in the current Salmon FMP were identified for organizational purposes rather than for management at the complex level as described in the NS1Gs. Some alternatives below propose reorganizing stock complexes for management purposes in order to explore the possibility of setting a catch-based ACL for Council area salmon stocks. In Section 2.3, ACL alternatives describe the basis of annual catch limits as spawning escapement or catch. In order to consider a catch-or spawning escapement-based ACLs for a stock, a preseason (before fishing) forecast of its abundance would be necessary, and a post season estimate of adult equivalent (AEQ) catch in all fisheries or spawning escapement would be necessary to assess compliance. A postseason estimate of catch in all fisheries for a specific stock requires a data intensive accounting process, generally involving CWT analysis. While tagging programs and CWT analyses are routinely conducted for many large stocks, most small stocks are not as well analyzed, if at all. Some stocks also lack escapement monitoring programs and forecasts sufficient to support individual escapement-based ACLs. Therefore, ACLs cannot be established for some individual stocks. These stocks may be formed into complexes with more data rich stocks of similar characteristics to facilitate meeting the requirements for specifying ACLs for all stocks in the fishery. This section describes alternatives for forming the stock complexes that would be necessary to consider a catch- or spawning escapement-based ACL.

2.1.4.1 Stock Complexes for Chinook

Three Chinook complexes could be established to allow specification of ACLs for data poor stocks that are in the fishery. These complexes would represent stocks with similar ocean distribution patterns and vulnerability in Council area fisheries. ACLs would be specified for indicator stocks within the complexes. As information becomes available for data poor stocks, they could be included as indicator stocks for the complex. Information necessary to serve as an indicator stock includes a preseason forecast of abundance available by April, the ability to model fishery impacts on the stock so that fisheries can be structured to achieve the ACL, and the ability to estimate postseason AEQ catch and exploitation rates (for catch-based ACLs) or spawning escapement (for escapement-based ACLs).

The first complex, designated Central Valley fall (CVF) complex, would consist of fall and late fall Chinook from the Sacramento and San Joaquin basins, and the indicator stock would be SRFC. The stocks in this complex are the non-ESA listed stocks currently identified in the FMP as the California Central Valley complex. All stocks in this complex have similar vulnerability to Council Area fisheries, being distributed primarily south of Cape Falcon, Oregon (Appendix G). Only SRFC have a defined conservation objective, but the objective is intended to provide adequate hatchery and natural escapement of San Joaquin fall and Sacramento late fall stocks as well (PFMC 2007). Because of the close genetic similarity, these stocks were placed in the same ESU (Central Valley Fall and Late Fall-Run Chinook Salmon ESU (Myers et al. 1998). The SRFC stock has made up at least 69 percent of the returning adults in the stock complex since 1971, and has averaged 88 percent (PFMC 2010a). Both San Joaquin fall Chinook and Sacramento River late fall Chinook have averaged six percent of the total return over the same period. SRFC is an appropriate indicator stock for this complex because of the large fraction of the total population represented, and the similar vulnerability to other stocks in the complex. In addition, the stock is currently used as an indicator stock for this complex and its conservation objective includes the needs of the other stocks in the complex. Currently, SDC for San Joaquin fall Chinook and Sacramento River late fall Chinook are undefined, and until separate objectives for those stocks are developed, they would not be acceptable indicator stocks.

The second complex, designated Southern Oregon and Northern California (SONC) complex, would consist of Chinook stocks south of the Elk River, Oregon to, and including, the Klamath River, plus Umpqua River spring Chinook. The indicator stock for this complex would be KRFC. Stocks in this complex would include Klamath River spring and fall Chinook, Smith River Chinook (currently associated with the ESA listed group of Eel, Mattole, and Mad Rivers), Rogue River spring and fall Chinook, and Umpqua River spring Chinook, and Chinook from smaller systems along the Southern Oregon Coast. Because of the close genetic similarity, most of these stocks were placed in the Southern Oregon and Northern California Coastal Chinook Salmon ESU (Myers et al. 1998). Upper Klamath and Trinity River stocks are in their own ESU, and Umpqua River spring Chinook are in the Oregon Coast ESU. Umpqua River spring Chinook were included in the SONC complex because they have an ocean distribution (and therefore vulnerability) more similar to the other stocks in the SONC complex than to fall Umpqua stocks and other Oregon Coast Chinook ESU stocks, which are considered FNM stocks. All stocks in the SONC complex have similar vulnerability to Council Area fisheries, being distributed primarily south of Cape Falcon, Oregon (Appendix G). There is insufficient abundance information to assess the relative proportions of the stocks in the SONC complex, but ocean genetic stock identification studies indicate that Klamath and Rogue stocks have comparable contributions to ocean fisheries in Oregon, with other southern Oregon and Northern California stocks contributing less (CROOS unpublished data). Of the stocks in the SONC complex, only KRFC and Southern Oregon Chinook have conservation objectives specified in the FMP; however the Southern Oregon Coast Chinook conservation objective is part of an aggregate that includes Central and Northern Oregon Coast stocks. The aggregate conservation objective is assessed through spawning densities in index streams and no forecasts of

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

abundance or exploitation rate in fisheries are available preseason. ODFW is currently reviewing available information with the intent of developing stock specific objectives, but until that process is complete, only KRFC have adequate information available to serve as an indicator stock for the SONC complex. The FMP specifies that the productive potential for Klamath River spring and southern Oregon Coast Chinook are protected by management objectives for KRFC, at least in part because of the relatively large allocation of KRFC impacts to river tribal and recreational fisheries (PFMC 2007).

The third complex, designated far north migrating spring/summer (FNMSS) complex would consist of spring/summer Chinook stocks from the Central and Northern Oregon Coast (from the Elk River North, except Umpqua River spring Chinook), Mid-Columbia spring Chinook (Klickitat, Warm Springs [Deschutes], John Day, and Yakima Rivers), and Grays Harbor Spring, Queets spring/summer, and Hoh spring, and Quillayute summer Chinook. Indicator stock for this complex would be Hoh spring Chinook. The stocks in this complex are grouped together because of their very low vulnerability to all ocean fisheries (Appendices B and F), and because they are neither ESA listed nor subject to terms of the PST. Ocean harvest of these stocks is so rare that exploitation rates are assumed to be negligible for all ocean fisheries (Alaska, Canada, and southern U.S.). Stock proportions of the complex are not readily available, but based on recent returns, the Mid-Columbia River spring stocks are probably the most abundant. However, the only stock in the complex that has both an established conservation objective in the FMP and a preseason forecast of abundance is Hoh spring Chinook. Therefore, those stocks will serve as indicator stocks for the FNMSS complex until sufficient information is available for other stocks. Under Stock Classification Alternative 3 these stocks would be designated as EC stocks (Table 2-3) eliminating the need for specifying the FNMSS complex.

Table 2-5. Alternatives for identifying Chinook stock complexes and indicator stocks. Stock classification alternatives that the complex would be associated with are also identified (see Table 2-3).

Stock Complex	**Component Stocks**	**Indicator Stocks**	**Stock Classification Alternative**
Central Valley Fall Chinook (CVF)	Sacramento River fall San Joaquin River fall Sacramento River late fall	Sacramento River fall	Alternative 2 Alternative 3
Southern Oregon northern California Chinook (SONC)	Rogue River fall and spring Umpqua River spring Smith River fall and spring Klamath River fall and spring Other small basins in Oregon south of the Elk River	Klamath River fall	Alternative 2 Alternative 3
Far-North-Migrating Spring/Summer Chinook (FNMSS)	Spring stocks from Oregon tributaries north of the Elk River (except Umpqua) Mid-Columbia River spring (Klickitat, Deschutes, John Day, Yakima) Grays Harbor spring Queets Spring/summer Hoh spring Quillayute summer	Hoh Spring	Alternative 2

2.1.5 The International Exception

The MSA require that FMPs establish ACL mechanisms and AMs for all stocks and stock complexes in the fishery, but provides an exception from the requirement for stocks or stock complexes that are managed under an international agreement in which the U.S. participates. Several coho, Chinook, and pink stocks in the Salmon FMP are subject to management under the Pacific Salmon Treaty (PST). The PST is a bilateral treaty between the U.S. and Canada that relates to the management of salmon stocks affected by the fisheries of both nations. Under MSA Section 3(24) "The term 'international fishery agreement' means any bilateral or multilateral treaty, convention or agreement which relates to fishing and to which the United States is a party." The PST clearly meets the criteria specified in the Magnuson-Stevens Act and NS1G related to international agreements. Although FMP stocks (i.e., stocks in the fishery) managed under an international agreement may be excepted from the ACL and AM requirements (and including exception to specification of ABC according to the NS1Gs), these stocks still require the specification of SDC.

Application of the international exception depends to a degree on how stocks are classified – i.e., its application is only relevant to stocks in the fishery that would otherwise require ACLs and AMs. In the preceding section, Alternative 3 classified FNM Chinook stocks as ECs and Alternative 2 classified two pink stocks as ECs (Tables 2-3 and 2-4). Ecosystem components are "out of the fishery", and as a result, do not require specification of ACLs or other reference points and MSA Section 303(a) requirements. These stocks might have been considered for the international exception if classified as stocks in the fishery, but such a designation is moot since none of the MSA Section 303(a) requirements apply to EC stocks. Because of the close relationship between stock classification and application of the international exception, the alternatives for use of the international exception are combined with the alternatives for stock classification described below (Table 2-6).

There are currently no stocks to which the MSA international exception (from the 2007 MSA amendments) has been applied, as reflected in the Status Quo Alternative (Table4 2-6).Under Classification Alternative 2, in which all stocks currently identified in the FMP would remain in the fishery, the international exception to specification of ABC, ACLs, and AMs would be applied to Puget Sound, Washington Coastal and Canadian coho stocks, Canadian, Columbia River summer, Columbia upriver fall, Washington Coast summer/fall, and mid- north-Oregon coast fall Chinook stocks, and Puget Sound and Fraser pink stocks. These are all the non-ESA listed stocks subject to the PST. Under stock Classification Alternative 3, the international exception would not be applied to Chinook stocks classified as EC (Columbia upriver fall, Washington Coast summer/fall, and mid- north-Oregon coast fall Chinook); otherwise application would be similar..

Table 2-6. Proposed Application of the MSA international exception to specification of ABC and ACLs to stocks managed under the Pacific Salmon Treaty and associated stock classification alternatives.

	Stock Classification Alternative		
Stocks	**Alternative 1 - Status Quo**	**Alternative 2**	**Alternative 3**
Coho	None	PS - 5 WA C - 5 CAN - 2	N/A
Chinook	None	CR S – 1 WA/OR S/F – 8 CR F – 1 CAN -2	CR S – 1 CAN -2

Pink	None	PS Fraser (CAN)	NA

2.2 Alternatives for Reference Points – Status Determination Criteria

Status Determination Criteria must be specified in fishery management plans to determine the status of a stock or complex.[1] This section presents alternatives to use as SDC to determine:

- Overfishing
- Overfished
- Approaching overfished
- Rebuilt

SDC will be applied to natural stocks for which specification of these reference points is appropriate and possible based on the best available science. These reference points will not be specified for any stocks that are identified in the FMP as EC. NS1Gs § 600.310(d)(5)(iii) specify that EC stocks are not considered in the fishery, and are thus not subject to any of the MSA 303(a) requirements.

The NS1Gs' provision on flexibility[2] explains that there are limited circumstances that may not fit the standard approaches set forth in the NS1Gs and cites hatchery and ESA-listed stocks as examples where alternative approaches may be appropriate. For ESA-listed stocks in the FMP, the NS1Gs flexibility provision will be utilized and ESA consultation standards will serve as all required reference points, including SDC reference points and ACLs For hatchery stocks as defined in Table 3-1 of the FMP, hatchery goals will continue to serve as their conservation objective and will serve as alternative approaches to specification of all required reference points, including SDC reference points and ACLs.

Some natural stocks listed in the FMP currently are managed on the basis of indicator stocks. SDC will be applied to and specified only for indicator stocks; the status of other stocks will not change as a result of indicator stock status changes.

Stocks managed under an international agreement can be excepted from specification of ABC and ACL reference points (50 CFR 600.310(e)(2)(ii)), but they are still required to have MSY and SDC specified. Based on the Stock Classification Alternative 3 (section 2.1 of this EA), the relevant stocks for specifying SDC reference points include KRFC, SRFC, Columbia Upper River summer Chinook, Washington Coast coho, and Puget Sound coho. Based on the Stock Classification Alternative 2, additional stocks would require SDC, including Columbia Upper River fall Chinook and Washington Coast Chinook. These stocks are relatively data rich, having age-structured information and models to assess compliance with both S and F based SDC. Oregon coast and Mid-Columbia River spring Chinook would also require SDC under Classification Alternative 2; however, there may be insufficient information to assess both S and F based SDC for these stocks.

2.2.1 Criteria Used to Evaluate the Alternatives

The criteria used to evaluate SDC alternatives were consistency with the NS1Gs and feasibility of implementation. Considerations within the criterion for NS1Gs consistency include:

- The SDC should be objective and measurable[3]
- The SDC should be assessed annually[4], if possible

[1] See MSA §303(a)(10) and 50 CFR 600.310(e)(2)
[2] 50 CFR 600.310(h)(3)
[3] MSA §303(a)(10)

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

- The SDC to determine overfishing[5]:should be based on either:
  1. the fishing mortality rate (F) exceeding the maximum fishing mortality threshold[6] (MFMT), i.e**.,** **F > MFMT**, or
  2. the annual catch exceeding the overfishing limit (OFL), i.e., **annual catch > OFL**
- The SDC to determine overfished[7] should be based on the minimum stock size threshold[8] (MSST) and must be expressed in terms of spawning biomass or other measure of reproductive potential, and should equal whichever of the following is greater: One-half (½) the MSY stock size (S_{MSY})[9], or the minimum stock size at which rebuilding to S_{MSY} would be expected to occur within 10 years, if the stock or complex were exploited at the MFMT.
- SDC to determine approaching overfished[10]: are when a stock is projected to have more than a 50 percent chance that the stock size (S)[11] will decline below the MSST within two years.
- SDC to determine when a stock is rebuilt should be based on a stock achieving S_{MSY}.[12]

2.2.2 Overview of Alternatives

For all of the alternatives:

- SDC are specified for each stock, as opposed to a stock complex;
- all determinations, except approaching overfished, are made postseason; and
- all status determinations are made annually.

Table 2-7 provides a description of the SDC alternatives, including formulaic representations. More detailed descriptions of the alternatives and assessment relative to the evaluation criteria above are provided in the subsequent sections below.

The proposed alternatives to the status quo all incorporate the reference points identified in the NS1Gs (e.g., F_{MSY}, MFMT, MSST). However, the proposed definitions of some of these references points differ slightly from those in the NS1Gs to accommodate the life history of Pacific salmon, where reproduction is semelparous and a stock's full reproductive potential can be spread out over a multi-year period. These modified approaches are proposed in accordance with the provision allowing for flexibility in the application of the NS1Gs.[13]

---

[4] 50 CFR 600.310(e)(2)(ii) explains that if SDC should be specified and expressed in a way that enables monitoring of each stock or complex to determine annually, if possible, whether overfishing has occurred or if a stock or complex is overfished.

[5] 50 CFR 600.310(e)(2)(ii)(A)

[6] MFMT is the level of fishing mortality (F), on an annual basis, above which overfishing is occurring. The MFMT or reasonable proxy may be expressed either as a single number (a fishing mortality rate or F value), or as a function of spawning biomass or other measure of reproductive potential. 50 CFR 600.310(e)(2)(i)(C)

[7] 50 CFR 600.310(e)(2)(ii)(B)

[8] MSST means the size below which the stock or stock complex is considered to be overfished. 50 CFR 600.310(e)(2)(i)(F)

[9] MSY stock size (S_{MSY}) means the long-term average size of the stock or stock complex, measured in terms of spawning biomass or other appropriate measure of the stock's reproductive potential that would be achieved by fishing at F_{MSY}. 50 CRF 600.310(e)(1)(i)(C). For salmon, the appropriate measure of the stock's reproductive potential is the number of adult spawners (S).

[10] 50 CFR 600.310(e)(2)(i)(G)

[11] Size (S) of the stock or complex for salmon is the number of adult spawners.

[12] 50 CFR 600.310(j)(3)(i)

[13] 50 CFR 600.310(h)(3)

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

Table 2-7: Overview of SDC alternatives for overfishing, overfished, approaching overfished, and rebuilt (S ≡ Spawning Escapement; C ≡ catch; t ≡ year; GM ≡ Geometric mean)

Status Category	**Alternative 1: Status Quo Determination Based on Three Consecutive Years: MSST = S_{MSY}**	**Alternative 2 Determination Based on a Single Year: MSST = 0.5*S_{MSY}**	**Alternative 3 Determination Based on 3-Year Geometric Mean: MSST = 0.5*S_{MSY}**	**Alternative 4 Determination Based on a Single Year: MSST = 0.75*S_{MSY}**	**Alternative 5 Determination Based on 3-Year Geometric Mean: MSST = 0.75*S_{MSY}**
Overfishing	S(t,t-1,t-2)<MSST and C(t,t-1,t-2) > MSST-S(t,t-I,t-2) i.e. fishing contributed to triggering Overfishing Concern	F > MFMT in one year, with MFMT = F_{MSY}. F used is most recently available postseason value.	Same as Alternative 2 i.e., single year basis	Same as Alternative 2 i.e., single year basis	Same as Alternative 2 i.e., single year basis
Overfished	S(t,t-1,t-2)<MSST Current NMFS interpretation of Overfishing Concern as defined in FMP.	S < MSST in one year, with MSST = 0.5*S_{MSY}. S used is most recently available postseason value.	GM(S) < MSST over three year period, with MSST = 0.5*S_{MSY}. S used are 3 most recently available postseason values.	S < MSST in one year, with MSST = 0.75*S_{MSY}. S used is most recently available postseason value.	GM(S) < MSST over three year period, with MSST = 0.75*S_{MSY}. S used are 3 most recently available postseason values.
Approaching overfished	S(t-1,t-2)<MSST and S(t) forecast < MSST	S < MSST in one year, with MSST = 0.5*S_{MSY}. S used is current preseason forecast.	GM(S) < MSST over three year period, with MSST = 0.5*S_{MSY}. S used are 2 most recently available postseason values and current preseason forecast.	S < MSST in one year, with MSST = 0.75*S_{MSY}. S used is current preseason forecast.	GM(S) < MSST over three year period, with MSST = 0.75*S_{MSY}. S used are 2 most recently available postseason values and current preseason forecast.
Rebuilt	S > S_{MSY} in one year or as otherwise determined in rebuilding plan. S used is most recently available postseason value.	S ≥ S_{MSY} in one year. S used is most recently available postseason value.	GM(S) ≥ S_{MSY} over three year period. S used are 3 most recently available postseason values.	Same as Alternative 2	Same as Alternative 3

The status categories for overfished, approaching overfished, and rebuilt within each alternative should be considered together, given the need to have comparable metrics among these abundance-based SDC.

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

2.2.3 SDC Alternative 1: Status Quo

The current Salmon FMP does not explicitly define when a stock is considered to be experiencing overfishing, overfished, or is approaching overfished. While SDC are not currently specified, the FMP has identified indicators of a declining status for a stock that trigger Council action (see below). However, triggering of the status indicators has resulted in status determinations of overfished, approaching overfished, and rebuilt, as indicated in the Report to Congress on Status of U.S. Fisheries (NMFS, 2010).

A **"conservation alert"** is triggered during the annual preseason process[14] if a stock is projected to fall short of its conservation objective (MSY, MSY proxy, MSP, or spawning escapement floor).

An **"overfishing concern"** is triggered if a stock fails to meet its conservation objective (evaluated postseason) for three consecutive years. If an overfishing concern is triggered, the FMP requires an assessment of factors that led to the shortfall. The Council directs its STT to work with state and tribal fishery managers to complete an assessment of factors that led to the overfishing concern within one year. Based on the results of the assessment, the STT will recommend management actions (i.e., a rebuilding plan) that will result in recovery of the stock in as short a time as possible, preferably within ten years or less, and provide criteria for identifying stock recovery and the end of the overfishing concern. In addition the Council directs its Habitat Committee (HC) to work with federal, state, local, and tribal habitat experts to review the status of the essential fish habitat affecting this stock and, as appropriate, provide recommendations to the Council for restoration and enhancement measures within a suitable time frame. The timing of this process is described in Figure 2-1 below.

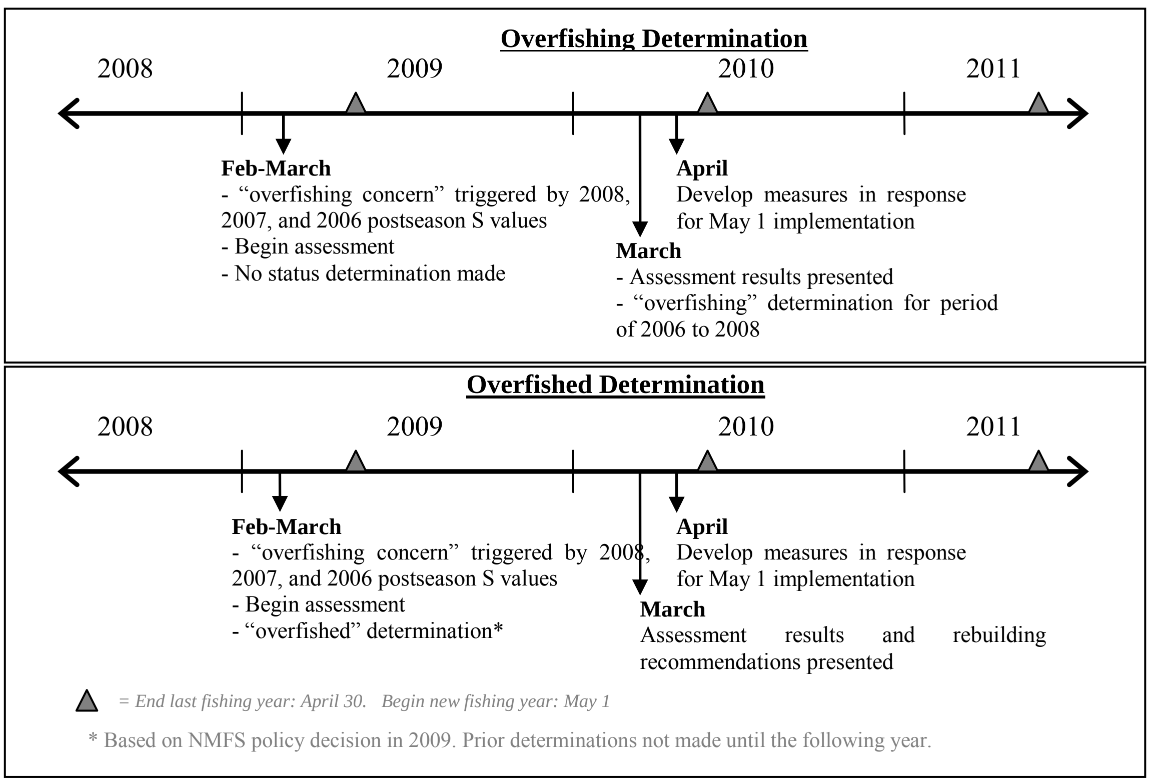


Figure 2-1. Timeline for overfishing concern process, making status determinations, and implementation of management response. Example timeline assumes "overfishing concern" is triggered in 2009.

[14] See Chapter 9 of the Salmon FMP

Because the FMP provides no specific guidance about when or under what circumstances a stock should be considered subject to overfishing or overfished, it has resulted in confusion and inconsistent status determinations. Absent clearly defined SDC, NMFS made a policy decision in 2009 to declare a stock "overfished" if it triggers an "overfishing concern" under the FMP.

2.2.3.1 Status quo definition of "overfishing".

After the triggering of an "overfishing concern", the STT conducts an assessment to determine whether overfishing occurred. If the STT assessment concludes that excessive fishing contributed to a stock not meeting its conservation objective for three consecutive years, overfishing is said to have occurred.

2.2.3.2 Status quo definition of "overfished"

As of 2009, a NMFS policy decision was made to interpret a stock that has not met its conservation objective for three consecutive years (i.e., an "overfishing concern" under the FMP) to be overfished.

2.2.3.3 Status quo definition of "approaching overfished"

When a stock has failed to achieve its conservation objective for two consecutive years and is projected not to meet the objective in the third year (a conservation alert), the FMP requires some specific action by the Council. The Council must notify pertinent fishery and habitat managers, advising them the stock may be temporarily depressed or approaching an overfishing concern and request the pertinent state and tribal managers to do a formal assessment of the primary factors leading to the shortfalls and report their conclusions and recommendations to the Council no later than the March meeting prior to the next salmon season.

2.2.3.4 Status quo definition of "rebuilt"

The default criterion in the FMP for when a stock is considered rebuilt is when its conservation objective is met for one year. In cases where a rebuilding plan has been adopted, the stock is considered rebuilt when the criteria defined in the rebuilding plan have been met.

2.2.3.5 Assessment of Status Quo SDC Alternatives

The status quo status determination criteria are not completely objective and measurable. Determination if overfishing occurred is not measurable for some stocks and is not objective. Overfishing determinations are case-specific; based on the STT assessments made after a stock has triggered an overfishing concern, not on an annual basis. Overfishing has generally been determined based on an amount of catch (analogous to an OFL) as opposed to a rate of fishing (analogous to a MFMT), and specification of the catch amount that results in overfishing has been determined differently for various STT overfishing assessments. This process has not resulted in a consistent definition of overfishing across stocks and is ambiguous.

Overfished status, while not defined in the FMP, is interpreted by NMFS as a stock subject to an overfishing concern. The NMFS interpretation of overfished is both objective and measurable. The assessments of whether stocks have met conservation objectives are made annually during the preseason planning process. The overfished status has been based on S.

The approaching overfished status is measurable and objective as both postseason estimates and preseason forecasts of S are routinely made during the preseason process. Approaching overfished status is based on postseason estimates, and preseason forecasts of S.

Rebuilt status may or may not be predicated upon an adopted rebuilding plan, which may specify rebuilding benchmarks that are or are not objective or measurable. Also, it is unclear in the FMP when the "default" rebuilding plan should be implemented versus development of a separate rebuilding plan and associated criteria for defining the end of the "overfishing concern".

The combination of terminologies used under the status quo has also proven very confusing. Even though a stock is determined as "overfished" under the status quo, an "overfishing concern" under the FMP is nevertheless triggered, leading to a great deal of confusion among stakeholders and the public about the true status of the stock. For instance, the stock might be determined as "overfished" but not "subject to overfishing", yet it has triggered an "overfishing concern".

Consistency with NS1Gs: The status quo alternative is partially consistent with NS1Gs, but is deficient in several important areas.

Overfishing: Determination if overfishing occurred is not measurable for some stocks and is not objective. Overfishing determinations are case-specific; based on the STT assessments made after a stock has triggered an overfishing concern, not on an annual basis. Overfishing has generally been determined based on an amount of catch (analogous to an OFL) as opposed to a rate of fishing (analogous to a MFMT), and specification of the catch amount that results in overfishing has been determined differently for various STT overfishing assessments. There is also a time lag of up to one year after the overfishing concern is triggered to conduct an assessment. During the interim, no status determination is made. This process has not resulted in a consistent definition of overfishing across stocks and is ambiguous.

Overfished: Overfished status, while not defined in the FMP, is interpreted by NMFS as a stock subject to an overfishing concern. The NMFS interpretation of overfished is both objective and measurable. The assessments of whether stocks have met conservation objectives are made annually during the preseason planning process, and are made in the year immediately following triggering of an overfishing concern. The overfished status is based on the MSY conservation objective, which in this case is equivalent to an MSST.

Approaching Overfished: The status quo alternative is consistent with NS1Gs in that there are specific objective and measurable criteria to use for determining when a stock is approaching an overfishing concern, which has been interpreted as overfished. Approaching overfished determinations are made annually during the preseason planning process. If the stock has failed to meet its conservation objective for the two previous years, and the forecast of S equals the conservation objective, the probability of becoming overfished in the current year is 0.5, assuming an unbiased predictor. If the forecast of S is lower than the conservation objective, the probability of becoming overfished in the current year is greater than 0.5, assuming an unbiased predictor.

Rebuilt: The default criterion in this alternative is compatible with the NS1Gs because it requires a stock to achieve its MSY based conservation objective. The overfishing assessment process, which includes specifying rebuilt criteria in a formal rebuilding plan, could result in criteria that is not consistent with the NS1Gs because rebuilding benchmarks may not measurable or objective. It is also unclear when the default rebuilding plan should be implemented versus development of a separate rebuilding plan.

Feasibility of Implementation: Implementation is feasible as status quo is the current status determination process. However, the requirement for STT overfishing assessments, including development of criteria for overfishing, overfished, and rebuilt, can be burdensome given time constraints and can lead to inconsistencies in status determination.

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

2.2.4 Alternative 2: Single Year Basis SDC, MSST = 0.5*S_{MSY}

Single year based SDC are used for many fish species, and the NS1Gs recommend a default overfished criteria (MSST) of 0.5*S_{MSY}. This alternative would require determination of overfishing, overfished, approaching an overfished condition, and rebuilt based on annual evaluations. Status determinations would be predicated upon meeting various fishing mortality (F) or escapement (S) benchmarks in the previous year only.

2.2.4.1 Overfishing

A stock would be considered subject to overfishing when the postseason estimate of F exceeds the MFMT, where the MFMT is defined as $F_{MSY.}$ Stock-specific estimates of F_{MSY} based on spawner-recruit data would be used if available. Otherwise, species-specific proxy values of F_{MSY} = 0.78 for Chinook, based on species-specific meta-analyses, would be used (Appendix C). Stock specific overfishing determinations would be made annually and based on exploitation during a single biological year. Figure 2-2 illustrates alternative SDC reference points for KRFC and SRFC relative to the current conservation objectives and the estimated and proxy values for F_{MSY} and S_{MSY}.

2.2.4.2 Overfished

A stock would be considered overfished if S falls below its MSST in a single year, with MSST defined as 0.5*S_{MSY}. Stock specific overfished determinations would be made annually.

2.2.4.3 Approaching an Overfished Condition

An approaching overfished determination would be made when the preseason forecast of S is falls below MSST in a single year. Stock specific determinations would be made each year during the preseason planning process.

2.2.4.4 Rebuilt

A stock would be rebuilt when S exceeds S_{MSY} for one year. The determination would be made annually during the preseason process.

2.2.4.5 Assessment of Single Year SDC Alternatives

Consistency with NS1Gs: The Alternative 2 SDC are consistent with NS1Gs.

Overfishing: Alternative 2 SDC to determine overfishing are based on MFMT, which is objective and measurable. Determinations would be made annually, and for most stocks could be made in the year immediately following the year in which exploitation may have occurred. However, estimating F for some stocks may take longer due to the availability of stock specific run reconstruction information. An overfishing SDC based on MFMT is consistent with one of the definitions in the NS1Gs.

Overfished: Alternative 2 SDC to determine overfished are based on MSST, which is objective and measurable. Determinations would be made annually, and generally could be made during the preseason planning process following the most recent return year. MSST is adopted as defined in the NS1Gs. Defining MSST in terms of S is consistent with the NS1Gs' requirement to define MSST as a measure of reproductive potential. Defining MSST as 0.5*S_{MSY} is appropriate because salmon populations are relatively productive compared to other managed fish species (Appendix B).

Approaching Overfished: Alternative 2 SDC to determine approaching overfished are objective and measurable. The criterion would be determined annually during the preseason planning process. If the preseason forecast of S equals the MSST, the probability of becoming overfished in the current year is

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

0.5, assuming an unbiased predictor. If the forecast of S is lower than the MSST, the probability of becoming overfished in the current year is greater than 0.5, assuming an unbiased predictor.

Rebuilt: Alternative 2 SDC to determine rebuilt are objective and measurable; benchmarks would be clearly identifiable. Rebuilt status determinations would be made annually during the preseason planning process. The NS1Gs generally refer to a rebuilt condition as achieving a stock or complex's S_{MSY}.

Feasibility of Implementation: Implementation of Alternative 2 is generally feasible. Postseason estimates of both F and S are routinely made for many stocks, though new methods may be needed for some stocks to obtain postseason estimates for these quantities in the immediately previous year. In some cases, postseason estimates of F made in the following year may be of lower quality than estimates made two or three years later. This alternative will also streamline the process for assessing SDC and reporting to Congress.

This alternative would likely reduce the frequency that overfished determinations are made compared to status quo. Overfished determinations normally involve conducting an assessment of the cause of the overfished condition, and development and implementation of a rebuilding plan may be required. Conducting assessments and developing rebuilding plans impact management agency workload and funding needed to support processes like Council meetings and advisory body meetings (e.g., STT). In addition, other tasks have to be delayed, resulting in indirect effects to other administrative programs, which could impact the biological and socioeconomic environments at some level.

Other Considerations: While it is, or can be, possible to make an overfished determination based on metrics estimated one year prior, it is not clear whether this accurately represents the status of salmon stocks. Salmon stock abundances can be quite variable owing in part to the semelparous nature of reproduction and short generation times. Hence, falling below the MSST in a single year may not be indicative of a longer term trend toward depressed abundance or the ability of the stock to produce MSY on a continuing basis. This reasoning also applies to the rebuilt determination. A single strong year class resulting in one year of exceeding S_{MSY} for a severely depressed stock may not truly represent that the stock is rebuilt.

2.2.5 Alternative 3: 3-Year Geometric Mean Basis SDC, MSST = 0.5*S_{MSY}

Salmon are relatively short-lived species with spawning escapements of coho and pink salmon dominated by a single year-class, and Chinook spawning escapements dominated by no more than two year-classes. The abundance of year-classes can fluctuate dramatically with combinations of natural and human-caused environmental variation. Therefore, it is not unusual for a healthy and relatively abundant salmon stock to produce occasional spawning escapements which, even with little or no fishing impacts, may be significantly below the long-term average associated with the production of MSY. Therefore, low stock size in one year is not necessarily a cause for concern; however, longer-term stock depression could signal the beginning of a critical downward trend, which may jeopardize the capacity of the stock to produce MSY over the long term if appropriate actions are not taken.

Alternative 3 would require determination of overfished, overfishing, approaching overfished, and rebuilt based on annual postseason evaluations. The definition of overfishing in Alternative 3 is equivalent to Alternative 2. However, the definitions of overfished, approaching overfished, and rebuilt are different in that they require multi-year postseason estimates of S to be assessed. The multi-year alternatives use a geometric mean to determine overfished, approaching overfished, and rebuilt status.

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

2.2.5.1 Overfishing

Same as Alternative 2: A stock would be considered subject to overfishing when the postseason estimate of F exceeds the MFMT, where the MFMT is defined as F_{MSY}. Stock-specific estimates of F_{MSY} based on spawner-recruit data will be used if available. Otherwise, species-specific proxy values of F_{MSY} = 0.75 for Chinook, and F_{MSY} = 0.60 for coho, based on species-specific meta-analyses, will be used. Stock specific overfishing determinations are made annually and based on exploitation during a single biological year.

2.2.5.2 Overfished

A stock would be considered overfished if the 3-year geometric mean of S fell below the MSST, defined as $0.5*S_{MSY}$. Overfished determinations would be made annually using the three most recently available postseason estimates of S.

2.2.5.3 Approaching an Overfished Condition

An approaching overfished determination would be made if the geometric mean of the two most recent postseason estimates of S, and the current preseason forecast of S, is below the MSST.

2.2.5.4 Rebuilt

A stock would be rebuilt when the 3-year geometric mean of S exceeds S_{MSY}.

2.2.5.5 Assessment of 3-Year Geometric Mean SDC Alternatives

Consistency with NS1Gs: The Alternative 3 SDC are consistent with NS1Gs.

Overfishing: Same comments as Alternative 2.

Overfished: Alternative 3 SDC to determine overfished are based on MSST, which is objective and measurable. Determinations would be made annually, and generally could be made during the preseason planning process following the most recent return year. MSST is not defined in a single year as in the NS1Gs (CFR 600.310 (e)(2)(ii)(B); however, the multi-year criterion does more accurately reflect the risk to reproductive potential as discussed above. Defining MSST in terms of S is consistent with the NS1Gs' requirement to define MSST as a measure of reproductive potential. Defining MSST as $0.5*S_{MSY}$ is appropriate because salmon populations are relatively productive (see Appendix B).

Approaching Overfished: Alternative 3 SDC to determine approaching overfished are objective and measurable. The criterion would be determined annually during the preseason planning process. If the stock failed to meet the MSST for the two previous years, and the forecast of S equals the MSST, the probability of becoming overfished in the current year is 0.5, assuming an unbiased predictor. If the forecast of S is lower than the MSST, the probability of becoming overfished in the current year is greater than 0.5, assuming an unbiased predictor.

Rebuilt: Same comments as Alternative 2, except that the rebuilding period would usually be longer.

Feasibility of Implementation: Same comments as Alternative 2.

Other Considerations: Overfished, approaching overfished, and rebuilt status defined in Alternative 3 are designed to acknowledge the variability common in salmon populations. Salmon stock abundances can be quite variable owing in part to the semelparous nature of reproduction and short generation times. Use of the geometric mean of the most recently available 3-year postseason estimates of S would decrease

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

the probability of a stock being declared overfished as a result of a single weak year class. Conversely, a single strong year class would be unlikely to result in a rebuilt status for an otherwise severely depressed stock. Reproductive potential of a stock, given the inherent variability of salmon populations, may best be described using a multi-year metric. Survival processes lead to variability in adult abundance that is approximately lognormally distributed. Lognormally distributed data have a skewed distribution where large values are possible, but the lower end the distribution is bounded by zero. The geometric mean was chosen instead of the arithmetic mean because the geometric mean is less sensitive to large values. The multi-year approach to status determination is currently used in the FMP to identify an overfishing concern for the same reasons, although the metric is different.

2.2.6 Alternative 4: Single Year SDC, MSST = 0.75*S_{MSY}

Alternative 4 SDC would be identical to Alternative 2 SDC except that Overfished and Approaching Overfished would be based on a value of 0.75 S_{MSY} rather than 0.5*S_{MSY}. Evaluation relative to the criteria in section 4.2.1 of this EA would also be similar to Alternative 2, although some of the benefits associated with overfished determinations would be less because they would be more likely to occur under this Alternative than under Alternative 2. However, there would still be some benefits relative to the Status Quo Alternative.

2.2.7 Alternative 5: 3-Year Geometric Mean Basis SDC, MSST = 0.75*S_{MSY}

Alternative 5 SDC would be identical to Alternative 3 SDC except that Overfished and Approaching Overfished would be based on a value of 0.75*S_{MSY} rather than 0.5*S_{MSY}. Evaluation relative to the criteria in section 4.2.1 of this EA would also be similar to Alternative 3, except that the effects associated with overfished determinations would be more similar to the Status Quo Alternative. Defining the MSST as 0.75*S_{MSY} provides a more conservative benchmark with the consequence that Overfished and Approaching Overfished determination are more likely to occur.

2.2.8 Stock Specific Considerations

Specification of SDC are dependent on identifying S_{MSY} reference points for individual stocks. The specification of S_{MSY} may also establish a conservation objective, (annual management constraint) for that stock. The individual S_{MSY} values identified in the SDC alternatives are, in some cases, different than those currently used as conservation objectives and management targets.

For example, SRFC have a range of 122,000-180,000 natural and hatchery spawners as their conservation objective. The SDC alternatives specify a single S_{MSY} value of 122,000, and yet other levels of S within the goal range have been targeted by the Council. The choice to specify S_{MSY} = 122,000 stems from it presently serving as the trigger value for an overfishing concern (Table 2-9).

Puget Sound coho have conservation objectives based on stepped exploitation rates associated with abundance break points. These objectives were established through the *U.S. v. Washington* process, and subsequently adopted into the PST and the Salmon FMP. The abundance break points correspond to S_{MSY} under average and low survival conditions and range from 0.59*S_{MSY} to 0.75*S_{MSY}. Using an SDC of 0.5*S_{MSY} would result in overfished status criteria at stock sizes that are less than the lower break point estimate of S for all Puget Sound coho stocks. Using an SDC of 0.75*S_{MSY} would result in overfished status criteria at stock sizes that are greater than the lower break point estimate of S for all Puget Sound coho stocks (Table 2-8).

Washington Coastal coho have FMP conservation objectives based on a range of S_{MSY} associated with high and low smolts per female and marine survival. The status quo control rule uses the lower end of the range as MSST. The alternatives use a mid-point of the range for S_{MSY} and 0.5*S_{MSY} or 0.75*S_{MSY} for

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

MSST. The mid-point of the S_{MSY} range is also used to categorize annual stock status for the PSC management process (Table 2-8). Analysis of stock-recruitment data provides additional estimates of S_{MSY} and F_{MSY} for these stocks (Appendix E), which should be reviewed and could be considered for use in establishing SDC in this FMP amendment process.

The current conservation objective and control rule for Oregon South Coast Chinook could allow for S based SDC; however, there is insufficient information to directly assess F based SDC. Oregon South Coast Chinook, or some stock components thereof, may soon have new objectives that would facilitate setting F based SDC, pending an ongoing review/revision of management objectives for that stock complex (Table 2-9). Another option for that stock would be to use a surrogate stock for F based SDC (e.g., KRFC).

The Canadian Chinook and coho stocks identified in the FMP are actually large stock complexes, made up of many individual stocks. The Canadian management agencies are responsible for determining the status of these individual stocks as they relate to provisions of the PST and other Canadian statutes. The Council has no authority to monitor or assess status of these individual stocks, or to specify their management objectives. The Council also has no authority to establish reference points for the larger stock complexes. Therefore, specification of SDC for Canadian stocks in the Council's Salmon FMP is not feasible (Tables 2-8, 2-9). The Council will continue to abide by the terms of the PST and manage its fisheries accordingly.

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

Table 2-8. Status determination criteria reference points, assumptions and issues for coho stocks.

Coho Stock	S_{MSY} Est	S_{MSY} Basis	MFMT (F_{MSY}) Est	MFMT (F_{MSY}) Basis	MSST Alt 1 Status Quo Cons Obj	MSST Alt 2 & 3 0.5*S_{MSY}	MSST Alt 4 & 5 0.75*S_{MSY}	Assumptions/Issues
CCC – ESA Endangered	Unk	NA	Unk	NA	0.0 HR in CA ESA BO	Unk	Unk	While these stocks remain listed and managed under the ESA, MSA SDC are not applicable and remain undefined. If a stock becomes de-listed, MSA SDC will be defined as possible.
SONCC – ESA Threatened	Unk	NA	Unk	NA	0.13 Ocean ER ESA BO	Unk	Unk	
OCN – ESA Threatened	Unk	NA	Unk	NA	0.08-0.45 ER ESA BO	Unk	Unk	
LRN – ESA Threatened	Unk	NA	Unk	NA	Council & MS CR ER ESA BO	Unk	Unk	
Columbia River Late - Hatchery	14,100	TAC	<1.0	ER		NA	NA	Hatchery egg take goals satisfy SDC (pursuant to NS1Gs' flexibility provision)
Columbia River Early - Hatchery	7,100	TAC	<1.0	ER	7,100	NA	NA	
Willapa Bay - Hatchery	6,100	WDFW	<1.0	ER	6,100	NA	NA	
Quinault - Hatchery	??	QIN?	<1.0	ER	??	NA	NA	
Quillayute Summer - Hatchery	300	WDFW	<1.0	ER	300	NA	NA	
S. Puget Sound - Hatchery	52,000	WDFW	<1.0	ER	52,000	NA	NA	
Grays Harbor	24,426	S_{MSP} (FMP) *F_{SMY} (App C	0.69	App C	35,400	12,213	18,320	App E Est's need review.
Queets	5,500 10,150 5,800	App E Mid Pt Low	0.68	App C	5,800-14,500	5,075	7,163	App E Est's need review. Need to decide if S_{MSY} (App E), lower or mid-point of FMP range used to calculate MSST: Assume midpoint for now, used in PST.
Hoh	2,250 3,500 2,000	App E Mid Pt Low	0.69	App C	2,000-5,000	1,750	2,625	
Quillayute Fall	5,873 11,050 6,300	App E Mid Pt Low	0.59	App C	6,300-15,800	5,525	8,826	
Strait of JdF	10,978	FMP	0.60	FMP	7,007	5,489	8,234	Need to decide if S_{MSY} (FMP), low/critical abundance breakpoint, or App E used to calculate MSST. Assume S_{MSY} (FMP)
Hood Canal	14,350	FMP	0.65	FMP	10,750	7,175	10,762	
Skagit	25,000	FMP	0.60	FMP	14,875	12,500	18,750	
Stillaguamish	10,000	FMP	0.50	FMP	6,100	5,000	7,500	
Snohomish	50,000	FMP	0.60	FMP	31,000	25,000	37,500	
Coastal Stocks	UnDef	FMP	UnDef	FMP	UnDef	NA	NA	Canadian manages stock components
Fraser River	UnDef	FMP	UnDef	FMP	UnDef	NA	NA	

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

Table 2-9. Status determination criteria reference points, assumptions and issues for Chinook stocks. Sp/Su = Spring/Summer, Su/F = Summer/Fall.

Chinook Stock	S_{MSY}		MFMT (F_{MSY})		MSST			Assumptions/Issues
	Est	Basis	Est	Basis	Alt 1 Status Quo Cons Obj	Alt 2 & 3 $0.5*S_{MSY}$	Alt 4 & 5 $0.75*S_{MSY}$	
Sacramento River Winter – ESA Endangered	Unk	NA	Unk	NA	Time/Area restrictions in CA ESA BO	Unk	Unk	While these stocks remain listed and managed under the ESA, MSA SDC are not applicable and remain undefined. If a stock becomes de-listed, MSA SDC will be defined as possible.
Sacramento River Spring – ESA Threatened	Unk	NA	Unk	NA	Time/Area restrictions in CA ESA BO	Unk	Unk	
Northern California Coast (Eel, Mattole, Mad Rivers) - ESA Threatened	Unk	NA	Unk	NA	≤ 0.16 Ocean Age-4 KRFC ER ESA BO	Unk	Unk	
Upper Willamette Spring – ESA Threatened	Unk	NA	Unk	NA	≤ 0.15 FW ER ESA BO	Unk	Unk	
Lower Columbia River (LCR) Chinook – ESA Threatened	Unk	NA	Unk	NA	≤ 0.39 Wild Tule ER ESA BO	Unk	Unk	
North Fork Lewis Fall – Part of LCR ESU	5,700 5,791	FMP CTC	0.76	CTC	5,700 ESA BO	Unk	Unk	
Snake River Fall Chinook – ESA Threatened	Unk	NA	Unk	NA	≤ 0.70 Base Period ER ESA BO	Unk	Unk	
Snake River Sp/Su Chinook – ESA Threatened	Unk	NA	Unk	NA	≤ 0.055 to 0.17 FW ER ESA BO	Unk	Unk	
Upper Columbia River Spring Chinook – ESA Endangered	Unk	NA	Unk	NA	≤ 0.055 to 0.17 FW ER ESA BO	Unk	Unk	
Eastern Strait of Juan de Fuca Su/F – ESA Threatened	Unk	NA	Unk	NA	Comp. Chinook ER ESA 4(d) Rule	Unk	Unk	
Skokomish Su/F – ESA Threatened	Unk	NA	Unk	NA	Comp. Chinook ER ESA 4(d) Rule	Unk	Unk	
Nooksack Sp/early Fall – ESA Threatened	Unk	NA	Unk	NA	Comp. Chinook ER ESA	Unk	Unk	

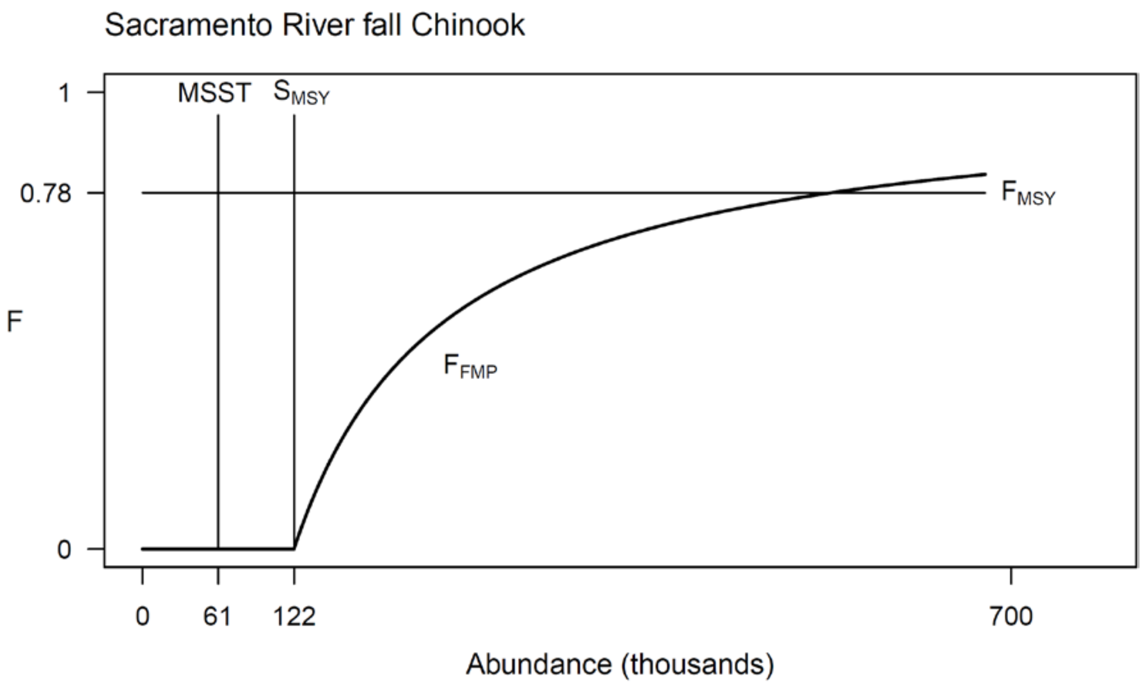
ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

Chinook Stock	S_{MSY} Est	S_{MSY} Basis	MFMT (F_{MSY}) Est	MFMT (F_{MSY}) Basis	MSST Alt 1 Status Quo Cons Obj	MSST Alt 2 & 3 $0.5*S_{MSY}$	MSST Alt 4 & 5 $0.75*S_{MSY}$	Assumptions/Issues
					4(d) Rule			
Skagit - Su/F – ESA Threatened	Unk	NA	Unk	NA	Comp. Chinook ER ESA 4(d) Rule	Unk	Unk	While these stocks remain listed and managed under the ESA, MSA SDC are not applicable and remain undefined. If a stock becomes de-listed, MSA SDC will be defined as possible.
Skagit Sp – ESA Threatened	Unk	NA	Unk	NA	Comp. Chinook ER ESA 4(d) Rule	Unk	Unk	
Stillaguamish Su/F – ESA Threatened	Unk	NA	Unk	NA	Comp. Chinook ER ESA 4(d) Rule	Unk	Unk	
Snohomish Su/F – ESA Threatened	Unk	NA	Unk	NA	Comp. Chinook ER ESA 4(d) Rule	Unk	Unk	
Cedar River Su/F – ESA Threatened	Unk	NA	Unk	NA	Comp. Chinook ER ESA 4(d) Rule	Unk	Unk	
White River Spring – ESA Threatened	Unk	NA	Unk	NA	Comp. Chinook ER - ESA 4(d) Rule	Unk	Unk	
Green River Su/F – ESA Threatened	Unk	NA	Unk	NA	Comp. Chinook ER - ESA 4(d) Rule	Unk	Unk	
Nisqually River Su/F – ESA Threatened	Unk	NA	Unk	NA	1,100 - ESA 4(d) Rule	Unk	Unk	
Lower Columbia River Fall - Hatchery	15,400	TAC	<1.0	ER	15,400	NA	NA	Hatchery egg take goals satisfy SDC (pursuant to NS1Gs' flexibility provision)
Lower Columbia River Spring - Hatchery	2,700	TAC	<1.0	ER	2,700	NA	NA	
Mid-Columbia River Bright Fall - Hatchery	?	TAC	<1.0	ER	Hatchery Egg Take	NA	NA	
Spring Creek Fall- Hatchery	7,000	TAC	<1.0	ER	7,000	NA	NA	
Willapa Bay Fall- Hatchery	8,200	WDFW	<1.0	ER	8,200	NA	NA	
Quinault Fall– Hatchery	?	QIN	<1.0	ER	Hatchery Egg Take	NA	NA	

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

Chinook Stock	S_{MSY} Est	S_{MSY} Basis	MFMT (F_{MSY}) Est	MFMT (F_{MSY}) Basis	MSST Alt 1 Status Quo Cons Obj	MSST Alt 2 & 3 $0.5*S_{MSY}$	MSST Alt 4 & 5 $0.75*S_{MSY}$	Assumptions/Issues
Sacramento Fall	122,000 151,000	Lower Mid Pt Of FMP range	0.78	App C	122,000	61,000	91,500	Need to decide if lower or mid-point of FMP range used to calculate MSST Assume lower for now
Klamath River Fall	40,700	STT	0.71	STT	35,000 FMP floor	20,350	30,525	Need to decide if STT or FMP floor used to calculate MSST Assume STT for now
Smith River Fall	UnDef	NA	0.78	App C	UnDef	UnDef	UnDef	Currently part of CA coastal, proposed alternatives would include with SONC complex
Southern Oregon	150,000 to 200,000	FMP	0.78	App C	>60 spawners/ mi	UnDef	UnDef	May have additional indicator stocks in future
Central and Northern Oregon		FMP	0.78	App C		UnDef	UnDef	
Klickitat, Warms Springs, John Day and Yakima River - Spring	Unk	FMP	Unk	NA	<1% ocean impact rate	Unk	Unk	Far North Migrating stocks (Alt 2) or EC (Alt 3) Upper River Summers might not fall into these categories
Upper River Bright - Fall	39,625	CTC	0.86	CTC	<4% ocean impact rate	Unk	Unk	
Upper River - Summer	37,041	CTC	0.75	CTC	<2% ocean impact rate	Unk (18,521)	Unk (27,781)	
Willapa Bay - Fall	4,350 (MSP)	WDFW	Unk	FMP	4,350 (MSP)	Unk	Unk	
Grays Harbor Fall	14,600 (MSP)	WDFW	Unk	FMP	14,600 (MSP)	Unk	Unk	
Grays Harbor Spring	1,400 (MSP)	FMP	Unk	FMP	1,400 (MSP)	Unk	Unk	
Queets - Fall	2,500	FMP	Unk	FMP	Unk	Unk	Unk	
Queets – Sp/Sur	700	FMP	Unk	FMP	Unk	Unk	Unk	
Hoh - Fall	1,200	FMP	Unk	FMP	Unk	Unk	Unk	
Hoh Sp/Su	900	FMP	Unk	FMP	Unk	Unk	Unk	
Quillayute - Fall	3,000	FMP	Unk	FMP	Unk	Unk	Unk	
Quillayute - Sp/Su	1,200	FMP	Unk	FMP	Unk	Unk	Unk	
Hoko -Su/F	850	FMP	Unk	FMP	Unk	Unk	Unk	
Coastal Stocks	UnDef	FMP	UnDef	FMP	UnDef	NA	NA	Canada manages stock components
Fraser River	UnDef	FMP	UnDef	FMP	UnDef	NA	NA	

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria



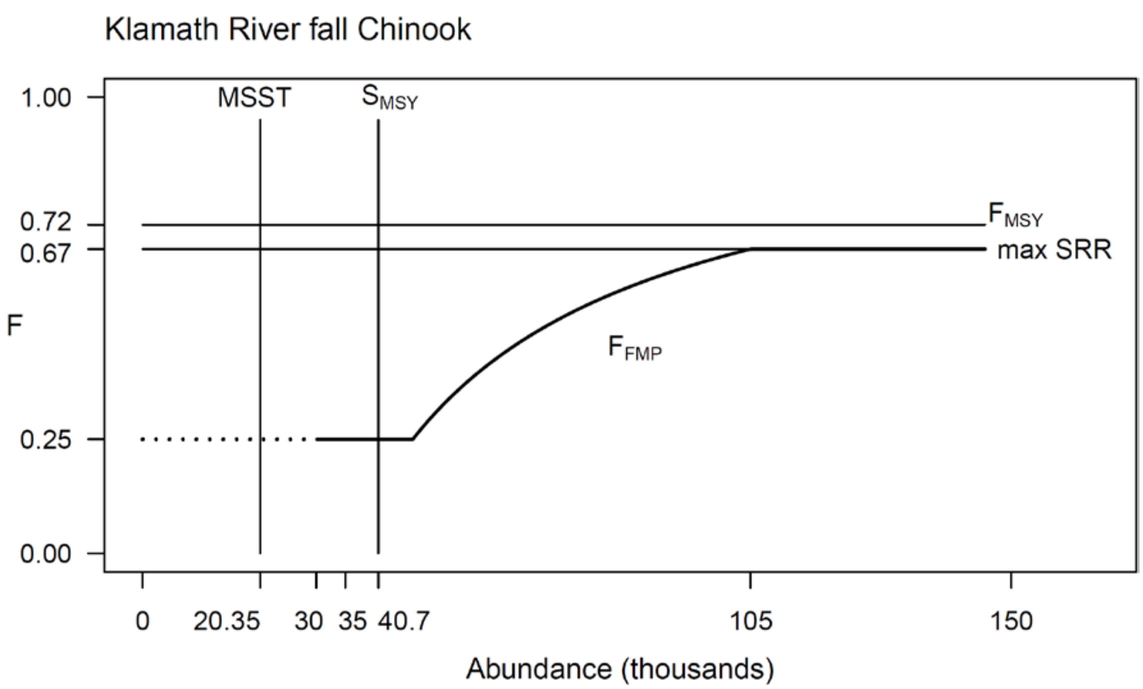


Figure 2-2. Current conservation objective control rules for Sacramento River fall Chinook and Klamath River fall Chinook. Proposed SDC reference points are superimposed on the control rules. MSST is assumed to be equal to 0.5*S_{MSY} in this figure..

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

2.3 Alternatives for Reference Points –OFL, ABC, ACL, and Associated Frameworks

Alternatives for specification of OFL, ABC, and ACL reference points will be made on an individual stock basis for all stocks as required, and to the extent possible based on the best available science. These reference points will not be specified for any stocks that are identified in the FMP as EC species[15] or stocks that are internationally managed. A statutory exception exists to the requirement for specification of an ACL where they are "otherwise provided for under an international agreement…"[16]. The NS1Gs state that with respect to the language regarding international agreements that "this exception applies to stocks or stock complexes subject to management under an international agreement." The NS1Gs also state that for internationally-assessed stocks, an ABC as defined in the NS1Gs is not required if they meet this international exception (see Section 4.1.3 for a list of salmon stocks proposed for classification as EC and stocks proposed as meeting the international exception).

The reference points identified in this section will not be specified for hatchery stocks and ESA-listed stocks identified in the FMP. This is consistent with the NS1Gs' which provide the flexibility to consider alternative approaches for specifying ACLs and AMs. The NS1Gs generally allow for flexibility for stocks with unusual life history characteristics like Pacific salmon, and particularly for species listed under the ESA and hatchery stocks[17]. For stocks classified as hatchery stocks (Tables 2-1 and 2-2), hatchery escapement goals will continue to serve as conservation objectives rather than specifying MSY-based reference points. For stocks classified as ESA stocks (Tables 2-1 and 2-2), ESA biological opinions and associated consultation standards will continue to provide necessary controls to insure their long term conservation.

Based on stock classifications Alternative 2 in Section 2.1 of this EA, the relevant stocks for specifying OFL/ABC/ACL reference points are SRFC, KRFC, and Hoh Spring Chinook. Classification Alternative 3 would only require OFL/ABC/ACL reference points for SRFC and KRFC. It is possible that South Oregon Coast Chinook, or some stock components thereof, may also support specification of these reference points prior to or shortly after implementation of this FMP amendment, depending on the outcome of an ongoing review/revision of management objectives for that stock complex. These stocks could then serve either as additional indicator stocks for the SONC complex, form an independent complex, or as individual stocks.

2.3.1 Criteria Used to Evaluate the Alternatives

The criteria used to evaluate SDC alternatives were consistency with the NS1Gs and feasibility of implementation. Considerations within the criterion for NS1Gs consistency include:

- Risk of Overfishing
- Feasibility of Implementation
- Consistency with MSA Section 303(a)(15) and MSA Section 302(g)(1)(b). Considerations within this criterion include consistency with the all applicable requirements of the MSA, particularly the requirement that FMPs provide a mechanism for specifying Annual Catch Limits[18] (ACL).
- Consistency with NS1 Guidelines. Considerations within this criterion include consistency with approaches in the NS1Gs for each reference point. The NS1Gs define all of these reference points as

[15] 50 CFR 600.310(d)(5)
[16] MSRA§104(b)(1)
[17] 50 CFR 600 310(h)(3)
[18] MSA Section 303(a)(15)

values that will be specified annually (or multiple years, if necessary) based on catch[19], expressed in terms of numbers or weight of fish and including all sources of fishing mortality from all fisheries (federal and non-federal). The reason for this is because the two statutorily required reference points (ABC and ACL) include the term "catch", which is most frequently defined in fisheries management in those terms.

2.3.2 Alternative Reference Points for OFL, ABC, and ACL

The stock classification alternatives will affect the viability of approaches for specifying these reference points, as will the specification of SDC for overfishing. Regarding the latter, implementation feasibility and assessment capability will be of particular interest. Based on the classification alternatives presented in Sections 2.1, Table 2-10 presents a conceptual view of stock specific based alternatives to be further considered.

Table 2-10. Overview of alternatives for OFL, ABC, ACL, ACT, and the associated framework.

Alternatives	OFL	ABC	ACL	ACT[a/]	Framework
1) Status Quo	Not identified	Not identified	Not identified	Not identified	--NA— Current conservation objectives specified not to exceed (S_{MSY})
2) Catch (C) Based	C_{OFL}	C_{ABC}	C_{ACL}	C_{ACT} [a/]	$C_{OFL} > C_{ABC} = C_{ACL} > C_{ACT}$ $C_{OFL}(t) = N(t) \times F_{MSY}$ $C_{ABC}(t) = N(t) \times F_{ABC}$ F_{ABC} = 95% or 90% F_{MSY}[b/]
3) Spawning Escapement (S) Based	S_{OFL}	S_{ABC}	S_{ACL}	S_{ACT} [a/]	$S_{OFL} < S_{ABC} = S_{ACL} < S_{ACT}$ $S_{OFL}(t) = N(t) \times (1-F_{MSY})$ $S_{ABC}(t) = N(t) \times (1-F_{ABC})$ F_{ABC} = 95% or 90% F_{MSY}[b/]

a/ ACT could be used, as needed, but is undefined at this time.
b/ The buffer to account for scientific uncertainty is either 95% or 90% of F_{MSY}, depending on whether the F_{MSY} value represents a stock-specific estimate (Tier 1) or proxy value (Tier 2), respectively.

F_{MSY} is defined as the constant value of the total annual exploitation rate (independent of stock abundance) that would result in MSY over the long term under prevailing ecological and environmental conditions.

All of the N, C, and F quantities in Table 2-10 are defined in terms of "spawner equivalents". For salmon, spawner equivalent units are biologically the most meaningful metric to use for these quantities, and are used as the basis of current conservation objective control rules.

Spawner equivalent units are the number of would-be spawners represented by the respective quantity, absent further fishing. Thus, S by definition is expressed in spawner equivalent units. For C, an adult fish caught in freshwater has a spawner equivalence of one, but a fish caught in the ocean has a spawner equivalence of less than one. A fish in the ocean may or may not have survived natural mortality, and may or may not have matured in the current year to return to freshwater to spawn. Thus, ocean catch, in spawner equivalent units, is discounted for natural mortality and maturation. N is pre-fishery ocean

[19] Catch is the total quantity of fish, measured in weight or numbers of fish, taken in commercial, recreational, subsistence, tribal, and other fisheries. Catch includes fish that are retained for any purpose, as well as mortality of fish that are discarded. 50 CFR 600.310 (f)(2)(i)

abundance likewise discounted for natural mortality and maturation. F is the total exploitation rate of spawner equivalents, C/N.

For succinctness, in the following sections the quantities N, C, and F will be simply referred to as “abundance”, “catch”, and “exploitation rate”, without the spawner equivalents qualifier except as necessary to discuss issues specifically pertaining to that fact.

2.3.3 Alternative 1: Status Quo – Not defined

Under the status quo, each stock is managed according to its individual conservation objectives. Current conservation objectives are based on exploitation rates or escapement goals. OFL, ABC, ACL, and ACT are not reference points that are currently specified for any stock.

Description: All current FMP conservation objectives can be translated into exploitation rate control rules which specify the allowable total exploitation rate (i.e., includes all mortality from federal and non-federal fisheries) on the basis of the abundance of the stock. The four control rule types are:

- constant escapement
  Example: Columbia River summer Chinook
- escapement range
  Example: Sacramento River fall Chinook. 122,000 – 180,000 natural and hatchery adult spawners
- exploitation rate with floor level of escapement
  Example: Klamath River fall Chinook. 33-34% of potential adult natural spawners, but no fewer than 35,000 naturally spawning adults in any one year
- stepped exploitation rate
  Example: Skagit Coho. ≤60% total exploitation rate at pre-fishing abundance ≥62,500; ≤35% total exploitation rate at pre-fishing abundance ≤62,500 and ≥22,857; ≤20% total exploitation rate at pre-fishing abundance ≤22,857

Exploitation rate based models are coupled with annual stock abundance forecasts to evaluate whether proposed fishery management measures are simultaneously consistent with the control rules of all FMP-managed stocks, the ESA consultation standards of all ESA-listed stocks, requirements of meeting Pacific Salmon Treaty obligations and giving due consideration to hatchery stock goals (egg-take needs).

The ocean salmon fishery is a mixed-stock fishery; therefore, total federal ocean harvest is managed to a level not to exceed the allowable ocean harvest of the most limiting stocks in the fishery. The potential ocean harvest of some stocks is often forgone in a given year, although overfishing still could occur on those stocks due to fishing mortality from non-federal fisheries. While the management paradigm for ocean salmon harvest has been termed “weak-stock management”, the resulting harvest is achieving optimum yield for the fishery each year.

Currently, ocean salmon harvest along the west coast is managed using either catch limits (quotas) or catch targets (based on time and area closures). Off the Washington coast mixed-stock quotas (not to be confused with complexes) are used to control the ocean harvest. Off the Oregon coast, both mixed-stock quotas and time/area closures (effort control) are used. The quotas off Washington and Oregon are monitored in-season and have rarely been exceeded. Off the California coast, time/area closures are primarily used to manage ocean harvest and are based on an expected effort and catch associated with achieving stock specific conservation objectives.

Risk of Overfishing: While OFL, ABC, and ACL are not currently specified in the Status Quo Alternative, this does not imply that the risk of overfishing is, or has been, high. Compared to the F_{MSY} approach described in the NS1Gs, however, it is not readily apparent whether or how the current set of control rules governing the exploitation of FMP-managed stocks account for scientific uncertainty. By overlaying the estimated F_{MSY} value onto the current control rules, it can be demonstrated that the current exploitation rate control rules are generally conservative (buffered) relative to F_{MSY}, with the exception of SRFC at high abundance levels (Figure 2-3).

Feasibility of Implementation: The Status Quo Alternative is currently implemented.

Consistency with MSA Section 303(a)(15) and MSA Section 302(g)(1)(b) and NS1Gs: Because the SQ Alternative does not specify ACLs, it is not a viable alternative and does not meet the purpose and need of the proposed action.

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

2.3.4 Alternatives 2 and 3 Overview

Alternatives 2 and 3 specify OFL and ABC on the basis of exploitation rate (i.e., F_{MSY} and F_{ABC}) and abundance for each stock. F_{MSY} and F_{ABC} are defined in terms of total exploitation rate across all salmon fisheries (federal and non-federal jurisdictions). Impacts in non-salmon fisheries are included in the natural mortality assumptions used to estimate population parameters for salmon stocks; therefore, all fishing mortality sources are accounted for when reference points are specified. Current conservation objectives for all FMP-managed stocks can be expressed as exploitation rate control rules, with exploitation rates dependent on stock abundance.

<u>OFL</u>: OFL will be derived from the stock specific estimate of $F_{MSY,}$ or a F_{MSY} proxy, and abundance. OFL will be expressed in terms of either catch (C) or spawning escapement (S). Stock-specific estimates of F_{MSY} based on spawner-recruit data will be used if available. Otherwise, species-specific proxy values of F_{MSY} = 0.78 for Chinook will be employed. The derivation of the Chinook F_{MSY} proxy values is documented in Appendix C.

<u>ABC and the ABC Control Rule</u>: ABC will be derived from an ABC control rule. The first step in determining the annual ABC is to specify $F_{ABC.}$ The second step requires applying F_{ABC} to the abundance to derive the annual ABC value expressed in terms of C or S.

F_{ABC} is a constant exploitation rate which is reduced from F_{MSY} by a buffer that accounts for scientific uncertainty. Two tiers of buffers have been established based on the level of scientific uncertainty associated with stocks having different levels of data richness. Taking such a tiered approach to specification of the ABC is consistent with the NS1Gs[20] and appropriately accounts for the differences in scientific uncertainty among the stocks.

- <u>Tier 1</u>: For stocks that have sufficient data to conduct a stock-specific spawner-recruit analysis, and for which F_{MSY} has been directly estimated, the buffer level is 5% ($F_{ABC} = F_{MSY} \times 0.95$).
- <u>Tier 2</u>: For stocks that have not undergone a spawner-recruit analysis, and F_{MSY} has been determined by proxy, the buffer level is 10% ($F_{ABC} = F_{MSY} \times 0.90$).

The resulting SRFC and KRFC F-based control rules, both the status quo forms and with incorporation of the ABC control rule, are displayed in Figure 2-3. With regard to SRFC, the control rules depicted assume S_{MSY} = 122,000. For SRFC, the most notable difference between status quo and the control rule incorporating the ABC is the specification of the maximum exploitation rate at F_{ABC}. Without the ABC control rule, the target exploitation rate for SRFC continues to increase with increasing abundance, approaching F = 1 as abundance increases. For KRFC, the status quo maximum allowable exploitation rate is 0.67, and application of the ABC control rule results in a minor change in maximum allowable F from 0.67 to 0.68. Another difference for the KRFC control rule is a decrease in the allowable exploitation rate over a portion of the range, owing to a target spawner escapement level of S_{MSY} = 40,700 instead of the status quo escapement target of 35,000.

[20] 50 CFR 600.310 (f)(4)

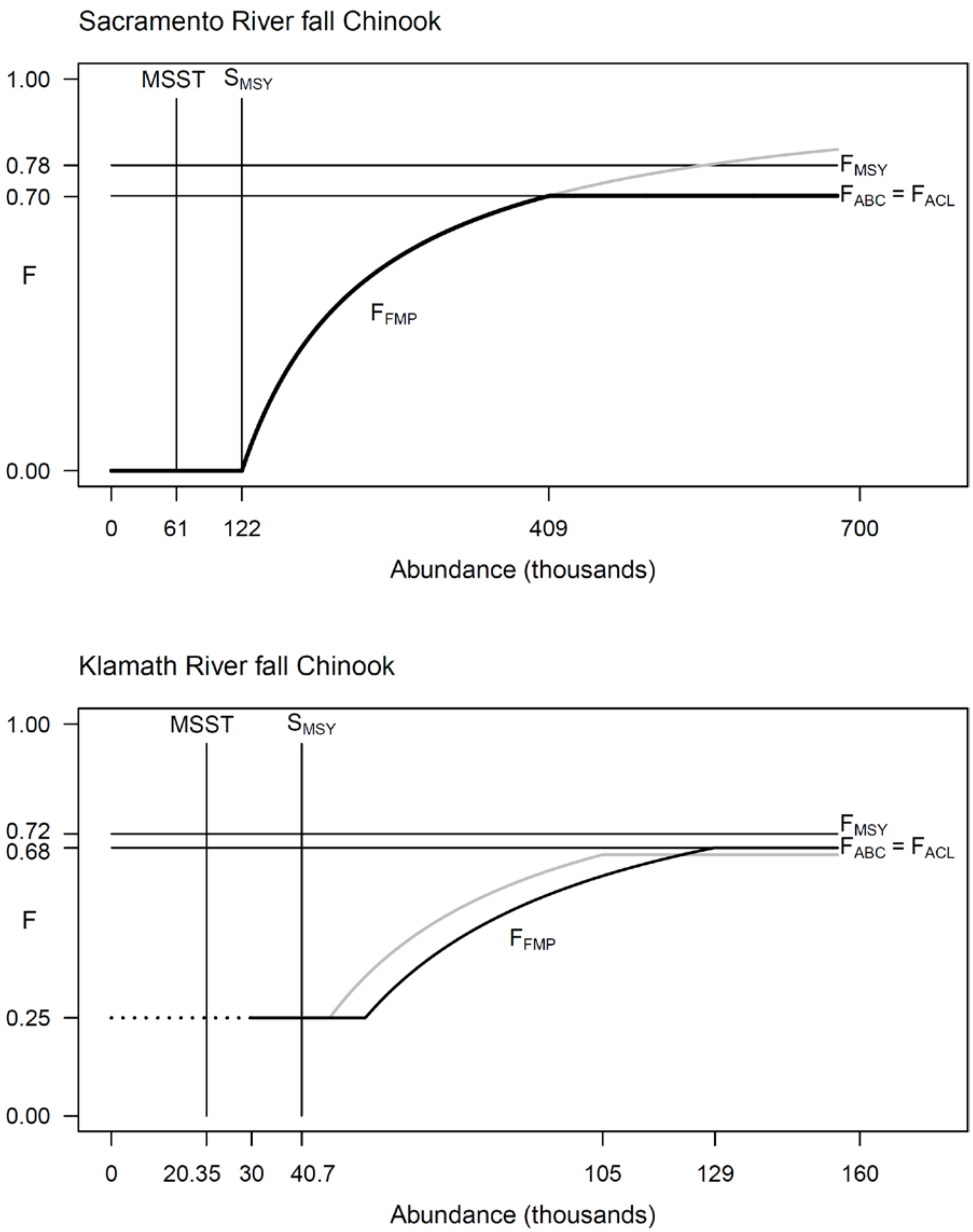


Figure 2-3. Status quo (thick gray line) and Alternative 2 and 3 (thick black line) F-based control rules for SRFC and KRFC. Reference points MSST, S_{MSY}, F_{MSY}, F_{ABC}, and F_{ACL}, are denoted by thin black lines.

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

Consistency with the NS1Gs on scientific uncertainty and specification of ABC:

For both the C-based alternative and the S-based alternative, the ABC is buffered from the OFL (i.e., reduced from the OFL under the C-based alternative and increased from the OFL under the S-based alternative) to account for scientific uncertainty as described in the NS1Gs. For alternative 2, the ABC is determined preseason by multiplying the F_{ABC} by the abundance forecast. For alternative 3, the ABC is determined preseason by multiplying 1-F_{ABC} by the abundance forecast.

However, the determination of whether the ABC is exceeded on an annual basis will be made using *postseason* estimates of abundance and the specified value of F_{ABC} (or its complement). Since the ABC will be evaluated on a postseason basis, with postseason estimates of abundance, the probability of overfishing is primarily dependent on whether F_{ABC} exceeds the true value of $F_{MSY.}$ Hence, the focal source of scientific uncertainty is uncertainty in the true value of $F_{MSY.}$

Preseason salmon abundance forecasts are uncertain, and comprise a large share of the uncertainty in annual preseason forecasts of catch and escapement. However, the methods used for salmon abundance forecasting and assessment are unbiased. Although forecast errors may be large in any particular year, the forecasting methods used result in a balancing of errors across years. The combination of (1) unbiased abundance forecasts and assessment variability, (2) the ABC control rule that specifies F_{ABC} as the maximum allowable exploitation rate, and (3) the buffer between F_{ABC} and F_{MSY} to account for scientific uncertainty in the true value of F_{MSY}, combines to result in an annual probability of overfishing of less than 50%.

The tiered approach to setting the ABC control rule reflects the expectation of different levels of uncertainty in F_{MSY} for salmon stocks with differing levels of data richness. Appendix D quantifies uncertainty in the true value of $F_{MSY,}$ both in the case where F_{MSY} is directly estimated, and for the case where an F_{MSY} proxy is relied upon. The 5% and 10% buffers for Tier 1 and Tier 2 stocks, respectively, were chosen to be general buffer levels that could be applied to all salmon stocks when necessary for specifying the ABC control rule. The results presented in Appendix D demonstrate that the buffers associated with both tiers substantially reduce the likelihood of the F_{ABC} exceeding the true $F_{MSY.}$ These results are interpreted as describing the degree to which the F_{ABC} control rule reduces the probability of overfishing.

In practice, the probability of overfishing will usually be less than the probability that F_{ABC} exceeds F_{MSY} because the target F will be less than F_{ABC} at low to moderate abundance. From a single stock perspective, individual stock conservation objectives require target exploitation rates lower than F_{ABC} as abundance declines (Figure 2-3). This clearly meets the intent of the NS1Gs which state that consideration should be given in the ABC control rule to reducing fishing mortality as stock size declines, but this is done through the conservation objective exploitation rate control rule rather than the F_{ABC} control rule. The conservation objective exploitation rate control rule thus provides a substantial amount of additional buffering beyond the F_{ABC} buffer at mid- and low-levels of abundance. From the perspective of the mixed-stock ocean fishery, meeting conservation objectives for ESA-listed and weak target stocks may further restrict the exploitation rate on the remaining stocks. Both of these factors frequently result in an exploitation rate lower than the F_{ABC} value.

The retrospective analysis of overfishing (Table 4-1) demonstrates that overfishing has been a highly infrequent occurrence since the mid 1990s. Note that the control rules determining allowable F in past years does not include an F_{ABC} control rule with a maximum allowable exploitation rate specified at $F_{ABC.}$ Nevertheless, the salmon management system described in the retrospective analysis clearly has been effective in controlling exploitation rates since the mid 1990s. Reductions in exploitation rates that occurred at this time were due to management constraints on fisheries to meet conservation objectives for both ESA-listed and weak target stocks. This management scenario, where ESA-listed and weak target stocks constrain fisheries, is not likely to change in the future. Thus, the buffer defining the ABC control rule sufficiently accounts for scientific uncertainty, and when coupled with the additional buffers present in the salmon management system, reduces the probability of overfishing to something well below 50%.

Process of ABC Specification and SSC Approval: The NS1Gs state that Councils should "identify the body that will apply the ABC control rule (i.e., calculates the ABC) and identify the review process that will evaluate the resulting ABC", and that "the SSC must recommend the ABC to the Council."[21]

The SSC will be involved in the review and approval of the ABC control rule initially through this plan amendment, and subsequently as it reviews annual preseason forecasts. The ABC control rule itself will be fixed, but the year specific ABC for a given stock varies depending on the preseason forecast. The SSC will have an ongoing role in setting ABCs through their existing responsibility to review these forecasts. Forecast methods are periodically revised and these too are routinely reviewed by the SSC through the existing methodology review process. The Council's Salmon Technical Team (STT) would develop the preseason forecasts, subject to the SSCs review, and apply the SSC-approved ABC control rule each year. The annual ABCs recommendations will be reported to the Council in STT Preseason Report I (PFMC 2010b). This process would follow the current preseason report process and Salmon Methodology Review process (PFMC 2008).

Currently, each February, the STT provides preseason stock abundance forecasts for the upcoming fishing year in Preseason Report I. The ABC recommendation would be included in this report. The SSC could revisit the ABC control rule annually or as needed in the fall when salmon methodologies are reviewed in preparation for the preseason process.

The STT forecasts fishery impacts using harvest models, which have been developed and documented by the STT, MEW, State, Tribal, and Federal management agencies, reviewed by the SSC, and approved by the Council. These models generally use stock specific abundance estimates, historical fishery exploitation patterns, and a combination of effort estimates and quotas to project impacts. The model algorithms generally do not change substantially from year to year, but any changes that are proposed must be reviewed by the SSC and approved by the Council. The abundance forecasts used in the harvest models are calculated annually based on methods documented in Preseason Report I, which is also reviewed by the SSC and approved by the Council. Other model inputs may be updated, such as adding another year of catch and effort data, without additional review and approval. During the preseason planning process, the STT uses the models to compare impacts from proposed management measures to that allowed under the control rules (determined by the FMP conservation objectives), so that the Council can adopt appropriate management specifications for the upcoming season.

This process allows the SSC to recommend to the Council control rules for salmon stocks that are adopted into the FMP either through formal FMP amendment or through technical review of updated conservation objectives (FMP §3.2.1). The SSC also recommends to the Council the methods used to project compliance with the control rules (PFMC 2008), and the significant annual model input data (Preseason Report I). The STT is delegated the responsibility of applying the control rule to develop annual management specifications, but in all other respects, the SSC is responsible for review and oversight of the process, and making recommendations to the Council for approval.

[21] 50 CFR 600.310 (f)(3)

2.3.4.1 Alternative 2: Catch (C) Based ACL Framework

Under this alternative, C_{OFL}, C_{ABC}, and C_{ACL} are specified for each stock considering all catch expected from federal and non-federal fisheries. These catch-based reference points would be derived each year by applying the corresponding exploitation rate based values (i.e., F_{MSY} and F_{ABC}), as described above, to the forecast abundance of the stock that year.

- **C_{OFL}** is the annual catch, derived by multiplying a stock's F_{MSY} with the stock's forecast abundance (N) in a given year (t).

  $$C_{OFL}(t) = N(t) \times F_{MSY}$$

- **C_{ABC}** is the annual catch derived by multiplying a stock's F_{ABC} with the stock's forecast abundance (N) in a given year (t).

  $$C_{ABC}(t) = N(t) \times F_{ABC}$$

  As described above, F_{ABC} is reduced from F_{MSY} to account for scientific uncertainty.

- **C_{ACL}** is equal to C_{ABC}, which could be greater than allowed by stocks' conservation objectives or other factors, such as constraints to protect ESA-listed stocks (Figure 2-4). As such, the C_{ACL} would be considered an upper limit associated with preventing overfishing only, rather than a harvest objective.

Actual computation of the C-based reference points are typically more complicated than the examples above and in Figure 2-4 owing to the age structure and time-dependence of various fishery and biological parameters, which varies among stocks and on the nature of the conservation objective. These reference points will be used in the pre-season process, along with stocks' conservation objectives, to design the fishery such that any specified C_{ACL} for a stock or complex is not exceeded. During the fishing year, an individual stock's or complex's C_{ACL} cannot be monitored in-season.

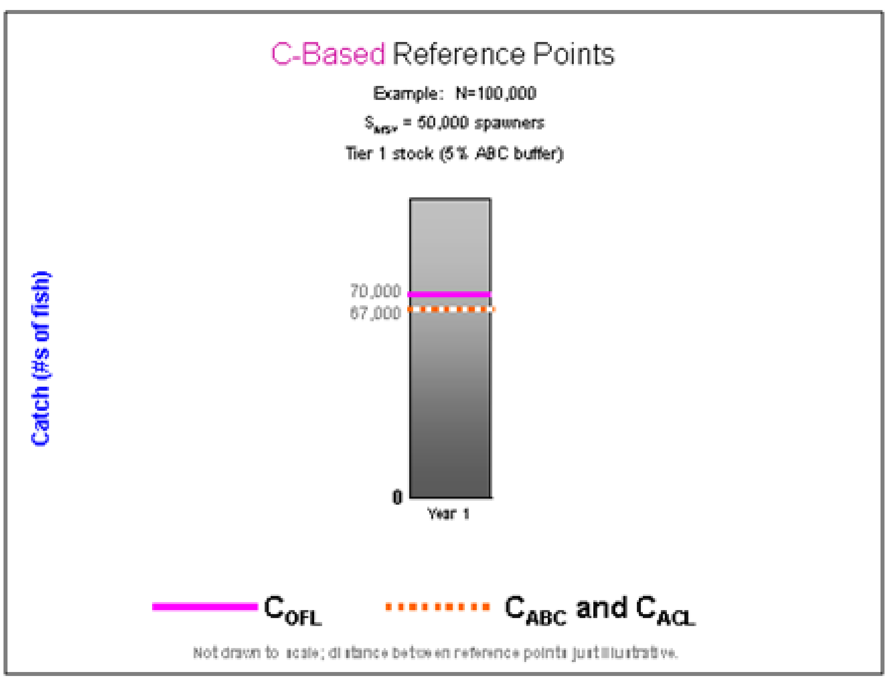


Figure 2-4: Example of C-based reference points. Note that C_{ACL} is greater than allowed under management for the stock's conservation objective (S_{MSY}, 50,000 fish).

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

Implementation of the C-based Alternative would require that F_{MSY} and F_{ABC} be explicitly defined for all stocks and complexes (i.e., for the indicator stocks) in the fishery requiring ACLs (Figure 2-3). F-based reference points are all independent of stock abundance, and would thus be fixed values across years unless the value of F_{MSY} was revised based on additional information. Implementation of this alternative would also require that current year abundance forecasts be made for all stocks and complexes (i.e., for the indicator stocks) subject to ACL requirements prior to the preseason management planning process. This is already done as part of the annual Council assessment and management process. No further work would be required to implement the C-based Alternative into the preseason planning process beyond what is currently done.

Implementation of the C-based Alternative would require postseason estimates each year of abundance and catch to compare with the preseason forecast reference points, particularly $C_{ACL,}$ and their postseason values, based on the actual abundance. This appears to be technically feasible (estimation methods vary by stock), though additional methods will need to be developed to estimate the catch of spawner equivalents for some stocks. The STT would conduct this work and report these results annually prior to the development of Council management measures for the following year's fisheries.

Current conservation objectives and control rules would change somewhat from the status quo under the C-based Alternative. For SRFC, in years of high abundance, harvest would be capped by the C_{ACL}. For KRFC, the F_{ABC} level would change slightly due to specification of F_{MSY} and the tier 1 buffer defining the ABC control rule. Furthermore, the F-based conservation objective control rule for Alternatives 2 and 3 specify allowable exploitation rates that result in a minimum spawner abundance of S_{MSY}, which is higher than target spawner abundance levels in the Status Quo Alternative (Figure 2-3).

The C-based Alternative would not require any change in the customary management measures used by the Council both north and south of Cape Falcon. In particular, it does not require that all salmon fisheries be managed by quota.

Consistency with MSA Section 303(a)(15) and MSA Section 302(g)(1)(b) and NS1Gs: This alternative is most obviously consistent with the statutory requirements and intent for ACLs and ABC because these reference points are expressed in terms of catch. This alternative also provides for an annual limit on catch. However, as in the S-based alternative, this limit will only be used preseason for providing an upper limit for each stock when planning fisheries and for postseason comparisons. Due to the nature of the mixed stock ocean fishery and the inability to identify individual stocks caught in the ocean, even the C-based ACL cannot currently be monitored inseason. Nevertheless, designing the fishery within each year's constraints will continue to prevent overfishing in the fishery consistent with the MSA requirements.

- **NS1Gs definitions and expression of reference points**: This alternative is also most obviously consistent with the NS1Gs' definitions of these reference points in that they will be expressed in terms of catch and specified annually.

- **NS1Gs' framework relationship of reference points**: This alternative is consistent with the framework established by the NS1Gs because C_{ABC} is specified at a level below $C_{OFL,}$ and C_{ACL} will be specified at a level that does not exceed C_{ABC}, specifically it will be set equal to C_{ABC} (although it could be set below C_{ABC}, if desired by the Council).

- **Scientific uncertainty and specification of ABC**: See discussion in "Basis of Alternative 2 and 3" above.

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

- **Management uncertainty**: An ACT is not, at this time, proposed for use but could be implemented, if necessary (see section 4.4.2 of this EA).

- **Relationship of the ACL to accountability measures (AMs)**: The NSGs identify "AMs for when the ACL is exceeded".[22] Under this alternative, such AMs would be characterized as "AMs for when the C_{ACL} is exceeded". For purposes of triggering "AMs for when the ACL is exceeded" a post-season C_{ACL} will be used. The C_{ACL} will be recalculated using post-season estimates of abundance and compared with the post-season catch. "AMs for when the ACL is exceeded" would be triggered if the post-season C_{ACL} value is exceeded, not if the post-season catch exceeded the pre-season $C_{ACL.}$

- **Performance standard for exceeding the ACL**: The NS1Gs include a performance standard that requires a re-evaluation of this framework if the ACL is exceeded more than one in four years. This performance standard will apply if the postseason catch exceeds the C_{ACL} calculated with postseason estimated abundance, rather than the preseason $C_{ACL,}$ to ensure the performance measure is biologically meaningful. For example, if the post-season catch exceeded the preseason C_{ACL} because the actual abundance was greater than was forecast, it would not present a biological concern. It would only be a biological concern if the actual catch exceeded the post-season C_{ACL}, i.e., calculated with the updated, actual abundance estimate. The use of postseason estimates of C_{ACL} rather than preseason forecasts of this reference point is uniquely appropriate for salmon management because high quality postseason abundance estimates are able to be made each year. This allows for the biologically relevant comparison between catch and the $C_{ACL,}$ as determined using high quality abundance estimates.

2.3.4.2 Alternative 3: Spawning Escapement (S) Based ACL Framework

Under Alternative 3, OFL, ABC, ACL, and ACT are specified on the basis of spawning escapement (S), which is the metric most commonly used for assessing the status of salmon stocks.

- S_{OFL}, S_{ABC}, and S_{ACL} are specified for each stock.
- The framework is: $S_{OFL} < S_{ABC} = S_{ACL} < S_{ACT}$. S_{ACT} is undefined at this time, but if ever specified, it would be at a level greater than S_{ACL}.

Under this alternative, S_{OFL}, S_{ABC}, and S_{ACL} are specified for each stock individually. These S based reference points are derived each year by applying the corresponding exploitation rate based values (i.e., F_{MSY} and F_{ABC}), as described above, to the pre-fishery abundance of the stock that year.

- $\mathbf{S_{OFL}}$ is the annual spawning escapement that is derived by subtracting a stock's estimate of F_{MSY} from 1 (which translates the mortality rate into a survival rate) and then multiplying that by the stock's abundance (N) in a given year (t).

$$S_{OFL}(t) = N(t) \times (1-F_{MSY})$$

- $\mathbf{S_{ABC}}$ is the annual spawning escapement that is derived by subtracting a stock's F_{ABC} from 1 (which translates the mortality rate into a survival rate) and then multiplying that by the stock's abundance (N) in a given year (t).

$$S_{ABC}(t) = N(t) \times (1-F_{ABC})$$

As described in section 4.3.5, F_{ABC} is reduced from F_{MSY} to account for scientific uncertainty. This same approach is used for this Alternative.

---

[22] 50 CFR 600.310 (g)(3)

- o <u>Tier 1</u>: For stocks for which F_{MSY} has been directly estimated the buffer level is 5% ($F_{ABC} = F_{MSY} \times 0.95$).
- o <u>Tier 2</u>: For stocks for which F_{MSY} has been determined by proxy the buffer level is 10% ($F_{ABC} = F_{MSY} \times 0.90$).

- **S_{ACL}** will be equal to S_{ABC}

The S_{ACL} will fluctuate above or below the conservation objective depending on abundance forecasts (Figure 2-5).

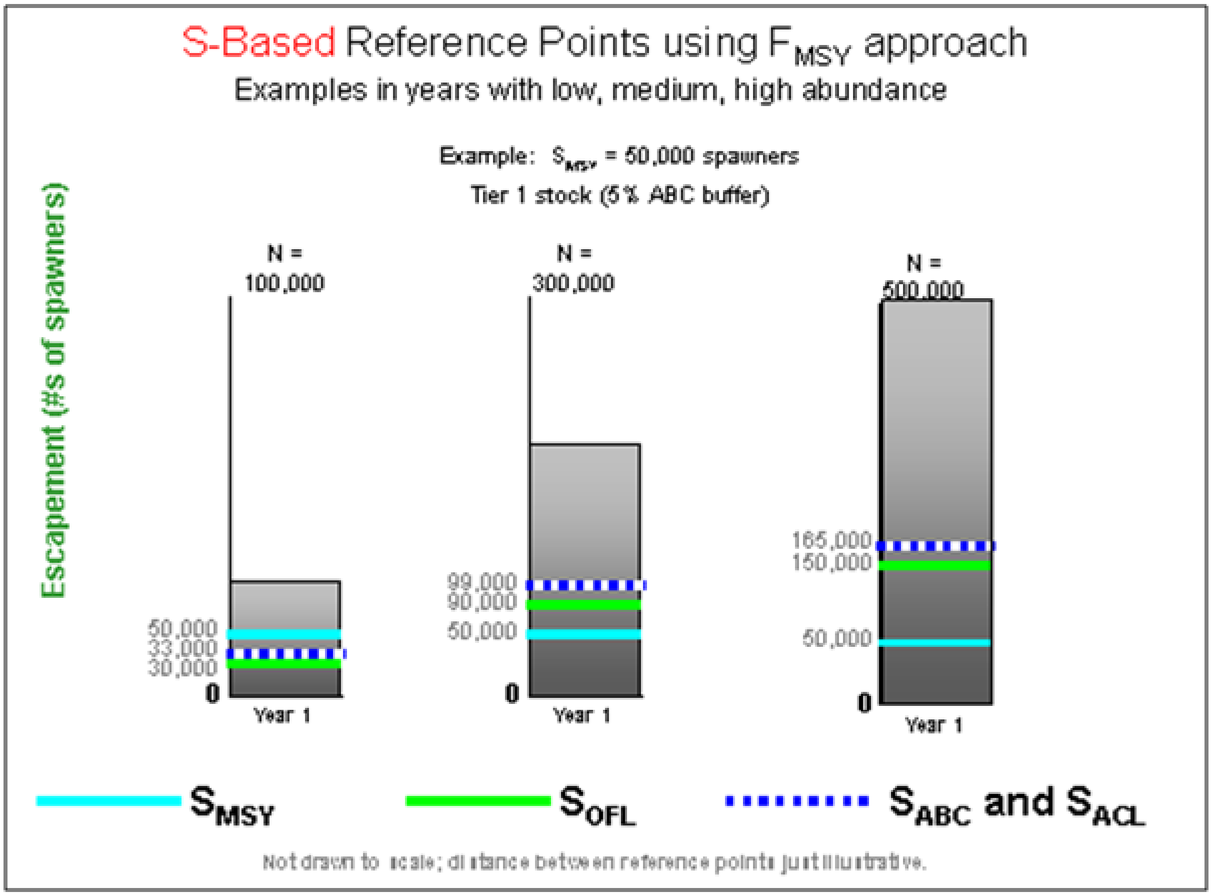


Figure 2-5. Example of S-based reference points. Note that SACL is less than the objective in low abundance years and greater than the spawning objective under management for the stock's conservation objective (S_{MSY}, 50,000 fish).

In years with low abundance, the S_{ACL} could be specified at a level lower than the conservation objective specified escapement target. In that situation, the conservation objective escapement target would remain the management target for the fishery. In years with high abundance, the S_{ACL} would be specified at a level that could be greater than the conservation objective escapement target. In that situation, the fishery would be designed to achieve an amount of returning spawners no less than the S_{ACL} (i.e., greater than S specified in the conservation objective).

Actual computation of the S-based reference points above are typically more complicated than in the above examples and Figure 2-5 owing to the age composition and time-dependence of various fishery and biological parameters. Computation of S-based reference points can also vary among stocks depending

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

on the nature of the conservation objective. These reference points will be used in the pre-season process, along with stocks' conservation objectives, to design the fishery such that the number of spawners exceeds any specified S_{ACL} for a stock or complex. During the fishing year, an individual stock's or complex's S_{ACL} cannot be monitored in-season.

Comparison to Status Quo: Current conservation objectives expressed as escapement control rules will be overlaid on the above S-based framework. The Council will continue to manage according to current conservation objective control rules except as limited by the S_{ACL} value. Fisheries would be managed to limit the expected value of spawning escapement to no less than the S_{ACL} value. However, escapement itself would not be directly controlled in-season so as not to fall below the S_{ACL} because this cannot be readily done with salmon fisheries. Spawners encounter the ocean fisheries often months before reaching their river of origin and in areas far from the river mouths, thus, escapement can only be monitored after the ocean fisheries have occurred. It is expected that the lack of direct control of the stock-specific escapement values in-season will not be an issue given other constraints on the fisheries.

Risk of Overfishing: The risk of overfishing is similar to or less than under the Status Quo Alternative (assuming overfishing is defined as $F > F_{MSY}$). In all years, regardless of stock abundance, the S_{ACL} will be greater than or equal to S_{MSY} owing to the buffer between F_{MSY} and F_{ABC} (equal to F_{ACL}; Figure 2-3) and the conservation objective control rules. The conservation objective control rules specify a maximum allowable exploitation rate of F_{ABC} (equal to F_{ACL}) at high abundance levels, and lower exploitation rates when abundance declines. Therefore, in years with low to moderate stock abundance, the target spawner abundance will be higher than the S_{ABC} and S_{ACL}.

The risk of overfishing (exceeding F_{MSY}) under the C-based and S-based Alternatives would be comparable. For additional stock specific considerations for the risk of overfishing, refer to the "Risk of Overfishing" section for description in section 4.3.5.1.

The S-based Alternative does not include directly controlling in-season the escapement for each stock, as it cannot be readily done with salmon fisheries.

The preseason values for S_{OFL}, S_{ABC}, and S_{ACL} will be used in the preseason process, as is done now with stocks' conservation objectives, to design the fishery and prevent overfishing. However, for purposes of monitoring performance and triggering AMs, the reference points will be recalculated using post-season estimates of abundance and compared to escapement.

Feasibility of Implementation: Implementation of the S-based Alternative would require that F_{MSY} and F_{ABC} be explicitly defined for all stocks and complexes in the fishery (i.e., all indicator stocks) that are subject to the ACL requirements. F-based reference points are all independent of stock abundance, and would thus be fixed values across years unless the value of F_{MSY} was revised based on additional information. Implementation of this alternative would also require that current year abundance forecasts be made for these stocks prior to the preseason management planning process. This is already done as part of the Council annual management process. No further work would be required to implement the S-based Alternative into the preseason management planning process beyond what is currently done.

Implementation of the S-based Alternative would require postseason estimates each year of abundance and escapement to compare with the preseason forecast reference points, particularly S_{ACL}, and their postseason actual values, based on the actual abundance. This appears to be technically feasible (estimation methods vary by stock), and it could be done without a great deal of additional effort. The Salmon Technical Team would conduct this work and report these results annually prior to the development of Council management measures for the following year's fisheries.

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

Current conservation objectives and control rules would change somewhat from the Status Quo under the S-based Alternative. For SRFC, in years of high abundance, target spawner abundance would be higher than that specified by the Status Quo control rule, owing to the capping of the allowable exploitation rate at F_{ABC}. For KRFC, the F_{ABC} level would change slightly due to specification of F_{MSY} and the tier 1 buffer defining the ABC control rule, which would result in very minor changes to target spawner abundance levels at high abundances. Furthermore, the F-based conservation objective control rule for Alternatives 2 and 3 specify allowable exploitation rates that result in a minimum spawner abundance of S_{MSY}, which is higher than target spawner abundance levels in the Status Quo Alternative (Figure 4-4).

The S-based Alternative would not require any change in the customary management measures used by the Council both north and south of Cape Falcon.

<u>Consistency with MSA Section 303(a)(15) and MSA Section 302(g)(1)(b) and NS1Gs</u>: While this alternative does not directly define annual limits in terms of catch, it does define such limits in terms of spawner escapement, and therefore in effect limits catch. By designing the fishery within each year's constraints and no lower than each stock's S_{ACL}, it will continue to prevent overfishing in the fishery consistent with the MSA.

- **NS1Gs definitions and expression of reference points**: This alternative is also generally consistent with the NS1Gs' definitions of these reference points. Although they will not be expressed in terms of catch, they will be specified in terms of numbers of fish and specified annually. The NS1G's allow for "flexibility" in achieving the goals of the guidelines for species with unique life histories such as salmon.

- **NS1Gs' framework relationship of reference points**: This alternative is consistent with the framework established by the NS1Gs because S_{ABC} is specified with a buffer to account for scientific uncertainty in the $S_{OFL,}$ and S_{ACL} will be specified at a level equal to the S_{ABC} (although it could be set above S_{ABC}, if desired by the Council).

- **Scientific uncertainty and specification of ABC**: See discussion in "Basis of Alternative 2 and 3" above.

- **Management uncertainty**: An ACT is not, at this time, proposed for use but could be implemented, if necessary.

- **Relationship of the ACL to accountability measures (AMs)**: The NSGs identify "AMs for when the ACL is exceeded". Under this alternative, such AMs would be characterized as "AMs for when the S_{ACL} is not achieved". For purposes of triggering these post-season spawner escapement-based AMs, a post-season S_{ACL} will be used. The S_{ACL} will be recalculated using post-season estimates of abundance and compared to the post-season escapement. These AMs would only be triggered if the post-season S_{ACL} is not achieved, not if the post-season escapement fell below the preseason S_{ACL}.

- **Performance standard for exceeding the ACL**: The NS1Gs include a performance standard that requires a re-evaluation of this framework if the ACL is exceeded more than one in four years. This performance standard would be triggered if the S_{ACL}, calculated with postseason abundance estimates, is not achieved in more than one in four years. This performance standard will only apply if the postseason, actual escapement falls below the S_{ACL}, calculated with postseason estimated abundance, to ensure the performance measure is biologically meaningful. For example, if the post-season

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

escapement estimate was lower than the preseason S_{ACL} because the actual abundance was lower than was forecast, it may not present a biological concern. It would only be a biological concern if the actual escapement was lower than the post-season S_{ACL}, i.e., calculated with the updated, actual abundance estimate. The use of postseason estimates of S_{ACL} rather than preseason forecasts of this reference point is uniquely appropriate for salmon management because high quality postseason abundance estimates are able to be made each year. This allows for the biologically relevant comparison between observed escapement and the $S_{ACL,}$ estimated with high quality abundance estimates.

2.3.4.3 Summary of Evaluation Criteria for Alternatives 2 and 3

The primary difference between Alternatives 2 and 3 relative to the evaluation criteria (section 4.3.2 of this EA) are the metrics used to express the ACL framework. Alternative 2 uses catch, which is more directly consistent with the NS1Gs, whereas Alternative 3 uses spawning escapement, which is more consistent with the FMP conservation objectives, and salmon management generally, but would require invoking the flexibility provisions of the NS1Gs (Table 2-11).

Table 2-11. Pros and cons of Alternatives 2 and 3 relative to the evaluation criteria.

Considerations	Alternative 2: C-Based	Alternative 3: S-Based
Similarity to Status Quo Processes and Terminology	**CON**: Current conservation objectives expressed in terms of spawning escapement, not catch	**PRO**: Current conservation objectives expressed in terms of spawning escapement, so may be easier to relate to current thresholds that are familiar
Risk of overfishing	No difference	No difference
Feasibility of Implementation	**CON**: Catch specified in terms of spawner equivalents, which does not necessarily equal total catch. Additional methods need development to estimate catch of spawner equivalents.	**PRO**: Spawning escapement estimated directly on an annual basis. Escapement clearly interpretable and does not require further methods to comply with the framework.
MSA and NS1Gs definitions and expression of reference points*	**PRO**: More obviously consistent because reference points are expressed in catch, as in the NS1Gs	***CON***: Generally consistent, but requires invoking "flexibility provision" in the NS1Gs to express the reference points in spawner escapement rather than catch
NS1Gs framework relationship of reference points*	**PRO**: More obviously consistent because reference points are expressed in catch, thus the relationship follows that identified in the NS1Gs where OFL would be greater than ABC, and ABC is greater than or equal to ACL	***CON***: Generally consistent but requires invoking "flexibility provision" in the NS1Gs so that the relationship would be OFL is less than ABC, and ABC is less than or equal to ACL (i.e., the inverse)
Scientific uncertainty and specification of ABC*	No difference (buffer between OFL and ABC)	No difference (buffer between OFL and ABC)
Management uncertainty*	No difference (No ACT specified at this time)	No difference (No ACT specified at this time)
Relationship of the ACL to AMs*	No difference (AMs triggered using post-season C_{ACL})	No difference (AMs triggered using post-season S_{ACL})
Performance standard for exceeding the ACL*	No difference (use post-season C_{ACL})	No difference (use post-season S_{ACL})
Others?		

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

2.3.5 Specification of Frameworks for Stock Complexes

Application of the Alternative OFL/ABC/ACL frameworks will be necessary for CVF and SONC Chinook stock complexes using SRFC and KRFC (respectively) as indicator stocks (based on Classification Alternative 3 in section 2.1 of this EA), and for the FNMSS Chinook complex using Hoh Spring/Summer Chinook as an indicator stock (Based on Classification Alternative 2 in Section 2.1 of this EA). Other stocks classified as in the fishery are either included in the CVF or SONC (or FNMSS) Chinook complexes, are not required to have ACLs specified under the international management exception (Section 2.1 of this EA).

2.3.5.1 Sacramento River Fall Chinook

The status quo control rule specifies a F dependent on abundance, i.e., the Sacramento Index (SI) (See Figure 4-4, gray line). The current conservation objective for SRFC is a combined hatchery and natural-area escapement goal range of 122,000 to 180,000 adults. In past years, the Council has targeted various SRFC escapement levels within this range. However, for the graphical presentation in Figure 4-4, the FMP control rule depicted represents an S_{MSY} level of 122,000. Under the current FMP, the F is zero when the SI is less than or equal to the lower end of the escapement goal range of 122,000-180,000 adults (see section 2.5 of this EA for possible modification of the SRFC conservation objective control rule). If the Sacramento Index exceeds 122,000, when 122,000 is the escapement objective, F is equal to the value that would result in a forecast SRFC escapement of 122,000.

For the C-based and S-based control rules $F_{MSY} = 0.78$, the proxy value for Chinook stocks which do not have estimates of this rate derived from stock-specific spawner-recruit analysis. This proxy value was determined to be the average F_{MSY} from Chinook stocks for which spawner-recruit analyses have been performed. For SRFC therefore, $F_{ABC} = F_{MSY} \times 0.90 = 0.70$, and $F_{ACL} = F_{ABC}$. For abundance less than approximately 409,000, $F_{FMP} \leq F_{ACL}$ and for abundance greater than approximately 409,000, $F_{FMP} > F_{ACL}$. Under the C-based, and S-based Alternatives, the F_{FMP} control rule would be capped at the F_{ACL} value for SI greater than approximately 409,000 (Figure 4-4).

Figure 2-6 displays the C-based and S-based ACL control rules and the FMP conservation objective control rule as catch or escapement plotted as a function of abundance. The C-based and S-based control rules in Figure 2-6 are a direct product of the F-based control rule (Figure 2-3).

2.3.5.1 Klamath River Fall Chinook

The status quo control rule specifies an F (i.e., the spawner reduction rate) dependent on the abundance, i.e., the expected number of natural area adult spawners absent fishing (See Figure 4-4, gray line,). As defined in the current conservation objective, the maximum F is 67 percent. At an abundance of approximately 105,000, F is reduced from the maximum level to a F that results in 35,000 natural-area adult spawners, the escapement floor component of the conservation objective. Amendment 15 of the FMP allows for a *de minimis* harvest of KRFC, F = 0.25, which is enacted at an abundance of approximately 47,000 (see section 2.5 of this EA for possible modification of the KRFC *de minimis* control rule).

For the C-based and S-based control rules $F_{MSY} = 0.72$ and $S_{MSY} = 40,700$. These values are based on stock-specific spawner-recruit data and analyses (STT 2005) and considered the best available science for KRFC and result in $F_{ABC} = F_{MSY} \times 0.95 = 0.68$, and $F_{ACL} = F_{ABC}$. The allowable F below an abundance of approximately 129,000 is lower than the $F_{ABC,}$ similar to the Status Quo control rule where target F is lower than the maximum F as abundance decreases. However, the control rule for Alternatives 2 and 3 specify a target spawner abundance level of 40,700, which results in a different control rule relative to the Status Quo, where the target spawner abundance level is 35,000 natural-area spawners (Figure 4-4). In all

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

cases, $F_{FMP} \leq F_{ACL;}$ that is, the current F control rule is uniformly more conservative than that allowed under a constant F_{MSY} framework.

Figure 2-6 displays the C-based and S-based ACL control rules and the FMP conservation objective control rule as catch or escapement plotted against abundance. The C-based and S-based control rules in Figure 2-6 are a direct product of the F-based control rule (Figure 2-3).

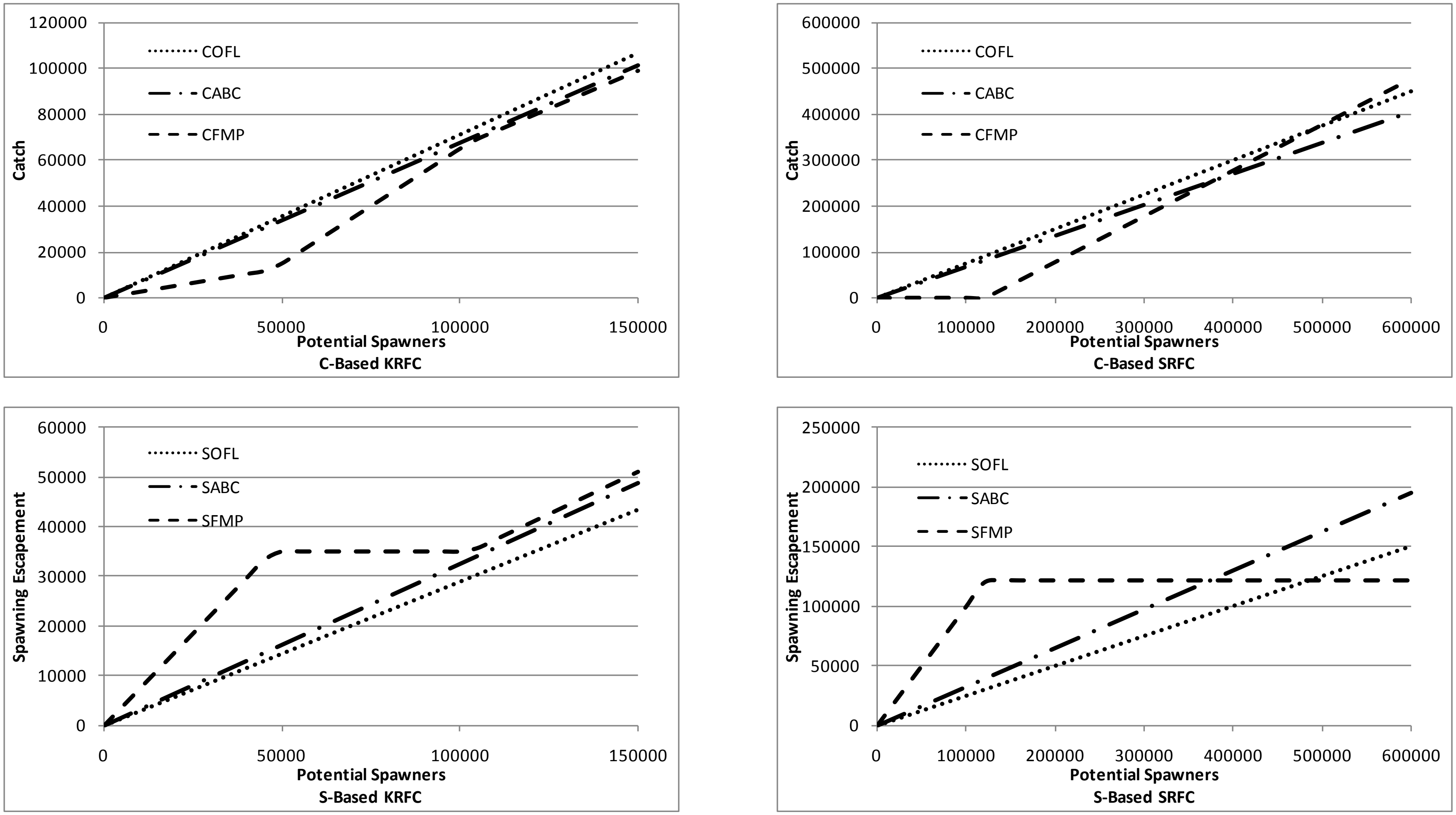


Figure 2-6. Catch and spawning escapement based OFL, ABC (ACL) control rules and current FMP conservation objective control rules for Klamath and Sacramento River fall Chinook.

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; MSA-Magnuson Stevens Act; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; SDC-status determination criteria

2.3.5.3 Hoh Spring/Summer Chinook

Place Holder…info on forecast, cohort database, ER estimates, ocean fishery assumptions…Can do S-based but not C-Based?

2.3.5.4 Hatchery Origin Stocks

There are a number of hatchery stocks in the fishery that are targeted and important contributors to Council area fisheries. Hatchery stocks are fundamentally different from natural stocks because hatcheries are man-made facilities designed with specified production capacities. Conservation objectives for hatchery stocks are based on egg take needs, usually associated with numbers of adult spawners.. The salmon FMP recognizes these objectives and strives to meet them; however, these artificially produced stocks generally do not need the additional protection associated with ACL and AM to insure their conservation or maintain long-term production. Spawning escapement goals are set to meet broodstock needs that are limited by the capacity of the hatcheries while conservation hatcheries assist with the recovery of weak stocks. The purpose of most production hatcheries is to produce large numbers of fish for harvest. Because of protections and management provided in the hatchery environment, egg-to-smolt survival rates are much higher for hatchery stocks than for naturally produced stocks. As a consequence, stock/production relationships and MSY concepts that are fundamental to the management of natural stocks do not apply to hatchery stocks. Hatchery stocks are able to sustain exploitation rates that are much higher than natural stocks. Conservation constraints for natural stocks and ESA listed species are such that hatchery escapement objectives are generally met with large surpluses. In the rare event that hatchery goals are not met there are alternatives for collecting additional broodstock at alternative sites or using more active collection techniques. Because of the unique circumstance related to hatchery stocks and the flexibility provided for by the NS1Gs, hatchery escapement goals will be used as annual catch limits. Accountability will be achieved through the annual review and reporting of escapement relative to these goals.

2.3.5.4 Stocks Listed Under the ESA

Species that are listed as threatened or endangered under the ESA are subject to ESA section 7 consultation. Because NMFS implements ocean harvest regulations, it is both the action and consulting agency for actions taken under the FMP. NMFS has completed a consultation for each of the ESA listed salmon species on the effects of ocean harvest including Council area fisheries. The resulting biological opinions set limits on incidental take, referred to as consultation standards, which are consistent with expectations for the survival and recovery of those species. NMFS periodically reviews and updates those biological opinions as required in response to new and developing information including information developed through the ongoing recovery planning process. Each year NMFS summarizes the current consultation standard for each of the ESA listed species and provides those to the Council in their annual guidance letter. The FMP obligates the Council to manage their fisheries subject to these standards. The standards are generally in the form of exploitation rate limits, or when necessary time/area closures and other management regime limitations. The ESA consultation standards serve the function of annual catch limits for ESA listed species. The biological opinions require that consultation be reinitiated if consultation standards are exceeded, or in response to new information regarding the species' status or the effects of the action on the species; therefore, the biological opinion also provides for annual accountability and ongoing review.

The requirements of the ESA are sufficient to meet the intent of the MSA overfishing provisions related to ACLs and AMs (REFERENCE). The purpose of the MSA is to maintain stocks or rebuild stocks when necessary to levels at or above MSY, and requires the Council to identify and develop rebuilding plans for stocks that are overfished. For many fish stocks regulated under the MSA, the elimination of excess

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

fishing pressure is the only action needed to recover the stocks. However, this is not the case for salmon stocks that are listed under the ESA.

Although harvest has certainly contributed to the depletion of West Coast salmon populations, the primary reason for their decline has been the degradation and loss of freshwater spawning, rearing and migration habitats. The quality and quantity of freshwater habitat are key factors in determining the MSY of salmon populations. The Council has no control over the destruction or recovery of freshwater habitat nor is it able to predict the length of time that may be required to implement the habitat improvements necessary to recover species. While the Council could theoretically establish new MSY escapement goals consistent with the limited or degraded habitat available to listed species, adoption of revised goals would potentially result in an ESA listed species being classified as producing at MSY and; therefore, not overfished under the MSA. The Council believes that the intent of the ESA and the MSA is the recovery of stocks to MSY levels associated with restored habitat conditions.

The Council considers the consultation standards and recovery plans developed by NMFS for listed species as interim rebuilding plans. Although NMFS' consultation standards and recovery plans may not by themselves recover listed populations to historical MSY levels within ten years, they are sufficient to stabilize populations until freshwater habitats and their dependent populations can be restored and estimates of MSY developed consistent with recovered habitat conditions. As species are delisted, the Council will establish new conservation objectives and reference points comparable to those for current non-listed stocks, and manage the stocks to sustain them at or above MSY levels.

2.3.6 Alternatives Eliminated From Detailed Study

Section 1.4.4, Scoping Summary, describes the alternatives considered by the Council, but not included in the final analysis. Consistent with 40 CFR 1502.14(a), several alternatives were eliminated from detailed study.

2.6.3.1 Conservation Objective Based ACL Framework

For the S-based Alternative, F-based reference points were used rather than the existing S-based conservation objectives. Introducing additional buffers into the current escapement-based conservation objectives to define stock-specific OFL, ABC, and ACL reference points, is overly conservative because the current conservation objectives are already generally more conservative than what is allowed under an MSY framework (see section 2.3.5 of this EA). Need references to Figures 2-9 and 2-10.

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

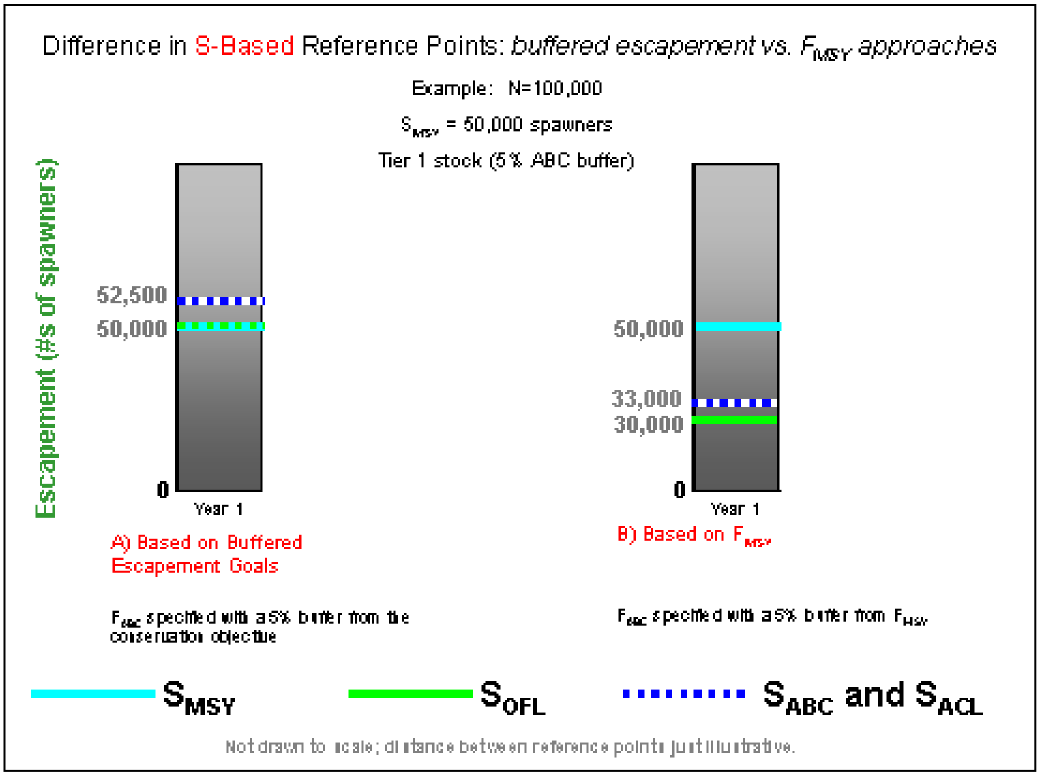


Figure 2-7.Comparison of S-based reference points with buffered escapement based reference points.

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

A key distinction between the two approaches is that the S_{OFL}, S_{ABC}, and S_{ACL} would remain fixed under the buffered escapement approach, while the S_{OFL}, S_{ABC}, and S_{ACL} would fluctuate every year with changing abundance under the F-based approach and could be either below or above the conservation objective.

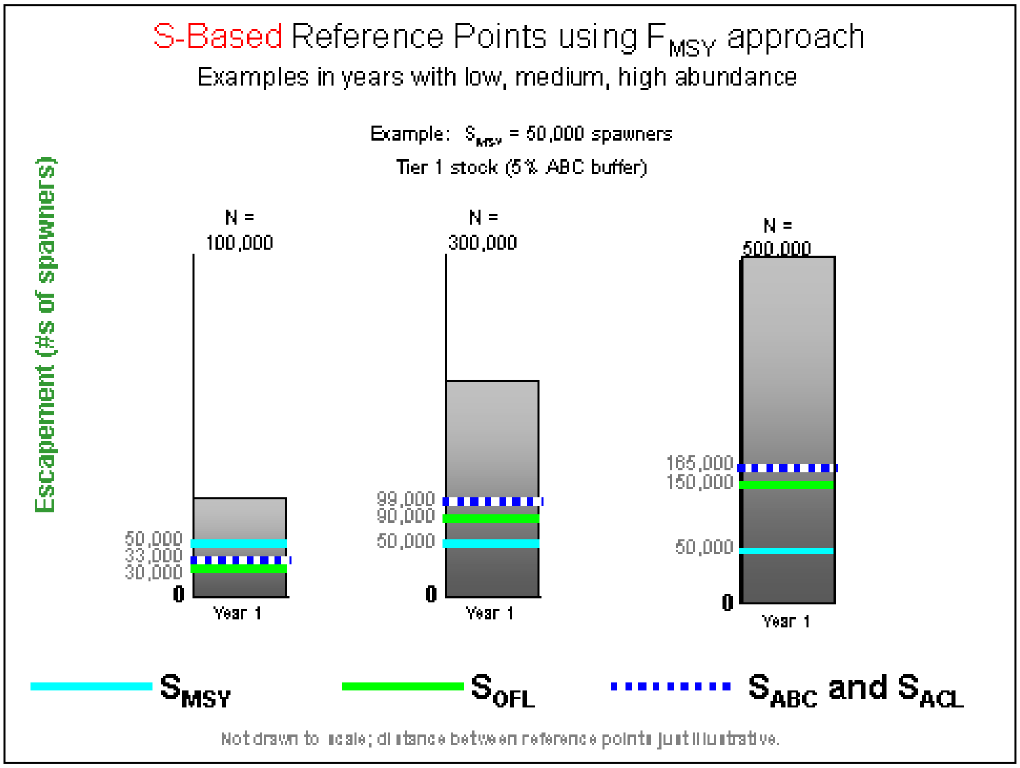


Figure 2-8. Examples of fluctuating S-based reference points in years of low and high abundance.

<u>Implications for *de minimis* fishing</u>: Using a buffered escapement framework has implications for adopting and implementing *de minimis* fishing provisions. Specifically, if the S_{ACL} is specified at a level above the minimum escapement objective, then de minimis fisheries that reduced escapement below the S_{ACL} would be problematic.

Currently, the FMP requires that if a stock is projected to fall below S_{MSY}, all fisheries impacting the stock are to be closed (as was the case in 2008 for SRFC). Amendment 15 created a *de minimis* fishing mortality rate for KRFC. Notably, no other federal fisheries are entirely closed as soon as the stock drops below the S_{MSY} level.

2.3.6.2 F-Based ACL Framework

A purely F-based approach was considered but was determined not to meet the purpose and need for this action (i.e., such an approach is not consistent with MSA Section 303(a)(15) and NS1Gs because it doesn't provide for the establishment of "catch" limits).

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

2.3.6.3 Coastwide Species Based ACL Framework

The NS1Gs allow specification of ACLs for stock complexes, and provide Pacific salmon as an example of an appropriate application of stock complex management[23]. Stock complexes are being proposed for Chinook stocks based on geography and other biological factors. However, species-level OFL, ABC, and ACL reference points are not being considered for Chinook fisheries south of Cape Falcon (i.e., mixed stock quotas corresponding to total Chinook or coho reference points). These fisheries have been managed for the most part by time-area specific regulations on the number of days open to fishing, with small, mixed-stock quotas used occasionally in some areas. The harvest management models used by the Council for south of Cape Falcon Chinook fisheries, the Klamath Ocean Harvest Model (KOHM) and Sacramento Harvest Model (SHM), would require new, currently unavailable data, as well as extensive structural modifications to be successfully used to forecast harvest and escapement of KRFC and SRFC exclusively from large mixed-stock quota fisheries. In particular, the data richness differences between KRFC (data rich; age structured catch and escapement data available) and SRFC (data poor; age structured catch and escapement data not available) results in different model structures, which does not allow for direct translation of catch expectations into large-scale mixed-stock quotas. The models, however, are well suited for forecasting catch and escapement of their respective stocks given the current and historic blend of days-open and mixed-stock quota fisheries for Chinook, and have performed well as assessment tools for Council management in the area South of Cape Falcon.

2.4 Accountability Measures

In addition to ACLs, accountability measures (AMs) are required by MSA Section 303(a)(15). The NS1Gs describe accountability measures (AMs) as management controls to both prevent ACLs from being exceeded, and to correct or mitigate overages of ACLs if they occur.[24] AMs are intended to minimize the frequency and magnitude of overages of the ACL, and to correct any problems that caused the overage.

2.4.1 Criteria Used to Evaluate the AM Alternatives

For creating and implementing AMs for the Salmon FMP, the following criteria were used to evaluate the alternatives:

- Feasibility of Implementation
- Consistency with MSA Section 303(a)(15)[25]and NS1Gs

The NS1Gs require that AMs in a fishery be adequate to prevent ACLs from being exceeded, and that additional AMs are invoked if [the] ACL is exceeded.[26] The NS1Gs identify two types of AMs:

- Inseason AMs[27], and
- AMs for when the ACL is exceeded[28]

The NS1Gs suggest using an annual catch target (ACT), a reference point specified at a level below an ACL, to reduce the probability of exceeding an ACL due to management uncertainty. The ACT is a type of inseason AM, although it would be specified during the preseason process and monitored inseason, as

[23] 50 CFR 600.310(d)(8)
[24] 50 CFR 600.310 (g)(1)
[25] MSA Section 303(a)(15): FMPs shall "establish a mechanism for specifying annual catch limits in the plan (including a multiyear plan), implementing regulations, or annual specifications, at a level such that overfishing does not occur in the fishery, including measures to ensure accountability"
[26] Final NS1Gs published Jan 16, 2009 (74 FR 3193)
[27] 50 CFR 600.310 (g)(2)
[28] 50 CFR 600.310 (g)(3)

possible. NMFS stated that whether or not an ACT is explicitly specified, the AMs must address the management uncertainty in the fishery in order to avoid exceeding the ACL.[29] If an ACL has been exceeded, the NS1Gs suggest considering overage adjustments and requires them in the following year if the stock is overfished, unless the best scientific information available indicates that it is not necessary to mitigate for the overage.[30]

For the Salmon FMP, two alternatives are being considered for the ACL, a catch based ACL and an escapement based ACL. In the latter, the objective is to achieve escapement above the ACL. Therefore, “AMs for when the ACL is exceeded” will apply to a catch-based ACL, and “AMs for when the ACL is not met” will apply to the escapement-based ACL.

The NS1Gs require that if catch exceeds the ACL for a given stock or stock complex more than once in the last four years, the system of ACLs and AMs should be re-evaluated, and modified if necessary, to improve its performance and effectiveness.[31]

2.4.2 Application of AMs

AMs are required for all stocks and stock complexes in the Salmon FMP that are required to have ACLs. Additional AMs may be considered for the other stocks and stock complexes in the fishery that are excepted from the ACL requirements. In this latter case, the AMs would not correspond directly to an ACL but instead to other management measures used to prevent overfishing, such as mixed stock quotas, SDC, and conservation objectives.

2.4.2.1 Alternative 1: Status Quo (SQ)

There are no measures in the FMP identified currently as AMs; however, a number of actions meet the general intent of AMs. Some of these are implemented during the preseason planning process and inseason. Others are implemented postseason through monitoring and reporting requirements.

Inseason (and preseason) actions

- Inseason authority to manage quota fisheries (FMP § 10.1)
- Mixed stock quota monitoring (FMP § 7.1)
- Quota partitioning (FMP § 5.3 and 10.2)
- Quota trading (FMP § 5.3 and 10.2)
- Allocation schedules (FMP § 5.3)
- Changes to gear/bag/size/trip limits (FMP § 6 and 10.2)
- Boundary modifications (FMP § 6 and 10.2)
- Landing restrictions(FMP § 6 and 10.2) , and
- Inseason monitoring and reporting requirements. (FMP § 7)

Post-season actions

- Postseason monitoring and reporting through the annual SAFE document (FMP § 8)
- Conservation alert assessment (FMP § 3.2.2)
- Overfishing concern assessment (FMP § 3.2.3)
- EFH assessment (FMP § 3.2.3), and
- Notice to state/tribal managers (FMP § 3.2.3)
- Salmon Methodology Review Process (COP-15; PFMC 2008).

[29] Final NS1Gs published Jan 16, 2009 (74 FR 3193), NMFS response to comment # 44, pg 3192.
[30] 50 CFR 600.310 (g)(3)
[31] 50 CFR 600.310 (g)(3)

Although they are not associated with an ACL at this time and are not identified as AMs, most of these actions fit the intent of AMs as they are now because they are in place to minimize instances in which the mixed-stock quotas or other preseason expectations are exceeded, or individual stocks' conservation objectives are not met, and to identify and correct any problems that caused either circumstance.

Evaluation of Status Quo

Feasibility of Implementation: As these are currently being implemented, feasibility of implementation is not an issue.

Consistency with MSA Section 303(a)(15)[32] and NS1Gs: Because the SQ Alternative does not specify these actions as AMs and currently none of the actions correspond to an ACL, it is not a viable alternative and does not meet the purpose and need of the proposed action.

2.4.2.2 Alternative 2 – Classify Current Measures in the FMP as AMs

As described above, a number of current FMP actions meet the intent of AMs. While some of them would not be directly working in combination with an ACL, they are in place to prevent overfishing. However, the "conservation alert" and "overfishing concern" are likely to be modified or replaced, given the proposed new SDC (see section 2.2 of this EA). Therefore, these will need some modification. Under this alternative, all of these AMs would apply to both stocks subject to the ACL requirements, and provide protections for other stocks that are not subject to the ACL requirements.

Alternatives for Inseason (and preseason) AMs

- Inseason authority to manage quota fisheries (FMP § 10.1)
- Mixed stock quota monitoring (FMP § 7.1)
- Quota partitioning (FMP § 5.3 and10.2)
- Quota trading (FMP § 5,3 and 10.2)
- Allocation schedules (FMP § 5.3)
- Changes to gear/bag/size/trip limits (FMP § 6 and 10.2)
- Boundary modifications (FMP § 6 and 10.2)
- Landing restrictions (FMP § 6), and
- Inseason monitoring and reporting requirements. (FMP § 7)
- Conservation alert (FMP § 3.2.2), with modification

  Currently the FMP requires notification to relevant State, Tribal, and Federal managers if a stock is not expected to meet its conservation objective, an assessment of probable causes, and closure of Council area fisheries impacting the stock. Under this alternative, the only required action would be notification to relevant State, Tribal, and Federal managers and that the STT would offer preliminary insights into the causes and recommendations to the Council, if any. On a case-by-case basis, the Council would determine whether there is a need to conduct a more detailed assessment or take additional restrictive fishery management actions.

Alternatives for Post-season AMs

- Postseason monitoring and reporting through the annual SAFE document (FMP § 8)

[32] MSA Section 303(a)(15): FMPs shall "establish a mechanism for specifying annual catch limits in the plan (including a multiyear plan), implementing regulations, or annual specifications, at a level such that overfishing does not occur in the fishery, including measures to ensure accountability"

- Overfishing concern (FMP § 3.2.3), with modification and renaming as **“Abundance Concern”** or **“Depletion Concern”**

    Currently, the FMP defines an overfishing concern as not meeting the conservation objective of a stock for three consecutive years. The FMP does not explicitly associate triggering of an overfishing concern with an “overfished” status determination, although this has been NMFS policy in recent years. As new and/or more explicit SDC are adopted as part of this amendment process, many of the actions currently required when an overfishing concern is triggered will be addressed through other processes. However, preserving the concept of this action as an indicator of a declining trend in stock status or bias in scientific or management methodologies may be desirable. If retained, the indicator should be renamed as a “abundance concern” or “depletion concern” to avoid any confusion with the formal SDC (i.e., overfishing, overfished, approaching overfished) and modified to remove the formal requirement for an assessment. Additionally, doing so will remove any connotation that fishing is necessarily the cause of a decline in stock abundance.

    Actions associated with this indicator would simply include, as is currently done, notification to the relevant State, Tribal, and Federal managers that a stock may be trending toward a depressed state, and that potential causes should be closely monitored or investigated, particularly with regard to excessive fishing mortality and bias in management models. Additionally, the STT would offer preliminary insights into the causes and provide recommendations to the Council, if any. On a case-by-case basis, the Council would determine whether there is a need to conduct a more detailed assessment or take additional restrictive fishery management actions.
- EFH assessment (FMP § 3.2.3)
- Notice to state/tribal managers (FMP § 3.2.3), and
- Salmon Methodology Review Process (COP-15; PFMC 2008).

2.4.2.3 Alternative 3 – Classify Current Measures in the FMP as AMs, Except “Conservation Alert” and “Overfishing Concern”

Alternative 3 is similar to Alternative 2, with the exception that the current “conservation alert” and “overfishing concern” actions would not be considered AMs and would also no longer be retained in the FMP. The conservation alert and overfishing concern processes in the current FMP were designed to address requirements related to overfishing and overfished status determinations and provide associated remedies. In practice, they proved to be inadequate in part because the criteria for making overfish and overfishing determinations were not sufficiently specific. New SDC are described in section 2.2 would replace the current conservation alert and overfishing concern requirements.

<u>Alternatives for Inseason (and preseason) AMs</u>

- Inseason authority to manage quota fisheries (FMP § 10.1)
- Mixed stock quota monitoring (FMP § 7.1)
- Quota partitioning (FMP § 5.3 and 10.2)
- Quota trading (FMP § 5.3 and 10.2)
- Allocation schedules (FMP § 5.3)
- Changes to gear/bag/size/trip limits (FMP § 6 and 10.2)
- Boundary modifications (FMP § 6 and 10.2)
- Landing restrictions (FMP § 6), and
- Inseason monitoring and reporting requirements. (FMP § 7)

<u>Alternatives for Post-season AMs</u>

- Postseason monitoring and reporting through the annual SAFE document (FMP § 8)

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

- EFH assessment (FMP § 3.2.3), and
- Notice to state/tribal managers (FMP § 3.2.3)
- Salmon Methodology Review Process (COP-15; PFMC 2008).

Under this alternative, "conservation alert" and "overfishing concern" actions would be removed from the FMP for two reasons: to avoid potential confusion with new SDC and because they may be redundant with other actions. These actions were put in the current FMP in order to assess the causes of the stocks not meeting their conservation objectives, to determine if fishing was a factor, and to determine if the stock was subject to overfishing, overfished, approaching overfished. With new measurable and objective SDC (i.e., with clear abundance thresholds), such assessments are not necessary to determine status. However, the Council may still want to investigate the causes of a stock not meeting its conservation objective. Eliminating these actions would not preclude the Council requesting the STT to conduct such an assessment when necessary. Preseason and postseason reporting requirements will continue to provide the Council with information relevant to stock status. Preseason Report I will continue to provide the Council with an assessment of stock status relative to their conservation objectives and new SDCs. The annual SAFE document provides a similar postseason accounting.

2.4.2.4 Other AMs Associated with Both Alternatives 2 and 3

Annual Catch Target (ACT): An ACT may be adopted in any fishing year in which there is increased management uncertainty in the fishery causing increased uncertainty in maintaining compliance with the ACL. The ACT would be specified at a level sufficiently below the ACL to buffer for the management uncertainty it is implemented to address, incorporating uncertainty in the ability to constrain catch for ACL compliance, and uncertainty in quantifying the true catch amounts (i.e., estimation errors)[33].

AMs for When the ACL is Exceeded: There are no post-season actions currently identified that would address a situation of an ACL overage (or underage under the escapement based ACL alternative). All of these post-season AMs are currently implemented on an individual stock basis and are directly tied to each stock's conservation objective, which under both ACL alternatives would be at different levels (or rates) than the proposed ACLs. For stocks not subject to the ACL requirements, these AMs would be triggered around the conservation objective. However, for those stocks and complexes subject to the ACL requirements, some of the proposed AMs above could easily be tied to the ACL, in addition to the conservation objective:

- Annual SAFE document (FMP § 8): Add reporting on the level of abundance in relationship to the ACL.
- Notice to state/tribal managers (FMP § 3.2.3): Notification when the stock has triggered a "conservation alert" and "abundance concern", if applicable, and when there was noncompliance with the ACL.
- Salmon Methodology Review Process (COP-15; PFMC 2008): Review methods when there are concerns with the assessment (e.g., abundance forecasts), when the stock has triggered a "conservation alert" and "abundance concern", if applicable, and when there was noncompliance with the ACL.

Re-evaluation of the ACLs and AMs System: The ACL alternatives for the Salmon FMP rely on a postseason evaluation for assessing compliance with ACLs. The NSIGs state that if catch exceeds the ACL for a given stock or stock complex more than once in the last four years, the system of ACLs and AMs should be re-evaluated, and modified if necessary, to improve its performance and effectiveness[34]. The re-evaluation could include consideration of the tiered buffers used to account for scientific

[33] As explained in 50 CFR 600.310(f)(6)(i)
[34] 600.310(g)(3)

uncertainty, and may include recommendations for changing the buffers to a level that would increase the compliance rate to an appropriate level. Any recommendations for changing the buffer between the ABC and OFL (i.e., ABC control rule) should be included, along with supporting analyses, in the annual Salmon Methodology Review process. The Salmon Methodology Review process allows an opportunity for review and comment by the SSC of any potential changes in the system of ACLs and AMs. Recommendations on changes to AMs or adding new AMs, including whether an ACT should be implemented, could also be introduced at the Methodology Review.

Pending the outcome of the re-evaluation of the system of ACLs and AMs, an ACT could be implemented as an interim measure if it was determined that the cause was related to management uncertainty in the fishery and to reduce the likelihood of future non-compliance with the ACL until any new or updated measures are approved. If the cause was determined to be scientific uncertainty, an additional 5 percent buffer could be added to the tiered uncertainty buffer used to set the ACL. The ACT or additional buffer could remain in place until either additional measures are adopted to ensure an appropriate compliance with ACLs, or it has been demonstrated that the ACT or additional buffer were not necessary to achieve an appropriate compliance level.

Conservation objectives would continue to provide a benchmark for evaluating the status of the stocks. The need for additional AMs and ACTs increases in proportion to the magnitude and frequency of shortfalls relative to S_{MSY}, including consideration for the projected spawning escapement for the following year. If the ACL is exceeded in more than one in four years, remedies in the first year should be tailored to address the best available information regarding why the ACL was exceeded and the broader context regarding the status of the stock. The short term remedies would be re-evaluated along with the overall system of ACLs and AMs prior to the following year.

Evaluation of Alternatives 2 and 3

Feasibility of Implementation: For those currently being implemented, feasibility of implementation is not an issue. However, it should be noted that all inseason actions are currently based on the species (e.g., mixed-stock quotas), rather by individual stock. It is not feasible to implement inseason actions on a stock-by-stock basis due to the inability to identify fish at the stock level during ocean fishing. For the proposed new AMs that are tied to an ACL, these can be feasibly implemented.

Consistency with MSA Section 303(a)(15)[35]and NS1Gs: Under these alternatives, all or most current actions would be reclassified as AMs and are partially consistent with the MSA and NS1Gs. Specific AMs for addressing non-compliance with ACLs are missing under this alternative.

- **Inseason AMs:** To the extent possible, there are inseason AMs. Their purpose is consistent with the NS1Gs that explain that inseason AMs "should include inseason monitoring and management measures to prevent catch from exceeding ACLs"[36]. To date, the purpose of these actions has been to monitor and manage the mixed-stock fishery inseason to prevent overfishing, and in some cases, to keep the fishery consistent with allocation agreements. However, as mentioned above, inseason AMs would be implemented at the species level for the mixed-stock ocean fisheries, rather than at the individual stock level. Under both ACL alternatives, the ACL would be specified at the individual stock level. Although these AMs would not be directly tied to an individual stock ACL due to the

[35] MSA Section 303(a)(15): FMPs shall "establish a mechanism for specifying annual catch limits in the plan (including a multiyear plan), implementing regulations, or annual specifications, at a level such that overfishing does not occur in the fishery, including measures to ensure accountability"

[36] 50 CFR 600.310 (g)(2)

nature of the fishery, this current system of inseason actions have proven to prevent overfishing (cite stat from SDC or ACL chapter). It should be noted that mixed-stock quotas for the stocks and complexes requiring ACLs are not consistently used south of Cape Falcon, but may be used as necessary (e.g., during the 2010 fishing year off Fort Bragg, CA).

- **ACT**: Currently, an ACT, or similar reference point, is not used in the ocean salmon fishery. While an ACT is not required by the MSA or NS1Gs, under this alternative, use of an ACT is proposed in situations where there is an increase in management uncertainty that would warrant its implementation. This is consistent with the NS1Gs to address management uncertainty if it is a factor leading to noncompliance with the ACL.
- **AMs for when the ACL is exceeded**[37]: Under these alternatives, there are additional post-season management actions proposed as AMs that will be directly tied to all ACLs specified, consistent with the NS1Gs.
- **Re-evaluation of the ACLs and AMs System:** Under these alternatives, there is an explicit process outlined for re-evaluating the system of ACLs and AMs if there is non-compliance with the ACL more than one in four consecutive years. This is consistent with the performance standard and requirement in the NS1Gs.

2.4.3 AM Alternatives for Triggering SDC

The actions identified in Section 4.2 of this EA responding to triggering an overfishing, overfished, and approaching overfished status are AMs. The ACL framework uses estimates of F_{MSY} and stock abundance to set appropriate levels for OFL, ABC and of ACL, and the Overfishing SDC uses estimates of F_{MSY}, so if overfishing occurs (exceeding F_{MSY}), it is likely that the ACL was exceeded. Therefore, any measures addressing overfishing SDC also apply to ACLs.

If a stock becomes overfished an assessment of the causes and, potentially, a rebuilding plan would be developed. These measures are intended, among other things, to ensure that fishing mortality is maintained at a sustainable level. Therefore, they should also be classified as AM.

The action required if a stock is determined to be approaching an overfished condition include a reduction in the allowable exploitation rate, which would also increase the likelihood of complying with the ACL. Therefore, this action should be classified as an AM.

2.5 *De Minimis Fishing Provisions*

The FMP conservation alert currently requires closure of all Council area salmon fisheries affecting stocks that are projected not to meet their conservation objective. This provision has in some cases resulted in the closure of fisheries and foregone harvest of more abundant stocks, and in other cases the promulgation of emergency rules to gain access to more abundant stocks. However, due to a number of reasons, this provision is not applied uniformly to all salmon stocks. Stocks that are subject to U.S. Court orders under *U.S. v. Washington* and *Hoh v. Baldrige* may be exempt if the Parties agree on annual management objectives that differ from those of the FMP. Stocks that have exploitation rate (ER) based management objectives are permitted a minimum exploitation rate regardless of stock status. KRFC have an explicit *de minimis* fishing provision as a result of Amendment 15 (Figure 2-2). FNM stocks with minimal impacts (less than 5 percent base period exploitation rate) in Council area fisheries are currently exempt from the conservation alert provisions in the FMP, as are ESA-listed and hatchery stocks. In this amendment, FNM stocks are proposed to be classified as EC stocks (i.e., out of the fishery) and therefore would remain exempt.

[37] Under the escapement based ACL alternative, these will be referred to as "AMs for when the ACL is not met".

Currently, only SRFC must either comply with the conservation alert provision or require an emergency rule to implement fisheries. This is by virtue of having both a spawning escapement based conservation objective and an abundance forecast available preseason. Oregon South Coast Chinook may also soon be subject to the provision, pending completion and adoption of new conservation objectives and development of preseason forecasts for those stocks.

De minimis fishing provisions give more flexibility to the rule-making process when the conservation objectives for limiting stocks are projected not to be met; and provide opportunity to access more abundant salmon stocks that are typically available in the Council management area when the status of one stock may preclude all ocean salmon fishing in a large region. At a minimum, this should allow for Council action without the need for NMFS to approve an emergency rule while providing for *de minimis* salmon fishery impacts. This will reduce the risk of fishery restrictions that impose severe economic consequences to local communities and states. While this action seeks to provide management flexibility in times of scarcity, there is an overriding mandate to preserve the long-term productive capacity of all stocks to ensure meaningful contributions to ocean and river fisheries in the future, and to ensure that the total fishing mortality rate does not exceed F_{MSY}.

2.5.1 *De minimis* Fishing Alternatives

For stocks that are managed for a spawner escapement objective, like SRFC, *de minimis* fishing provisions will modify the conservation objective control rule to permit limited exploitation at low abundance levels (See Figure 2-3 for examples of conservation objective control rules with [KRFC] and without [SRFC] *de minimis* provisions). For stocks that currently have a *de minimis* fishing mechanism through the *Hoh v. Baldrige* or *U.S. v. Washington* processes, any additional *de minimis* fishing provisions would not affect the ability of the Parties to exercise their options.

Currently, *de minimis* fishing provisions are either undefined, as with SRFC, or defined inconsistently among stocks. Furthermore, *de minimis* exploitation rates for KRFC established in Amendment 15 are not clearly defined at low abundance levels. This section defines three generic *de minimis* fishing Alternatives that are based on the S_{MSY} and MSST reference points. The generic nature of these *de minimis* provisions allows them to be applied to any stock with defined S_{MSY} and MSST reference points, and can be applied regardless of the relationship between S_{MSY} and MSST. Each of the generic *de minimis* fishing alternatives can be applied as extensions to the current F-based conservation objective control rules at low stock abundances.

The criteria used to evaluate *de minimis* fishing alternatives include:

- Risk of overfishing
- Risk of overfished
- Feasibility of implementation
- Consistency with NS1 guidelines.

2.5.1.1 Alternative 1: Status Quo- Variable Among Stocks

Status quo *de minimis* fishing provisions are variable among stocks, and not defined for SRFC.

<u>Risk of overfishing</u>: The risk of overfishing is low for status quo *de minimis* fishing provisions. In all cases where *de minimis* fishing is allowed, the allowable exploitation rates at low abundance are much lower than $F_{MSY.}$ For SRFC, which has no *de minimis* fishing provisions, the risk of overfishing when the stock is at low abundance is very small, since the allowable exploitation rate at abundance levels less than or equal to S_{MSY} is zero in the absence of an emergency rule.

Risk of overfished: The risk of becoming overfished is variable among stocks with different *de minimis* fishery provisions. Risk of overfished is low for SRFC since the allowable exploitation rate is zero at abundance levels less than $S_{MSY.}$

Feasibility of implementation: The Status Quo Alternative is currently implemented.

Consistency with NS1 guidelines: *De minimis* fishing provisions that specify a nonzero exploitation rate regardless of stock size are inconsistent with the intent of the NSIG's because fishing mortality is not reduced as stock size declines[38]. *De minimis* provisions that allow exploitation rates that would result in the stock abundance falling below its MSST more than 50 percent of the time at low stock abundance levels are inconsistent with the NS1Gs[39]

2.5.1.2 Alternative 2: F = 0 at midpoint between S_{MSY} and MSST

Alternative 2 specifies a *de minimis* exploitation rate of 0.25, subject to a minimum spawner abundance level defined as the midpoint between S_{MSY} and the MSST [(S_{MSY} + MSST)/2].

The F-based control rule with the Alternative 2 *de minimis* alternative is displayed in Figure 2-7, top panel. As stock size declines, the allowable exploitation rate declines from F_{ABC} in order to achieve S_{MSY}, until F = 0.25. A constant exploitation rate of 0.25 is then allowed until the point where F must be further reduced in order to achieve a spawner abundance equal to the midpoint between S_{MSY} and MSST. The constant exploitation rate of 0.25 is derived from results in the FMP Amendment 15 analysis, and closely approximates the total exploitation rate on KRFC when the age-4 ocean exploitation rate equals 0.10[40]. We specify the *de minimis* total exploitation rate of 0.25 rather than the ocean exploitation rate of 0.10 because the total exploitation rate accounts for mortality from all fisheries. This rate has been adopted for the generic *de minimis* Alternatives because it is very likely that other stocks will be affected in a similar manner as KRFC, given the relative consistency in salmon productivity (Appendices C and D). At abundances less than or equal to the midpoint between S_{MSY} and MSST, the allowable exploitation rate is zero.

Risk of overfishing

The risk of overfishing is low. Allowable exploitation rates specified for *de minimis* fisheries are well below F_{MSY}.

Risk of overfished

The risk of becoming overfished is low. Allowable exploitation rates are zero at abundance levels greater than the MSST. *De minimis* fishing, as described for Alternative 2, would result in a spawner abundance being higher than the MSST more than 50 percent of the time, assuming unbiased assessments and abundance greater than the MSST in the absence of fishing.

Feasibility of implementation

Implementation is feasible, as the *de minimis* provision in this alternative is an extension of the current F-based control rule.

Consistency with NS1 guidelines

Alternative 2 is consistent with the NSIGs. Allowable exploitation rates for *de minimis* fisheries are well below $F_{MSY,}$ and therefore result in a low risk of overfishing. Allowable *de minimis* exploitation rates

---

[38] 600.310(f)(4)

[39] 600.310(m)(3)

[40] PFMC Salmon FMP Amendment 15 (p. 27, 30, 58).

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

specified in this alternative do not result in the expected stock abundance falling below its MSST more than 50 percent of the time[41] if the abundance is greater than the MSST in the absence of fishing.

2.5.1.3 Alternative 3: F = 0 at MSST

Alternative 3 specifies a *de minimis* exploitation rate of 0.25, subject to a minimum spawner abundance level of MSST.

The F-based control rule with the Alternative 3 *de minimis* alternative is displayed in Figure 2-7, middle panel. As stock size declines, the allowable exploitation rate declines from F_{ABC} in order to achieve S_{MSY}, until F = 0.25. A constant exploitation rate of 0.25 is allowed until the point where F must be further reduced in order to achieve a spawner abundance equal to the MSST. The description of Alternative 2 details the justification for the *de minimis* exploitation rate of 0.25. At abundances less than or equal to MSST, the allowable exploitation rate is zero.

Risk of overfishing
Same comments as Alternative 2.

Risk of overfished
The risk of becoming overfished is low to moderate. At low stock abundance (i.e., at abundance levels resulting in exploitation rates in the range of $0 < F < 0.25$), the allowable exploitation rate is specified at a level resulting in an expected spawner abundance greater than or equal to the MSST. For years in which abundance is low, and fisheries regulations result in an expected spawner abundance equal to the MSST, the realized spawner abundance would be expected to be below the MSST with a probability of 50 percent, assuming assessments are unbiased and abundance is greater than the MSST in the absence of fishing.

Feasibility of implementation
Same comments as Alternative 2.

Consistency with NS1 guidelines
Same comments as Alternative 2.

2.5.1.4 Alternative 4: F = 0 at MSST / 2

Alternative 4 specifies a *de minimis* exploitation rate of 0.25, subject to a minimum spawner abundance level of one half of MSST (MSST/2).

The F-based control rule with the Alternative 4 *de minimis* alternative is displayed in Figure 2-7, bottom panel. As stock size declines, the allowable exploitation rate declines from F_{ABC} in order to achieve S_{MSY}, until F = 0.25. A constant exploitation rate of 0.25 is allowed until the point where F must be further reduced in order to achieve a spawner abundance to equal to MSST/2. The description of Alternative 2 details the justification for the *de minimis* exploitation rate of 0.25. At abundance less than or equal to one half of MSST, the allowable exploitation rate is zero.

Risk of overfishing
Same comments as Alternative 2.

Risk of overfished
The risk of becoming overfished is moderate. As stock abundance decreases, allowable exploitation rates can be as high as 0.25, and result in an expected spawner escapement lower than the MSST. At

[41] 600.310(m)(3)

abundance levels resulting in exploitation rates in the range of $0 < F < 0.25$, the allowable exploitation rate is specified at a level resulting in an expected spawner escapement greater than or equal to MSST/2. For years in which abundance is low, and fisheries regulations result in an expected spawner abundance between MSST and MSST/2, the realized spawner abundance would be expected to be below the MSST with a probability greater than 50 percent, assuming assessments are unbiased.

Feasibility of implementation

Same comments as Alternative 2.

Consistency with NS1 guidelines

Alternative 4 is not consistent with all provisions in the NSIGs. Allowable exploitation rates for *de minimis* fisheries are well below $F_{MSY,}$ and therefore result in a low risk of overfishing. However, at low abundance levels, the allowable *de minimis* exploitation rates specified in this alternative can result in spawner abundance falling below MSST more than 50 percent of the time[42]. Alternative 4 allows for exploitation rates resulting in spawner abundance levels between MSST and MSST/2, which is not consistent with the intent of the NS1Gs[43].

[42] 600.310(m)(3)

[43] 600.310(f)(4)

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

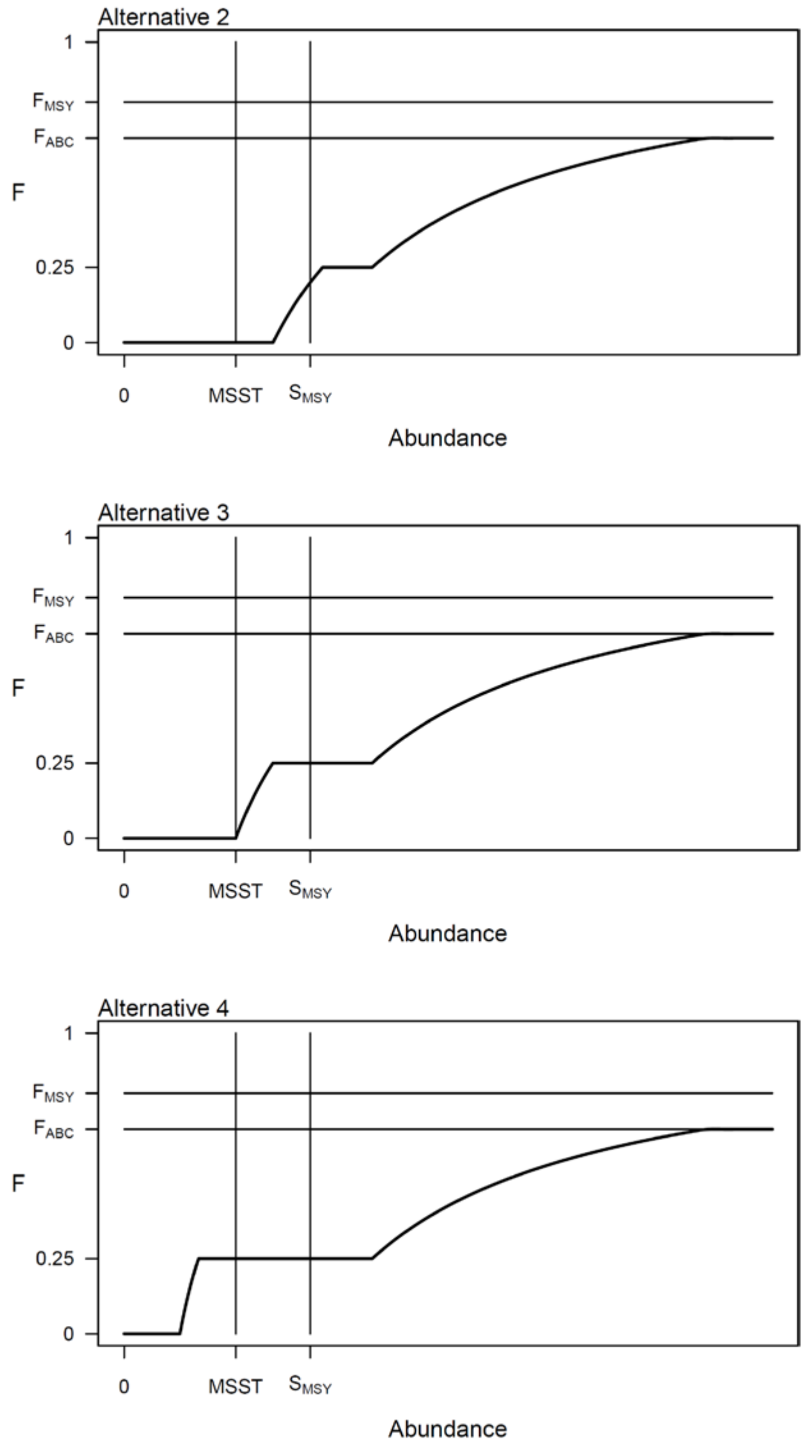


Figure 2-9. *De minimis* fishing alternatives. Alternative 1 (status quo) is not shown because it is variable among stocks.

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

2.5.2 Stock Specific Considerations

2.5.2.1 Sacramento River Fall Chinook

Sacramento River fall Chinook are the only stock in the FMP without some form of *de minimis* fishing provisions. As a result, when the spawner abundance of SRFC is forecast to be lower than S_{MSY} in the absence of fishing, the exploitation rate allowed by the FMP is zero. This scenario existed in 2008, when the Sacramento Index was forecast to be well below the lower end of the SRFC goal range of 122,000 natural-area and hatchery adult spawners. This resulted in the closure of all Chinook-directed fisheries south of Cape Falcon. The top panel of Figure 2-8 demonstrates that the lack of a *de minimis* fishery provision for SRFC results in F = 0 when the abundance is less than 122,000.

De minimis fishing Alternatives 2–4 depicted for SRFC are also displayed in Figure 2-8. The specific reference points identified in Figure 2-8 assume that S_{MSY} = 122,000 and MSST = S_{MSY} / 2 for SRFC. Each of Alternatives 2–4 allows for some level of fishing when abundance is lower than $S_{MSY.}$ Alternative 2 would allow *de minimis* fishing down to spawner abundance levels observed in prior years for SRFC. Alternative 3 would allow *de minimis* fisheries resulting in a spawner level lower than all observed escapement estimates for SRFC, with the exception of 2009. Only Alternative 4 would allow *de minimis* fishing down to spawner abundance levels not yet observed for SRFC.

The productivity of the SRFC stock is likely sufficient for some level of *de minimis* fisheries. While a SRFC-specific spawner-recruit analysis has not been performed, estimates of the Ricker α parameter (a measure of stock productivity in terms of recruits per spawner at low spawner abundance) for other Chinook stocks suggest high productivity at low stock sizes (Appendix C). Furthermore, the *de minimis* fishing rate of 0.25, developed for KRFC in Amendment 15, is likely to be appropriate for SRFC. The estimate of F_{MSY} for KRFC of 0.72 is lower than the proxy F_{MSY} level of 0.78 used for SRFC, which suggests similar levels of productivity at low stock sizes for these two stocks.

Available evidence suggests that SRFC are heavily subsidized by hatchery production (Barnett-Johnson et al. 2007). Hatchery stocks can be highly productive and are generally able to support very high exploitation rates. A key concern for this stock is whether de *minimis* fisheries would allow for ample escapement to meet hatchery egg take goals. The minimum aggregate number of spawners necessary to meet egg take goals at the three Basin hatcheries is estimated to be 22,000 adults (PFMC 2010d). Each *de minimis* Alternative specifies an exploitation rate of zero at spawner levels greater than 22,000. Alternative 4, the most liberal *de minimis* Alternative, specifies that F = 0 when abundance is less than or equal to 30,500 (assuming S_{MSY} = 122,000 and MSST = S_{MSY} / 2).

While each Alternative meets minimum spawner guidelines for egg take goals at Sacramento Basin hatcheries, there may be concerns over other Central Valley Chinook stocks with spawner abundance that co-varies with SRFC. In particular, San Joaquin River fall Chinook (SJFC) have consistently exhibited spawner abundances of 10 percent or less than SRFC over the past 20 years (mean ratio of SJFC to SRFC = 0.04 between 1990 and 2009; PFMC 2010a). If SRFC spawner levels are allowed to be fished to low levels as a result of *de minimis* fisheries, the abundance of San Joaquin fall Chinook could be reduced to extremely low levels. In particular, Alternative 4 *de minimis* provisions allow fishing down to a SRFC spawner abundance level of 30,500, which would result in an expected SJFC abundance of 30,500 × 0.04 = 1,220 spawners, given the average ratio of SJFC to SRFC over the last 20 years. While this is a low abundance of SJFC spawners, escapement levels below 1,220 have been observed in previous years.

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

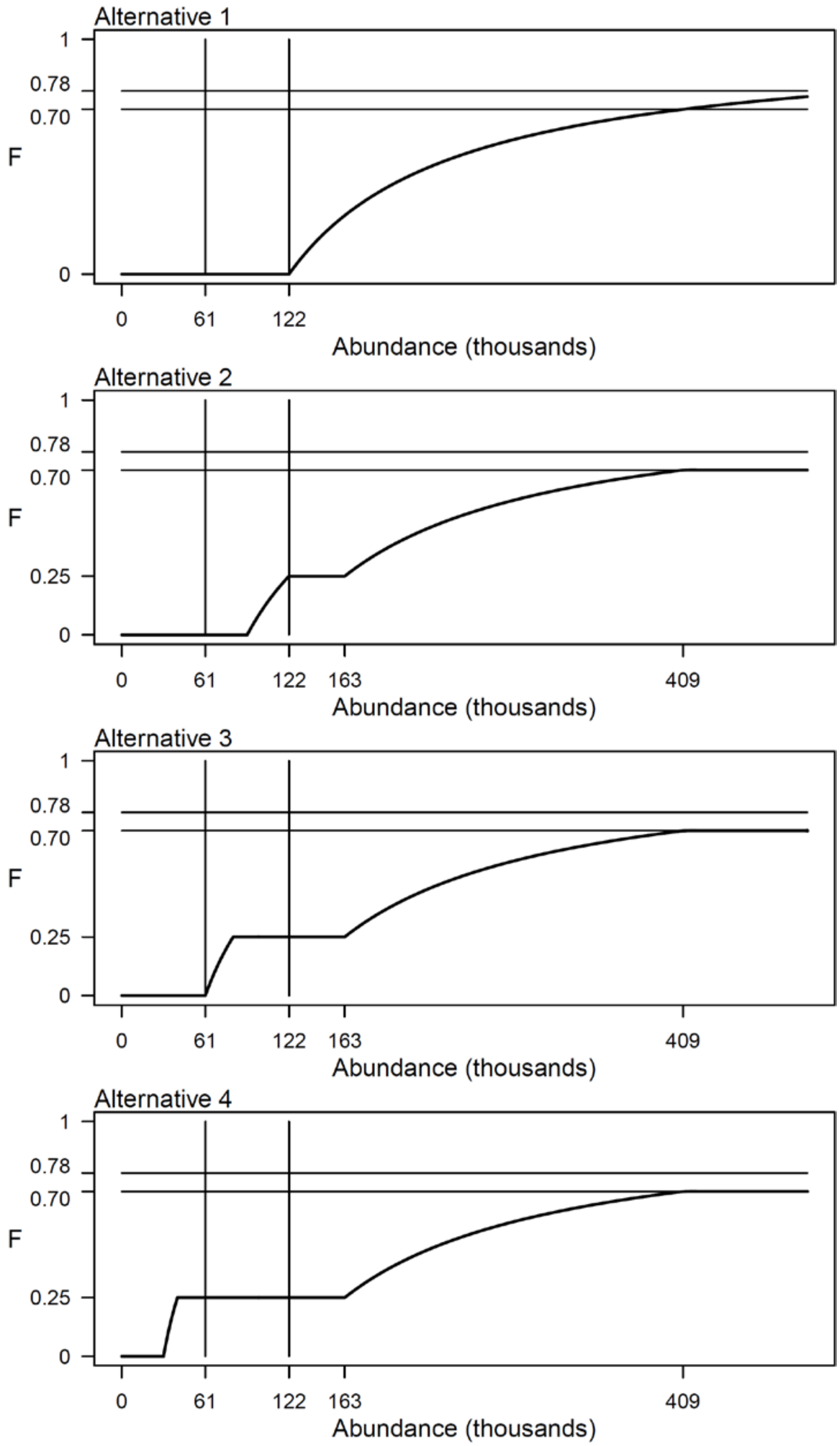


Figure 2-10.*De minimis* fishing Alternatives for Sacramento River fall Chinook.

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

2.5.2.2 Klamath River Fall Chinook

Amendment 15 to the salmon FMP established *de minimis* fishing provisions for KRFC (FR Ref for A15). The top panel of Figure 2-9 displays the current KRFC F-based control rule including the Amendment 15 *de minimis* fishing provisions. For abundance less than 30,000, the allowable exploitation rate of 0.25 is denoted by a dotted line. The dotted line in this figure is meant to portray the exploitation rate as a maximum rate. Amendment 15 states that if the projected natural-area escapement associated with a 10 percent age-4 ocean exploitation rate (0.25 total exploitation rate, approximately) is less than 22,000, the Council should further reduce the allowable exploitation rate. NMFS[44] interprets this as requiring the exploitation rate to decline from 0.25 as abundance declines below approximately 30,000. The exact nature of how F should be reduced as abundance decreases below 30,000 is not articulated.

Alternatives 2–4, displayed graphically in Figure 2-9 share many of the attributes of the Alternative 1, status quo F-based control rule with some exceptions. First, for the status quo control rule, the exploitation rate is capped at a maximum level of 0.67. For Alternatives 2–4, the maximum allowable exploitation rate is capped at the F_{ABC} level of 0.68. Second, for exploitation rates between the maximum rate and the 0.25 *de minimis* rate, the status quo Alternative specifies an exploitation rate that would result in 35,000 natural-area spawners. For Alternative 2–4, exploitation rates in this range are specified to result in S_{MSY} = 40,700 natural area spawners. Finally, Alternative 1 does not specify how exploitation rates will approach zero as abundance declines. Alternatives 2–4 prescribe target exploitation rates as a function of potential spawner abundance, as described in section 2.5.1.

In Amendment 15, a focal concern was the risk level associated with KRFC substocks crossing abundance thresholds considered crucial for genetic integrity. Analysis in the Amendment 15 EA identified a natural area adult spawner abundance of 22,000 as a benchmark that would help provide assurance that the long-term productivity of KRFC would not be jeopardized. In part this benchmark was developed based on the aggregate number of KRFC spawners necessary to reduce the probability that spawning abundance in the Salmon, Scott, and Shasta Rivers would not drop below the genetic threshold of 720 adults in each tributary.

Alternative 2 specifies an exploitation rate of zero at a spawner level greater than 22,000. Alternative 3 specifies that exploitation rate will be zero at a level slightly lower than 22,000 spawners. Finally, Alternative 4 specifies F > 0 for abundance levels greater than approximately 10,000. This alternative specifies that under low abundance conditions, fishing could be allowed that reduces spawner abundance to levels never before observed for KRFC, and well below escapement levels deemed necessary for the genetic integrity of key substocks.

[44] NMFS NWR letter to PFMC, March 22, 2007

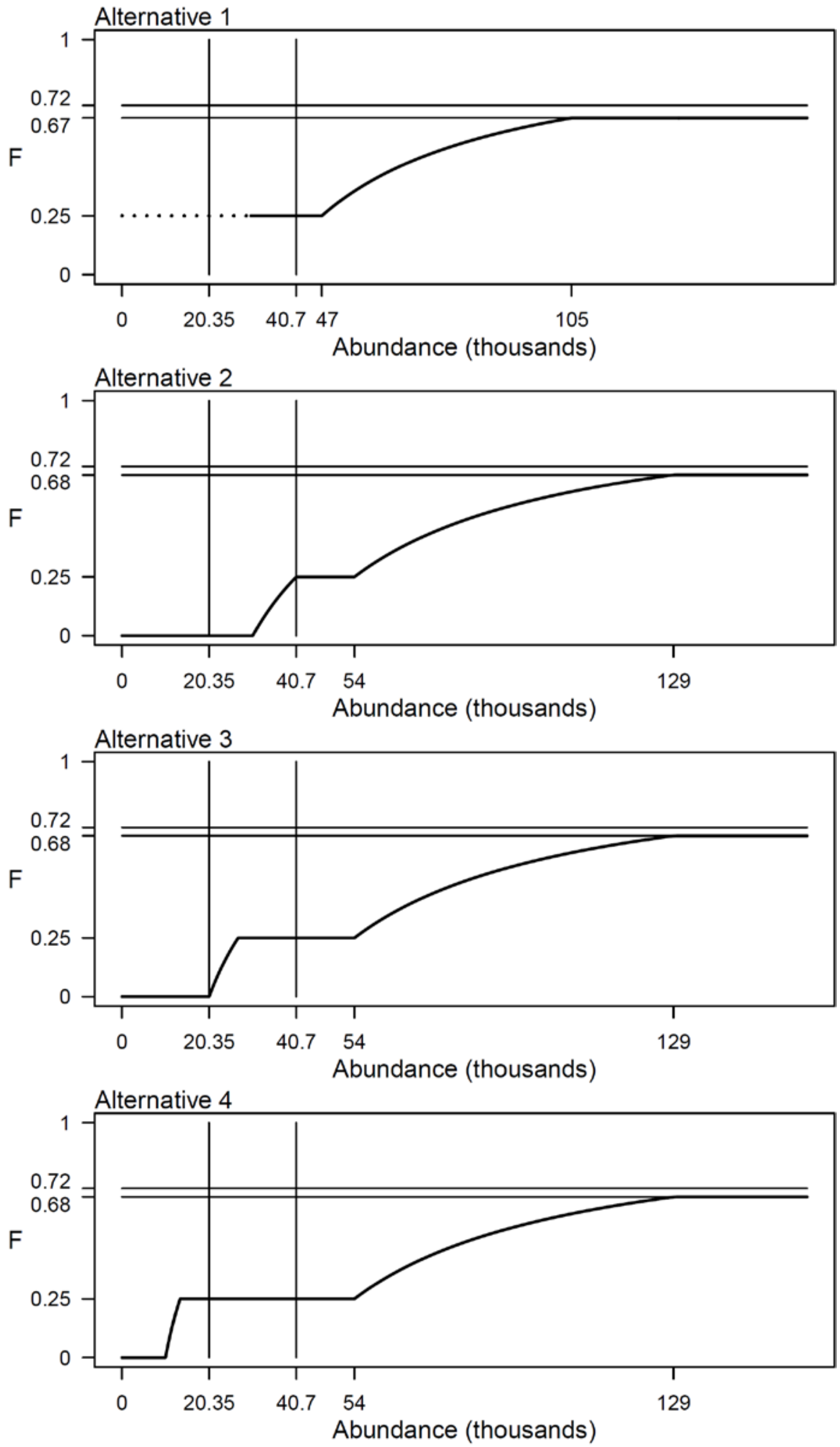


Figure 2-11.*De minimis* fishing Alternatives for Klamath River fall Chinook.

2.5.3 *De Minimis* Fishing Provisions and Stock Rebuilding

De minimis fishing provisions could also serve as default rebuilding plans for stocks that become overfished (or depleted). This would provide management guidance for the stock immediately, rather than waiting a year or more for an assessment and/or formal rebuilding plan to be developed; however, this would not preclude development of a formal rebuilding plan through the current Overfishing Concern assessment process. Under the current process, when an Overfishing Concern is triggered the STT must complete an assessment of the cause, including the role of fishing and estimation error, within one year. Based on the recommendations in the Overfishing Assessment, the Council determines necessary steps to rebuild the stock, including establishing criteria and any necessary changes to management. These steps may take the form of a formal rebuilding plan, or simply implementing the default rebuilding feature of the FMP (i.e., managing to meet the conservation objectives for all stocks annually).

The Council is usually informed that an Overfishing Concern has been triggered at the March meeting, the same time as it is beginning the preseason management process. Thus, the Council does not have the benefit of the Overfishing Assessment in the first year of rebuilding an overfished stock. If the stock is projected to again fall short of its conservation objective, the Council must close its fisheries that impact the stock. However, if a formal rebuilding plan were in place, it is likely that there would be some level of fishing allowed that would not jeopardize the stock's rebuilding requirements. Providing a similar opportunity through *de minimis* fishing provisions in the first year of rebuilding would temper the impact to fishing communities, and provide a more stable transition to management under a formal rebuilding plan, if necessary.

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

3.0 AFFECTED ENVIRONMENT

This section is under development at this stage; however the reader is referred to the 2006 regulations EA (PFMC 2006; http://www.pcouncil.org/wp-content/uploads/Salmon_EA_2006.pdf) and the Review of 2009 Ocean Salmon Fisheries (PFMC 2010a; http://www.pcouncil.org/salmon/stock-assessment-and-fishery-evaluation-safe-documents/review-of-2009-ocean-salmon-fisheries/). We expect to incorporate by reference relevant parts of those documents.

The affected environment analyzed in this EA consists of the biological and socioeconomic environments. The biological environment includes the Chinook, coho, and pink salmon stocks identified in the FMP, (Tables 3-1, 3-2, and 3-3) and specified as in the fishery in the alternatives considered in this EA (Tables 2-2, 2-3, and 2-4), as well as the EFH designated for these stocks

Currently in the Pacific Salmon FMP, there are 12 stock complexes identified that consist of 68 stocks.

- 21 stocks are coho salmon (Table 3-1)
- 45 stocks are Chinook salmon (Table 3- 2)
- Two stocks are pink salmon (Table 3-3)
- 23 stocks are listed under the Endangered Species Act (ESA). These are non-target stocks in the fishery and the fishery is managed to minimize impacts on these species. In doing so, the level of harvest of target stocks is limited by these species to varying degrees each year.
- 11 stocks are hatchery stocks (artificially produced stocks comprised exclusively of hatchery production). These make up many of the target stocks in the fishery.
- 63 stocks originate in U.S. streams south of the U.S./Canada border. Most of these are harvested in the Council area salmon fisheries. However, there are some Chinook stocks that originate in southern U.S. streams but have ocean residence primarily north of the U.S./Canada border; these stocks are called “north or far-north migrating (FNM) stocks”. These include most Columbia River fall (CR F) stocks, Washington coastal and Columbia River spring/summer stocks (WA/CR Sp/S), and Washington coastal and northern Oregon summer/fall stocks (WA/OR S/F). Columbia River summer (CR S) Chinook are also currently classified as FNM; however their status is under review. FNM stocks have lower vulnerability to Council area fisheries, and for some stocks, especially the WA/CR Sp/S stocks, to all ocean fisheries.
- Five stocks originate in Canadian streams. The Canadian stocks are highly diverse and generally composed of many individual stocks (e.g., Coastal and Fraser River stocks). Some components of these stocks migrate south into U.S. waters where they are subject to significant harvest.
- 29 FMP stocks are managed jointly with Canada under the Pacific Salmon Treaty (PST), a bilateral agreement between the U.S. and Canada. These stocks include CR S, CR F, WA/OR S/F, and Canadian Chinook stocks, natural coho stocks from the Washington Coast and Puget Sound, and both pink stocks.

Currently in the Pacific Salmon FMP, stock complexes are identified as a way to organize stocks that have similar geographic origins as other stocks (Tables 3-1 and 3-2). However, they are not necessarily managed as a group as is often the case with many non-salmon stock complexes. In some cases, one or more stocks in the current complexes lack sufficient information with which to specify the individual conservation objective, and in these situations, surrogates or indicator stocks from the same complex are used as the basis for their conservation objectives and subsequent management and conservation actions

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

by the Council. For example, there is no aggregate complex-level management or conservation objective for the current Central Valley Chinook complex; fisheries are managed to achieve a conservation objective for Sacramento River Fall Chinook (SRFC) of 122,000-180,000 adult spawners, and to comply with ESA consultation standards for Sacramento winter Chinook and Central Valley spring Chinook. The SRFC conservation objective is intended to provide adequate spawning escapement for San Joaquin fall and Sacramento River late-fall Chinook as well. However, the Columbia River Chinook complex does not include any specified indicator stocks, and because of the greatly different ocean distributions of its component stocks, the complex cannot be managed as a unit, i.e., conservation and management actions designed to protect one stock in the complex may or may not provide a similar level of protection for the other stocks in the complex.

Table 3-1. Coho stocks and complexes listed in the current Pacific Salmon FMP.

Coho Complexes	Coho Stocks	Target	Non-target	ESA Listed	Hatchery stock	Far North Migrating	Subject to PST
Oregon Production Index All Washington, Oregon, and California natural and hatchery coho stocks from streams south of Leadbetter Pt., WA	Central California Coast		X	Threatened			
	Southern Oregon-Northern California Coastal		X	Threatened			
	Oregon Coastal Natural		X	Threatened			
	Columbia River Late - Hatchery	X			X		
	Columbia River Early - Hatchery	X			X		
	Lower Columbia River - Natural		X	Threatened			
Washington Coastal All pertinent natural and hatchery stocks originating in Washington coastal streams north of the Columbia River through the western Strait of Juan de Fuca (West of the Elwha and south of the Sekiu River).	Willapa Bay - Hatchery	X			X		
	Grays Harbor	X					X
	Quinault - Hatchery	X			X		
	Queets	X					X
	Hoh	X					X
	Quillayute - Fall	X					X
	Quillayute - Summer - Hatchery	X			X		
Puget Sound All pertinent natural and hatchery stocks originating from U.S. tributaries to Puget Sound and the eastern Strait of Juan de Fuca (east of Salt Creek).	Strait of Juan de Fuca	X					X
	Hood Canal	X					X
	Skagit	X					X
	Stillaguamish	X					X
	Snohomish	X					X
	South Puget Sound - Hatchery	X			X		
Southern British Columbia Coast	Coastal Stocks	X					X
	Fraser River	X					X
4	21	17	4	4	6		11

Table 3-2. Chinook stocks and complexes listed in the current Pacific Salmon FMP.

Chinook Complex	Chinook Stocks	Target Stock*	Non-target Stock*	ESA Listed	Hatchery stock	Far North Migrating	Subject to PST
California Central Valley All fall, late-fall, winter, and spring stocks of the Sacramento and San Joaquin Basins	Sacramento River - Fall	X					
	Sacramento River - Spring		X	Threatened			
	Sacramento River - Winter		X	Endangered			
Northern California Coast All fall and spring stocks of California streams north of the entrance to San Francisco Bay	Eel, Mattole, Mad, and Smith Rivers - Fall and Spring		X Incidental to harvest of SRFC and KRFC	Eel, Mattole and Mad River stocks - Threatened			
	Klamath River - Fall	X					
	Klamath River - Spring		X Incidental to harvest of SRFC and KRFC				
Oregon Coast All Oregon fall and spring stocks south of the Columbia River	Southern Oregon	X					
	Central and Northern Oregon		X			X	X
Columbia River Basin All pertinent fall, summer, and spring stocks of the Columbia River and its tributaries	North Lewis River - Fall		X	Threatened			X
	Lower River Hatchery - Fall	X			X		
	Lower River Hatchery - Spring		X		X		
	Upper Willamette - Spring		X	Threatened		X	
	Mid-River Bright Hatchery - Fall	X			X	X	
	Spring Creek Hatchery - Fall	X			X		
	Klickitat, Warm Springs, John Day, and Yakima Rivers - Spring		X			X	
	Snake River - Fall		X	Threatened			X
	Snake River - Spring/Summer		X	Threatened		X	
	Upper River Bright - Fall		X			X	X
	Upper River - Summer	X				X; Under Review	X

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

Chinook Complex	Chinook Stocks	Target Stock*	Non-target Stock*	ESA Listed	Hatchery stock	Far North Migrating	Subject to PST
	Upper River - Spring		X	Endangered		X	
Washington Coast All pertinent fall, summer and spring stocks from coastal streams north of the Columbia River through the western Strait of Juan de Fuca (west of the Elwha River)	Willapa Bay Fall (natural)		X			X	
	Willapa Bay Fall (hatchery)		X		X	X	
	Grays Harbor Fall		X			X	X
	Grays Harbor Spring		X			X	
	Quinault Fall (Hatchery)		X		X	X	
	Queets Fall		X			X	X
	Queets Spring/Summer		X			X	
	Hoh Fall		X			X	X
	Hoh Spring/Summer		X			X	
	Quillayute Fall		X			X	X
	Quillayute Spring/Summer		X			X	
	Hoko Summer/Fall		X			X	X
Puget Sound All fall, summer, and spring stocks originating from U.S. tributaries to Puget Sound and the eastern Strait of Juan de Fuca (east of Salt Creek)	Eastern Strait of Juan de Fuca Summer/Fall		X	Threatened		X	X
	Skokomish Summer/Fall		X	Threatened		X	X
	Nooksack Spring - early		X	Threatened		X	X
	Skagit - Summer/Fall		X	Threatened		X	X
	Skagit - Spring		X	Threatened		X	X
	Stillaguamish - Summer/Fall		X	Threatened		X	X
	Snohomish - Summer/Fall		X	Threatened		X	X
	Cedar River - Summer/Fall		X	Threatened		X	X
	White River - Spring		X	Threatened		X	
	Green River - Summer/Fall		X	Threatened		X	X
	Nisqually River - Summer/Fall		X	Threatened		X	X
Southern British Columbia Fall and spring stocks of B.C. coastal streams and the Fraser River	Coastal Stocks	X				X	X
	Fraser River	X					X
7	45	25	20	19	6	32	22

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

Table 3-3. Pink stocks and complexes listed in the current Pacific Salmon FMP.

Pink Complex		Target Stock*	Non-target Stock*	ESA Listed	Hatchery stock	Far North Migrating	Subject to PST
Puget Sound			X				X
Fraser			X				X

3.1.5 EFH

3.3 Socioeconomic Environment – Needs Updating and NOF Addition

Chapter IV in the *Review of 2009 Ocean Salmon Fisheries* (STT 2010a) provides information on the socioeconomic environment. More extensive information on ocean and inside salmon fisheries is provided in Appendix B to the Salmon FMP. Information on fishing communities is provided in Salmon FMP Appendices A and B to the Council's description of West Coast fishing communities.

Recreational fishing for ocean salmon includes private vessels, charter boats, and some shore-based fishing, although this last component accounts for a small amount of the recreational ocean catch. In 2005, California exhibited the highest proportion of charter boat participation of the three states and the highest overall level of recreational effort, with a combined 171,900 estimated trips, of which 40 percent were on charter boats. This reflects a general recovery in recreational participation since 2003, although down from 2004. Effort in Oregon and Washington fell substantially in 2005 from the levels seen in 2003 and 2004, although it was still higher than typical values in the 1990s. Over the long term there has been a decline in the number of ocean recreational trips, with most of the decline occurring from the Eureka area north. In recent years, ocean recreational trips have been supported in Washington and Oregon by the implementation of mark-selective fisheries for coho with healed adipose fin clips.

While analysis of impacts to the natural environment is organized around stocks that spawn in particular rivers, the social dimension, including management measures, is organized around ocean management areas, as described in the Salmon FMP. These areas also correspond to some extent with the ocean distribution of salmon stocks, although stocks are mixed in offshore waters. Broadly, from north to south these areas are (1) from the U.S./Canada border to Cape Falcon (45°46' N. lat.), which is on the Oregon coast south of the Columbia River mouth; (2) between Cape Falcon and Humbug Mountain (42°40' 30" N. lat.) on Oregon=s southern coast; (3) the Klamath Management Zone, which covers ocean waters from Humbug Mountain in southern Oregon to Horse Mountain (40°05' N. lat.) in northern California; and (4) from Horse Mountain to the U.S./Mexican border. There are also numerous subdivisions within these areas used to further balance stock conservation and harvest allocation considerations (Figure 3-1). The following description of the fisheries and fishing communities is organized around these areas and is derived from the *Review*. For the purpose of characterizing the economic impact of Council area salmon fisheries, coastal community level personal income impacts were used.

As salmon seasons become more restrictive, the potential for effort transfer into other fisheries increases, particularly for commercial groundfish, albacore, and crab fisheries, and recreational groundfish, halibut, and inside fisheries. Commercial and recreational charter businesses will seek other opportunities to generate income by participating in other fisheries, which could accelerate quota attainment and increase competition. Private recreational fishermen will also seek alternate fishing activities with similar results.

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

3.3.1 U.S./Canada border to Cape Falcon (North of Falcon)

Stocks on Which the Fisheries Rely

Commercial Fisheries

Recreational Fisheries

3.3.2 Cape Falcon to Humbug Mountain (Central Oregon Coast)

Stocks on Which the Fisheries Rely

Fisheries in this area catch a mix of stocks, which varies from year to year in response to the status of individual stocks. Oregon Coast Chinook, Central Valley, and KRFC stocks contribute substantially to these fisheries. Fisheries are limited primarily to recreational mark-selective coho fisheries since 1999. Washington coastal, Columbia River, and Oregon coastal coho stocks are encountered in this area.

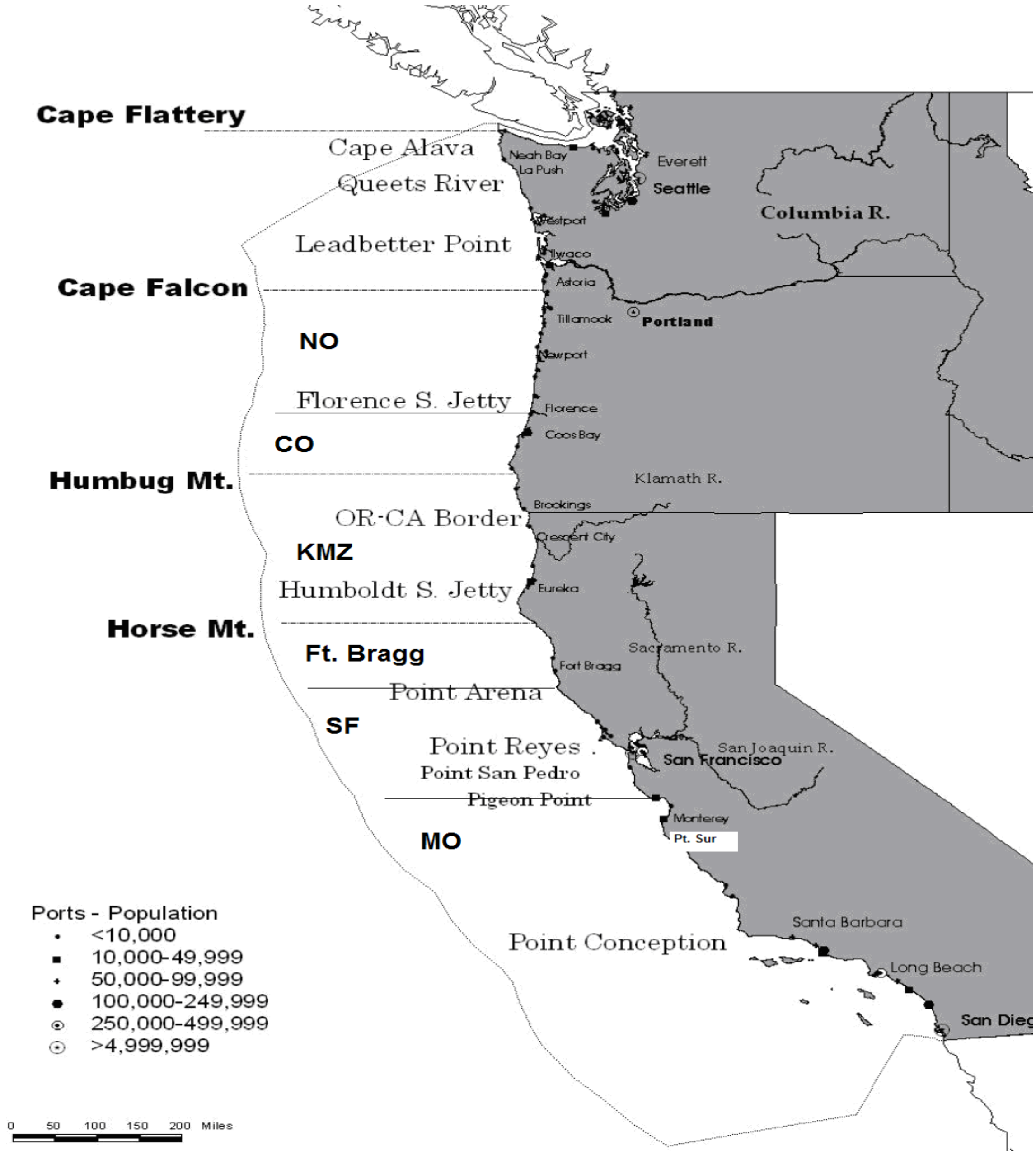


Figure 3-1. Map of West Coast ocean salmon fishery management areas.

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

Commercial Fisheries

Oregon coast ports between Cape Falcon and the KMZ are the major contributors to Chinook landings, along with California ports south of the KMZ; in 2005, the Cape Falcon to Humbug Mountain harvest accounted for 36% of all commercial Chinook landings from the Council area. Coho landings were very large between Cape Falcon and Humbug Mountain until 1992 when, as noted, stock declines coupled with regulatory actions eliminated most landings south of Cape Falcon. (Some mortality to coho stocks still occurs in conjunction with effort targeted on Chinook. Mortality from gear encounters, including drop-off and hook-and-release, is accounted for in coho mortality estimates.) Tillamook, Newport, and Coos Bay are the major port areas in this zone; almost half of the Chinook landings were made at Newport.

Recreational Fisheries

Central Oregon recreational coho landings accounted for about 6% of Council-area-wide recreational coho catch and 8% of the total recreational salmon catch in 2005. Seasonal management measures allowed a selective fishery for marked coho in this area. This area accounted for 15% of Council-area-wide recreational fishing trips in 2005; 85% were on private boats. Of the three ports in this area, Newport originated the most charter trips in 2005. But the two other ports (Tillamook and Coos Bay) each originated more private trips than the number of charter trips or private trips out of Newport. Thus, while Newport is an important center for charter fishing, recreational fishing on private boats is important at all of the ports in the area.

3.3.3 Humbug Mountain to Horse Mountain (KMZ)

The KMZ covers waters in southern Oregon and northern California around the mouth of the Klamath River. This is geographically the smallest zone. A significant component of the allocation issues in this zone are the harvest needs of Klamath River tribal and sport fisheries.

Stocks on Which the Fisheries Rely

The KMZ was created to focus management on KRFC because the impacts of ocean fisheries have predominantly occurred in this area. Other major contributors to the harvest in this area include the Sacramento Valley and southern Oregon coast Chinook stocks. Retention of coho is prohibited in California (NMFS ESA consultation standard for southern Oregon/northern California coastal [SONCC] and central California coastal [CCC] coho ESUs (NMFS 1999).

Commercial Fishery

This area accounts for a small proportion of commercial landings. In 2005, only about 1% of Council-area-wide commercial Chinook landings were made at the three major ports in this zone: Brookings, Oregon; and Crescent City and Eureka in California.

Recreational Fishery

This area accounts for a small portion of recreational landings, about 11% of coast wide Chinook landings. About 9% of Council-area-wide angler trips occurred in the KMZ in 2005, with 96% of these trips made on private vessels. Charter fishing in the zone, from a Council- area-wide perspective, accounted for less than half a percent in 2005.

ABC-acceptable biological catch; ACL-annual catch limit; ACT-annual catch target; AM-accountability measures; F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

3.3.4 South of Horse Mountain

Although this area is defined as stretching to the U.S./Mexican border, ocean salmon fishing generally occurs only as far south as Point Conception, California

Stocks on Which the Fisheries Rely

Central Valley Chinook stocks are important throughout this area, particularly south of Fort Bragg (Point Arena). Southern Oregon Chinook stocks contribute to fisheries in the northern portion of this area. KRFC and Sacramento River winter run Chinook stocks are also caught in this area, and the conservation needs for these stocks often have a significant effect on ocean harvest management measures. Coho retention is prohibited in California (NMFS ESA consultation standard for SONCC and CCC coho ESUs, NMFS 1999).

Commercial Fisheries

California commercial fisheries historically have been the major component of Council-area-wide ocean salmon fishing, consistently accounting for a major share of Chinook landings; 50% in 2005, and as much as 75% as recently as 2000. Coho were less important historically than Chinook; coho retention in commercial fisheries south of the Oregon/California border has not been allowed since 1993 to reduce impacts on OCN and other depressed coho stocks.

Major ports in this area (as listed in *Review* Table IV-6) are Fort Bragg, San Francisco, and Monterey. In recent years San Francisco has been the major port for commercial landings, accounting for about two-thirds of landings at the three ports and half of landings in this area in 2005. Opportunity in Fort Bragg was reduced beginning in 1990 to reduce impacts on KRFC. Monterey and Fort Bragg had a greater share of landings in the past, and as recently as 1996, Monterey landings exceeded San Francisco's.

Recreational Fisheries

This area had the largest share of Council-area-wide recreational Chinook landings in 2005 at 46%; coho landings were negligible, reflecting regulations prohibiting coho retention. (The reported landings include some illegal harvest, as footnoted in the Review tables.) The number of recreational trips has remained more stable over the long term in the area south of Horse Mountain than in areas to the north where effort declined substantially in the 1990s. As a result, the number of trips occurring in this area as a proportion of coast wide trips has generally increased and accounted for the largest share of angler trips in Council-area recreational salmon fisheries. Charter fishing historically, and today, has accounted for a much larger fraction of recreational trips in this area, as compared to areas to the north; in 2005, 43% of trips south of Horse Mountain were made by charter vessels. San Francisco is by far the largest port for charter trips, while private recreational trips are more evenly distributed among the three ports in this area.

3.3.5 Catch, Effort and Economic Impact Data for Oregon and Washington Ocean Salmon Fisheries North of Cape Falcon

3.3.6 Catch, Effort and Economic Impact Data for Oregon and California Ocean Salmon Fisheries South of Cape Falcon

Catch and effort data for 2000-2004 were used to describe and compare the Oregon and California ocean salmon fisheries south of Cape Falcon (Table 3-x). In these years, the Oregon troll fishery averaged 11,600 boat days and 253,000 Chinook salmon per year. Most of the effort and catch was in the

Tillamook-Newport area (Northern Oregon). The California troll fishery averaged 17,900 boat days and 411,800 Chinook salmon per year. Most (55%) of the California fish were landed in the San Francisco area. The low effort and catch in the KMZ troll fishery was the result of regulations aimed at reducing fishery impacts on KRFC, which are in high abundance in the area.

The Oregon sport fishery averaged 101,600 angler-days and 37,200 Chinook salmon per year during 2001-2005 (Table 3-x). The California fishery averaged 180,100 angler days and 148,000 Chinook salmon per year. San Francisco averaged 46% of the recreational effort and 52% of the California recreational Chinook salmon catch. The KMZ sport fisheries (KO and KC) landed more Chinook salmon than the KMZ troll fishery (22,600 compared to 17,600). The combined troll fisheries in the other areas took 80% of the total Chinook salmon catch. The shift of troll catch out of the KMZ shows the effect of regulations aimed at reducing troll fishery impacts on KRFC while attempting to maintain a viable KMZ ocean salmon recreational fishery.

Economic impact estimate averages for 2001-2005 show that about half (52%) of the Oregon impact estimate of $20.0 million occurred in the Northern Oregon area (Table 3-2). It is important to note that some of the recreational fishery impact was associated with mark selective hatchery coho salmon fishing. The California ocean salmon fisheries which were entirely based on Chinook salmon were valued at about $44 million annually with about half (58%) of the impact in San Francisco-area fisheries.

Table 3-4. Average annual Oregon and California ocean Chinook salmon fishing effort and catch by fishery and KOHM port area during 2001-2005.

State	Area[a/]	Effort	Catch
Commercial Troll (boat days)			
Oregon	NO	6,251	151,595
South of Cape Falcon	CO	4,934	117,519
	KO	439	5,245
	Total	11,624	274,359
California	KC	381	12,430
	FB	3,258	96,438
	SF	8,823	210,097
	MO	4,665	64,879
	Total	17,127	383,844
Sport (angler days)			
Oregon	NO	48,788	15,022
South of Cape Falcon	CO	34,491	15,190
	KO	18,291	7,027
	Total	101,571	37,238
California	KC	20,947	15,559
	FB	28,175	23,706
	SF	83,482	77,207
	MO	47,488	31,501
	Total	180,092	147,973

a/ NO=Northern Oregon (Tillamook/Newport); CO=Central Oregon (Coos Bay); KO=Oregon KMZ (Brookings); KC=California KMZ (Crescent City/Eureka); FB=Fort Bragg; SF = San Francisco; MO=Monterey.

Table 3-5. Estimates of average annual coastal community and state personal income impacts for Oregon and California troll and recreational ocean salmon fisheries by port area in 2005 dollars (000s) during 2001-2005.[a/]

	Area[b/]					
		NO	CO	KO	Community Total	State
Oregon						
Troll		$5,741.4	$4,367.1	$836.2	$10,944.7	$12,705.1
Recreational		$2,823.7	$1,815.3	$805.1	$5,444.1	$7,274.3
Totals		$8,565.1	$6,182.4	$1,641.3	$16,388.8	$19,979.4
California	KC	FB	SF	MO	Community Total	State
Troll	$730.2	$5,225.4	$13,556.2	$4,008.0	$23,519.9	$24,854.0
Recreational	$1,193.2	$2,133.2	$9,551.1	$3,529.2	$16,406.7	$19,152.8
Totals	$1,923.4	$7,358.7	$23,107.3	$7,537.2	$39,926.6	$44,006.8

a/ Per pound and per day estimates of income impacts provided by the Fishery Economic Assessment Model (FEAM). These are the income impacts associated with expenditures in the troll or recreational sectors. There is no differentiation between money new to the area and money which would otherwise have been expended in other sectors. It is assumed that all fish landed at a port is processed in the port area. Values are based on a 1998 run of the FEAM using 1996 U.S. Forest Service IMPLAN data.

b/ NO=Northern Oregon (Tillamook/Newport); CO=Central Oregon (Coos Bay); KO=Oregon KMZ (Brookings); KC=California KMZ (Crescent City/Eureka); FB=Fort Bragg; SF = San Francisco; MO=Monterey.

4.0 ANALYSIS OF ALTERNATIVES

4.1 Analysis of Environmental Impacts from Classification Alternatives

Classification alternatives, for the most part, have no potentially significant impacts on the affected environment. Management of the stocks and constraints on the fisheries would not change relative to status quo because conservation objectives would remain the same; stocks subject to the PST would continue to be managed as such; ESA listed stocks would continue to have their management deferred to consultation standards; and hatchery stocks would not constrain fisheries. Revising or forming new stock complexes would not change the indicator stocks currently used to manage fisheries. Classifying FNM stocks as ECs would not change fishery management as these stocks are currently excepted from the FMP overfishing criteria. If FNM stocks were kept in the fishery and became subject to overfishing criteria (SDC for overfishing, overfished, etc.), the impacts would be negligible since Council area fisheries would be unlikely to affect rebuilding plans. However, the EC designation would result in one potentially significant impact. Based on NMFS policy, stocks that are not in the fishery would not be subject to the MSA provisions for identification and description of Essential Fish Habitat (EFH). Activities with a Federal nexus in areas designated as EFH require consultation with NMFS to minimize adverse effects of such activities on fish habitat. If the stocks that occupy such areas are not classified as in the fishery, the EFH designation would presumably be revoked.

The classification alternatives propose designating FNM Chinook and pink stocks as ECs. EFH is currently designated for Puget Sound Chinook, coho, and pink stocks. If the Puget Sound pink stock is designated as an EC, the associated EFH would be removed. However, EFH for Puget Sound Chinook and coho would remain and includes all of the sub-basins for Puget Sound pinks. Conservation recommendations for EFH would no longer consider the specific needs of pink salmon, but would be diminished only to the degree that the habitat needs and associated conservations for Chinook and coho salmon differ. Since Puget Sound Chinook salmon are also ESA listed, habitat protections are also provided through ESA section 7 consultations related to critical habitat.

Whether EFH protections for FNM Chinook are lost or diminished depends on the basin specific circumstances. There are three potential scenarios:

1. In sub-basins where FNM Chinook salmon co-occur with non-FNM or ESA-listed Chinook salmon, EFH designations would remain intact and there would be no change in the EFH consultation requirements or the species covered by these consultations;
2. In sub-basins where FNM Chinook salmon co-occur with coho salmon, but not other Chinook salmon, EFH designations would remain intact, consultation requirements will remain in effect, but NMFS conservation recommendations would apply only to coho salmon;
3. In sub-basins where FNM Chinook salmon are the only salmon with currently designated EFH, EFH designations would be removed and EFH consultations would no longer occur.

Most EFH areas are designated as such for both coho and Chinook; however, there are a few that are only designated as Chinook EFH. These areas are limited to FNM spring Chinook from the mid-Columbia River. If the stocks that occupy such areas are not classified as in the fishery, the EFH designation could be revoked.

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

EFH in the Walla Walla, Umatilla, Upper Deschutes, Lower Crooked, Upper and Lower John Day, and North Fork and Middle Fork John Day rivers is currently specified for Chinook only. Chinook stocks in these basins are FNM and would be classified as not in the fishery under alternative 2; therefore salmon EFH would no longer be designated in these areas.

Another consideration in this matter is the range overlap of ESA-listed steelhead and the conservation benefits of ESA section 7 consultations. Except for the lower Crooked River and Upper Deschutes where experimental reintroduction efforts are underway, all of the affected mid-Columbia sub-basins are also occupied by ESA-listed steelhead, and most have critical habitat designated. The ranges of steelhead and Chinook salmon overlap, but are not completely coincident. Federal actions in these areas are subject to the consultation requirements of ESA Section 7, which like the MSA EFH provisions, are also designed to protect habitat. As with the EFH consultations for coho salmon, we would expect some incidental protection for Chinook salmon habitats from ESA consultations on steelhead, but the conservation measures would not target Chinook habitats or life stages. As a result, we would still expect some erosion of regulatory capabilities to protect Chinook salmon habitat in these sub-basins with the loss of EFH designations.

4.2 Analysis of Environmental Impacts from SDC Alternatives

4.2.1 Overfishing

To evaluate the effects of the overfishing SDC alternatives on these environments, annual exploitation rates from 1983 to 1986-forward for SRFC, KRFC, Columbia River summer Chinook, Washington Coastal coho, and Puget Sound coho were judged against the SDC in order to retrospectively determine the relative frequency of years that each stock would have been designated as subjected to overfishing. The analysis used the best currently available estimate of F_{MSY} for each of these stocks in making this determination; if a direct estimate of F_{MSY} was unavailable, the proxy values of 0.78 for Chinook was used (see Appendix C). FMSY for Puget Sound coho represent the normal exploitation rates used in the FMP conservation objectives. F_{MSY} for Washington Coastal coho were obtained from stock recruitment data used in Coho FRAM (Appendix E). The analysis assumes that the stocks were managed to achieve conservation and management objectives in place at the time, and that exploitation rates were not adjusted to reflect how stocks might have been managed had updated estimates of F_{MSY}, alternative SDC, or other alternative management requirements been in place (e.g., ACLs, rebuilding measures).

Results: Based on the comparison of historical exploitation rates to F_{MSY}, it appears that most stocks experienced exploitation rates exceeding F_{MSY} (Alternative 2 overfishing SDC) frequently prior to the mid-early 1990's. Since that time, overfishing was observed only once (SRFC 2004) for the stocks analyzed (Table 4-1). The lower exploitation rates observed since the mid 1990's were largely the result of ocean fishery constraints for ESA listed stocks, adoption of exploitation rate management for PST stocks, constraints in Canadian fisheries to address stock depression for several Canadian stocks, and management constraints on KRFC. The assessment of effects on the environment assumes that management under the overfishing SDC Alternative 2 would have similar frequencies of overfishing determinations as those observed since the late-1990s (after the most recent ESA listings). Compared to the status quo, it is expected that overfishing would be determined less frequently, in fact rarely, under Alternative 2 (Table 4-1).

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

Table 4-1. Retrospective analysis of overfishing occurrences based on status determination criteria alternatives for select stocks. Analysis assumes fisheries were managed to meet objectives in place at the time, not those associated with the alternatives.

Stock / Criterion		Rel Freq. OF'ing
SRFC: F_{MSY} =	0.78	
Alt 1-Status Quo: S(t,t-1,t-2)<122,000&C+S>122,000		7.4%
Alt 2: F(t) > F_{MSY}		22.2%
KRFC: F_{MSY} =	0.72	
Alt 1-Status Quo: S(t,t-1,t-2)<35,000&C+S>35,000		17.4%
Alt 2: F(t) > F_{MSY}		4.0%
CRSu: S_{MSY} =	0.75	
Alt 1-Status Quo: S(t,t-1,t-2)<37,041&C+S>37,041		27.3%
Alt 2: F(t) > F_{MSY}		0.0%
Grays Harbor Coho: F_{MSY} =	0.69	
Alt 1-Status Quo: S(t,t-1,t-2)<35,400&C+S>35,400		3.7%
Alt 2: F(t) > F_{MSY}		8.7%
Queets Coho: F_{MSY} =	0.68	
Alt 1-Status Quo: S(t,t-1,t-2)<5,800&C+S>5,800		18.5%
Alt 2: F(t) > F_{MSY}		21.7%
Hoh Coho: F_{MSY} =	0.69	
Alt 1-Status Quo: S(t,t-1,t-2)<2,000&C+S>2,000		0.0%
Alt 2: F(t) > F_{MSY}		21.7%
Quillayute Fall Coho: F_{MSY} =	0.59	
Alt 1-Status Quo: S(t,t-1,t-2)<6,300&C+S>6,300		0.0%
Alt 2: F(t) > F_{MSY}		17.4%
Strait JDF: F_{MSY} =	0.60	
Alt 1-Status Quo: S(t,t-1,t-2)<14,800&C+S>14,800		21.7%
Alt 2: F(t) > F_{MSY}		13.0%
Skagit: F_{MSY} =	0.60	
Alt 1-Status Quo: S(t,t-1,t-2)<30,000&C+S>30,000		17.4%
Alt 2: F(t) > F_{MSY}		21.7%
Hood Canal: F_{MSY} =	0.65	
Alt 1-Status Quo: S(t,t-1,t-2)<21,500&C+S>21,500		26.1%
Alt 2: F(t) > F_{MSY}		34.8%
Stilliguamish: F_{MSY} =	0.50	
Alt 1-Status Quo: S(t,t-1,t-2)<17,000&C+S>17,000		26.1%
Alt 2: F(t) > F_{MSY}		43.5%
Snohomish: S_{MSY} =	0.60	
Alt 1-Status Quo: S(t,t-1,t-2)<70,000&C+S>70,000		0.0%
Alt 2: F(t) > F_{MSY}		34.8%
Year: 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009		

An overfishing determination could affect the biological socioeconomic environments in several ways.

- BIOLOGICAL: With respect to the biological environment, Alternative 2 overfishing SDC (Alternatives 3, 4, and 5 are identical to Alternative 2, see Table 2-7) should have direct positive effects because the SDC are more objective than the status quo alternative and criteria are assessed on an annual basis rather than only after the stock is determined to be overfished. As a result, management actions would be more responsive, and overfishing would end sooner; however, based on the results in Table 4-1 since the mid-1990s, the need for such actions would be expected only rarely.
- SOCIO-ECONOMIC: With respect to the socioeconomic environment, the Alternative 2 for

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

overfishing SDC should have long-term positive effects because the SDC will help ensure the stock is exploited at levels that do not exceed F_{MSY}. Short-term effects could be negative if exploitation rates are constrained and access to production in excess of spawning escapement goals or access to other stocks in constrained; however, based on the results in Table 4-1 since the mid-1990's such constraints are not expected.

Overall, environmental effects would be generally positive, but not significantly so. The difference in frequency of overfishing determinations between the two alternatives would have positive, but negligible, impacts to the biological and socioeconomic environments.

4.2.2 Overfished

To evaluate the effects of the overfished SDC alternatives on the environment, annual spawning escapements from 1970-forward (STT 2010a) for six Chinook and nine coho stocks were judged against the SDC in order to retrospectively determine the relative frequency of years that each stock would have been designated as overfished. In making this determination, Alternatives 2 through 5 were based on the best currently available estimate of S_{MSY}; Alternative 1 (status quo) used the current conservation objective value, or if a range, the low end of the range. The analysis assumes that the stocks were managed to achieve conservation and management objectives in place at the time, and that spawning escapements were not adjusted to reflect how stocks might have been managed had updated estimates of S_{MSY}, alternative SDC, or other alternative management requirements been in place (e.g., ACLs, rebuilding measures).

Chinook: the Chinook stocks assessed include:

- SRFC,
- KRFC,
- Columbia River summer,
- Hoh fall,
- Queets spring/summer, and
- Quillayute summer.

SRFC, KRFC, and Columbia River summer Chinook stocks would be in the fishery under all classification alternatives, and KRFC and SRFC would serve as indicator stocks for the SONC and CVF complexes, respectively.

Hoh fall, Queets spring/summer, and Quillayute summer stocks (considered Far North Migrating Stocks) are proposed as EC stocks under Classification Alternative 3, and, as such, would not require SDC. The NS1G's criteria for classification as an EC are that the stock is not overfished and not likely to become overfished. Therefore, this analysis provides an assessment of those criteria, in addition to the overfished SDC if the stocks are classified as in the fishery. The three FNM Chinook stocks are not all inclusive, but represent the range of results that could be expected from other FNM Chinook stocks.

The Basis of Chinook S_{MSY} used for this analysis were as follows:

- SRFC: S_{MSY} corresponding to the lower end of the current conservation objective range of 122,000-180,000.
- KRFC: an S_{MSY} estimate of 40,700 natural area adult spawners (STT 2005).
- Columbia River summer Chinook: an S_{MSY} estimate of 37,041 (CTC 1999).
- Hoh fall and Quillayute summer Chinook: S_{MSY} estimates of 1,200 and 1,200, respectively (Cooney 1984).
- Queets spring/summer Chinook: an S_{MSY} estimate of 700 as listed in the Salmon FMP (PFMC 2007).

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

Coho: The Coho stocks assessed include:

- Grays Harbor,
- Queets,
- Hoh,
- Quillayute,
- Strait of Juan de Fuca,
- Skagit,
- Hood Canal,
- Stillaguamish, and
- Snohomish.

All of the coho stocks would be in the fishery under all classification alternatives.

The Basis of Coho S_{MSY} and S_{MSP} used for this analysis were as follows:

- Grays Harbor: A direct estimate of S_{MSY} was not available for Grays Harbor coho, but the FMP conservation objective is based on an estimate of SMSP. Therefore, S_{MSY} for Grays Harbor coho was calculated using the following relationship: $S_{MSY} = S_{MSP} \times F_{MSY}$. F_{MSY} for Grays Harbor coho was estimated at 0.69 (Appendix E), resulting in an S_{MSY} estimate of 24,436.
- Queets, Hoh, and Quillayute: an estimate of S_{MSY} equal to the midpoint of the range of S_{MSY} estimates provided in Lestelle et al. (1984), which is consistent with the PSC process for reporting categorical status for setting annual allowable exploitation rates. The current status quo conservation alert criteria use the lower end of the range of S_{MSP} estimates.
- Puget Sound stocks: S_{MSY} estimates derived from the allowable normal exploitation rate applied to the normal/low preseason abundance breakpoint. Another set of alternatives for Puget Sound stocks are presented based on the low/critical preseason abundance breakpoint and the low exploitation rate rather than $0.5*S_{MSY}$ or $0.75 *S_{MSY}$. This latter set of alternatives are presented because they were suggested by the STT as possible criteria for triggering an overfishing concern when the Puget Sound coho exploitation rate matrix conservation objectives were adopted by the Council in March, 2010, and to facilitate discussion with State and Tribal comanagers regarding appropriate triggers. These spawning escapement levels correspond to a range of $0.59*S_{MSY}$ and $0.75*S_{MSY}$ for the five Puget Sound coho stocks. These spawning escapement levels also correspond to trigger points for management action under the PST.

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

Results: The results of the analysis indicate that for most stocks, overfished status would have occurred periodically, and that the stocks would have remained depressed for a few years before rebuilding (Tables 4-2, 4-3, 4-4). Three periods of general stock depression were observed in the analysis: one in the early 1980's, one in the early 1990's, and one in the mid 2000's. The duration of stock depression was generally in the three to six year range. While the pattern was not observed in all stocks, it was prevalent enough to suggest that cyclical, broad-scale changes in environmental conditions likely underlie these periods of stock depression, e.g., shifts in ocean productivity regimes or extended droughts. The assessment of effects on the environment assumes that management under the overfished SDC Alternatives would have similar frequencies and durations of overfished determinations as those observed since the late-1990s (see Section 4.2.1 of this EA).

The alternatives based on 3-year geometric means or consecutive years would have less frequent overfished determinations than those based on single a year for a given percentage of S_{MSY}. They also would tend to start later and end no earlier than the annual alternatives, meaning the duration of the overfished status would generally be longer for the annual alternatives. Annual alternatives also exhibited more of a tendency for short (1-year) determinations to occur, as expected, due to the natural variability of salmon abundance. This feature of annual alternatives could have a substantial negative impact on the administrative environment by necessitating frequent assessments, which may not be completed before the stock recovers. If the cause of such frequent determinations was natural variability in population abundance, the determination would not represent a real risk to the capacity of the stock to produce MSY on a continuing basis.

In terms of the relative frequency of overfished determinations, status quo (Alternative 1) was most similar to a 3-year geometric mean $< 0.75*S_{MSY}$ (Alternative 5) (Figure 4-1). Ranking the alternatives by the relative frequency of overfished determinations indicates that Alternative 3 had the lowest frequency, followed by Alternative 2, Alternatives 1 and 5, and Alternative 4 with the highest frequency. Effects on the environment would reflect these ranks, with Alternative 3 having the fewest negative effects on the socioeconomic and administrative environments and the greatest risk of negative effects to the biological environment; Alternative 4 would have the greatest negative effects on the socioeconomic and administrative environments and the least risk to the biological environment. However, the difference in relative risk is not similar among the environments. Risk to the biological environment between Alternatives 3 and 4 should be negligible if Alternative 3 accurately reflects abundance from which salmon stocks can recover to MSY levels without reduction in the long-term stock reproductive potential. Based on the patterns observed in Tables 4-2, 4-3, and 4-4, it appears that this is the case, since most stocks have had 3-year (or longer) geometric mean spawning escapements less than $0.5*S_{MSY}$ and have subsequently recovered. The NS1Gs also recommend $0.5*S_{MSY}$ as an appropriate reference point for overfished SDC, particularly given the high productivity and short life-cycle of salmon. Use of the geometric mean also helps ensure that overfished determinations represent more than natural variation in stock abundance, and thus reduces potential negative effects on the socioeconomic and administrative environments.

Based on Alternative 3, it is evident that the FNM Chinook stocks analyzed are not overfished (represented in this analysis by the Hoh fall, Queets spring/Summer, and Quillayute Summer stocks), and are much less likely to become overfished than not, and therefore that the criteria for designating FNM Chinook stocks as EC would be satisfied.

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

Table 4-2. Retrospective analysis of overfished and rebuilt (R) occurrences based on status determination criteria alternatives for select Chinook stocks. Analysis assumes fisheries were managed to meet objectives in place at the time, not those associated with the alternatives. (Page 1 of 2)

Stock / Criterion	Rebuilt (R) year(s)	Rel Freq. OF'd
SRFC: S_{MSY} = 122,000		
Alt 1-Status Quo: S(t,t-1,t-2)<122,000	1993	5.3%
Alt 1b-Status Quo: S(t,t-1,t-2)<S_{MSY}	1993	5.3%
Alt 2: S(t) < 0.5*S_{MSY}		2.5%
Alt 3: 3-Yr GeoMean < 0.5*S_{MSY}		2.6%
Alt 4: S(t) < 0.75*S_{MSY}	1993	10.0%
Alt 5: 3-Yr GeoMean < 0.75*S_{MSY}		2.6%
KRFC: S_{MSY} = 40,700		
Alt 1-Status QuoS(t,t-1,t-2)<35,000	1986, 1995, 2007	30.0%
Alt 1b: S(t,t-1,t-2)<S_{MSY}	1986, 1995, 2007	30.0%
Alt 2: S(t) < 0.5*S_{MSY}	1986, 1995, 2000	15.6%
Alt 3: 3-Yr GeoMean < 0.5*S_{MSY}	1995	10.0%
Alt 4: S(t) < 0.75*S_{MSY}	1986, 1995, 2000, 2007	34.4%
Alt 5: 3-Yr GeoMean < 0.75*S_{MSY}	1987, 1995, 2009	30.0%
Spawning Escapement	# (1978–2009)	
Rebuilt: 3-yr GM>S_{MSY}		
CRSu: S_{MSY} = 37,041		
Alt 1: S(t,t-1,t-2)<S_{MSY}	2001	69.0%
Alt 2: S(t) < 0.5*S_{MSY}	2001	58.1%
Alt 3: 3-Yr GeoMean < 0.5*S_{MSY}	2002	69.0%
Alt 4: S(t) < 0.75*S_{MSY}	2001, 2009	74.2%
Alt 5: 3-Yr GeoMean < 0.75*S_{MSY}	2002	69.0%

Year: 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

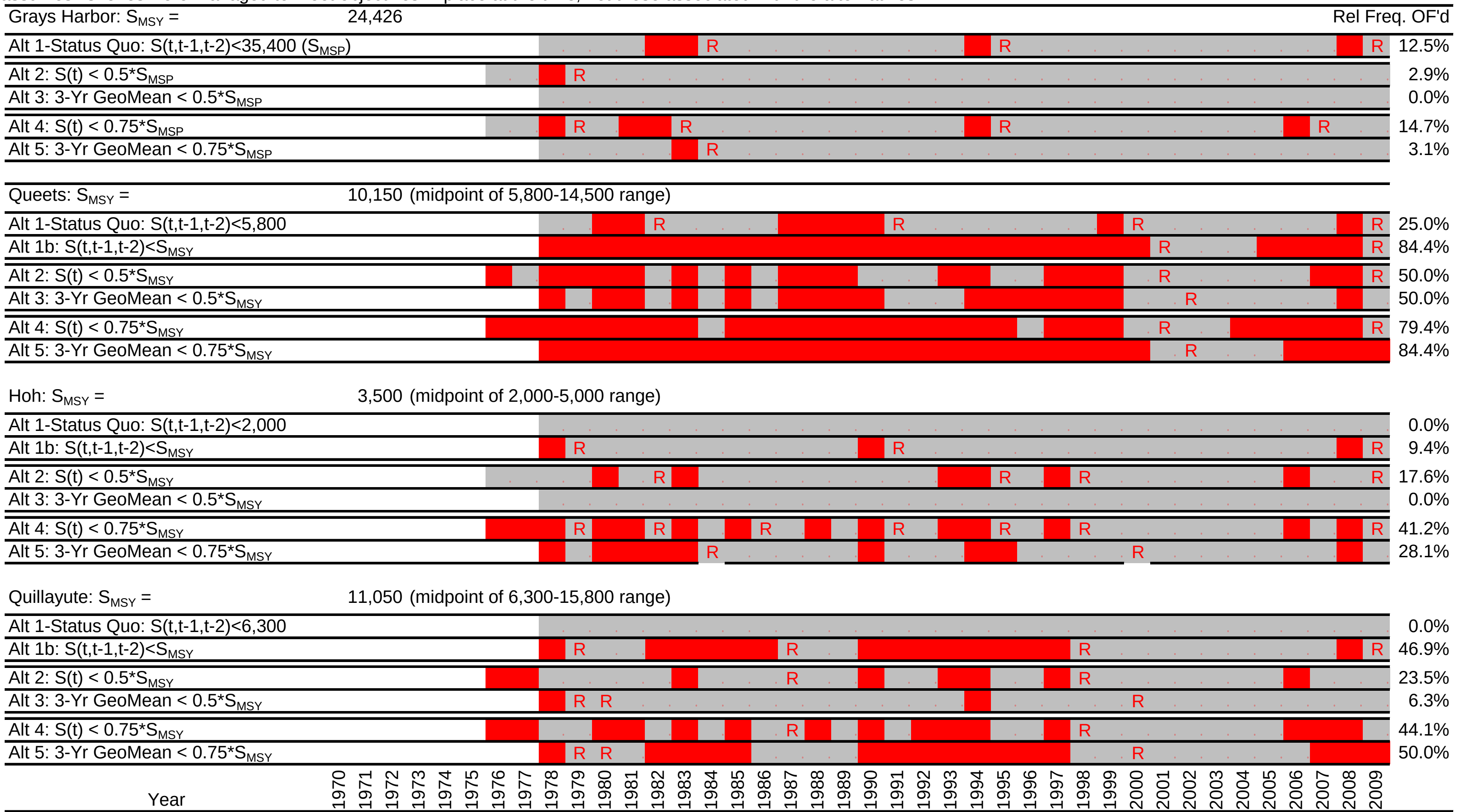
Table 4-2. Retrospective analysis of overfished and rebuilt (R) occurrences based on status determination criteria alternatives for select Chinook stocks. Analysis assumes fisheries were managed to meet objectives in place at the time, not those associated with the alternatives. (Page 2 of 2)

Stock / Alternative	S_{MSY}	Rel Freq. OF'd
Hoh Fall	1,200	
Alt 1: $S(t,t-1,t-2)<S_{MSY}$		0.0%
Alt 2: $S(t) < 0.5*S_{MSY}$		0.0%
Alt 3: 3-Yr GeoMean $< 0.5*S_{MSY}$		0.0%
Alt 4: $S(t) < 0.75*S_{MSY}$		0.0%
Alt 5: 3-Yr GeoMean $< 0.75*S_{MSY}$		0.0%
Queets Spring/Summer	700	
Alt 1: $S(t,t-1,t-2)<S_{MSY}$		25.0%
Alt 2: $S(t) < 0.5*S_{MSY}$		15.2%
Alt 3: 3-Yr GeoMean $< 0.5*S_{MSY}$		9.4%
Alt 4: $S(t) < 0.75*S_{MSY}$		32.4%
Alt 5: 3-Yr GeoMean $< 0.75*S_{MSY}$		34.4%
Quillayute Summer	1,200	
Alt 1: $S(t,t-1,t-2)<S_{MSY}$		31.3%
Alt 2: $S(t) < 0.5*S_{MSY}$		11.8%
Alt 3: 3-Yr GeoMean $< 0.5*S_{MSY}$		3.1%
Alt 4: $S(t) < 0.75*S_{MSY}$		35.3%
Alt 5: 3-Yr GeoMean $< 0.75*S_{MSY}$		28.1%

Year: 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

Table 4-3. Retrospective analysis of overfished and rebuilt (R) occurrences based on status determination criteria alternatives for Washington Coastal coho stocks. Analysis assumes fisheries were managed to meet objectives in place at the time, not those associated with the alternatives.



F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

Table 4-4. Retrospective analysis of overfished and rebuilt (R) occurrences based on status determination criteria alternatives for Puget Sound coho stocks. Analysis assumes fisheries were managed to meet objectives in place at the time, not those associated with the alternatives.

Stock / Alternative	S_{MSY}	Low S_{MSY} [a/]	% S_{MSY}	Rel Freq. OF'd
Strait JDF: S_{MSY} =	10,978	7,007 (low S_{MSY} [a/])	64% S_{MSY}	
Alt 1: $S(t,t-1,t-2)<S_{MSY}$				26.9%
Alt 2: $S(t) < 0.5*S_{MSY}$				10.7%
Alt 3: 3-Yr GeoMean < $0.5*S_{MSY}$				0.0%
Alt 4: $S(t) < 0.75*S_{MSY}$				25.0%
Alt 5: 3-Yr GeoMean < $0.75*S_{MSY}$				23.1%
Skagit: S_{MSY} =	25,000	14,857 (low S_{MSY} [a/])	59% S_{MSY}	
Alt 1: $S(t,t-1,t-2)<S_{MSY}$				19.2%
Alt 2: $S(t) < 0.5*S_{MSY}$				17.9%
Alt 3: 3-Yr GeoMean < $0.5*S_{MSY}$				7.7%
Alt 4: $S(t) < 0.75*S_{MSY}$				39.3%
Alt 5: 3-Yr GeoMean < $0.75*S_{MSY}$				36.0%
Hood Canal: S_{MSY} =	14,350	10,750 (low S_{MSY} [a/])	75% S_{MSY}	
Alt 1: $S(t,t-1,t-2)<S_{MSY}$				0.0%
Alt 2: $S(t) < 0.5*S_{MSY}$				3.6%
Alt 3: 3-Yr GeoMean < $0.5*S_{MSY}$				0.0%
Alt 4: $S(t) < 0.75*S_{MSY}$				3.6%
Alt 5: 3-Yr GeoMean < $0.75*S_{MSY}$				3.8%
Stilliguamish: S_{MSY} =	10,000	6,100 (low S_{MSY} [a/])	61% S_{MSY}	
Alt 1: $S(t,t-1,t-2)<S_{MSY}$				0.0%
Alt 2: $S(t) < 0.5*S_{MSY}$				0.0%
Alt 3: 3-Yr GeoMean < $0.5*S_{MSY}$				0.0%
Alt 4: $S(t) < 0.75*S_{MSY}$				8.1%
Alt 5: 3-Yr GeoMean < $0.75*S_{MSY}$				0.0%
Snohomish: S_{MSY} =	50,000	31,000 (low S_{MSY} [a/])	62% S_{MSY}	
Alt 1: $S(t,t-1,t-2)<S_{MSY}$				0.0%
Alt 2: $S(t) < 0.5*S_{MSY}$				0.0%
Alt 3: 3-Yr GeoMean < $0.5*S_{MSY}$				0.0%
Alt 4: $S(t) < 0.75*S_{MSY}$				5.4%
Alt 5: 3-Yr GeoMean < $0.75*S_{MSY}$				0.0%

Year: 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009

a/ Low MSY refers to the spawning escapement associated with the low/critical abundance break-point multiplied by the low exploiataion rate as represneted in the FMP conservation objective matrix of allowable exploitation rates (i.e., Comprehensive Coho Agreement). This represents S_{MSY} at low stock specific productivity levels.

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

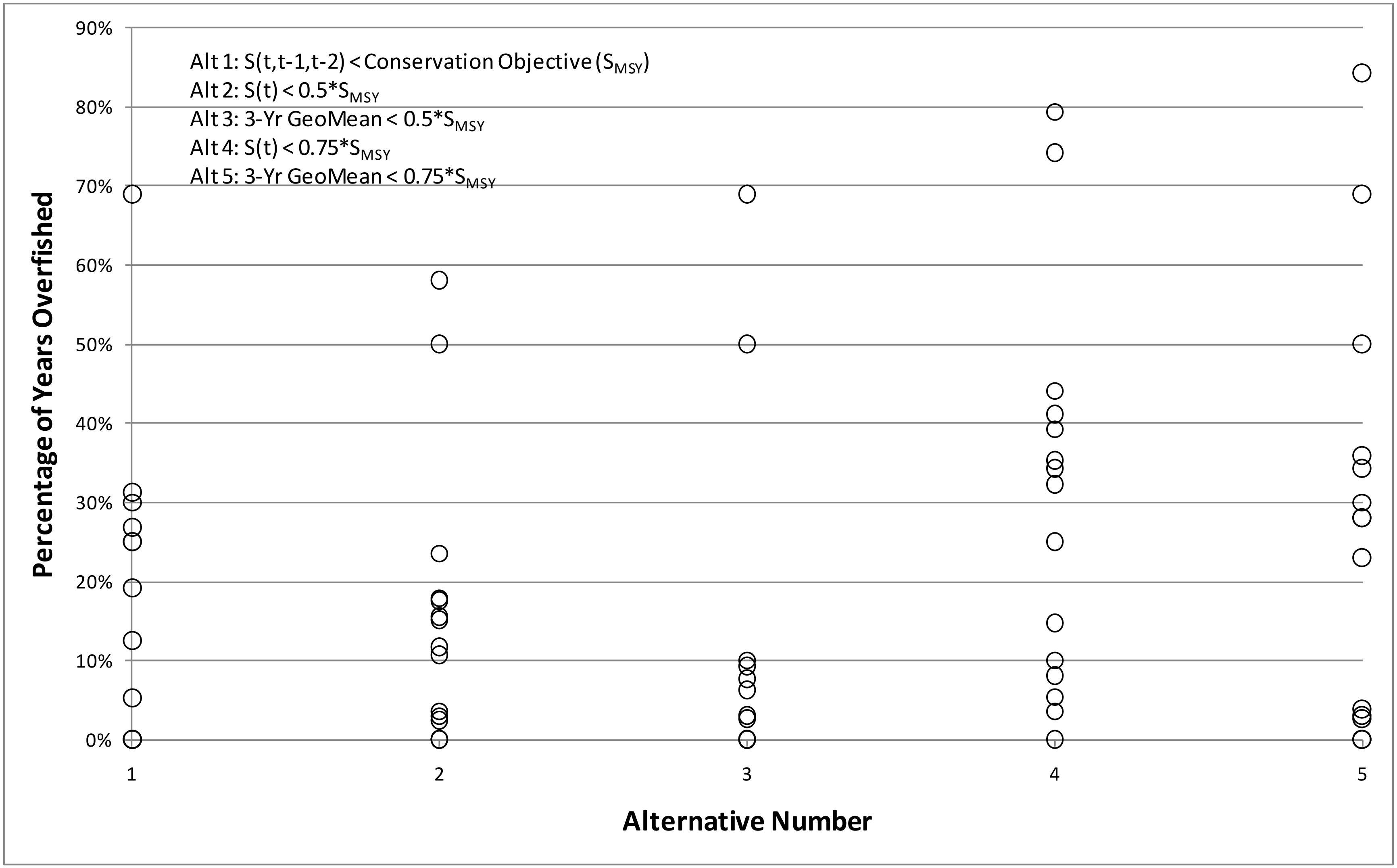


Figure 4-1. Relative frequency of overfished occurrences for status determination criteria alternatives for various Chinook and coho stocks presented in Tables 4-2, 4-3, and 4-4.

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

An overfished determination could affect the biological and socioeconomic environments in several ways.

- BIOLOGICAL: With respect to the biological environment, a determination of an overfished condition has no direct effects; however, the biological environment is affected by the condition of the stock. The primary direct effect of a stock being in an overfished condition is that it jeopardizes the capacity of the stock or stock complex to produce MSY on a continuing basis[45], while indirect effects potentially include reduced long-term reproductive potential of the stock, foregone opportunity to harvest more abundant stocks due to the additional fishery controls enacted because of the overfished stock, and listing of the stock under the ESA.
- SOCIO-ECONOMIC: With respect to the socio-economic environment, the primary direct effect of an overfished determination is that it may result in market-driven forces that reduce ex-vessel value in the fishery, as occurred with the 2010 SRFC overfished designation which caused the Monterey Bay Aquarium Seafood Watch program to change its rating of California and Oregon commercially caught Chinook salmon from "Good Alternative" to "Avoid".

4.2.3 Approaching Overfished

The analysis of environmental effects from the approaching overfished SDC alternatives would follow the same pattern as the overfished SDC alternatives in terms of expected frequency and relative differences between alternatives. Substantial effects expected would include constrained fisheries in order to prevent a stock from becoming overfished there would be positive biological effects from reduced harvest on weak stocks, and negative socioeconomic effects from reduced harvest of healthy stocks. The magnitude of socioeconomic effects would be similar to that of an overfished determination, but likely of shorter duration because an approaching overfished determination normally ends after one year with either the stock becoming overfished or rebounding.

4.2.4 Rebuilt

To evaluate the effects of the rebuilt SDC alternatives on these environments, annual spawning escapements from 1986-forward (STT 2010a) for six Chinook and nine coho stocks were judged against the SDC in order to retrospectively determine the year in which rebuilding would have been achieved given the corresponding overfished SDC. In making this determination, Alternatives 2 through 5 were based on the best currently available estimate of S_{MSY}; Alternative 1 (status quo) used the current conservation objective value, or if a range, the low end of the range. The analysis assumes that the stocks were managed to achieve conservation and management objectives in place at the time, and that spawning escapements were not adjusted to reflect how stocks might have been managed had updated estimates of S_{MSY}, alternative SDC, or other alternative management requirements been in place (e.g., ACLs, rebuilding measures).

Results: Rebuilt status would be achieved at about the same time for all alternatives, usually the year following the overfished status determination, and almost always within three years (Tables 4-2, 4-3, and 4-4). This is indicative of the relatively high productivity and resilience of salmon populations and because from one year to the next, spawning returns are largely independent of each other, relying on separate broods.

The status quo alternative showed rebuilding occurring the year after the overfished status ended, as expected since there was no difference between the overfished and rebuilt reference points (Tables 4-2, 4-3, and 4-4). The other single year SDC alternatives (2, and 4) would usually be rebuilt the year after the overfished status ended, but not always. Rebuilt alternatives relaying on achieving a 3-year geometric

[45] 50 CFR 600.310 (e)(2)(i)(E)

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

mean (3 and 5) would most often be rebuilt two years after the overfished status ended, but occasionally up to four year or five years. The longer rebuilding period compared to single year SDC alternatives would be expected because the criteria was intended to require multiple broods contribute to the rebuilt status. However, there was evidence that one strong return year could compel rebuilt status across all alternatives. This was exemplified by the 1995 return year of KRFC, which would have resulted in rebuilt status for all alternatives, regardless of when the overfished status ended. Other instances included 1986 KRFC, 2001 Columbia River summer Chinook, 2000 Queets coho.

Impacts to the biological environment from the 3-year geometric mean alternatives (3 and 5) would have more beneficial effects than the single year alternatives because any rebuilding measures would likely be in effect longer. The longer rebuilding period could, for example, reduce allowable exploitation rates. It could also increase the genetic diversity of the population by ensuring that more than one strong brood contributes to the rebuilt population.

Impacts to the socioeconomic environment from the 3-year geometric mean alternatives (3 and 5) would be the reverse of the impacts to the biological environment because a longer rebuilding period could reduce allowable harvest, and thus revenue generated from fishing related businesses. The longer rebuilding period could also have marketing effects, such as lower consumer ranking scores.

4.3 Analysis of Environmental Impacts from OFL/ABC/ACL Framework Alternatives

4.3.1 Analysis of Environmental Impacts from the ACL Framework Alternatives

The ACL framework alternatives are based on establishing limits on F (F_{ABC}/F_{ACL}), as a percentage of F_{MSY}. Therefore, an analysis similar to that presented in Section 4.2.1 for overfishing SDC was used to assess impacts to the environment.

To evaluate the effects of the ACL alternatives on these environments, annual exploitation rates for SRFC, KRFC, and Hoh spring/summer Chinook were judged against the ACL in order to retrospectively determine the relative frequency of years that each stock would have been exceeded the ACL. The analysis used the best currently available estimate of F_{MSY} for each of these stocks in making this determination; if a direct estimate of F_{MSY} was unavailable, the proxy values of 0.78 for Chinook was used (Appendix C). The analysis assumes that the stocks were managed to achieve conservation and management objectives in place at the time, and that exploitation rates were not adjusted to reflect how stocks might have been managed had updated estimates of F_{MSY}, alternative SDC, or other alternative management requirements been in place (e.g., ACLs, rebuilding measures).

Results: Based on the comparison of historical catch to C_{ACL} (Alternative 2), it appears that SRFC experienced excessive exploitation rates frequently prior to the mid-early 1990's. Since that time, catch exceeding C_{ACL} was observed only once, in 2004 (Table 4-5). The lower catch rates observed since the mid 1990's are largely the result of ocean fishery constraints for ESA listed stocks and management constraints on KRFC.

Assuming future frequency of exceeding ACLs would be similar to those since the mid-1990s in the retrospective analysis (Table 4-5), the impacts to the biological and socioeconomic environments compared to status quo would be essentially the same as overfishing SDC Alternative 2 (section 4.2.1 of this EA).

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

Again, the analysis for S_{ACL} (Alternative 3) is parallel to that of C_{ACL}. There S-based alternative would require a full run-reconstruction analysis to estimate annual exploitation rates, which would include estimates of S and C; therefore, there would be no advantage of one alternative over the other with respect to assessing compliance with the ACL.

Adopting an ACL framework for SRFC, KRFC, and Hoh spring/summer Chinook could affect the biological, administrative, and socioeconomic environments in several ways.

- BIOLOGICAL: With respect to the biological environment, Alternatives 2 and 3 for ACLs should have direct positive effects because compared to the status quo alternative because it would limit exploitation rates on SRFC to something (10 percent) less than F_{MSY}. Compared to the status quo alternative, overfishing determinations would occur on an annual basis rather than only as the need arose (e.g., after the stock was determined to be overfished or the SHM performed poorly). As a result, management actions would be more responsive, and overfishing would end sooner.
- SOCIO-ECONOMIC: With respect to the socioeconomic environment, Alternatives 2 and 3 for ACLs should have long-term positive effects because the ACL framework would help ensure the stock is exploited at levels that do not exceed F_{MSY}. Short-term effects may be negative if exploitation rates are constrained and access to production in excess of spawning escapement goals or access to other stocks in constrained. For KRFC, Alternatives 2 and 3 may have a direct negative effect because these alternatives specify a spawner escapement goal of S_{MSY} = 40,700, as opposed to the status quo which specifies a spawner escapement goal of 35,000. When translated into an F-based control rule, this change results in a lower allowable exploitation rate for abundance levels between 46,700 and 122,000.

The environmental effects from Alternatives 2 and 3 for ACL frameworks (C- and S-based) should be identical because they rely on the same parameters (exploitation rate and abundance). For this analysis, comparison to status quo assumes no action in the existing SDC framework (i.e., Alternative 1 SDC status quo). As a result of this assumption, the analysis of environmental effects from implementing an ACL framework differs from the analysis of overfishing SDC Alternative 2 only by a matter of degree because both actions propose to use exploitation rates to limit impacts to stocks, one at F_{MSY} and one at a buffered level of F_{MSY} (F_{ABC}) Additionally, the ACL control rules proposed for KRFC are nearly identical to the current F limit in the FMP conservation objective, and assuming the more conservative management framework is maintained, there would be small effects to the biological or socioeconomic environments associated with the proposed ACL alternatives for KRFC. However, because only stocks and stock complexes classified as in the fishery would require specification of an ACL framework, this analysis considers all possible applications of the ACL requirements associated with the Classification Alternatives (section 4.1 of this EA).

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

Table 4-5. Retrospective analysis of ACL compliance for C- and S-based alternatives for SRFC, KRFC, and Hoh spring/summer Chinook (indicator stocks for CVF, SONC, and FNMSS Chinook complexes, respectively). Analysis assumes fisheries were managed to meet objectives in place at the time, not those associated with the alternatives.

SRFC: F_{ABC} =	0.70		Rel Freq. > ACL
Alt 2 & 3: $C(t) > C_{ACL}$; $S(t) < S_{ACL}$			51.9%
KRFC: F_{ABC} =	0.68		
Alt 2 & 3: $C(t) > C_{ACL}$; $S(t) < S_{ACL}$			0.0%
Year		1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009	

4.4 Analysis of Environmental Impacts from Alternatives for Accountability Measures

4.5 Analysis of Environmental Impacts from De Minimis Fishing Alternatives

De minimis provisions may affect the biological, administrative, and socioeconomic environments in several ways.

- BIOLOGICAL: With respect to the biological environment, Alternatives 2–4 could have a negative effect on the SRFC stock because they specify various levels of exploitation at potential spawner levels lower than S_{MSY}. The status-quo alternative specifies an exploitation rate of zero at potential spawner levels lower than S_{MSY}. For KRFC, Alternative 4 would likely have a direct negative effect because it allows fishing at very low abundances that have not been experienced for this stock. Alternatives 2 and 3 could have direct positive or negative effects, though the ambiguous nature of the status quo *de minimis* fishing provisions does not allow for direct comparisons.
- SOCIO-ECONOMIC: With respect to the socio-economic environment, Alternatives 2–4 should provide short term positive effects because complete fishery closures owing to low abundance of SRFC should become less frequent. Alternatives 2–4 may have long term negative effects because stocks could become overfished more frequently, which could lead to rebuilding plans that restrict fisheries further than the FMP control rules. For KRFC, Alternatives 2–4 may have a direct negative effect because these alternatives specify a spawner escapement goal of S_{MSY} = 40,700, as opposed to the status quo which specifies a spawner escapement goal of 35,000. When translated into an F-based control rule, this change results in a lower allowable exploitation rate for potential spawner abundances between 46,700 and 122,000.

5.0 CONSISTENCY WITH OTHER APPLICABLE LAW

6.0 FMP LANGUAGE FOR THE PREFERRED ALTERNATIVE

7.0 LITERATURE CITED

Barnett-Johnson, R., Grimes, C.B., Royer, C.F, and C.J. Donohoe. 2007. Identifying the contribution of wild and hatchery Chinook salmon (Oncorhynchus tshawytscha) to the ocean fishery using otolith microstructure as natural tags. Canadian Journal of Fisheries and Aquatic Sciences 64:1683-1692.

CTC. 1999. Pacific Salmon Commission Joint Chinook Technical Committee Report TCCHINOOK99-3: Maximum sustainable yield or biologically based escapement goals for selected Chinook salmon stocks used by the Pacific Salmon Commission's Chinook Technical Committee for escapement assessment. Vancouver, British Columbia, Canada. 108 p.

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

Cooney, T. D. 1984. A probing approach for determining spawning escapement goals for fall Chinook salmon on the Washington North coast. Pp. 205-213. In: J. M. Walton, and D. B. Houston, eds. Proceedings of the Olympic Wild Fish Conference. Peninsula College, Port Angeles, Washington, 1984. 308 p.

Lestelle, L. C., G.S. Morishima, and T.D. Cooney. 1984. Determining spawning escapement goals for wild coho salmon on the Washington north coast. Pp. 243-254. In: J.M. Walton, and D.B. Houston, eds. Proceedings of the Olympic Wild Fish Conference. Peninsula College, Port Angeles, Washington, 1984. 308 p.

Goldwasser, L., M. S. Mohr, A. M. Grover, and M. L. Palmer-Zwahlen. 2001. The supporting databases and biological analyses for the revision of the Klamath Ocean Harvest Model. Unpublished report. National Marine Fisheries Service, Southwest Fisheries Science Center, Fisheries Ecology Division, Santa Cruz, CA.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. U.S. Dept. of Commer., NOAA Tech. Memo. NMFS-NWFSC-35. 443p.

NMFS NWR letter to PFMC, March 22, 2007

NMFS. 2010. Annual Report to Congress on the Status of U.S. Fisheries-2009. U.S. Department of Commerce, NOAA, National Marine Fisheries Service. Silver Spring, MD, 20 pp.

PFMC. 2007. Pacific Coast Salmon Plan. PFMC Portland OR (see: http://www.pcouncil.org/salmon/salfmp/fmpthrua14.pdf).

PFMC Amendment 15 EA

Amendment 15 FR Notice

_____. 2010a. Review of 2009 Ocean Salmon Fisheries. PFMC, Portland OR 97220. 331 p.

_____. 2010b. Pre-season Report I. PFMC, Portland OR 97220. 103 p.

_____. 2010c. Pre-season Report II. PFMC, Portland OR 97220. 44 p.

_____. 2010d. Pre-season Report III. PFMC, Portland OR 97220. 38 p.

PFMC. 2010e. Agenda ItemC.1.b, Salmon Amendment Committee Report: Progress report on alternatives for Pacific Coast Salmon Plan Amendment 16: classifying stocks, revising status determination criteria, establishing annual catch limits and accountability measures, and establishing de minimis fishing provisions. Pacific Fishery Management Council, Portland OR 97220. 40 p.

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

Prager, M. H., and M. S. Mohr. 2001. The harvest rate model for Klamath River fall chinook salmon, with management applications and comments on model development and documentation. North American Journal of Fisheries Management 21(3):533-547.

Reisenbichler, R.R. 1986. Use of spawner-recruit relations to evaluate the effect of degraded environment and increased fishing on the abundance of fall-run Chinook salmon, Oncorhynchus tshawytscha, in several California streams. Ph.D. dissertation. University of Washington, Seattle, WA. 175 p.

STT. 2005. Klamath River Fall Chinook Stock-recruitment analysis. Agenda Item G.1.b, Sept 2005. PFMC, Portland OR 97220. 36p. (see: http://www.pcouncil.org/wp-content/uploads/G1b_KlamathConsObj_STT_Rpt.pdf)

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

APPENDIX A: COMMITTEE MEMBER NAMES AND AFFILIATIONS

Chuck Tracy, Council staff	Document management and committee staffing
Craig Foster, ODFW, STT	Fishery management and policy analysis
Doug Milward, WDFW, STT	Fishery management and policy analysis
Henry Yuen, USFWS, STT	Population dynamics analysis
Jennifer Hogan, NMFS SWR.	Fishery management and policy analysis
Jennifer Isé, NMFS SWR.	Fishery management and policy analysis
Keith Lutz, NMIFC, STT	Fishery management and policy analysis
Larrie LaVoy, NMFS NWR	Population dynamics analysis
Michael Mohr, NMFS-SWFSC	Population dynamics analysis
Mike O'Farrell, NMFS SWFSC, STT	Population dynamics analysis
Peggy Busby, NMFS NWR	Fishery management and policy analysis
Peter Dygert, NMFS NWR	Fishery management and policy analysis
Pete Lawson, NMFS-NWFSC, SSC	Population dynamics analysis, scientific oversight
Sheila Lynch, NOAA GC, NWR	Legal compliance
Shelby Mendez, NMFS SWR	NEPA coordination
Robert Kope, NMFS-NWFSC, STT	Population dynamics analysis
Ron Boyce, ODFW	Fishery management and policy analysis

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

APPENDIX B: VULNERABILITY OF SALMON FMP STOCKS TO COUNCIL AREA FISHERIES

In the National Standard 1 (NS1) guidelines, the "vulnerability" of fish stocks is referenced as one of the bases for differentiating between stocks that are "in the fishery" versus those that are "ecosystem components." To clarify the definition of "vulnerability" a Vulnerability Evaluation Work Group (VEWG) was established to develop a methodology for determining the vulnerability of stocks managed under a fishery management plan (FMP) (Patrick et al. 2010). We applied the methodology developed by the VEWG to three salmon stock groups to help establish a basis for distinguishing stocks that can reasonably be considered "ecosystem components" in Council fisheries.

In general, stocks "in the fishery" include target stocks (those that are directly pursued by commercial fisheries) and non-target stocks (fish species that are not targeted but are caught incidentally in target fisheries). Stocks may be managed as single species or in stock complexes. All stocks "in the fishery" are generally retained for sale or personal use and/or are vulnerable to overfishing, being overfished, or could become so in the future based on the best available information. As a default, NMFS declares that all stocks and stock complexes currently listed in FMPs are considered "in the fishery." Because ecosystem component stocks are a type of non-target stock, occasional retention of the stock is not in and of itself a reason to classify it as "in the fishery. In addition, ecosystem component stocks must not be subject to overfishing, becoming overfished, or likely to become so in the future in the absence of conservation and management measures.

The vulnerability of a stock to becoming overfished was described by the VEWG as the potential for the productivity of the stock to be diminished by direct or indirect fishing pressure. Vulnerability is expected to differ among stocks based on their life history characteristics and susceptibility to the fishery. The definition developed by the VEWG followed Stobutzki (2001) and includes two key elements: 1) stock productivity (a function of the stock's life history characteristics) and 2) stock susceptibility (the degree to which the fishery can negatively impact the stock.) Stocks with low productivity are not necessarily vulnerable to overfishing unless they have some level of susceptibility to the fishery. The methodology developed to assess vulnerability is termed a "productivity and sensitivity analysis" (PSA).

The PSA was originally developed to classify differences in bycatch sustainability in the Australian prawn fishery (Stobutzki et al. 2001) and has been modified and adapted to include habitat and community components (Hobday et al. 2004). Both methods create numerical indexes of productivity (p) and susceptibility (s) separately using a variety of ranking factors. Based largely on these two studies the VEWG created a PSA designed to accommodate a wide variety of U.S. fisheries ranging from long-line tuna and swordfish to trawl groundfish.

The PSA adaptation developed by the VEWG included ten productivity attributes and twelve susceptibility attributes. Each attribute was scored from 1 (low productivity, low susceptibility) to 3 (high productivity, high susceptibility) and weighted from 0 to 4 (with a default of 2). Note that the least vulnerable stocks have high productivity (3) and low susceptibility (1). Factors can be weighted to emphasize those most relevant to a class of fishery and to de-emphasize factors that are uninformative or, even misleading. The weighed factors are combined in to an index for p and an index for s. These can then be combined to calculate a vulnerability score (v) or plotted to show p and s relative to other stocks and fisheries. Guidelines are provided for scoring, but ultimately there is an element of expert opinion involved in the evaluation. The VEWG also provided a data quality index to aid in evaluating data-poor stocks. Salmon, in general, are data rich, so we did not consider data quality in this analysis. More

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

information, and a spreadsheet for doing the evaluation can be obtained at: http://www.nmfs.noaa.gov/msa2007/vulnerability.htm.

The Vulnerability Analysis Working Group assessed productivity and susceptibility scores for 166 non-salmonid species in U.S. fisheries. These included Atlantic sharks, Bering Sea and Aleutian Island Skates, California nearshore groundfish, California Current pelagics, Northeast groundfish, Hawaii pelagic longline swordfish, Hawaii pelagic longline tuna, and South Atlantic and Gulf of Mexico longline species (Patrick et al. 2010). Overall vulnerability can be visualized in a plot of productivity vs. susceptibility (Figure B-1.) Since the least vulnerable stocks have high productivity and low susceptibility the x-axis in Figure B-1 is reversed so that the stocks closest to the origin have the lowest vulnerability.

We applied PSA analysis to Pacific salmon to evaluate their vulnerability to Council-area fisheries in the context of other fish and fisheries. In the context of all U.S. fisheries, most Pacific salmon stocks are quite similar in productivity and susceptibility, so PSA analysis is not useful for differentiating individual stocks for management purposes. There are, however, two groups of stocks that differ from what might be considered generic salmon in the Eastern Pacific. These are Far North Migrating (FNM) Chinook stocks, with migration timings and patterns that separate them from southern U.S. Fisheries, and Fraser River and Puget Sound pink salmon, somewhat more productive, and caught at very low rates in Council-area fisheries. We developed a PSA for three salmon stock groups; 1) generic salmon, 2) FNM salmon, and 3) pink salmon. Generic salmon include most Chinook and coho salmon from Washington, Oregon, and California. These fish share productivity characteristics and are effectively targeted in Council-area fisheries. FNM Chinook stocks migrate north to Alaska as juveniles and have low susceptibility to Council-area fisheries. Pink stocks mature at a younger age and also have low susceptibility to Council-area fisheries.

Attribute scores were determined based on the criteria in the VEWG spreadsheet and discussion among several scientists knowledgeable about salmon biology and Council-area fisheries. Most factors were scored directly using the quantitative criteria specified by the VEWG. All weights were left at the default of 2 except for “r,” intrinsic rate of increase, weighted at 4. We felt that this was one of the defining properties of Pacific salmon, and warranted stronger consideration.

Productivity for Pacific salmon stocks is quite high, with scores of 2.409 for generic and FNM salmon, and 2.455 for pink salmon (Table B-1). Susceptibility was moderate to low, with scores of 2.208 (generic), 1.875 (FNM), and 1.708 (pink). In relation to other U.S. fisheries, these productivity scores are among the highest. Susceptibility scores range from average to low. Overall vulnerability scores (distance from the origin in Figure B-1) were 1.345 (generic), 1.056 (FNM), and 0.894 (pink). Pink salmon and FNM salmon are among the least vulnerable to overfishing of all the stocks analyzed by the VEWG. Generic salmon are more vulnerable because, despite their high productivity they are susceptible to highly effective fisheries.

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

Table B-1. The VEWG worksheet, including productivity and susceptibility attributes, with definitions, and attribute scores for three salmon stocks. “Generic Salmon” includes most Chinook and coho salmon in Council-area fisheries, “Far North Migrate” includes stocks of spring Chinook that migrate out of Council fisheries, and “Pink Salmon” includes mostly Fraser River pink salmon that are caught at very low rates in the Strait of Juan de Fuca and Puget Sound. Attributes that differ for individual stocks are in bold.

					Generic Salmon		**Far North Migrate**		**Pink Salmon**	
Productivity Attributes	**High (3)**	**Moderate (2)**	**Low (1)**	**Weight**	**Attribute Score**	**Weighted Attribute Score**	**Attribute Score**	**Weighted Attribute Score**	**Attribute Score**	**Weighted Attribute Score**
r	>0.5	0.5-0.16 (mid-point 0.10)	<0.16	4	3.0	12.0	3.0	12.0	3.0	12.0
Maximum Age	< 10 years	10 - 30 years (mid-point 20)	> 30 years	2	3.0	6.0	3.0	6.0	3.0	6.0
Maximum Size	< 60 cm	60-150 cm (mid-point 105)	> 150 cm	2	2.0	4.0	2.0	4.0	**3.0**	**6.0**
von Bertalanffy Growth Coefficient (k)	> 0.25	0.15-0.25 (mid-point 0.20)	< 0.15	2	3.0	6.0	3.0	6.0	3.0	6.0
Estimated Natural Mortality	> 0.40	0.20-0.40 (mid-point 0.30)	< 0.20	2	2.0	4.0	2.0	4.0	2.0	4.0
Measured Fecundity	> 10e4	10e2-10e3	< 10e2	2	2.0	4.0	2.0	4.0	2.0	4.0
Breeding Strategy	0	between 1 and 3	≥4	2	2.0	4.0	2.0	4.0	2.0	4.0
Recruitment Pattern	highly frequent recruitment success (> 75% of year classes are successful)	moderately frequent recruitment success (between 10% and 75% of year classes are successful)	infrequent recruitment success (< 10% of year classes are successful)	2	3.0	6.0	3.0	6.0	3.0	6.0
Age at Maturity	< 2 years	2-4 years (mid-point 3.0)	> 4 years	2	2.5	5.0	2.5	5.0	**2.0**	**4.0**
Mean Trophic Level	<2.5	2.5-3.5 (mid-point 3)	>3.5	2	1.0	2.0	1.0	2.0	1.0	2.0
		Overall Productivity Scores				**2.409**		**2.409**		**2.455**
Susceptibility Attributes	**Low (1)**	**Moderate (2)**	**High (3)**	**Weight**						
Management Strategy	Targeted stocks have catch limits and proactive accountability measures; Non-target stocks are closely monitored.	Targeted stocks have catch limits and reactive accountability measures	Targeted stocks do not have catch limits or accountability measures; Non-target stocks are not closely monitored.	2	1.0	2.0	1.0	2.0	1.0	2.0
Areal Overlap	< 25% of stock occurs in the area fished	Between 25% and 50% of the stock occurs in the area fished	> 50% of stock occurs in the area fished	2	3.0	6.0	**1.0**	**2.0**	**1.0**	**2.0**
Geographic Concentration	stock is distributed in > 50% of its total range	stock is distributed in 25% to 50% of its total range	stock is distributed in < 25% of its total range	2	1.0	2.0	1.0	2.0	1.0	2.0
Vertical Overlap	< 25% of stock occurs in the depths fished	Between 25% and 50% of the stock occurs in the depths fished	> 50% of stock occurs in the depths fished	2	3.0	6.0	3.0	6.0	3.0	6.0
Fishing rate relative to M	<0.5	0.5 - 1.0	>1	2	3.0	6.0	**1.0**	**2.0**	**1.0**	**2.0**
Biomass of Spawners (SSB) or other proxies	B is > 40% of B0 (or maximum observed from time series of biomass estimates)	B is between 25% and 40% of B0 (or maximum observed from time series of biomass estimates)	B is < 25% of B0 (or maximum observed from time series of biomass estimates)	2	3.0	6.0	3.0	6.0	3.0	6.0
Seasonal Migrations	Seasonal migrations decrease overlap with the fishery	Seasonal migrations do not substantially affect the overlap with the fishery	Seasonal migrations increase overlap with the fishery	2	1.0	2.0	1.0	2.0	1.0	2.0
Schooling/Aggregation and Other Behavioral Responses	Behavioral responses decrease the catchability of the gear	Behavioral responses do not substantially affect the catchability of the gear	Behavioral responses increase the catchability of the gear [i.e., hyperstability of CPUE with schooling behavior]	2	3.0	6.0	3.0	6.0	3.0	6.0
Morphology Affecting Capture	Species shows low selectivity to the fishing gear.	Species shows moderate selectivity to the fishing gear.	Species shows high selectivity to the fishing gear.	2	3.0	6.0	3.0	6.0	3.0	6.0
Survival After Capture and Release	Probability of survival > 67%	33% < probability of survival < 67%	Probability of survival < 33%	2	1.5	3.0	1.5	3.0	1.5	3.0
Desirability/Value of the Fishery	stock is not highly valued or desired by the fishery	stock is moderately valued or desired by the fishery	stock is highly valued or desired by the fishery	2	3.0	6.0	3.0	6.0	**1.0**	**2.0**
Fishery Impact to EFH or Habitat in General for Non-targets	Adverse effects absent, minimal or temporary	Adverse effects more than minimal or temporary but are mitigated	Adverse effects more than minimal or temporary and are not mitigated	2	1.0	2.0	1.0	2.0	1.0	2.0
		Overall Susceptibility Scores				**2.208**		**1.875**		**1.708**
				Vulnerability		**1.345**		**1.056**		**0.894**

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

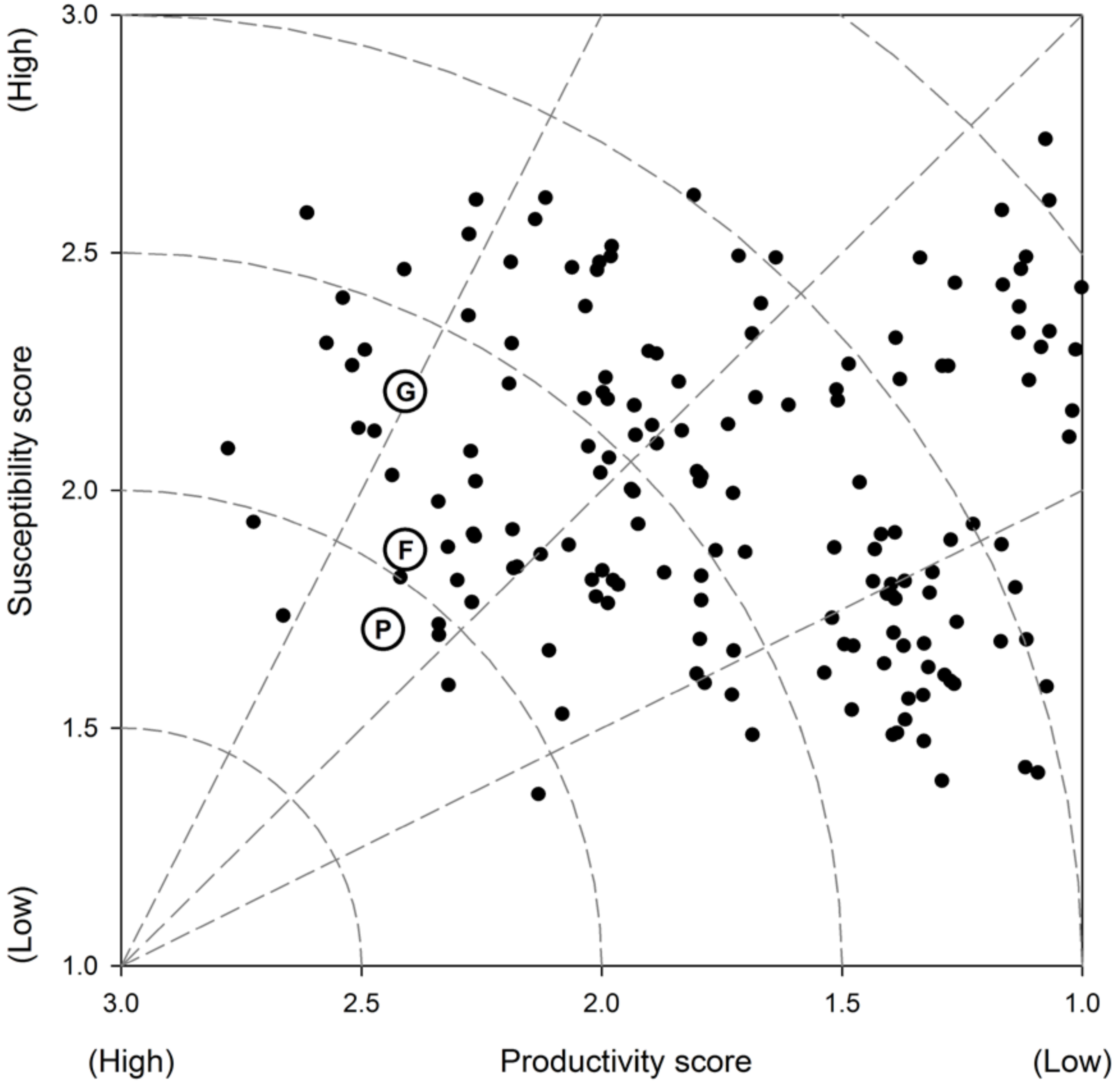


Figure B-1. Productivity and susceptibility scores for three Pacific salmon stocks (open circles) and 166 other species of fish (solid dots) in U.S. fisheries. Vulnerability is interpreted as distance from the origin, as indicated by the arcs, with higher vulnerability in the upper right and lower vulnerability in the lower left. The three salmon stocks are; G: generic, F: far north migrating, and P: pink. Figure is adapted from Patrick et al. 2010, Figure 2, using data from Table 5.

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

Literature cited

Hobday, A.J., A. Smith, and I. Stobutzki. 2004. Ecological risk assessment for Australian Commonwealth fisheries, final report. Report R01/0934 to the Australian Fisheries Management Authority, Canberra, Australia, 72 p. (http://www.afma,gov.au/researchy/reports/2004/r01_0934.pdf

Patrick, W.S., P. Spenser, O. Ormseth, J. Cope, J. Field, D. Kobayashi, T Gedamke, E Cortes, K. Bigelow, W. Overholtz, J. Link, and P. Lawson. 2010. Use of productivity and susceptibility indices to determine stock vulnerability, with example applications to six U.S. fisheries. Fish. Bull. 108 (3):305–322..

Stobutzki, I., M. Miller, and D. Brewer. 2001. Sustainability of fishery bycatch: a process for assessing highly diverse and numerous bycatch. Environmental Conservation 28:167-181.

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

APPENDIX C: CHINOOK F_{MSY} PROXY DEVELOPMENT

The development of a proxy F_{MSY} value is necessary for Chinook salmon since direct estimates of this rate are not available for all stocks in the fishery. F_{MSY} is defined as the fixed annual exploitation rate (e.g., harvest fraction or spawner reduction rate) that results in MSY over the long-term, under prevailing ecological and environmental conditions. An estimate of F_{MSY} can be readily computed given the estimated parameters from a stock-recruitment analysis. However, because many stocks do not have adequate data to perform such an analysis, the development of an F_{MSY} proxy is necessary for determining required reference points such as OFL and ABC for all stocks in the fishery.

We began by amassing all stock-recruitment analyses that we could find for California, Oregon, and Washington stocks. The data sets underlying these analyses varied both in quantity (number of spawner-recruit data points) and quality (contrast in spawner abundance, measurement error). It was also evident that some data sets would not be appropriate to include in the development of the F_{MSY} proxy, which lead to the following rules for eliminating data sets from further consideration.

1. Data sets from British Columbia and Alaska were omitted. In particular, many British Columbia Chinook stocks have obligate "stream-type" life histories, where freshwater emigration occurs at the yearling stage. This life history type is by and large not present in Chinook stocks managed by the PFMC.

2. Data sets were omitted if they were very old and characterized an era very different than the present one. For example, data sets from pre-dam periods on the Columbia River were omitted.

3. Data sets were omitted if grilse (age-2) escapement was included with adult (> age-2) escapement in the estimate of "spawner" abundance. Grilse contribute little to the reproductive potential of a stock.

4. Data sets were omitted if they were not the most recent one available for a given stock.

Twenty data sets remained for F_{MSY} proxy development, which included a broad spatial representation of stocks, from northern Washington to the Sacramento River basin, and included spring-, summer-, and fall-run life history types.

For the retained data sets, the Ricker stock-recruitment model (Ricker 1975), most commonly expressed as

$$R = \alpha \cdot S \cdot \exp(-\beta S),$$

was used in the original analyses to characterize the relationship between recruitment, R, and spawner abundance, S, where the parameter α reflects stock productivity (recruits per spawner at low spawner abundance), and the parameter β reflects stock habitat capacity. For this model, F_{MSY} depends only on a stock's productivity, and it can be estimated by solving (iteratively)

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

$$(1-F_{MSY})\cdot\alpha\cdot\exp(-F_{MSY}) = 1$$

for F_{MSY} given the α estimate from the original stock-recruitment analysis (Ricker 1975, Appendix III, Curve No. 1, equations 17 and 20).

Table C-1 displays the 20 independent estimates of α and the corresponding F_{MSY} estimates. The F_{MSY} estimates ranged from 0.62 to 0.90, with a mean value of 0.78. We therefore set

$$F_{MSY} \text{ proxy} = 0.78.$$

Currently, this F_{MSY} proxy value will be applied only to Sacramento River fall Chinook because it is the only tier 2 Chinook stock in the fishery which requires SDC and ACLs.

References

Chapman, D., J. M. Van Hyning, and D. H. McKenzie. 1982. Alternative approaches to base run and compensation goals for Columbia River salmon and steelhead resources. Pacific Northwest Utilities Conference Committee, Portland, Oregon.

Cooney, T.D. 1984. A probing approach for determining spawning escapement goals for fall Chinook salmon on the Washington north coast. Pages 205-213 in J. M. Walton and D. B. Houston, editors. Proceedings of the Olympic wild fish conference. Peninsula College, Fisheries Technology Program, Port Angeles, Washington.

CTC (Chinook Technical Committee). 1999. Maximum sustained yield or biologically based escapement goals for selected chinook salmon stocks used by the Pacific Salmon Commission's Chinook Technical Committee for escapement assessment. Pacific Salmon Commission, Joint Chinook Technical Committee Report TCCHINOOK (99)-3, Vancouver.

Langness, O.P, and K.F. Reidinger. 2003. Escapement goals for Upriver Bright (URB) fall Chinook salmon stocks of the Columbia River. Completion Report submitted to the U.S. Chinook Technical Committee and the U.S. National Marine Fisheries Service. 96p.

Reisenbichler, R.R. 1986. Use of spawner-recruit relations to evaluate the effect of degraded environment and increased fishing on the abundance of fall run chinook salmon, Oncorhynchus tshawytscha, in several California streams. Doctoral dissertation. University of Washington, Seattle.

Reisenbichler, R.R. 1987. Basis for managing the harvest of Chinook salmon. North American Journal of Fisheries Management 7:589-591.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Fisheries Research Board of Canada Bulletin 191.

Sharma, R., Seals, J., Graham, J., Clemons, E., Yuen, H., McClure, M., Kostow, K., and S. Ellis. Deschutes River Chinook spawner escapement goal using U.S. v. Oregon Technical Advisory Committee data. Unpublished Report.

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

Table C-1. Independent estimates of F_{MSY} used in the development of the Chinook F_{MSY} proxy.

Run	Location	Brood years	α	F_{MSY}	Source
Fall	Hoh River	1968-1982	23.57	0.90	Cooney (1984)
Fall	Queets River	1968-1982	18.27	0.87	Cooney (1984)
Fall	Quillayute River	1968-1982	17.71	0.87	Cooney (1984)
Fall	Columbia River	1947-1959	7.40	0.72	Chapman et al. (1982), from Reisenbichler (1987)
Spring	Columbia River	1957-1972	8.70	0.76	Chapman et al. (1982), from Reisenbichler (1987)
Summer	Columbia River	1979-1995	8.60	0.75	CTC (1999)
Fall	Columbia River bright	1964-1991	16.75	0.86	Langness and Reidinger (2003)
Fall	North Lewis River	1964-1991	8.93	0.76	CTC (1999)
Fall	Deschutes River	1977-1998	4.85	0.62	Sharma et al. (2010)
Fall	Nehalem River	1967-1991	6.54	0.69	CTC (1999)
Fall	Siletz River	1973-1991	12.10	0.81	CTC (1999)
Fall	Siuslaw River	1965-1991	4.84	0.62	CTC (1999)
Spring	Umpqua River	1946-1977	7.20	0.72	ODFW (Pers. Comm.), from Reisenbichler (1987)
Spring	Rogue River	1960-1979	11.80	0.81	ODFW (Pers. Comm.), from Reisenbichler (1987)
Fall	Klamath River	1979-2000	7.19	0.72	STT (2005)
Fall	Shasta River	1955-1978	9.70	0.78	Reisenbichler (1986)
Fall	South Fork Eel River	1963-1972	11.80	0.81	Reisenbichler (1986)
Fall	Upper Sacramento River	1967-1979	10.40	0.79	Reisenbichler (1986)
Fall	Feather River	1955-1966	13.20	0.83	Reisenbichler (1986)
Fall	San Joaquin River	1955-1976	16.40	0.86	Reisenbichler (1986)
				0.78	mean

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

APPENDIX D: F_{MSY} SCIENTIFIC UNCERTAINTY AND THE LIKELIHOOD OF OVERFISHING

For salmon fishery management, F_{MSY} and F_{ABC} estimates are needed for setting OFLs, ABCs, ACLs as well as determining stock status on an annual basis. As specified in the Alternatives, $F_{ABC} < F_{MSY,}$ where the buffer between F_{ABC} and F_{MSY} accounts for scientific uncertainty. In particular, buffers applied to F_{MSY} as presented herein account for scientific uncertainty about the true value of F_{MSY}.

Two levels of buffers are proposed for the two "tiers" of salmon stocks that differ in the level of information associated with them. Tier 1 stocks include those for which an estimate of F_{MSY} has been obtained directly from a stock-specific spawner-recruit analysis. The Tier 1 buffer between F_{MSY} and F_{ABC} is 5%. Tier 2 stocks include those for which there isn't a stock-specific estimate of F_{MSY} from a spawner-recruit analysis, and a proxy F_{MSY} value is used instead (see Appendix C for derivation of proxy F_{MSY} values for Chinook). The Tier 2 buffer between F_{MSY} and F_{ABC} is 10%. In the next sections, we describe and quantify how the Tier 1 and Tier 2 buffers reduce the likelihood of overfishing.

Tier 1

For Tier 1 stocks, where a spawner-recruit model has been fitted to stock-specific data, the uncertainty of the F_{MSY} estimate can be readily characterized using standard statistical methods, assuming the model is in fact appropriate. Because Klamath River fall Chinook (KRFC) is presently the only Tier 1 stock in the FMP (see Stock Classification section 2.1), our analysis of the effect of a 5% buffer between the F_{MSY} and F_{ABC} values given this uncertainty is restricted to KRFC.

In 2005, a spawner-recruit analysis for KRFC was completed by the PFMC Salmon Technical Team (STT 2005), and endorsed by the PFMC Scientific and Statistical Committee as the best available science on the subject. Model 2 in that analysis (a Ricker model that includes an early-life survival covariate) was found to have the greatest statistical support of the alternative models considered, and was adopted for the present analysis. The STT did not report the corresponding F_{MSY} point estimate (the focus of the report was on S_{MSY}), but it can be readily computed from the β and S_{MSY} point estimates (STT 2005, Table 2): $F_{MSY} = \beta \cdot S_{MSY} = 0.72$.

To quantify the uncertainty of this F_{MSY} estimate, we used the same bootstrap model-based resampling of errors procedure employed by the STT (2005). Denoting spawner abundance as S and recruitment as R, a bootstrap dataset was created by sampling with replacement the log(R/S) fitted model residuals and adding them to the log(R/S) fitted model values at the observed covariate values. Model 2 was fit to each dataset as described by the STT (2005), and F_{MSY} estimated. The number of bootstrap replications was 100,000.

The resulting bootstrap distribution of F_{MSY} estimates is shown in Figure D-1. The bootstrap 0.90 percentile interval for the true F_{MSY} is [0.62, 0.78]. Moreover, $F_{ABC} = F_{MSY}(1\text{-buffer}) = 0.68$ corresponds to the 0.26 percentile. For KRFC then, we can state with confidence level 74% that the true $F_{MSY} \geq F_{ABC}$. Thus, use of the Tier 1 5% buffer substantially reduces the likelihood that the F_{ABC} value in fact exceeds the true F_{MSY} level, and thereby substantially reduces the probability of overfishing assuming that the fishery was being managed to achieve $F = F_{ABC}$.

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

Figure D-1. Distribution of bootstrap F_{MSY} estimates for Klamath River fall Chinook (100,000 replications). Vertical dashed lines reference point estimates of F_{MSY} (0.72) and F_{ABC} (0.68).

More generally, for any Tier 1 stock, the scientific uncertainty associated with the F_{MSY} estimate will depend on the inherent variation in the spawner-recruit relationship for that stock, along with the data quantity and quality. Thus, the degree to which the 5% buffer between F_{MSY} and F_{ABC} reduces the likelihood of overfishing will vary among the Tier 1 stocks.

Tier 2

For Tier 2 stocks, where a spawner-recruit model has not been fitted to stock-specific data, a proxy F_{MSY} value is relied upon. The proxy F_{MSY} value is 0.78 for Chinook (Appendix C). While the proxy F_{MSY} value used for Tier 2 stocks is species-specific, it is not stock-specific, and therefore likely more uncertain than F_{MSY} for Tier 1 stocks. For this reason, the buffer between F_{MSY} and F_{ABC} for Tier 2 stocks was doubled to 10%.

To quantify the uncertainty of these proxy F_{MSY} values, we first characterized the distribution of the stock-specific F_{MSY} estimates that were used to derive the proxy value for each species, and then evaluated the probability that an F_{MSY} value for an individual stock would exceed the F_{ABC} level. The analysis does not directly take into account the estimation error contained in the individual stock-specific F_{MSY} estimates. A beta(a, b) distribution was used to characterize the species-specific estimates because, like F, it is defined on the (0, 1) interval, and because it fit the histogram of F_{MSY} estimates fairly well. The distribution parameters a and b were estimated by the method-of-moments (Johnson et al. 1995, Chapter 25), which insured that the mean value of the fitted distribution, $a/(a+b)$, was equal to the proxy F_{MSY} value (the arithmetic mean of the stock-specific F_{MSY} estimates).

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

For Chinook, the histogram of the 20 stock-specific F_{MSY} estimates used to develop the proxy F_{MSY} (Appendix C, Table C-1) along with the fitted beta (21.84, 6.30) distribution[46] is shown in Figure D-2. With the Tier 2 10% buffer, F_{ABC} = proxy F_{MSY} * (1-0.10) = 0.70. The probability that an F_{MSY} value for an individual stock would exceed this F_{ABC} level (the proportion of the beta distribution to the right of the F_{ABC} value) was thus estimated to be 0.84, and compared favorably to the empirical estimate of 17/20 = 0.85. Thus, use of the Tier 2 10% buffer substantially reduces the likelihood that the F_{ABC} value in fact exceeds a stock's F_{MSY} level, and thereby substantially reduces the probability of overfishing assuming that the fishery was being managed to achieve $F = F_{ABC}$.

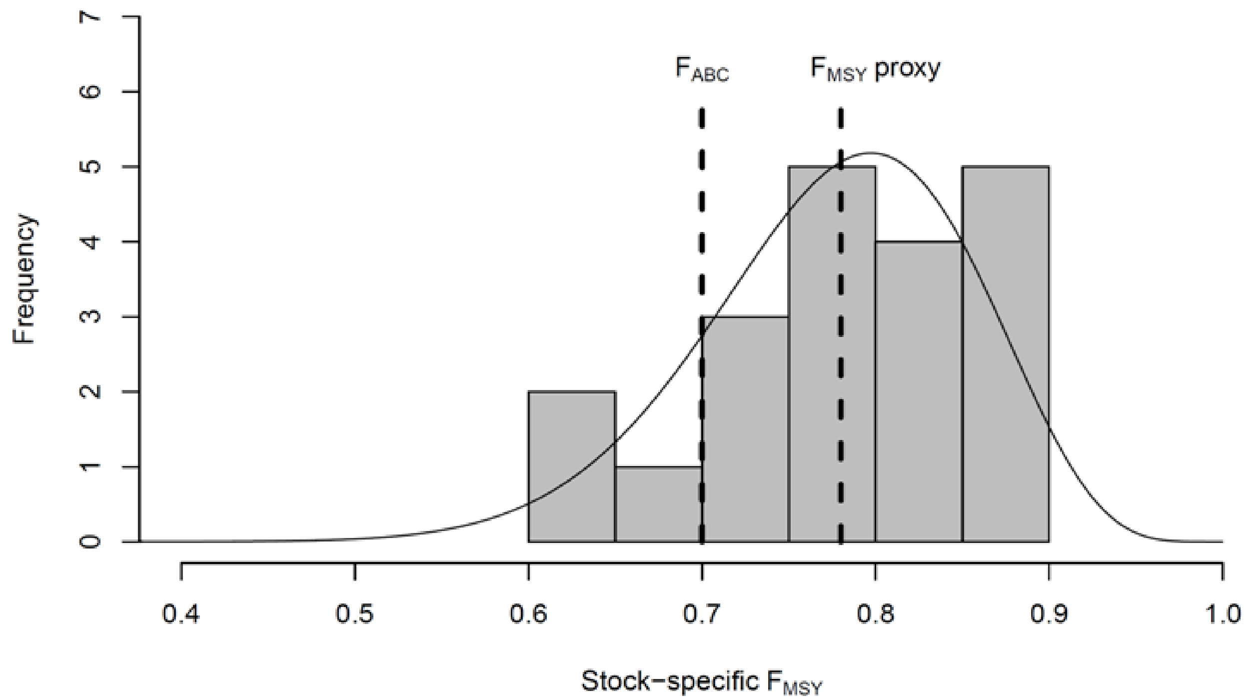


Figure D-2. Histogram of 20 stock-specific Chinook F_{MSY} estimates (Appendix C, Table C-1) and fitted beta(21.84, 6.30) distribution. Vertical dashed lines reference Tier 2 Chinook proxy F_{MSY} (0.78) and F_{ABC} (0.70) values.

A summary of the Tier 2 proxy F_{MSY} analysis results for Chinook are provided in Table D-1.

Table D-1. Summary of Tier 2 proxy F_{MSY} analysis results.

	Chinook
N	20
a	21.84
b	6.30
F_{MSY} proxy	0.78
F_{ABC}	0.70
$Pr(F_{MSY} \geq F_{ABC})$	0.84

[46] Estimation by maximum likelihood yielded essentially equivalent results.

References

Johnson, N.L., S. Kotz, and N. Balakrishnan. 1995. Continuous univariate distributions, volume 2, second edition. John Wiley, New York.

STT (Salmon Technical Team) 2005. Klamath River fall Chinook stock-recruitment analysis. Pacific Fishery Management Council, 7700 NE Ambassador Place, Suite 200, Portland, Oregon.

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

APPENDIX E: DEVELOPMENT OF REFERENCE POINTS FOR WASHINGTON COASTAL COHO STOCKS

Estimates of biological reference points (F_{MSY} and S_{MSY}) are lacking for Washington coastal coho stocks. These reference points are needed to develop needed to develop required status determination criteria (SDC) for Amendment 16 to the Salmon Fishery Management Plan. Required SDC include a maximum fishing mortality threshold (MFMT) and a minimum stock size threshold (MSST). One solution to this problem is to use a proxy value for F_{MSY} derived from other stocks to develop MFMTs and to develop MSSTs from the current conservation objectives for Washington coastal coho. However, data are available to derive stock specific estimates of the necessary reference points for Washington coastal stocks, eliminating the need for a proxy.

Methods

Spawning escapement estimates and reconstructed ocean abundance for natural coho stocks were extracted from outputs of backward coho FRAM runs for each individual year from 1986-2008. The initial ocean abundances were scaled by a factor of 0.812, which is the product of natural survival (1-natural mortality) over the 5 time periods used in the coho FRAM, and represents the probability of a fish at the beginning of the first time period surviving to spawn in the absence of fishing. This scales the initial ocean abundance to adult-equivalent (AEQ) recruits, with the result that exploitation rates are also in terms of AEQ.

Beverton-Holt (equation 1) and Ricker (equation 2) SRRs were fitted to the data for each stock. In the analyses done in support of current FMP reference points for Puget Sound stocks, Beverton-Holt SRRs were used. There is some evidence to support this form of relationship, but this SRR always produced higher intrinsic productivity than a Ricker SRR fitted to the same data, with a consequently higher estimate of F_{MSY}, and in some cases the best fit of a Beverton-Holt SRR was spawner independent (i.e., F_{MSY} = 1.0 and S_{MSY} = 0). For this reason, and the fact that Ricker SRRs were used in developing F_{MSY} values for Chinook, both forms were examined for coho.

(1)

(2)

Beverton-Holt SRRs were fitted by non-linear least-squares regression of recruits on spawning escapement. For the Beverton-Holt SRR S_{MSY} was calculated using equation (3).

(3)

F_{MSY} was calculated as (R_{MSY}-S_{MSY})/R_{MSY}, and R_{MSY} was calculated by substituting S_{MSY} from equation (3) into equation (1).
Ricker SRR were fitted using the procedures described in STT (2005), including correction for process error.

Results and Discussion

Fits of Beverton-Holt SRRs (Table E-1) do not appear to provide meaningful results. With the exception of the Skagit management unit, all estimates of S_{MSY} are below current goals (Tables E-2 and E-3) and all estimates of F_{MSY} are greater than 0.8. For the Snohomish, Big Beef Creek, and Quillayute fall stocks, the best fits are independent of spawning escapement and expected yield is maximized by harvesting 100% of

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

the abundance. For these reasons, results from fitting Beverton-Holt SRRs are excluded from further consideration.

The Ricker SRRs appear to be much more reasonable fits of the data than those of the Beverton-Holt (Figure E-1). For Quillayute fall, Queets, and Hoh stocks, all estimates of S_{MSY} (Table E-4) are within the range of estimates used to develop current management objectives (Table E-3) (Lestelle, et al. 1984). Estimates of F_{MSY} range from 0.59 for Quillayute fall coho to 0.69 for the Hoh and Grays Harbor.

Recommendations

In light of these results, we recommend that reference points in Table E-4 be used as SDC for Washington Coastal stocks with MFMT = F_{MSY} and MSST = 0.5*S_{MSY}.

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

Table E-1. Parameters and associated reference points from fitting Beverton-Holt SRRs to Puget Sound and Washington coast coho stocks, and MSST calculated as 0.5*S_{MSY}. Big Beef Creek, Dungeness, and Chehalis do not encompass the entire management unit, so the S_{MSY} and MSST are not applicable to the FMP stock.

Stock	a	b	F_{MSY}	S_{MSY}	MSST
Skagit	146286	41734.4	0.47	36,401	18,201
Stillaguamish	39568	700.5	0.87	4,564	2,282
Snohomish	185475	0.0	1.00	0	0
Big Beef Creek (Hood Canal)	34523	0.0	1.00	0	0
Dungeness (Strait of Juan de Fuca)	3291	87.2	0.84	448	224
Quillayute Fall	14592	0.0	1.00	0	0
Hoh	7421	107.6	0.88	786	393
Queets	14647	254.8	0.87	1,677	839
Chehalis (Grays Harbor)	67623	1792.4	0.84	9,217	4,609

Table E-2. Current proposed FMP reference points for Puget Sound Management units.

Management Unit	MFMT	S_{MSY}	MSST
Skagit	0.60	25,000	14,857
Stillaguamish	0.50	10,000	6,100
Snohomish	0.60	50,000	31,000
Hood Canal	0.65	14,362	10,217
Strait of Juan de Fuca	0.60	11,000	7,007

Table E-3. Current proposed reference points for Washington coastal coho stocks.

Management Unit	MFMT	Escapement goal	S_{MSY}
Quillayute fall	F_{MSY} proxy	6,300-15,800	4,700-9,600
Hoh	F_{MSY} proxy	2,000-5,000	1,500-3,100
Queets	F_{MSY} proxy	5,800-14,500	4,200-9,400
Grays Harbor	F_{MSY} proxy	35,400	-

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

Table E-4. Parameters and associated reference points from fitting Ricker SRRs to Washington Coast coho stocks. Chehalis does not encompass the entire management unit, so the S_{MSY} and MSST are not applicable to the FMP stock.

Stock	α'	β	F_{MSY}	S_{MSY}	MSST
Quillayute Fall	4.36	0.0000987	0.59	5,873	2,937
Hoh	6.34	0.0002729	0.69	2,520	1,260
Queets	6.10	0.0001232	0.68	5,500	2,750
Chehalis (Grays Harbor)	6.43	0.0000303	0.69	22,802	11,401

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

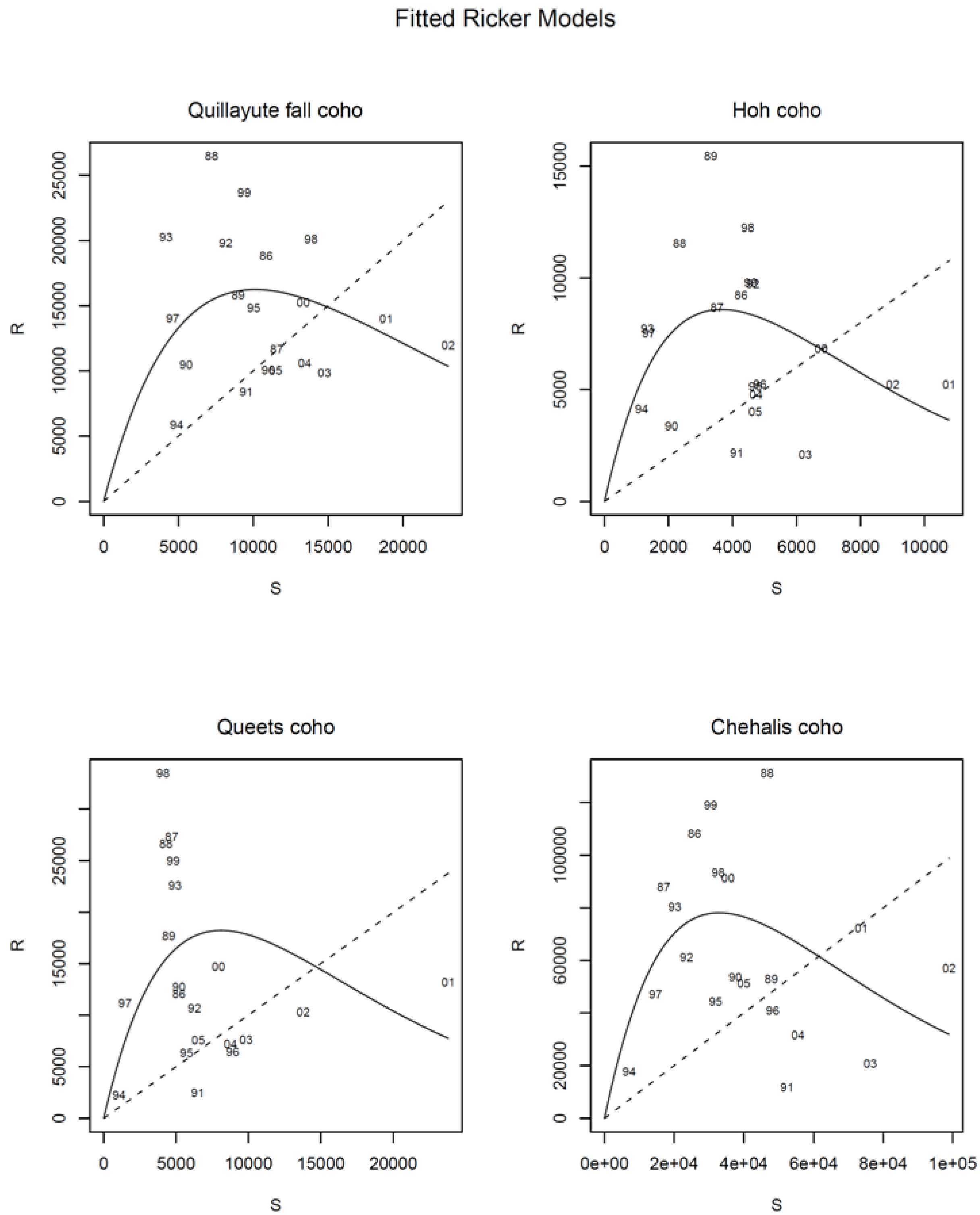


Figure E-1. Fit of Ricker spawner-recruit models to Washington coast coho stocks. Recruitment is expressed in adult equivalents. Data points are represented by brood year.

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

References

Lestelle, L.C., G.S. Morishima, and T.D. Cooney. 1984. Determining spawning escapement goals for wild coho salmon on the Washington north coast. Pp 243-254 In: J.M Walton, and D.B. Houston, eds. Proceedings of the Olympic Wild Fish Conference. Peninsula College, Port Angeles, Washington. 1984. 308 p.

STT (Salmon Technical Team) 2005. Klamath River fall Chinook stock-recruitment analysis. Pacific Fishery Management Council, 7700 NE Ambassador Place, Suite 101, Portland, Oregon 97220-1384. 31p.

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

APPENDIX F: COMPLIANCE WITH QUOTAS AND CATCH EXPECTATIONS FOR COUNCIL AREA FISHERIES

Quota Fisheries

Quota fisheries require inseason monitoring and closure authority to prevent overages. They also require models that account for the majority of stocks composing the catch to accurately predict stock specific impacts and total catch. Chinook and Coho FRAM have extensive stock representation and therefore lend themselves to quota management in areas north of Cape Falcon (NOF). The States of Oregon and Washington have intensive monitoring programs for both recreational and commercial sectors to track effort and catch. The FMP also has allocation provisions for both sectors, and the flexibility to allow quota transfers within and between sectors NOF. As a result, quota fisheries have been used exclusively since the early 1980s. The management system NOF has performed well, with a 92 percent and 96 percent compliance rate since 1996 for non-Indian commercial and recreational quota fisheries, respectively (Figure F-1). More than half of quota fisheries evaluated were managed to within 75 percent of the quota, which implies that management was able to monitor and constrain fisheries effectively, and the high compliance rate was not generally the result of quotas set beyond the fishery capacity, or of lower than expected stock abundance. The apparent exception is non-Indian commercial coho quotas, which rarely achieve more than 50 percent of the quota. However, this is not surprising because the commercial fleet targets Chinook stocks due to their relatively higher economic value. The emphasis on commercial Chinook targeting is also reflected in the FMPs fishery objectives and allocation formulas.

One reason for the high compliance rate in NOF commercial fisheries is the structured format used in recent years with weekly open and closed periods. This format allows more accurate monitoring and provides managers with more reaction time to implement closures or season modifications. This format has also been combined with weekly landing limits to control effort (e.g., open Thursday through Sunday with a landing limit of no more than 100 salmon per vessel per open period). This combined format has had benefits to both fishers and processors by maintaining a more consistent supply of fish over time while preventing market gluts, as well as providing more structured notice to the public and stakeholders of management actions. Establishing per vessel landing limits also reduces the tendency for a derby type approach to quota fisheries by creating a form of individual quota (IQ) program. This allows individual harvesters to plan their weeks' activities according to weather forecasts and the cost/benefits of pursuing a given allocation of fish. It also improves safety-at-sea for the fleet in comparison to unconstrained quota fisheries. There are, however, associated costs for management agencies in terms of enforcement, monitoring fisheries, more frequent inseason management actions, and additional notice requirements.

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

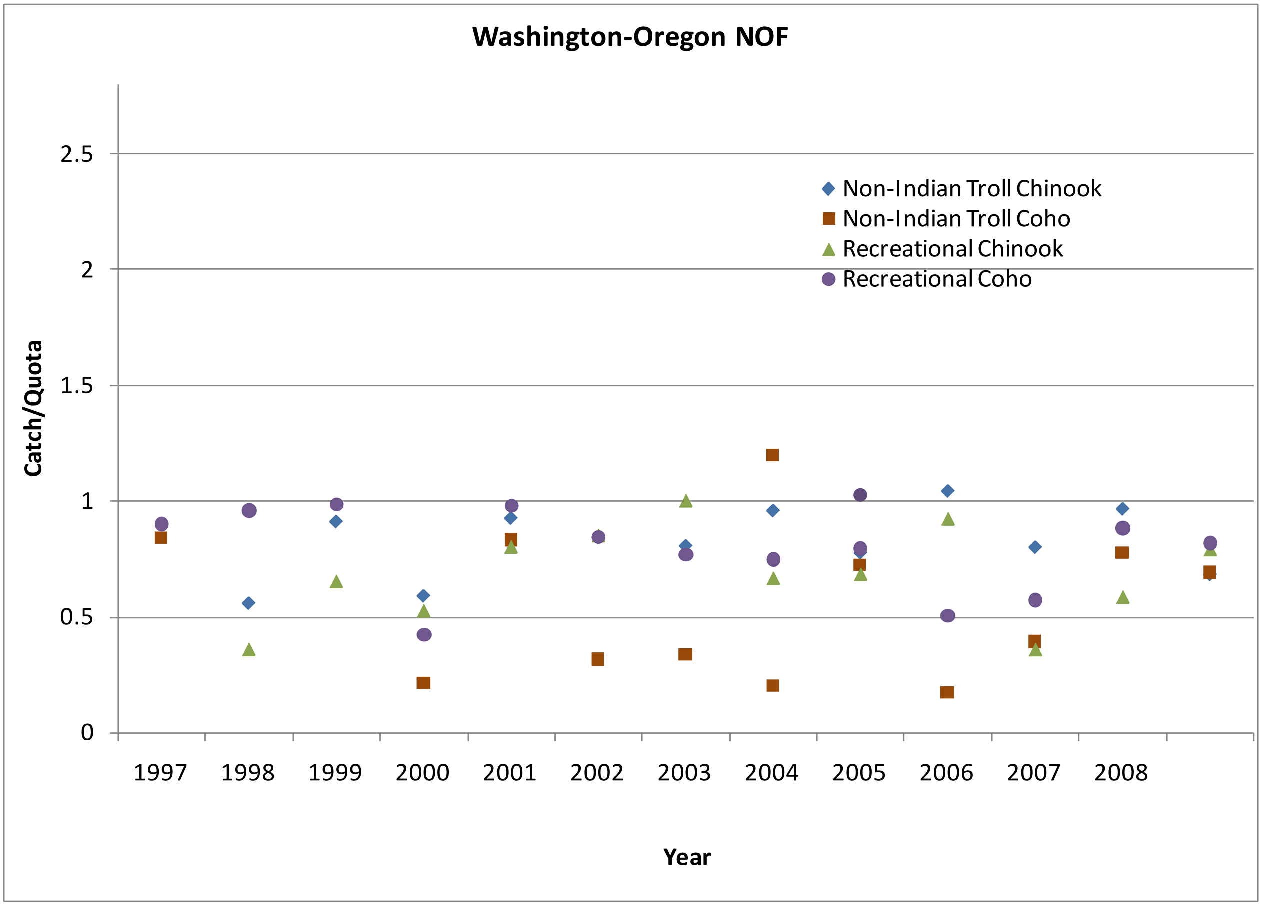


Figure F-1. Quota compliance rates for non-Indian commercial and recreational fisheries in the ocean north of Cape Falcon. Only post-season total allowable catch quotas were evaluated for each sector due to frequent inseason trades among sectors and port areas.

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

The treaty Indian fisheries NOF are also primarily quota managed for the same reasons as the non-Indian fisheries. The Treaty Indian fisheries have had a 78 percent compliance rate, and about half of the quota fisheries were managed to within 75 percent or more of the quota (Figure F-2).

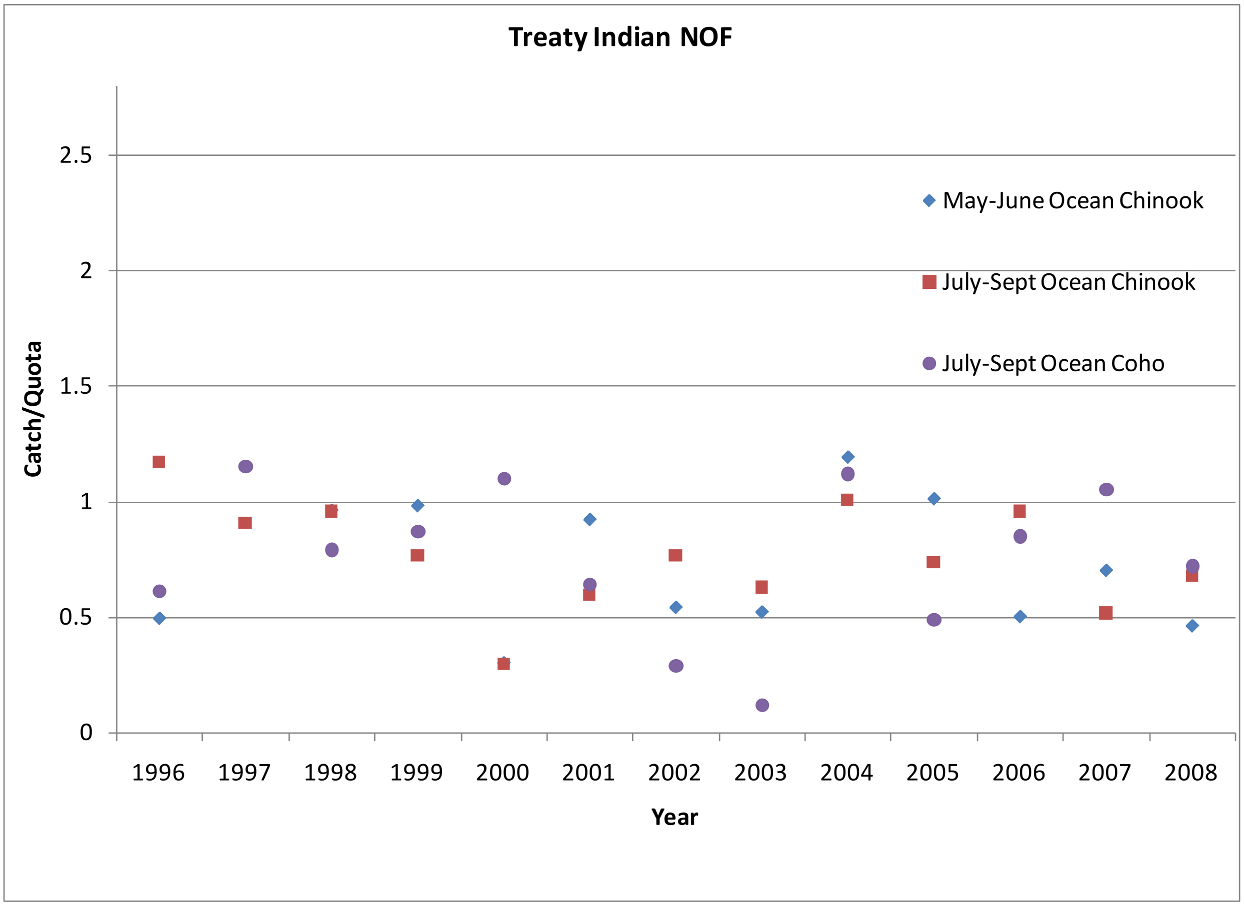


Figure F-2. Quota compliance rates for treaty Indian commercial fisheries in the ocean north of Cape Falcon. Separate evaluations for May-June and July-September fishery periods were possible because carry-over of unused quota was generally prohibited.

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

Oregon fisheries south of Cape Falcon (SOF) are managed with quotas primarily for commercial Chinook fisheries in the KMZ and recreational coho fisheries coast wide, plus some small state-waters only fisheries. Oregon commercial quota fisheries have had an 83 percent compliance rate and recreational quota fisheries have had a 90 percent compliance rate. About 40 percent have been managed to within 75 percent or more of their quota. Three of the four fisheries to exceed their quota were KMZ commercial fisheries, which typically have three or four month long quota fisheries per year, with most coming in well below the quota, and the occasional high success month resulting in an overage (Figure F-3).

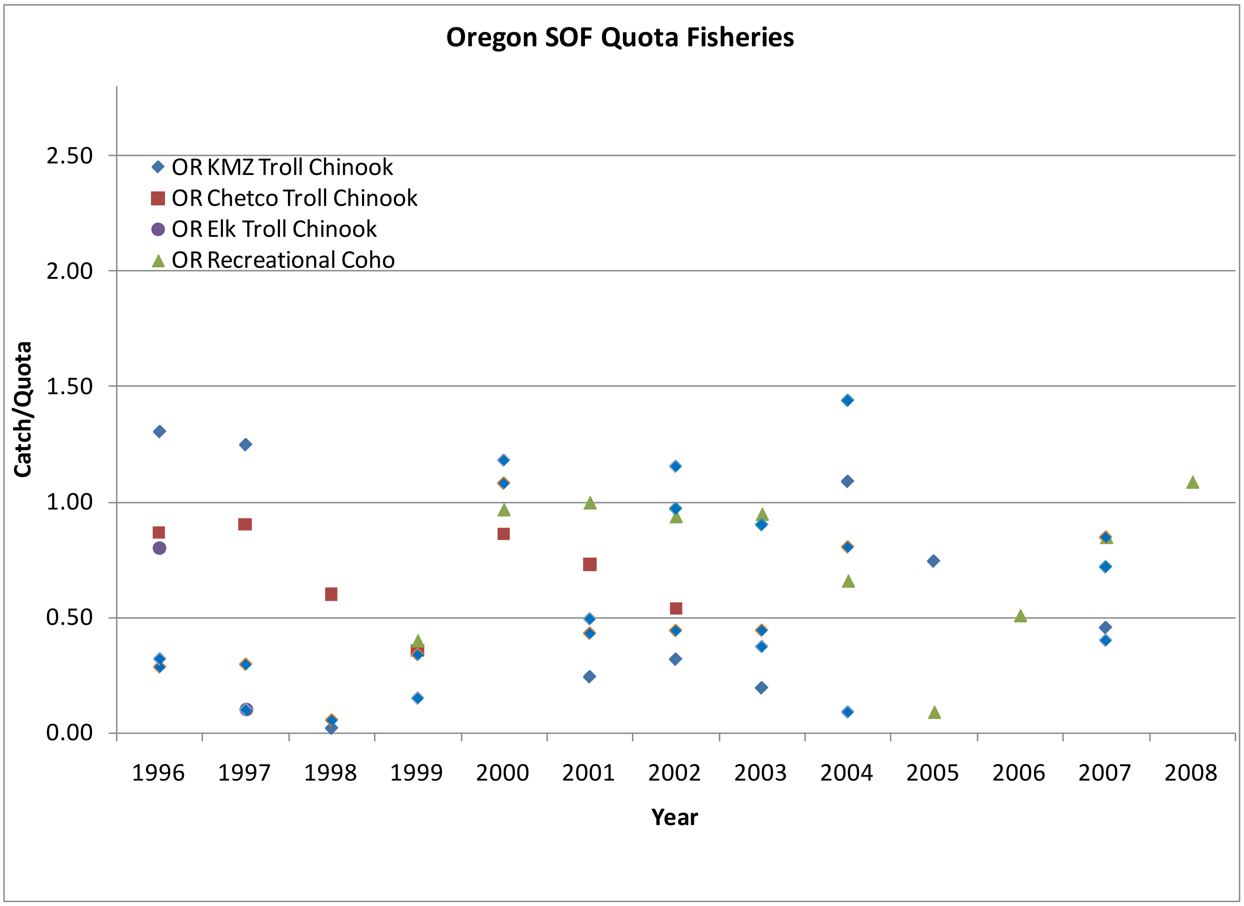


Figure F-3. Quota compliance rates for commercial fisheries in the ocean between of Cape Falcon and the Oregon/California border. KMZ troll fisheries also included some quota fisheries that extended up to Cape Arago in 1996 and 1997.

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

California fisheries are primarily managed by time-area seasons, with commercial quota fisheries used in the KMZ, occasionally in the Fort Bragg area, and rarely south of Fort Bragg. California quota fisheries have a 52 percent compliance rate, with about 55 percent managed to within 75 percent or more of their quota. Quota fisheries in all areas had similar compliance rates (Figure F-4).

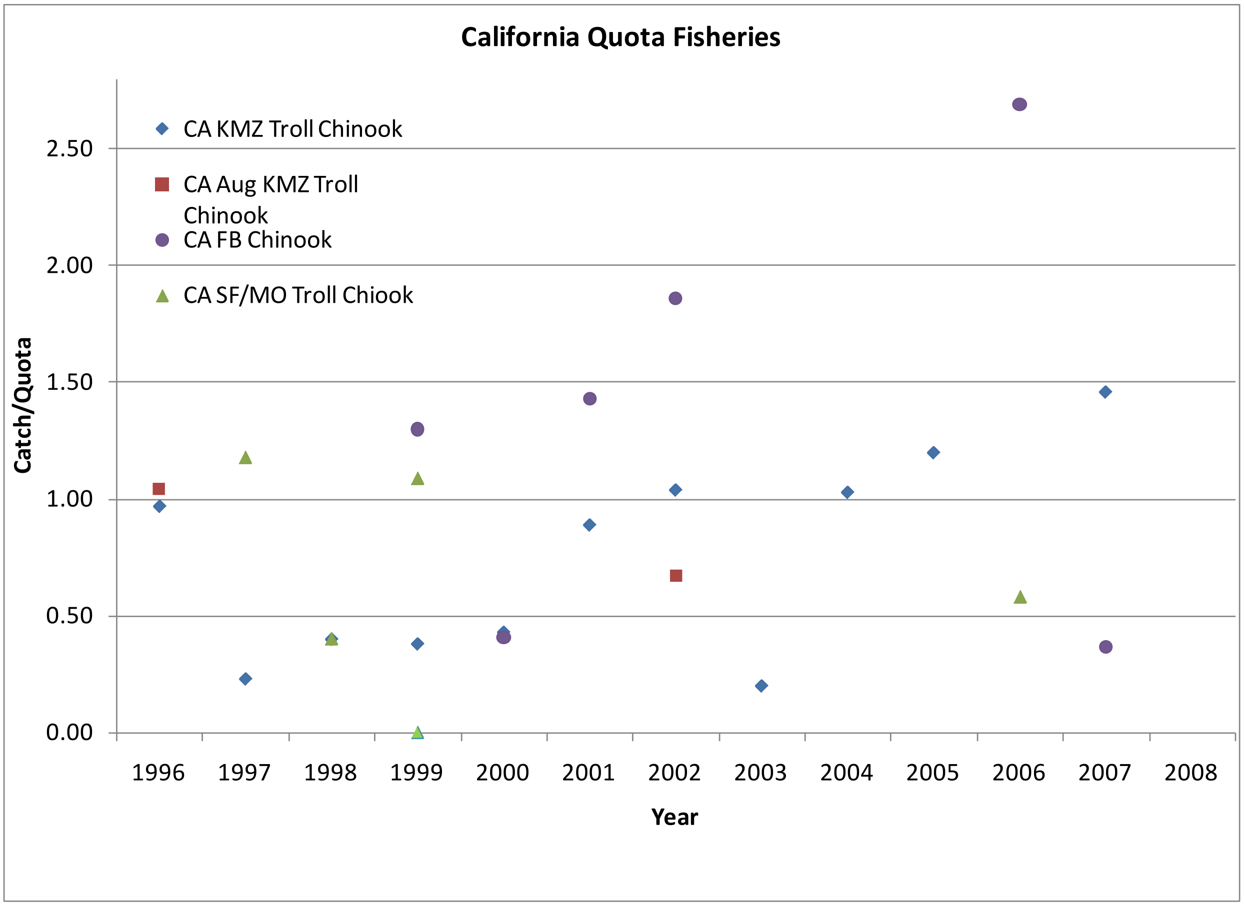


Figure F-4. Quota compliance rates for commercial fisheries in the ocean south of the Oregon/California border.

Most Chinook fisheries SOF have not been managed by quotas, partly because the KOHM was the primary harvest model used for ocean Chinook fisheries SOF. The KOHM is a single stock model and was only considered adequate to model quota fisheries in the KMZ where KRFC make up the majority of the catch. Other quota fisheries SOF were set to constrain catch below historical levels during conservation concerns (e.g., 2006 when an emergency rule was required to prosecute fisheries due to KRFC concerns), or to collect information on new or recently reopened time/area strata (e.g., April 2007 Fort Bragg commercial fishery). With the development of the Sacramento Harvest Model (SHM), the use of quota fisheries SOF may be more practible given that SRFC and KRFC constitute the majority of catch in most fishery strata.

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

Time-Area Fisheries

The majority of Chinook catch in Oregon and California occurs in time-area managed fisheries. The STT develops an expected catch for both commercial and recreational fisheries in areas NOF Falcon, Cape Falcon to Humbug Mt., the KMZ, and south of the KMZ. Their forecasts include quota fisheries in those areas, but those make up a small portion of the total expected catch SOF, except for KMZ commercial fisheries. Since 2000, about 52 percent of time-area fisheries had an actual catch less than the preseason expectation, as would be expected given unbiased projections. (Figure F-5). However, the Oregon fisheries exhibited a declining trend of in the ratio of catch-to-expectations over the time series. The expectations are based on historical fishery patterns and most were adjusted for preseason abundance forecasts; however, the early part of the decade had near record high abundance of SRFC, and contact rates for KRFC were greater than the historical data range. Since 2006, catch has been generally below expectations, which coincides with record low SRFC abundance. It is possible that abundance relative to average conditions affects the catch-to-expectation ratio, but it may also be a result of improving forecast methods since the trend was not observed in California fisheries or the KMZ recreational fishery.

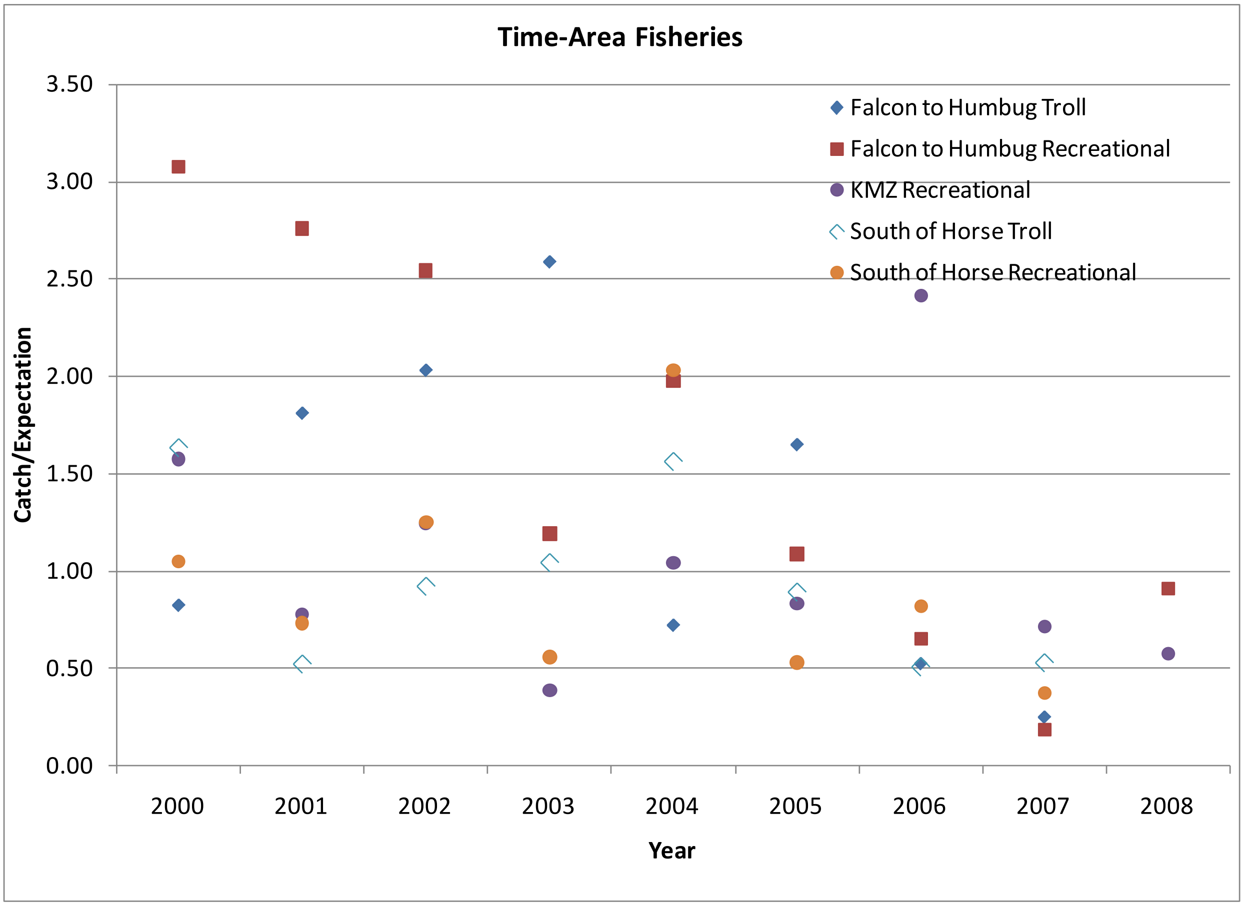


Figure F-5. Time-Area fisheries south of Cape Falcon. Actual catch compared with preseason expectations.

F-fishing mortality rate; MFMT-maximum fishery mortality threshold; MSST-minimum stock size threshold; MSY-maximum sustainable yield; NS1Gs-National Standard 1 Guidelines; OFL-overfishing limit; S-spawning escapement; SDC-status determination criteria

HOOPA VALLEY TRIBAL COMMENTS ON

C.2 Fishery Management Plan Amendment 16, Annual Catch Limits and Accountability Measures

The Hoopa Valley Tribal Council (HVTC) retains sole management authority governing the HVT fishery prosecuted by Tribal members on the Hoopa Valley Reservation. Under its authority the HVTC allows for utilization of Klamath River Fall Chinook (KRFC) to meet the purposes of subsistence, ceremony, and commerce.

Today, the Pacific Fishery Management Council (Council) is developing a preferred alternative for the Environmental Assessment (EA) of FMP Amendment 16: "Annual Catch Limits and Accountability Measures".

The HVTC has pursued direct government-to-government consultation with its federal trustee under the principles of Self-Governance to better understand the proposed Amendment 16 and its ramifications to our reserved fishing rights, held in trust by the federal government.

Our staff have participated in two technical conferences with NOAA and are appreciative of the agency's interest in providing detailed technical insights into Amendment 16. However, we have also requested and await further policy level consultations with our federal trustee with regard to the broader implications of Amendment 16 as it overlays with prospects for Klamath Basin Restoration Agreement (KBRA) implementation. The HVTC has openly criticized the KBRA for what we believe to be an unacceptable compromise of tribal rights in exchange for a very questionable plan for restoring anadromy to the upper Klamath Basin and promoting vitality of Klamath Basin fisheries. Indeed the KBRA threatens the very success of our efforts over the past three decades to restore the Trinity River and the fishery we've depended upon since time immemorial. Since 2005, Trinity River restoration has cleared litigation impediments and presently is being managed under the Trinity River Record of Decision (ROD) that our Tribe concurred with former Interior Secretary Babbitt in December 2000 as mandated by the Central Valley Project Improvement Act (CVPIA), (PL 102-575). The Tribe is very protective and cautious of any initiative (including the KBRA) that may hinder the ability to 'restore the Trinity River fishery to per-Dam levels' as mandated by Congress in numerous federal statues including the CVPIA.

Specific to PFMC's deliberations of the Preferred Alternative for Amendment 16, we offer the following technical recommendations:

(1) Overall, the intent of clarifying and removing ambiguity with regard to definitions of "overfishing", and *de minimis* fisheries is strongly embraced;

(2) The HVTC believes that prudent management of mixed-stock marine fisheries must favor stock conservation, and in particular, protection of the genetic and racial diversity of the fishes of Klamath Basin. The Amendment recognizes Klamath River Spring Chinook (KRSC) as "in the fishery" of targeted KRFC, and our concern for adequate protection of KRSC when managing on productivity estimates specific to KRFC conforms with a prescription for management

conservatism. Hence, where shaping of the preferred alternative for Amendment 16 contemplates ranges of risk, we advocate pursuing more conservative thresholds. In particular;

(a) *Minimum Stock Size Threshold (MSST)*, the Council will narrow MSST to being 0 .86, 0.75, or 0.50 of Spawning Escapement at Maximum Sustained Yield (S_{MSY}). Consistent with HVTC's aim for conservatism in Amendment 16, **we strongly advocate that MSST be set as 0.86 of S_{MSY}, or 0.86 * 40,700 = 35,000 natural area spawners**. This closely relates to the long standing "floor level" escapement of 35,000 natural spawners, while incorporating new insights with respect to productivity of the stock pursuant the recent STT review (Klamath River Fall Chinook Stock-Recruitment Analysis, STT 2005). Further, we would condemn assignment of MSST to 0.5 of S_{MSY} (0.5 * 40,700 = 20,350) as this threshold would fall well below the minimum stock size identified in Amendment 15 (22,000), as a population level which could lead to dispensatory effects in the population structure for Klamath River Fall Chinook, with yet to be understood ramifications for KRSC.

(b) *Overfished definition*, the Council will need to define the trigger for determining the stock overfished as either a single year of transgression of MSST or a retrospective three-year geometric mean of S compared to MSST. **In the case that the Council does select MSST to equal 0.86 * S_{MSY} (35,000), we would support the *three-year geometric mean of S* criterion for declaring the stock overfished**.

(c) *F_{ABC} a function of F_{MSY} and Scientific Uncertainty, for tier 1 stock where MSY is empirically derived:* The preferred alternative will need to specify an approach for determining the annual Acceptable Biological Catch (ABC) for KRFC. The HVTC generally agrees that population dynamics are better understood for the KRFC than for stocks such as the Sacramento River Fall Chinook, for which age-structured cohort models are not presently derived and estimation of an empirical MSY is not possible. It is debatable however, from the perspective of accepting a 5% buffer for scientific uncertainty upon the F_{MSY} for KRFC (a "tier" 1 stock), that adequate protection is offered KRSC as specific productivity parameters estimated for KRFC can not be verified for the latter stock. Moreover, the proposed alternative would lead to an inflation of the ABC beyond what was established in Amendment 9, which capped exploitation at 2/3 (0.67) brood-wise spawner reduction. **Hence, the HVTC would advocate that the buffer for scientific uncertainty be adjusted to 7% such that the F_{ABC} results in 0.67 (F_{ABC} = (1- 0.07) * F_{MSY} = 0.93 * 0.72 = 0.67) and not 0.68 as proposed in the draft EA.**

(d) *De minimis fishing limits*, Amendment 15 is ambiguous with regard to allowable rates of *de minimis* fishing at stock sizes below 22,000. The Council will now have the opportunity to define limits to *de minimis* fishing at low stock sizes. The HVTC seeks to protect the long-term productivity of both KRFC and KRSC. Accordingly, **we recommend a *de minimis* rule which would preclude fishing at natural adult spawner populations (S) of 22,000 or less**. Presently, none of the proposed *de minimis* rules capture this intent. HVTC encourages the Council to develop such a standard which would curtail *de* minimis fishing at S of 22,000 or less. If the Council pursues a MSST of 0.5 of S_{MSY} (MSST = 20,350), Alternative 2, wherein the *de minimis* rate of fishing (F = 0.25) declines to zero mid-way between S_{MSY} (40,700 natural spawners), and MSST, would most closely represent HVTC's intent. The other alternatives presently offered in the draft EA lead to progressively greater threats to the long-term productivity of KRFC.

Salmon Amendment Committee Report

Amendment 16 to the Pacific Coast Salmon Fishery Management Plan:

Draft Environmental Assessment for Stock Classification, Status Determination Criteria, Annual Catch Limits and Accountability Measures, and *De Minimis* Fishing Provisions

Status of Amendment Process

- The SAC has Developed a Draft Environmental Assessment (EA)
  - The Council can adopt alternatives for public review
  - The Council can take final action in November
- Stock classification, stock complexes, ecosystem components, and international exceptions could affect EFH, SDC, and ACL specification.
- SDC alternatives likely to result in substantial changes to assessment and reporting on overfishing, overfished, approaching overfished, etc.
- ACL alternatives will not result in substantive changes in preseason planning process or NOF/SOF fishery structure
- AM alternatives could result in substantive changes to preseason process, and postseason reporting and assessments.
- *De Minimis* fishing provision alternatives should add management flexibility and streamline the preseason process.

Classification Alternative 1 – Status Quo

- "In the Fishery" – 69 stocks in FMP
  - Coho Stocks (21) – Hatchery, ESA, Washington Coastal, Puget Sound, Canadian
  - Chinook (45) – Hatchery, ESA, Central Valley Fall/Late Fall, Northern California Coast, Southern Oregon Coast, Mid-Northern Oregon Coast, Columbia River Summer and Fall, Washington Coast, Canadian
  - Pink (2) – Puget Sound, Canadian
- Ecosystem Components - None

Classification Alternative 2

- All stocks remain in the fishery, minor reorganization
  - Southern OCN component moved to SONCC ESU
    - Facilitate re-evaluation of the OCN Matrix
    - SONCC ESA Consultation Standard uses Rogue/Klamath coho
  - Smith River (CA) Chinook separated from ESA listed California Coastal ESU
- Stock complexes formed for Chinook ACL framework
  - Central Valley Fall (CVF) with SRFC indicator
  - Southern OR-Northern CA (SONC) with KRFC indicator
  - Far North Migrating Sp/Su (FNMSS) with Hoh indicator
- Ecosystem Components – None
- International exception for PST stocks
  - Puget Sound, WA coast and Canadian coho
  - Columbia River summer, URB, WA/OR Summer/fall, and Canadian Chinook
  - Puget Sound, Fraser pink salmon

Classification Alternative 3

- Ecosystem component stocks - Not in the fishery
  - Pink and FNM Chinook designated as EC (except ESA stocks)
    - Lower vulnerability in Council fisheries
    - Not generally retained
    - Not overfished or likely to become so absent Council management (based on new SDC)
    - EFH not specified for EC – some EFH overlap with coho, but not for mid-Columbia spring Chinook in Walla Walla, Umatilla, Upper Deschutes, Lower Crooked, and John Day rivers
    - More overlap with ESA steelhead Critical Habitat except for Upper Deschutes and Lower Crooked
- Minor reorganization as in Alternative 2
- Stock complexes formed for Chinook ACL framework
  - CVF with SRFC indicator
  - SONC with KRFC indicator
- International exception for Columbia River summer and Canadian Chinook

Other Classification Issues

- Consider additional alternative to remove FNM Chinook and pink salmon from the FMP
  - Same EFH issues as Alternative 3
  - Possibly better fit administratively
- Include FMP language to outline process for adding indicator stocks, partitioning stock complexes, etc.

Status Determination Criteria

- Overfishing, Overfished, Approaching Overfished, Rebuilt
- Based on Classification Alternative 3, SDC would be developed for:
  - Sacramento River Fall Chinook
  - Klamath River Fall Chinook
  - South Oregon Coast Chinook (OF'd and Rebuilt only for now)
  - Columbia River Summer Chinook
  - Washington Coast Coho
  - Puget Sound Coho
- Based on Classification Alternative 2, SDC also needed for FNM Chinook:
  - URB
  - WA/OR fall Chinook
  - WA Coast spring/summer Chinook
- SDC remain undefined for complex components (e.g., Klamath spring Chinook), Canadian Chinook and coho, Puget Sound and Canadian pink salmon

SDC Alternative 1- Status Quo

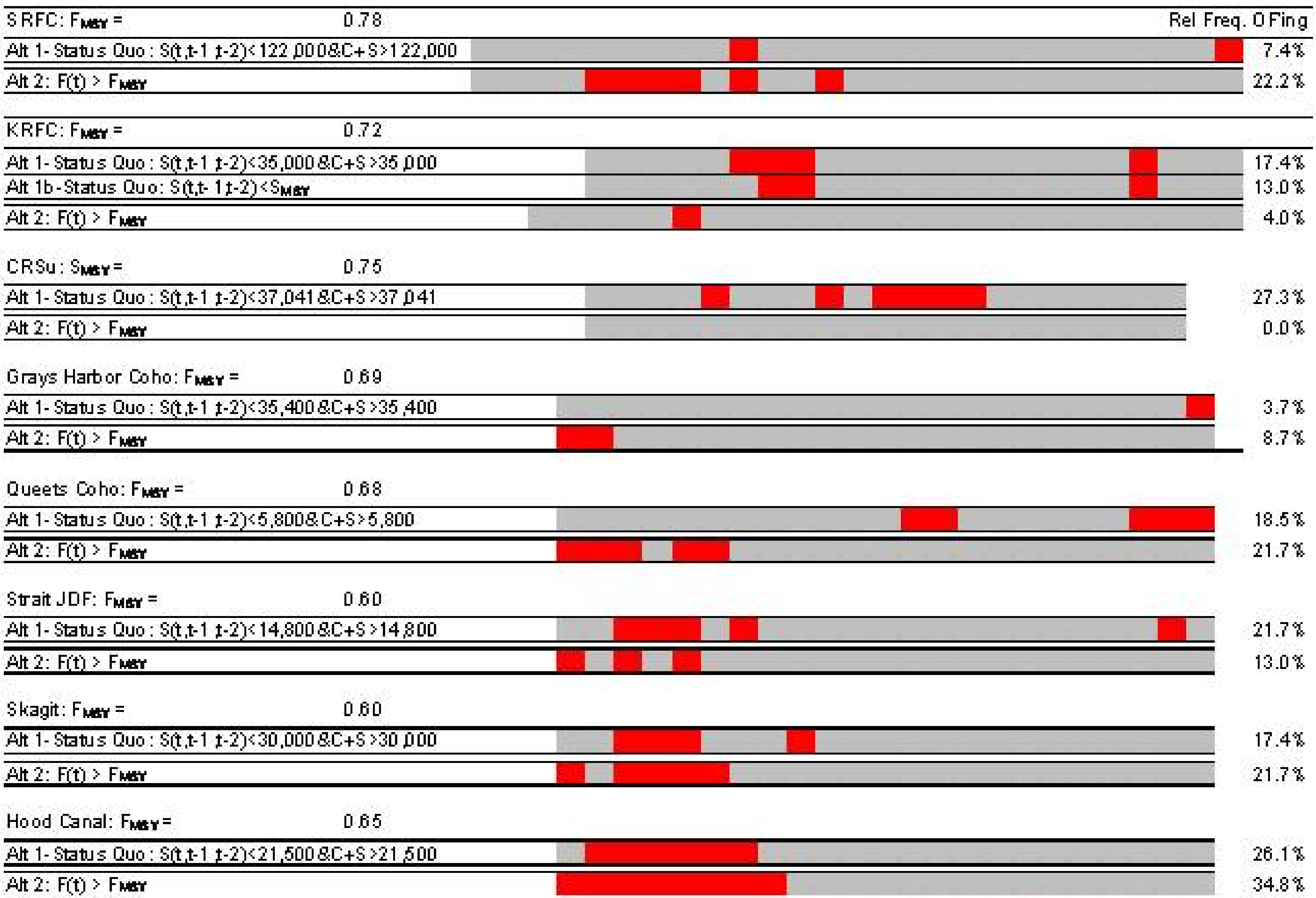
- Overfishing – Fishing contributed to triggering overfishing Concern
  - Not evaluated annually, only after triggering concern
  - Inconsistent interpretation of contribution
  - Not explicit in FMP
- Overfished – Overfishing concern triggered
  - Not explicit in FMP
- Approaching Overfished – Overfishing concern projected to be triggered
- Rebuilt – Conservation objective met or rebuilding plan objective met

SDC Alternatives 2 & 4 - Single Year

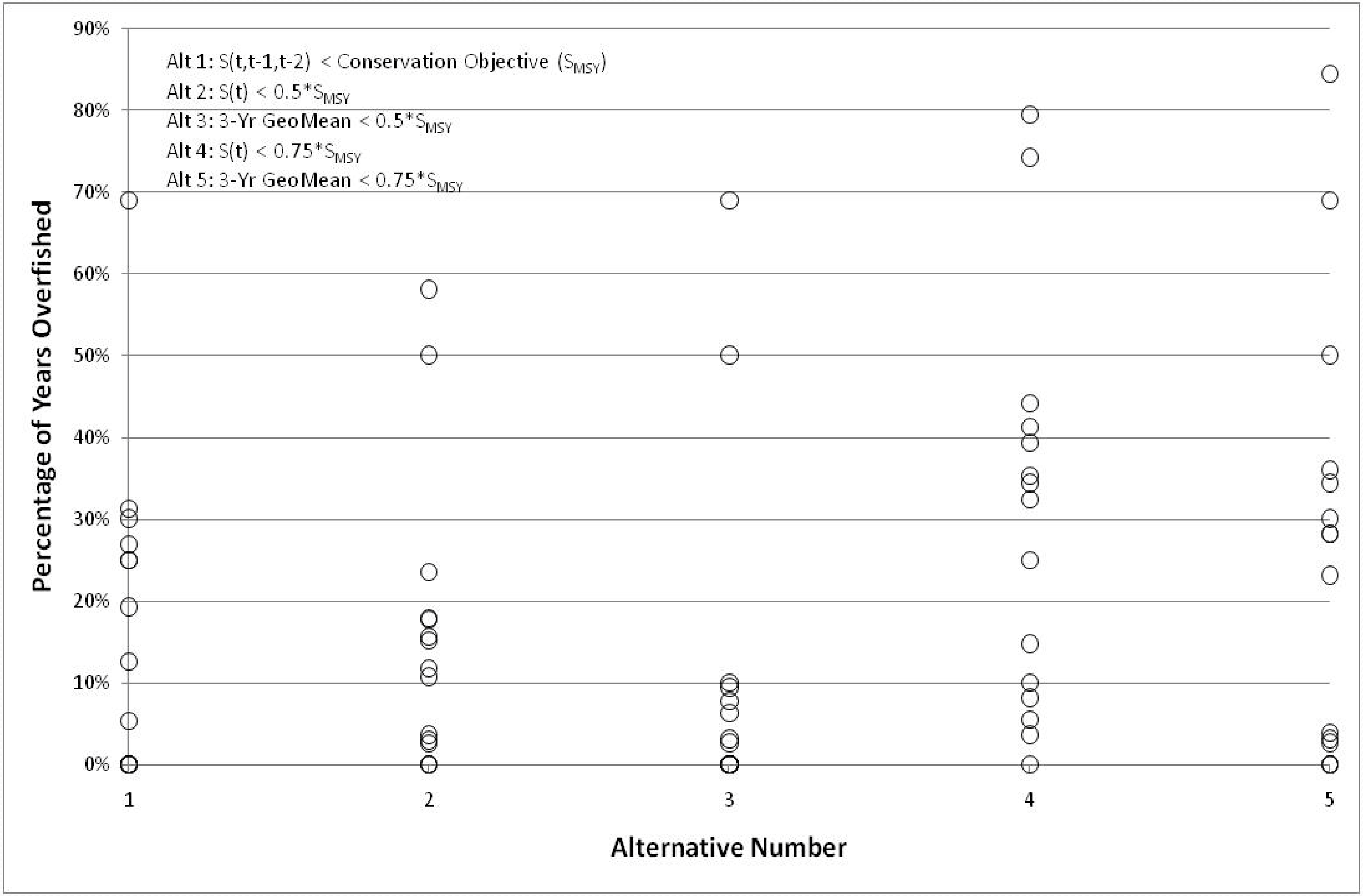
- Overfishing – MFMT: Exploitation Rate Exceeds F_{MSY} Exploitation Rate
- Overfished – MSST: Spawning Escapement $<0.5*S_{MSY}$ or $<0.75*S_{MSY}$
- Approaching Overfished: Spawning Escapement Projected $<0.5*S_{MSY}$ or $<0.75*S_{MSY}$
- Rebuilt: Spawning Escapement $>S_{MSY}$

SDC Alternatives 3 & 5 - Multi-Year

- Overfishing – MFMT: Exploitation Rate Exceeded F_{MSY} Exploitation Rate (Same as Single Year)
- Overfished: Recent 3-Year Geometric Mean of Spawning Escapements $<0.5*S_{MSY}$ or $<0.75*S_{MSY}$ (MSST)
- Approaching Overfished: Geometric Mean of Recent 2-Year Spawning Escapements and Projected Spawning Escapement $<0.5*S_{MSY}$ or $<0.75*S_{MSY}$ (MSST)
- Rebuilt: Recent 3-Year Geometric Mean of Spawning Escapements $>S_{MSY}$


SRFC: F_{MSY} = 0.78
Rel Freq. OF'ing
Alt 1- Status Quo : S(t,t-1 ,t-2)<122,000&C+S>122,000 7.4%
Alt 2: F(t) > F_{MSY} 22.2%
KRFC: F_{MSY} = 0.72
Alt 1- Status Quo : S(t,t-1 ,t-2)<35,000&C+S>35,000 17.4%
Alt 1b-Status Quo: S(t,t- 1,t-2)<S_{MSY} 13.0%
Alt 2: F(t) > F_{MSY} 4.0%
CRSu: S_{MSY} = 0.75
Alt 1- Status Quo : S(t,t-1 ,t-2)<37,041&C+S>37,041 27.3%
Alt 2: F(t) > F_{MSY} 0.0%
Grays Harbor Coho: F_{MSY} = 0.69
Alt 1- Status Quo : S(t,t-1 ,t-2)<35,400&C+S>35,400 3.7%
Alt 2: F(t) > F_{MSY} 8.7%
Queets Coho: F_{MSY} = 0.68
Alt 1- Status Quo : S(t,t-1 ,t-2)<5,800&C+S>5,800 18.5%
Alt 2: F(t) > F_{MSY} 21.7%
Strait JDF: F_{MSY} = 0.60
Alt 1- Status Quo : S(t,t-1 ,t-2)<14,800&C+S>14,800 21.7%
Alt 2: F(t) > F_{MSY} 13.0%
Skagit: F_{MSY} = 0.60
Alt 1- Status Quo : S(t,t-1 ,t-2)<30,000&C+S>30,000 17.4%
Alt 2: F(t) > F_{MSY} 21.7%
Hood Canal: F_{MSY} = 0.65
Alt 1- Status Quo : S(t,t-1 ,t-2)<21,500&C+S>21,500 26.1%
Alt 2: F(t) > F_{MSY} 34.8%

Overfished Alternatives Analysis



SDC Analysis

- Overfishing is very unlikely to occur under Alternative 2 Exploitation Rate > F_{MSY}
- Overfished less likely to occur for multi-year criteria compared to single year criteria
- Rebuilding takes longer for multi-year criteria
- Multi-year criteria with MSST = 0.75*S_{MSY} most similar to Status Quo
- Overfished more frequent with MSST = 0.75*S_{MSY} than Status Quo
- Alternatives 2-5 are consistent with MSA, NS1Gs, objective and measurable, and implementation is practical

Stocks that Require ACLs

- Based on SAC proposed classification, international exception, and flexibility for hatchery and ESA-listed stocks, ACLs need to be developed for:

  Central Valley Fall (CVF) Complex

  - Sacramento River Fall Chinook – Indicator
  - Central Valley Fall/Late Fall Chinook

  Southern Oregon Northern California (SONC) Complex

  - Klamath River Fall Chinook – Indicator
  - Southern Oregon
  - Smith River Chinook
  - Klamath River Spring Chinook

  Far North Migrating Spring Summer (FNMSS) Complex (if not EC)

  - Hoh Spring Chinook – Indicator
  - Mi-North Oregon Coast Spring Chinook (except Umpqua)
  - Mid – Columbia Spring Chinook
  - Grays Harbor Spring Chinook
  - Queets River Spring/Summer Chinook
  - Quillayute Summer Chinook

Alternatives Considered

- Alt 1) Status Quo: Undefined
  - Does not meet purpose and need – no OFL, ABC, or ACL
- Alt 2) Catch-based (C)
- Alt 3) Spawning Escapement-Based (S)
  - Will require use of “flexibility” provision in the NS1Gs

Alternatives Considered but Not Viable

- F Based (as mentioned in June 2010)
- Based on buffered conservation objective
  - Overly conservative
- Species level complexes (e.g., Chinook)
  - Data and models used for South of Falcon assessments are currently not suitable for large scale quota management
- Sector-ACLs under the C-based framework :
  - $ACL > ACL_{PFMC}$
  - $ACL_{PFMC}=ACL_{Commercial}+ACL_{Sport}$

Viable Alternatives – C & S

- C & S approaches are the inverse of each other but both specify ACL equal to the ABC:
  - Catch-based (C)
    - OFL > ABC = ACL
  - Spawning Escapement-based (S)
    - OFL < ABC = ACL

<u>Under Both Approaches</u>:

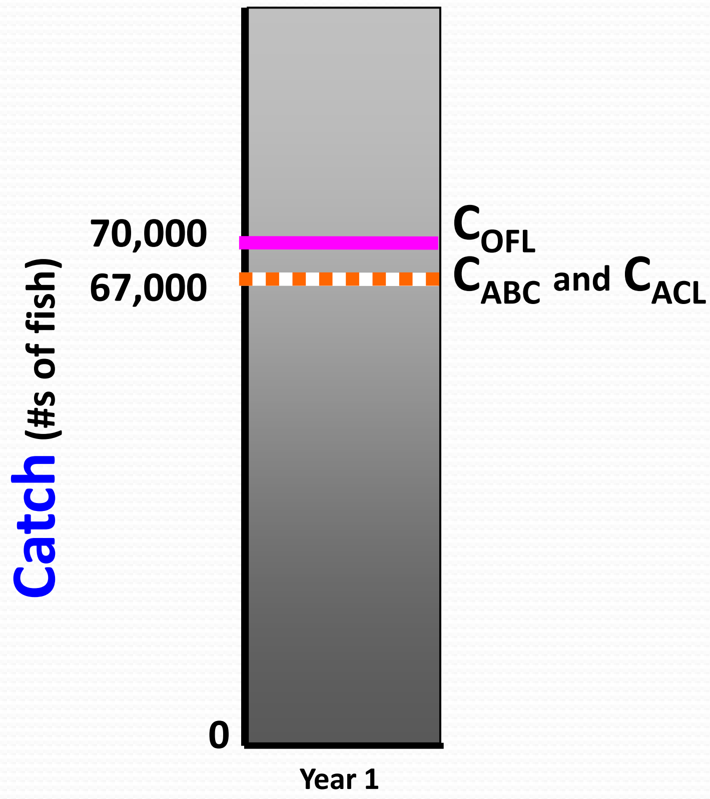
- OFL is based on a stock's estimated F_{MSY} and its preseason abundance forecast (N)
  - C Based: $C_{OFL} = F_{MSY} * N_t$
  - S Based: $S_{OFL} = (1-F_{MSY}) * N_t$
- Difference between ABC and OFL to account for scientific uncertainty
  - Tier 1: 5% for Directly Estimated F_{MSY}
  - Tier 2: 10% for Proxy Based F_{MSY} Estimates

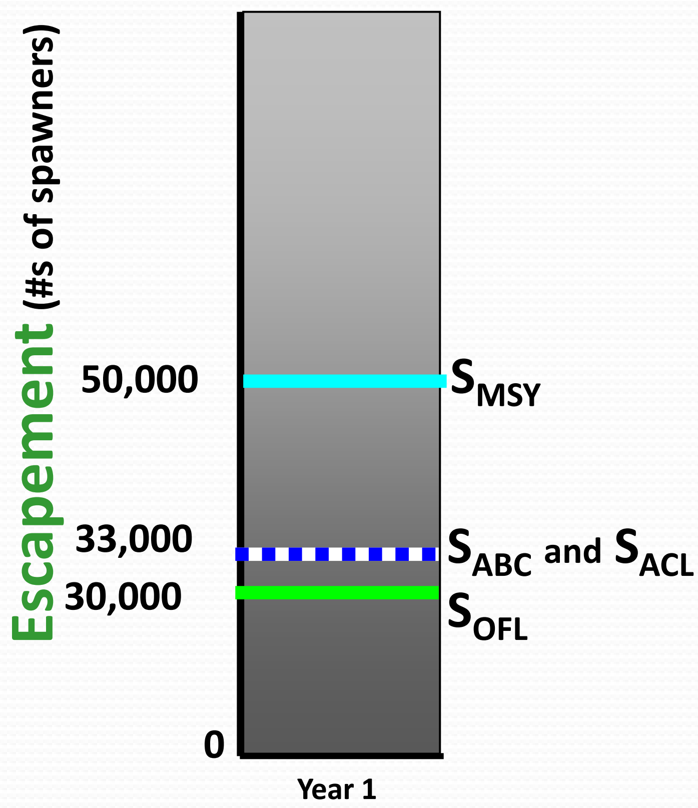
C-Based vs. S-Based Examples

Abundance (N) =100,000

S_{MSY} = 50,000 spawners

Tier 1 stock (5% ABC buffer)



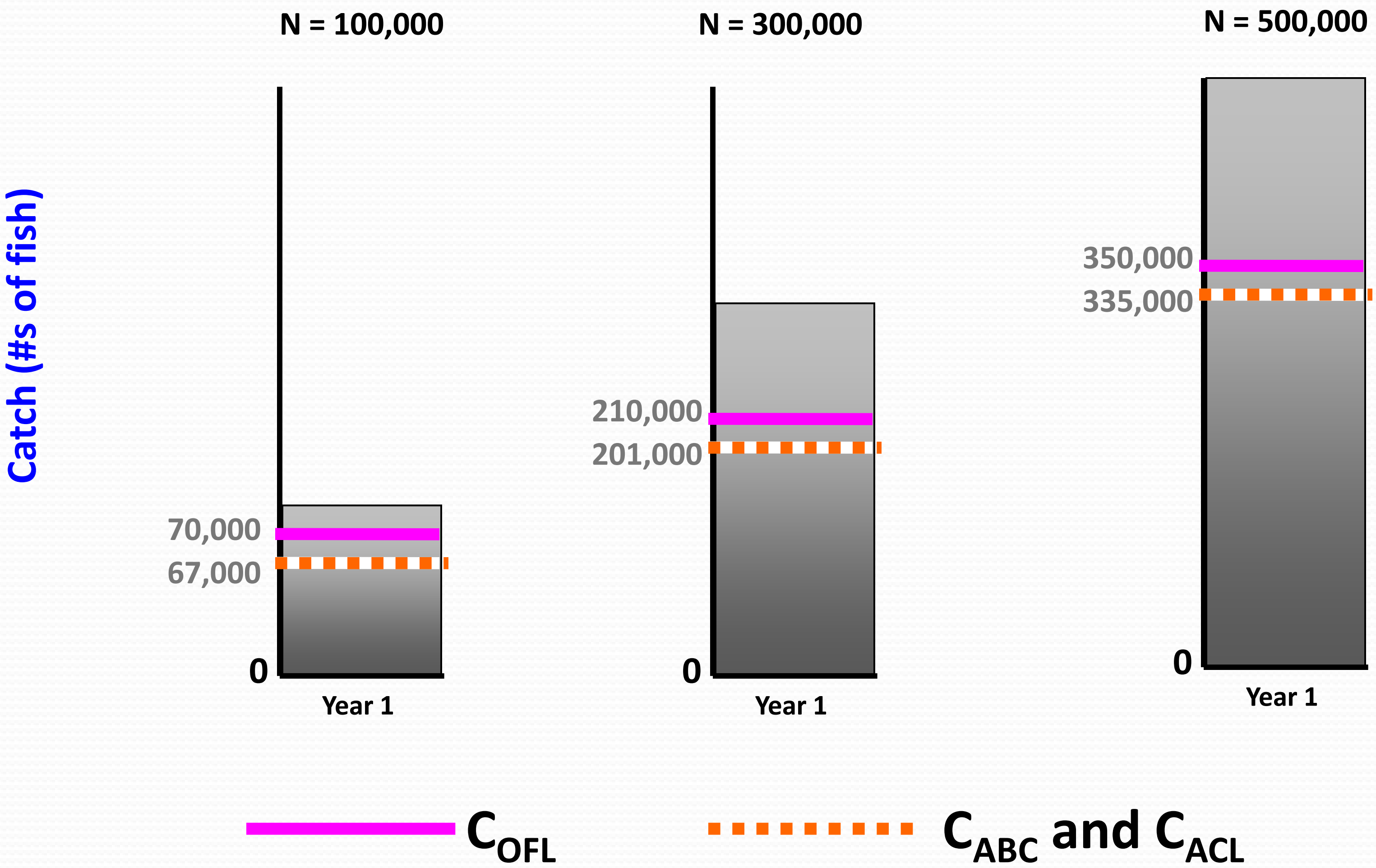


Not drawn to scale; distance between reference points just illustrative.

C-Based Reference Points

Examples in years with low, medium, high abundance

S_{MSY} = 50,000 spawners, Tier 1 stock (5% ABC buffer)

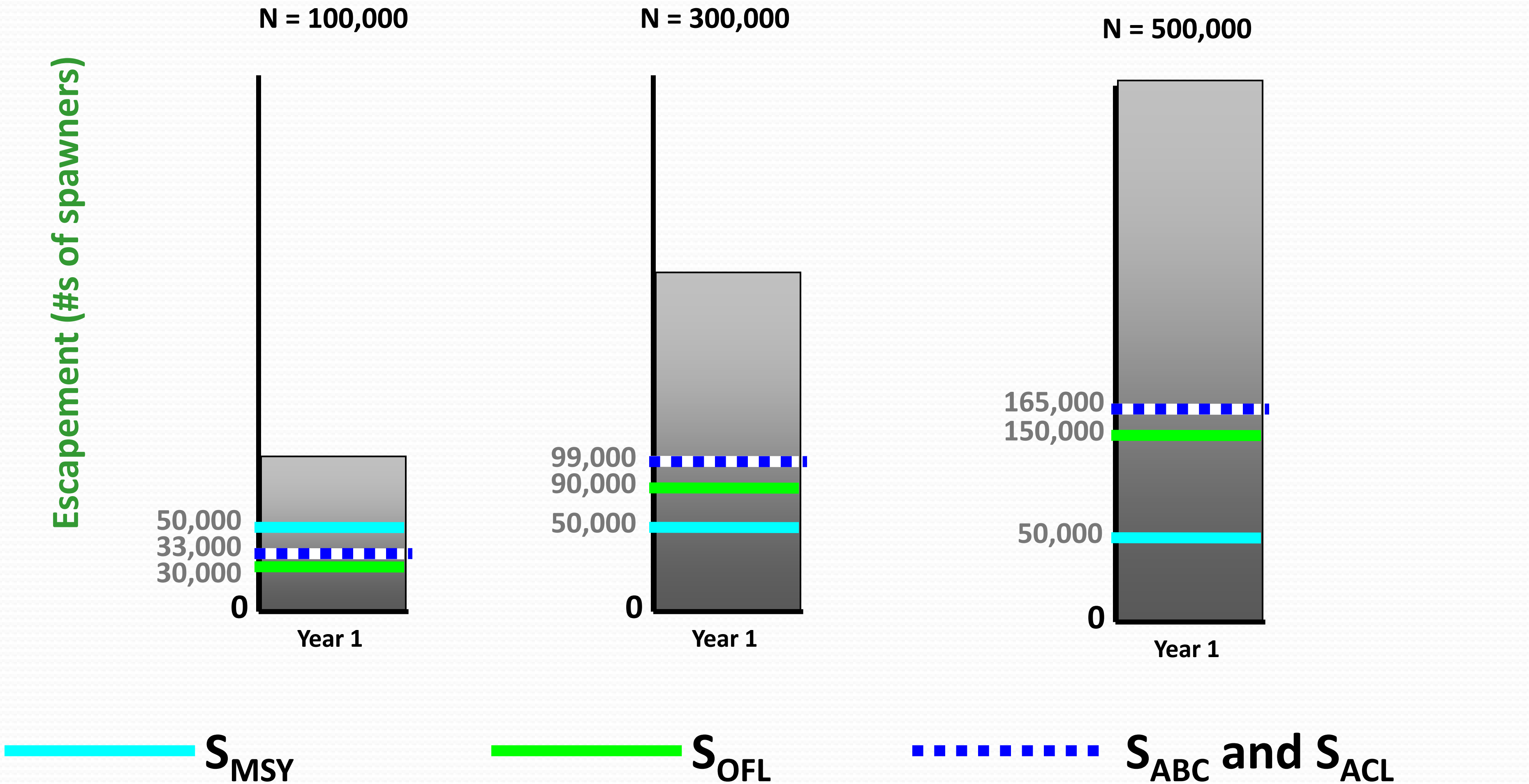


Not drawn to scale; distance between reference points just illustrative.

S-Based Reference Points

Examples in years with low, medium, high abundance

S_{MSY} = 50,000 spawners, Tier 1 stock (5% ABC buffer)



Not drawn to scale; distance between reference points just illustrative.

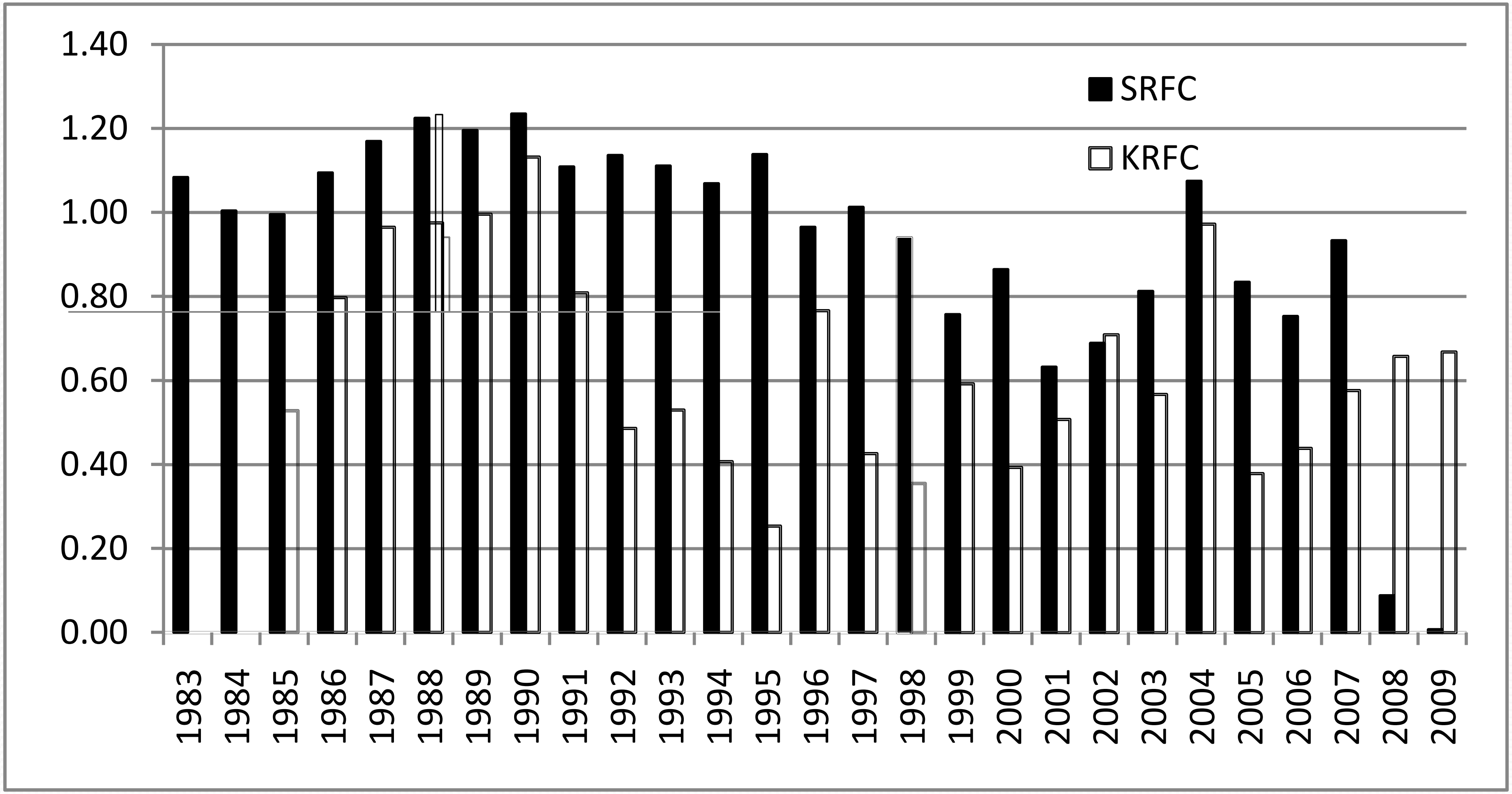
Pros & Cons of the C & S Approaches

Considerations	Alt 2: C-Based	Alt 3: S-Based
Similarity to Status Quo Processes and Terminology	CON: Current conservation objectives expressed in terms of spawning escapement, not catch	PRO: Current conservation objectives expressed in terms of spawning escapement, so may be easier to relate to current thresholds that are familiar
Risk of overfishing	No difference	No difference
Feasibility of Implementation	CON: Catch specified in terms of spawner equivalents, which does not necessarily equal total catch. Additional methods need development to estimate catch of spawner equivalents.	PRO: Spawning escapement estimated directly on an annual basis. Escapement clearly interpretable and does not require further methods to comply with the framework.
MSA and NS1Gs definitions and expression of reference points	PRO: More obviously consistent because reference points are expressed in catch, as in the NS1Gs	CON: Generally consistent, but requires invoking "flexibility provision" in the NS1Gs to express the reference points in spawner escapement rather than catch
NS1Gs framework relationship of reference points	PRO: More obviously consistent because reference points are expressed in catch, thus the relationship follows that identified in the NS1Gs where OFL would be greater than ABC, and ABC is greater than or equal to ACL	CON: Generally consistent but requires invoking "flexibility provision" in the NS1Gs so that the relationship would be OFL is less than ABC, and ABC is less than or equal to ACL (i.e., the inverse)
Scientific uncertainty & specification of ABC	No difference (buffer between OFL and ABC)	No difference (buffer between OFL and ABC)
Mgt uncertainty	No difference (No ACT specified at this time)	No difference (No ACT specified at this time)
Relationship of the ACL to AMs	No difference (AMs triggered using post-season CACL)	No difference (AMs triggered using post-season SACL)
Performance standard for exceeding the ACL	No difference (use post-season CACL)	No difference (use post-season SACL)

ACL Evaluation and Performance Measure

- Under both approaches, the reference points (OFL, ABC, & ACL) will be calculated:
  - **Pre-season** –with forecast estimates to design the fishery to prevent overfishing and achieve conservation objectives, as is currently done
  - **Post-season** – with actual values for abundance and exploitation rates for the purposes of performance monitoring and triggering AMs
    - KRFC: Preliminary in One Year, “Final” in Two Years
    - SRFC: “Final” in One Year

ACL Compliance Analysis



Retrospective compliance as a percentage of ACL

Accountability Measures

- None Specified, but many FMP measures qualify
  - Inseason – Closure Authority, Quota Monitoring, Gear/Bag/Size/Trip Limits, Reporting Requirements, Conservation Alert Action, etc.
  - Postseason – Annual SAFE Document, Overfishing Concern Assessment, Methodology Review, etc.
- Additional Alternatives May be Considered
  - Modify Overfishing Concern and/or Conservation Alert Actions
  - Annual Catch Targets
  - Others Related to ACL compliance

AM Alternative 1 – Status Quo

- Specify measures currently identified in FMP as AM
  - Many meet the intent of preventing overfishing and mitigating for exceeding target harvest levels.
  - Include Preseason, inseason, and postseason measures
- Limit fishing, assess cause and implications of shortfalls at the conservation objective (S_{MSY}) level
  - Notify Co-managers of situation
  - Conservation Alert action – constrain fishing
  - Approaching Overfished – Co-managers report
  - Overfishing Concern - STT and HC reports
- Develop rebuilding plan, criteria for end of Concern

AM Alternative 2 – Modify FMP "Overfishing Criteria"

- Eliminate Conservation Alert fishing restriction
- Change terminology of Overfishing Concern to Abundance Advisory
  - Less prescriptive actions
    - Relax assessment periods
    - Defer assessment of implications to AMs associated with ACLs and SDC (e.g., rebuilding plans)
- Retain assessment of cause and role of fishing
- Retain co-manager notifications

AM Alternative 3 – Eliminate Overfishing Criteria

- Eliminate Conservation Alert and Overfishing Concern
  - Defer actions to rebuilding plans and AMs associated with ACLs and SDC (e.g., rebuilding plans)

AM Alternatives 2 and 3 – Common Elements

- Specify other measures currently identified in FMP as AM
- ACT available to address management uncertainty, but not prescribed
- Limit fishing, assess cause and implications of shortfalls at the ACL level
  - SAFE report
  - Co-manager notice
  - Methodology Review
- Re-evaluate framework if ACL non-compliance more than 1 in 4 years
  - Tier levels, S/R update (F_{MSY}, S_{MSY}), other scientific and management uncertainty (e.g., ACT)
  - Adaptive Management approach

Measures Associated with SDC

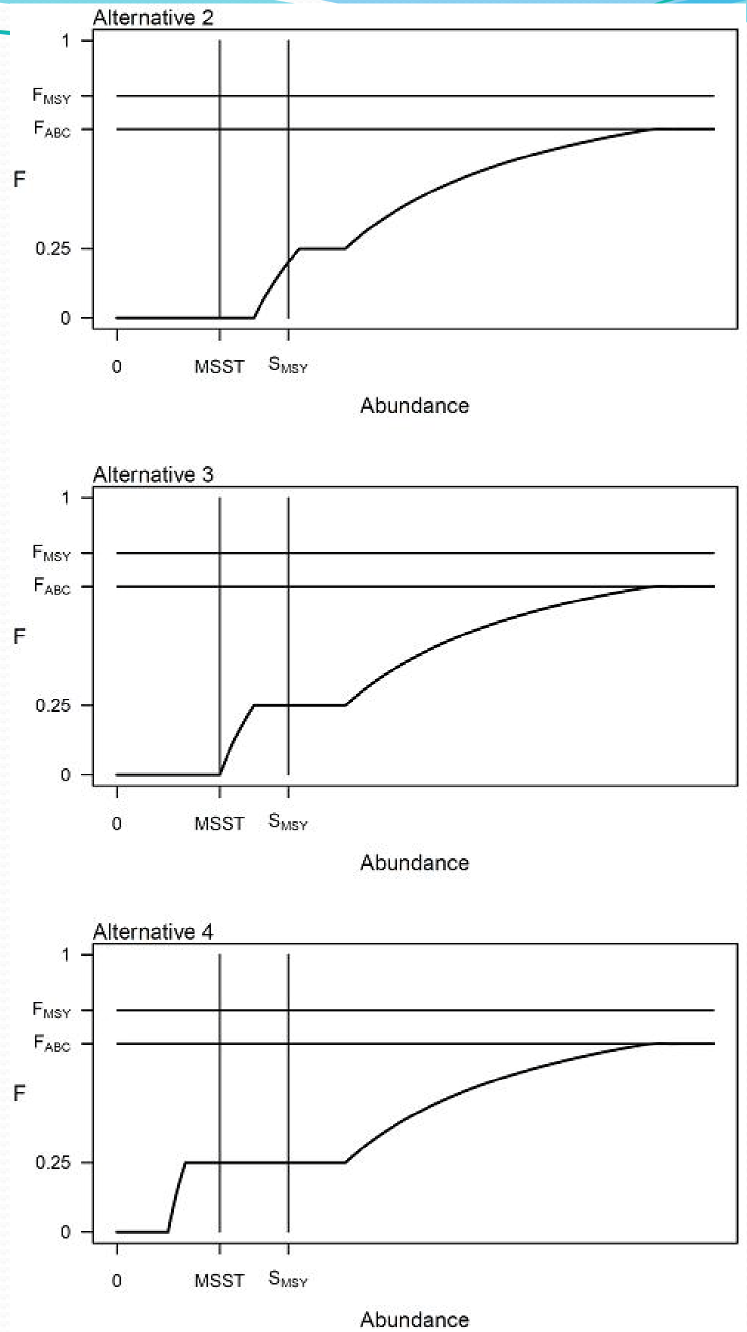
- Should consider actions associated with triggering SDC, analogous to Overfishing Criteria in current FMP
- Overfishing – Would already trigger AM associated with ACL
- Overfished – Assessment, Rebuilding Plan
- Approaching Overfished – Assessment, Potential Management Action

De Minimis Alternatives

- Flexibility for *U.S. v. Washington* and *Hoh v. Baldrige* preserved
- Would not apply to other stocks with explicit *de minimis* provisions
- Developed for KRFC and SRFC as directed by Council
- Modify conservation objective control rules to allow limited exploitation rate
  - < 25% AEQ exploitation rate (total)
  - Rates tied to S_{MSY} and MSST
  - Rates scale down to zero at lower abundance

Alternative *De Minimis* Control Rules

- $F_{de\ min} = 0.25$
- Alt 2: F = 0 at midpoint between S_{MSY} and MSST
- Alt 3: F = 0 at MSST
- Alt 4 F = 0 at ½MSST



De Minimis Alternatives Analysis

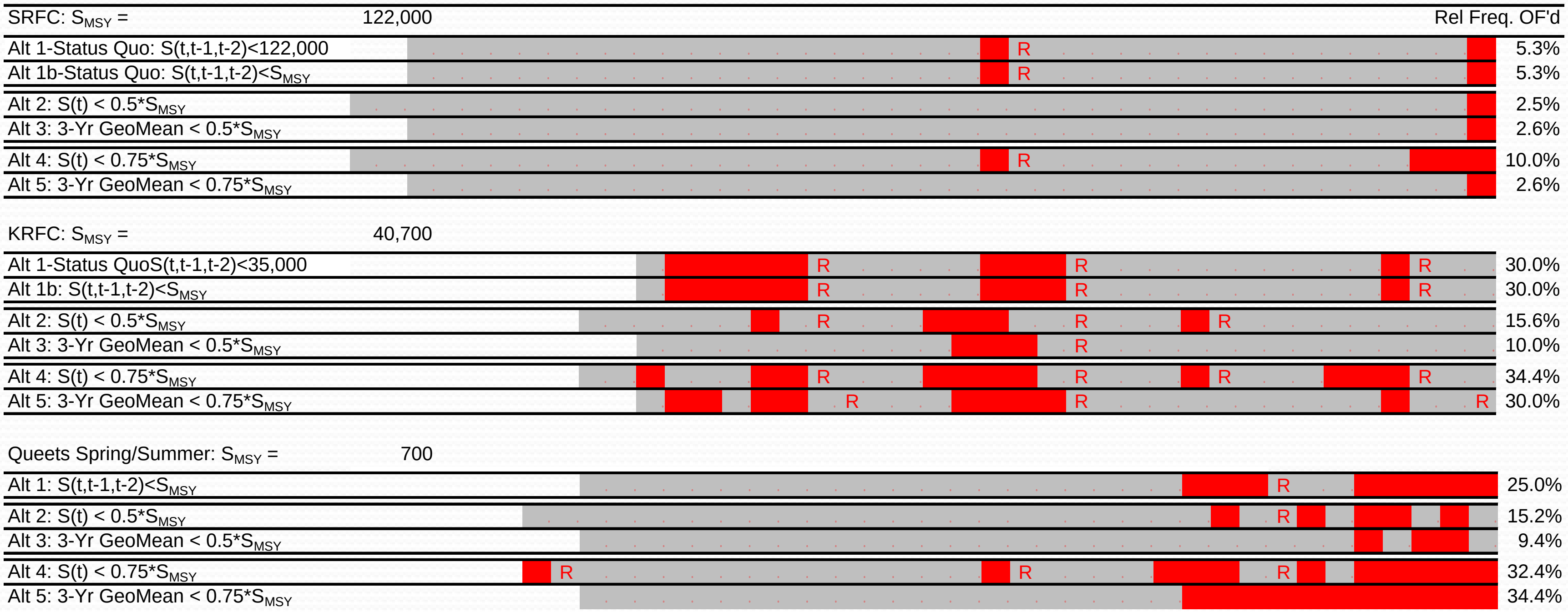
- KRFC – $F_{de\ min}$ starts at 54,000 natural area spawners, not 47,000 if based on S_{MSY}, not 35,000 floor
- KRFC – Amendment 15 nebulous reduction at spawners less than 30,000 or 22,000 is now structured
- SRFC – $F_{de\ min}$ starts at 163,000 spawners if based on S_{MSY} = 122,000
- Alternative 4 with F = 0 at ½MSST not viable because probability of becoming overfished > 50%.
- Intent is that the Council would manage fisheries on the basis of these control rules at all stock abundance levels without need for emergency rules or other special approval

Council Guidance Needed

- Stock Classification
  - Alternative removing FNM Chinook and pink salmon from FMP
  - Hoh Sp/Su Chinook indicator stock for FNMSS Chinook stock complex
  - More detailed stock boundaries
- Status Determination Criteria
  - F_{MSY} and S_{MSY} assumptions for SRFC, WA Coastal coho
- OFL/ABC/ACL Framework
  - Range of Alternatives – C-based and S-based
  - Scientific uncertainty buffers and adaptive management approach
- Accountability Measures
  - Disposition of conservation alert, overfishing concern, and related actions
  - ACT options
- De Minimis Fishing Provisions
  - Other alternatives

The End

Overfished/Rebuilt Alternatives Analysis



Summary of draft environmental assessement alternatives for Amendment 16 to the salmon FMP.

Classifying Stocks in the FMP

Alternative 1

Status Quo

all stocks currently in FMP remain

Alternative 2

Minor reorganization + 3 Complexes

Smith River Chinook separated from CA coastal Chinook (ESA listed); Rogue coho out of OCN, into SONCC; CVF, SONC, FNMSS Chinook complexes

Alternative 3

Ecosystem Components + 2 Complexes

Smith River Chinook, Rogue coho same as Alt. 2; Non-ESA FNM Chinook and pink are EC; CVF, SONC Chinook complexes

International Exception

Alternative 1

Status Quo

None Specified

Alternative 2

Non-ESA PST stocks

URB, CR Summers, OR/WA Coastal fall, Canadian Chinook;
WA Coastal, Puget Sound coho;
Puget Sound, Canadian pink

Alternative 3

Non-EC PST stocks

CR Summers, Canadian Chinook;
WA Coastal, Puget Sound coho

Status Determination Criteria for Overfishing and Overfished

Alternative 1

Status Quo - SDC Not explicit in FMP

Overfishing: STT Assessment
Overfished: STT Assessment, Overfishing Concern triggered
Approaching Overfished: 2-years below conservation objective and Conservation Alert triggered
Rebuilt: Spawning escapement > conservation objective or rebuilding plan

Alternatives 2 & 4

Single-year; MSST = 0.5*Smsy & 0.75*Smsy

Overfishing: Exploitation rate >Fmsy
Overfished: Spawning Escapement < MSST
Approaching Overfished: Projected spawning escapement < MSST
Rebuilt: Spawning Escapement > Smsy

Alternatives 3 & 5

3-year Geo Mean; MSST = 0.5*Smsy & 0.75*Smsy

Overfishing: Exploitation rate >Fmsy (single-year)
Overfished: 3-year GeoMean Spawning Escapement < MSST
Approaching Overfished: 2-year and projected GeoMean spawning escapement < MSST
Rebuilt: 3-year GeoMean spawning Escapement > Smsy

OFL, ABC, and ACL Specification

Alternative 1

Status Quo - Not Defined in FMP

None Specified

Alternative 2

Catch-Based (C-Based)

OFL: Fmsy

ABC: Fabc=Fmsy*0.95 (Tier 1 stocks; KRFC) or Fabc=Fmsy*0.90 (Tier 2 stocks; SRFC, Hoh)

ACL: Fabc*N

Alternative 3

Spawning escapement-Based (S-Based)

OFL: Fmsy

ABC: Fabc=Fmsy*0.95 (Tier 1 stocks; KRFC) or Fabc=Fmsy*0.90 (Tier 2 stocks; SRFC, Hoh)

ACL: (1-Fabc)*N

Accountability Measures

Alternative 1

Status Quo

Target conservation objective except at low abundance

Specify current FMP measures as AM: SAFE Report, Methodology Review, Notice to Managers, OF'ing and EFH Assessments, Conservation Alert action, Inseason authority, etc.

Alternative 2

Modify Overfishing Criteria

Target Conservation Objective except at high (ACL) or low (demin) abundance

Rename OF'ing Concern to Abundance or Depletion Concern

Increase flexibility to implement *de minimis* fisheries under Conservation Alert

Retain notification measures, other current FMP measures

Reevaluate ACL if exceeded more than 1 in 4 years: Uncertainty tiers, ACT, S/R update, etc.

Alternative 3

Replace Overfishing Criteria

Target Conservation Objective except at high (ACL) or low (demin) abundance

AM for SDC would be developed

AM for ACL would include other current FMP measures

Retain other current FMP measures

Reevaluate ACL if exceeded more than 1 in 4 years: Uncertainty tiers, ACT, S/R update, etc.

De minimis Fishing Provisions

Alternative 1

Status Quo

SRFC: 0% SRR below 122K

KRFC: A-15; ~26% SRR b-t47K and 30K, less below 30K

US v Wash, Hoh v Baldrige: No Change

Alternative 2

No fishing below midpoint of Smsy-MSST

SRFC: 25% SRR b-t 163K and 122K, 0% at 91.5K

KRFC: 25% SRR b-t 54K and 40.7K, 0% at 30.5K

US v Wash, Hoh v Baldrige: No Change

Alternative 3

No fishing below MSST

SRFC: 25% SRR b-t 163K and 81.3K, 0% at 61K

KRFC: 25% SRR b-t 54K and 27.1K, 0% at 20.35K

US v Wash, Hoh v Baldrige: No Change

SALMON ADVISORY SUBPANEL REPORT ON AMENDMENT 16 TO THE SALMON FISHERY MANAGEMENT PLAN

Stock Classification

The Salmon Advisory Subpanel (SAS) recommends the Council adopt Alternative 2 as the preliminary preferred alternative. This would preserve the Essential Fish Habitat designations for far-north-migrating Chinook and pink salmon, and allow regulation of pink salmon retention in Council area fisheries. Regardless of which alternative is ultimately selected, the SAS recommends that the Council include explicit language allowing management of pink salmon and flexibility for stock reclassification without a formal Fishery Management Plan (FMP) amendment if sufficient technical information justifies a change. The Council should also preserve the current FMP language allowing addition of stocks and modification of conservation objectives through similar technical review processes, and extend these provisions to include other reference points such as S_{MSY} and F_{MSY}.

Status Determination Criteria

The SAS recommends the Council adopt Alternative 3 for overfishing status criteria as the preliminary preferred alternative.

The SAS was unable to reach consensus on a preliminary preferred alternative for overfished status criteria, but does request the Council include another alternative for public review similar to Alternative 3 (based on a 3-year geometric mean) except that the minimum stock size threshold (MSST) for Klamath River fall Chinook only would be set at $0.86*S_{MSY}$; MSST for all other stocks would be set at $0.5*S_{MSY}$.

Annual Catch Limits

The SAS recommends the Council adopt Alternative 3, the spawning escapement based alternative, as the preliminary preferred alternative. This alternative will keep objectives in the familiar terms of spawners, as is currently done.

Accountability Measures

The SAS recommends the Council adopt Alternative 2 as the preliminary preferred alternative; however, the term "overfishing concern" should be changed to "abundance alert." Alternative 2 promotes awareness of declining stock status before reaching overfished thresholds.

***De Minimis* Fishing Provisions**

The SAS favors establishing structured control rules for low abundance levels, including a defined point at which fishing would cease. However, the SAS notes that, for example, a desired stock size at which fishing would cease could be achieved through either Alternative 2 or 3, depending on the selection of MSST (50 percent or 75 percent of maximum sustainable yield). Therefore, the SAS recommends the Council select a preliminary preferred alternative for MSST to allow evaluation of alternatives for *de minimis* fishing provisions. The SAS was not able to reach consensus on a preliminary preferred alternative; however, Alternatives 1-3 provide an adequate range of alternatives from which to select a preferred alternative when the Council takes final action on Amendment 16.

PFMC 9/10/10

SCIENTIFIC AND STATISTICAL COMMITTEE REPORT ON FISHERY MANAGEMENT PLAN AMENDMENT 16, ANNUAL CATCH LIMITS AND ACCOUNTABILITY MEASURES

The Scientific and Statistical Committee (SSC) met with Dr. Peter Dygert of the Salmon Amendment Committee (SAC) to discuss the current "Draft Environmental Assessment for Pacific Coast Salmon Plan Amendment 16: Classifying Stocks, Revising Status Determination Criteria, Establishing Annual Catch Limits and Accountability Measures and *De Minimis* Fishing Provisions". The SSC reviewed an earlier draft of this document at the June Council meeting (Agenda Item C.1.b, Supplemental SSC Report).

The SSC commends the SAC on producing, in a relatively short amount of time, a document that covers a broad range of topics. The current draft is greatly improved and addresses most of the SSC concerns from the previous draft, including:

- The proposal should include a process for the SSC to recommend overfishing limits (OFLs) and acceptable biological catches (ABCs) to the Council based on preseason estimates: A section of the document (page 48) now specifically addresses this topic. Further discussion of this issue occurred at this meeting between the SSC and members of the SAC and Salmon Technical Team (STT). It was suggested that two tables could be provided in future versions of Pre-season Report I that are prepared by the STT. The first table would present preliminary OFLs and ABCs by stock for SSC review and approval. This table would only cover natural stocks in the fishery that are not ESA listed or covered by an international exception. A second table, similar to the current Table I-3 in Pre-season Report I, would present a status determination table for the above stocks and stocks covered by an international exception. The SSC recommends that the annual Review of Ocean Salmon Fisheries report include a table that summarizes post-season performance of the previous year's management results relative to the OFL and MSST (minimum stock size threshold).

- Alternatives were presented for single-year and three-year status determination criteria (SDC). Current overfishing criteria are based on three-year stock performance. The MSST was proposed to be one half of S_{MSY}. This is consistent with the National Standard 1 Guidelines, but the SSC requested analysis supporting use of this criterion for salmon and a comparison of using one and three year time frames for determining overfishing: Tables 4-1 and 4-2 in the draft document now provide this information. The SSC recommends the SDC be based on 3-year geometric means as they will be less subject to random error (noise) in the estimation and evaluation process.

- The SSC was concerned that the Council adopt appropriate levels of F_{MSY} and requested documentation for the F_{MSY} proxy values used for Chinook and coho: Appendix C of the current draft provides this documentation for Chinook. The SSC notes that using mean F_{MSY} gives equal weight to each estimate of $F_{MSY.}$ It might have been better to use a method that accounts for the variability (uncertainty) in the estimate of F_{MSY} from each source. However, the STT reported that the data are not available for such an analysis. The SSC endorses the proposed value of 0.78 as an F_{MSY} proxy for Chinook. Appendix E documents the development of reference points for Washington coastal coho stocks. In the previous draft, it was proposed that a proxy be used for F_{MSY} for these stocks. In the current draft, F_{MSY} has been explicitly estimated for each stock. This should be preferable to the use of a proxy and the SSC endorses the stock-specific values of F_{MSY} proposed in Table E-4. The SSC Council may want to reconsider the Chinook F_{MSY} proxy in the future using more recent data and recommends that the F_{MSY} for Washington coastal coho be subject to a future Methodology Review that would evaluate stock-specific-values of F_{MSY} compared to a F_{MSY} proxy for the group.

- In its June statement, the SSC requested a discussion of the rationale for the choice of 5 percent and 10 percent buffers between F_{MSY} and F_{ABC} for Tier 1 and Tier 2 stocks, respectively: This is now documented in Appendix D. The SSC notes that the choice of the size of the buffer and the probability of over-fishing is ultimately a policy decision. The Council may want to consider alternatives to buffer sizes other than those proposed. Additional analyses would be needed to evaluate other buffer choices.

- No buffers to account for management uncertainty are proposed at this time. The SAC proposes to use an adaptive management approach. If ACLs are consistently exceeded, the use of buffers would be considered and implemented as needed. In June, the SAC reported that quotas have rarely been exceeded in recent quota-managed fisheries. The SSC requested a historical comparison of preseason quotas and postseason catches to support this statement: Appendix F of the current draft provides this information.

The SSC notes that it is difficult to evaluate the long-term consequences of any of the proposed alternatives without some comparison of possible outcomes under the different alternatives. Something similar to a management strategy evaluation modeling process could have provided these comparisons. However, given the time constraints for developing this amendment it was not possible.

There is a new *de minimis* fishing section in the current draft. The choice of *de minimis* fishing alternatives is largely a policy decision. The SSC notes that Alternative 4 would allow fishing at stock abundances below levels that have been seen previously.

The SSC notes the difficulty of comparing economic effects of the alternatives in a quantitative manner. However, a qualitative discussion that clearly describes the potential consequences of increasing/decreasing annual harvest opportunities relative to effects on overfished probabilities would be helpful. The only economic effect of overfished determinations noted in the current analysis is a reduction in ex-vessel prices due to lower ratings by seafood watch programs (p. 104). The SSC notes that other factors exert greater influence on west coast salmon prices – for instance, supply and prices of farmed salmon and Alaska wild salmon. A more relevant economic effect to consider in the context of overfished determinations is loss of harvest opportunity associated with more stringent management restrictions and potential expansion of such restrictions over a broader geographic area.

PFMC
09/11/10

Yurok Tribal Comments regarding Draft Amendment 16 to the Pacific Salmon Fisheries Management Plan

My name is Dave Hillemeier, Fisheries Program Manager for the Yurok Tribe. The Yurok Reservation is located along the lower 44 miles of the Klamath River. Given that the Yurok Tribe sustains themselves from all anadromous runs of fish in the Klamath River, my comments are focused on the affects of A16 to Klamath River fish. The Yurok Tribe manages their fishery with an eye toward meeting the needs of future generations of Yurok People; therefore the Tribal Council adheres to a conservative management philosophy regarding the management of their fishery.

It's worth noting that not long ago I was trying to figure out the meaning of the various acronyms within the proposed amendment and determine the significance of the amendment to the Yurok Tribe, if any. Since then, I've come to realize that this amendment is quite complex and extremely important regarding the management of Klamath Fall Chinook. In fact, this amendment changes some of the primary precepts contained within Amendments 9 and 15; both which have provided the basis for management of this stock. While we are still striving to understand the draft EA which just recently became available to us, I should note that my current understanding is that this Amendment has the potential to improve certain aspects regarding the management of Klamath Fall Chinook; in particular 1) utilization of the best available science regarding the spawning abundance which provides for MSY over the long term, 2) adoption of "overfished" criteria and associated "rebuilt" criteria, and 3) elimination of ambiguity and adoption of a control rule for the implementation of deminimus fisheries at times of low stock abundance for Klamath fall chinook.

MSY

The Tribe supports using the best available science when determining the value that represents the spawner abundance that yields Maximum Sustained Yield of Klamath fall Chinook over the long-term. Table 2-8 of the draft EA sates that the decision needs to be made regarding whether to use the FMP's current 35,000 floor (which has served as a quasi proxy for MSY since the adoption of Amendment 9) or the STT's 2005 estimate of MSY (40,700) that was the result of a Stock/Recruit analysis based upon 22 completed cohorts of data, in addition to an index for early life history survival; much more information than was available at the time that Amendment 9 was adopted. We recommend that the PFMC adopt the STT's estimate of 40,700 adult Chinook as being the appropriate MSY value for Klamath Basin fall Chinook. This estimate of MSY is further supported by the SSC's determination that the STT's analysis represents the best available science regarding the MSY value.

Of course, as we move toward implementation of the Klamath Basin Restoration Agreement, the removal of the four dams from the mainstem Klamath River, and full implementation of the Trinity River Record of Decision, we expect that the MSY value will need to be re-assessed to account for the improved habitat conditions.

Stock Complex

Regarding Stock complexes, the alternatives seem to make little difference regarding the management of Klamath fish stocks. We support the use of Klamath fall Chinook as an indicator species for the Southern Oregon/Northern California (SONC) Chinook complex as is proposed in each of the alternatives. It is also important to the Tribe that the door be left open regarding the potential development of conservation objectives for Klamath spring Chinook in the future. All of the alternatives seem to meet these objectives.

Status Determination Criteria

MSST/Overfished

The value adopted for certain parameters, such as Minimum Stock Size Threshold (MSST), and the criteria used to determine SDC are critical regarding the usefulness of SDC's for protecting the viability of stocks in the future. The definition arrived at for MSST and the criteria adopted for determining when a stock is overfished are intricately linked; these linkages could jeopardize the health of the Klamath fall chinook if caution is not used. For example, if an extremely low value for MSST value is chosen (e.g. ½ MSY (20,350) for Klamath fall chinook – a value that may likely result in genetic damage to basin substocks), combined with certain criteria for determining when a stock is overfished (such as a geometric mean of three years being below this extremely low MSST value), then the genetic health of the stock could be jeopardized without ever considering the stock as being "overfished".

Analysis conducted for the drafting of Amendment 15 indicates that the risk of going below genetic thresholds for substocks of Klamath fall Chinook substantially increases when KRFC abundance drops below 22,000. If the stock is at extremely low abundance, near levels that are likely to result in genetic damage that would hinder the long-term viability of the stock, then a special status, such as "overfished" should be acknowledged and addressed. The processes/burdens that accompany addressing stocks that are overfished should not be avoided by dramatically changing definitions and stock determination criteria. We recognize that "overfished" is not the most appropriate word for describing the primary causes of stock decline, however it is the word that the Magnuson Act gives us to identify stocks that are at dangerously low levels and that require special attention regarding harvest management and habitat restoration.

We recommend the preliminary preferred alternative for public review be a definition of MSST equal to 0.75 * S_{MSY}. If this is adopted, then we recommend that the criteria associated with being considered as overfished be the geometric mean of stock abundance over a three year period. If the much lower value (20,350) is adopted for MSST, then we recommend that a single year of dropping below this value be used to represent when a stock is "overfished".

Rebuilt

We currently support the criteria associated with considering an overfished stock as being rebubilt being the geometric mean of three consecutive years of the stock meeting S_{MSY}

Rebuilt

We believe that the preferred alternative should be geometric mean of three consecutive years being above MSY, which is the same as Alternatives 3, 4, and 5.

De minimis fishing

We are pleased to see the ambiguity which was left by Amendment 15 at stock sizes below 30,000 being addressed in this proposed Amendment. However, there is currently not an alternative listed that we fully support. As you may recall, Amendment 15 allowed for de minimis fisheries that result in a spawner reduction rate of up to 25% without clarifying what would happen at lower stock sizes. However, a letter from the NMFS Northwest Regional Director to the Yurok Tribal Council, as well as the PFMC, clarified that in practice they expected to see this rate only at the upper end of the range, and that they expected this rate to decline as stock size dropped below 30,000. The NMFS letter also stated that they expected to see a substantially greater decline in harvest rates at stock sizes near 22,000 (thought to be the genetic threshold for increased probability of damage to substocks).

To be more reflective of what was stated in this letter from NMFS, and to be more protective of KRFC, would like to see an alternative similar to Alternative 3, however we would like the inflection point at which the rate begins to decline be at our preferred MSST value (i.e. 0.75 * MSY – 30,525), rather than at approximately 27,000 as is in the current Alternative 3. This rate would then reach 0 at 22,000 (or at the same level currently contained within alternative 3; 20,350). We recommend that this be the preliminary preferred alternative for public review.

Salmon FMP Amendment 16: Tentative range of alternatives for public review based on Council staff interpretation of motion 3 and amendments at the September 2010 Council meeting.

Classifying Stocks in the FMP

Alternative 1

Status Quo

All stocks currently in FMP remain in the fishery.

Alternative 2

Minor reorganization + 3 Complexes

Smith River Chinook separated from CA coastal Chinook (ESA listed); Rogue coho out of OCN, into SONCC; CVF, SONC, FNMSS Chinook complexes

Alternative 3

Ecosystem Components + 2 Complexes

Smith River Chinook, Rogue coho same as Alt. 2; Non-ESA FNM Chinook and pink are EC; CVF, SONC Chinook complexes

Prelimimary Preferred Alternative

Minor reorganization + 2 Complexes and no Ecosystem Components

Smith River Chinook separated from CA coastal Chinook (ESA listed); Rogue coho out of OCN, into SONCC; CVF, SONC Chinook complexes

International Exceptions

Alternative 1

Status Quo

None Specified

Alternative 2

Non-ESA PST stocks

URB, CR Summers, OR/WA Coastal fall, Canadian Chinook;
WA Coastal, Puget Sound coho;
Puget Sound and Canadian Pink

Alternative 3

Non-EC PST stocks

CR Summers, Canadian Chinook;
WA Coastal, Puget Sound coho

Prelimimary Preferred Alternative

Non-ESA PST stocks - 14 Chinook, 11 coho and 2 pink

URB, CR Summers, OR/WA Coastal fall, Canadian Chinook;
WA Coastal, Puget Sound coho;
Puget Sound, Canadian pink

Status Determination Criteria for Overfishing and Overfished

Alternative 1

Status Quo - SDC Not explicit in FMP

Overfishing: STT Assessment

Overfished: STT Assessment, Overfishing Concern triggered (3 consecutive years < conservation objective

Approaching Overfished: 2-years below conservation objective and Conservation Alert triggered

Rebuilt: Spawning escapement > conservation objective (single year) or rebuilding plan

Alternatives 2 & 4

Single-year; MSST = 0.5*Smsy (Alt 2) & 0.75*Smsy (Alt 4)

Overfishing: Exploitation rate >Fmsy

Overfished: Spawning Escapement < MSST

Approaching Overfished: Projected spawning escapement < MSST

Rebuilt: Spawning Escapement > Smsy

Alternatives 3 & 5

3-year Geo Mean; MSST = 0.5*Smsy (Alt 3) & 0.75*Smsy (Alt 5)

Overfishing: Exploitation rate >Fmsy (single-year)

Overfished: 3-year GeoMean Spawning Escapement < MSST

Approaching Overfished: 2-year and projected GeoMean spawning escapement < MSST

Rebuilt: 3-year GeoMean spawning Escapement > Smsy

NEW Alternatives 6 & 7

3-year Arithmetic Mean; MSST = 0.5*Smsy (Alt 6) & 0.75*Smsy (Alt 7)

Overfishing: Exploitation rate >Fmsy (single-year)

Overfished: 3-year arithmetic mean Spawning Escapement < MSST

Approaching Overfished: 2-year and projected arithmetic mean spawning escapement < MSST

Rebuilt: 3-year arithmetic mean spawning Escapement > Smsy

Preliminary Preferred Alternative

Blend of 3-year Arithmetic Mean and single year; MSST = 0.5*Smsy

Overfishing: Exploitation rate >Fmsy (single-year)

Overfished: 3-year Arithmetic Mean Spawning Escapement < MSST

Approaching Overfished: 2-year and projected Arithmetic Mean spawning escapement < MSST

Rebuilt: Spawning Escapement > Smsy (single-year)

Analysis of all SDC alternatives includes Smsy assumptions in Table 2-8 and 2-9, plus an assumption of KRFC Smsy = 35,000

Include language defining Cape Falcon as northern limit for impacts counted toward SRFC and KRFC for Overfishing SDC, ACL compliance, and *de minimis* provisions

OFL, ABC, and ACL Specification

Alternative 1

Status Quo - Not Defined in FMP

None Specified

Alternative 2

Catch-Based (C-Based)

OFL: Fmsy

ABC: Fabc=Fmsy*0.95 (Tier 1 stocks; KRFC) or Fabc=Fmsy*0.90 (Tier 2 stocks; SRFC, Hoh)

ACL: Fabc*N

Alternative 3 - Preliminary Preferred

Spawning escapement-Based (S-Based)

OFL: Fmsy

ABC: Fabc=Fmsy*0.95 (Tier 1 stocks; KRFC) or Fabc=Fmsy*0.90 (Tier 2 stocks; SRFC)

ACL: (1-Fabc)*N

Include language defining Cape Falcon as northern limit for impacts counted toward SRFC and KRFC for Overfishing SDC, ACL compliance, and *de minimis* provisions

Accountability Measures

Alternative 1

Status Quo

Target conservation objective except at low abundance

Specify current FMP measures as AM: SAFE Report, Methodology Review, Notice to Managers, OF'ing and EFH Assessments, Conservation Alert action, Inseason authority, etc.

Alternative 2 - Preliminary Preferred

Modify Overfishing Criteria

Target Conservation Objective except at high (ACL) or low (demin) abundance

Rename OF'ing Concern to Abundance Alert

Increase flexibility to implement *de minimis* fisheries under Conservation Alert

Retain notification measures, other current FMP measures

Reevaluate ACL if exceeded more than 1 in 4 years: Uncertainty tiers, ACT, S/R update, etc.

Alternative 3

Replace Overfishing Criteria

Target Conservation Objective except at high (ACL) or low (demin) abundance

AM for SDC wouild be developed

AM for ACL would include other current FMP measures

Retain other current FMP measures

Reevaluate ACL if exceeded more than 1 in 4 years: Uncertainty tiers, ACT, S/R update, etc.

De minimis Fishing Provisions

Alternative 1

Status Quo
SRFC: 0% SRR below 122K
KRFC: A-15; ~26% SRR between 47K and 30K, less below 30K
US v Wash, Hoh v Baldrige: No Change

Alternative 2

No fishing below midpoint of Smsy-MSST
SRFC: 25% SRR between 163K and 122K, 0% at 91.5K
KRFC: 25% SRR between 54K and 40.7K, 0% at 30.5K
US v Wash, Hoh v Baldrige: No Change

Alternative 2b

No fishing below midpoint of Smsy-MSST; KRFC Smsy = 35K (add line to Table 2-9)
SRFC: 25% SRR between 163K and 122K, 0% at 91.5K
KRFC: 25% SRR between 47K and 35K, 0% at 26.25K
US v Wash, Hoh v Baldrige: No Change

Alternative 3

No fishing below MSST
SRFC: 25% SRR between 163K and 76K, 0% at 61K
KRFC: 25% SRR between 54K and 25.4K, 0% at 20.35K
US v Wash, Hoh v Baldrige: No Change

Alternative 3b

No fishing below MSST: KRFC Smsy = 35K (add line to Table 2-9)
SRFC: 25% SRR between 163K and 76K, 0% at 61K
KRFC: 25% SRR between 47K and 26.25K, 0% at 17.5K
US v Wash, Hoh v Baldrige: No Change

Alternative 4

KRFC No fishing below 1/2 of MSST
SRFC: 25% SRR between 163K and 45K, 0% at 30.5K
KRFC: 25% SRR between 54K and 15K, 0% below 10.2K
US v Wash, Hoh v Baldrige: No Change

Preliminary Preferred Alternative

No defined structure for reducing F below 25% when below midpoint of Smsy-MSST
SRFC: 25% SRR between 163K and 91.5K, F < 25% below 91.5K
KRFC: 25% SRR between 47K and 26.25K, F < 25% below 26.25K
US v Wash, Hoh v Baldrige: No Change

Include language defining Cape Falcon as northern limit for impacts counted toward SRFC and KRFC for Overfishing SDC, ACL compliance, and *de minimis* provisions

MITCHELL ACT HATCHERY DRAFT ENVIRONMENTAL IMPACT STATEMENT (EIS)

Production from Mitchell Act (MA) hatchery programs has provided fish for tribal treaty fisheries in the Columbia River, and for ocean and in-river recreational and commercial fisheries. More recently, MA hatchery programs are conserving genetic resources for the purposes of the Endangered Species Act (ESA) and reintroducing salmon into parts of their former range.

NOAA Fisheries has issued a draft environmental impact statement (DEIS) that will inform Columbia River basin hatchery operations and funding of MA hatchery programs. The public comment deadline is November 4, 2010. Agenda Item C.3.a, Attachment 1 includes a fact sheet and the executive summary from the DEIS. Attachment 2 is the complete DEIS, and is available in electronic format on the briefing book CD and website.

NOAA Fisheries will hold three public meetings on the draft EIS:

- Sept. 20, 2010; 5:30 to 7:30 p.m.
  Clark Regional Wastewater District, 8000 NE 52nd Crt., Vancouver, WA 98665
- Sept. 24, 2010; 5:30 to 7:30 p.m.
  Kennewick Public Library, 1620 S. Union St., Kennewick, WA 99338
- Sept. 30, 2010; 5:30 to 7:30 p.m.
  Columbia River Maritime Museum, 1792 Marine Dr., Astoria, OR 97103

NOAA will consider and address all substantive comments received by Nov. 4, 2010.

It will be difficult for the Council to provide well-considered comments by the September Council meeting; completing comments at the November meeting would be far preferable. However, because the comment deadline falls on the first day of the November Council meeting, it will be difficult to complete and transmit comments on that day unless they have been carefully drafted in advance to present a consensus position. State and Tribal agency representatives would need to consider preliminary discussions of MA issues affecting Council Area fisheries so that their common interests can be established and Council deliberations can be appropriately focused.

The Council may also consider a contingency if an extension to the comment deadline is granted. This could facilitate development of a statement between the September and November Council meetings. If an extension is granted, the Council should consider further procedures for submitting comments on the DEIS. Options include establishing a committee made up of Council members to draft a report, Salmon Technical Team review of any relevant analyses in the DEIS, and requesting State and Tribal representatives to prepare comments for the November briefing book.

<u>Council Action</u>:

1. Provide guidance for submitting comments on the Mitchell Act Draft Environmental Impact Statement.

Reference Materials:

1. Agenda Item C.3.a, Attachment 1: Draft Environmental Impact Statement to Inform Columbia River Basin Hatchery Operations and the Funding of Mitchell Act Hatchery Programs: Fact Sheet and Executive Summary.
2. Agenda Item C.3.a, Attachment 2: Draft Environmental Impact Statement to Inform Columbia River Basin Hatchery Operations and the Funding of Mitchell Act Hatchery Programs: ***Available on Briefing Book CD and Website Only***.

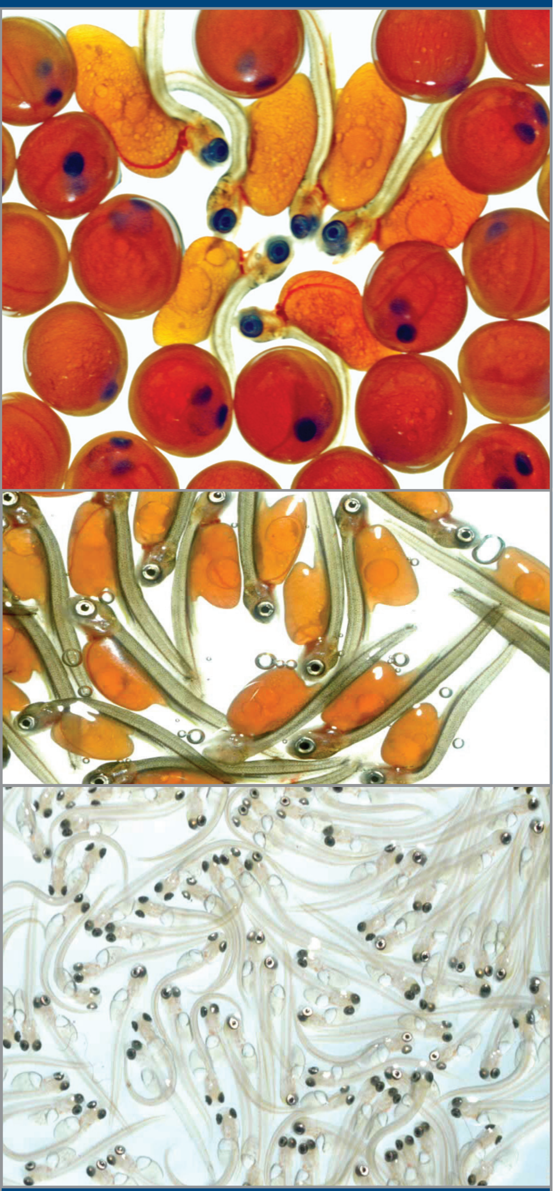
Agenda Order:

a. Agenda Item Overview **Chuck Tracy**
b. Reports and Comments of Advisory Bodies and Management Entities
c. Public Comment
d. **Council Action**: Develop Comments on the DEIS

PFMC
08/23/10

Agenda Item C.3.a
Attachment 1
September 2010

National
Marine
Fisheries
Service



Draft Environmental Impact Statement to Inform Columbia River Basin Hatchery Operations and the Funding of Mitchell Act Hatchery Programs

- National Marine Fisheries Service (NMFS; also known as NOAA Fisheries) seeks public comment on a draft Environmental Impact Statement (EIS) that will be used to develop a NMFS policy direction that will 1) guide NMFS's distribution of Mitchell Act hatchery funds and 2) inform NMFS's future review of individual Columbia River basin hatchery programs under the Endangered Species Act (ESA).

- The draft EIS analyzes and compares the direct, indirect, and cumulative effects of operating all 178 hatchery programs in the Columbia River basin under a full range of alternatives. There are five alternatives analyzed in the draft EIS.

- The draft EIS compares the effects of the alternatives on natural-origin fish populations, hatchery production levels, harvest, socioeconomics, environmental justice, wildlife, water quality and quantity, and human health.

- There is no preferred alternative in the draft EIS. A preferred alternative will be developed and published in the final EIS by NMFS after considering comments received during the 90-day public comment period on the draft. NMFS anticipates that the preferred alternative will be a blend of more than one of the alternatives evaluated in the draft EIS.

- While the final EIS will not make specific determinations on how individual hatchery programs should be operated, it will provide a comprehensive foundation for subsequent decision-making by NMFS under the ESA and Mitchell Act.

Science, Service, Stewardship

How to comment

Written comments submitted during the public comment period must be received by November 4, 2010.

When submitting written comments, include the following document identifier in the comment subject line: Mitchell Act EIS.

Please send all comments to the Responsible Program Official:

William W. Stelle, Jr.
Regional Administrator
NMFS Northwest Region
7600 Sand Point Way NE
Seattle, WA 98115
206-526-6150 Telephone
206-526-6426 Fax

Comments also can be submitted electronically to MitchellActEIS.nwr@noaa.gov.

For more information

The draft EIS is accessible electronically through the Northwest Region website at www.nwr.noaa.gov.

Should you have questions, please contact Allyson Purcell at 503-736-4736 or Allyson.Purcell@noaa.gov.

Public meetings during comment period:

September 20, 2010	September 24, 2010	September 30, 2010
5:30 to 7:30 pm	5:30 to 7:30 pm	5:30 to 7:30 pm
Clark Regional Wastewater District	Kennewick Public Library	Columbia River Maritime Museum
8000 NE 52nd Ct.	1620 S. Union St.	1792 Marine Dr.
Vancouver, WA 98662	Kennewick, WA 99338	Astoria, OR 97103

NOAA

Executive Summary

Draft Environmental Impact Statement to Inform Columbia River Basin Hatchery Operations & the Funding of Mitchell Act Hatchery Programs

Introduction

Congress enacted the Mitchell Act (16 United States Code [USC]755 757) in 1938 for the conservation of anadromous (salmon and steelhead) fishery resources in the Columbia River basin (defined as all tributaries of the Columbia River in the United States [U.S.] and the Snake River basin). It authorized the establishment, operation, and maintenance of one or more hatchery facilities in the states of Oregon, Washington, and Idaho, scientific investigations to facilitate the conservation of the fishery resource, and “all other activities necessary for the conservation of fish in the Columbia River basin in accordance with law.” While the Mitchell Act provided the authority for the conservation of fishery resources in the Columbia River, Congress must appropriate funds to implement it.

Since 1946, Congress has continued to appropriate Mitchell Act funds on an annual basis. These funds have been used to support research, improve fish passage, install screens on water diversions, and build and operate more than 20 salmon and steelhead hatchery facilities (referred to in this EIS as Mitchell Act hatchery facilities). Each year, Congress allocates a specific portion of the money appropriated for the Mitchell Act to hatchery operations. For each of the past 10 years, hatchery operation funding has been between $11 and $16 million dollars. The National Marine Fisheries Service (NMFS), part of the National Oceanic and Atmospheric Administration (NOAA) within the Department of Commerce, currently distributes these appropriations to the operators of 62 hatchery programs that annually produce more than 71 million fish. Historically, production levels have been as high as 128.6 million juvenile fish annually, but these levels have been substantially reduced as inflation, maintenance, and other costs have eroded the amount of funding available for fish production.

Table S-1. ESA Status of Columbia River Basin Salmon and Steelhead

Species	ESU/DPS	Current Endangered Species Act Listing Status
Sockeye salmon (Oncorhynchus nerka)	Snake River	Endangered (70 Fed. Reg. 37160, June 28, 2005)
Chinook salmon (O. tshawytscha)	Upper Columbia River Spring-run	Endangered (70 Fed. Reg. 37160, June 28, 2005)
	Snake River Spring/Summer-run	Threatened (70 Fed. Reg. 37160, June 28, 2005)
	Snake River Fall-run	Threatened (70 Fed. Reg. 37160, June 28, 2005)
	Lower Columbia River	Threatened (70 Fed. Reg. 37160, June 28, 2005)
	Upper Willamette	Threatened (70 Fed. Reg. 37160, June 28, 2005)
Coho salmon (O. kisutch)	Lower Columbia River	Threatened (70 Fed. Reg. 37160, June 28, 2005)
Chum salmon (O. keta)	Columbia River	Threatened (70 Fed. Reg. 37160, June 28, 2005)
Steelhead (O. mykiss)	Upper Columbia River	Threatened (71 Fed. Reg. 834, January 5, 2006)
	Snake River basin	Threatened (71 Fed. Reg. 834, January 5, 2006)
	Middle Columbia River	Threatened (71 Fed. Reg. 834, January 5, 2006)
	Upper Willamette River	Threatened (71 Fed. Reg. 834, January 5, 2006)
	Lower Columbia River	Threatened (71 Fed. Reg. 834, January 5, 2006)

Source: NMFS

What is an ESU? What is a DPS?

Under the ESA, NMFS lists salmon as threatened or endangered according to the status of the "evolutionarily significant unit" (ESU). An ESU is a population or a group of populations that 1) is substantially reproductively isolated from other groups of populations of the same species and 2) represents an important component of the evolutionary legacy of the species. See http://www.nwfsc.noaa.gov/trt/glossary.cfm#E for formal definitions of ESA related terms used by NMFS.

In contrast to salmon, NMFS lists steelhead runs under the joint NMFS-U.S. Fish and Wildlife Service (USFWS) policy for recognizing distinct population segments (DPSs) under the ESA (61 Fed. Reg. 4722, February 7, 1996). This policy adopts criteria similar to those in the ESU policy, but applies them to a broader range of animals that includes all vertebrates. For determining when a group of vertebrates constitutes a DPS, the group must be discrete from other populations, and it must be significant to its animal group, or taxon. A group is discrete if it is "markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, and behavioral factors" (61 Fed. Reg. 4722, February 7, 1996). NMFS lists steelhead according to the status of their DPS.

During the same time that production levels were reduced at hatchery facilities funded under the Mitchell Act, NMFS listed eight evolutionarily significant units (ESUs) of salmon and five distinct population segments (DPSs) of steelhead in the Columbia River basin under the ESA (i.e., 13 ESUs/DPSs total) (Table S-1).

When listing both salmon and steelhead under the ESA, NMFS cited the adverse effects of hatchery operations as one of the factors for the decline of most of these listed ESUs/DPSs. Under the ESA, NMFS must make ongoing determinations about how hatchery operations affect ESUs and DPSs listed as threatened or endangered. Determination of these effects is complex because the effects of any one hatchery program can only be fully understood through a comprehensive analysis that considers the interrelationship of the many natural-origin and hatchery-origin populations in the basin. Management determinations are better informed when made with an understanding of this inter relationship. The combination of funding pressures under the Mitchell Act, the listing of 13 ESUs/DPSs of salmon and steelhead under the ESA in the Columbia River basin, and the benefits of a comprehensive review of hatchery programs form the basis for NMFS' proposed action.

The proposed action is to develop a NMFS policy direction that will 1) guide NMFS' distribution of Mitchell Act hatchery funds and 2) inform NMFS' future review of individual Columbia River basin hatchery programs under the ESA.

What is NMFS' Proposed Action?

The proposed action is to develop a NMFS policy direction that will 1) guide NMFS' distribution of Mitchell Act hatchery funds and 2) inform NMFS' future review of individual Columbia River basin hatchery programs under the ESA.

What is a policy direction?

A policy direction is the overarching theme that will guide and shape decisions NMFS makes related to hatchery production in the Columbia River basin. It is defined by a series of goals and/or principles.

Although this environmental impact statement (EIS) itself will not determine whether any specific alternative meets ESA requirements, the analyses within the EIS will inform NMFS, hatchery operators, and the public about the current and anticipated cumulative environmental effects of operating the Columbia River basin hatchery programs under a full range of alternatives. The alternatives are designed to reduce or minimize adverse effects of hatchery operations on natural-origin salmon and steelhead populations, while hatchery operators continue to pursue not only the conservation or harvest goals that currently apply to each hatchery program, but also different or additional conservation and harvest goals as identified within the alternatives. NMFS anticipates that the alternative it pursues after completion of this EIS will be applicable for 10 years.

How should reviewers approach this EIS?

NMFS encourages reviewers to perform the following activities:

1. Review the draft EIS to gain an understanding of how it is organized and how the alternatives are framed and analyzed.
2. Formulate a notion of what the hatchery programs should accomplish; that is, formulate a notion of the policy direction they think should guide NMFS decisions on hatchery production in the Columbia River basin.
3. Carefully consider the information provided in Chapters 4 and 5, Environmental Consequences and Cumulative Effects, respectively.
4. After considering the effects, comment on how NMFS should formulate a preferred alternative for publication in the final EIS and ROD.

Project Area

This project area covered in this EIS includes rivers, streams, and hatchery facilities where hatchery-origin salmon and steelhead occur or are anticipated to occur in the Columbia River basin, including the Snake River and all other tributaries of the Columbia River in the United States (Figure S-1). The project area also includes the Columbia River estuary and plume. The project area comprises two salmon recovery domains (the Willamette/Lower Columbia and the Interior Columbia) as established by NMFS under its ESA recovery planning responsibilities. The project area also contains seven ecological provinces and more than 37 subbasins (i.e., tributaries to the Columbia or Snake Rivers). There are 178 salmon and steelhead hatchery programs in the Columbia River basin. These hatchery programs originate from 80 hatchery facilities and produced over 143 million salmon and steelhead in 2007 (Table S-2).

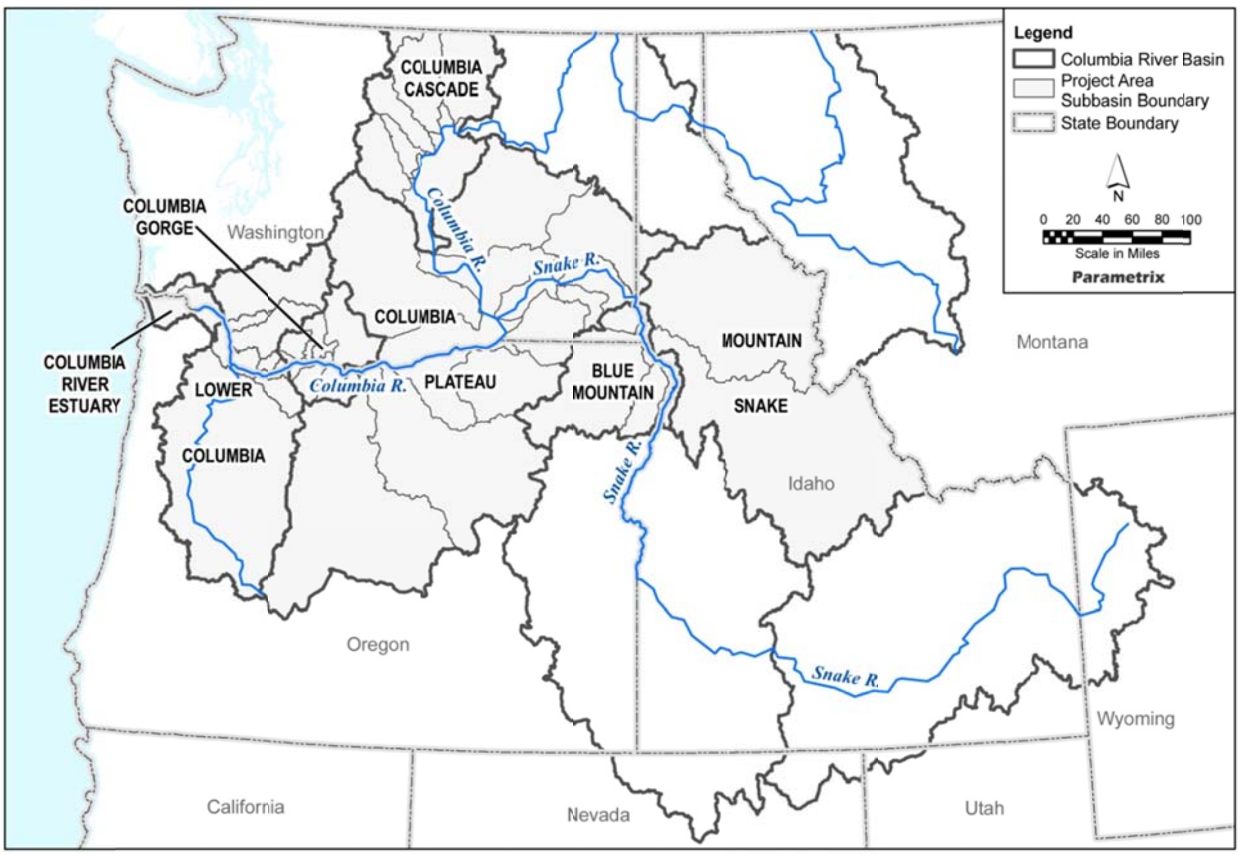


Figure S-1. Project Area by Ecological Province

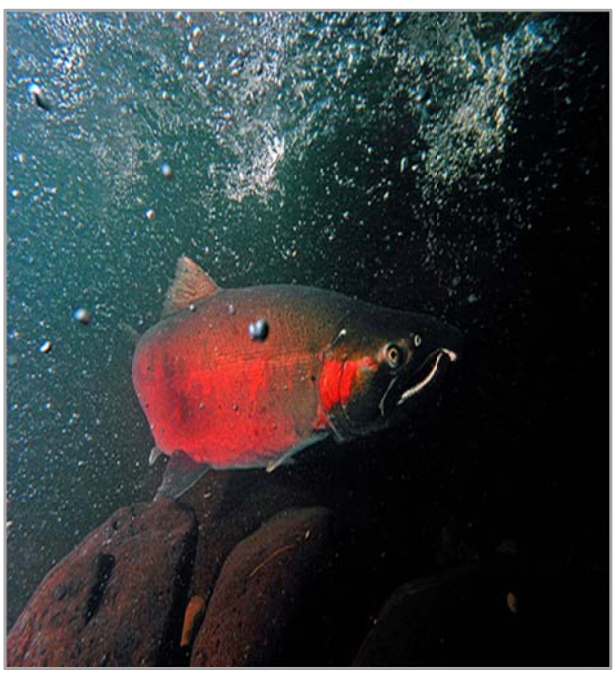
Table S-2. Total Hatchery-Origin Salmon and Steelhead Production within the Columbia River Basin (X 1,000)

Recovery Domain	Fall Chinook Salmon	Spring Chinook Salmon	Summer Chinook Salmon	Coho Salmon	Winter Steelhead	Summer Steelhead	Chum Salmon	Sockeye Salmon	Total
Willamette / Lower Columbia	46,968	12,480	0	16,985	1,992	1,968	300	0	80,693
Interior Columbia	22,976	20,019	3,733	4,787	20	10,986	0	363	62,884
Total	69,944	32,499	3,733	21,772	2,012	12,954	300	363	143,577

Source: Appendix C through Appendix F. Numbers are based on production levels in 2007.

Purpose and Need

The combination of funding pressures under the Mitchell Act, the 13 ESA listings for salmon and steelhead in the Columbia River basin (Table S-1), and the value of a comprehensive review of hatchery programs to inform decision makers have resulted in the need for NMFS' proposed action. NMFS' purpose for the action is to develop a policy direction related to Columbia River basin hatchery production that will 1) guide its decisions about the distribution of funds for hatchery production under the Mitchell Act; and 2) inform its future review of individual Columbia River hatchery programs under the ESA. The future reviews will be informed through this EIS's analysis of the effects of hatchery programs on the environment, including natural-origin salmon and steelhead populations. The review of hatchery programs is comprehensive in the sense that information on the effects of all Columbia River basin hatchery programs throughout the basin and across a full range of alternatives is exposed in the EIS. Each alternative identifies a different policy direction that would be used to guide NMFS decisions on Columbia River basin hatchery production.



What is the relationship between NMFS and hatchery operators who receive Mitchell Act funding?

Under the authority of the Mitchell Act, NMFS provides the USFWS, states, and tribes with funds Congress appropriates to manage and operate hatchery programs. NMFS has broad discretion in using these funds either to prescribe narrowly way the production programs will be operated or to allow hatchery operator discretion. Historically, NMFS has provided wide latitude in the use of these hatchery funds.

NMFS plans to continue to provide flexibility to hatchery operators with regard to the operation of Mitchell Act funded hatchery programs but will offer an overarching vision of how the Mitchell Act funded programs can best operate as one component of the Columbia River basin hatchery system. NMFS understands that hatchery operators must make good management decisions on a case-by-case basis after considering specific data relevant to their hatchery programs. There are no "one-size-fits-all" solutions. As a result of this environmental review, NMFS anticipates adopting a policy direction that identifies general goals for NMFS to pursue with regard to Columbia River basin hatchery production and a series of recommendations for hatchery operators to consider and adapt when developing plans for their individual hatchery programs.

Activities that are not considered to be within a reasonable range of potential funding or operational opportunities and that are not, therefore, envisioned within the alternatives in this draft EIS, include the following:

- **Construction of New Hatchery Facilities with Mitchell Act Funds.** Current and reasonably foreseeable appropriations under the Mitchell Act for hatchery production would preclude this option. All reasonably foreseeable decisions for the use of Mitchell Act funding at anticipated levels also would preclude this option.

- **Fish Screens and Fishways.** The Mitchell Act Screens and Fishways Program is a separate program with separate congressionally appropriated funding.

- **Habitat Restoration.** While Congress clearly has the discretion to direct Mitchell Act funds toward habitat restoration, it has not done so. Congress consistently and specifically has directed funds to hatchery production (and related monitoring, evaluation, and reform) and to screens and fishways. This EIS is directed at the use of the funds Congress specifically directs towards hatcheries. Through 2009, NMFS has funded habitat restoration through the Pacific Coastal Salmon Recovery Fund, created by Congress in 2000, to address the need to protect, restore, and conserve salmon, steelhead, and their habitat.

- **Hatchery Practices that Increase Adverse Effects.** While not all salmon ESUs or steelhead DPSs in the Columbia River basin are listed under the ESA, there is at least one salmon or steelhead population that is a member of a listed ESU or DPS in each of the major subbasins within the project area. Hatchery practices have been identified as a factor for the decline of most listed salmon and steelhead. Because of these factors, the purpose and need for this action is to establish a policy direction that, among other things, includes information on performance standards that reduce adverse effects on natural-origin fish. Implementation of hatchery practices that would increase adverse effects on listed species when compared to existing practices is not considered in this draft EIS.

It is not the purpose of this EIS to determine whether specific actions or hatchery programs meet the requirements of the ESA. These ESA decisions will be made in separate processes consistent with applicable regulations as required by the ESA

What is the relationship between the ESA and the National Environmental Policy Act (NEPA)?

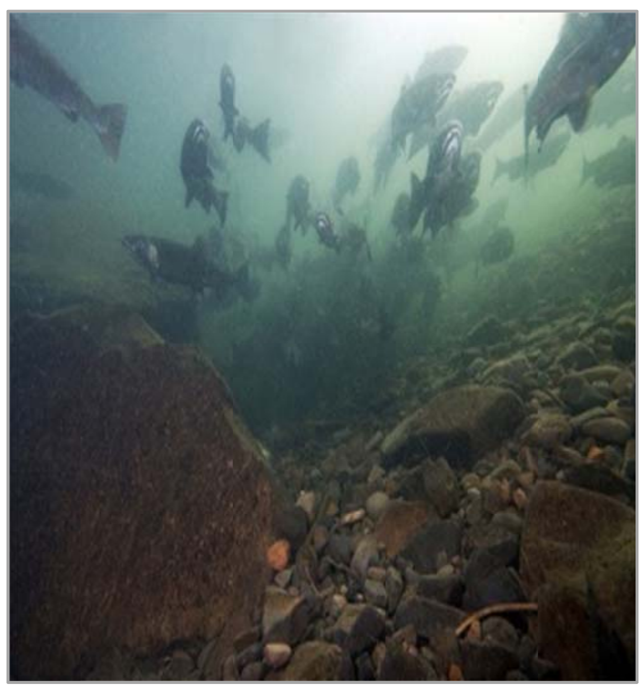
The relationship between the ESA and NEPA is complex, in part because both laws address environmental values related to the impacts of a proposed action. However, each law has a distinct purpose, and the scope of review and standards of review under each statute are different. This EIS analysis under NEPA should not be viewed as contributing to a conclusion about whether an alternative meets or does not meet ESA requirements.

The purpose of an EIS under NEPA is to promote disclosure, analysis, and consideration of the broad range of environmental issues surrounding a proposed major Federal action by considering a full range of reasonable alternatives, including a no-action alternative. Public involvement promotes this purpose.

The purpose of the ESA is to conserve listed species and the ecosystems upon which they depend. Determinations about whether Mitchell Act hatchery programs meet ESA requirements will be made under section 4(d), section 7, or section 10 of the ESA. Each of these ESA sections has its own substantive requirements, and the documents that reflect the analysis and decisions are different than those related to a NEPA analysis.

It is not the purpose of this EIS to suggest to the reader any conclusions relative to the ESA. While the Record of Decision (ROD) identifies the selected NEPA alternative, the ROD does not determine whether that alternative complies with the ESA.

NMFS acknowledges that the analyses of environmental effects on listed species under the ESA and under NEPA are similar and can lead to confusion; however the analyses under these separate statues are not functionally equivalent. Language in this draft EIS has been chosen in an effort to minimize the confusion between a NEPA analysis and an ESA analysis. For instance, “jeopardize,” “endanger,” “recover,” and similar terms are commonly used to describe the effect of actions under an ESA analysis. This EIS avoids using these terms, using in their place terms and phrases such as performance goals and performance metrics.



Alternatives Analyzed in Detail

Alternative 1 (No Action)

Under Alternative 1, there would not be a defined policy direction, and Columbia River basin hatchery production would continue baseline conditions. Based on NMFS' observations, the following describe the baseline conditions:

- Hatchery programs are used primarily to contribute to harvest, although some hatchery programs are designed to help conserve natural-origin salmon and steelhead populations.
- Most hatchery programs cannot control the number of hatchery fish on the spawning grounds. In most cases, the number of hatchery-origin fish on the spawning ground is higher than what current research suggests is desirable.
- Many hatchery programs are used to meet mitigation agreements. Most mitigation occurs to reduce the effects from hydropower on the fisheries.
- Monitoring, evaluation, and reform (MER) occurs, but it is neither prioritized nor guided by a comprehensive basin-wide plan. Fish managers use available funds to meet fish production goals first; if any money remains, MER occurs.
- There is no defined policy on the use of weirs to control the number of hatchery-origin fish on the spawning grounds.
- Conservation hatchery programs, although viewed as a temporary solution to reduce extinction risk, typically are developed and operated with no explicit sizing or termination criteria.
- Best management practices (BMPs) are widely applied, but their application is not universal. In many cases, application is based on available funding and/or whether the BMP is a regulatory requirement.
- The amount of Mitchell Act hatchery funds can vary annually. Hatchery operators generally receive a similar proportion each year.

Alternative 2 (No Mitchell Act Funding)

Under Alternative 2, the policy direction would be defined by the following goals and/or principles:

- Mitchell Act hatchery funding would be eliminated, and all Mitchell Act-funded hatchery programs would be closed.
- Substantially fewer fish would be produced to support fisheries than under Alternative 1.

- The intermediate performance goal would be applied to non-Mitchell Act-funded hatchery programs that affect primary and contributing salmon and steelhead populations (Table S-3). Application of the intermediate performance goal would, in most cases, reduce negative effects of hatchery programs on natural-origin salmon and steelhead populations.
    - Integrated hatchery programs would be better integrated than under Alternative 1.
    - Segregated hatchery programs would be better segregated than under Alternative 1.
- Production levels would be reduced from levels under Alternative 1 in hatchery programs designed to meet mitigation requirements only when those production levels conflicted with the ability of a hatchery program to meet performance goals.
- Conservation hatchery programs would be operated at a level determined by conservation need, with hatchery-origin production diminishing as natural-origin production increased.
- BMPs would be applied in all hatchery programs.
- No new hatchery programs would be initiated.
- No new weirs would be installed to help control the number of hatchery-origin fish on the spawning grounds.
- MER would be guided by a comprehensive basin-wide plan.

Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

Under Alternative 3, the policy direction would be defined by the following goals and/or principles:

- The intermediate performance goal would be applied to all Columbia River basin hatchery programs that affect primary and contributing salmon and steelhead populations (Table S-3). Application of the intermediate performance goal would, in most cases, reduce negative effects of hatchery programs on natural-origin salmon and steelhead populations.
    - Integrated hatchery programs would be better integrated than under Alternative 1.
    - Segregated hatchery programs would be better segregated than under Alternative 1.
- Production levels would be reduced from levels under Alternative 1 in hatchery programs designed to meet mitigation requirements only when those production levels conflicted with the ability of a hatchery program to meet performance goals.
- Conservation hatchery programs would be operated at a level determined by conservation need, with hatchery-origin production diminishing as natural-origin production increases.

- BMPs would be applied in all hatchery programs.
- No new hatchery programs would be initiated.
- New temporary (i.e., seasonal) weirs would be installed to help control the number of hatchery-origin fish on the spawning grounds.
- MER would be guided by a comprehensive basin-wide plan.
- Mitchell Act funds would be disbursed in support of the above goals and/or principles.

Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under Alternative 4, the policy direction would be defined by the following goals and/or principles:

- The intermediate performance goal would be applied to all Columbia River basin hatchery programs that affect primary and contributing salmon and steelhead populations in the Interior Columbia River recovery domain (Table S-3). Application of the intermediate performance goal would, in most cases, reduce negative effects of hatchery programs on natural-origin salmon and steelhead populations.
    - Integrated hatchery programs would be better integrated than under Alternative 1.
    - Segregated hatchery programs would be better segregated than under Alternative 1.
- The stronger performance goal would be applied to all Columbia River basin hatchery programs that affect primary and contributing salmon and steelhead populations in the Willamette/Lower Columbia River recovery domain. Application of the stronger performance goal would reduce negative impacts of hatchery programs on natural-origin salmon and steelhead populations even more than the intermediate performance goal.
    - Integrated hatchery programs would be better integrated than under Alternative 1.
    - Segregated hatchery programs would be better segregated than under Alternative 1.
- Production levels would be reduced from levels under Alternative 1 in hatchery programs designed to meet mitigation requirements only when those production levels conflicted with the ability of a hatchery program to meet performance goals.
- Conservation hatchery programs would be operated at a level determined by conservation need, with hatchery-origin production diminishing as natural-origin production increases.
- BMPs would be applied in all hatchery programs.

- New conservation hatchery programs would be initiated in the Willamette/Lower Columbia River recovery domain, if appropriate, using existing hatchery capacity. New conservation hatchery programs would be initiated only for populations deemed at high risk of extinction.
- New harvest hatchery programs would be initiated and/or existing hatchery programs would be changed to better support harvest opportunities below Bonneville Dam, including ocean fisheries, using any hatchery capacity that remains after appropriate conservation hatchery programs are initiated.
- New temporary (i.e., seasonal) and permanent weirs would be installed to help control the number of hatchery-origin fish on the spawning grounds.
- MER would be guided by a comprehensive basin-wide plan.
- Mitchell Act funds would be disbursed in support of the above goals and/or principles.

Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under Alternative 5, the policy direction would be defined by the following goals and/or principles:

- The intermediate performance goal would be applied to all Columbia River basin hatchery programs that affect primary and contributing salmon and steelhead populations in the Willamette/Lower Columbia River recovery domain (Table S-3). Application of the intermediate performance goals would, in most cases, reduce negative effects of hatchery programs on natural-origin salmon and steelhead populations.
  - Integrated hatchery programs would be better integrated than under Alternative 1.
  - Segregated hatchery programs would be better segregated than under Alternative 1.
- The stronger performance goal would be applied to all Columbia River basin hatchery programs that affect primary and contributing salmon and steelhead populations in the Interior Columbia River recovery domain. These stronger performance goals would reduce negative impacts of hatchery programs on natural-origin salmon and steelhead populations even more than the intermediate performance goal.
  - Integrated hatchery programs would be better integrated than under Alternative 1.
  - Segregated hatchery programs would be better segregated than under Alternative 1.
- Production levels would be reduced from levels under Alternative 1 in hatchery programs designed to meet mitigation requirements only when those production levels conflicted with the ability of a hatchery program to meet performance goals.

- Conservation hatchery programs would be operated at a level determined by conservation need, with hatchery-origin production diminishing as natural-origin production increased.
- BMPs would be applied in all hatchery programs.
- New conservation hatchery programs would be initiated in the Interior Columbia River recovery domain, if appropriate, using existing hatchery capacity. New conservation hatchery programs would be initiated only for populations deemed at high risk of extinction.
- New harvest hatchery programs would be initiated, and/or existing hatchery programs would be changed to better support harvest opportunities above Bonneville Dam, including treaty Indian commercial fisheries, using any hatchery capacity that remains after appropriate conservation hatchery programs are initiated.
- New temporary (i.e., seasonal) and permanent weirs would be installed to help control the number of hatchery-origin fish on the spawning grounds.
- MER would be guided by a comprehensive basin-wide plan.
- Mitchell Act funds would be disbursed in support of the above goals and/or principles.

Table S-3. Hatchery Performance Goals Indentified Under Each Alternative's Policy Direction

Recovery Domain	Population Type*	Funding Entity	- - Hatchery Performance Goals by Alternative - -				
			Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Willamette / Lower Columbia	Primary	Mitchell Act	Baseline conditions	N/A**	Intermediate	Stronger	Intermediate
		Other	Baseline conditions	Intermediate	Intermediate	Stronger	Intermediate
	Contributing	Mitchell Act	Baseline conditions	N/A	Intermediate	Stronger	Intermediate
		Other	Baseline conditions	Intermediate	Intermediate	Stronger	Intermediate
	Stabilizing	Mitchell Act	Baseline conditions	N/A	Baseline conditions	Baseline conditions	Baseline conditions
		Other	Baseline conditions	Baseline conditions	Baseline conditions	Baseline conditions	Baseline conditions
Interior Columbia	Primary	Mitchell Act	Baseline conditions	N/A	Intermediate	Intermediate	Stronger
		Other	Baseline conditions	Intermediate	Intermediate	Intermediate	Stronger
	Contributing	Mitchell Act	Baseline conditions	N/A	Intermediate	Intermediate	Stronger
		Other	Baseline conditions	Intermediate	Intermediate	Intermediate	Stronger
	Stabilizing	Mitchell Act	Baseline conditions	N/A	Baseline conditions	Baseline conditions	Baseline conditions
		Other	Baseline conditions	Baseline conditions	Baseline conditions	Baseline conditions	Baseline conditions

Each population's role in recovery was designated as primary, contributing, or stabilizing. These designations were used by the LCRFRB in the development of the Lower Columbia Fish Recovery Plan (LCFRB 2004). The HSRG adapted them throughout the basin after discussions with the hatchery operators, and they are applied in this EIS (Appendix C through Appendix F).

N/A means not applicable since hatchery programs would be terminated.

Is there a preferred alternative for this draft EIS?

As noted in Chapter 1, Purpose of and Need for the Proposed Action, and explained in further detail in Chapter 2, Alternatives, this draft EIS does not contain a preferred alternative. Rather, it establishes several distinct policy directions as alternatives that would 1) guide the NMFS' decisions on distribution of Mitchell Act funds for hatchery production in the Columbia River basin, and 2) inform NMFS' future review of individual hatchery programs under the ESA. NMFS anticipates identifying the preferred alternative in the final EIS after considering the comments received on this document. The preferred alternative likely will be a blend of more than one of the alternatives evaluated in this EIS. The environmental effects of the preferred alternative will be explained in the final EIS and summarized in the ROD.

Reviewers are not constrained to comment solely on the specific alternatives in this EIS but may comment or recommend a preferred alternative that combines elements of several alternatives presented in this draft EIS.

Identifying an Implementation Scenario

The policy directions that are associated with each of the action alternatives are goal oriented and do not identify specific actions that would be taken under each alternative. This is because NMFS believes that specific hatchery actions should be determined on a hatchery-program-by-hatchery-program basis. To analyze, illustrate and compare the potential environmental effects of each alternative, however, an implementation scenario was developed for each alternative's policy direction. Each implementation scenario is one plausible example of how each hatchery program could be operated to meet the policy direction of the alternative. There are, however, multiple implementation scenarios that could be applied consistent with each policy direction.

NMFS does not advocate any of the implementation scenarios evaluated in this EIS, and the Chapter 4 analyses may show that implementing some components of a scenario would be unreasonable. For example, some components of these implementation scenarios may or may not be viewed as consistent with commitments in the U.S. v Oregon Management Agreement. The intent of the EIS analyses is not to make a determination that an alternative or its implementation scenario is or is not consistent with the U.S. v. Oregon Management Agreement, and no such assertion is made. Rather, NMFS anticipates that the affected parties will ensure that their hatchery plans (e.g., hatchery genetic and management plans) are consistent with the most current Management Agreement.

To identify implementation scenarios, specific performance metrics (i.e., measurements of performance) were identified for each performance goal (Table S-4). The performance metrics include two measurements:

- The proportionate natural influence (PNI) in a population, which is a measure of the hatchery influence on a population and is a function of both the percent hatchery-origin spawners (pHOS) in the natural escapement and the percent of natural-origin broodstock (pNOB) incorporated into the hatchery program
- The pHOS that join natural-origin adults on the stream's spawning ground

The following performance metrics were applied for each hatchery performance goal:

- For the stronger performance goal, integrated populations that are affected by hatchery programs would have a PNI of 0.67 or higher, and segregated, natural-origin populations would maintain pHOS less than or equal to 0.05 (Table S-4).
- For the intermediate performance goal, integrated populations that are affected by hatchery programs would have a PNI of 0.50 or higher, and segregated, natural-origin populations would maintain pHOS of less than or equal to 0.10 (Table S-4).

What is the difference between a hatchery performance goal and a performance metric?

In this EIS, performance goals are identified within each alternative. These goals apply to hatchery programs. There are two performance goals: stronger and intermediate. Both performance goals would likely reduce negative effects of hatchery programs on salmon and steelhead populations compared to the baseline conditions.

Performance metrics are identified for each performance goal so that an implementation scenario can be identified. Performance metrics apply to the populations that are being affected by the hatchery programs. Performance metrics include two measurements: PNI and pHOS.

Although NMFS uses these performance metrics in this EIS, no determination has been made on their adequacy under the ESA. NMFS is not advocating their use by hatchery managers. Reviewers are encouraged to understand the dynamics of the population that affect its PNI and pHOS values, particularly in an integrated population. In some cases, the favorable values of an integrated population may disguise underlying risks. For example, if the naturally spawning component of the integrated population is small, then it may be necessary to maintain a high number of natural-origin fish in the hatchery broodstock to maintain a high overall PNI value. This mining of the natural-origin population could maintain its PNI, but increase genetic and demographic risks to the population as a whole.

Table S-4. Performance Metrics applied for each hatchery performance goal

Hatchery Performance Goal	Performance metrics for affected populations
Intermediate Performance Goal	Integrated populations maintain a PNI greater than or equal to 0.50. Segregated, natural-origin populations maintain pHOS less than or equal to 0.10.
Stronger Performance Goal	Integrated populations maintain a PNI greater than or equal to 0.67. Segregated, natural-origin populations maintain pHOS less than or equal to 0.05.

Summary of Resource Effects

Table S-5 summarizes predicted effects from implementation of the No-action Alternative (Alternative 1) and action alternatives (Alternative 2 through Alternative 5). The summary reflects the detailed resource discussions in Chapter 4, Environmental Consequences. No preferred alternative has been selected for the Draft EIS.

Table S-5. Summary of Environmental Consequences for EIS Alternatives by Resource.

Resource	Indicator	Alternative 1 (No Action)	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Fish	Number of salmon and steelhead hatchery programs	178	106	161	174	171
	Number of hatchery-origin salmon and steelhead produced annually	143,577,000	51,896,000	106,928,000	118,362,000	110,630,000
	Percent (%) of primary and contributing salmon and steelhead populations that meet stronger metrics	50	71	63	71	71
	Percent (%) of primary and contributing salmon and steelhead populations that meet intermediate metrics or stronger metrics	58	91	89	90	88
	Number of weirs installed to control pHOS	0	0	13	16	17

Resource	Indicator	Alternative 1 (No Action)	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Socio-economics	Annual cost of Columbia River basin hatchery production (millions of 2007 U.S. dollars [$])	79.5	51.9	76.9	79.4	81.5
	Number of Columbia River basin salmon and steelhead harvested in all fisheries	602,368	309,465	482,509	535,529	497,085
	Net economic value (2007 U.S. dollars [$]) of commercial fisheries (tribal and non-tribal) in the Columbia River basin	2,115,979	1,145,205	1,793,706	2,016,671	2,025,634
	Net economic value (2007 U.S. dollars [$]) of commercial fisheries (tribal and non-tribal) in the Pacific Ocean and Puget Sound to which Columbia River basin fish contribute	13,474,389	12,537,078	13,262,657	13,408,620	13,280,994
	Commercial ex-vessel value (2007 U.S. dollars [$]) in Columbia River basin	6,188,673	3,735,500	5,436,555	6,169,064	6,155,051
	Commercial ex-vessel value (2007 U.S. dollars [$]) in the Pacific Ocean and Puget Sound	36,594,962	34,379,075	36,169,953	36,561,643	36,228,773
	Net economic value (2007 U.S. dollars [$]) of recreational fisheries in the Columbia River basin	35,791,853	21,065,837	28,841,018	31,415,967	30,567,085
	Net economic value (2007 U.S. dollars [$]) of recreational fisheries in the Pacific Ocean and Puget Sound to which Columbia River basin fish contribute	22,380,896	18,975,560	20,728,811	20,838,677	20,744,041
	Total (direct and indirect) economic impacts on income (2007 U.S. dollars [$]) in the Columbia River basin	103,988,544	64,595,934	90,800,063	99,052,073	99,939,014

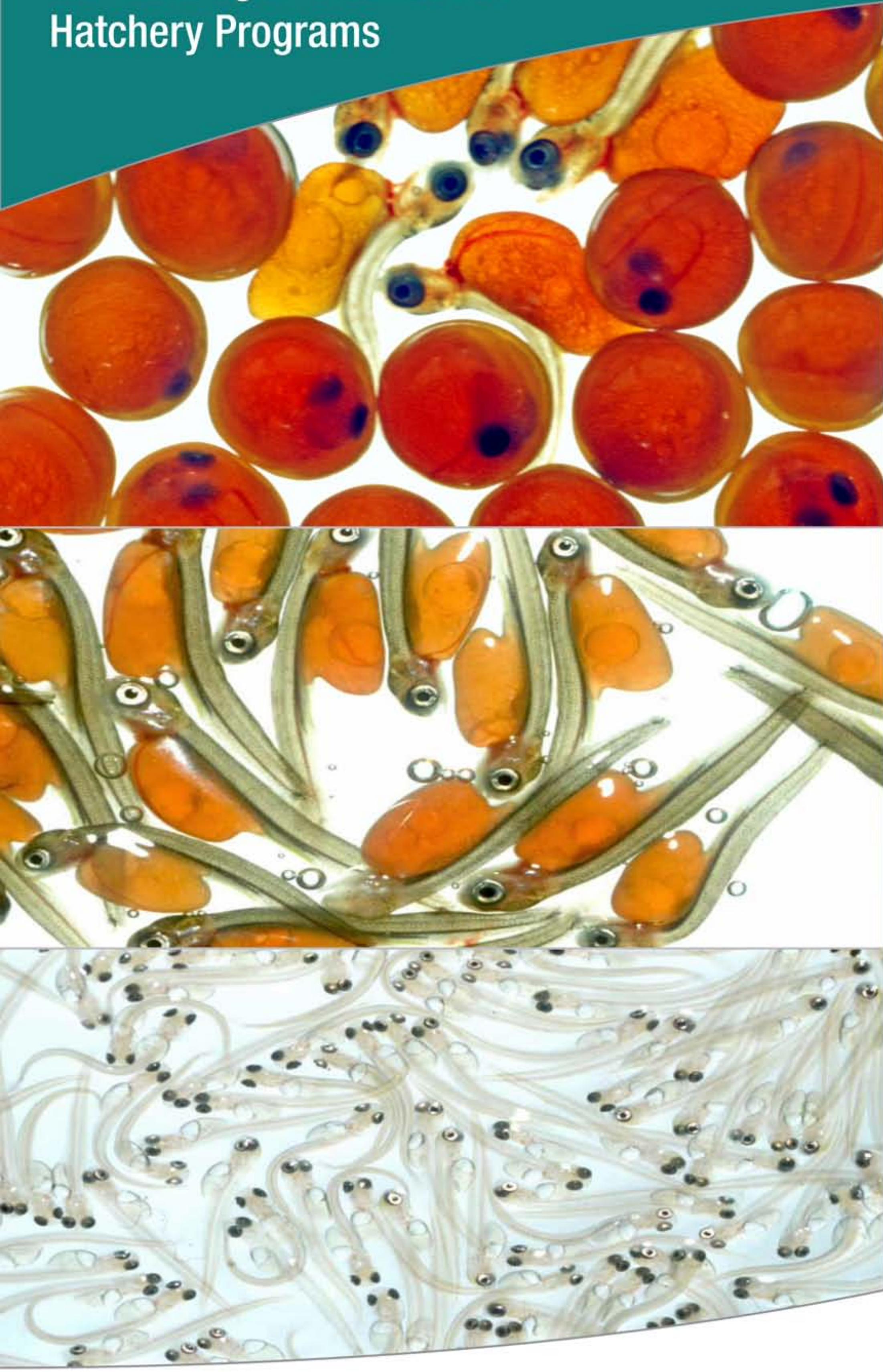
Resource	Indicator	Alternative 1 (No Action)	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Socio-economics (continued)	Total (direct and indirect) economic impacts on income (2007 U.S. dollars [$]) in the Pacific Ocean and Puget Sound	115,961,205	106,837,236	113,052,011	113,967,297	113,205,357
	Total (direct and indirect) economic impacts on jobs in the Columbia River basin	2,540.6	1,584.7	2,201.0	2,385.0	2,417.4
	Total (direct and indirect) economic impacts on jobs in the Pacific Ocean and Puget Sound	2,264.5	2,035.6	2,179.6	2,194.5	2,182.3
	Recreational expenditures (2007 U.S. dollars [$]) in the Columbia River basin	47,476,271	27,942,878	38,256,303	41,671,856	40,545,853
	Recreational expenditures (2007 U.S. dollars [$]) in the Pacific Ocean and Puget Sound	56,516,450	51,174,142	54,382,756	54,807,054	54,452,342
Environmental Justice	Total tribal fish harvests (commercial, ceremonial, and subsistence) by number of fish in the Columbia River basin	79,328	36,519	63,702	63,494	73,619
	Tribal fishing revenue (2007 U.S. dollars [$]) in the Columbia River basin	3,484,670	2,355,731	3,352,910	3,346,917	4,048,727
Wildlife	Caspian terns and bald eagles	Populations increasing	Potential reductions in abundance, distribution, and fitness relative to Alternative 1	Same as Alternative 2	Same as Alternative 1	Same as Alternative 2
	Southern resident killer whale (listed)	89 individuals are currently in Southern Resident stock; populations fluctuate from decreasing to increasing	Potential reductions in abundance relative to Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1

Resource	Indicator	Alternative 1 (No Action)	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Wildlife (continued)	California sea lions	Populations increasing	Abundance in Columbia River would probably decline relative to Alternative 1	Abundance may be affected relative to Alternative 1	Same as Alternative 1	Same as Alternative 3
	Stellar sea lions (listed)	Populations increasing	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Water Quality & Quantity	NPDES permit compliance and water use	NPDES permits current	Potential improvements in water quality and reduction in water use	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
Human Health	Hatchery chemical safety and use	Chemicals and antibiotics would be used consistent with Federal and state guidelines; potential pathogen exposure.	Potential decrease in use of chemicals and antibiotics; no change in exposure to pathogens	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

Primary and contributing populations are terms that were used by the Lower Columbia Fish Recovery Board (LCFRB) in the development of the Lower Columbia River Salmon Recovery and Fish and Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and they are applied in this draft EIS (Section 2.4, Alternative Development).

Socioeconomic values for the Pacific Ocean and Puget Sound are based on the total number of salmon and steelhead harvested in those areas, not just those from the Columbia River basin.

Draft Environmental Impact Statement to Inform Columbia River Basin Hatchery Operations and the Funding of Mitchell Act Hatchery Programs



NOAA

National Marine Fisheries Service

U.S. Department of Commerce | National Oceanic and Atmospheric Administration | National Marine Fisheries Service

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
PROGRAM PLANNING AND INTEGRATION
Silver Spring, Maryland 20910

JUL 1 9 2010

Dear Reviewer:

In accordance with provisions of the National Environmental Policy Act (NEPA), we enclose for your review the Draft Environmental Impact Statement (DEIS) to Inform Columbia River Basin Hatchery Operations and the Funding of Mitchell Act Hatchery Programs.

This DEIS is prepared pursuant to NEPA to assess the environmental impacts associated with NOAA proceeding to develop a NMFS policy direction that will 1) guide NMFS' distribution of Mitchell Act funds and 2) inform NMFS future review of individual Columbia River basin hatchery programs under the Endangered Species Act.

Additional copies of the DEIS may be obtained from the Responsible Program Official identified below. The document is also accessible electronically through NMFS Northwest Region website at www.nwr.noaa.gov.

Written comments should be submitted through mail, facsimile (fax), or email to the Responsible Program Official identified below. Written comments submitted during the agency' 90-day public comment period must be received by **November 4, 2010.** When submitting comments include the following document identifier in the comment subject line: **Mitchell Act EIS.**

Responsible Program Official:

William W. Stelle, Jr.
Regional Administrator
NMFS Northwest Region
National Oceanic and Atmospheric Administration
7600 Sand Point Way NE
Seattle, Washington 98115
206-526-6150 Telephone
206-526-6426 Fax
MitchellActEIS.nwr@noaa.gov

Sincerely,

Paul N. Doremus, Ph.D.
NOAA NEPA Coordinator

Enclosure

TITLE OF ENVIRONMENTAL REVIEW	Draft Environmental Impact Statement to Inform Columbia River Basin Hatchery Operations and the Funding of Mitchell Act Hatchery Programs
RESPONSIBLE AGENCY AND OFFICIAL	William W. Stelle, Jr., Regional Administrator National Marine Fisheries Service, Northwest Region 7600 Sand Point Way NE, Building 1 Seattle, WA 98115-0070 (206) 526-6150
CONTACT	Allyson Purcell NMFS Salmon Recovery Division 1201 NE Lloyd Blvd., Suite 1100 Portland, OR 97232 allyson.purcell@noaa.gov (Note: not for commenting) 503-736-4736
LOCATION OF PROPOSED ACTIVITIES	The Columbia River basin, which is located in Oregon, Washington, and Idaho
PROPOSED ACTION	To develop a NMFS policy direction that will 1) guide NMFS' distribution of Mitchell Act funds and 2) inform NMFS future review of individual Columbia River basin hatchery programs under the Endangered Species Act.
ABSTRACT	Congress enacted the Mitchell Act in 1938 for the conservation of anadromous fishery resources in the Columbia River basin. Since 1946, Congress has continued to appropriate Mitchell Act funds on an annual basis. These funds have been used to support research, improve fish passage, install screens on water diversions, and build and operate more than 20 salmon and steelhead hatchery facilities. During the same time that production levels were reduced at hatchery facilities funded under the Mitchell Act, NMFS listed eight evolutionarily significant units (ESUs) of salmon and five Distinct Population Segments (DPSs) of steelhead in the Columbia River basin under the ESA (i.e., 13 ESUs/DPSs total). The combination of funding pressures under the Mitchell Act, the listing of 13 ESUs/DPSs of salmon and steelhead under the ESA in the Columbia River basin, and the benefits of a comprehensive review of hatchery programs form the basis for NMFS' proposed action.

Executive Summary

Draft Environmental Impact Statement to Inform Columbia River Basin Hatchery Operations & the Funding of Mitchell Act Hatchery Programs

Introduction

Congress enacted the Mitchell Act (16 United States Code [USC]755 757) in 1938 for the conservation of anadromous (salmon and steelhead) fishery resources in the Columbia River basin (defined as all tributaries of the Columbia River in the United States [U.S.] and the Snake River basin). It authorized the establishment, operation, and maintenance of one or more hatchery facilities in the states of Oregon, Washington, and Idaho, scientific investigations to facilitate the conservation of the fishery resource, and "all other activities necessary for the conservation of fish in the Columbia River basin in accordance with law." While the Mitchell Act provided the authority for the conservation of fishery resources in the Columbia River, Congress must appropriate funds to implement it.

Since 1946, Congress has continued to appropriate Mitchell Act funds on an annual basis. These funds have been used to support research, improve fish passage, install screens on water diversions, and build and operate more than 20 salmon and steelhead hatchery facilities (referred to in this EIS as Mitchell Act hatchery facilities). Each year, Congress allocates a specific portion of the money appropriated for the Mitchell Act to hatchery operations. For each of the past 10 years, hatchery operation funding has been between $11 and $16 million dollars. The National Marine Fisheries Service (NMFS), part of the National Oceanic and Atmospheric Administration (NOAA) within the Department of Commerce, currently distributes these appropriations to the operators of 62 hatchery programs that annually produce more than 71 million fish. Historically, production levels have been as high as 128.6 million juvenile fish annually, but these levels have been substantially reduced as inflation, maintenance, and other costs have eroded the amount of funding available for fish production.

Table S-1. ESA Status of Columbia River Basin Salmon and Steelhead

Species	ESU/DPS	Current Endangered Species Act Listing Status
Sockeye salmon (Oncorhynchus nerka)	Snake River	Endangered (70 Fed. Reg. 37160, June 28, 2005)
Chinook salmon (O. tshawytscha)	Upper Columbia River Spring-run	Endangered (70 Fed. Reg. 37160, June 28, 2005)
	Snake River Spring/Summer-run	Threatened (70 Fed. Reg. 37160, June 28, 2005)
	Snake River Fall-run	Threatened (70 Fed. Reg. 37160, June 28, 2005)
	Lower Columbia River	Threatened (70 Fed. Reg. 37160, June 28, 2005)
	Upper Willamette	Threatened (70 Fed. Reg. 37160, June 28, 2005)
Coho salmon (O. kisutch)	Lower Columbia River	Threatened (70 Fed. Reg. 37160, June 28, 2005)
Chum salmon (O. keta)	Columbia River	Threatened (70 Fed. Reg. 37160, June 28, 2005)
Steelhead (O. mykiss)	Upper Columbia River	Threatened (71 Fed. Reg. 834, January 5, 2006)
	Snake River basin	Threatened (71 Fed. Reg. 834, January 5, 2006)
	Middle Columbia River	Threatened (71 Fed. Reg. 834, January 5, 2006)
	Upper Willamette River	Threatened (71 Fed. Reg. 834, January 5, 2006)
	Lower Columbia River	Threatened (71 Fed. Reg. 834, January 5, 2006)

Source: NMFS

What is an ESU? What is a DPS?

Under the ESA, NMFS lists salmon as threatened or endangered according to the status of the "evolutionarily significant unit" (ESU). An ESU is a population or a group of populations that 1) is substantially reproductively isolated from other groups of populations of the same species and 2) represents an important component of the evolutionary legacy of the species. See http://www.nwfsc.noaa.gov/trt/glossary.cfm#E for formal definitions of ESA related terms used by NMFS.

In contrast to salmon, NMFS lists steelhead runs under the joint NMFS-U.S. Fish and Wildlife Service (USFWS) policy for recognizing distinct population segments (DPSs) under the ESA (61 Fed. Reg. 4722, February 7, 1996). This policy adopts criteria similar to those in the ESU policy, but applies them to a broader range of animals that includes all vertebrates. For determining when a group of vertebrates constitutes a DPS, the group must be discrete from other populations, and it must be significant to its animal group, or taxon. A group is discrete if it is "markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, and behavioral factors" (61 Fed. Reg. 4722, February 7, 1996). NMFS lists steelhead according to the status of their DPS.

During the same time that production levels were reduced at hatchery facilities funded under the Mitchell Act, NMFS listed eight evolutionarily significant units (ESUs) of salmon and five distinct population segments (DPSs) of steelhead in the Columbia River basin under the ESA (i.e., 13 ESUs/DPSs total) (Table S-1).

When listing both salmon and steelhead under the ESA, NMFS cited the adverse effects of hatchery operations as one of the factors for the decline of most of these listed ESUs/DPSs. Under the ESA, NMFS must make ongoing determinations about how hatchery operations affect ESUs and DPSs listed as threatened or endangered. Determination of these effects is complex because the effects of any one hatchery program can only be fully understood through a comprehensive analysis that considers the interrelationship of the many natural-origin and hatchery-origin populations in the basin. Management determinations are better informed when made with an understanding of this inter relationship. The combination of funding pressures under the Mitchell Act, the listing of 13 ESUs/DPSs of salmon and steelhead under the ESA in the Columbia River basin, and the benefits of a comprehensive review of hatchery programs form the basis for NMFS' proposed action.

The proposed action is to develop a NMFS policy direction that will 1) guide NMFS' distribution of Mitchell Act hatchery funds and 2) inform NMFS' future review of individual Columbia River basin hatchery programs under the ESA.

What is NMFS' Proposed Action?

The proposed action is to develop a NMFS policy direction that will 1) guide NMFS' distribution of Mitchell Act hatchery funds and 2) inform NMFS' future review of individual Columbia River basin hatchery programs under the ESA.

What is a policy direction?

A policy direction is the overarching theme that will guide and shape decisions NMFS makes related to hatchery production in the Columbia River basin. It is defined by a series of goals and/or principles.

Although this environmental impact statement (EIS) itself will not determine whether any specific alternative meets ESA requirements, the analyses within the EIS will inform NMFS, hatchery operators, and the public about the current and anticipated cumulative environmental effects of operating the Columbia River basin hatchery programs under a full range of alternatives. The alternatives are designed to reduce or minimize adverse effects of hatchery operations on natural-origin salmon and steelhead populations, while hatchery operators continue to pursue not only the conservation or harvest goals that currently apply to each hatchery program, but also different or additional conservation and harvest goals as identified within the alternatives. NMFS anticipates that the alternative it pursues after completion of this EIS will be applicable for 10 years.

How should reviewers approach this EIS?

NMFS encourages reviewers to perform the following activities:

1. Review the draft EIS to gain an understanding of how it is organized and how the alternatives are framed and analyzed.
2. Formulate a notion of what the hatchery programs should accomplish; that is, formulate a notion of the policy direction they think should guide NMFS decisions on hatchery production in the Columbia River basin.
3. Carefully consider the information provided in Chapters 4 and 5, Environmental Consequences and Cumulative Effects, respectively.
4. After considering the effects, comment on how NMFS should formulate a preferred alternative for publication in the final EIS and ROD.

Project Area

This project area covered in this EIS includes rivers, streams, and hatchery facilities where hatchery-origin salmon and steelhead occur or are anticipated to occur in the Columbia River basin, including the Snake River and all other tributaries of the Columbia River in the United States (Figure S-1). The project area also includes the Columbia River estuary and plume. The project area comprises two salmon recovery domains (the Willamette/Lower Columbia and the Interior Columbia) as established by NMFS under its ESA recovery planning responsibilities. The project area also contains seven ecological provinces and more than 37 subbasins (i.e., tributaries to the Columbia or Snake Rivers). There are 178 salmon and steelhead hatchery programs in the Columbia River basin. These hatchery programs originate from 80 hatchery facilities and produced over 143 million salmon and steelhead in 2007 (Table S-2).

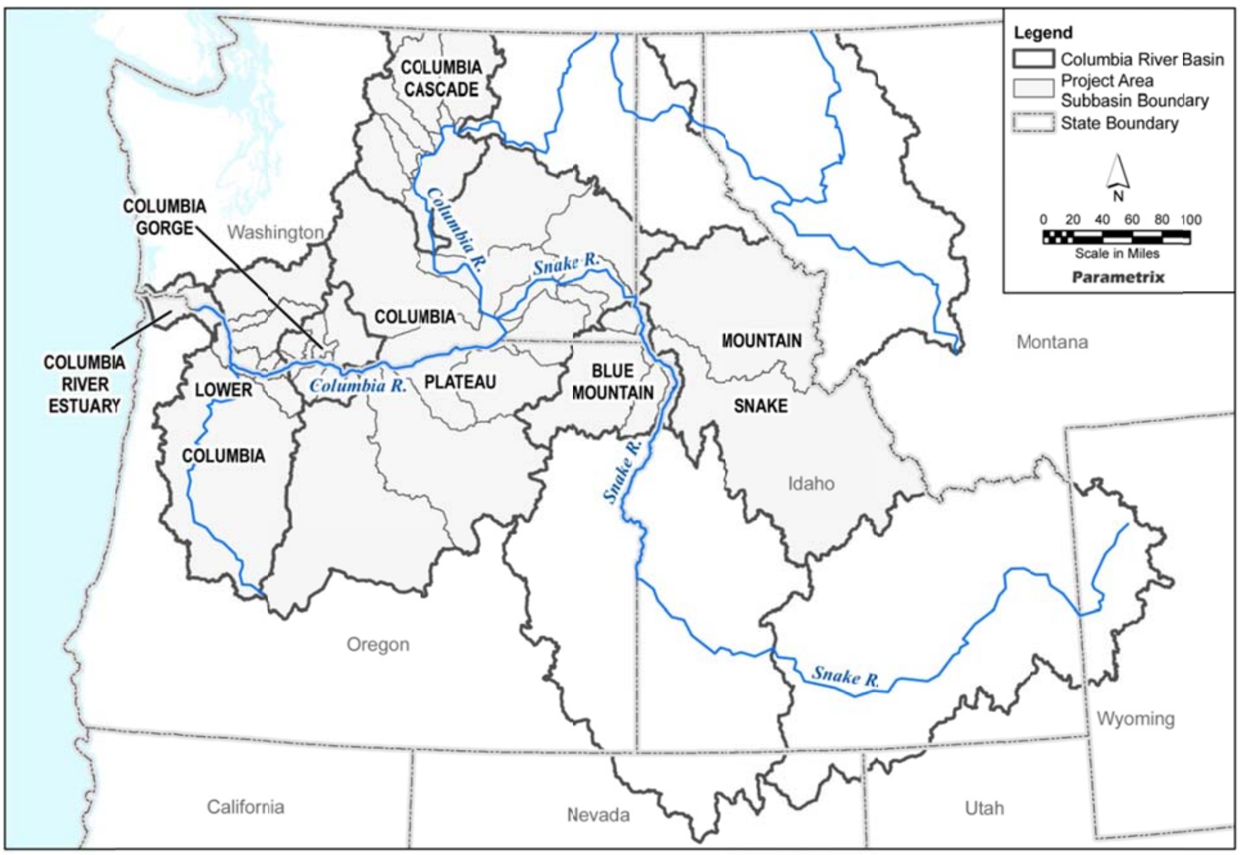


Figure S-1. Project Area by Ecological Province

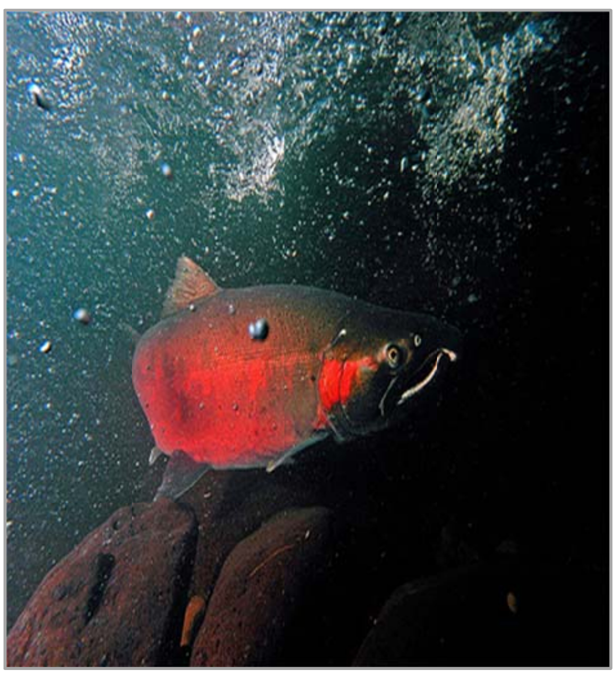
Table S-2. Total Hatchery-Origin Salmon and Steelhead Production within the Columbia River Basin (X 1,000)

Recovery Domain	Fall Chinook Salmon	Spring Chinook Salmon	Summer Chinook Salmon	Coho Salmon	Winter Steelhead	Summer Steelhead	Chum Salmon	Sockeye Salmon	Total
Willamette / Lower Columbia	46,968	12,480	0	16,985	1,992	1,968	300	0	80,693
Interior Columbia	22,976	20,019	3,733	4,787	20	10,986	0	363	62,884
Total	69,944	32,499	3,733	21,772	2,012	12,954	300	363	143,577

Source: Appendix C through Appendix F. Numbers are based on production levels in 2007.

Purpose and Need

The combination of funding pressures under the Mitchell Act, the 13 ESA listings for salmon and steelhead in the Columbia River basin (Table S-1), and the value of a comprehensive review of hatchery programs to inform decision makers have resulted in the need for NMFS' proposed action. NMFS' purpose for the action is to develop a policy direction related to Columbia River basin hatchery production that will 1) guide its decisions about the distribution of funds for hatchery production under the Mitchell Act; and 2) inform its future review of individual Columbia River hatchery programs under the ESA. The future reviews will be informed through this EIS's analysis of the effects of hatchery programs on the environment, including natural-origin salmon and steelhead populations. The review of hatchery programs is comprehensive in the sense that information on the effects of all Columbia River basin hatchery programs throughout the basin and across a full range of alternatives is exposed in the EIS. Each alternative identifies a different policy direction that would be used to guide NMFS decisions on Columbia River basin hatchery production.



What is the relationship between NMFS and hatchery operators who receive Mitchell Act funding?

Under the authority of the Mitchell Act, NMFS provides the USFWS, states, and tribes with funds Congress appropriates to manage and operate hatchery programs. NMFS has broad discretion in using these funds either to prescribe narrowly way the production programs will be operated or to allow hatchery operator discretion. Historically, NMFS has provided wide latitude in the use of these hatchery funds.

NMFS plans to continue to provide flexibility to hatchery operators with regard to the operation of Mitchell Act funded hatchery programs but will offer an overarching vision of how the Mitchell Act funded programs can best operate as one component of the Columbia River basin hatchery system. NMFS understands that hatchery operators must make good management decisions on a case-by-case basis after considering specific data relevant to their hatchery programs. There are no “one-size-fits-all” solutions. As a result of this environmental review, NMFS anticipates adopting a policy direction that identifies general goals for NMFS to pursue with regard to Columbia River basin hatchery production and a series of recommendations for hatchery operators to consider and adapt when developing plans for their individual hatchery programs.

Activities that are not considered to be within a reasonable range of potential funding or operational opportunities and that are not, therefore, envisioned within the alternatives in this draft EIS, include the following:

- **Construction of New Hatchery Facilities with Mitchell Act Funds.** Current and reasonably foreseeable appropriations under the Mitchell Act for hatchery production would preclude this option. All reasonably foreseeable decisions for the use of Mitchell Act funding at anticipated levels also would preclude this option.
- **Fish Screens and Fishways.** The Mitchell Act Screens and Fishways Program is a separate program with separate congressionally appropriated funding.
- **Habitat Restoration.** While Congress clearly has the discretion to direct Mitchell Act funds toward habitat restoration, it has not done so. Congress consistently and specifically has directed funds to hatchery production (and related monitoring, evaluation, and reform) and to screens and fishways. This EIS is directed at the use of the funds Congress specifically directs towards hatcheries. Through 2009, NMFS has funded habitat restoration through the Pacific Coastal Salmon Recovery Fund, created by Congress in 2000, to address the need to protect, restore, and conserve salmon, steelhead, and their habitat.
- **Hatchery Practices that Increase Adverse Effects.** While not all salmon ESUs or steelhead DPSs in the Columbia River basin are listed under the ESA, there is at least one salmon or steelhead population that is a member of a listed ESU or DPS in each of the major subbasins within the project area. Hatchery practices have been identified as a factor for the decline of most listed salmon and steelhead. Because of these factors, the purpose and need for this action is to establish a policy direction that, among other things, includes information on performance

standards that reduce adverse effects on natural-origin fish. Implementation of hatchery practices that would increase adverse effects on listed species when compared to existing practices is not considered in this draft EIS.

It is not the purpose of this EIS to determine whether specific actions or hatchery programs meet the requirements of the ESA. These ESA decisions will be made in separate processes consistent with applicable regulations as required by the ESA

What is the relationship between the ESA and the National Environmental Policy Act (NEPA)?

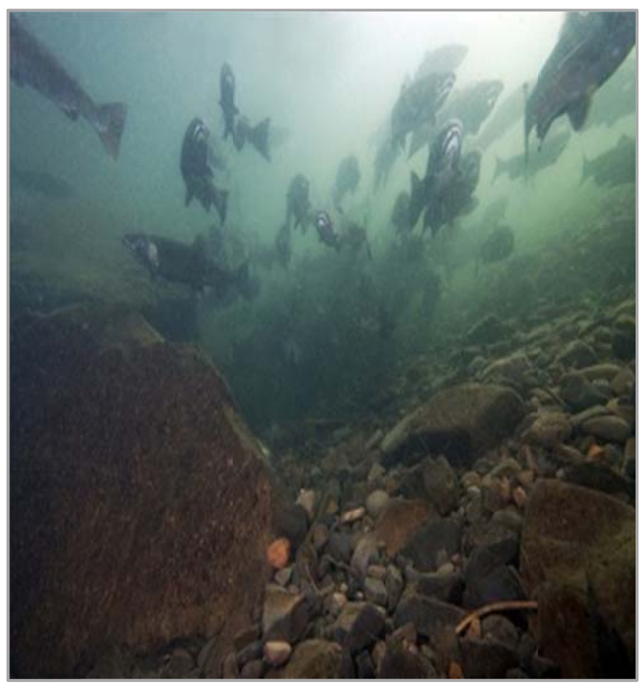
The relationship between the ESA and NEPA is complex, in part because both laws address environmental values related to the impacts of a proposed action. However, each law has a distinct purpose, and the scope of review and standards of review under each statute are different. This EIS analysis under NEPA should not be viewed as contributing to a conclusion about whether an alternative meets or does not meet ESA requirements.

The purpose of an EIS under NEPA is to promote disclosure, analysis, and consideration of the broad range of environmental issues surrounding a proposed major Federal action by considering a full range of reasonable alternatives, including a no-action alternative. Public involvement promotes this purpose.

The purpose of the ESA is to conserve listed species and the ecosystems upon which they depend. Determinations about whether Mitchell Act hatchery programs meet ESA requirements will be made under section 4(d), section 7, or section 10 of the ESA. Each of these ESA sections has its own substantive requirements, and the documents that reflect the analysis and decisions are different than those related to a NEPA analysis.

It is not the purpose of this EIS to suggest to the reader any conclusions relative to the ESA. While the Record of Decision (ROD) identifies the selected NEPA alternative, the ROD does not determine whether that alternative complies with the ESA.

NMFS acknowledges that the analyses of environmental effects on listed species under the ESA and under NEPA are similar and can lead to confusion; however the analyses under these separate statues are not functionally equivalent. Language in this draft EIS has been chosen in an effort to minimize the confusion between a NEPA analysis and an ESA analysis. For instance, “jeopardize,” “endanger,” “recover,” and similar terms are commonly used to describe the effect of actions under an ESA analysis. This EIS avoids using these terms, using in their place terms and phrases such as performance goals and performance metrics.



Alternatives Analyzed in Detail

Alternative 1 (No Action)

Under Alternative 1, there would not be a defined policy direction, and Columbia River basin hatchery production would continue baseline conditions. Based on NMFS' observations, the following describe the baseline conditions:

- Hatchery programs are used primarily to contribute to harvest, although some hatchery programs are designed to help conserve natural-origin salmon and steelhead populations.
- Most hatchery programs cannot control the number of hatchery fish on the spawning grounds. In most cases, the number of hatchery-origin fish on the spawning ground is higher than what current research suggests is desirable.
- Many hatchery programs are used to meet mitigation agreements. Most mitigation occurs to reduce the effects from hydropower on the fisheries.
- Monitoring, evaluation, and reform (MER) occurs, but it is neither prioritized nor guided by a comprehensive basin-wide plan. Fish managers use available funds to meet fish production goals first; if any money remains, MER occurs.
- There is no defined policy on the use of weirs to control the number of hatchery-origin fish on the spawning grounds.
- Conservation hatchery programs, although viewed as a temporary solution to reduce extinction risk, typically are developed and operated with no explicit sizing or termination criteria.
- Best management practices (BMPs) are widely applied, but their application is not universal. In many cases, application is based on available funding and/or whether the BMP is a regulatory requirement.
- The amount of Mitchell Act hatchery funds can vary annually. Hatchery operators generally receive a similar proportion each year.

Alternative 2 (No Mitchell Act Funding)

Under Alternative 2, the policy direction would be defined by the following goals and/or principles:

- Mitchell Act hatchery funding would be eliminated, and all Mitchell Act-funded hatchery programs would be closed.
- Substantially fewer fish would be produced to support fisheries than under Alternative 1.

- The intermediate performance goal would be applied to non-Mitchell Act-funded hatchery programs that affect primary and contributing salmon and steelhead populations (Table S-3). Application of the intermediate performance goal would, in most cases, reduce negative effects of hatchery programs on natural-origin salmon and steelhead populations.
    - Integrated hatchery programs would be better integrated than under Alternative 1.
    - Segregated hatchery programs would be better segregated than under Alternative 1.
- Production levels would be reduced from levels under Alternative 1 in hatchery programs designed to meet mitigation requirements only when those production levels conflicted with the ability of a hatchery program to meet performance goals.
- Conservation hatchery programs would be operated at a level determined by conservation need, with hatchery-origin production diminishing as natural-origin production increased.
- BMPs would be applied in all hatchery programs.
- No new hatchery programs would be initiated.
- No new weirs would be installed to help control the number of hatchery-origin fish on the spawning grounds.
- MER would be guided by a comprehensive basin-wide plan.

Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

Under Alternative 3, the policy direction would be defined by the following goals and/or principles:

- The intermediate performance goal would be applied to all Columbia River basin hatchery programs that affect primary and contributing salmon and steelhead populations (Table S-3). Application of the intermediate performance goal would, in most cases, reduce negative effects of hatchery programs on natural-origin salmon and steelhead populations.
    - Integrated hatchery programs would be better integrated than under Alternative 1.
    - Segregated hatchery programs would be better segregated than under Alternative 1.
- Production levels would be reduced from levels under Alternative 1 in hatchery programs designed to meet mitigation requirements only when those production levels conflicted with the ability of a hatchery program to meet performance goals.
- Conservation hatchery programs would be operated at a level determined by conservation need, with hatchery-origin production diminishing as natural-origin production increases.

- BMPs would be applied in all hatchery programs.
- No new hatchery programs would be initiated.
- New temporary (i.e., seasonal) weirs would be installed to help control the number of hatchery-origin fish on the spawning grounds.
- MER would be guided by a comprehensive basin-wide plan.
- Mitchell Act funds would be disbursed in support of the above goals and/or principles.

Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under Alternative 4, the policy direction would be defined by the following goals and/or principles:

- The intermediate performance goal would be applied to all Columbia River basin hatchery programs that affect primary and contributing salmon and steelhead populations in the Interior Columbia River recovery domain (Table S-3). Application of the intermediate performance goal would, in most cases, reduce negative effects of hatchery programs on natural-origin salmon and steelhead populations.
  - Integrated hatchery programs would be better integrated than under Alternative 1.
  - Segregated hatchery programs would be better segregated than under Alternative 1.
- The stronger performance goal would be applied to all Columbia River basin hatchery programs that affect primary and contributing salmon and steelhead populations in the Willamette/Lower Columbia River recovery domain. Application of the stronger performance goal would reduce negative impacts of hatchery programs on natural-origin salmon and steelhead populations even more than the intermediate performance goal.
  - Integrated hatchery programs would be better integrated than under Alternative 1.
  - Segregated hatchery programs would be better segregated than under Alternative 1.
- Production levels would be reduced from levels under Alternative 1 in hatchery programs designed to meet mitigation requirements only when those production levels conflicted with the ability of a hatchery program to meet performance goals.
- Conservation hatchery programs would be operated at a level determined by conservation need, with hatchery-origin production diminishing as natural-origin production increases.
- BMPs would be applied in all hatchery programs.

- New conservation hatchery programs would be initiated in the Willamette/Lower Columbia River recovery domain, if appropriate, using existing hatchery capacity. New conservation hatchery programs would be initiated only for populations deemed at high risk of extinction.
- New harvest hatchery programs would be initiated and/or existing hatchery programs would be changed to better support harvest opportunities below Bonneville Dam, including ocean fisheries, using any hatchery capacity that remains after appropriate conservation hatchery programs are initiated.
- New temporary (i.e., seasonal) and permanent weirs would be installed to help control the number of hatchery-origin fish on the spawning grounds.
- MER would be guided by a comprehensive basin-wide plan.
- Mitchell Act funds would be disbursed in support of the above goals and/or principles.

Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under Alternative 5, the policy direction would be defined by the following goals and/or principles:

- The intermediate performance goal would be applied to all Columbia River basin hatchery programs that affect primary and contributing salmon and steelhead populations in the Willamette/Lower Columbia River recovery domain (Table S-3). Application of the intermediate performance goals would, in most cases, reduce negative effects of hatchery programs on natural-origin salmon and steelhead populations.
    - Integrated hatchery programs would be better integrated than under Alternative 1.
    - Segregated hatchery programs would be better segregated than under Alternative 1.
- The stronger performance goal would be applied to all Columbia River basin hatchery programs that affect primary and contributing salmon and steelhead populations in the Interior Columbia River recovery domain. These stronger performance goals would reduce negative impacts of hatchery programs on natural-origin salmon and steelhead populations even more than the intermediate performance goal.
    - Integrated hatchery programs would be better integrated than under Alternative 1.
    - Segregated hatchery programs would be better segregated than under Alternative 1.
- Production levels would be reduced from levels under Alternative 1 in hatchery programs designed to meet mitigation requirements only when those production levels conflicted with the ability of a hatchery program to meet performance goals.

- Conservation hatchery programs would be operated at a level determined by conservation need, with hatchery-origin production diminishing as natural-origin production increased.
- BMPs would be applied in all hatchery programs.
- New conservation hatchery programs would be initiated in the Interior Columbia River recovery domain, if appropriate, using existing hatchery capacity. New conservation hatchery programs would be initiated only for populations deemed at high risk of extinction.
- New harvest hatchery programs would be initiated, and/or existing hatchery programs would be changed to better support harvest opportunities above Bonneville Dam, including treaty Indian commercial fisheries, using any hatchery capacity that remains after appropriate conservation hatchery programs are initiated.
- New temporary (i.e., seasonal) and permanent weirs would be installed to help control the number of hatchery-origin fish on the spawning grounds.
- MER would be guided by a comprehensive basin-wide plan.
- Mitchell Act funds would be disbursed in support of the above goals and/or principles.

Table S-3. Hatchery Performance Goals Indentified Under Each Alternative's Policy Direction

Recovery Domain	Population Type*	Funding Entity	- - Hatchery Performance Goals by Alternative - -				
			Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Willamette / Lower Columbia	Primary	Mitchell Act	Baseline conditions	N/A**	Intermediate	Stronger	Intermediate
		Other	Baseline conditions	Intermediate	Intermediate	Stronger	Intermediate
	Contributing	Mitchell Act	Baseline conditions	N/A	Intermediate	Stronger	Intermediate
		Other	Baseline conditions	Intermediate	Intermediate	Stronger	Intermediate
	Stabilizing	Mitchell Act	Baseline conditions	N/A	Baseline conditions	Baseline conditions	Baseline conditions
		Other	Baseline conditions	Baseline conditions	Baseline conditions	Baseline conditions	Baseline conditions
Interior Columbia	Primary	Mitchell Act	Baseline conditions	N/A	Intermediate	Intermediate	Stronger
		Other	Baseline conditions	Intermediate	Intermediate	Intermediate	Stronger
	Contributing	Mitchell Act	Baseline conditions	N/A	Intermediate	Intermediate	Stronger
		Other	Baseline conditions	Intermediate	Intermediate	Intermediate	Stronger
	Stabilizing	Mitchell Act	Baseline conditions	N/A	Baseline conditions	Baseline conditions	Baseline conditions
		Other	Baseline conditions	Baseline conditions	Baseline conditions	Baseline conditions	Baseline conditions

Each population's role in recovery was designated as primary, contributing, or stabilizing. These designations were used by the LCRFRB in the development of the Lower Columbia Fish Recovery Plan (LCFRB 2004). The HSRG adapted them throughout the basin after discussions with the hatchery operators, and they are applied in this EIS (Appendix C through Appendix F).

N/A means not applicable since hatchery programs would be terminated.

Is there a preferred alternative for this draft EIS?

As noted in Chapter 1, Purpose of and Need for the Proposed Action, and explained in further detail in Chapter 2, Alternatives, this draft EIS does not contain a preferred alternative. Rather, it establishes several distinct policy directions as alternatives that would 1) guide the NMFS' decisions on distribution of Mitchell Act funds for hatchery production in the Columbia River basin, and 2) inform NMFS' future review of individual hatchery programs under the ESA. NMFS anticipates identifying the preferred alternative in the final EIS after considering the comments received on this document. The preferred alternative likely will be a blend of more than one of the alternatives evaluated in this EIS. The environmental effects of the preferred alternative will be explained in the final EIS and summarized in the ROD.

Reviewers are not constrained to comment solely on the specific alternatives in this EIS but may comment or recommend a preferred alternative that combines elements of several alternatives presented in this draft EIS.

Identifying an Implementation Scenario

The policy directions that are associated with each of the action alternatives are goal oriented and do not identify specific actions that would be taken under each alternative. This is because NMFS believes that specific hatchery actions should be determined on a hatchery-program-by-hatchery-program basis. To analyze, illustrate and compare the potential environmental effects of each alternative, however, an implementation scenario was developed for each alternative's policy direction. Each implementation scenario is one plausible example of how each hatchery program could be operated to meet the policy direction of the alternative. There are, however, multiple implementation scenarios that could be applied consistent with each policy direction.

NMFS does not advocate any of the implementation scenarios evaluated in this EIS, and the Chapter 4 analyses may show that implementing some components of a scenario would be unreasonable. For example, some components of these implementation scenarios may or may not be viewed as consistent with commitments in the U.S. v Oregon Management Agreement. The intent of the EIS analyses is not to make a determination that an alternative or its implementation scenario is or is not consistent with the U.S. v. Oregon Management Agreement, and no such assertion is made. Rather, NMFS anticipates that the affected parties will ensure that their hatchery plans (e.g., hatchery genetic and management plans) are consistent with the most current Management Agreement.

To identify implementation scenarios, specific performance metrics (i.e., measurements of performance) were identified for each performance goal (Table S-4). The performance metrics include two measurements:

- The proportionate natural influence (PNI) in a population, which is a measure of the hatchery influence on a population and is a function of both the percent hatchery-origin spawners (pHOS) in the natural escapement and the percent of natural-origin broodstock (pNOB) incorporated into the hatchery program
- The pHOS that join natural-origin adults on the stream's spawning ground

The following performance metrics were applied for each hatchery performance goal:

- For the stronger performance goal, integrated populations that are affected by hatchery programs would have a PNI of 0.67 or higher, and segregated, natural-origin populations would maintain pHOS less than or equal to 0.05 (Table S-4).
- For the intermediate performance goal, integrated populations that are affected by hatchery programs would have a PNI of 0.50 or higher, and segregated, natural-origin populations would maintain pHOS of less than or equal to 0.10 (Table S-4).

What is the difference between a hatchery performance goal and a performance metric?

In this EIS, performance goals are identified within each alternative. These goals apply to hatchery programs. There are two performance goals: stronger and intermediate. Both performance goals would likely reduce negative effects of hatchery programs on salmon and steelhead populations compared to the baseline conditions.

Performance metrics are identified for each performance goal so that an implementation scenario can be identified. Performance metrics apply to the populations that are being affected by the hatchery programs. Performance metrics include two measurements: PNI and pHOS.

Although NMFS uses these performance metrics in this EIS, no determination has been made on their adequacy under the ESA. NMFS is not advocating their use by hatchery managers. Reviewers are encouraged to understand the dynamics of the population that affect its PNI and pHOS values, particularly in an integrated population. In some cases, the favorable values of an integrated population may disguise underlying risks. For example, if the naturally spawning component of the integrated population is small, then it may be necessary to maintain a high number of natural-origin fish in the hatchery broodstock to maintain a high overall PNI value. This mining of the natural-origin population could maintain its PNI, but increase genetic and demographic risks to the population as a whole.

Table S-4. Performance Metrics applied for each hatchery performance goal

Hatchery Performance Goal	Performance metrics for affected populations
Intermediate Performance Goal	Integrated populations maintain a PNI greater than or equal to 0.50. Segregated, natural-origin populations maintain pHOS less than or equal to 0.10.
Stronger Performance Goal	Integrated populations maintain a PNI greater than or equal to 0.67. Segregated, natural-origin populations maintain pHOS less than or equal to 0.05.

Summary of Resource Effects

Table S-5 summarizes predicted effects from implementation of the No-action Alternative (Alternative 1) and action alternatives (Alternative 2 through Alternative 5). The summary reflects the detailed resource discussions in Chapter 4, Environmental Consequences. No preferred alternative has been selected for the Draft EIS.

Table S-5. Summary of Environmental Consequences for EIS Alternatives by Resource.

Resource	Indicator	Alternative 1 (No Action)	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Fish	Number of salmon and steelhead hatchery programs	178	106	161	174	171
	Number of hatchery-origin salmon and steelhead produced annually	143,577,000	51,896,000	106,928,000	118,362,000	110,630,000
	Percent (%) of primary and contributing salmon and steelhead populations that meet stronger metrics	50	71	63	71	71
	Percent (%) of primary and contributing salmon and steelhead populations that meet intermediate metrics or stronger metrics	58	91	89	90	88
	Number of weirs installed to control pHOS	0	0	13	16	17

Resource	Indicator	Alternative 1 (No Action)	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Socio-economics	Annual cost of Columbia River basin hatchery production (millions of 2007 U.S. dollars [$])	79.5	51.9	76.9	79.4	81.5
	Number of Columbia River basin salmon and steelhead harvested in all fisheries	602,368	309,465	482,509	535,529	497,085
	Net economic value (2007 U.S. dollars [$]) of commercial fisheries (tribal and non-tribal) in the Columbia River basin	2,115,979	1,145,205	1,793,706	2,016,671	2,025,634
	Net economic value (2007 U.S. dollars [$]) of commercial fisheries (tribal and non-tribal) in the Pacific Ocean and Puget Sound to which Columbia River basin fish contribute	13,474,389	12,537,078	13,262,657	13,408,620	13,280,994
	Commercial ex-vessel value (2007 U.S. dollars [$]) in Columbia River basin	6,188,673	3,735,500	5,436,555	6,169,064	6,155,051
	Commercial ex-vessel value (2007 U.S. dollars [$]) in the Pacific Ocean and Puget Sound	36,594,962	34,379,075	36,169,953	36,561,643	36,228,773
	Net economic value (2007 U.S. dollars [$]) of recreational fisheries in the Columbia River basin	35,791,853	21,065,837	28,841,018	31,415,967	30,567,085
	Net economic value (2007 U.S. dollars [$]) of recreational fisheries in the Pacific Ocean and Puget Sound to which Columbia River basin fish contribute	22,380,896	18,975,560	20,728,811	20,838,677	20,744,041
	Total (direct and indirect) economic impacts on income (2007 U.S. dollars [$]) in the Columbia River basin	103,988,544	64,595,934	90,800,063	99,052,073	99,939,014

Resource	Indicator	Alternative 1 (No Action)	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Socio-economics (continued)	Total (direct and indirect) economic impacts on income (2007 U.S. dollars [$]) in the Pacific Ocean and Puget Sound	115,961,205	106,837,236	113,052,011	113,967,297	113,205,357
	Total (direct and indirect) economic impacts on jobs in the Columbia River basin	2,540.6	1,584.7	2,201.0	2,385.0	2,417.4
	Total (direct and indirect) economic impacts on jobs in the Pacific Ocean and Puget Sound	2,264.5	2,035.6	2,179.6	2,194.5	2,182.3
	Recreational expenditures (2007 U.S. dollars [$]) in the Columbia River basin	47,476,271	27,942,878	38,256,303	41,671,856	40,545,853
	Recreational expenditures (2007 U.S. dollars [$]) in the Pacific Ocean and Puget Sound	56,516,450	51,174,142	54,382,756	54,807,054	54,452,342
Environmental Justice	Total tribal fish harvests (commercial, ceremonial, and subsistence) by number of fish in the Columbia River basin	79,328	36,519	63,702	63,494	73,619
	Tribal fishing revenue (2007 U.S. dollars [$]) in the Columbia River basin	3,484,670	2,355,731	3,352,910	3,346,917	4,048,727
Wildlife	Caspian terns and bald eagles	Populations increasing	Potential reductions in abundance, distribution, and fitness relative to Alternative 1	Same as Alternative 2	Same as Alternative 1	Same as Alternative 2
	Southern resident killer whale (listed)	89 individuals are currently in Southern Resident stock; populations fluctuate from decreasing to increasing	Potential reductions in abundance relative to Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1

Resource	Indicator	Alternative 1 (No Action)	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Wildlife (continued)	California sea lions	Populations increasing	Abundance in Columbia River would probably decline relative to Alternative 1	Abundance may be affected relative to Alternative 1	Same as Alternative 1	Same as Alternative 3
	Stellar sea lions (listed)	Populations increasing	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Water Quality & Quantity	NPDES permit compliance and water use	NPDES permits current	Potential improvements in water quality and reduction in water use	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2
Human Health	Hatchery chemical safety and use	Chemicals and antibiotics would be used consistent with Federal and state guidelines; potential pathogen exposure.	Potential decrease in use of chemicals and antibiotics; no change in exposure to pathogens	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

Primary and contributing populations are terms that were used by the Lower Columbia Fish Recovery Board (LCFRB) in the development of the Lower Columbia River Salmon Recovery and Fish and Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and they are applied in this draft EIS (Section 2.4, Alternative Development).

Socioeconomic values for the Pacific Ocean and Puget Sound are based on the total number of salmon and steelhead harvested in those areas, not just those from the Columbia River basin.

Acronyms and Abbreviations

4,4’DDE	dichlorodiphenyldichloroethylene
AHA	all-H analyzer
BKD	bacterial kidney disease
BMP	best management practice
BOD	biochemical oxygen demand
BPA	Bonneville Power Administration
BOR	Bureau of Reclamation
BRT	Biological Review Team
CBFWA	Columbia Basin Fish and Wildlife Authority
CFR	Code of Federal Regulations
CRP	Community-based Restoration Program
CTUIR	Confederated Tribes of the Umatilla Reservation
CWT	coded wire tag
DDT	dichlorodiphenyltrichloroethane
DPS	distinct population segment
Ecology	Washington State Department of Ecology
EIS	environmental impact statement
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESU	evolutionarily significant unit
FCRPS	Federal Columbia River Power System
FDA	Food and Drug Administration
FERC	Federal Energy Regulatory Commission

Acronyms and Abbreviations (continued)

FFDCA	Federal Food, Drug, and Cosmetic Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FPC	Fish Passage Center
FTE	full-time equivalent
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
HACCP	hazard analysis critical control point
HPV	hatchery population viewer
HSD	Hazardous Substance Databank
HSRG	Hatchery Scientific Review Group
IARC	International Agency for Research on Cancer
ICTRT	Interior Columbia Technical Recovery Team
IDAPA	Idaho Administrative Procedures Act
IDEQ	Idaho Department of Environmental Quality
IDFG	Idaho Department of Fish and Game
IHOT	Integrated Hatchery Operations Team
IRIS	Integrated Risk Information System
ISAB	Independent Science Advisory Board
LCFRB	Lower Columbia Fish Recovery Board
LCREP	Lower Columbia River Estuary Partnership
LNG	liquefied natural gas
MER	monitoring, evaluation, and reform
MMPA	Marine Mammal Protection Act
MOA	memorandum of understanding
MSDS	material safety data sheet

Acronyms and Abbreviations (continued)

N/A	not available
NH3	un-ionized ammonia
NH4+	ammonium ion
NMFS	National Marine Fisheries Service
NOS	natural-origin spawners
NPCC	Northwest Power and Conservation Council
NPDES	National Pollutant Discharge Elimination System
NRC	National Research Council
NRCS	Natural Resources Conservation Service
NWIFC	Northwest Indian Fisheries Commission
ODEQ	Oregon Department of Environmental Quality
ODFW	Oregon Department of Fish and Wildlife
OSHA	Occupational Safety and Health Administration
PCBs	polychlorinated biphenyls
PCFRF	Pacific Coastal Salmon Recovery Fund
PFMC	Pacific Fishery Management Council
pHOS	proportion of hatchery-origin spawners
PNFHPC	Pacific Northwest Fish Health Protection Committee
PNI	proportionate natural influence
PNI	proportionate natural influence
pNOB	proportion of natural-origin fish in the broodstock
PNPTT	Point No Point Treaty Tribes
$PROD_{adj}$	adjusted productivity
PSC	Pacific Salmon Commission
PSE	Puget Sound Energy

Acronyms and Abbreviations (continued)

RES Americas	Renewable Energy Systems Americas Inc.
R/S	recruits-per-spawner
RIST	Recovery Implementation Science Team
RM	River Mile
ROD	record of decision
SIWG	Species Interaction Work Group
SRFB	Salmon Recovery Funding Board
TMDL	total maximum daily load
TSS	total suspended solids
U&A	usual and accustomed
U.S.	United States
USACE	U.S. Army Corps of Engineers
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VSP	Viable Salmonid Population
WDFW	Washington Department of Fish and Wildlife
WHO	World Health Organization
WISHA	Washington State Industrial Safety and Health Act
WRIA	Watershed Resource Inventory Area

Glossary of Key Terms

Abundance: The number of fish in a population.

Adaptive management: 1) A management process involving step-wise evolution of a flexible management system in response to feedback information actively collected to check or test its performance (in biological, social, and economic terms); 2) The process of improving management effectiveness by learning from the results of carefully designed decisions or experiments.

Acclimation pond: Concrete or earthen pond or a temporary structure used for rearing and imprinting juvenile fish in the water of a particular stream before their release into that stream.

Adfluvial: Fish migrating between lakes and rivers or streams.

Adipose fin: A small fleshy fin with no rays, located between the dorsal and caudal fins of salmon and steelhead. The adipose fin is often “clipped” on hatchery-origin fish so they can be differentiated from natural-origin fish.

Anadromous: Fish that hatch and rear in fresh water, migrate to the ocean to grow and mature, and return to freshwater to spawn.

Analysis area: Within this EIS, the analysis area is the geographic extent that is being evaluated for each resource. For some resources (e.g., socioeconomics), the analysis area is larger than the project area.

Best management practices (BMPs): Policies, practices, procedures, or structures implemented to mitigate adverse environmental effects.

Broodstock: A group of sexually mature individuals of a species that is used for breeding purposes as the source for a subsequent generation. The analysis in this EIS distinguishes between broodstock that is of hatchery-origin from broodstock that is of natural-origin.

Captive breeding hatchery program: A type of conservation hatchery program that collects fish from a natural-origin population, spawns them in a hatchery, and rears the progeny to maturity in captivity.

Columbia River plume: The region of the near-shore Pacific Ocean representing the outflow of the Columbia River. The plume is generally defined by a reduced-salinity contour near the ocean surface of approximately 31 parts per thousand. The plume varies seasonally and annually with discharge, prevailing near-shore winds, and ocean currents. For purposes of this EIS, the Columbia River plume is considered to be off the immediate coast of both Oregon and Washington and to extend outward to the continental shelf.

Composite population: A population made up of both hatchery-origin and natural-origin fish.

Copepod: Any of numerous minute marine and freshwater crustaceans of the subclass Copepoda, having an elongated body and a forked tail.

Cyprinid: Any of numerous often small freshwater fishes of the family Cyprinidae, which includes minnows and carps. Cyprinids are soft-finned mainly freshwater fishes typically having toothless jaws and cycloid scales.

Glossary of Key Terms (continued)

Dewatering: Typically refers to the immediate downstream habitat effects associated with a water withdrawal action that diverts the entire flow of a stream or river to another location.

Direct take: The term "take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Direct take for hatchery activities includes, for example, the collection of listed fish (adults and juveniles) for hatchery broodstock, the collection of listed hatchery-origin fish to prevent them from spawning naturally, and the collection of listed fish (juvenile and adult fish) for scientific purposes.

Dissolved oxygen (DO): The amount of oxygen that is dissolved in a particular body of water. The amount of DO can be an important indicator of the condition of the water body.

Distinct population segment (DPS): Under the ESA, the term "species" includes any subspecies of fish or wildlife or plants, and any "distinct population segment" of any species or vertebrate fish or wildlife that interbreeds when mature. The ESA thus considers a DPS of vertebrates to be a "species". The Act does not however establish how distinctness should be determined. Under NMFS policy for Pacific salmon, a population or group of populations will be considered a DPS if it represents an evolutionarily significant unit (ESU) of the biological species. In contrast to salmon, NMFS lists steelhead runs under the joint NMFS-U.S. Fish and Wildlife Service (USFWS) Policy for recognizing DPSs (DPS Policy: 61 Federal Register 4722; February 7, 1996). This policy adopts criteria similar to those in the ESU policy, but applies to a broader range of animals to include all vertebrates.

Diversity: Variation at the level of individual genes (polymorphism); provides a mechanism for populations to adapt to their ever-changing environment.

Ecological province: The Columbia River basin contains 11 ecological provinces as defined by the Northwest Power and Conservation Council. Each ecological province consists of groups of adjoining subbasins with similar climates and geology.

Economic impact region: In this EIS, information about socioeconomic effects are organized according to economic impact regions. The economic impact regions used in the EIS are as follows: lower Columbia River, mid Columbia River, upper Columbia River, lower Snake River, Oregon coast, Washington coast, California coast, Puget Sound/Strait of Juan de Fuca, British Columbia, and Southeast Alaska.

Endangered species: As defined in the ESA, an endangered species means any species that is in danger of extinction throughout all or a significant portion of its range.

Endangered Species Act (ESA): A United States law that provides for the conservation of endangered and threatened species of fish, wildlife, and plants.

Environmental justice: The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

Estuary: The area where fresh water of a river meets and mixes with the salt water of the ocean.

Euphasiids: Tiny crustaceans that resemble shrimp from the genus *Euphausia*.

Glossary of Key Terms (continued)

Evolutionarily significant unit (ESU): A concept NMFS uses to identify distinct population segments of Pacific salmon under the ESA. An ESU is a population or group of populations of Pacific salmon that 1) is substantially reproductively isolated from other population, and 2) contributes substantially to the evolutionary legacy of the biological species.

Ex-vessel value: The price received for a product "at the dock."

Federal Register: The United States government's daily publication of Federal agency regulations and documents, including executive orders and documents that must be published per acts of Congress.

Fingerling: A juvenile fish.

First Nation: A term referring to the aboriginal people located in what is now Canada.

First-order stream: A stream that has no permanent tributaries. A first-order stream is also considered an unforked or unbranched stream.

Fish screen: A fish screen is used to prevent entrainment of salmonids into water diversions or intakes at hatchery facilities.

Fishway: A fishway is any structure or modification to a natural or artificial structure for the purpose of providing or enhancing fish passage.

Fluvial: Fish migrating between rivers.

Forage fish: Small fish that breed prolifically and serve as food for predatory fish.

Fry: Juvenile salmon and steelhead that are usually less than one year old and have absorbed their egg sac.

Habitat: The physical, biological, and chemical characteristics of a specific unit of the environment occupied by a specific plant or animal; the place where an organism naturally lives.

Habitat capacity: A category of habitat assessment metrics, including habitat attributes that promote juvenile salmon production through conditions that promote foraging, growth, and growth efficiency, and/or decreased mortality.

Hatchery facility: A facility that supports one or more hatchery programs.

Hatchery operators: The Federal agencies, state agencies, and Native American tribes that operate hatchery programs.

Hatchery-origin fish: A fish that originated from a hatchery facility.

Hatchery-origin spawners (HOS): Hatchery-origin fish spawning naturally.

Hatchery program: A program that artificially propagates fish. Most hatchery programs for salmon and steelhead spawn adults in captivity, raise the resulting progeny for a few months or longer, and then release the fish into the natural environment where they will mature.

Haulout: A site where seals, sea lions, and other marine mammals climb out of water to rest on land.

Glossary of Key Terms (continued)

Headwaters: The source or headwaters of a river or stream is the place from which the water in the river or stream originates.

Hydropower: Electrical power generation through use of gravitational force of falling water at dams.

Implementation measures: A generalized set of measures that hatchery managers could implement, if appropriate, to increase the likelihood that the hatchery programs would meet performance goals. These measures include reducing production levels, installing weirs, or correcting water quality problems. This EIS identifies implementation measures that could be taken under each alternative to help meet performance goals.

Implementation scenario: Because the alternatives in this EIS are goal-oriented and do not identify specific actions that would be taken under each alternative, an implementation scenario was developed for each alternative so that potential environmental effects could be analyzed, illustrated, and compared.

Incidental rake: An unintentional, but not unexpected, taking.

Integrated hatchery program: A hatchery program that intends for the natural environment to drive the adaptation and fitness of a composite population of fish that spawns both in a hatchery and in the natural environment.

Interior Columbia recovery domain: The Interior Columbia recovery domain covers all of the Columbia River basin accessible to anadromous salmon and steelhead upstream of Bonneville Dam.

Jacks: Precocious or early maturing salmon or steelhead; most are males.

Limiting factor: Physical, chemical, or biological features that impede species and their independent populations from reaching a viable status.

Willamette/Lower Columbia recovery domain: The Willamette/Lower Columbia recovery domain encompasses the Columbia River basin downstream of the Hood River in Oregon and the White Salmon River in Washington.

Macroinvertebrates: Invertebrates that are of visible size, such as clams and worms.

Mainstem: The principle channel of a drainage system into which other smaller streams or rivers flow. In this EIS, "mainstem" usually refers to the Columbia River as opposed to any of its tributaries.

Mitchell Act: The Mitchell Act was enacted in 1938 to provide for the conservation of the fishery resources of the Columbia River, establishment, operation, and maintenance of one or more stations in Oregon, Washington, and Idaho, and for the conduct of necessary investigations, surveys, stream improvements, and stocking operations for these purposes.

Mitchell Act production: References in this EIS to "Mitchell Act production," "production under the Mitchell Act," or similar phrases are intended to mean production that is funded by Congressional appropriations authorized by the Mitchell Act.

Mouth of river: The location where a river flows into a larger body of water. For the Columbia River, the mouth of the river is where it meets the Pacific Ocean.

Glossary of Key Terms (continued)

National Marine Fisheries Service (NMFS): A United States agency within the National Oceanic and Atmospheric Administration and under the Department of Commerce charged with the stewardship of living marine resources through science-based conservation and management, and the promotion of healthy ecosystems.

National Pollutant Discharge Elimination System (NPDES): A provision of the Clean Water Act that prohibits discharge of pollutants into waters of the United States unless a special permit is issued by the Environmental Protection Agency, a state, or, where delegated, a tribal government on an Indian reservation.

Native fish: Fish that are endemic to or limited to a specific region.

Natural-origin fish (NOS): "Natural-origin," "natural," and "wild" are terms used interchangeably throughout this document to refer to fish that are offspring of parents that spawned in the natural environment rather than the hatchery environment unless specifically explained otherwise in the text. "Naturally spawning" and similar terms refer to fish spawning in the natural environment.

Outmigration: The downstream migration of salmon and steelhead toward the ocean.

Parts per million (ppm): The number of "parts" by weight of a substance per million parts of water. This unit is commonly used to represent pollutant concentrations.

Performance goals: Performance goals are broad goals for hatchery programs related to their effects on natural-origin salmon and steelhead populations. Two performance goals are used in this EIS: stronger and intermediate.

Performance metrics: In this EIS, performance metrics are identified for each performance goal so that an implementation scenario can be identified. Performance metrics apply to the populations that are being affected by the hatchery programs. Performance metrics include two measurements: PNI and pHOS.

pH: A measure of the relative acidity or alkalinity of a solution, expressed on scale from 0 to 14, with the neutral point at 7.0. Acid solutions have pH values lower than 7.0, and basic (i.e., alkaline) solutions have pH values higher than 7.0.

pHOS: Proportion of naturally spawning salmon or steelhead that are hatchery-origin fish.

Piscivorous: An animal that eats fish.

Planktivorous: An animal, such as a fish, that eats plankton.

Plume: See **Columbia River plume**.

pNOB: The proportion of a hatchery program's broodstock that is made up of natural-origin fish.

Policy direction: The overarching theme that is the subject of this EIS and that will guide and shape decisions made by NMFS related to hatchery production in the Columbia River basin, defined by a series of goals and/or principles.

Polychlorinated biphenyls (PCBs): A group of synthetic, toxic industrial chemical compounds that are chemically inert and not biodegradable; they once were used in making paint and electrical transformers.

Glossary of Key Terms (continued)

Polycyclic aromatic hydrocarbons (PAHs): A group of more than 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage, or other organic substances like tobacco or charbroiled meat.

Population: A group of fish of the same species that spawns in a particular locality at a particular season and does not interbreed substantially with fish from any other group.

Productivity: The rate at which a population is able to produce reproductive offspring.

Project area: Geographic area where the proposed action will take place.

Proportionate natural influence (PNI): PNI is a measure of hatchery influence on natural populations that is a function of both the percent hatchery-origin spawners (pHOS) in the natural escapement and the percent of natural-origin broodstock incorporated into the hatchery program (pNOB). PNI can also be thought of as the percentage of time all the genes of population collectively have spent in the natural environment.

Recovery domain: An administrative unit for recovery planning defined by NMFS based on ESU boundaries, ecosystem boundaries, and existing local planning processes. Recovery domains may contain one or more listed ESUs.

Recruitment: The number of fish that enter the harvestable stock due to growth and/or migration.

Reference area: A reference area is used in an environmental justice analysis. It is the area used as a benchmark of comparison when identifying whether a target population has a minority or low-income population that may be subject to disproportionate environmental or economic effects.

Resident fish: Fish that reside in freshwater throughout their life cycle.

Rotifer: Minute aquatic multicellular organisms having a ciliated wheel-like organ for feeding and locomotion; constituents of freshwater plankton.

Run: In the Columbia River basin, a "run" of salmon is defined by the season they return as adults to the mouth of the Columbia River.

Salmonids: Fish of the family Salmonidae, which includes salmon and steelhead.

Scoping: An early and open process for determining the extent and variety of issues to be addressed and for identifying the significant issues related to a proposed action (40 CFR 1501.7).

Section 7 consultation: Section 7 of the ESA requires Federal agencies to consult with NMFS or USFWS (dependent on agency jurisdiction) on any actions that may affect listed species.

Section 10 permit: Section 10(a)(1)(A) of the ESA authorizes the NMFS or USFWS (dependent on agency jurisdiction) to issue permits for direct take of listed species for scientific purposes or to enhance the propagation or survival of listed species.

Segregated hatchery program: A hatchery program that intends for the hatchery-origin population to be reproductively segregated from the natural-origin population.

Selective fisheries: Fisheries that target specific fish or fish runs. Selective fisheries often target hatchery-origin fish.

Glossary of Key Terms (continued)

Smolts: Juvenile salmonids that have left their natal stream and are headed downriver toward the ocean.

Smoltification: Refers to those physiological changes anadromous salmonids and trout undergo in freshwater while migrating to saltwater that allow them to live in the ocean.

Spatial structure: The spatial structure of a population refers both to the spatial distributions of individuals in the population and the processes that generate that distribution.

Straying (of hatchery-origin fish): When hatchery-origin fish return to and/or spawn in areas where they are not intended to return/spawn.

Sympatric: Occupying the same or overlapping geographic areas without interbreeding.

Target area: A target area is used in an environmental justice analysis. It is the geographical study area that is potentially affected by EIS alternatives. The target area is compared to a reference area (a benchmark) to determine if there is a substantially larger minority or low-income population within the target area.

Terminal fishery: The fishery that takes place in the last portion of the migration route of fish returning to freshwater to spawn.

Thalweg: The deepest part of the stream that carries water during low-flow conditions.

Threat: A human action or natural event that causes or contributes to limiting factors; threats may be caused by past, present, or future actions or events.

Threatened species: As defined by Section 4 of the ESA, a threatened species means any species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

Total maximum daily load (TMDL): A calculation of the maximum amount of pollutant that a water body can receive and still meet water quality standards.

Tributary: A stream or river that flows into a larger stream or river.

Turbidity: The amount of solid particles that are suspended in water and that cause light rays shining through the water to scatter. Thus, turbidity makes water cloudy or even opaque in extreme cases.

Viability: As used in this document, a measure of the status of anadromous salmonids that uses four performance criteria: abundance, productivity, spatial distribution, and diversity.

Viable salmonid population: An independent population of Pacific salmon or steelhead that has a negligible risk of extinction over a 100-year timeframe.

Water intake screen: A screen used to prevent entrainment of salmonids into a water diversion or intake. Also see **fish screen**.

Weir: An adjustable dam placed across a river to regulate the flow of water downstream; a fence placed across a river to catch fish.

Wild fish: See **natural-origin fish**.

Glossary of Key Terms (continued)

Zone 1 through 5 fisheries: The statistical zones of the Columbia River commercial fishing area downstream from Bonneville Dam, as defined in Section 635 042 0001 of the Oregon Administrative Rules. Zones 1 through 5 encompass the Columbia River mainstem easterly of a line projected from the knuckle of the south jetty on the Oregon bank to the inshore end of the north jetty on the Washington bank, and westerly of a line projected from a deadline marker on the Oregon bank (approximately 4 miles downstream from Bonneville Dam Powerhouse 1) in a straight line through the western tip of Pierce Island, to a deadline marker on the Washington bank at Beacon Rock.

Zone 6 fisheries: The statistical zone of the Columbia River treaty Indian commercial fishing area upstream from Bonneville Dam running from Bonneville to McNary Dams.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

List of Tables

List of Tables (continued)

List of Tables (continued)

List of Tables (continued)

List of Tables (continued)

List of Tables (continued)

List of Tables (continued)

List of Tables (continued)

List of Tables (continued)

List of Tables (continued)

List of Tables (continued)

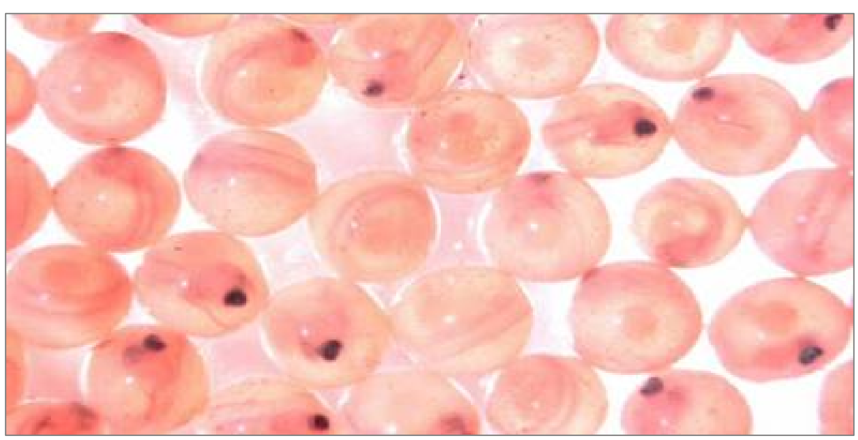
List of Tables (continued)

List of Figures

Science, Service, Stewardship

Chapter 1

Purpose of of and Need for the Proposed Action



1.0 PURPOSE OF AND NEED FOR THE PROPOSED ACTION

1.1 Introduction

Congress enacted the Mitchell Act (16 United States Code [USC]755-757) in 1938 for the conservation of anadromous (salmon and steelhead) fishery resources in the Columbia River basin (defined as all tributaries of the Columbia River in the United States [U.S.] and the Snake River basin). It authorized the establishment, operation, and maintenance of one or more hatchery facilities in the states of Oregon, Washington, and Idaho, scientific investigations to facilitate the conservation of the fishery resource, and "all other activities necessary for the conservation of fish in the Columbia River basin in accordance with law." While the Mitchell Act provided the authority for the conservation of fishery resources in the Columbia River, Congress must appropriate funds to implement it.

Since 1946, Congress has continued to appropriate Mitchell Act funds on an annual basis. These funds have been used to support research, improve fish passage, install screens on water diversions, and build and operate more than 20 salmon and steelhead hatchery facilities (referred to in this environmental impact statement (EIS) as Mitchell Act hatchery facilities). Each year, Congress allocates a specific portion of the money appropriated for the Mitchell Act to hatchery operations. For each of the past 10 years, hatchery operation funding has been between $11 and $16 million dollars. The National Marine Fisheries Service (NMFS), part of the National Oceanic and Atmospheric Administration (NOAA) within the Department of Commerce, currently distributes these appropriations to the operators of 62 hatchery programs that annually produce more than 71 million fish. Historically, production levels have been as high as 128.6 million juvenile fish annually, but these levels have been substantially reduced as inflation, maintenance, and other costs have eroded the amount of funding available for fish production.

During the same time that production levels were reduced at hatchery facilities funded under the Mitchell Act, NMFS listed eight evolutionarily significant units (ESUs) [1] of salmon and five

---

[1] NMFS administers the Federal Endangered Species Act (ESA) for salmon and steelhead. Rather than focusing on salmon "populations" in its ESA listings, NMFS specifically lists salmon ESUs. An ESU represents a distinct population segment or group of populations that is considered distinct because 1) it is substantially reproductively isolated from other groups of populations of the same species, and 2) it represents an important component in the evolutionary legacy of the biological species. An ESU qualifies as a "species" under ESA. In contrast to salmon, NMFS lists steelhead runs under the joint NMFS-U.S. Fish and Wildlife Service (USFWS) Policy for recognizing distinct population segments (DPSs) (61 Fed. Reg. 4722, February 7, 1996). This policy adopts criteria similar to those in the ESU policy, but applies to a broader range of animals to include all vertebrates (Box 1-1).

DPSs of steelhead in the Columbia River basin under the ESA (i.e., 13 ESUs/DPSs total) (Box 1-1) (Table 1-1).

Box 1-1. What is an ESU? What is a DPS?

Under the ESA, NMFS lists salmon as threatened or endangered according to the status of the "evolutionarily significant unit" (ESU). An ESU is a population or a group of populations that 1) is substantially reproductively isolated from other groups of populations of the same species and 2) represents an important component of the evolutionary legacy of the species. See http://www.nwfsc.noaa.gov/trt/glossary.cfm#E for formal definitions of ESA-related terms used by NMFS.

In contrast to salmon, NMFS lists steelhead runs under the joint NMFS-USFWS policy for recognizing DPSs under the ESA (61 Fed. Reg. 4722, February 7, 1996). This policy adopts criteria similar to those in the ESU policy, but applies them to a broader range of animals that includes all vertebrates. For determining when a group of vertebrates constitutes a DPS, the group must be discrete from other populations, and it must be significant to its animal group, or taxon. A group is discrete if it is "markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, and behavioral factors" (61 Fed. Reg. 4722, February 7, 1996). NMFS lists steelhead according to the status of their DPS.

When listing both salmon and steelhead under the ESA, NMFS cited the adverse effects of hatchery operations as one of the factors for the decline of most of these listed ESUs/DPSs. Under the ESA, NMFS must make ongoing determinations about how hatchery operations affect ESUs and DPSs listed as threatened or endangered. Determination of these effects is complex because the effects of any *one* hatchery program can only be fully understood through a comprehensive analysis that considers the interrelationship of the *many* natural-origin and hatchery-origin populations in the basin. Management determinations are better informed when made with an understanding of this inter-relationship. The combination of funding pressures under the Mitchell Act, the listing of 13 ESUs/DPSs of salmon and steelhead under the ESA in the Columbia River basin, and the benefits of a comprehensive review of hatchery programs form the basis for NMFS' proposed action.

The proposed action is to develop a NMFS policy direction that will 1) guide NMFS' distribution of Mitchell Act hatchery funds and 2) inform NMFS' future review of individual Columbia River basin hatchery programs under the ESA.

TABLE 1-1. ESA STATUS OF COLUMBIA RIVER BASIN SALMON AND STEELHEAD.

SPECIES	ESU/DPS	CURRENT ESA LISTING STATUS
Sockeye salmon (*Oncorhynchus nerka*)	Snake River	Endangered (70 Fed. Reg. 37160, June 28, 2005)
Chinook salmon (*O. tshawytscha*)	Upper Columbia River Spring-run	Endangered (70 Fed. Reg. 37160, June 28, 2005)
	Snake River Spring/Summer-run	Threatened (70 Fed. Reg. 37160, June 28, 2005)
	Snake River Fall-run	Threatened (70 Fed. Reg. 37160, June 28, 2005)
	Lower Columbia River	Threatened (70 Fed. Reg. 37160, June 28, 2005)
	Upper Willamette	Threatened (70 Fed. Reg. 37160, June 28, 2005)
Coho salmon (*O. kisutch*)	Lower Columbia River	Threatened (70 Fed. Reg. 37160, June 28, 2005)
Chum salmon (*O. keta*)	Columbia River	Threatened (70 Fed. Reg. 37160, June 28, 2005)
Steelhead (*O. mykiss*)	Upper Columbia River	Threatened (71 Fed. Reg. 834, January 5, 2006)
	Snake River basin	Threatened (71 Fed. Reg. 834, January 5, 2006)
	Middle Columbia River	Threatened (71 Fed. Reg. 834, January 5, 2006)
	Upper Willamette River	Threatened (71 Fed. Reg. 834, January 5, 2006)
	Lower Columbia River	Threatened (71 Fed. Reg. 834, January 5, 2006)

Source: NMFS

Although this EIS itself will not determine whether any specific alternative meets ESA requirements, the analyses within the EIS will inform NMFS, hatchery operators, and the public about the current and anticipated cumulative environmental effects of operating the Columbia River basin hatchery programs under a full range of alternatives. The alternatives are designed to reduce or minimize adverse effects of hatchery operations on natural-origin salmon and steelhead populations, while hatchery operators continue to pursue not only the conservation or harvest goals that currently apply to each hatchery program, but also different or additional conservation and harvest goals as identified within the alternatives. NMFS anticipates that the alternative it pursues after completion of this EIS will be applicable for 10 years.

1.1.1 The Mitchell Act

The Mitchell Act was enacted in 1938 for the conservation of fishery resources in the Columbia River (Box 1-2). The Mitchell Act authorized the establishment, operation, and maintenance of hatchery facilities in the states of Oregon, Washington, and Idaho; scientific investigations to facilitate the conservation of the fishery resource; and "all other activities necessary for the conservation of fish in the Columbia River basin in accordance with law" (see below for congressional separation of hatchery funding from that for other activities authorized by the Mitchell Act). In part, this EIS addresses the distribution of Mitchell Act hatchery funds for the operation of hatchery facilities in the Columbia River basin.

Box 1-2. What is the specific text of the Mitchell Act?

To provide for the conservation of the fishery resources of the Columbia River, establishment, operation, and maintenance of one or more stations in Oregon, Washington, and Idaho, and for the conduct of necessary investigations, surveys, stream improvements, and stocking operations for these purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, that the Secretary of the Interior[2] is authorized and directed to establish one or more salmon-cultural stations in the Columbia River basin in each of the States of Oregon, Washington, and Idaho. Any sums appropriated for the purpose of establishment of such stations may be expended, and such stations shall be established, operated, and maintained, in accordance with the provision of the Act entitled "An Act to provide for a five-year construction and maintenance program for the United States Bureau of Fisheries," approved May 21, 1930, insofar as the provisions of such Act are not inconsistent with the provisions of this Act.

Sec. 2. The Secretary of the Interior is further authorized and directed 1) to conduct such investigations, and such engineering and biological surveys and experiments, as may be necessary to direct and facilitate conservation of the fishery resources of the Columbia River and its tributaries; 2) to construct and install devices in the Columbia River basin for the improvement of feeding and spawning conditions for fish, for the protection of migratory fish from irrigation projects, and for facilitating free migration of fish over obstructions; and 3) to perform all other activities necessary for the conservation of fish in the Columbia River basin in accordance with law.

---

[2] Administration of the Mitchell Act was later transferred to the Secretary of the Department of Commerce upon creation of NOAA in 1970.

Box 1-2. What is the specific text of the Mitchell Act? (continued)

Sec. 3. In carrying out the authorizations and duties imposed by Section 2 of this Act, the Secretary of the Interior is authorized to utilize the facilities and services of the agencies of the States of Oregon, Washington, and Idaho responsible for the conservation of the fish and wildlife resources in such States, under the terms of agreements entered into between the United States and these States, without regard to the provisions of Section 3709 of the Revised Statutes, and funds appropriated to carry out the purposes of this Act may be expected for the construction of facilities on and the improvement of lands not owned or controlled by the United States; Provided, That the appropriate agency of the State wherein such construction or improvement is to be carried on first shall have obtained without cost to the United States the necessary title to, interest therein, right-of-way over, or licenses covering the use of such lands.

Approved May 11, 1938 (Public Law [PL] 75-502) and amended on August 8, 1946 (PL 79-676).

Funding for the Mitchell Act was initiated in 1938 when Congress appropriated $500,000 to support the intent of the Mitchell Act. This money was used to assemble data on salmon and steelhead populations in Columbia River tributaries and to compile a catalog of unscreened diversions, impassible waterfalls, log and debris jams, splash dams, and pollution sources (NMFS 1981).

In 1946, Congress amended the Mitchell Act (PL 79-676) to allow additional appropriations to further fund the intent of the Act. Congress also authorized the Secretary of the Interior to use facilities and services in Oregon, Washington, and Idaho.

In 1947, the Lower Columbia River Fisheries Development Program (the term "lower" meant below the McNary Dam) was established in the Department of the Interior to carry out the mandates of the Mitchell Act. Between 1949 and the early 1960s, the Lower Columbia River Fisheries Development Program constructed 22 hatchery facilities with Mitchell Act funds (Table 1-2). Several of those facilities are no longer funded under the Mitchell Act.

Initially Oregon and Washington were the only states actively engaged in the Lower Columbia River Fisheries Development Program. In 1956, however, Congress instructed that the program be activated above McNary Dam, and Idaho became a participant in 1957. At this time, the word "Lower" was dropped from the program name.

TABLE 1-2. HATCHERY FACILITIES CONSTRUCTED USING MITCHELL ACT FUNDS.

HATCHERY FACILITY (LOCATION)	GENERAL LOCATION	FIRST YEAR OF OPERATION	FUNDING AGENCY
Abernathy	Longview, WA	1959	NMFS, USFWS
Beaver Creek	Cathlamet, WA	1958	NMFS
Carson	Carson, WA	1932	NMFS, USFWS
Elochoman	Cathlamet, WA	1954	NMFS
Grays River	Grays River, WA	1961	NMFS
Kalama Falls	Kalama, WA	1959	NMFS
Klickitat	Glenwood, WA	1950	NMFS
Little White Salmon	Cook, WA	1898	NMFS, USFWS
Willard	Cook, WA	1951	NMFS, USFWS
Skamania	Washougal, WA	1956	NMFS, WDF
Spring Creek	Underwood, WA	1901	NMFS, USACE, USFWS
Toutle	Toutle, WA	1952	NMFS
Washougal	Washougal, WA	1958	NMFS
Big Creek	Knappa, OR	1938	NMFS, ODFW
Bonneville	Bonneville, OR	1909	NMFS, USACE, ODFW
Cascade	Cascade Locks, OR	1958	NMFS
Clackamas	Estacada, OR	1979	ODFW, NMFS, PGE
Eagle Creek	Estacada, OR	1957	NMFS
Gnat Creek	Westport, OR	1960	NMFS
Klaskanine	Astoria, OR	1911	NMFS, ODFW
Oxbow	Cascade Locks, OR	1938	NMFS, ODFW
Sandy	Sandy, OR	1950	NMFS

Source: NMFS 1981

When NMFS was listed as a funding agency, Mitchell Act funds were used. In addition to the hatchery facilities included in Table 1-3, several rearing ponds were constructed using Mitchell Act funds, Five of the rearing ponds were constructed in Washington (Alder Creek, Big White Salmon, Gobar, Ringold Salmon, and Ringold Trout), one in Oregon (Wahkenna), and two in Idaho (Decker Flats and Pahsimeroi).

WDF: Washington Department of Fisheries; USACE: U.S. Army Corps of Engineers; ODFW: Oregon Department of Fish and Wildlife; PGE: Portland General Electric

In 1970, administration of the Mitchell Act was transferred from the Department of the Interior to the Department of Commerce. Today, the Columbia River Fisheries Development Program is administered through NMFS' Salmon Recovery Division in Portland, Oregon, and consists of two sub-programs:

1. **Mitchell Act Artificial Production Program**
    - Operation of 62 hatchery programs with an annual release of more than 71 million juvenile salmon and steelhead in Oregon, Washington, and Idaho
    - Associated monitoring, evaluation, and reform to incorporate new and improved technologies
    - Fish marking (e.g., adipose fin clips, electronic tags, and other marking devices)

2. Mitchell Act Screens and Fishways Program

- Construction, operation, and maintenance of more than 700 fish screens at irrigation diversions to protect juvenile salmon and steelhead in Oregon, Washington, and Idaho
- Ongoing operations and maintenance of 90 fishways to enhance adult fish passage to nearly 2,000 miles of stream habitat in Oregon, Washington, and Idaho

In recent years, Congress annually appropriated funds under the authority of the Mitchell Act in categories that correspond with the Administration's budget request to address operation of hatchery programs separately from funds appropriated for the screens and fishway program. This EIS addresses only those appropriated funds used for hatchery programs. In the past 10 years, Congress has appropriated funds used for hatchery production under two to four broad categories, depending on the year. These categories are Columbia River hatcheries; conservation marking; monitoring, evaluation, and reform; and fall Chinook salmon rearing (Table 1-3). In each year, NMFS allocates these funds to the hatchery operators. Generally, each year's allocation has been in proportion to the previous year's distribution, with a minor amount of evolution and adjustment through the years. In addition to allocating funds, NMFS works with hatchery operators to identify appropriate program goals to ensure that funds are used consistent with the authority Congress established in the Mitchell Act for conserving fishery resources in the Columbia River basin.

1.1.2 The Endangered Species Act

The Endangered Species Act of 1973 (16 USC 1531) provides for the conservation of species that are endangered or threatened throughout all or a significant portion of their range and the conservation of the ecosystems on which they depend. The purposes of the ESA are 1) to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved and 2) to provide a program for the conservation of such endangered species and threatened species. A species is considered endangered if it is in danger of extinction throughout all or a significant portion of its range. A species is considered threatened if it is likely to become an endangered species within the foreseeable future.

TABLE 1-3. MITCHELL ACT HATCHERY APPROPRIATION LEVELS (IN THOUSANDS OF U.S. DOLLARS).

	FISCAL YEAR												
HATCHERY ACTIVITY	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Columbia River Hatcheries/ Mitchell Act Operations[1]	10,300	11,400	11,400	11,400	11,455	11,457	11,457	11,457	11,292	11,292	11,300	10,836	10,782
Conservation Marking/Marking Funds[2]	655	655	2,200	655	300		2,690						
Monitoring, Evaluation, and Reform[3]					1,700	1,700	1,700	1,700	1,200	1,200	1,162	1,184	1,689
Fall Chinook Salmon Rearing[4]					600								
TOTAL	**10,977**	**12,055**	**13,600**	**12,055**	**14,055**	**13,157**	**15,847**	**14,257**	**12,492**	**12,492**	**12,462**	**12,021**	**12,471**

Source: NMFS

[1] Congress used two different terms—Mitchell Act Operations and Columbia River Hatcheries—to indicate that funds should be used for fish food, water, electricity, etc., in support of individual hatchery programs.

[2] Congress used two different terms—Conservation Marking and Marking Funds—to indicate monies that should be used for marking hatchery-origin fish (adipose fin clip, PIT tags, etc.). In Fiscal Year 2003, there was also a line item, Marking Trailers-Idaho.

[3] Monitoring, Evaluation, and Reform money had been included under the Mitchell Act Operations line item before Fiscal Year 2001

[4] Fall Chinook Salmon Rearing was a line item that was only found in the Fiscal Year 2001 budget.

Appropriation levels have been rounded to the nearest thousand dollars.

NMFS and USFWS (collectively referred to as the Services) share responsibility for implementing the ESA. Generally, USFWS has authority for land and freshwater species, while NMFS has authority under the ESA for marine and anadromous species such as salmon and steelhead. There are currently eight salmon ESUs and five steelhead DPSs in the Columbia River basin that are federally listed as threatened or endangered (Table 1-2) (Box 1-2) (Box 1-3).

Box 1-3. What is NMFS' policy on listing hatchery-origin fish under the ESA?

The viability of salmon and steelhead is defined by their abundance, productivity, spatial structure, and genetic/behavioral diversity. High abundance alone is not adequate to demonstrate viability of a salmon ESU or steelhead DPS (Box 1-1).

NMFS' 1993 interim policy on artificial propagation of Pacific salmon stated that hatchery-origin fish should be listed only if they were essential to the conservation of the species. In 2001, however, the U.S. District Court in Oregon ruled that any hatchery-origin component that is part of a listed ESU must also be listed under the ESA (*Alsea Valley Alliance v. NMFS*, 161 F. Supp. 2d 1154, [D. Or. 2001]). NMFS subsequently modified its hatchery policy to conform to this ruling. NMFS' revised hatchery listing policy provides for the listing of a population that is found to be part of the ESU (for salmon) or DPS (for steelhead), regardless of whether it was naturally or artificially produced.

The revised hatchery listing policy was upheld by the 9th Circuit in *Trout Unlimited v. Lohn*, 559 F3d 946 (2009).

With ESA listings and a substantial focus on rebuilding natural-origin salmon and steelhead populations throughout the Columbia River basin, changes in hatchery practices have been and will continue to be implemented to reduce risk and conserve natural-origin salmon and steelhead populations (Section 1.5.2, Other Reviews of Columbia River Basin Hatchery Programs). In each major region in the Columbia River basin, local groups are working with NMFS to develop and implement regional recovery plans for the conservation and survival of listed species (Box 1-4). These recovery plans describe specific management actions needed to achieve recovery as defined under the ESA, and they include management actions that affect hatchery programs. This EIS includes many of these specific management actions within its alternatives.

Box 1-4. What are recovery plans? What are primary, contributing, and stabilizing populations?

NMFS is required, pursuant to section 4(f) of the ESA, to develop recovery plans for marine species listed under the Mitchell Act. Recovery plans are required, to the maximum extent practicable, to incorporate a description of site-specific management actions needed to achieve conservation and survival of the species; incorporate objective, measureable criteria that, when met, would result in a determination that the species be removed from the list; and include estimates of the time and cost to carry out the needed measures.

A recovery plan serves as a road map for species recovery—it identifies recovery objectives and describes how best to meet them. Without a plan to organize, coordinate, and prioritize the many possible recovery actions on the part of Federal, state, and tribal agencies, local watershed councils and districts, and private citizens, recovery efforts may be inefficient or even ineffective. Prompt development and implementation of a recovery plan will help target limited resources effectively. Although recovery plans are guidance, not regulatory documents, the ESA clearly envisions recovery plans as the central organizing tool for guiding each species' recovery process.

While NMFS is directly responsible for ESA recovery planning for salmon and steelhead, it believes that ESA recovery plans for these species should be based on the many state, regional, tribal, local, and private conservation efforts already underway throughout the region. Local support of recovery plans by those whose activities directly affect the listed species and whose actions will be most affected by recovery efforts is essential. NMFS, therefore, supports and participates in locally led collaborative efforts to develop recovery plans that involve local communities, state, tribal, and Federal entities, and other stakeholders.

While the primary goal of ESA recovery plans is for the species to reach the point that it no longer needs the protection of the Act and can be delisted, these locally developed recovery plans may also contain broad-sense goals that go beyond the requirements for delisting to address other legislative mandates or social, economic, and ecological values. The various locally produced plans contain broad-sense goals adopted by local planning entities. These broad-sense goals, although stated in slightly different ways, usually share some combination of the following elements: ensuring long-term

Box 1-4. What are recovery plans? What are primary, contributing, and stabilizing populations? (continued)

persistence of viable populations of natural-origin salmon and steelhead distributed across their native range (viability criteria), enjoying the social and cultural benefits of meaningful harvest opportunities that are sustainable over the long term, and pursuing salmon recovery using an open and cooperative process that respects local customs and benefits local communities and economies. Recovery plans for the Columbia River basin can be found at http://www.nwr.noaa.gov/Salmon-Recovery-Planning/. For a discussion of viability criteria, see McElhany et al. (2006) at http://www.nwfsc.noaa.gov/trt/wlc/viability_report_revised.cfm.

NMFS contributes substantially to the technical considerations underlying the viability of salmon and steelhead populations and ESA delisting criteria. In each recovery domain[3], NMFS established a technical recovery team responsible for, among other things, developing scientific recommendations on how populations and subpopulations within an ESU could be managed at different levels of risk depending on their significance while ensuring recovery. The initial recovery plan developed in the Columbia River basin was by Washington's Lower Columbia Fish Recovery Board (LCFRB). This plan included a recovery scenario that designated individual populations according to the level of recovery contribution for the population (Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan [LCFRB 2004]). The Hatchery Scientific Review Group (HSRG) and this EIS have adopted the designations of the LCFRB. The designations used by the LCFRB are as follows:

Primary Populations. Targeted for restoration to high or very high viability. These populations are the foundation of salmon recovery. Primary populations are typically the strongest extant populations and/or those with the best prospects for protection or restoration.

Contributing Populations. Those for which some improvement will be needed to achieve medium viability. Contributing populations might include those of low to medium significance and viability where improvements can be expected to contribute to recovery.

Stabilizing Populations. Those that would be maintained at current levels. These are typically populations currently at very low viability. Stabilizing populations might include those where significance is low, feasibility of improvement is low, and uncertainty is high.

---

[3] For discussion of recovery domains and other geographic designations, see Section 2.2, Description of Project Area.

1.2 Purpose and Need for Action

As stated in Section 1.1, Introduction, the combination of funding pressures under the Mitchell Act, the 13 ESA listings for salmon and steelhead in the Columbia River basin, and the value of a comprehensive review of hatchery programs to inform decision-makers have resulted in the need for NMFS' proposed action. NMFS' purpose for the action is to develop a policy direction (Box 1-5) related to Columbia River basin hatchery production that will 1) guide its decisions about the distribution of funds for hatchery production under the Mitchell Act; and 2) inform its future review of individual Columbia River hatchery programs under the ESA. The future reviews will be informed through this EIS's analysis of the effects of hatchery programs on the environment, including natural-origin salmon and steelhead populations.

Box 1-5. What is a policy direction?

A policy direction is the overarching theme that will guide and shape decisions NMFS makes related to hatchery production in the Columbia River basin. It is defined by a series of goals and/or principles.

The review of hatchery programs is comprehensive in the sense that information on the effects of all Columbia River basin hatchery programs (Box 1-6) throughout the basin and across a full range of alternatives is exposed in the EIS. Each alternative identifies a different policy direction that would be used to guide NMFS decisions on Columbia River basin hatchery production.

Box 1-6. What is the relationship between NMFS and hatchery operators who receive Mitchell Act funding?

Under the authority of the Mitchell Act, NMFS provides the USFWS, states, and tribes with funds Congress appropriates to manage and operate hatchery programs. NMFS has broad discretion in using these funds either to prescribe narrowly way the production programs will be operated or to allow hatchery operator discretion. Historically, NMFS has provided wide latitude in the use of these hatchery funds.

NMFS plans to continue to provide flexibility to hatchery operators with regard to the operation of Mitchell Act-funded hatchery programs but will offer an overarching vision of how the Mitchell Act-funded programs can best operate as one component of the Columbia River basin hatchery system. NMFS understands that hatchery operators must make good management decisions on a case-by-case basis after considering specific data relevant to their hatchery programs. There are no "one-size-fits-all" solutions. As a result of this environmental review, NMFS anticipates adopting a policy direction that

Box 1-6. What is the relationship between NMFS and hatchery operators who receive Mitchell Act funding? (continued)

identifies general goals for NMFS to pursue with regard to Columbia River hatchery production and a series of recommendations for hatchery operators to consider and adapt when developing plans for their individual hatchery programs.

Activities that are not considered to be within a reasonable range of potential funding or operational opportunities and that are not, therefore, envisioned within the alternatives in this draft EIS, include the following:

- **Construction of New Hatchery Facilities with Mitchell Act Funds.** Current and reasonably foreseeable appropriations under the Mitchell Act for hatchery production would preclude this option. All reasonably foreseeable decisions for the use of Mitchell Act funding at anticipated levels also would preclude this option.
- **Fish Screens and Fishways.** The Mitchell Act Screens and Fishways Program is a separate program with separate congressionally appropriated funding.
- **Habitat Restoration.** While Congress clearly has the discretion to direct Mitchell Act funds toward habitat restoration, it has not done so. Congress consistently and specifically has directed funds to hatchery production (and related monitoring, evaluation, and reform) and to screens and fishways. This EIS is directed at the use of the funds Congress specifically directs towards hatcheries. Through 2009, NMFS has funded habitat restoration through the Pacific Coastal Salmon Recovery Fund, created by Congress in 2000, to address the need to protect, restore, and conserve salmon, steelhead, and their habitat.
- **Hatchery Practices that *Increase* Adverse Effects.** While not all salmon ESUs or steelhead DPSs in the Columbia River basin are listed under the ESA, there is at least one salmon or steelhead population that is a member of a listed ESU or DPS in each of the major subbasins within the project area. Hatchery practices have been identified as a factor for the decline of most listed salmon and steelhead (Section 1.1, Introduction). Because of these factors, the purpose and need for this action is to establish a policy direction that, among other things, includes information on performance standards that *reduce* adverse effects on natural- origin fish. Implementation of hatchery practices that would *increase* adverse effects on listed species when compared to existing practices is not considered in this draft EIS.

It is not the purpose of this EIS to determine whether specific actions or hatchery programs meet the requirements of the ESA. These ESA decisions will be made in separate processes consistent with applicable regulations as required by the ESA (Box 1-7).

Box 1-7. What is the relationship between the ESA and the National Environmental Policy Act (NEPA)?

The relationship between the ESA and NEPA is complex, in part because both laws address environmental values related to the impacts of a proposed action. However, each law has a distinct purpose, and the scope of review and standards of review under each statute are different. This EIS analysis under NEPA should not be viewed as contributing to a conclusion about whether an alternative meets or does not meet ESA requirements.

The purpose of an EIS under NEPA is to promote disclosure, analysis, and consideration of the broad range of environmental issues surrounding a proposed major Federal action by considering a full range of reasonable alternatives, including a no-action alternative. Public involvement promotes this purpose.

The purpose of the ESA is to conserve listed species and the ecosystems upon which they depend. Determinations about whether Mitchell Act hatchery programs meet ESA requirements will be made under section 4(d), section 7, or section 10 of the ESA. Each of these ESA sections has its own substantive requirements, and the documents that reflect the analysis and decisions are different than those related to a NEPA analysis.

It is not the purpose of this EIS to suggest to the reader any conclusions relative to the ESA. While the Record of Decision (ROD) identifies the selected NEPA alternative, the ROD does not determine whether that alternative complies with the ESA.

NMFS acknowledges that the analyses of environmental effects on listed species under the ESA and under NEPA are similar and can lead to confusion; however the analyses under these separate statues are not functionally equivalent. Language in this draft EIS has been chosen in an effort to minimize the confusion between a NEPA analysis and an ESA analysis. For instance, “jeopardize,” “endanger,” “recover,” and similar terms are commonly used to describe the effect of actions under an ESA analysis. This EIS avoids using these terms, using in their place terms and phrases such as performance goals and performance metrics (Section 2.4, Alternative Development, and Section 2.6, Identifying an Implementation Scenario).

1.3 Decisions to be Made

1.3.1 Preferred Alternative Formulated and Identified in Final EIS

This draft EIS evaluates a full range of reasonable policy directions available to NMFS to guide Columbia River basin hatchery operations and the funding on Mitchell Act hatchery programs. Potential implementation scenarios are identified and evaluated for each policy direction so that environmental effects can be analyzed. However, no preferred policy direction is identified in the draft EIS.

NMFS will formulate and identify a preferred policy direction, informed by public comment on the draft EIS, in the final EIS. The preferred policy direction could be one of the alternative policy directions considered in the draft EIS, or it could consist of a combination or blend of the alternative policy directions evaluated in the draft EIS. Information from the public review process will be used in selecting a preferred policy direction and, therefore, a preferred alternative.

1.3.2 Record of Decision

This draft EIS will culminate in a ROD that will record the adoption of a policy direction. The ROD will document the preferred alternative and summarize the impacts expected to result from the implementation of the alternative. The ROD will also identify measures that should be considered by the hatchery operators as they develop their hatchery management plans. Finally, the ROD will address comments and responses on the final EIS.

1.3.3 Potential Future Decisions in Response to Hatchery Actions

1.3.3.1 Federal Agency Hatchery Actions Requiring Section 7 Consultation

As mentioned above, section 7 of the ESA requires Federal agencies to consult with NMFS on any actions that may adversely affect listed salmon and steelhead. Section 7 provides a mechanism to authorize the incidental take of listed species should it be found to occur as a result of hatchery actions. In addition to NMFS, several other Federal agencies fund or operate hatchery programs in the Columbia River basin (USFWS, U.S. Army Corps of Engineers, Bonneville Power Administration, U.S. Bureau of Reclamation, public utility districts) and will have to consult with NMFS. Their hatchery actions may fall within the scope of hatchery operations analyzed in this document. If so, NMFS' consultation under section 7 on those actions (including NMFS consultations with itself on Mitchell Act operations) may be informed by the analysis in this document. Following consultation on these Federal actions, NMFS issues a biological opinion addressing whether the action will jeopardize listed species and an incidental take statement authorizing the incidental take (if appropriate) to the Federal agency.

1.3.3.2 ESA Section 10 Permits and Related Section 7 Consultations

Where take of a listed species is the purpose of the action, regardless of whether the action is by a Federal agency, take must be authorized under the ESA through either a section 10 take permit or a section 4(d) approval. Section 10(a)(1)(A) of the ESA authorizes NMFS to issue permits for direct take of listed species for scientific purposes or to enhance the propagation or survival of listed species. As an example, direct take can occur in a hatchery program when the fish that are taken for broodstock are listed under the ESA. ESA section 10(a)(1)(A) permits can be issued to either Federal or non-Federal entities.

Issuances of section 10(a)(1)(A) permits are Federal actions that require consultation under ESA section 7 (Section 1.3.3.1, Federal Agency Hatchery Actions Requiring Section 7 Consultation). As a result, section 10 permits cannot be issued without a completed section 7 consultation. Future section 10(a)(1)(A) permit requests and subsequent section 7 consultations by NMFS on issuance of such a permit could be informed by the analyses in this EIS; the EIS analyses will not be a substitute for the ESA analyses and determination.

1.3.3.3 ESA Section 4(d) Rules Limiting the Prohibition against Incidental Take and Related Section 7 Consultations

Section 4(d) of the ESA directs NMFS to issue regulations necessary to conserve species listed as threatened. Through the statute itself or through an existing, broad section 4(d) regulation, NMFS automatically prohibits the take of any species listed as threatened or endangered. Section 4(d) does, however, allow NMFS to adopt regulations that limit the broad application of the prohibition against take when it applies to threatened (but not endangered) species under circumstances specified in the rule so that an activity described in the rule can lawfully proceed. NMFS has adopted 13 such limits, including two that are applicable to hatchery production (one applying to hatchery production generally and one applying to tribal activities generally) (for full discussion of section 4(d) limits, see http://www.nwr.noaa.gov/ESA-Salmon-Regulations-Permits/4d-Rules/Index.cfm). Each of these limits requires management plans to 1) specify the goals and objectives for the hatchery program, 2) specify the donor population's critical and viable threshold levels, 3) prioritize broodstock collection programs to benefit listed fish, 4) specify the protocols that will be used for spawning and raising the hatchery-origin fish, 5) determine the genetic and ecological effects arising from the hatchery program, 6) describe how the hatchery operation relates to fishery management, 7) ensure that the hatchery facility can adequately accommodate listed fish if collected for the program, 8) monitor and evaluate the management plan to ensure that it accomplishes its objective, and 9) be consistent with tribal trust obligations (65 Fed. Reg. 42422, July 10, 2000). Should NMFS be requested in the future to determine whether a hatchery management plan qualifies under section 4(d) for a limitation of the prohibition against take, its determination may be informed by the analyses in this document.

The determination that a hatchery management plan qualifies under the section 4(d) rule is a Federal action that triggers the consultation requirements of ESA section 7. As a result, such determinations cannot be made unless the hatchery management plan for which the approval is requested has been found under section 7 not to jeopardize listed species or result in the destruction or adverse modification of their critical habitat. Should NMFS be asked to make a determination under section 4(d) in the future, the section 7 consultation on the determination may be informed by the analyses in this EIS; the EIS analyses will not be a substitute for the ESA analyses and determinations.

1.3.3.4 NEPA Requirements for NMFS ESA Determinations under Sections 7, 4(d), or 10 on Hatchery Operations

As described above, hatchery operators in the Columbia River basin may decide to implement practices at hatchery facilities consistent with the adopted policy direction and seek or require authorization of their activities under ESA sections 7, 4(d), or 10. In response to these requests for authorization, NMFS may assess the applicability of this EIS to inform any required NEPA review accompanying its ESA determination. NMFS will first assess whether the proposed activities fall within the scope of the actions analyzed in this EIS, whether the affected environment has changed since this EIS was prepared, and whether any new information on potential environmental impacts has become available or could be uncovered by conducting further NEPA analysis. If no new information on impacts would be revealed by a new NEPA review, NMFS may seek to avoid repetitive analyses of the same practices on the same resources in an additional EIS and rely upon this EIS to disclose the environmental effects.

1.4 Project and Analysis Area

The project area is the geographic area where the proposed action will take place. This project area covered in this EIS includes rivers, streams, and hatchery facilities where hatchery-origin salmon and steelhead occur or are anticipated to occur in the Columbia River basin, including the Snake River and all other tributaries of the Columbia River in the U.S. (Figure 1-1). The project area also includes the Columbia River estuary and plume. For a full discussion of the project area, see Section 2.1, Description of Project Area.

The analysis area is the geographic extent that is being evaluated for a particular resource. For some resources, the analysis area may be larger than the project area, since some of the effects of the alternatives may occur outside the project area. For example, Alaska is not in the project area, but because the alternatives would have varying effects on Alaska fisheries (since hatchery-origin fish produced in the Columbia River basin are caught in Alaska), Alaska is included in the analysis area for socioeconomics. The analysis area for each resource is described at the beginning of Chapter 3, Affected Environment.

Prepared by Parametrix, Inc. March 8, 2010 (DEIS_Figure_1-1_20100308.mxd).

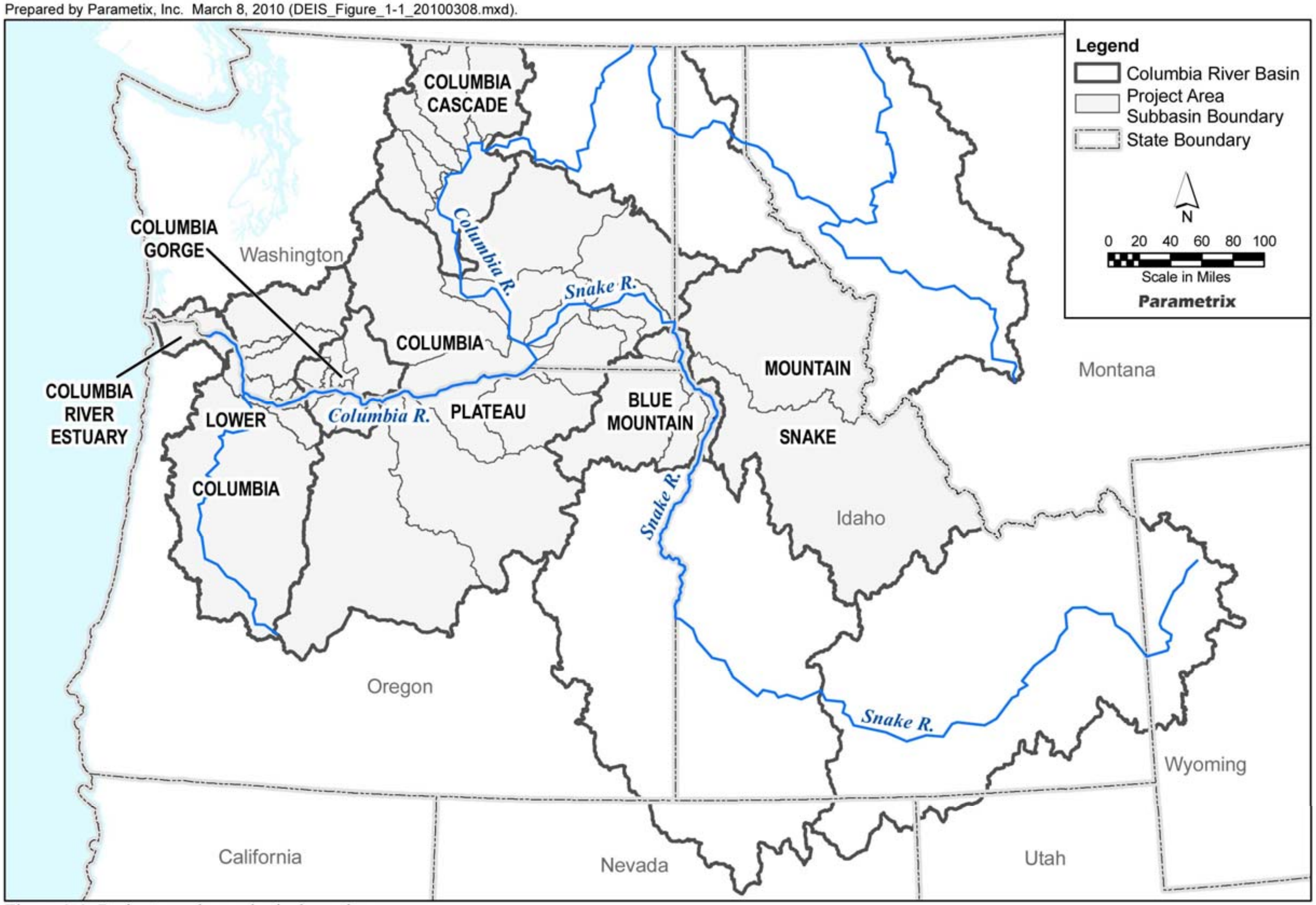


Figure 1-1. Project area by ecological province.

1.5 Background

1.5.1 Hatchery Facilities in the Columbia River Basin

There are more than 58 hatchery facilities for anadromous fish in the Columbia River basin that are operated by Federal and state agencies, tribes, and private interests (Figure 1-2) (Figure 1-3). In 2007, these hatchery facilities supported more than 178 hatchery programs (Table 1-4). Many of the hatchery programs operated at these hatchery facilities are intended to mitigate for lost habitat and other impacts of hydroelectric dams. In 2007, 21 of the hatchery facilities supported one or more hatchery programs funded through the Mitchell Act (Table 1-4) (Figure 1-4).

In addition to the hatchery facilities that are home to production programs funded under the Mitchell Act, hatchery facilities funded under the Lower Snake River Compensation Program are also supported by Federal funds. These hatchery facilities were built to mitigate for the effect of Federal dams on the lower Snake River (Lower Snake River Fish and Wildlife Compensation Plan, Washington and Idaho, March 6, 1985; authorized by the Water Resources Development Act of 1976). Furthermore, the Columbia River Basin Fish and Wildlife Program of the Northwest Power and Conservation Council allocates Bonneville Power Administration funding to finance artificial production programs authorized by the Northwest Power Planning and Conservation Act of 1980 (PL 96-501, December 5, 1980). Other hatchery facilities in the Columbia River basin are funded by private power companies or public utility districts and do not receive Federal funds.

1.5.2 Other Reviews of Columbia River Basin Hatchery Programs

Because of potential adverse effects of hatchery programs on natural salmon and steelhead populations (Section 1.1.2, The Endangered Species Act), Columbia River hatchery programs have undergone several reviews designed to maximize benefits and reduce risks. These reviews include the Northwest Power and Conservation Council's Artificial Production Review and Evaluation (APRE) Process (http://www.nwcouncil.org/fw/apre/Default.htm), NMFS' ESA consultations (http://www.nwr.noaa.gov/Salmon-Harvest-Hatcheries/Hatcheries/ESA-Sec-7-Hatchery.cfm), an ongoing USFWS review of its hatchery programs (http://www.fws.gov/pacific/fisheries/hatcheryreview/), and the Columbia River Hatchery Reform Project (http://www.hatcheryreform.us).

This page left blank intentionally.

Prepared by Parametix, Inc. March 8, 2010 (DEIS_Figure_1-2_20100308.mxd).

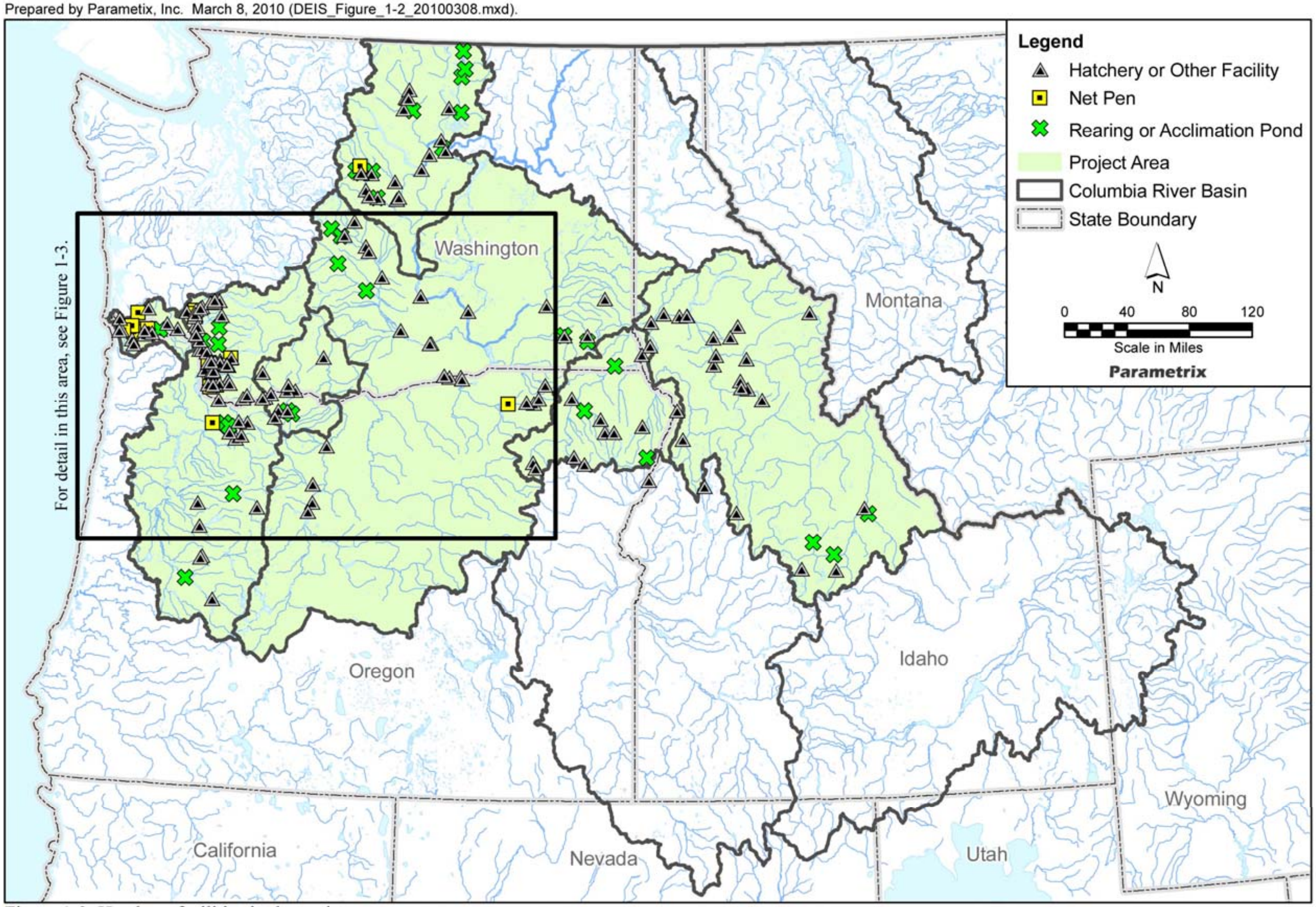


Figure 1-2. Hatchery facilities in the project area.

Prepared by Parametix, Inc. March 8, 2010 (DEIS_Figure_1-3_20100308.mxd).

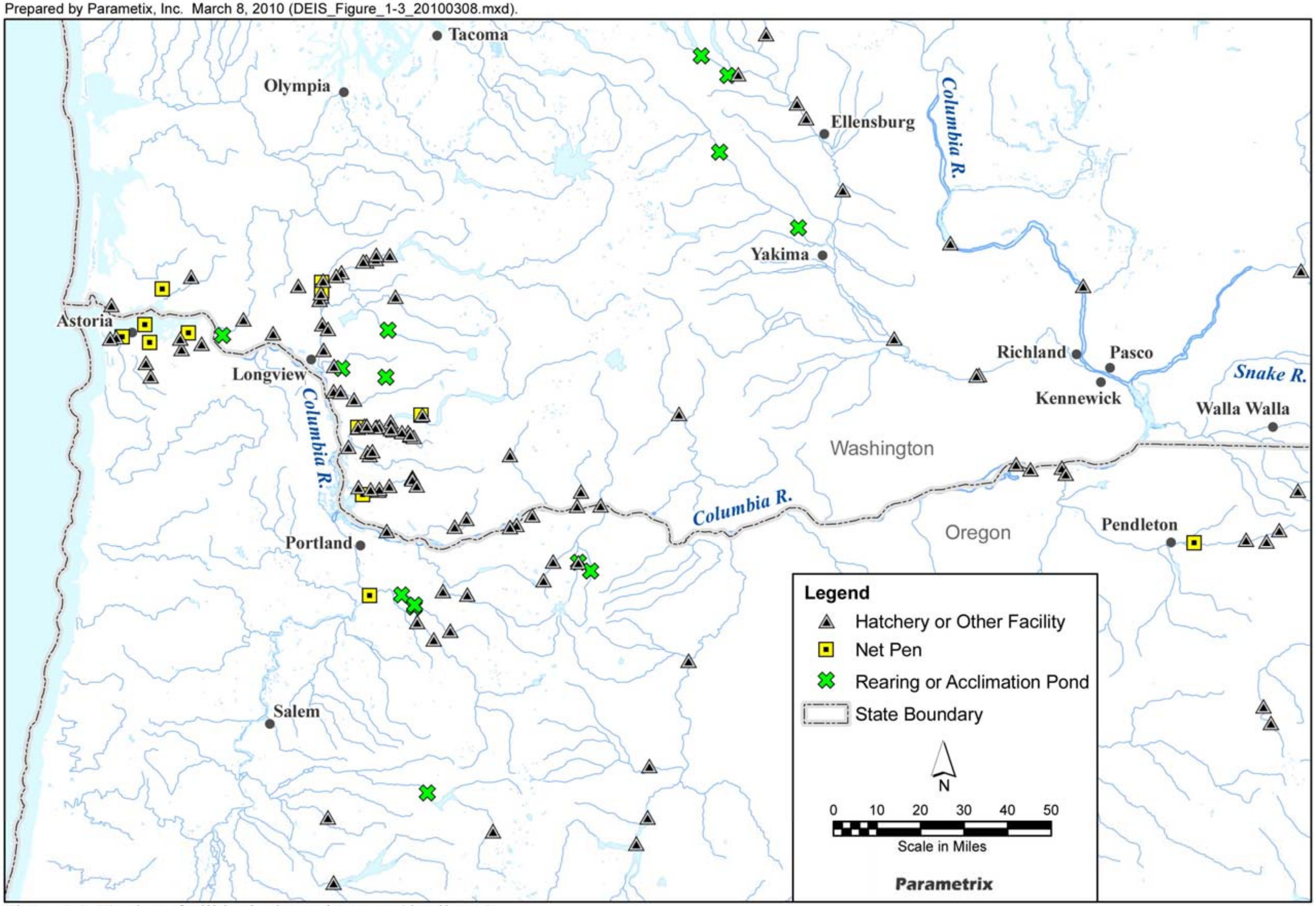


Figure 1-3. Hatchery facilities in the project area (detail area).

Prepared by Parametix, Inc. March 8, 2010 (DEIS_Figure_1-4_20100308.mxd).

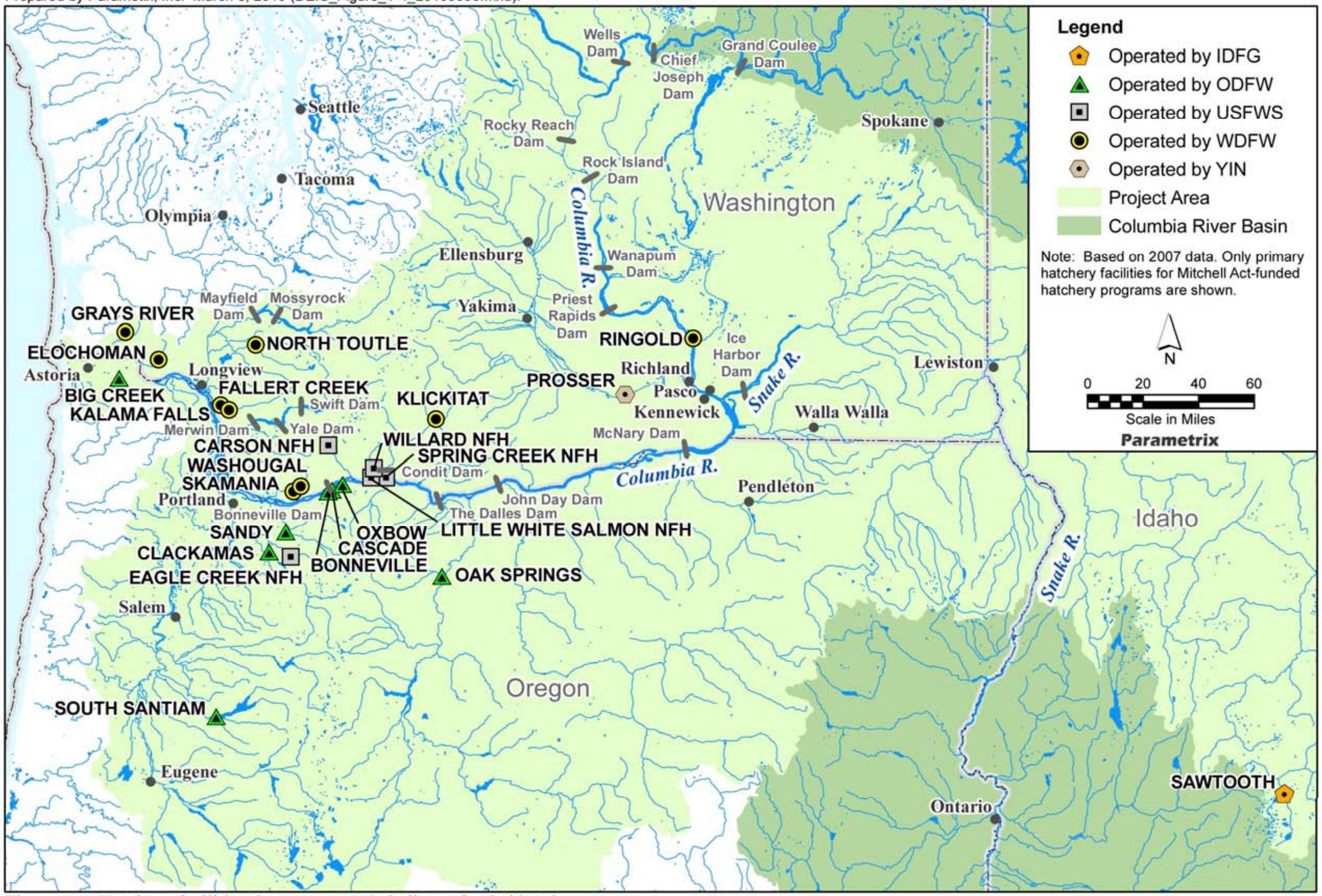


Figure 1-4. Hatchery facilities that support Mitchell Act-funded hatchery programs.

1 **TABLE 1-4. COLUMBIA RIVER BASIN HATCHERY FACILITIES AND PROGRAMS.**

PRIMARY HATCHERY FACILITY	POPULATION/PROGRAM NAME	HATCHERY PROGRAM PURPOSE	FUNDING SOURCE
Colville Tribes Cassimer Bar	Okanogan Summer Steelhead	Conservation	Other
Cowlitz Salmon Hatchery	Lower Cowlitz Fall Chinook Salmon	Harvest	Other
Confederated Tribes of the Umatilla Indian Reservation (CTUIR) Three Mile Dam Facility	Umatilla Fall Chinook Salmon	Both	Other
Idaho Department of Fish and Game (IDFG) Clearwater Fish Hatchery	Lochsa Spring Chinook Salmon	Harvest	Other
	Lower Selway Spring Chinook Salmon	Both	Other
	Lower Selway Spring Chinook Salmon	Harvest	Other
	Upper Selway Spring Chinook Salmon	Harvest	Other
	South Fork Clearwater-Newsome Creek Spring Chinook Salmon	Both	Other
	South Fork Clearwater Spring Chinook Salmon	Harvest	Other
	Lolo Creek Spring Chinook Salmon	Both	Other
	South Fork Clearwater Summer Steelhead (B-run)	Harvest	Other
	Lower Clearwater Summer Steelhead (B-run)	Harvest	Other
	South Fork Clearwater-Crooked River Summer Steelhead (B-run)	Harvest	Other
	Lolo Summer Steelhead (A- and B-run)	Conservation	Other
IDFG Magic Valley Hatchery	Upper Salmon Summer Steelhead (B-run/ Dworshak)	Harvest	Other
IDFG McCall Fish Hatchery	South Fork Salmon Summer Chinook Salmon	Harvest	Other
	East Fork and South Fork Johnson Creek Summer Chinook Salmon	Both	Other
IDFG Oxbow Hatchery	Snake Hells Canyon Spring Chinook Salmon (Adult collection/ holding and early incubation at Oxbow Hatchery)	Harvest	Other

Table 1-4. COLUMBIA RIVER BASIN HATCHERY FACILITIES AND PROGRAMS (CONTINUED).

PRIMARY HATCHERY FACILITY	POPULATION/PROGRAM NAME	HATCHERY PROGRAM PURPOSE	FUNDING SOURCE
	Snake Hells Canyon Summer Steelhead (Adult collection, spawning, and incubation at Oxbow Hatchery)	Harvest	Other
IDFG Pahsimeroi Hatchery	Pahsimeroi Summer Chinook Salmon	Harvest	Other
	Lemhi Summer Steelhead (A-run)	Harvest	Other
	East Fork Salmon Summer Steelhead (A-run)	Harvest	Other
IDFG Rapid River Hatchery	Little Salmon Spring Chinook Salmon	Harvest	Other
IDFG Sawtooth Hatchery	Upper Salmon Mainstem Spring Chinook Salmon	Harvest	Other
	Redfish Lake Sockeye Salmon (Adult h olding, incubation, and rearing at Sawtooth Hatchery)	Conservation	Mitchell Act
	Little Salmon Summer Steelhead (A-run/Pahsimeroi and Oxbow Hatchery) (broodstock and early incubation at Sawtooth Hatchery)	Harvest	Other
	Pahsimeroi Summer Steelhead (A-run) (Broodstook and early incubation at Sawtooth Hatchery)	Harvest	Other
	Upper Salmon Summer Steelhead (A-run) (Broodstock and early incubation at Sawtooth Hatchery)	Harvest	Other
	East Fork Salmon Summer Steelhead (Early incubation at Sawtooth Hatchery)	Conservation	Other
Nez Perce Tribal Fish Hatchery	Lower Mainstem Spring Chinook Salmon	Harvest	Other
ODFW Big Creek Hatchery	Big Creek Fall Chinook Salmon (Tules)	Harvest	Mitchell Act
	Big Creek Coho Salmon	Harvest	Mitchell Act
	Big Creek Winter Steelhead	Harvest	Mitchell Act
	Gnat Creek Winter Steelhead	Harvest	Mitchell Act

Table 1-4. COLUMBIA RIVER BASIN HATCHERY FACILITIES AND PROGRAMS (CONTINUED).

PRIMARY HATCHERY FACILITY	POPULATION/PROGRAM NAME	HATCHERY PROGRAM PURPOSE	FUNDING SOURCE
	Youngs Bay Tributary Winter Steelhead	Harvest	Mitchell Act
ODFW Bonneville Hatchery	Bonneville Fall Chinook Salmon	Harvest	Mitchell Act
	Youngs Bay Coho Salmon	Harvest	Mitchell Act
	Bonneville Coho Salmon	Harvest	Mitchell Act
	Umatilla Fall Chinook Salmon (Broodstock, incubation, and rearing at Bonneville Hatchery)	Harvest	Other
ODFW Bonneville/Oxbow/Cascade Hatcheries	Umatilla Coho Salmon	Harvest	Mitchell Act
ODFW Clackamas Hatchery	Clackamas Summer Steelhead	Harvest	Other
	Lower Clackamas Winter Steelhead (Late)	Harvest	Other
	Clackamas Spring Chinook Salmon	Harvest	Mitchell Act
ODFW Irrigon Hatchery	Little Sheep Summer Steelhead	Both	Other
ODFW Klaskanine Hatchery (North Fork)	Youngs Bay Fall Chinook Salmon (Rogue River Upriver Brights-Select Area Fisheries)	Harvest	Other
ODFW Lookingglass Hatchery	Lostine Spring Chinook Salmon	Conservation	Other
	Imnaha Spring/Summer Chinook Salmon	Both	Other
	Catherine Creek Spring Chinook Salmon	Conservation	Other
	Lookingglass Creek Spring Chinook Salmon	Both	Other
	Upper Grande Ronde Spring Chinook Salmon	Conservation	Other
ODFW Marion Forks Hatchery	North Santiam Spring Chinook Salmon	Both	Other
ODFW McKenzie Hatchery	McKenzie Spring Chinook Salmon	Both	Other
ODFW Oak Springs Hatchery (Deschutes Subbasin)	Hood Summer Steelhead	Conservation	Other
	Hood Summer Steelhead (Santiam)	Harvest	Other
	Hood Winter Steelhead	Conservation	Other

Table 1-4. COLUMBIA RIVER BASIN HATCHERY FACILITIES AND PROGRAMS (CONTINUED).

PRIMARY HATCHERY FACILITY	POPULATION/PROGRAM NAME	HATCHERY PROGRAM PURPOSE	FUNDING SOURCE
ODFW Round Butte Hatchery	Deschutes Spring Chinook Salmon	Harvest	Other
	Hood Spring Chinook Salmon	Conservation	Other
	Deschutes Summer Steelhead	Harvest	Other
ODFW Sandy Hatchery	Sandy Coho Salmon	Harvest	Mitchell Act
	Sandy Winter Steelhead (Late)	Harvest	Mitchell Act
	Sandy Spring Chinook Salmon	Harvest	Mitchell Act
ODFW South Santiam Hatchery	Sandy Summer Steelhead (Broodstock, spawning, eyed egg at South Santiam Hatchery/ incubation and rearing at Oak Springs Hatchery/ incubation and rearing at Bonneville Hatchery/ acclimation and release at Sandy Hatchery)	Harvest	Mitchell Act
	Molalla Spring Chinook Salmon	Both	Other
	South Santiam Spring Chinook Salmon	Harvest	Other
	South Santiam Summer Steelhead	Harvest	Other
	MF Willamette Summer Steelhead (Broodstock, incubation, and rearing at South Santiam Hatchery)	Harvest	Other
	Mainstem Willamette Summer Steelhead (Broodstock, incubation, and rearing at South Santiam Hatchery)	Harvest	Other
	McKenzie Summer Steelhead (Broodstock, incubation, and rearing at South Santiam Hatchery)	Harvest	Other
	North Santiam Summer Steelhead (Broodstock, incubation, and rearing at South Santiam Hatchery)	Harvest	Other
ODFW Wallowa Hatchery	Wallowa Summer Steelhead	Harvest	Other
ODFW Willamette Hatchery	Youngs Bay Spring Chinook Salmon (Select Area Fisheries)	Harvest	Other

Table 1-4. COLUMBIA RIVER BASIN HATCHERY FACILITIES AND PROGRAMS (CONTINUED).

PRIMARY HATCHERY FACILITY	POPULATION/PROGRAM NAME	HATCHERY PROGRAM PURPOSE	FUNDING SOURCE
ODFW Willamette Hatchery and Dexter Ponds	Middle Fork Willamette Spring Chinook Salmon	Both	Other
ODFW/CTUIR Umatilla Hatchery	Umatilla Summer Steelhead	Both	Other
USFWS Carson National Fish Hatchery	Walla Walla Spring Chinook Salmon	Conservation	Other
	Wind Spring Chinook Salmon	Harvest	Mitchell Act
USFWS Dworshak Hatchery	Little Salmon Summer Steelhead (B-run)	Harvest	Other
	East Fork Salmon Summer Steelhead (B-run)	Harvest	Other
	Upper Salmon Summer Steelhead (B-run)	Harvest	Other
	South Fork Clearwater Summer Steelhead (B-run)	Harvest	Other
	North Fork Clearwater Summer Steelhead (B-run)	Harvest	Other
	North Fork Clearwater Spring Chinook Salmon	Harvest	Other
USFWS Eagle Creek National Fish Hatchery	Clearwater Coho Salmon	Conservation	Mitchell Act
	Clackamas-Eagle Creek Coho Salmon	Harvest	Mitchell Act
	Clackamas-Eagle Creek Winter Steelhead (Early)	Harvest	Mitchell Act
USFWS Kooskia National Fish Hatchery	Middle Fork Clearwater Spring Chinook Salmon	Harvest	Other
USFWS Leavenworth National Fish Hatchery	Wenatchee Spring Chinook Salmon	Harvest	Other
USFWS Little White Salmon/Willard National Fish Hatchery Complex	Umatilla Spring Chinook Salmon	Both	Other
	Wenatchee (White) Spring Chinook Salmon	Conservation	Other
	Yakima Fall Chinook Salmon	Harvest	Mitchell Act
	Wenatchee Coho Salmon	Conservation	Other
	Upper Yakima-Naches Coho Salmon	Both	Mitchell Act
	Little White Salmon Fall Chinook Salmon (Upriver Brights)	Harvest	Mitchell Act
	Little White Salmon Spring Chinook Salmon	Harvest	Mitchell Act

Table 1-4. Columbia River Basin Hatchery Facilities and Programs (continued).

Primary Hatchery Facility	Population/Program Name	Hatchery Program Purpose	Funding Source
USFWS Spring Creek National Fish Hatchery	Spring Creek Fall Chinook Salmon (Tules)	Harvest	Mitchell Act
USFWS Warm Springs National Fish Hatchery	Deschutes Spring Chinook Salmon	Harvest	Other
USFWS Winthrop Hatchery	Methow Spring Chinook Salmon	Both	Other
	Methow Coho Salmon	Conservation	Other
	Methow Summer Steelhead	Both	Other
Washington Department of Fish and Wildlife (WDFW) Cowlitz Hatchery	Cowlitz Upper Cowlitz Coho Salmon	Harvest	Other
	Lower Cowlitz Coho Salmon (Type N)	Harvest	Other
	Upper Cowlitz Spring Chinook Salmon	Harvest	Other
	Lower Cowlitz Summer Steelhead (Skamania)	Harvest	Other
	Lower Cowlitz Winter Steelhead (Early)	Harvest	Other
	Lower Cowlitz Winter Steelhead (Late)	Both	Other
	Upper Cowlitz Winter Steelhead (Late)	Both	Other
WDFW Eastbank Hatchery Complex	Wenatchee Summer Chinook Salmon	Both	Other
	Wenatchee Sockeye Salmon	Conservation	Other
	Wenatchee Summer Steelhead	Both	Other
	Okanogan-Similkimeen Summer Chinook Salmon	Both	Other
	Wenatchee (Chiwawa) Spring Chinook Salmon	Conservation	Other
WDFW Elochoman Hatchery	Elochoman Fall Chinook Salmon	Harvest	Mitchell Act
	Elochoman Coho Salmon (Early/ Type S)	Harvest	Mitchell Act
	Elochoman Coho Salmon (Late/ Type N)	Both	Mitchell Act
	Elochoman Summer Steelhead	Harvest	Mitchell Act
	Elochoman Winter Steelhead (Early)	Harvest	Mitchell Act

Table 1-4. COLUMBIA RIVER BASIN HATCHERY FACILITIES AND PROGRAMS (CONTINUED).

PRIMARY HATCHERY FACILITY	POPULATION/PROGRAM NAME	HATCHERY PROGRAM PURPOSE	FUNDING SOURCE
	Bernie Creek Coho Salmon (Late/ Type N)	Harvest	Mitchell Act
	Coweeman Winter Steelhead (Early)	Harvest	Mitchell Act
WDFW Fallert Creek Hatcheries	Kalama Summer Steelhead	Conservation	Mitchell Act
	Kalama Summer Steelhead (Skamania)	Harvest	Mitchell Act
	Kalama Coho Salmon (Early/ Type S)	Harvest	Mitchell Act
	Kalama Winter Steelhead (Early)	Harvest	Mitchell Act
	Kalama Winter Steelhead (Late)	Harvest	Mitchell Act
WDFW Grays River Hatchery	Deep River Spring Chinook Salmon (Cowlitz, Merwin, and Grays)	Harvest	Other
	Grays-Chinook Salmon River Chum Salmon	Conservation	Other
	Deep River Coho Salmon (Early/ Type S)	Harvest	Other
	Grays Coho Salmon (Early/ Type S)	Harvest	Other
	Grays Winter Steelhead (Early)	Harvest	Mitchell Act
WDFW Green River Hatchery (North Fork Toutle River)	Toutle Coho Salmon (Early/ Type S)	Harvest	Mitchell Act
WDFW Kalama Falls Hatchery	Kalama Fall Chinook Salmon	Harvest	Mitchell Act
	Kalama Spring Chinook Salmon	Harvest	Mitchell Act
	Kalama Coho Salmon (Late/ Type N)	Harvest	Mitchell Act
WDFW Lewis River Hatchery	NF Lewis Spring Chinook Salmon	Harvest	Other
	NF Lewis Coho Salmon (Early/ Type S)	Both	Other
	NF Lewis Coho Salmon (Late/ Type N)	Harvest	Other
	NF Lewis Coho Salmon (Late/ Type N)	Harvest	Other

Table 1-4. COLUMBIA RIVER BASIN HATCHERY FACILITIES AND PROGRAMS (CONTINUED).

PRIMARY HATCHERY FACILITY	POPULATION/PROGRAM NAME	HATCHERY PROGRAM PURPOSE	FUNDING SOURCE
WDFW Lyons Ferry Hatchery	Tucannon Spring Chinook Salmon	Conservation	Other
	Snake Hells Canyon Fall Chinook Salmon	Both	Other
	Tucannon Summer Steelhead	Conservation	Other
	Tucannon Summer Steelhead	Harvest	Other
	Snake Lower Summer Steelhead	Harvest	Other
	Walla Walla Summer Steelhead	Harvest	Other
	Touchet Summer Steelhead	Harvest	Other
	Touchet Summer Steelhead	Conservation	Other
	Cottonwood Creek Summer Steelhead (Wallowa)	Harvest	Other
WDFW Merwin Hatchery	North Fork Lewis Summer Steelhead	Harvest	Other
	North Fork Lewis Winter Steelhead	Harvest	Other
WDFW Methow Hatchery	Methow (Methow-Chewuch) Spring Chinook Salmon	Conservation	Other
	Methow (Twisp) Spring Chinook Salmon	Conservation	Other
WDFW North Toutle River Hatchery	Toutle Fall Chinook Salmon	Harvest	Mitchell Act
WDFW Priest Rapids Hatchery Complex	Columbia Lower Middle Hanford Fall Chinook Salmon (Priest Rapids Upriver Brights)	Harvest	Other
WDFW Ringold Springs Hatchery	Ringold Summer Steelhead (Wells)	Harvest	Mitchell Act
	Middle Columbia Fall Chinook Salmon (Upriver Brights)	Harvest	Mitchell Act
	Spring Chinook Salmon (Via Little White Salmon Hatchery)	Harvest	Other
WDFW Skamania Hatchery	North Fork Toutle Summer Steelhead	Harvest	Mitchell Act
	South Fork Toutle Summer Steelhead	Harvest	Mitchell Act
	Klickitat Summer Steelhead (Skamania)	Harvest	Mitchell Act
	East Fork Lewis Summer Steelhead (Skamania)	Harvest	Mitchell Act

Table 1-4. COLUMBIA RIVER BASIN HATCHERY FACILITIES AND PROGRAMS (CONTINUED).

PRIMARY HATCHERY FACILITY	POPULATION/PROGRAM NAME	HATCHERY PROGRAM PURPOSE	FUNDING SOURCE
	East Fork Lewis Winter Steelhead (Skamania)	Harvest	Mitchell Act
	Salmon Creek Winter Steelhead (Skamania)	Harvest	Mitchell Act
	Washougal Summer Steelhead (Skamania)	Harvest	Mitchell Act
	Washougal Winter Steelhead (Early/ Skamania)	Harvest	Mitchell Act
	White Salmon Summer Steelhead (Skamania)	Harvest	Mitchell Act
	White Salmon Winter Steelhead (Skamania)	Harvest	Mitchell Act
WDFW Washougal Hatchery	Washougal Fall Chinook Salmon	Harvest	Mitchell Act
	Duncan Creek Chum Salmon	Conservation	Other
	Klickitat Coho Salmon (Washougal)	Harvest	Mitchell Act
	Washougal Coho Salmon	Harvest	Mitchell Act
WDFW Wells Hatchery	Methow Summer Chinook Salmon (Wells)	Both	Other
	Upper Middle Columbia Summer Chinook Salmon (Wells)	Harvest	Other
	Okanogan Summer Steelhead (Wells)	Harvest	Other
	Mainstem Summer Chinook Salmon (Also uses the Eastbank Hatchery Complex)	Harvest	Other
Yakama Nation Cle Elum Hatchery	Upper Yakima Spring Chinook Salmon	Both	Other
Yakama Nation Marion Drain Hatchery	Marion Drain Fall Chinook Salmon	Conservation	Other
Yakama Nation Prosser Hatchery	Yakima Fall Chinook Salmon (Little White Salmon)	Harvest	Mitchell Act
	Yakima Coho Salmon	Both	Mitchell Act
Yakama Nation Klickitat Hatchery	Klickitat Fall Chinook Salmon (Upriver Brights)	Harvest	Mitchell Act
	Klickitat Spring Chinook Salmon	Both	Mitchell Act
	Klickitat Coho Salmon (Lewis)	Harvest	Mitchell Act

Source: Appendix A

1.6 Scoping and the Relevant Issues

The first step in preparing an EIS is to conduct scoping of the issues that may be associated with the proposed action. This occurs through public and internal scoping processes. The purpose of public and internal scoping is to identify the environmental issues relevant to implementation of the proposed action, eliminate insignificant issues from detailed study, and identify the alternatives to be analyzed. Scoping can also help determine the level of analysis and data required for analysis.

1.6.1 Scoping Process

The scoping process for this EIS involved public and internal scoping activities that are described in the following paragraphs.

1.6.2 Notice of Intent

Public scoping was officially initiated with the Notice of Intent to prepare a draft EIS in the Federal Register on September 3, 2004 (69 Fed. Reg. 171). This notice announced a 90-day public comment period (September 3, 2004 to December 2, 2004) to gather information on the scope of the issues and the range of alternatives to be analyzed in the EIS. A second notice, published on March 12, 2009 (74 Fed. Reg. 47), was announced to inform the public of NMFS' intent to expand the project scope to include all Columbia River hatchery programs, regardless of funding source.

NMFS developed a website for this EIS at http://www.nwr.noaa.gov/1srd/Propagation/ MAHatchEIS/. The website was available to the public during the scoping period and will be updated and available throughout the project duration. A notice describing the project was also distributed through electronic mail to addresses on a project mailing list of almost 200 individuals, agencies, private businesses, and environmental organizations that have shown an interest in salmon issues. *The Columbian* newspaper and the *Columbia Basin Bulletin* published announcements that informed the public that NMFS had initiated public scoping for the project.

1.6.3 Internal Scoping

NMFS began internal project scoping in the spring of 2004. The objective of internal scoping was to identify the environmental parameters considered relevant to hatchery actions associated with the proposed action. An interdisciplinary project team identified resources both likely and unlikely to be affected by the proposed action. The resources identified as likely to be affected by the proposed action were then included in Chapter 3 and Chapter 4 of this EIS. In addition, the internal scoping process included review of comments received from the public during scoping. A range of reasonable alternatives was then created via internal scoping by incorporating key issues identified by public and internal scoping comments. The range of resources identified as likely to be affected by the proposed action was also modified if warranted by public comment.

1.6.4 Written Comments

Twenty comment letters were received during the two public scoping periods, including six letters from governmental agencies, one letter from a tribal organization, seven letters from non-governmental organizations and businesses, and six letters from individual citizens. The letters all originated in Washington and Oregon, except for one from Alaska and one from Illinois.

1.6.5 Issues Identified During Scoping

The following issues were identified during both public and internal scoping. These issues were considered during development of alternatives and in evaluating effects of the proposed action.

- **Hatchery Research, Monitoring, and Performance Standards.** Requests were received to develop a performance-based funding structure based on research and monitoring, as well as a cost-benefit analysis of hatchery programs considered for funding.
- **Distribution of Hatchery Production.** Commenters were divided as to whether funding and production should be prioritized in the upper or lower Columbia River basins.
- **Location, Type, and Timing of Hatchery Production.** Some comments focused on methods to decrease hatchery fish interactions with natural-origin fish, including timing of the release of hatchery-origin fish, eliminating release of non-native fish, eliminating stock transfers among hatchery facilities and off-site release in rivers, constructing fish passage barriers for hatchery facilities, replacing fish screens that may be deficient, and raising fish better adapted to reproduce naturally.
- **Funding.** Comments included requests for information on how funding is allocated among hatchery programs, monitoring, and research.
- **Hatchery Maintenance Projects.** Commenters requested a process for including hatchery facility maintenance backlogs in the hatchery funding process.
- **Hatchery Production.** Comments included requests to both increased and decreased hatchery production.

- **Guidance on Adverse Effects**. Commenters stressed the importance of linking Mitchell Act hatchery policy with an analysis of its effects on natural-origin salmon and steelhead populations. They also stressed the importance of identifying and analyzing the effects of other hatchery production in the basin to determine the effects of the Mitchell Act production.

1.6.6 Future Public Review and Comment

This draft EIS has been issued for a 90-day public review period, which was announced in newspapers, through correspondence with tribes and other interested parties, and by publication in the Federal Register. Following this public review period, responses to public comments will be prepared and included in the final EIS. Responses will include changes to the EIS as a result of public comments, if warranted.

1.7 Relationship to Other Plans, Regulations, Agreements, Laws, and Secretarial Orders

In addition to the ESA and NEPA, other plans, regulations, agreements, laws, and Secretarial Orders also affect hatchery operations in the Columbia River basin. They are summarized below to provide additional context for the Mitchell Act Hatchery Program.

1.7.1 *U.S. v. Oregon*

U.S. v. Oregon was originally a combination of two cases, *Sohappy v. Smith* and *U.S. v. Oregon* (302 F. Supp. 899, 1978), which legally upheld the Columbia River Treaty Tribes' reserved fishing rights and tribal entitlement to a fair share of fish runs. Although the *Sohappy* case was closed in 1978, *U.S. v. Oregon* remains under the Federal court's continuing jurisdiction. In his 1969 decision, Judge C. Belloni ruled that state regulatory power over Indian fishing is limited because the 1855 treaties between the United States and the Nez Perce, Umatilla, Warm Springs, and Yakama Tribes preserved their reserved rights to fish at all usual and accustomed places whether on or off reservation. In 1974, Judge George Boldt decided in *U.S. v. Washington* that Belloni's citing of the tribes' fair and equitable share was 50 percent of all of the harvestable fish destined for the tribes' traditional fishing places. The following year, Judge Belloni applied the 50 percent standard to *U.S. v. Oregon*. In 1977, under the jurisdiction in *U.S. v. Oregon*, the Federal court ordered a 5-year plan to develop an in-river harvest sharing formula between non-Indian and Indian fisheries. In 1988, the cooperatively negotiated Columbia River Fish Management Agreement (Management Agreement) was adopted by the Federal court, which included a detailed harvest and fish production process. The most current Management Agreement was adopted by the Federal court in 2008 and will be in place for 10 years (Appendix B). Approximately half of the production currently funded under the Mitchell Act is used to fulfill commitments of the Management Agreement.

Fisheries in the Columbia River are carefully designed to be consistent with Federal court rulings related to treaty Indian fishing rights. The governing Management Agreement has been cooperatively negotiated by the Federal and state governments and the involved treaty Indian tribes under the continuing jurisdiction of the Federal court to ensure implementation of the tribe's fishing rights. The agreement includes important and substantive commitments related to hatchery production (Appendix B, Table B1 through Table B7) that are "intended to ensure that Columbia River fish runs continue to provide a broad range of benefits in perpetuity." The Management Agreement also includes provisions to "facilitate cooperative action by the Parties with regard to fishing regulations, policy issues or disputes, and the coordination of the management of fisheries on Columbia River runs and production and harvest measures."

The purpose of this EIS is to analyze the environmental effects of a range of reasonable alternatives related to hatchery production. For the purpose of analysis, NMFS developed alternatives that may or may not be viewed by any particular commenter as consistent with the current commitments in the Management Agreement. No specific assertions will be made in this EIS about the relationship between an alternative and the Management Agreement. Rather, NMFS assumes that affected parties will exercise their authority regarding production measures following this environmental analysis in a manner that is consistent with the most current Management Agreement.

1.7.2 Secretarial Order 3206

Secretarial Order 3206 (American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and the Endangered Species Act, http://www.fws.gov/endangered/tribal/Esatribe.htm) issued by the secretaries of the departments of Interior and Commerce, clarifies the responsibilities of the agencies, bureaus, and offices of the departments when actions taken under the ESA and its implementing regulations affect, or may affect, Indian lands, tribal trust resources, or the exercise of American Indian tribal rights as they are defined in the Order. Secretarial Order 3206 acknowledges the trust responsibility and treaty obligations of the U.S. toward tribes and tribal members, as well as its government-to-government relationship when corresponding with tribes. Under the Order, the Services "will carry out their responsibilities under the [ESA] in a manner that harmonizes the Federal trust responsibility to tribes, tribal sovereignty, and statutory missions of the [Services], and that strives to ensure that Indian tribes do not bear a disproportionate burden for the conservation of listed species, so as to avoid or minimize the potential for conflict and confrontation."

More specifically, the Services shall, among other things, do the following:

- Work directly with Indian tribes on a government-to-government basis to promote healthy ecosystems (Sec. 5, Principal 1).
- Assist Indian tribes in developing and expanding tribal programs so that healthy ecosystems are promoted and conservation restrictions are unnecessary (Sec. 5, Principal 3).
- Be sensitive to Indian culture, religion, and spirituality (Sec. 5, Principal 4).

1.7.3 Clean Water Act

The Clean Water Act (33 USC 1251, 1977, as amended in 1987), administered by the U.S. Environmental Protection Agency and state water quality agencies, is the principal Federal legislation directed at protecting water quality. Each state implements and carries forward Federal provisions, approves and reviews National Pollutant Discharge Elimination System applications, and establishes total maximum daily loads for rivers, lakes, and streams. The states are responsible for setting the water quality standards needed to support all beneficial uses, including protection of public health, recreational activities, aquatic life, and water supplies.

The Washington State Water Pollution Control Act, codified as Revised Code of Washington Chapter 90.48, designates the Washington Department of Ecology (Ecology) as the agency responsible for carrying out the provisions of the Clean Water Act in Washington State. Ecology is responsible for establishing water quality standards, making and enforcing water quality rules, and operating waste discharge permit programs. These regulations are described in Washington Administrative Code 173.

In Oregon, the Oregon Department of Environmental Quality is responsible for carrying out the Clean Water Act through its water quality program rules adopted by the Environmental Quality Commission as part of Oregon Administrative Rules Chapter 340 and 468b. Similarly, the Idaho Department of Environmental Quality is responsible for carrying out the Clean Water Act in Idaho through the water quality and antidegradation policies contained in the Idaho Administrative Procedure Act, 58.01.02, Section 05.

1.7.4 Pacific Salmon Treaty

The Pacific Salmon Treaty between Canada and the U.S. was finalized March 17, 1985 (Pacific Salmon Commission 1985). The treaty established a framework for managing salmon stocks either originating from one country and intercepted by the other, or affecting the management or the biology of the stocks of the other country. The treaty commits the U.S. and Canada to equitable cross-border sharing of harvest and conservation of United States and Canadian stocks. The objective of the treaty and the several fishing regimes established in its "Annex IV" is to constrain harvest on both sides of the border and to rebuild depressed salmon stocks. The Pacific Salmon Commission oversees implementation of the treaty and negotiates periodic revisions of the Annex IV fishing regimes. A new agreement was reached on portions of Annex IV in May 2008. The agreement governs Chinook salmon and several other species from 2009 through 2018. The agreement was finalized by exchange of diplomatic notes on December 23, 2008. Coho salmon harvest regimes are also among those governed by the Annex IV, but those provisions do not expire until 2018.

1.7.5 Washington State's Wild Salmonid Policy

The Wild Salmonid Policy was adopted in 1997 by the Washington Fish and Wildlife Commission (WDFW and Western Washington Treaty Tribes 1997) to guide WDFW in harvest, hatchery, and habitat protection programs. The policy's goal is to restore Washington's wild salmon and steelhead stocks to healthy, harvestable runs by performing the following activities:

- Managing commercial and sport fishing to ensure that enough of the wild run returns to spawn while providing fishing opportunities where possible
- Producing and releasing hatchery salmon and steelhead without harming wild fish runs
- Identifying habitat priorities that are essential for the protection and rebuilding of the salmonid resource in Washington State

Not all tribal governments endorsed the Wild Salmonid Policy. Where WDFW and the tribes could not reach a common goal or standard, they deferred further agreement and discussion to a particular subbasin or tribal region. This approach reserves the prerogative for WDFW and the tribes to provide additional fishery management guidance, directives, or policies that better address the needs of specific subbasins and regions.

1.7.6 State Endangered, Threatened, and Sensitive Species Acts

This EIS will consider the effects of hatchery operations on state endangered, threatened, and sensitive species. The state of Washington has species of concern listings (Washington Administrative Code Chapters 232-12-014 and 232-12-011) that include all state endangered, threatened, sensitive, and candidate species. These species are managed by WDFW, as needed, to prevent them from becoming endangered, threatened, or sensitive. The state-listed species are identified on WDFW's website (http://wdfw.wa.gov/wlm/diversty/soc/soc.htm); the most recent update occurred in June 2008. The criteria for listing and de-listing and the requirements for recovery and management plans for these species are provided in Washington Administrative Code Chapter 232-12-297. The state list is separate from the Federal ESA list; the state list includes species status relative to Washington State jurisdiction only. Critical wildlife habits associated with state or federally listed species are identified in Washington Administrative Code Chapter 222-16-080.

Oregon also has a state ESA (Oregon Administrative Rules 635-100-0001-0180). ODFW is responsible for fish and wildlife under the Oregon ESA, and the Oregon Department of Agriculture is responsible for plants. The Oregon ESA generally affects only the actions of state agencies on state-owned or leased lands.

The state of Idaho's list of threatened and endangered species is under the Idaho Administrative Procedures Act, 13.01.06.000 *et seq*. The Idaho Department of Lands is the legal authority concerning take of a state-listed species and the classification of state-listed wildlife species.

1.7.7 Oregon Native Fish Conservation Policy

The purpose of Oregon's Native Fish Conservation Policy (Oregon Administrative Rules 635-007-0502 through -0509) is to ensure the conservation and recovery of native fish in Oregon and to focus on natural-origin, native fish. The policy is based on the premise that "…locally adapted populations provide the best foundation for maintaining and restoring sustainable naturally produced native fish." (Oregon Administrative Rule 635-007-0505(2)). The intent of this policy is to provide a basis for managing hatchery programs, fisheries, habitat, predators, competitors, and pathogens in balance with sustainable production of natural-origin fish.

1.7.8 Oregon Fish Hatchery Management Policy

The Oregon Fish Hatchery Management Policy (Oregon Administrative Rules 635-007-0542 through -0548) describes best management practices that are intended to help ensure the conservation of both hatchery-origin and natural-origin fish in Oregon through the responsible use of hatchery programs. The Hatchery Management Policy complements and supports the Native Fish Conservation Policy (Oregon Administrative Rules 635-007-0502 through -0509) and is implemented through the development of conservation plans.

1.7.9 Federal Columbia River Power System (FCRPS) Biological Opinion

The 2008 FCRPS Reasonable and Prudent Alternative (RPA) proposed new and expanded hatchery facilities for conservation hatchery programs that promote salmon and steelhead recovery. In addition, the RPA directed the action agencies to 1) ensure that hatchery programs funded by the FCRPS are not impeding recovery of ESA-listed salmon ESUs or steelhead DPSs, and 2) preserve and rebuild genetic resources through safety-net and conservation actions to reduced short-term extinction risk and promote recovery. Specific proposals to achieve these objectives will be developed and proposed in the hatchery genetic management plans (HGMPs) that the hatchery managers submit to NMFS under the ESA.

1.8 Organization of this Draft EIS

This EIS has been prepared in accordance with NEPA (40 CFR 1500 to 1508) and NEPA guidelines adopted by NMFS (2003). The contents of this draft EIS are described briefly below:

- **Introductory Materials**. Before Chapter 1, there is a cover sheet, executive summary, list of acronyms and abbreviations, glossary of key terms, and table of contents.
- **Chapter 1**. This chapter describes the purpose and need for the action; decisions to be made; scoping and relevant issues; and applicable plans, regulations, and laws.
- **Chapter 2**. This chapter describes each of the alternatives and lists their major components. The No-action Alternative is included, along with four action alternatives.
- **Chapter 3**. This chapter describes the existing environmental setting that would be affected under each of the alternatives. It includes a section on fish, socioeconomics, environmental justice, wildlife, water quality and quantity, and human health.
- **Chapter 4**. This chapter contains a description and analysis of the potential direct and indirect effects of each alternative on the resources identified in Chapter 3. It also compares the action alternatives to the no-action alternative.
- **Chapter 5**. This chapter addresses cumulative impacts, which are the incremental effects of an action when added to other past, present, and reasonably foreseeable actions, regardless of what agency or person undertakes such actions. Climate change is addressed in this chapter.
- **Remaining Material**. After Chapter 5, there is a list of references, a distribution list, a list of preparers, and appendices.

Science, Service, Stewardship

Chapter 2

Alternatives

2.0 ALTERNATIVES

2.1 Introduction

This chapter describes and compares the five alternatives considered in this draft environmental impact statement (EIS). The environmental effects of the alternatives are presented in more detail in Chapter 4, Environmental Consequences. Specifically, this chapter describes the following:

- Context for the alternatives
- How the alternatives were developed
- Alternatives that were considered in detail
- Alternatives that were considered but eliminated from detailed discussion
- The process for developing a preferred alternative (Box 2-1)

Box 2-1. Is there a preferred alternative for this draft EIS?

As noted in Chapter 1, Purpose of and Need for the Proposed Action, and explained in further detail in Chapter 2, Alternatives, this draft EIS does not contain a preferred alternative. Rather, it establishes several distinct policy directions as alternatives that would 1) guide the National Marine Fisheries Services' (NMFS') decisions on distribution of Mitchell Act funds for hatchery production in the Columbia River basin, and 2) inform NMFS' future review of individual hatchery programs under the Endangered Species Act (ESA). NMFS anticipates identifying the preferred alternative in the final EIS after considering the comments received on this document. The preferred alternative likely will be a blend of more than one of the alternatives evaluated in this EIS. The environmental effects of the preferred alternative will be explained in the final EIS and summarized in the Record of Decision (ROD).

Reviewers are not constrained to comment solely on the specific alternatives in this EIS but may comment or recommend a preferred alternative that combines elements of several alternatives presented in this draft EIS.

NMFS encourages reviewers to perform the following activities:

1. Review the draft EIS to gain an understanding of how it is organized and how the alternatives are framed and analyzed.
2. Formulate a notion of what the hatchery programs should accomplish; that is, formulate a notion of the policy direction they think should guide NMFS decisions on hatchery production in the Columbia River basin.
3. Carefully consider the information provided in Chapter 4, Environmental Consequences, and Chapter 5, Cumulative Effects, respectively.
4. After considering the effects, comment on how NMFS should formulate a preferred alternative for publication in the final EIS and ROD.

2.2 Description of Project Area

As described in Section 1.4, Project and Analysis Area, the EIS project area includes rivers, streams, and hatchery facilities where hatchery-origin salmon and steelhead occur or are anticipated to occur in the Columbia River basin, including the Snake River and all other tributaries of the Columbia River in the United States (U.S.). The project area also includes the Columbia River estuary and plume[1]. The project area comprises two salmon recovery domains (the Willamette/Lower Columbia and the Interior Columbia) as established by NMFS under its ESA recovery planning responsibilities. The project area also contains seven ecological provinces and more than 37 subbasins (i.e., tributaries to the Columbia or Snake Rivers) as defined by the Northwest Power and Conservation Council (NPCC) for purposes of administering its Fish and Wildlife Program (Table 2-1).

The Willamette/Lower Columbia recovery domain includes the Willamette River basin and all Columbia River tributaries from the mouth of the Columbia River to the Hood River in Oregon and the White Salmon River in Washington. The domain contains four ESA-listed evolutionarily significant units (ESUs) of salmon and two ESA-listed distinct population segments (DPSs) of steelhead: lower Columbia River Chinook salmon, Columbia River chum salmon, upper Willamette River Chinook salmon, lower Columbia River coho salmon, lower Columbia River steelhead, and upper Willamette River steelhead.

The Interior Columbia recovery domain covers all of the Columbia River basin accessible to anadromous salmon and steelhead above Bonneville Dam. The Interior Columbia recovery domain contains four ESA-listed ESUs of salmon and three ESA-listed DPSs of steelhead: middle Columbia River steelhead, Snake River sockeye, Snake River spring/summer Chinook salmon, Snake River fall Chinook salmon, Snake River steelhead, upper Columbia River spring Chinook salmon, and upper Columbia River steelhead. The Interior and Willamette/Lower Columbia recovery domains overlap just upstream of Bonneville Dam based on ESU boundaries.

[1] The plume is generally defined by a reduced-salinity contour near the ocean surface of approximately 31 parts per thousand. The plume varies seasonally with discharge, prevailing near-shore winds, and ocean currents. For purposes of this EIS, the plume is considered to be off the immediate coast of both Oregon and Washington and to extend outward to the continental shelf.

TABLE 2-1. PROJECT AREA BY RECOVERY DOMAIN, ECOLOGICAL PROVINCE, AND SUBBASIN

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	SUBBASIN[1]
Willamette/ Lower Columbia	Columbia Estuary	Grays River (WA)
		Elochoman River (WA)
		Youngs River (OR)
	Lower Columbia	Cowlitz River (WA)
		Kalama River (WA)
		Lewis River (WA)
		Washougal River (WA)
		Willamette River (OR)
		Sandy River (OR)
Willamette/ Lower Columbia and Interior Columbia[2]	Columbia Gorge	Wind River (WA)
		Little White Salmon River (WA)
		White Salmon River (WA)
		Klickitat River (WA)
		Hood River (OR)
		Fifteen Mile Creek (OR)
Interior Columbia	Columbia Plateau	Yakima River (WA)
		Crab Creek (WA)
		Palouse River (WA)
		Tucannon River (WA)
		Walla Walla River (WA/OR)
		Deschutes River (OR)
		John Day River (OR)
		Umatilla River (OR)
		Lower Middle Columbia River (WA/OR)
		Lower Snake River (WA)
	Columbia Cascade	Wenatchee River (WA)
		Entiat River (WA)
		Lake Chelan (WA)
		Methow River (WA)
		Okanogan River (WA/BC)
		Upper Middle Columbia River (WA)
	Blue Mountain	Asotin Creek (WA)
		Grande Ronde River (WA/OR)
		Imnaha River (OR)
		Snake Hell's Canyon (OR/ID)
	Mountain Snake	Clearwater River (ID)
		Salmon River (ID)

Source: NMFS

[1]Not all subbasins are included in this table.

[2]The Willamette/Lower Columbia recovery domain and the Interior Columbia recovery domain overlap within the Columbia Gorge ecological province.

Each recovery domain consists of several ecological provinces, as identified by NPCC (see www.nwcouncil.org for more information). Ecological provinces encompass subbasins with similar climates and geography (Figure 1-1). In many cases, the EIS compares alternatives across ecological provinces rather than by recovery domain (which can be too general of a comparison) or by subbasin (which can be too detailed of a comparison). This project area EIS covers 7 of the 11 Columbia River basin ecological provinces; anadromous salmon and steelhead do not currently have access to four ecological provinces (the Middle Snake, Upper Snake, Intermountain, and Mountain Columbia provinces).

2.3 Context for the Alternatives

2.3.1 Distribution of Hatchery Programs

There are 178 salmon and steelhead hatchery programs in the Columbia River basin (Table 2-2). These hatchery programs originate from 80 hatchery facilities in the Columbia River basin (Figure 1-2). There are 83 hatchery programs (48 percent of the total) located in the Willamette/Lower Columbia recovery domain and 95 hatchery programs (52 percent of the total) located in the Interior Columbia recovery domain (Table 2-2). Of the 178 hatchery programs in the Columbia River basin, 62 (35 percent) are funded through the Mitchell Act (Table 2-2) (Chapter 1, Purpose of and Need for the Proposed Action). The remaining 116 (65 percent) hatchery programs are funded primarily by the Bonneville Power Administration, the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service (USFWS), the U.S. Bureau of Reclamation, public utility districts, and private power companies. The most common species produced are fall Chinook salmon, coho salmon, and spring Chinook salmon in the Willamette/Lower Columbia recovery domain and fall Chinook salmon, spring Chinook salmon, and summer steelhead in the Interior Columbia recovery domain (Table 2-3). Chum salmon, sockeye salmon, and summer Chinook salmon are the least common species produced.

2.3.2 Purpose of Hatchery Programs

Hatchery programs in the Columbia River basin are implemented to augment harvest (referred to as harvest augmentation hatchery programs or harvest hatchery programs), to help conserve a population (referred to as conservation hatchery programs) (Box 2-2), or for both purposes. In this EIS, the purpose of each hatchery program was identified by its manager in response to a survey by the Hatchery Scientific Review Group (HSRG) (Box 2-3) (Appendix B through Appendix E).

TABLE 2-2. COUNT OF MITCHELL ACT FUNDED HATCHERY PROGRAMS AND TOTAL COUNT OF HATCHERY PROGRAMS BY ECOLOGICAL PROVINCE AND BY SPECIES.

		MITCHELL ACT-FUNDED HATCHERY PROGRAMS							
RECOVERY DOMAIN	ECOLOGICAL PROVINCE	CHINOOK SALMON	COHO SALMON	STEELHEAD	CHUM SALMON	SOCKEYE SALMON	TOTAL NUMBER MITCHELL ACT-FUNDED HATCHERY PROGRAMS	TOTAL NUMBER OF HATCHERY PROGRAMS	PERCENT MITCHELL ACT-FUNDED (%)
Willamette/ Lower Columbia	Columbia Estuary	5	6	2	0	0	13	19	68
	Lower Columbia	7	15	7	0	0	29	56	52
	Columbia Gorge	4	0	0	0	0	4	8	50
Interior Columbia	Columbia Gorge[1]	2	2	3	0	0	7	7	100
	Columbia Plateau	3	1	3	0	0	7	18	39
	Columbia Cascade	0	0	0	0	0	0	22	0
	Blue Mountain	0	0	0	0	0	0	15	0
	Mountain Snake	0	1	0	0	1	2	33	6
Total		**21**	**25**	**15**	**0**	**1**	**62**	**178**	**35**

Source: Appendix C through Appendix F

[1] The Willamette/Lower Columbia recovery domain and the Interior Columbia recovery domain overlap within the Columbia Gorge ecological province.

TABLE 2-3. TOTAL HATCHERY-ORIGIN SALMON AND STEELHEAD PRODUCTION WITHIN THE COLUMBIA RIVER BASIN (X 1,000).

RECOVERY DOMAIN	FALL CHINOOK SALMON	SPRING CHINOOK SALMON	SUMMER CHINOOK SALMON	COHO SALMON	WINTER STEELHEAD	SUMMER STEELHEAD	CHUM SALMON	SOCKEYE SALMON	TOTAL
Willamette/Lower Columbia	46,968	12,480	0	16,985	1,992	1,968	300	0	80,693
Interior Columbia	22,976	20,019	3,733	4,787	20	10,986	0	363	62,884
Total	**69,944**	**32,499**	**3,733**	**21,772**	**2,012**	**12,954**	**300**	**363**	**143,577**

Source: Appendix C through Appendix F. Numbers are based on production levels in 2007.

Box 2-2. How can hatchery programs help conserve a salmon or steelhead population?

Hatchery programs have been shown to be effective in bolstering the number of fish spawning naturally under certain conditions and guarding against catastrophic loss of a natural-origin population at low abundance levels. Freshwater habitat-related factors limiting the survival and productivity of a natural-origin population can be circumvented by spawning, incubating, rearing, and releasing fish from the population in a hatchery facility. Short-term success in increasing the number of naturally spawning fish has been demonstrated for some hatchery programs (e.g., Hood Canal summer chum salmon supplementation and reintroduction programs) (WDFW and Point No Point Treaty Tribes [PNPTT] 2007). In addition, spatial structure may be expanded, and, in some cases, diversity may be increased. Productivity may also be increased if the added hatchery-origin fish improve the condition of the spawning gravel or add nutrients to the system.

Box 2-3. What is the HSRG?

In the past several years, the scientific basis for management of hatcheries in the Pacific Northwest has been examined through the work of the HSRG. Members of the HSRG are regionally and nationally recognized scientists with expertise in hatchery management, genetics, and population biology. Congress initiated the hatchery review process in the Columbia River basin by creating and funding the HSRG in 2006. The HSRG issued its final report Columbia River Hatchery Reform System-Wide Report (February 2009), which can be found at www.hatcheryreform.us.

According to the hatchery operators, 123 of the total hatchery programs in the Columbia River basin (69 percent) currently are operated for harvest augmentation only. Twenty-six hatchery programs (15 percent) are operated for conservation only, and 29 hatchery programs (16 percent) are operated for both conservation and harvest augmentation (Figure 2-1).

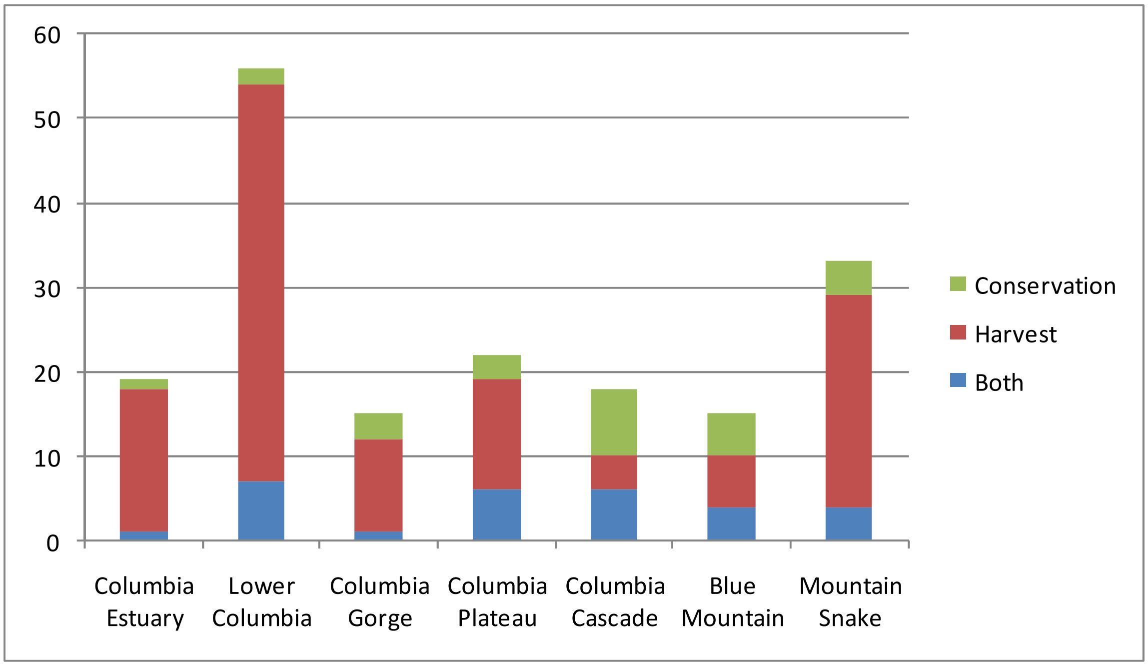


Figure 2-1. Distribution of Columbia River basin hatchery programs by purpose and ecological province.

2.3.3 Hatchery Program Operational Strategies

Each hatchery program has both a purpose and an operational strategy. Operational strategies fall into two categories: 1) segregating or isolating hatchery-origin fish from natural-origin fish (creating a *segregated* hatchery-origin population and a *segregated* natural-origin population), or 2) integrating hatchery-origin fish and natural-origin fish so that they are genetically similar creating one *integrated* population.

Segregated hatchery programs seek to minimize interaction between hatchery-origin and natural-origin fish. Fish are released from hatchery facilities, and the surviving adults are expected to return to the hatchery facility to produce fish for the next generation. Adult traps or weirs are often used to remove the returning hatchery-origin fish to minimize the number of hatchery-origin fish that spawn in nature. A common strategy used to identify hatchery-origin fish is to remove the adipose fin from hatchery-origin fish prior to release, making the returning adults easily identifiable (Box 2-4). There are 110 (62 percent) salmon and steelhead hatchery programs in the Columbia River basin currently designed as segregated hatchery programs (Figure 2-2). Segregated hatchery programs are the dominant hatchery type in the Columbia Estuary, Lower Columbia, Columbia Gorge, and Mountain Snake ecological provinces.

Integrated hatchery programs deliberately combine hatchery-origin and natural-origin fish into a single population. They typically incorporate substantial numbers of natural-origin fish into the hatchery broodstock and limit the number of hatchery-origin fish that spawn in the natural environment, in an attempt to produce a population whose adaptation and fitness are influenced predominantly by the natural environment.

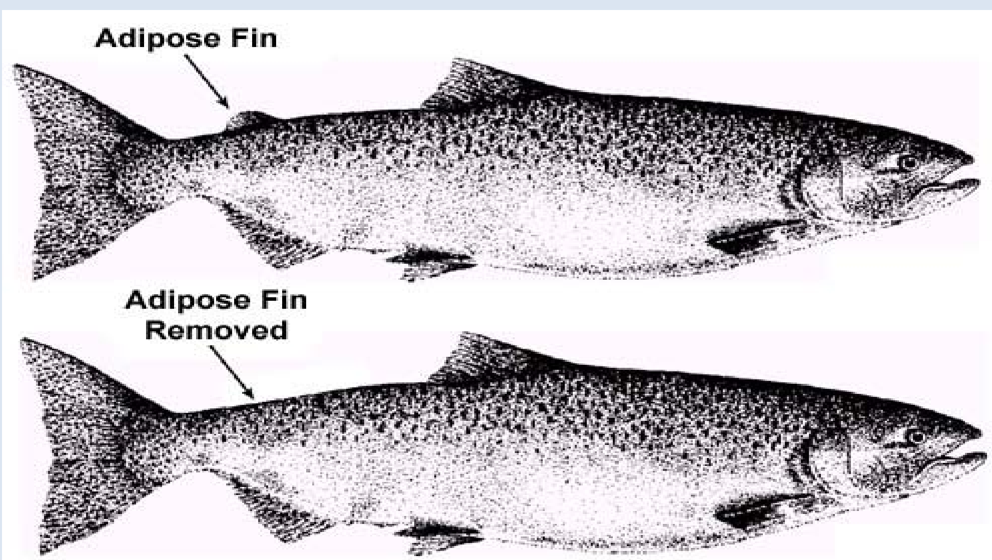
There are 68 (38 percent) integrated salmon and steelhead hatchery programs in the Columbia River basin (Figure 2-2). The majority of hatchery programs in the Columbia Cascade and Blue Mountain ecological provinces are integrated programs.

Box 2-4. What is mass marking?

Mass marking is a technique currently used to distinguish hatchery-origin salmon and steelhead from natural-origin fish. Most hatchery-origin fish are marked by removal of their adipose fin, a small fin on the fish’s back near the tail.

To mark large numbers of fish, managers use an automated fish marking machine housed in a trailer that can be moved from one hatchery to another when marking is underway.

The mass marking machine, which can mark 7,000 juvenile fish per hour, uses a flow of cold water to attract fish to a chute where mechanized gates separate, hold, and mark individual fish.



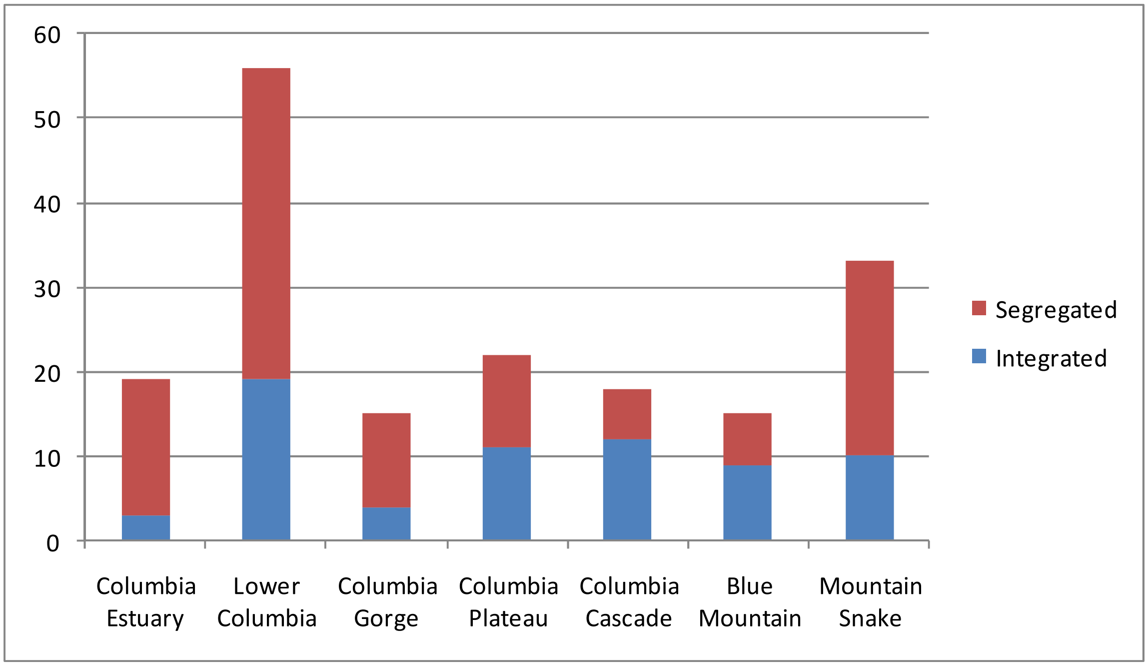


Figure 2-2. Distribution of Columbia River basin hatchery programs by operational strategy and ecological province.

2.4 Alternative Development

From 2004 through 2009, NMFS solicited and considered public comment on the development of alternatives for this EIS. First, as described in Section 1.6, Scoping and the Relevant Issues, NMFS published a Federal Register notice on September 3, 2004, opening a 90-day public comment period to gather information on the scope of issues and range of alternatives to be analyzed in this draft EIS (69 Fed. Reg. 53892, September 3, 2004). In addition, NMFS held a series of internal and external meetings to seek input on potential EIS alternatives for Mitchell Act hatchery production. External meetings were attended by representatives from the Washington Department of Fish and Wildlife (WDFW), the Oregon Department of Fish and Wildlife (ODFW), the USFWS, the Nez Perce Tribe, the Pacific Fishery Management Council, the Northwest Indian Fisheries Commission, the Confederated Tribes of the Colville Reservation, the Columbia River Inter-tribal Fish Commission, the Institute for Tribal Government, and various fishing and environmental groups.

During the scoping process, two challenges became clear (Box 2-5). The first was that there are an incalculable number of hatchery actions – and combinations of actions – that could be implemented with hatchery programs funded under the Mitchell Act, a reality that would make the formulation of alternatives comparing every potential hatchery action impossibly high in number. The second was that the distribution of funds for Mitchell Act-funded hatchery production could be better analyzed in the context of all other, non-Mitchell Act-funded hatchery programs in the Columbia River basin – in other words, the effects of operation of all other hatchery programs could be evaluated to improve the analysis of the effects of Mitchell Act-funded hatchery programs. Once it was recognized that this comprehensive analysis would provide additional policy development benefits, NMFS published a notice in the Federal Register to inform the public that the scope of the earlier notice to prepare an EIS would be expanded to include the examination of environmental effects of all hatchery programs within the Columbia River basin (Section 1.6.2, Notice of Intent).

Ultimately, the scoping process resulted in the development of five alternatives, each of which (with the exception of the No-action Alternative) centers on a policy direction that would 1) guide the distribution of Mitchell Act funds and 2) inform NMFS' future ESA reviews on individual Columbia River basin hatchery programs (Box 2-6). Each policy direction is defined by a set of goals and/or principles.

Box 2-5. What were the two main challenges in identifying alternatives?

Challenge 1: Unlimited Number of Potential Actions

The number of potential actions that could be implemented through distribution of Mitchell Act hatchery funds, given the number of hatchery programs that could be adjusted, is too large to enable an analysis of all possible alternatives in an EIS. However, NMFS found that any potential action could be characterized under one of several potential policy directions. In other words, all reasonable uses of Mitchell Act hatchery funds could be grouped under a limited number of policy direction alternatives. For example, one policy direction might be to maximize ocean harvest, and a hatchery program could be directed at achieving that policy objective. Another might be to maximize efforts to conserve ESA-listed fish with a hatchery program that could be modified to pursue conservation of ESA-listed fish.

NMFS concluded that the best approach for disclosing environmental effects for this EIS was to formulate each alternative around a discrete policy direction intended, in part, to guide the distribution of Mitchell Act funds for hatchery production in the Columbia River basin (Box 2-6).

Challenge 2: Effects of All Hatchery Production Programs Should be Analyzed

It also became clear during scoping that the environmental effects of alternative policy directions for the use of Mitchell Act-funded hatchery production could be better analyzed when the effects of all other, non-Mitchell Act-funded hatchery programs in the Columbia River basin are analyzed, as well. Like choosing pieces of a complex puzzle, decisions about the salmon and steelhead produced with Mitchell Act funds (e.g., the populations chosen for hatchery production, the size of the hatchery programs, the location of hatchery programs) are all coordinated and inter-related with decisions about the remainder of natural-origin and hatchery-origin production in the Columbia River basin.

Box 2-6. What is a policy direction?

A policy direction is the overarching theme that will guide and shape decisions NMFS makes related to hatchery production in the Columbia River basin, defined by a series of goals and/or principles.

Harvest goals are identified in some alternatives' policy directions and are described in terms of harvest goals above or below Bonneville Dam. In general, fisheries above Bonneville Dam include recreational fisheries, tribal commercial fisheries, and tribal ceremonial and subsistence fisheries. Fisheries below Bonneville Dam generally include recreational fisheries, non-tribal commercial fisheries, and ocean fisheries.

Under each policy direction, performance goals are identified for hatchery programs according to the location of the hatchery programs and the type of salmon and steelhead populations that may be affected. For example, stronger performance goals are applied under some alternatives when the hatchery programs affect populations that have an important role in the recovery of listed DPSs/ESUs or are strongholds of non-listed ESUs or DPSs. Performance goals are intended to reduce the negative effects of hatchery programs on natural-origin salmon and steelhead populations. Two performance goals (in addition to the baseline conditions) were identified for use in this EIS: 1) a stronger performance goal and 2) an intermediate performance goal.

Each population was designated as primary, contributing, or stabilizing. The Lower Columbia Fish Recovery Board (LCFRB) used these designations in the development of the Lower Columbia River Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004). The HSRG adapted the designations throughout the basin after discussions with hatchery managers, and they are applied in this draft EIS (Appendix C through Appendix F). In some cases, there may be differences between the HSRG classifications and what is found in the most current recovery planning documents. HSRG classifications will be replaced with current designations from recovery planning documents before any policy direction is implemented.

In general, managers seek primary populations to have a low level of biological risk to their continued existence, contributing populations to have a more moderate level of biological risk, and stabilizing populations to maintain their current level of risk. For a full discussion of the role of biological risk among populations in a recovered salmon ESU or steelhead DPS, see "Revised Viability Criteria for Salmon and Steelhead in the Willamette and Lower Columbia River Basins" (April 2006) by the Willamette/Lower Columbia Technical Recovery Team and ODFW, which can be found at http://www.nwfsc.noaa.gov/trt/wlc/viability_report_revised.cfm.

The EIS uses the terms *stronger performance goal* and *intermediate performance goal* to avoid terms that may be found in an ESA-related analysis, such as *jeopardy*, *recovery*, or similar concepts. These goals are not intended to infer compliance with any legal standard, nor are they intended to be analogous to ESA terminology or threshold standards, but they are helpful in aggregating and describing the effect of multiple hatchery programs on natural-origin populations of salmon and steelhead. To avoid any inference that the performance goals are associated with legal standards, they are described in this EIS in terms that compare them only to each other. Reviewers are encouraged to provide comments on the application of hatchery performance goals.

Each alternative's policy direction also includes goals and/or principles related to the following:

- Use of weirs to control the number of hatchery-origin fish on the spawning grounds
- Mitigation agreements
- Initiation of new hatchery programs
- Integration of harvest and hatchery policy
- Monitoring, evaluation, and reform (MER)
- Disbursement of Mitchell Act funds

2.5 Alternatives Analyzed in Detail

2.5.1 Alternative 1 (No Action)

Under Alternative 1, there would not be a defined policy direction, and Columbia River basin hatchery production would continue baseline conditions. Based on NMFS’ observations, the following describe the baseline conditions:

- Hatchery programs are used primarily to contribute to harvest, although some hatchery programs are designed to help conserve natural-origin salmon and steelhead populations.
- Most hatchery programs cannot control the number of hatchery fish on the spawning grounds. In most cases, the number of hatchery-origin fish on the spawning ground is higher than what current research suggests is desirable.
- Many hatchery programs are used to meet mitigation agreements. Most mitigation occurs to reduce the effects from hydropower on the fisheries.
- MER occurs, but it is neither prioritized nor guided by a comprehensive basin-wide plan. Fish managers use available funds to meet fish production goals first; if any money remains, MER occurs.
- There is no defined policy on the use of weirs to control the number of hatchery-origin fish on the spawning grounds.
- Conservation hatchery programs, although viewed as a temporary solution to reduce extinction risk, typically are developed and operated with no explicit sizing or termination criteria.
- Best management practices (BMPs) are widely applied, but their application is not universal. In many cases, application is based on available funding and/or whether the BMP is a regulatory requirement.
- The amount of Mitchell Act hatchery funds can vary annually. Hatchery operators generally receive a similar proportion each year.

2.5.2 Alternative 2 (No Mitchell Act Funding)

Under Alternative 2, the policy direction would be defined by the following goals and/or principles:

- Mitchell Act hatchery funding would be eliminated, and all Mitchell Act-funded hatchery programs would be closed.
- Substantially fewer fish would be produced to support fisheries than under Alternative 1.

- The intermediate performance goal would be applied to non-Mitchell Act-funded hatchery programs that affect primary and contributing salmon and steelhead populations (Table 2-4). Application of the intermediate performance goal would, in most cases, reduce negative effects of hatchery programs on natural-origin salmon and steelhead populations.
    - Integrated hatchery programs would be better integrated than under Alternative 1.
    - Segregated hatchery programs would be better segregated than under Alternative 1.
- Production levels would be reduced from levels under Alternative 1 in hatchery programs designed to meet mitigation requirements only when those production levels conflicted with the ability of a hatchery program to meet performance goals.
- Conservation hatchery programs would be operated at a level determined by conservation need, with hatchery-origin production diminishing as natural-origin production increased.
- BMPs would be applied in all hatchery programs.
- No new hatchery programs would be initiated.
- No new weirs would be installed to help control the number of hatchery-origin fish on the spawning grounds.
- MER would be guided by a comprehensive basin-wide plan.

2.5.3 Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

Under Alternative 3, the policy direction would be defined by the following goals and/or principles:

- The intermediate performance goal would be applied to all Columbia River basin hatchery programs that affect primary and contributing salmon and steelhead populations (Table 2-4). Application of the intermediate performance goal would, in most cases, reduce negative effects of hatchery programs on natural-origin salmon and steelhead populations.
    - Integrated hatchery programs would be better integrated than under Alternative 1.
    - Segregated hatchery programs would be better segregated than under Alternative 1.

TABLE 2-4. HATCHERY PERFORMANCE GOALS IDENTIFIED UNDER EACH ALTERNATIVE'S POLICY DIRECTION.

RECOVERY DOMAIN	POPULATION TYPE[1]	FUNDING ENTITY	HATCHERY PERFORMANCE GOALS BY ALTERNATIVE				
			ALTERNATIVE 1 (NO ACTION)	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5
Willamette/Lower Columbia	Primary	Mitchell Act	Baseline conditions	N/A[2]	Intermediate	Stronger	Intermediate
		Other	Baseline conditions	Intermediate	Intermediate	Stronger	Intermediate
	Contributing	Mitchell Act	Baseline conditions	N/A	Intermediate	Stronger	Intermediate
		Other	Baseline conditions	Intermediate	Intermediate	Stronger	Intermediate
	Stabilizing	Mitchell Act	Baseline conditions	N/A	Baseline conditions	Baseline conditions	Baseline conditions
		Other	Baseline conditions	Baseline conditions	Baseline conditions	Baseline conditions	Baseline conditions
Interior Columbia	Primary	Mitchell Act	Baseline conditions	N/A	Intermediate	Intermediate	Stronger
		Other	Baseline conditions	Intermediate	Intermediate	Intermediate	Stronger
	Contributing	Mitchell Act	Baseline conditions	N/A	Intermediate	Intermediate	Stronger
		Other	Baseline conditions	Intermediate	Intermediate	Intermediate	Stronger
	Stabilizing	Mitchell Act	Baseline conditions	N/A	Baseline conditions	Baseline conditions	Baseline conditions
		Other	Baseline conditions	Baseline conditions	Baseline conditions	Baseline conditions	Baseline conditions

[1] Each population's role in recovery was designated as primary, contributing, or stabilizing. These designations were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004). The HSRG adapted them throughout the basin after discussions with the hatchery operators, and they are applied in this EIS (Appendix C through Appendix F).

[2] N/A means not applicable since hatchery programs would be terminated.

- Production levels would be reduced from levels under Alternative 1 in hatchery programs designed to meet mitigation requirements only when those production levels conflicted with the ability of a hatchery program to meet performance goals.
- Conservation hatchery programs would be operated at a level determined by conservation need, with hatchery-origin production diminishing as natural-origin production increases.
- BMPs would be applied in all hatchery programs.
- No new hatchery programs would be initiated.
- New temporary (i.e., seasonal) weirs would be installed to help control the number of hatchery-origin fish on the spawning grounds.
- MER would be guided by a comprehensive basin-wide plan.
- Mitchell Act funds would be disbursed in support of the above goals and/or principles.

2.5.4 Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under Alternative 4, the policy direction would be defined by the following goals and/or principles:

- The intermediate performance goal would be applied to all Columbia River basin hatchery programs that affect primary and contributing salmon and steelhead populations in the Interior Columbia River recovery domain (Table 2-4). Application of the intermediate performance goal would, in most cases, reduce negative effects of hatchery programs on natural-origin salmon and steelhead populations.
  - Integrated hatchery programs would be better integrated than under Alternative 1.
  - Segregated hatchery programs would be better segregated than under Alternative 1.
- The stronger performance goal would be applied to all Columbia River basin hatchery programs that affect primary and contributing salmon and steelhead populations in the Willamette/Lower Columbia River recovery domain. Application of the stronger performance goal would reduce negative impacts of hatchery programs on natural-origin salmon and steelhead populations even more than the intermediate performance goal.
  - Integrated hatchery programs would be better integrated than under Alternative 1.
  - Segregated hatchery programs would be better segregated than under Alternative 1.
- Production levels would be reduced from levels under Alternative 1 in hatchery programs designed to meet mitigation requirements only when those production levels conflicted with the ability of a hatchery program to meet performance goals.

- Conservation hatchery programs would be operated at a level determined by conservation need, with hatchery-origin production diminishing as natural-origin production increases.
- BMPs would be applied in all hatchery programs.
- New conservation hatchery programs would be initiated in the Willamette/Lower Columbia River recovery domain, if appropriate, using existing hatchery capacity. New conservation hatchery programs would be initiated only for populations deemed at high risk of extinction.
- New harvest hatchery programs would be initiated and/or existing hatchery programs would be changed to better support harvest opportunities below Bonneville Dam, including ocean fisheries, using any hatchery capacity that remains after appropriate conservation hatchery programs are initiated.
- New temporary (i.e., seasonal) and permanent weirs would be installed to help control the number of hatchery-origin fish on the spawning grounds.
- MER would be guided by a comprehensive basin-wide plan.
- Mitchell Act funds would be disbursed in support of the above goals and/or principles.

2.5.5 Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under Alternative 5, the policy direction would be defined by the following goals and/or principles:

- The intermediate performance goal would be applied to all Columbia River basin hatchery programs that affect primary and contributing salmon and steelhead populations in the Willamette/Lower Columbia River recovery domain (Table 2-4). Application of the intermediate performance goals would, in most cases, reduce negative effects of hatchery programs on natural-origin salmon and steelhead populations.
    - ➢ Integrated hatchery programs would be better integrated than under Alternative 1.
    - ➢ Segregated hatchery programs would be better segregated than under Alternative 1.
- The stronger performance goal would be applied to all Columbia River basin hatchery programs that affect primary and contributing salmon and steelhead populations in the Interior Columbia River recovery domain. These stronger performance goals would reduce negative impacts of hatchery programs on natural-origin salmon and steelhead populations even more than the intermediate performance goal.
    - ➢ Integrated hatchery programs would be better integrated than under Alternative 1.
    - ➢ Segregated hatchery programs would be better segregated than under Alternative 1.

- Production levels would be reduced from levels under Alternative 1 in hatchery programs designed to meet mitigation requirements only when those production levels conflicted with the ability of a hatchery program to meet performance goals.
- Conservation hatchery programs would be operated at a level determined by conservation need, with hatchery-origin production diminishing as natural-origin production increased.
- BMPs would be applied in all hatchery programs.
- New conservation hatchery programs would be initiated in the Interior Columbia River recovery domain, if appropriate, using existing hatchery capacity. New conservation hatchery programs would be initiated only for populations deemed at high risk of extinction.
- New harvest hatchery programs would be initiated, and/or existing hatchery programs would be changed to better support harvest opportunities above Bonneville Dam, including treaty Indian commercial fisheries, using any hatchery capacity that remains after appropriate conservation hatchery programs are initiated.
- New temporary (i.e., seasonal) and permanent weirs would be installed to help control the number of hatchery-origin fish on the spawning grounds.
- MER would be guided by a comprehensive basin-wide plan.
- Mitchell Act funds would be disbursed in support of the above goals and/or principles.

2.6 Identifying an Implementation Scenario

The policy directions that are associated with each of the action alternatives are goal-oriented and do not identify specific actions that would be taken under each alternative. This is because NMFS believes that specific hatchery actions should be determined on a hatchery-program-by-hatchery-program basis. To analyze, illustrate, and compare the potential environmental effects of each alternative, however, an implementation scenario was developed for each alternative's policy direction. Each implementation scenario is one plausible example of how each hatchery program could be operated to meet the policy direction of the alternative. There are, however, multiple implementation scenarios that could be applied consistent with each policy direction. NMFS does not advocate any of the implementation scenarios evaluated in this EIS, and the Chapter 4 analysis may show that implementing some components of a scenario would be unreasonable. For example, some components of these implementation scenarios may or may not be viewed as consistent with commitments in the *U.S. v Oregon* Management Agreement (Section 1.7.1, *U.S. v Oregon)*. The intent of the EIS analyses is not to make a determination that an alternative or its implementation scenario is or is not consistent with the *U.S. v. Oregon* Management Agreement, and no such assertion is made. Rather, NMFS anticipates that the affected parties will ensure that their hatchery plans (e.g., hatchery genetic and management plans) are consistent with the most current Management Agreement.

To identify implementation scenarios, specific performance metrics (i.e., measurements of performance) were identified for each performance goal (Table 2-5) (Box 2-7). The performance metrics include two measurements:

- The proportionate natural influence (PNI) in a population, which is a measure of the hatchery influence on a population and is a function of both the percent hatchery-origin spawners (pHOS) in the natural escapement and the percent of natural-origin broodstock (pNOB) incorporated into the hatchery program
- The pHOS that join natural-origin adults on the stream's spawning ground

The following performance metrics were applied for each hatchery performance goal (Box 2-7):

- For the stronger performance goal, integrated populations that are affected by hatchery programs would have a PNI of 0.67 or higher, and segregated, natural-origin populations would maintain pHOS less than or equal to 0.05 (Table 2-5).

- For the intermediate performance goal, integrated populations that are affected by hatchery programs would have a PNI of 0.50 or higher, and segregated, natural-origin populations would maintain pHOS of less than or equal to 0.10 (Table 2-5).

> **Box 2-7. What is the difference between a hatchery performance goal and a performance metric?**
>
> In this EIS, performance goals are identified within each alternative. These goals apply to hatchery programs. There are two performance goals: stronger and intermediate. Both performance goals would likely reduce negative effects of hatchery programs on salmon and steelhead populations compared to the baseline conditions.
>
> Performance metrics are identified for each performance goal so that an implementation scenario can be identified. Performance metrics apply to the populations that are being affected by the hatchery programs. Performance metrics include two measurements: PNI and pHOS.

TABLE 2-5. PERFORMANCE METRICS APPLIED FOR EACH HATCHERY PERFORMANCE GOAL.

HATCHERY PERFORMANCE GOAL	PERFORMANCE METRICS FOR AFFECTED POPULATIONS
Intermediate Performance Goal	Integrated populations maintain a PNI greater than or equal to 0.50. Segregated, natural-origin populations maintain pHOS less than or equal to 0.10.
Stronger Performance Goal	Integrated populations maintain a PNI greater than or equal to 0.67. Segregated, natural-origin populations maintain pHOS less than or equal to 0.05.

Although NMFS uses these performance metrics in this EIS, no determination has been made on their adequacy under the ESA. NMFS is not advocating their use by hatchery managers. Reviewers are encouraged to understand the dynamics of the population that affect its PNI and pHOS values, particularly in an integrated population. In some cases, the favorable values of an integrated population may disguise underlying risks. For example, if the naturally spawning component of the integrated population is small, then it may be necessary to maintain a high number of natural-origin fish in the hatchery broodstock to maintain a high overall PNI value. This mining of the natural-origin population could maintain its PNI, but increase genetic and demographic risks to the population as a whole.

For all hatchery programs, hatchery operators could implement a generalized set of measures that, if appropriate, would increase the likelihood that the hatchery programs would meet performance metrics. These measures include reducing production levels, installing weirs, or correcting water quality problems. A list of potential measures and their applications within the implementation scenarios can be found in Table 2-6. A description of *how* these measures affect performance metrics is found in Box 2-8.

Box 2-8. How can measures at, or associated with, hatchery programs and facilities be used to meet performance metrics?

The following measure could be taken to help meet performance metrics:

- Reducing production would result in fewer hatchery-origin fish spawning naturally. This would reduce pHOS and increase PNI.
- Increasing the number of natural-origin fish used in the hatchery broodstock would generally increase the PNI of an integrated population.
- Using adult traps and weirs to reduce the number of hatchery-origin fish returning to a stream's natural spawning ground would decrease pHOS. Under this approach, the use of adult traps and weirs would require that hatchery fish be externally marked (Box 2-4).
- Changing a hatchery program's operational strategy from segregated to integrated, or from integrated to segregated, could help a program meet performance goals. For example, if managers cannot successfully segregate a hatchery program from the naturally spawning population, they may choose to integrate the hatchery program with the natural-spawning population to reduce the risk of genetic introgression. On the other hand, an integrated program may be impossible to integrate properly because of the program size relative to the natural-origin population. If the hatchery program is intended to meet harvest objectives, the program may have to be converted to a segregated hatchery program. This would require implementing measures to isolate returning hatchery-origin adults from the natural-origin population and selecting harvest measures that would reduce impacts to natural-origin fish while removing a higher proportion of the hatchery-origin return.
- Relocating a hatchery program to areas removed from natural-origin populations would reduce pHOS.
- Although not necessarily associated with hatchery operations, selective fisheries can be used to remove hatchery-origin fish to reduce pHOS before they reach a stream's natural spawning area. Fisheries can be selective through a variety of means, including the time and area within which they are conducted.

Box 2-8. How can measures at, or associated with, hatchery programs and facilities be used to meet performance metrics? (continued)

If hatchery-origin fish are externally marked (Box 2-4), fishing techniques that allow release of natural-origin fish are selective. The intended effect of selective fisheries in the EIS is similar to the intended effect of weirs – to reduce pHOS. However, the benefit of using selective fisheries instead of weirs is that the catch of hatchery-origin fish would contribute to recreational, commercial, or treaty Indian harvest rather than being disposed of by the operator of a weir. The greater the difference in the rate of harvest between hatchery-origin fish and mortality of natural-origin fish in a fishery, the more selective is that fishery. Selective fisheries that do not rely on an external mark to identify hatchery-origin fish (i.e., those that rely instead on regulating time, area, or in some cases, gear-type) are common in management as mentioned above, but generally have not been sufficiently selective to address concerns with pHOS and PNI. Currently, some experience and information are being gained in the conduct of selective recreational fisheries for externally marked salmon. However, mark-selective commercial fisheries have to-date been infrequent and few data currently exist upon which to base assumptions[2] for analysis about their effect on pHOS and PNI. This EIS does not attempt to do so and, therefore, does not assume implementation of mark selective commercial fisheries. Nevertheless, it should be noted, as did the HSRG, that "[w]ithout increases in selective fisheries, solutions to meet conservation goals will require reduced hatchery production and catch." (HSRG 2009). In that regard, experimentation with commercial harvest methods and gear is ongoing in the lower Columbia River (For information see http://www.dailyastorian.info/main.asp?SectionID=2&SubSectionID =398&ArticleID=64115). Further, to help illustrate the effects of mark-selective fisheries generally, Alternative 4 and Alternative 5 in the EIS assume harvest rates on hatchery origin fish in the "terminal" areas, i.e., the tributaries into which adult fish are returning, that are sufficient to achieve escapement goals. These rates include mark-selective fisheries on hatchery-origin fish where appropriate.

After identifying measures (i.e., implementation measures) that could be taken under each alternative to help meet performance metrics, a computer spreadsheet tool called the All-H Analyzer or "AHA" was used to develop a scenario that would meet performance metrics for PNI and pHOS. The AHA tool is a Microsoft Excel-based application that evaluates salmon

[2] Important assumptions would include the relative rates of encounter between hatchery origin fish and natural origin fish in each commercial fishery and the rate of survival for released natural origin fish.

management options in the context of the four “Hs” that affect salmon populations (habitat degradation, passage through the hydroelectric system, harvest, and hatchery effects). The AHA allows users to input data reflecting habitat productivity/capacity, harvest rates, and hatchery operations. Data inputs for hatchery operations include production levels, hatchery program strategies, use of weirs and/or selective fisheries, and the proportion of natural-origin fish in the broodstock. The AHA then produces a result from that set of factors in terms of the number of hatchery-origin and natural-origin fish returning both to the habitat and to the hatchery facility, the number of hatchery-origin and natural-origin fish harvested, and the PNI and pHOS of a population. Through multiple iterations, scenarios for each hatchery program were identified that produce outputs meeting the PNI and pHOS goals of each alternative. Data used in the AHA model were obtained from hatchery operators and reflect 2007 hatchery conditions (HSRG 2009). See Appendix G for a more in-depth discussion on AHA.

In some cases, when developing an implementation scenario for each alternative, a salmon or steelhead population was not projected to meet its performance metrics even after use of all available measures (i.e., even with reduction in production, changes to a hatchery program’s operational strategy, and installation of weirs). In these cases, the hatchery program was terminated within that implementation scenario with the following two exceptions:

- Conservation hatchery programs were not terminated. This was the case for 70 percent of the hatchery programs that were not terminated, even though they prevented a population from meeting target performance metrics.
- Hatchery programs were not terminated if they affected a population with such low abundance that the population’s status would not improve, even if the offending hatchery program was terminated. This was the case for 30 percent of the hatchery programs that were not terminated, even though they prevented a population from meeting target performance metrics.

After an initial implementation scenario was developed using AHA, NMFS looked for opportunities to use any remaining hatchery capacity to support other goals and/or principles of the alternative. Finally, BMPs were applied to all hatchery programs operating under each alternative’s implementation scenario. While there is not one set of appropriate BMPs for all hatchery programs, NMFS used those developed by the HSRG (available in Appendix H) because it needed a standardized set for the EIS’s analyses. NMFS does not advocate the use of the HSRG’s BMPs over other BMPs that may have been developed through separate processes.

2.7 Comparison of Implementation Scenarios

A no-action alternative and four action alternatives are analyzed in detail in this EIS. One implementation scenario has been identified for each alternative so that the effects can be understood and compared. Implementation scenarios are compared in this section using the following categories:

- Measures that could be implemented to meet performance metrics (PNI and/or pHOS) (Table 2-6)
- Combined production levels by species for the entire Columbia River basin, as well as the portion of production funded under the Mitchell Act (Table 2-7)
- Terminated hatchery programs (Table 2-8)
- New hatchery programs (Table 2-8)
- Weirs (Table 2-9)
- Number of populations that meet and do not meet intermediate or stronger performance metrics by alternative (Table 2-10)
- Harvest contribution (Table 2-11)
- Subbasins where hatchery fish would not be released (Table 2-12)

Some of the alternative effects, particularly those that affect natural-origin fish populations, are presented in this summary. The full discussion of all environmental impacts is found in Chapter 4, Environmental Consequences.

2.7.1 Implementation Scenario for Alternative 1 (No Action)

The implementation scenario for Alternative 1 (No Action) represents a future scenario of continuing existing operations with no policy changes and is referred to as baseline conditions operations in this EIS. For the action alternatives, in contrast, all hatchery programs in the Columbia River basin would be operated to reduce their adverse effects on natural-origin fish by pursuing policy directions that would benefit natural-origin listed salmon and steelhead. Although salmon and steelhead populations fluctuate annually due to environmental effects outside of hatcheries, Alternative 1 assumes that future salmon and steelhead population size would be similar to that under existing conditions.

TABLE 2-6. COMPARISON OF IMPLEMENTATION MEASURES FOR EACH ALTERNATIVE'S IMPLEMENTATION SCENARIO.

IMPLEMENTATION MEASURES	ALTERNATIVE 1	2	3	4	5
Change production levels in hatchery programs.	No	Yes	Yes	Yes	Yes
Change broodstock collection protocols in hatchery programs.	No	Yes	Yes	Yes	Yes
Update water intake screens at hatchery facilities.	No	Yes	Yes	Yes	Yes
Update hatchery facilities to allow all salmon and steelhead of all ages to by-pass or pass through hatchery facility related structures.	No	Yes	Yes	Yes	Yes
Improve rearing and release protocols in hatchery programs.	No	Yes	Yes	Yes	Yes
Correct water quality issues at hatchery facilities.	No	Yes	Yes	Yes	Yes
Install new temporary weirs.	No	No	Yes	Yes	Yes
Install new permanent weirs.	No	No	No	Yes	Yes
Establish new selective fisheries in terminal areas.	No	No	No	Yes	Yes
Change hatchery program goals (i.e., harvest or conservation).	No	No	No	Yes	Yes
Change hatchery program's operational strategy (i.e., segregated or integrated).	No	No	No	Yes	Yes
Establish new hatchery programs.	No	No	No	Yes	Yes
Change policy by which harvest rates are established.	No	No	No	No	No
Terminate hatchery programs that support harvest if they fail to meet performance goals.	No	Yes	Yes	Yes	Yes
Terminate hatchery programs that support conservation if they fail the meet performance goals.	No	No	No	No	No

These changes apply to hatchery programs funded through the Mitchell Act and hatchery programs receiving funding from other sources.

Under the implementation scenario for Alternative 1, no new or formal policy direction would be adopted. NMFS would disburse Mitchell Act funds to agencies and tribes as in 2007, and hatchery production in the Columbia River basin would continue at current levels (Table 2-3). In this EIS, the 2007 data from the most recent year available were used for the modeling analysis and represent baseline conditions for hatchery operations. Production levels in 2008 through 2010 were similar to those in 2007. No performance goals would be established. As a result, no additional implementation measures would be taken to reduce adverse effects on natural-origin fish (Table 2-6).

More than 143 million smolts would continue to be produced by existing Columbia River hatchery programs, with 50 percent coming from hatchery programs funded through the Mitchell Act (Table 2-7). Under Alternative 1, Chinook salmon represent the highest number of hatchery fish produced for all hatchery programs combined (74 percent of the total) (Table 2-7). Nearly

67 percent of the coho salmon hatchery production would be funded through the Mitchell Act followed by 52 percent of Chinook salmon hatchery production (Table 2-7). Approximately 10 percent of the 15 million hatchery-origin steelhead released under Alternative 1 would be produced by Mitchell Act-funded hatchery programs (Table 2-7). Relatively few sockeye would be produced under Alternative 1 by Mitchell Act-funded hatchery programs and no chum salmon would be produced (Table 2-7). Details on the operation of individual hatchery programs under Alternative 1 can be found in Appendix C through Appendix F.

TABLE 2-7. HATCHERY PRODUCTION LEVELS BY EACH ALTERNATIVE'S IMPLEMENTATION SCENARIO WHEN IMPLEMENTATION MEASURES ARE USED TO MEET PERFORMANCE METRICS (ROUNDED TO THE NEAREST 1,000 FISH).

		CHINOOK SALMON	STEELHEAD	COHO SALMON	CHUM SALMON	SOCKEYE SALMON	TOTAL
Alternative 1	All hatchery programs	106,176	14,965	21,773	300	363	143,577
	Mitchell Act-funded hatchery programs	54,761	1,501	14,480	0	152	70,894
Alternative 2	All hatchery programs	37,703	10,317	3,364	300	212	51,896
	Mitchell Act-funded hatchery programs	0	0	0	0	0	0
Alternative 3	All hatchery programs	79,892	12,946	12,828	300	962	106,928
	Mitchell Act-funded hatchery programs	41,973	1,454	8,981	0	751	53,159
Alternative 4	All hatchery programs	87,624	13,137	15,450	1,189	962	118,362
	Mitchell Act-funded hatchery programs	46,114	1,650	11,301	974	751	60,789
Alternative 5	All hatchery programs	82,296	14,244	12,828	300	962	110,630
	Mitchell Act-funded hatchery programs	45,823	2,589	8,981	0	751	58,143

No new hatchery programs would be initiated, nor would existing hatchery programs be terminated under Alternative 1 (Table 2-8). No new weirs would be installed in the Willamette/Lower Columbia recovery domain (Lower Columbia and Columbia Gorge) or the Interior Columbia recovery domain (Columbia Plateau, Columbia Cascade, Blue Mountain, and Mountain Snake)[3] (Table 2-9).

While performance metrics would not be applied under Alternative 1, under this baseline conditions alternative, 29 (53 percent) of the 55 primary populations in the Willamette/Lower Columbia recovery domain meet the stronger metrics for pHOS (less than 0.05 for naturally spawning populations) or PNI (greater than 0.67 for integrated populations). Three (5 percent) of the populations reflect the intermediate metrics for pHOS (greater than 0.05 but less than 0.10) or PNI (greater than 0.50 but less than 0.67). Twenty-three (42 percent) of the populations had either a pHOS greater than 0.10 or a PNI less than 0.50 (Table 2-10). Of the 27 contributing populations, 33 percent of the populations reflect the stronger metrics, 11 percent met the intermediate metrics, and 56 percent of the populations either had a pHOS greater than 0.10 or a PNI less than 0.50. Of the 36 stabilizing populations in the Willamette/Lower Columbia recovery domain, 17 percent reflect the stronger metrics, 6 percent met the intermediate metrics, and a majority of the populations (78 percent) either had a pHOS greater than 0.10 or a PNI less than 0.50.

In the Interior Columbia recovery domain, nearly 60 percent of the 75 primary populations reflect the stronger metrics for pHOS or PNI, 9 percent reflect the intermediate metrics, and 33 percent had a pHOS greater than 0.10 or a PNI less than 0.50 (Table 2-10). Of the 22 contributing populations in the Interior Columbia recovery domain, 41 percent reflect the stronger metrics, 5 percent met the intermediate metrics, and a majority of the populations (55 percent) had a pHOS greater than 0.10 or a PNI less than 0.50. Of the 25 stabilizing populations in the Interior Columbia recovery domain, only 8 percent met the stronger metrics, none of the populations (0 percent) met the intermediate metrics, and most populations had a pHOS greater than 0.10 or a PNI less than 0.50. Again, while useful for comparison purposes, performance metrics were not applied under Alternative 1.

[3] Weirs discussed within these alternatives are intended, generally, to aid in the removal of hatchery fish from natural spawning grounds. The weirs are not considered part of the Mitchell Act “Screens and Fishways” program that focuses on structures to bypass fish around dams and irrigation diversions (Section 1.1.1, The Mitchell Act).

The number of fish harvested under Alternative 1 would be approximately 602, 368 salmon and steelhead (Table 2-11). These fish are coho salmon (37 percent), Chinook salmon (46 percent), steelhead (22 percent), sockeye salmon (less than 1 percent), and chum salmon (less than 1 percent) (Table 2-11). Nine subbasins would not receive direct releases of hatchery fish under Alternative 2 (Table 2-12).

2.7.2 Implementation Scenario for Alternative 2 (No Mitchell Act Funding)

Under the implementation scenario for Alternative 2, hatchery programs currently funded through the Mitchell Act would be terminated. Hatchery programs that receive partial funding through Mitchell Act sources would also be terminated. This includes hatchery programs that rely on fish provided by Mitchell Act-funded hatchery programs. Remaining Columbia River basin hatchery programs would be operated to achieve intermediate performance metrics (Table 2-5). As shown in Table 2-6, measures implemented to achieve performance metrics vary under each implementation scenario so that their environmental effects can be compared and contrasted. Under the implementation scenario for Alternative 2, implementation measures include reductions in production levels and/or changes in the proportion of natural-origin fish in the broodstock to help meet target performance metrics (Table 2-6). BMPs would be implemented so that screens on the water intakes would be updated, rearing and release protocols would be changed, and any water quality issues would be addressed.

Under the implementation scenario for Alternative 2, there are two noteworthy measures that would *not* be implemented to meet metrics. First, no new weirs would be installed to help control the number of hatchery fish spawning naturally. This exception is made so that the reviewer may isolate and compare effects when new weirs would be installed (as planned under the implementation scenarios for Alternative 3 through Alternative 5) from effects when new weirs would not be installed (under the implementation scenario for Alternative 2). Second, no new selective fisheries would be implemented in tributaries (known as *terminal area fisheries*) to reduce the number of hatchery adults returning to spawn. Again, the purpose of this exception is to allow the reader to isolate and compare effects when such fisheries would be implemented (under the implementation scenarios for Alternative 4 and Alternative 5) with effects when they would not be implemented (implementation scenario for Alternative 2).

TABLE 2-8. NUMBER OF HATCHERY PROGRAMS TERMINATED AND HATCHERY PROGRAMS INITIATED UNDER EACH ALTERNATIVE'S IMPLEMENTATION SCENARIO.

	Alternative 1	Alternative 2			Alternative 3			Alternative 4			Alternative 5		
Ecological Province	**Total Number of Hatchery Programs**	**Total Hatchery Programs Terminated (Mitchell Act Programs Terminated)**	**Hatchery Programs Initiated**	**Total Number Hatchery Programs**	**Hatchery Programs Terminated**	**Hatchery Programs Initiated**	**Total Number Hatchery Programs**	**Hatchery Programs Terminated**	**Hatchery Programs Initiated**	**Total Number Hatchery Programs**	**Hatchery Programs Terminated**	**Hatchery Programs Initiated**	**Total Number Hatchery Programs**
Columbia Estuary	19	16 (13)	0	**3**	5	0	**14**	2	7	**24**	5	0	**14**
Lower Columbia	56	29 (29)	0	**27**	3	0	**53**	9	11	**58**	4	1	**53**
Columbia Gorge	15	11 (11)	0	**4**	1	0	**14**	3	0	**12**	3	1	**13**
Columbia Plateau	22	9 (7)	0	**13**	3	0	**19**	3	0	**19**	2	0	**20**
Columbia Cascade	18	1 (0)	0	**17**	1	0	**17**	1	0	**17**	1	2	**19**
Blue Mountain	15	1 (0)	0	**14**	1	0	**14**	1	0	**14**	1	2	**16**
Mountain Snake	33	5 (2)	0	**28**	3	0	**30**	3	0	**30**	0	3	**36**
Grand Total	**178**	**72 (62)**	**0**	**106**	**17**	**0**	**161**	**22**	**18**	**174**	**16**	**9**	**171**

TABLE 2-9. NEW WEIRS BY EACH ALTERNATIVE'S IMPLEMENTATION SCENARIO AND ECOLOGICAL PROVINCE.

		ALTERNATIVE				
RECOVERY DOMAIN	ECOLOGICAL PROVINCE	1	2	3	4	5
Willamette/ Lower Columbia	Columbia Estuary	0	0	6	7	6
	Lower Columbia	0	0	2	4	2
	Columbia Gorge	0	0	0	0	0
Interior Columbia	Columbia Gorge	0	0	0	0	0
	Columbia Plateau	0	0	2	2	5
	Columbia Cascade	0	0	1	1	1
	Blue Mountain	0	0	0	0	0
	Mountain Snake	0	0	2	2	3
Total		**0**	**0**	**13**	**16**	**17**

This page left blank intentionally.

TABLE 2-10. NUMBER OF POPULATIONS MEETING TARGET METRICS (PNI AND pHOS) BY EACH ALTERNATIVE'S IMPLEMENTATION SCENARIO.

Willamette/ Lower Columbia Recovery Domain		Alternative 1			Alternative 2			Alternative 3			Alternative 4			Alternative 5		
		Stronger Metrics[1]	Intermediate Metrics[2]	Weaker Than Intermediate Metrics[3]	Stronger Metrics	Intermediate Metrics	Weaker Than Intermediate Metrics	Stronger Metrics	Intermediate Metrics	Weaker Than Intermediate Metrics	Stronger Metrics	Intermediate Metrics	Weaker Than Intermediate Metrics	Stronger Metrics	Intermediate Metrics	Weaker Than Intermediate Metrics
Primary Populations	Target		Current Status			55			55			55			55	
	Result	29	3	23	42	9	4	32	18	5	53	0	2	32	18	5
Contributing Populations	Target		Current Status			27			27			27			27	
	Result	9	3	15	19	4	4	15	5	7	11	8	8	16	4	7
Stabilizing Populations	Target		Current Status			Maintain Current Status			Maintain Current Status			Maintain Current Status			Maintain Current Status	
	Result	6	2	28	28	2	6	8	2	26	6	3	27	8	2	26
Interior Columbia																
Primary Populations	Target		Current Status			75			75			75			75	
	Result	43	7	25	56	15	4	55	16	4	45	15	4	71	0	4
Contributing Populations	Target		Current Status			22			22			22			22	
	Result	9	1	12	10	7	5	10	9	3	10	9	3	8	9	5
Stabilizing Populations	Target		Current Status			Maintain Current Status			Maintain Current Status			Maintain Current Status			Maintain Current Status	
	Result	2	0	23	6	0	19	3	0	22	3	0	22	3	0	22

[1] PNI greater than 0.67 for integrated populations; pHOS less than 0.05 for segregated, naturally-spawning populations.
[2] PNI greater than 0.50 for integrated populations; pHOS less than 0.10 for segregated, naturally-spawning populations.
[3] PNI less than 0.50 for integrated populations; pHOS greater than 0.10 for segregated, naturally-spawning populations.
Number of populations meeting or exceeding target metrics is in green. Number of populations not meeting target metrics is in red. This EIS does not evaluate habitat improvements or other measures unrelated to hatchery programs that could contribute improved conditions for these or any populations.

TABLE 2-11. NUMBER OF FISH HARVESTED UNDER EACH ALTERNATIVE'S IMPLEMENTATION SCENARIO.

	ALTERNATIVE				
	1	**2**	**3**	**4**	**5**
Chinook Salmon	277,623	183,322	258,193	273,843	264,782
Steelhead	130,364	88,811	113,716	119,294	121,703
Coho Salmon	193,279	36,293	109,421	140,929	109,421
Chum Salmon	477	425	479	763	479
Sockeye Salmon	625	614	700	700	700
Total	**602,368**	**309,465**	**482,509**	**535,529**	**497,085**

These harvest numbers reflect the number of Columbia River basin salmon and steelhead harvested in all fisheries.

TABLE 2-12. COLUMBIA RIVER SUBBASINS OR MAJOR WATERSHEDS WITHIN A SUBBASIN WHERE HATCHERY FISH ARE NOT RELEASED BY EACH ALTERNATIVE'S IMPLEMENTATION SCENARIO.

ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5
Asotin	Asotin	Asotin	Asotin	Asotin
Chinook	Big Creek	Chinook	Chinook	Chinook
Clatskanie	Chinook River	Clatskanie	Clatskanie	Clatskanie
Entiat	Clatskanie	Entiat	Entiat	Entiat
Fifteenmile	Coweeman	Fifteenmile	Fifteenmile	Fifteenmile
John Day	Elochoman	John Day	John Day	John Day
MiddleFork Salmon	Entiat	MiddleFork Salmon	MiddleFork Salmon	MiddleFork Salmon
Mill-Abernathy-Germany	Fifteenmile	Mill-Abernathy-Germany	Mill-Abernathy-Germany	Mill-Abernathy-Germany
Scappoose	Gnat Creek	Scappoose	Scappoose	Scappoose
	Grays		White Salmon	
	John Day			
	Kalama			
	Klickitat			
	Little White Salmon			
	MiddleFork Salmon			
	Mill-Abernathy-Germany			
	Sandy			
	Scappoose			
	Toutle			
	White Salmon			
	Wind			

These subbasins do not represent those with populations that are entirely free of hatchery influence because several receive strays from nearby hatchery programs (e.g., the Asotin has documented steelhead strays from Lyons Ferry Hatchery releases) (A. Appleby, pers. comm., to HSRG 2009).

Production under the implementation scenario for Alternative 2 would represent about 36 percent of production levels under Alternative 1 with Mitchell Act funded hatcheries representing zero percent of total production (Table 2-7). Under the implementation scenario for Alternative 2, Chinook salmon would represent 73 percent of all hatchery fish produced, steelhead 20 percent and coho salmon 6 percent (Table 2-7). All 62 hatchery programs that rely on Mitchell Act funds (either entirely or because those hatchery programs rely on fish provided by Mitchell Act-funded hatchery programs) would be terminated (Table 2-8). Another 10 harvest hatchery programs would be terminated to achieve the target performance metrics (Table 2-8). Table 2-13 (found at the end of this chapter) lists the hatchery programs terminated under the implementation scenario for Alternative 2. No new hatchery programs would be initiated.

Under the implementation scenario for Alternative 2, intermediate performance metrics would be achieved or exceeded for 93 percent of the primary and contributing populations in the Willamette/Lower Columbia recovery domain and 95 percent of the populations in the Interior Columbia recovery domain (Table 2-10). Despite eliminating 72 hatchery programs (Table 2-8) and reducing many others, some hatchery programs would be retained, even though intermediate performance metrics would not be achieved for 17 populations affected by the hatchery programs (Table 2-10). In the Willamette/Lower Columbia recovery domain, hatchery programs would be retained even though they would affect four primary and four contributing populations that would not achieve target performance metrics (Table 2-10). These populations and the reasons for continuing the hatchery programs are as follows:

1. **Willamette North Santiam Spring Chinook Salmon (Primary).** Maintain spring Chinook salmon conservation hatchery program in the North Santiam River.
2. **Sandy Chum Salmon (Primary).** Maintain nearby chum salmon conservation hatchery program (Duncan Creek).
3. **Kalama Spring Chinook Salmon (Primary).** Maintain nearby spring Chinook salmon conservation hatchery programs (Lewis and Cowlitz Rivers).
4. **Youngs Bay Tributaries Chum Salmon (Primary).** Maintain chum salmon conservation hatchery program in the Grays River.
5. **White Salmon Spring Chinook Salmon (Contributing).** Population abundance is zero. The population was designated contributing by LCFRB (2004) in anticipation of future removal of Condit Dam.
6. **Middle Fork Willamette Spring Chinook Salmon (Contributing).** Maintain spring Chinook salmon conservation hatchery program in the Middle Fork Willamette River.

7. **Big Creek Chum Salmon (Contributing).** Maintain chum salmon conservation hatchery program in the Grays River.
8. **Clatskanie Creek Chum Salmon (Contributing).** Maintain chum salmon conservation hatchery program in Grays River.

In the Interior Columbia recovery domain, hatchery programs would be maintained even though four primary and five contributing populations would not achieve target performance metrics. These populations and the reasons for retaining the associated hatchery programs are as follows:

1. **Clearwater Upper Selway River Spring Chinook Salmon (Primary).** Maintain spring Chinook salmon conservation hatchery program in the upper Selway River.
2. **Entiat spring Chinook Salmon (Primary).** Maintain spring Chinook salmon conservation hatchery programs in the Upper Columbia.
3. **Entiat Summer Steelhead (Primary).** Population abundance is low (less than 100 fish) and heavily influenced by hatchery-origin strays (i.e., spawning fitness is degraded). Habitat productivity is poor and, until improved, would not sustain a conservation hatchery program.
4. **Okanogan Summer Steelhead (Primary).** Maintain summer steelhead conservation hatchery program in the Okanogan River.
5. **Clearwater Lower Selway River Spring Chinook Salmon (Contributing).** Maintain spring Chinook salmon conservation hatchery program in the lower Selway River.
6. **Yakima Fall Chinook Salmon (Contributing).** Maintain nearby fall Chinook salmon conservation hatchery program in Umatilla River.
7. **Yakima Marion Drain fall Chinook Salmon (Contributing).** Maintain fall Chinook salmon conservation hatchery program in Marion Drain.
8. **Upper Yakima Summer Steelhead (Contributing).** Abundance of population is low (less than 100 fish) and heavily influenced by hatchery-origin strays (i.e., spawning fitness is degraded). Pending improvement, habitat productivity is poor. Habitat productivity is poor and, until improved, would not sustain a conservation hatchery program.
9. **Walla Walla Spring Chinook Salmon (Contributing).** Maintain spring Chinook salmon conservation hatchery program in the Walla Walla River.

The number of fish harvested under the implementation scenario for Alternative 2 would be about 51 percent of fish harvested under Alternative 1 (No Action) (Table 2-11). Most of this decrease would be due to substantial reductions in Chinook salmon, steelhead, and coho salmon

(Table 2-11). Twenty-one subbasins would not receive direct releases of hatchery-origin fish under the implementation scenario for Alternative 2 (Table 2-12). Most of these would be within the Willamette/Lower Columbia recovery domain.

2.7.3 Implementation Scenario for Alternative 3 (All Hatchery Programs Meet Intermediate Performance Goal)

Under the implementation scenario for Alternative 3, Mitchell Act-funded hatchery programs and non-Mitchell Act-funded hatchery programs would be operated in a manner that achieves intermediate performance metrics for primary and contributing salmon and steelhead populations (Table 2-5). Measures implemented under the implementation scenario for Alternative 3 to help hatchery programs meet performance metrics would include all of the measures under the implementation scenario for Alternative 2, plus the installation of new seasonal weirs (Table 2-6). The use of additional weirs under the implementation scenario for Alternative 3 would reduce the number of hatchery-origin fish spawning with natural-origin fish compared to the implementation scenarios for Alternative 1 and Alternative 2 (Box 2-9) and would improve PNI and pHOS for affected salmon and steelhead populations.

Hatchery production levels under the implementation scenario for Alternative 3 would be approximately 74 percent of hatchery production levels under Alternative 1 with Mitchell Act-funded hatchery programs producing 50 percent of the total hatchery production (Table 2-7). To meet the PNI and pHOS performance metrics for both Mitchell Act and non-Mitchell Act funded hatchery programs, hatchery production levels would be reduced by 36.6 million juvenile fish from Alternative 1 levels (Table 2-7), thereby reducing the number of hatchery-origin adults spawning with natural-origin fish. However, nearly 107 million juvenile fish (about 74 percent of production levels under Alternative 1) would continue to be produced in Columbia River basin hatchery programs, with 50 percent of the fish being released from Mitchell Act-funded hatchery programs (Table 2-7). Similar to Alternative 1, most of the hatchery production under the implementation scenario for Alternative 3 would be Chinook

Box 2-9. What are weirs and how do they help achieve performance metrics?

Weirs are structures in streams designed to block the migration of adult fish but allow passage of water, juvenile fish, debris, and, in some cases, boats. Fish collection facilities often use weirs to collect broodstock and, if externally marked, sort hatchery-origin from natural-origin fish (Box 2-4). This capability allows managers to control the number of hatchery fish allowed to spawn in the natural environment or collect the appropriate proportion of natural-origin broodstock to maintain an integrated hatchery program. Decreasing pHOS and/or increasing pNOB are often required for a hatchery program to meet performance metrics. Although fish mortality from weir operation is generally considered to be quite low (McLean et al. 2004), weirs can present other biological risks including juvenile or adult migration delay, isolating formerly connected populations, limiting movement of non-target species, increasing predation by concentrating fish, and altering habitat conditions upstream and downstream of the weir (RIST 2009). Weirs can also affect boat passage or other recreational activities and degrade the scenic qualities of a river. Weirs can be expensive to construct and operate.

While this EIS does not intend to fulfill any required environmental review associated with weir installation, it does evaluate how the use of a weir under reasonable assumptions could result in environmental effects on the hatchery programs analyzed in the alternatives. For instance, while not being specific in the design and operation of any particular weir, the draft EIS considers two broad types of weirs for analysis in the alternatives: permanent weirs and seasonal (temporary) weirs.

Permanent weirs are substantial structures relative to the size of streams within which they are built and can withstand a wide spectrum of water flow throughout the year. This is true even though they may be operated only during certain times to target a particular run. Permanent weirs are efficient at capturing fish, but do not generally catch all of the fish targeted for removal due to mismarking of fish or regeneration of the clipped adipose fin. For this reason, this analysis assumes that a seasonal weir would be operated with the trapping efficiency necessary to achieve the performance goal, but not greater than 95 percent (i.e., through use of a permanent weir, *not more than* 95 percent of the fish targeted for removal would be removed).

Seasonal weirs are installed during certain times of the year to capture adults of a particular run. The weirs are usually built to withstand only the flow levels expected during their use. When the weir is not needed, it may be removed to allow for fish passage or recreational activities. This removal also prevents destruction by high flows. Even so, seasonal weirs are more prone to partial or total physical failure compared to

Box 2-9. What are weirs and how do they help achieve performance metrics? (continued)

permanent weirs because of the inherent constraints of constructing a portable structure (which is less costly) versus a permanent structure. Thus, this analysis assumes that a seasonal weir would be operated with the trapping efficiency necessary to achieve the performance goal, but not greater than 60 percent (i.e., through the use of a seasonal weir, *not more than* 60 percent of the fish targeted for removal would be removed).

Because of its lower efficiency (maximum of 60 percent), the use of a seasonal weir is sometimes not sufficient to remove enough hatchery-origin fish to achieve pHOS and PNI metrics. If not replaced by a higher efficiency weir (such as a permanent weir), a reduction in the number of hatchery-origin fish produced may be needed to reduce the number of hatchery-origin adults that return to the spawning grounds.

To illustrate the effects of different weir efficiencies, this EIS assumes the use of permanent weirs (maximum efficiency of 95 percent) if their efficiency is necessary to meet performance metrics in the Willamette/Lower Columbia recovery domain under Alternative 4. Under Alternative 5, this EIS assumes the use of permanent weirs if their efficiency is necessary to meet performance metrics in the Interior Columbia recovery domain. For comparison, seasonal weirs are assumed to be used at all other times, including under Alternative 3.

For more information on weirs, including costs and their usage in salmon management, see Johnson et al. (2007) and Recovery Implementation Science Team (2009). Again, this draft EIS is not intended to fulfill requirements for environmental review, if any, for weir installation or operations.

salmon (75 percent), followed by approximately equal numbers of steelhead and coho salmon (12 percent each), with 1 percent or less of both chum and sockeye salmon (Table 2-7). Seventeen hatchery programs would be terminated because they would not meet performance metrics through available implementation measures (Box 2-10) (Table 2-6). For more details on terminated hatchery programs, see Table 2-14 at the end of this chapter. Under the implementation scenario for Alternative 3, no new hatchery programs would be initiated (Table 2-8). To minimize the number of hatchery fish that spawn in the wild, the implementation scenario for Alternative 3 would include the installation of 13 new weirs in addition to the existing weirs under Alternative 1 (Table 2-9). Weirs would be located in all ecological provinces, except the Columbia Gorge and Blue Mountains. Most of the new weirs (62 percent) would be placed in the Willamette/ Lower Columbia recovery domain (Table 2-9). Weirs would be placed where, based upon their assumed efficiency, they would be expected to allow primary or contributing populations to meet performance metrics (Box 2-9).

Box 2-10. Why terminate hatchery programs to meet performance metrics?

In general, most hatchery programs currently fall short of intermediate or stronger performance goals because of the effect of hatchery strays on nearby populations. This failure occurs because hatchery programs individually or cumulatively result in a high number of hatchery-origin spawners on natural spawning grounds.

In circumstances where hatchery programs cumulatively lead to high pHOS levels, more than one hatchery program may produce fish that stray into the same subbasin, thus affecting the same natural-origin salmon or steelhead population. In these cases, there are two ways to meet the performance goals:

1. Reduce the level of production, or close one of the hatchery programs affecting the natural-origin salmon or steelhead population. This action would reduce the total number of strays to an acceptable level.
2. Reduce production in more than one hatchery program (if not all hatchery programs) affecting the natural-origin salmon or steelhead population.

When considering the widest range of options for achieving performance goals, the implementation scenarios for different alternatives have diverse approaches to achieving performance goals. For example, hatchery-origin spring Chinook from the Middle Fork Willamette River program stray into the McKenzie, South Santiam, and North Santiam Rivers and affect populations in each of these rivers. In addition, hatchery programs operating in these rivers produce fish that also stray into these populations. Under the implementation scenario for Alternative 2, all hatchery programs would remain, but would be reduced considerably to achieve performance goals. Under the implementation scenario for Alternative 3, the Middle Fork Willamette hatchery program would be terminated as it was the largest contributor of hatchery-origin strays, but other hatchery programs would be maintained at current levels.

There are two circumstances in this draft EIS where hatchery programs would not be closed even though affected populations would not meet performance metrics. The first is when the purpose of the hatchery program is conservation of a salmon or steelhead population listed under the ESA. The second is when the affected population is small, dominated by spawning hatchery-origin strays, and habitat productivity is so low that it cannot sustain a naturally spawning population.

For primary populations, the intermediate performance metrics would be achieved or exceeded for more than 91 percent of the populations in the Willamette/Lower Columbia recovery domain and 95 percent of the populations in the Interior Columbia recovery domain (Table 2-10).

Despite implementing the actions previously described and reducing juvenile releases from many others, hatchery programs would be retained even though the intermediate performance metrics would not be achieved for 19 affected populations in the Willamette/Lower Columbia and Interior Columbia recovery domains (Box 2-9). In the Willamette/Lower Columbia recovery domain, hatchery programs would be retained, although five affected primary populations and seven contributing populations would not achieve target performance metrics. These populations and the reasons for continuing the hatchery programs are as follows:

1. **Willamette North Santiam Spring Chinook Salmon (Primary).** Maintain spring Chinook salmon conservation hatchery program in the North Santiam River.
2. **Sandy Chum Salmon (Primary).** Maintain nearby chum salmon conservation hatchery program (Duncan Creek).
3. **Kalama Spring Chinook Salmon (Primary).** Maintain nearby spring Chinook salmon conservation hatchery programs (Lewis and Cowlitz Rivers).
4. **Columbia Gorge Tributaries Coho Salmon (Washington) (Primary).** Population abundance is very low (fewer than 50 fish) and is heavily influenced by hatchery strays (i.e., spawning fitness is degraded). Conservation hatchery programs would not be effective without habitat improvement.
5. **Youngs Bay Tributaries Chum Salmon (Primary).** Maintain chum salmon conservation hatchery program in the Grays River.
6. **White Salmon Spring Chinook Salmon (Contributing).** Abundance of the population currently is zero pending re-introduction after potential removal of Condit Dam.
7. **Middle Fork Willamette Spring Chinook Salmon (Contributing).** Maintain spring Chinook salmon conservation hatchery program in the Middle Fork Willamette River.
8. **Big Creek Chum Salmon (Contributing).** Maintain chum salmon conservation hatchery program in the Grays River.
9. **Clatskanie Creek Chum Salmon (Contributing).** Maintain chum salmon conservation hatchery program in the Grays River.
10. **Hood Coho Salmon (Contributing).** Population abundance is very low (fewer than 50 fish) and is heavily influenced by hatchery-origin strays (i.e., spawning fitness is

degraded). Conservation hatchery programs would not be effective without habitat improvement.

11. **White Salmon Fall Chinook Salmon (Contributing).** Population abundance is very low (fewer than 200 fish) and is heavily influenced by hatchery-origin strays (i.e., spawning fitness is degraded). Currently, pending removal of Condit Dam and improvement in the habitat, conservation hatchery programs would not be effective.
12. **Clackamas Fall Chinook Salmon (Contributing).** Population abundance is very low (fewer than 50 fish) and is heavily influenced by hatchery-origin strays (i.e., spawning fitness is degraded). Conservation hatchery programs would not be effective without habitat improvement.

In the Interior Columbia recovery domain, four primary and three contributing populations would not achieve target performance metrics (Table 2-10). These populations and the reasons for continuing the hatchery programs are as follows:

1. **Clearwater Upper Selway River Spring Chinook Salmon (Primary).** Maintain spring Chinook salmon conservation hatchery program in the upper Selway River.
2. **Entiat Summer Steelhead (Primary).** Maintain summer steelhead conservation hatchery programs in the Upper Columbia.
3. **Okanogan Summer Steelhead (Primary).** Maintain summer steelhead conservation hatchery program in the Okanogan River.
4. **Salmon River (Redfish Lake) Sockeye Salmon (Primary).** Maintain sockeye salmon conservation hatchery program in the Salmon River.
5. **Clearwater Lower Selway River Spring Chinook salmon (Contributing).** Maintain spring Chinook salmon hatchery conservation program in the lower Selway River.
6. **Yakima Marion Drain Fall Chinook (Contributing).** Maintain fall Chinook salmon conservation hatchery program in Marion Drain.
7. **Yakima Upper Yakima Summer Steelhead (Contributing).** Population abundance is low (fewer than 100 fish) and is heavily influenced by hatchery-origin strays (i.e., spawning fitness is degraded). Conservation hatchery programs would not be effective without habitat improvement.

The number of fish harvested under the implementation scenario for Alternative 3 would be approximately 80 percent of the fish harvested under Alternative 1 (No Action) (Table 2-11). Most of this decrease would be due to a 43 percent reduction in the number of coho salmon harvested (Table 2-11). The number of subbasins not receiving direct releases of hatchery fish under the implementation scenario for Alternative 3 would be the same as under Alternative 1 (No Action) (Table 2-12).

2.7.4 Implementation Scenario for Alternative 4 (Willamette/Lower Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 4, hatchery programs in the Willamette/ Lower Columbia recovery domain would be operated to allow primary and contributing salmon and steelhead populations to meet stronger performance metrics (Table 2-4). Hatchery programs in the Interior Columbia recovery domain would be operated to allow primary and contributing salmon and steelhead populations to meet intermediate performance metrics (Table 2-4). Under the implementation scenario for Alternative 4, several additional measures would be implemented (when compared to the implementation scenarios for Alternative 1 through Alternative 3) in the Willamette/Lower Columbia recovery domain to help programs meet performance metrics (Table 2-6). Weirs would be installed, the purpose or type of hatchery programs could be changed, and new selective terminal fisheries would be added to control the number of hatchery fish on the spawning ground (Table 2-6).

Under the implementation scenario for Alternative 4, production would be about 82 percent of production levels under Alternative 1 with Mitchell Act-funded hatchery programs producing 51 percent of total hatchery production (Table 2-7). More than 118 million fish would continue to be produced by hatcheries. Similar to the implementation scenarios for Alternative 1, Alternative 2, and Alternative 3, most fish production (74 percent) under the implementation scenario for Alternative 4 would be Chinook salmon, while 11 percent, 13 percent, 1 percent, and 1 percent would be of steelhead, coho salmon, chum salmon, and sockeye salmon, respectively (Table 2-7).

Eighteen new hatchery programs would be initiated in the Columbia Estuary and Lower Columbia ecological provinces under the implementation scenario for Alternative 4 (Table 2-8). Eight of these new hatchery programs would support conservation objectives (seven chum salmon hatchery programs and one fall Chinook salmon hatchery program), while four hatchery programs would support harvest (all coho salmon hatchery programs), and six hatchery programs would support both conservation and harvest (four steelhead hatchery programs, one coho salmon hatchery program, and one spring Chinook salmon hatchery program) (Table 2-8). For more details on hatchery programs that would be initiated under the implementation scenario for Alternative 4, see Table 2-17 at the end of this chapter.

More hatchery programs would be terminated under the implementation scenario for Alternative 4 than under the implementation scenarios for Alternative 3 and Alternative 5 (Table 2-8). These eliminations would occur in both the Willamette/Lower Columbia and Interior Columbia recovery domains (Table 2-8). Eliminations would occur because programs would prevent salmon and steelhead populations from meeting target performance metrics. For more details on terminated programs, see Table 2-15 at the end of this chapter.

To minimize the number of hatchery-origin fish that spawn naturally, the implementation scenario for Alternative 4 includes the installation of 16 new weirs (Table 2-9), which would be located in all ecological provinces except the Columbia Gorge (Interior Columbia recovery domain) ecological province (Table 2-9). Eleven weirs would be permanent structures in the Willamette/Lower Columbia recovery domain, and the other five would be seasonal weirs in the Interior Columbia recovery domain (Box 2-9).

Stronger performance metrics would be achieved for 96 percent of the primary populations in the Willamette/Lower Columbia recovery domain (Table 2-10). Hatchery programs would continue operating in the implementation scenario for Alternative 4, even though this would result in two primary populations not achieving stronger performance metrics (Table 2-10). Of the 27 contributing populations, 19 (70 percent) would achieve or exceed target performance metrics, but some hatchery programs would continue operating, even though they would affect 8 contributing populations that would not meet target performance metrics (Table 2-10). These populations and the reasons for continuing the hatchery programs are as follows:

1. **Willamette North Santiam Spring Chinook Salmon (Primary).** Maintain spring Chinook salmon conservation hatchery program in the North Santiam River.
2. **Columbia Gorge Tributaries Coho Salmon (Washington) (Primary).** Population abundance is very low (fewer than 50 fish) and is heavily influenced by hatchery-origin strays (i.e., spawning fitness is degraded). Conservation hatchery programs would not be effective without habitat improvement.
3. **White Salmon Spring Chinook Salmon (Contributing).** Population abundance is zero. Currently, pending removal of Condit Dam and improvement in habitat, conservation hatchery programs would not be effective.
4. **White Salmon Fall Chinook Salmon (Contributing).** Population abundance is very low (fewer than 200 fish) and is heavily influenced by hatchery-origin strays (i.e., spawning fitness is degraded). Currently, pending removal of Condit Dam and improvement in habitat, conservation hatchery programs would not be effective.

5. **Middle Fork Willamette Spring Chinook Salmon (Contributing).** Maintain spring Chinook salmon conservation hatchery program in the Middle Fork Willamette River.
6. **Clackamas Fall Chinook Salmon (Contributing).** Population abundance is very low (fewer than 50 fish) and is heavily influenced by hatchery-origin strays (i.e., spawning fitness is degraded). Conservation hatchery programs would not be effective without habitat improvement.
7. **Big Creek Chum Salmon (Contributing).** Maintain chum salmon conservation hatchery program in the Grays River.
8. **Clatskanie Chum Salmon (Contributing).** Maintain chum salmon conservation hatchery program in the Grays River.
9. **Kalama Chum Salmon (Contributing).** Maintain chum salmon conservation hatchery programs in the Lower Columbia River.
10. **Hood Coho Salmon (Contributing).** Population abundance is very low (fewer than 50 fish) and is heavily influenced by hatchery-origin strays (i.e., spawning fitness is degraded). Conservation hatchery programs would not be effective without habitat improvement.

In the Interior Columbia recovery domain, four primary and three contributing populations would not achieve target performance metrics. These populations and the reasons for continuing the hatchery programs are as follows:

1. **Upper Selway River Spring Chinook Salmon (Primary).** Maintain spring Chinook salmon conservation hatchery program in the upper Selway River.
2. **Entiat Summer Steelhead (Primary).** Maintain summer steelhead conservation hatchery programs in the Upper Columbia.
3. **Okanogan Summer Steelhead (Primary).** Maintain summer steelhead conservation hatchery program in the Okanogan River.
4. **Salmon River (Redfish Lake) Sockeye Salmon (Primary).** Maintain sockeye salmon conservation hatchery program in the Salmon River.
5. **Clearwater Lower Selway River Spring Chinook Salmon (Contributing).** Maintain spring Chinook salmon conservation hatchery program in the lower Selway River.
6. **Yakima Marion Drain Fall Chinook Salmon (Contributing).** Maintain fall Chinook salmon conservation hatchery program in Marion Drain.
7. **Yakima Upper Yakima Summer Steelhead (Contributing).** Population abundance is low (less than 100 fish) and is heavily influenced by hatchery-origin strays (i.e.,

spawning fitness is degraded). Conservation hatchery programs would not be effective without habitat improvement.

The number of fish harvested under the implementation scenario for Alternative 4 would be approximately 89 percent of fish harvested under Alternative 1 (No Action) (Table 2-11). Most of this decrease would be because of a 27 percent reduction in the number of coho salmon harvested (Table 2-11). Slightly more Chinook salmon, chum salmon, and sockeye salmon would be harvested. The number of subbasins not receiving direct releases of hatchery fish under the implementation scenario for Alternative 4 would be similar to Alternative 1 (No Action) but would additionally include the White Salmon subbasin (Table 2-12).

2.7.5 Implementation Scenario for Alternative 5 (Interior Columbia River Hatchery Programs Meet Stronger Performance Goal)

Under the implementation scenario for Alternative 5, hatchery programs in the Interior Columbia recovery domain would be operated to allow primary and contributing populations to achieve stronger performance metrics (Table 2-5). Programs in the Willamette/Lower Columbia recovery domain would be operated to allow primary and contributing populations to achieve intermediate performance metrics (Table 2-5).

Under the implementation scenario for Alternative 5, new opportunities would be identified to support harvest opportunities above Bonneville Dam, including the tribal commercial fisheries. Because some existing hatchery production levels would be reduced under the implementation scenario for Alternative 5 to ensure that hatchery programs could meet performance metrics, opportunities would be explored for increasing hatchery production in other existing hatchery facilities while still meeting target performance metrics.

Unlike under the implementation scenarios for Alternative 2 and Alternative 3, *all* hatchery programs would be operated to achieve stronger performance metrics in the Interior Columbia recovery domain under the implementation scenario for Alternative 5 (Table 2-5). In addition, hatchery programs within the Willamette/Lower Columbia recovery domain would be operated to achieve intermediate performance metrics (Table 2-5). Under the implementation scenario for Alternative 5, several additional measures would be implemented (when compared to Alternative 1, Alternative 2, and Alternative 3) in the Interior Columbia recovery domain. These measures would aid programs in meeting target performance metrics (the same as under the implementation scenario for Alternative 4) (Table 2-6). Permanent weirs could be installed to help meet performance metrics, the purpose or type of hatchery programs could be changed, and new terminal selective fisheries could be added to control the number of hatchery fish on the spawning ground (Table 2-6).

Under the implementation scenario for Alternative 5, five new hatchery programs would be initiated in the Interior Columbia recovery domain (Table 2-8). Two of these new hatchery programs would support conservation objectives (both for spring Chinook salmon) while two programs would support harvest (one for winter steelhead and one for spring Chinook salmon) and one program would support both conservation and harvest (for summer steelhead) (Table 2-8). For more details on new hatchery programs that would be initiation under the implementation scenario for Alternative 5, see Table 2-17 at the end of this chapter.

Hatchery production levels under the implementation scenario for Alternative 5 would be 77 percent of the production levels under Alternative 1 (No Action) with Mitchell Act-funded hatchery production representing 53 percent of total hatchery production (Table 2-7). More than 110 million juvenile fish would continue to be produced in Columbia River basin hatchery programs. Chinook salmon, steelhead, and coho salmon would represent 74 percent, 13 percent, and 12 percent of total hatchery production under the implementation scenario for Alternative 5 (Table 2-7). Chum and sockeye salmon would represent 0.3 percent and 0.9 percent, respectively, of the total production under the implementation scenario for Alternative 5 (Table 2-7).

At least one hatchery program would be terminated in all ecological provinces, except Mountain Snake (Table 2-8). These terminations would occur because of the inability of the programs to meet target performance metrics (Table 2-4) (Table 2-5). For more details on terminated hatchery programs, see Table 2-16 at the end of this chapter. There would be 17 new weirs under the implementation scenario for Alternative 5 (Table 2-9). New weirs would be placed in all provinces except the Columbia Gorge and Blue Mountain provinces (Table 2-9). These weirs would be a combination of seasonal and permanent structures (as necessary) in the Interior Columbia recovery domain and all seasonal structures in the Willamette/Lower Columbia recovery domain (Box 2-9). Weirs would be located where they could achieve the desired benefits to primary or contributing populations.

The stronger performance metrics would be achieved for 71 of the 75 primary populations (95 percent) in the Interior Columbia recovery domain (Table 2-10). Hatchery programs would be maintained in the implementation scenario for Alternative 5 even though four affected primary populations would not achieve the intermediate performance metrics (Table 2-10). Of the 22 contributing populations, 17 populations (77 percent) would achieve or exceed the intermediate performance metrics (Table 2-10). Some hatchery programs would be maintained under the implementation scenario for Alternative 5 even though nine contributing populations would not achieve target performance metrics (Table 2-10). These populations and the reasons for continuing the hatchery programs are as follows:

1. **Clearwater Upper Selway River Spring Chinook (Primary).** Maintain spring Chinook salmon conservation hatchery program in the upper Selway River.
2. **Entiat Summer Steelhead (Primary).** Population abundance is low (fewer than 100 fish) and is heavily influenced by hatchery-origin strays (i.e., spawning fitness is degraded). Conservation hatchery programs would not be effective without habitat improvement.
3. **Okanogan Summer Steelhead (Primary).** Maintain summer steelhead conservation hatchery program in the Okanogan River.
4. **Salmon River (Redfish Lake) Sockeye Salmon(Primary).** Maintain sockeye salmon conservation hatchery program in the Salmon River.
5. **Clearwater Lower Selway River Spring Chinook Salmon (Contributing).** Maintain spring Chinook salmon conservation hatchery program in the lower Selway River.
6. **Yakima Marion Drain Fall Chinook Salmon (Contributing).** Maintain fall Chinook salmon conservation hatchery program in Marion Drain.
7. **Middle Fork Salmon River Lower Mainstem Spring Chinook Salmon (Contributing).** Maintain Chinook salmon conservation hatchery programs in the Upper Salmon River (Upper Salmon and Pahsimeroi).
8. **Salmon River Lower Main Stem Spring Chinook Salmon (Contributing).** Maintain Chinook salmon conservation hatchery programs in the Upper Salmon River (Upper Salmon and Pahsimeroi).
9. **North Fork Salmon River Spring Chinook Salmon (Contributing).** Maintain Chinook salmon conservation hatchery programs in the Upper Salmon River (Upper Salmon and Pahsimeroi).

In the Willamette/Lower Columbia recovery domain, hatchery programs would be maintained in the alternative, even though five primary and seven contributing populations would not achieve target performance metrics (Table 2-10). These populations and the reasons for continuing the hatchery programs are as follows:

1. **Willamette North Santiam Spring Chinook Salmon (Primary).** Maintain spring Chinook salmon conservation hatchery program in the North Santiam River.

2. **Kalama Spring Chinook Salmon (Primary).** Maintain nearby spring Chinook salmon conservation hatchery programs (Lewis and Cowlitz Rivers).
3. **Sandy Chum Salmon (Primary).** Maintain nearby chum salmon conservation hatchery program (Duncan Creek).
4. **Columbia Gorge Tributaries Coho Salmon (Washington) (Primary).** Population abundance is very low (fewer than 50 fish) and is heavily influenced by hatchery-origin strays (i.e., spawning fitness is degraded). Conservation hatchery programs would not be effective without habitat improvement.
5. **Youngs Bay Tributaries Chum Salmon (Primary).** Maintain chum salmon conservation hatchery program in the Grays River.
6. **White Salmon Spring Chinook Salmon (Contributing).** Population is zero. Currently, pending removal of Condit Dam and habitat improvement, conservation hatchery programs would not be effective.
7. **Middle Fork Willamette Spring Chinook Salmon (Contributing).** Maintain spring Chinook salmon conservation hatchery program in the Middle Fork Willamette River.
8. **Big Creek Chum Salmon (Contributing).** Maintain chum salmon conservation hatchery program in the Grays River.
9. **Clatskanie Chum Salmon (Contributing).** Maintain chum salmon conservation hatchery program in the Grays River.
10. **Hood Coho Salmon (Contributing).** Population abundance is very low (fewer than 50 fish) and is heavily influenced by hatchery-origin strays (i.e., spawning fitness is degraded). Conservation hatchery programs would not be effective without habitat improvement.
11. **White Salmon Fall Chinook Salmon (Contributing).** Population abundance is very low (fewer than 200 fish) and is heavily influenced by hatchery-origin strays (i.e., spawning fitness is degraded). Currently, pending removal of Condit Dam and habitat improvement, conservation hatchery programs would not be effective.
12. **Clackamas Fall Chinook Salmon (Contributing).** Population abundance is very low (fewer than 50 fish) and is heavily influenced by hatchery-origin strays (i.e., spawning fitness is degraded). Conservation hatchery programs would not be effective without habitat improvement.

The number of fish harvested under the implementation scenario for Alternative 5 would be about 83 percent of fish harvested under Alternative 1 (No Action) (Table 2-11). Most of this decrease would be due to a 43 percent reduction in the number of coho salmon harvested (Table 2-11). The number of subbasins that would *not* receive direct releases of hatchery fish under the implementation scenario for Alternative 5 would be the same as under Alternative 1 (No Action) (Table 2-12).

2.8 Alternatives Considered but Eliminated from Detailed Analysis

Most comments received during scoping were incorporated into the four action alternatives. Four additional alternatives were considered but not further analyzed for the following reasons:

1) The alternative would not provide any additional information beyond what was revealed through evaluation of the four action alternatives described in Section 2.5, Alternatives Analyzed in Detail.

2) The proposed alternatives were inconsistent with the purpose and need of this Federal action, particularly the congressional intent under Mitchell Act appropriations for operating and maintaining hatcheries in the Columbia River basin (Section 1.1.1, The Mitchell Act) (Table 1-3).[4]

2.8.1 Alternative that Eliminates All Hatchery Programs in Subbasins that can Support Natural Production

This alternative would terminate hatchery programs in Columbia River subbasins where quality aquatic habitat occurs and, alternatively, would use the funds planned for those hatchery programs for habitat restoration in subbasins that could support natural-origin salmon and steelhead production. This alternative was considered but eliminated from detailed analysis because the Mitchell Act funding subject to this EIS is directed by congressional appropriation to be used for artificial production and cannot be used for habitat restoration. Congress could, but did not, appropriate funds under the authority of the Mitchell Act for habitat restoration. However, the environmental effects of eliminating Mitchell Act-funded hatchery programs are included within the scope of the analysis under Alternative 2 (No Mitchell Act funding). Alternative 2 does not, however, evaluate habitat restoration actions because those actions cannot be funded with Mitchell Act funds Congress designated for hatchery operations. These actions are, thus, beyond the scope of this environmental review. Under Alternative 2, several subbasins would no longer receive direct releases of hatchery salmon or steelhead. However, this does not mean that populations in these subbasins are free of hatchery influences. As an example, no fish

[4] In recent years, the President’s Budget Request submitted to Congress has identified funding for Mitchell Act hatchery operations, Monitoring, Evaluation and Reform, and the Screens and Fishways Program as three Mitchell Act subaccounts within an account entitled “Salmon Management Activities.” Congress has appropriated the total to the Salmon Management Activities account, which the Administration then allocates to the three Mitchell Act activities in amounts requested in the budget.

are released into the Asotin subbasin under Alternative 1, but marked hatchery strays are counted every year at a downstream weir (WDFW unpublished data provided to the HSRG).

In contrast to Mitchell Act-funded hatchery programs, NMFS does not fund or operate non-Mitchell Act-funded hatchery programs. While the purpose and need of this EIS include informing NMFS' future review under the ESA of these non-Mitchell Act-funded hatchery programs, those reviews will occur only in response to specific proposals from the agencies and tribes that operate them. The alternatives carried forward for analysis do, however, include many circumstances where non-Mitchell Act-funded hatchery programs would be closed to meet the performance goals established in the alternatives.

2.8.2 Alternative that Converts All Segregated Hatchery Programs to Integrated Hatchery Programs

This alternative would convert all segregated hatchery programs to integrated hatchery programs. An integrated hatchery program uses natural-origin fish in the hatchery broodstock so that the fish produced in the hatchery facility are genetically similar to the natural-origin fish in the subbasin where they are being released. While many integrated hatchery programs already exist in the Columbia River basin and are analyzed in this EIS, segregated hatchery programs remain valuable in situations where natural-origin populations are not large enough to contribute fish to a hatchery program's broodstock while also sustaining the naturally spawning portion of the population. In such cases, integrated hatchery programs would remove critically needed naturally spawning adults from a subbasin to provide for hatchery broodstock. The hatchery program would likely be unsuccessful because too few fish could be taken for hatchery broodstock due to the need to ensure sufficient natural-origin spawners. In many cases, this limitation impairs the ability of the population meaningfully to support either a conservation objective or a harvest objective. In those instances, analysis of the effects of such a program would not add meaningful information to this EIS. The alternatives carried forward for analysis do, however, include many integrated hatchery programs.

2.8.3 Alternative that Focuses on Habitat Improvements Rather than Hatchery Production

Under this alternative, Mitchell Act funds would be diverted from hatchery programs to aquatic habitat improvements. Through its appropriations process, Congress directs NMFS to use the Mitchell Act funds subject to this environmental review specifically for Columbia River hatchery production (Section 1.1.1, The Mitchell Act). As a result, this alternative was eliminated from detailed analysis.

2.8.4 Alternative that Terminates Non-Mitchell Act-funded Hatchery Programs that Meet Performance Metrics

Comments were received recommending the termination of some or all hatchery programs. Alternative 2 would eliminate Mitchell Act-funded hatchery programs because these are the only hatchery programs in the Columbia River basin that are funded by NMFS through specific congressional appropriations but not specifically prescribed by another mitigation agreement (although many Mitchell Act-funded hatchery programs currently are used to fulfill commitments in the 2008 Columbia River Fish Management Plan authorized in *U.S. v. Oregon*). All operating non-Mitchell Act-funded hatchery programs in the basin address requirements described in 2008 Columbia River Fish Management Plan, an applicable license issued by the Federal Energy Regulatory Commission, or congressional mandate (Snake River Compensation Plan). The termination of these hatchery programs if they cannot not meet performance metrics that reduce adverse effects on natural-origin fish is already analyzed under one or more of the action alternatives (Table 2-8). Further, NMFS does not fund or operate non-Mitchell Act funded hatcheries and, therefore, could not mandate their termination. While the purpose and need of this EIS include informing NMFS' future review under the ESA of these non-Mitchell Act-funded hatchery programs, those reviews will occur only in response to specific proposals to actually operate the hatcheries when submitted by operating agencies and tribes.

2.9 Selection of a Preferred Alternative

As explained in Section 1.3.1, Preferred Alternative Formulated and Identified in Final EIS, NMFS will review public comment received on the draft EIS and identify a preferred policy direction in the final EIS. The preferred policy direction may be one of the policy directions presented in the draft EIS or a combination of components of more than one policy direction (Figure 2-3). Information from the public review process will be used in choosing a preferred policy direction. In addition, any preferred policy direction will be informed by the concurrent and complex authorities and initiatives that currently exist in the Columbia River basin, including judicial orders from *U.S. v. Oregon* (Section 1.7.1, *U.S. v Oregon*), the Federal Columbia River Power System Biological Opinion (Section 1.7.9, Federal Columbia River Power System [FCRPS] Biological Opinion), and ESA recovery planning (Section 1.1.2, The Endangered Species Act).

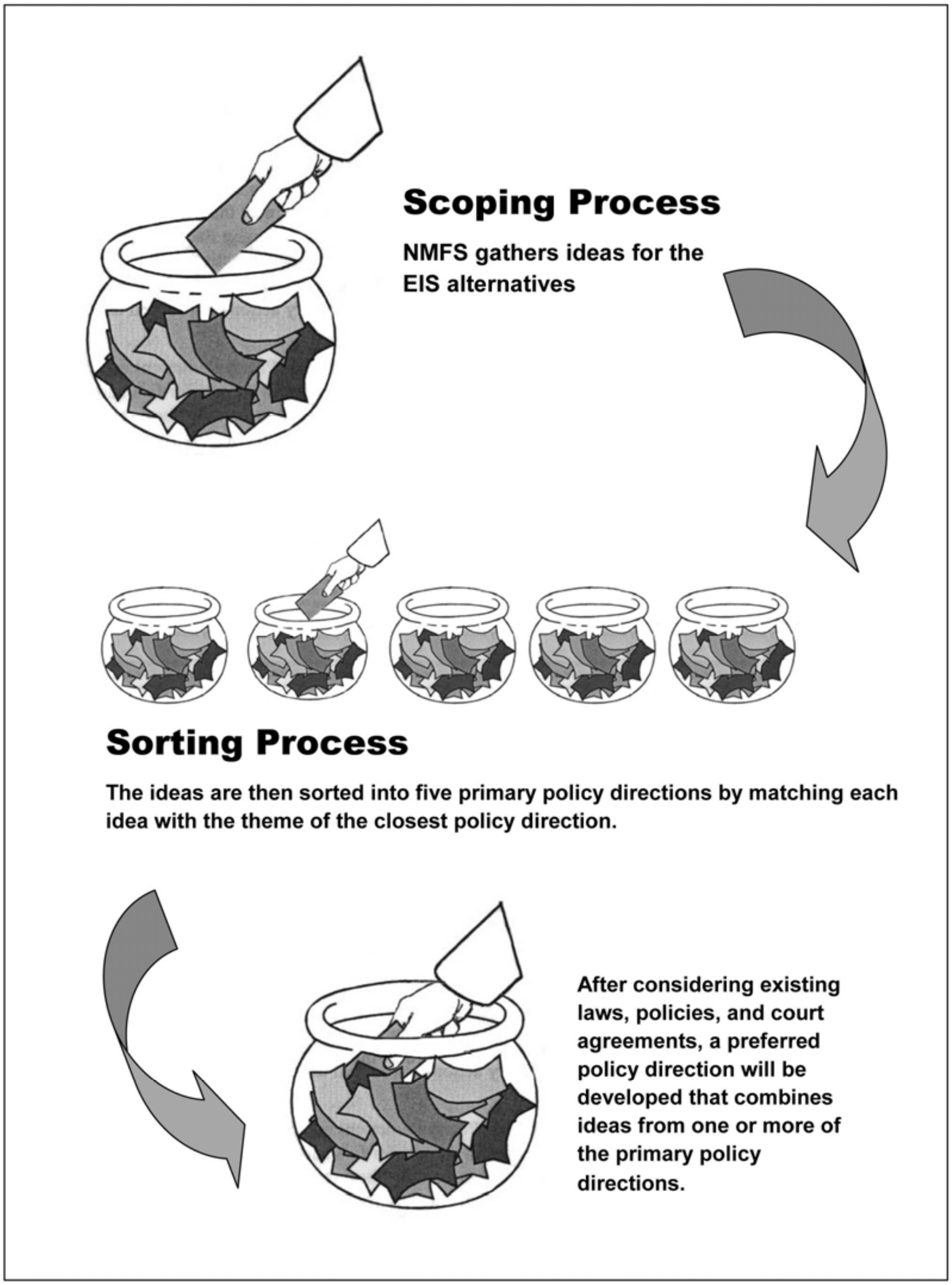


Figure 2-3. Sorting public comments to identify alternative policy directions.

TABLE 2-13. HATCHERY PROGRAMS TERMINATED UNDER THE IMPLEMENTATION SCENARIO FOR ALTERNATIVE 2.

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	SUBBASIN	HATCHERY PROGRAM	REASON FOR TERMINATION
Willamette/ Lower Columbia	Columbia River Estuary	Columbia Estuary	Big Creek Fall Chinook Salmon (Tules-Hatchery)	Hatchery program depends on Mitchell Act funds.
			Grays-Chinook River Chum Salmon	Strays from hatchery program adversely affect productivity and abundance of primary chum salmon populations in Grays and Chinook Rivers.
			Big Creek Winter Steelhead	Hatchery program depends on Mitchell Act funds.
			Gnat Creek Winter Steelhead	Hatchery program depends on Mitchell Act funds.
			Big Creek Coho Salmon	Hatchery program depends on Mitchell Act funds.
			Bernie Creek Coho Salmon (Late-Type N)	Hatchery program depends on Mitchell Act funds.
			Youngs Bay Tributary Winter Steelhead	Hatchery program depends on Mitchell Act funds.
			Youngs Bay Coho Salmon (Bonneville and Sandy Hatcheries)	Hatchery program depends on Mitchell Act funds.
			Youngs Bay Fall Chinook Salmon (Rogue Upriver Brights/ Select Area Fisheries)	Strays from hatchery program adversely affect productivity and abundance of primary fall Chinook salmon populations in Clatskanie and Elochoman Rivers.
		Elochoman	Elochoman Coho Salmon (Late/ Type N)	Hatchery program depends on Mitchell Act funds.
			Elochoman Summer Steelhead (Merwin Hatchery)	Hatchery program depends on Mitchell Act funds.
			Elochoman Winter Steelhead (Early)	Hatchery program depends on Mitchell Act funds.
			Elochoman Coho Salmon (Early/ Type S)	Hatchery program depends on Mitchell Act funds.
			Elochoman Fall Chinook Salmon	Hatchery program depends on Mitchell Act funds.
		Grays	Grays Winter Steelhead (Early/ Elochoman Hatchery)	Hatchery program depends on Mitchell Act funds.
	Lower Columbia	Columbia Lower	Bonneville Fall Chinook Salmon	Hatchery program depends on Mitchell Act funds.
			Bonneville Coho Salmon	Hatchery program depends on Mitchell Act funds.
			Salmon Creek Winter Steelhead (Skamania Hatchery)	Hatchery program depends on Mitchell Act funds.
		Cowlitz	Toutle Fall Chinook Salmon	Hatchery program depends on Mitchell Act funds.

TABLE 2-13. HATCHERY PROGRAMS TERMINATED UNDER THE IMPLEMENTATION SCENARIO FOR ALTERNATIVE 2 (CONTINUED).

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	SUBBASIN	HATCHERY PROGRAM	REASON FOR TERMINATION
			Cowlitz-Coweeman Winter Steelhead (Early/ Elochoman Hatchery)	Hatchery program depends on Mitchell Act funds.
			North Fork Toutle Summer Steelhead	Hatchery program depends on Mitchell Act funds.
			Toutle Coho Salmon (Early/ Type S)	Strays from hatchery program adversely affect productivity and abundance of primary coho salmon population in the Toutle River.
			South Fork Toutle Summer Steelhead	Hatchery program depends on Mitchell Act funds.
		Kalama	Kalama Winter Steelhead (Early)	Hatchery program depends on Mitchell Act funds.
			Kalama Coho Salmon (Late/ Type N)	Hatchery program depends on Mitchell Act funds.
			Kalama Fall Chinook Salmon	Hatchery program depends on Mitchell Act funds.
			Kalama Summer Steelhead	Hatchery program depends on Mitchell Act funds.
			Kalama Summer Steelhead (Skamania Hatchery)	Hatchery program depends on Mitchell Act funds.
			Kalama Winter Steelhead (Late)	Hatchery program depends on Mitchell Act funds.
			Kalama Coho Salmon (Early/ Type S)	Hatchery program depends on Mitchell Act funds.
			Kalama Spring Chinook Steelhead	Hatchery program depends on Mitchell Act funds.
		Lewis	East Fork Lewis Winter Steelhead (Skamania Hatchery)	Hatchery program depends on Mitchell Act funds.
			North Fork Lewis Winter Steelhead (Merwin Hatchery)	Strays from hatchery program adversely affect productivity and abundance of primary and contributing steelhead populations in the East Fork and North Fork Lewis River.
			East Fork Lewis Summer Steelhead (Skamania Hatchery)	Hatchery program depends on Mitchell Act funds.
		Sandy	Sandy Winter Steelhead (Late)	Hatchery program dependent on Mitchell Act funds.
			Sandy Coho Salmon	Hatchery program depends on Mitchell Act funds.
			Sandy Summer Steelhead (South Santiam Hatchery)	Hatchery program depends on Mitchell Act funds.
			Sandy Spring Chinook Salmon	Hatchery program depends on Mitchell Act funds.

TABLE 2-13. HATCHERY PROGRAMS TERMINATED UNDER THE IMPLEMENTATION SCENARIO FOR ALTERNATIVE 2 (CONTINUED).

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	SUBBASIN	HATCHERY PROGRAM	REASON FOR TERMINATION
		Washougal	Washougal Winter Steelhead (Early/ Skamania Hatchery)	Hatchery program depends on Mitchell Act funds.
			Washougal Summer Steelhead (Skamania Hatchery)	Hatchery program depends on Mitchell Act funds.
			Washougal Fall Chinook Salmon	Hatchery program depends on Mitchell Act funds.
			Washougal Coho Salmon	Hatchery program depends on Mitchell Act funds
		Willamette	Clackamas Spring Chinook Salmon	Hatchery program depends on Mitchell Act funds.
			McKenzie Spring Chinook Salmon	Strays from hatchery program adversely affect productivity and abundance of primary Spring Chinook salmon population in the McKenzie River.
			North Santiam Summer Steelhead (South Santiam Hatchery)	Strays from hatchery program adversely affect productivity and abundance of primary steelhead population in the North Santiam River.
			Clackamas-Eagle Creek Coho Salmon	Hatchery program depends on Mitchell Act funds.
			Lower Clackamas Winter Steelhead (Late)	Hatchery program depends on Mitchell Act funds.
			Clackamas-Eagle Creek Winter Steelhead (Early)	Hatchery program depends on Mitchell Act funds.
			Clackamas Summer Steelhead	Hatchery program depends on Mitchell Act funds.
Willamette/ Lower Columbia and Interior Columbia	Columbia Gorge	Big White Salmon	White Salmon Summer Steelhead (Skamania Hatchery)	Hatchery program depends on Mitchell Act funds.
			White Salmon Winter Steelhead (Skamania Hatchery)	Hatchery program depends on Mitchell Act funds.
		Columbia Gorge	Gorge Fall Chinook Salmon (Spring Creek Tules)	Hatchery program depends on Mitchell Act funds.
		Klickitat	Klickitat Spring Chinook Salmon	Hatchery program depends on Mitchell Act funds.
			Klickitat Coho Salmon (Washougal)	Hatchery program depends on Mitchell Act funds.
			Klickitat Fall Chinook Salmon (Upriver Brights)	Hatchery program depends on Mitchell Act funds.
			Klickitat Summer Steelhead (Skamania Hatchery)	Hatchery program depends on Mitchell Act funds.
			Klickitat Coho Salmon (Lewis Hatchery)	Hatchery program depends on Mitchell Act funds.

TABLE 2-13. HATCHERY PROGRAMS TERMINATED UNDER THE IMPLEMENTATION SCENARIO FOR ALTERNATIVE 2 (CONTINUED).

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	SUBBASIN	HATCHERY PROGRAM	REASON FOR TERMINATION
		Little White Salmon	Little White Salmon Spring Chinook Salmon	Hatchery program depends on Mitchell Act funds.
			Little White Salmon Fall Chinook Salmon (Upriver Brights)	Hatchery program depends on Mitchell Act funds.
		Wind	Wind Spring Chinook Salmon	Hatchery program depends on Mitchell Act funds.
Interior Columbia	Columbia Plateau	Columbia Lower Middle	Mainstem Columbia Summer Steelhead (Wells Hatchery)	Hatchery program depends on Mitchell Act funds.
			Mainstem Columbia Fall Chinook salmon (Upriver Brights/ Ringold Hatchery)	Hatchery program depends on Mitchell Act funds.
		Deschutes	Deschutes Spring Chinook Salmon (Round Butte Hatchery)	Strays from hatchery program adversely affect productivity and abundance of primary spring Chinook salmon population in the Deschutes River.
		Umatilla	Umatilla Coho Salmon	Hatchery program depends on Mitchell Act funds.
		Yakima	Naches Coho Salmon	Hatchery program depends on Mitchell Act funds.
			Upper Yakima Coho Salmon	Hatchery program depends on Mitchell Act funds.
			Yakima Fall Chinook Salmon	Hatchery program depends on Mitchell Act funds.
	Columbia Cascade	Wenatchee	Icicle Creek Spring Chinook Salmon (Leavenworth Hatchery)	Strays from hatchery program adversely affect productivity and abundance of primary spring Chinook salmon population in the Wenatchee River.
	Blue Mountian	Snake Hells Canyon	Snake Hells Canyon Summer Steelhead (Oxbow Hatchery)	Strays from hatchery program adversely affect productivity and abundance of primary steelhead population in the Snake River.
	Mountain Snake	Clearwater	Lower Selway Spring Chinook Salmon	Strays from hatchery program adversely affect productivity and abundance of primary spring Chinook salmon populations in the Clearwater River (Upper Selway and South Fork Clearwater).
			Clearwater Coho Salmon	Hatchery program depends on Mitchell Act funds.
			South Fork Clearwater Steelhead (B-run)	Strays from hatchery program adversely affect productivity and abundance of primary steelhead populations in the Clearwater River (Selway and Lochsa Rivers).

TABLE 2-13. HATCHERY PROGRAMS TERMINATED UNDER THE IMPLEMENTATION SCENARIO FOR ALTERNATIVE 2 (CONTINUED).

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	SUBBASIN	HATCHERY PROGRAM	REASON FOR TERMINATION
			North Fork Clearwater Spring Chinook Salmon (Dworshak Hatchery)	Strays from hatchery program adversely affect productivity and abundance of primary spring Chinook salmon populations in the Clearwater River (Upper Selway and South Fork Clearwater).
			Upper Selway Spring Chinook	Strays from hatchery program adversely affect productivity and abundance of primary spring Chinook salmon population in the Upper Selway River.
			Clear Creek Summer Steelhead (B-run)	Strays from hatchery program adversely affect productivity and abundance of primary steelhead populations in the Clearwater River (Selway and Lochsa Rivers).
			Lower Selway Meadow Creek Spring Chinook Salmon	Strays from hatchery program adversely affect productivity and abundance of primary spring Chinook salmon populations in the Clearwater River (Upper Selway and South Fork Clearwater).
			Lochsa Spring Chinook Salmon	Strays from hatchery program adversely affect productivity and abundance of primary spring Chinook salmon populations in the Clearwater River (Upper Selway and South Fork Clearwater).
			Middle Fork Clearwater Spring Chinook Salmon (Kooskia Hatchery)	Strays from hatchery program adversely affect productivity and abundance of primary spring Chinook salmon populations in the Clearwater River (Upper Selway and South Fork Clearwater).
			South Fork Clearwater Spring Chinook Salmon	Strays from hatchery program adversely affect productivity and abundance of primary spring Chinook salmon populations in the Clearwater River (Upper Selway and South Fork Clearwater).
		Salmon	Pahsimeroi Summer Steelhead (A-run/Sawtooth Hatchery)	Strays from hatchery program adversely affect productivity and abundance of contributing steelhead population in the Pahsimeroi River.

TABLE 2-13. HATCHERY PROGRAMS TERMINATED UNDER THE IMPLEMENTATION SCENARIO FOR ALTERNATIVE 2 (CONTINUED).

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	SUBBASIN	HATCHERY PROGRAM	REASON FOR TERMINATION
			Little Salmon Summer Steelhead (B-run Dworshak Hatchery)	Strays from hatchery program adversely affect productivity and abundance of contributing steelhead population in the Little Salmon River.
			Little Salmon Summer Steelhead (A-run/ Sawtooth Hatchery)	Strays from hatchery program adversely affect productivity and abundance of contributing steelhead population in the Little Salmon River.
			Salmon Upper Salmon Summer Steelhead (A-run/ Sawtooth Hatchery)	Strays from hatchery program adversely affect productivity and abundance of primary steelhead population in the Upper Salmon River.
			Little Salmon Spring Chinook Salmon (Rapid River)	Strays from hatchery program adversely affect productivity and abundance of primary spring Chinook population in the South Fork Salmon River.
			Little Salmon Summer Steelhead (A-run)	Strays from hatchery program adversely affect productivity and abundance of contributing steelhead population in the Little Salmon River.
			Salmon East Fork-South Fork Johnson Creek Summer Chinook Salmon	Strays from hatchery program adversely affect productivity and abundance of primary spring Chinook salmon population in the South Fork Salmon River.
			Upper Salmon Summer Steelhead (B-run)	Strays from hatchery program adversely affect productivity and abundance of primary steelhead population in the Upper Salmon River.
			Redfish Lake Sockeye Salmon Captive Brood Program	Hatchery program depends on Mitchell Act funds.

TABLE 2-14. HATCHERY PROGRAMS TERMINATED UNDER THE IMPLEMENTATION SCENARIO FOR ALTERNATIVE 3.

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	SUBBASIN	HATCHERY PROGRAM	REASON FOR TERMINATION
Willamette/ Lower Columbia	Columbia River Estuary	Columbia Estuary	Big Creek Coho Salmon	Strays from hatchery program adversely affect productivity and abundance of primary coho salmon population in Big Creek.
			Youngs Bay Coho Salmon (Bonneville and Sandy Hatcheries)	Strays from hatchery program adversely affect productivity and abundance of primary coho salmon population in Big Creek.
	Lower Columbia	Columbia Lower	Salmon Creek Winter Steelhead (Skamania Hatchery)	Strays from hatchery program adversely affect productivity and abundance of nearby primary and contributing steelhead populations.
		Lewis	North Fork Lewis Coho Salmon (Early/ Type S)	Strays from hatchery program adversely affect productivity and abundance of primary and contributing coho salmon populations in the East Fork and North Fork Lewis River.
			East Fork Lewis Winter Steelhead (Skamania Hatchery)	Strays from hatchery program adversely affect productivity and abundance of primary winter steelhead population in the East Fork Lewis River.
		Willamette	Middle Fork Willamette Spring Chinook Salmon	Strays from hatchery program adversely affect productivity and abundance of primary Spring Chinook salmon populations in the McKenzie River and North Santiam River.
Willamette/ Lower Columbia and Interior Columbia	Columbia Gorge	Klickitat	Klickitat Coho Salmon (Washougal Hatchery)	This hatchery program would be closed because of high stray rates to primary and contributing populations outside of the Klickitat basin (mainly to the Washougal River).
Interior Columbia	Mountain Snake	Clearwater	South Fork Clearwater Steelhead (B-run)	Strays from hatchery program adversely affect productivity and abundance of primary steelhead populations in the Clearwater River (Selway and Lochsa Rivers).
			Clear Creek Summer Steelhead (B-run)	Strays from hatchery program adversely affect productivity and abundance of primary steelhead populations in the Clearwater River (Selway and Lochsa Rivers).
		Salmon	Little Salmon Spring Chinook Salmon (Rapid River Hatchery)	Strays from hatchery program adversely affect productivity and abundance of primary spring Chinook salmon population in the South Fork Salmon River.

TABLE 2-15. HATCHERY PROGRAMS TERMINATED UNDER THE IMPLEMENTATION SCENARIO FOR ALTERNATIVE 4.

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	SUBBASIN	HATCHERY PROGRAM	REASON FOR TERMINATION
Willamette/ Lower Columbia	Columbia River Estuary	Columbia Estuary	Big Creek Coho Salmon	Strays from hatchery program adversely affect productivity and abundance of primary coho population in Big Creek. A portion of this lost production would be replaced with an integrated hatchery program in Big Creek.
			Youngs Bay Coho Salmon (Bonneville and Sandy Hatcheries)	Strays from hatchery program adversely affect productivity and abundance of primary coho salmon population in Big Creek.
		Elochoman	Elochoman Winter Steelhead (Early)	This hatchery program would be closed because of high stray rates to contributing population in the Elochoman River. This hatchery program would be replaced with an integrated winter steelhead hatchery program in the Elochoman River.
			Elochoman Summer Steelhead (Merwin Hatchery)	This hatchery program would be closed because of high stray rates to contributing population in the Elochoman River. This hatchery program would be replaced with an integrated winter steelhead hatchery program in the Elochoman River.
			Elochoman Coho Salmon (Early/ Type S)	Strays from hatchery program adversely affect productivity and abundance of primary coho salmon population in the Elochoman River.
	Lower Columbia	Columbia Lower	Salmon Creek Winter Steelhead (Skamania Hatchery)	Strays from hatchery program adversely affect productivity and abundance of nearby primary and contributing steelhead populations.
		Cowlitz	Toutle Coho Salmon (Early/ Type S)	Strays from hatchery program adversely affect productivity and abundance of primary coho salmon population in the Toutle River. A portion of this lost production would be replaced with an integrated hatchery program in the Toutle River.

TABLE 2-15. HATCHERY PROGRAMS TERMINATED UNDER THE IMPLEMENTATION SCENARIO FOR ALTERNATIVE 4 (CONTINUED).

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	SUBBASIN	HATCHERY PROGRAM	REASON FOR TERMINATION
			Coweeman Winter Steelhead (Early/ Elochoman Hatchery)	This hatchery program would be closed because of high stray rates to primary population in the Coweeman River. This lost production would be replaced with an integrated winter steelhead hatchery program in the Coweeman River.
		Lewis	North Fork Lewis Coho Salmon (Late/ Type N)	Strays from hatchery program adversely affect productivity and abundance of primary and contributing coho salmon populations in the East Fork and North Fork Lewis River.
			East Fork Lewis Summer Steelhead (Skamania Hatchery)	Strays from hatchery program adversely affect productivity and abundance of primary summer steelhead population in the East Fork Lewis River.
			East Fork Lewis Winter Steelhead (Skamania Hatchery)	Strays from hatchery program adversely affect productivity and abundance of primary winter steelhead population in the East Fork Lewis River.
		Sandy	Sandy Coho Salmon	Strays from hatchery program adversely affect productivity and abundance of primary coho salmon population in the Sandy River. This lost production would be replaced with an integrated coho salmon hatchery program in the Sandy River.
		Willamette	Middle Fork Willamette Spring Chinook Salmon	Strays from hatchery program adversely affect productivity and abundance of primary spring Chinook populations in the McKenzie River and North Santiam River.
			Clackamas-Eagle Creek Coho Salmon	Strays from hatchery program adversely affect productivity and abundance of primary coho salmon population in the Clackamas River. This lost production would be replaced with an integrated hatchery program in the Clackamas River.

TABLE 2-15. HATCHERY PROGRAMS TERMINATED UNDER THE IMPLEMENTATION SCENARIO FOR ALTERNATIVE 4 (CONTINUED).

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	SUBBASIN	HATCHERY PROGRAM	REASON FOR TERMINATION
Willamette/ Lower Columbia and Interior Columbia	Columbia Gorge	Klickitat	Klickitat Summer Steelhead (Skamania Hatchery)	Strays from hatchery program adversely affect productivity and abundance of primary steelhead population in the Klickitat River. This lost production would be replaced with an integrated steelhead hatchery program of the same size in the Klickitat River.
			Klickitat Coho Salmon (Washougal Hatchery)	This hatchery program would be closed because of high stray rates to primary and contributing populations outside of the Klickitat basin (mainly the Washougal River).
Interior Columbia	Mountain Snake	Clearwater	South Fork Clearwater Steelhead (B-run)	Strays from hatchery program adversely affect productivity and abundance of primary steelhead populations in the Clearwater River (Selway and Lochsa Rivers)
		Salmon	East Fork Salmon Summer Steelhead (B-run/ Dworshak Hatchery)	Strays from hatchery program adversely affect productivity and abundance of contributing steelhead population in the East Fork Salmon River and primary population in the Upper Salmon River.

TABLE 2-16. HATCHERY PROGRAMS TERMINATED UNDER THE IMPLEMENTATION SCENARIO FOR ALTERNATIVE 5.

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	SUBBASIN	HATCHERY PROGRAM	REASON FOR TERMINATION
Willamette/Lower Columbia	Columbia River Estuary	Columbia Estuary	Big Creek Coho Salmon	Strays from hatchery program adversely affect productivity and abundance of primary coho salmon population in Big Creek.
		Columbia Estuary	Youngs Bay Coho Salmon (Bonneville and Sandy Hatcheries)	Strays from hatchery program adversely affect productivity and abundance of primary coho salmon population in Big Creek.
		Elochoman	Elochoman Coho Salmon (Early/ Type S)	Strays from hatchery program adversely affect productivity and abundance of primary coho salmon population in the Elochoman River.
	Lower Columbia	Columbia Lower	Salmon Creek Winter Steelhead (Skamania Hatchery)	Strays from hatchery program adversely affect productivity and abundance of nearby primary and contributing steelhead populations.
		Lewis	NF Lewis Coho Salmon (Early/ Type S)	Strays from hatchery program adversely affect productivity and abundance of primary and contributing coho salmon populations in the East Fork and North Fork Lewis River.
		Lewis	East Fork Lewis Winter Steelhead (Skamania Hatchery)	Strays from hatchery program adversely affect productivity and abundance of primary winter steelhead population in the East Fork Lewis River.
		Willamette	Middle Fork Willamette Spring Chinook Salmon	Strays from hatchery program adversely affect productivity and abundance of primary spring Chinook salmon populations in the McKenzie and North Santiam Rivers.
Willamette/Lower Columbia and Interior Columbia	Columbia Gorge	Klickitat	Klickitat Coho Salmon (Washougal Hatchery)	This hatchery program would be closed because of high stray rates to primary and contributing populations outside of the Klickitat basin (mainly to the Washougal River).
		Klickitat	Klickitat Summer Steelhead (Skamania Hatchery)	Strays from hatchery program adversely affect productivity and abundance of primary steelhead population in the Klickitat River. This lost production would be replaced with a larger integrated steelhead hatchery program in the Klickitat River.

TABLE 2-16. HATCHERY PROGRAMS TERMINATED UNDER THE IMPLEMENTATION SCENARIO FOR ALTERNATIVE 5 (CONTINUED).

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	SUBBASIN	HATCHERY PROGRAM	REASON FOR TERMINATION
Interior Columbia	Columbia Plateau	Columbia Lower Middle	Mainstem Columbia Fall Chinook (Upriver Brights/ Ringold Hatchery)	Strays from hatchery program adversely affect productivity and abundance of primary fall Chinook salmon population in the Hanford Reach of the Columbia River. This hatchery program would be terminated, and lost production would be added to the integrated Hanford Reach/Priest Rapids fall Chinook salmon hatchery program.
	Blue Mountain	Snake Hells Canyon	Snake Hells Canyon Summer Steelhead (Oxbow Hatchery)	Strays from hatchery program adversely affect productivity and abundance of primary steelhead population in the Snake River. A portion of this lost production would be replaced with an integrated program in the Snake River mainstem.
	Mountain Snake	Clearwater	South Fork Clearwater Steelhead (B-run)	Strays from hatchery program adversely affect productivity and abundance of primary steelhead populations in the Clearwater River (Selway and Lochsa Rivers). A small portion of this lost production would be replaced by increasing the South Fork Clearwater integrated hatchery program.
		Salmon	Little Salmon Spring Chinook Salmon (Rapid River Hatchery)	Strays from hatchery program adversely affect productivity and abundance of primary spring Chinook salmon population in the South Fork Salmon River
		Salmon	East Fork Salmon Summer Steelhead (B-run/ Dworshak Hatchery)	Strays from hatchery program adversely affect productivity and abundance of contributing steelhead population in the East Fork Salmon River and the primary population in the Upper Salmon River.

TABLE 2-17. NEW HATCHERY PROGRAMS INITIATED UNDER ONE OR MORE OF THE ALTERNATIVES' IMPLEMENTATION SCENARIOS.

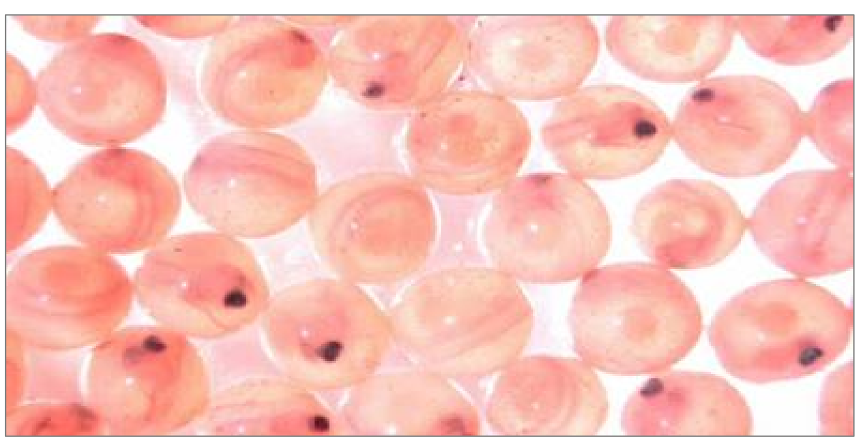
ECOLOGICAL PROVINCE	HATCHERY PROGRAM	PURPOSE	INITIATED UNDER THE FOLLOWING ALTERNATIVES				
			1	2	3	4	5
Columbia Estuary	Big Creek Coho Salmon (Late/ Type N)	Harvest				X	
	Columbia Estuary Chum Salmon (Sea Resources)	Conservation				X	
	Youngs Bay Chum Salmon	Conservation				X	
	Elochoman Chum Salmon	Conservation				X	
Lower Columbia River	Cowlitz-Coweeman Winter Steelhead (Late)	Harvest and Conservation				X	
	Mill, Abernathy, Germany Creek Coho Salmon (Late/ Type N)	Harvest and Conservation				X	
	Cowlitz Coho Salmon (Early/ Type S)	Harvest				X	
	North Fork Lewis Coho Salmon (Late/ Type N)	Harvest				X	
	Sandy Coho Salmon	Harvest				X	
	Clackamas Coho Salmon (Early)	Harvest				X	
	Mill, Abernathy, Germany Creek Chum Salmon	Conservation				X	
	Sandy Chum Salmon	Conservation				X	
	Lewis Chum Salmon	Conservation				X	
	Washougal Chum Salmon	Conservation				X	
Columbia Gorge	Klickitat Summer-Winter Steelhead	Harvest				X	X
Columbia Plateau	Walla Walla Spring Chinook Salmon	Conservation					X
	Ringold Spring Chinook Salmon	Harvest					X
Blue Mountain	Hells Canyon Summer Steelhead	Harvest and Conservation					X
Mountain Snake	Yankee Fork Spring Chinook Salmon (Salmon River)	Conservation					X

This EIS assumes that these programs would be funded through the Mitchell Act.

Science, Service, Stewardship

Chapter 3

Affected Environment



3.0 AFFECTED ENVIRONMENT

3.1 Introduction

Chapter 3 describes baseline conditions for six resources that may be affected by implementation of the environmental impact statement (EIS) alternatives: fish, socioeconomics, environmental justice, wildlife, water quality and quantity, and human health. No other resources were identified during scoping that could potentially be impacted by the proposed action or alternatives. Chapter 4 (Environmental Consequences) will analyze effects on these resources from implementing the EIS alternatives. The specific section sequence for this chapter is as follows:

- Introduction (Section 3.1)
- Fish (Section 3.2)
- Socioeconomics (Section 3.3)
- Environmental Justice (Section 3.4)
- Wildlife (Section 3.5)
- Water Quality and Quantity (Section 3.6)
- Human Health (Section 3.7)

The project area for this EIS includes rivers, streams, and hatchery facilities where hatchery-origin salmon and steelhead occur or are anticipated to occur in the Columbia River basin, including the Snake River and all other tributaries of the Columbia River in the United States (U.S.). The project area includes the Columbia River estuary and plume (Section 2.2, Description of Project Area).

Each resource's analysis area includes the project area as a minimum area, but may also include locations beyond the Columbia River basin if some of the effects of the EIS alternatives on that resource occur outside the project area (Section 1.4, Project and Analysis Area). For example, Alaska is not in the project area, but because the EIS alternatives would have varying effects on Alaska fisheries (since hatchery-origin fish produced in the Columbia River basin are caught in Alaska), Alaska is included in the analysis area for socioeconomics. Table 3-1 provides a comparative resource summary of the different analysis areas for this EIS. In addition, a separate section titled Analysis Area is included in each resource section.

TABLE 3-1. GEOGRAPHIC RANGE OF EACH RESOURCE'S ANALYSIS AREA.

		GEOGRAPHIC RANGE OF RESOURCE'S ANALYSIS AREA					
COLUMBIA RIVER RECOVERY DOMAIN	ECOLOGICAL PROVINCE/ GEOGRAPHIC AREA[1]	FISH	SOCIOECONOMICS[2]	ENVIRONMENTAL JUSTICE	WILDLIFE	WATER QUALITY AND QUANTITY	HUMAN HEALTH
Willamette/ Lower Columbia	Columbia Estuary	X	X	X	X	X	X
	Lower Columbia	X	X	X	X	X	X
Willamette/ Lower Columbia and Interior Columbia	Columbia Gorge	X	X	X	X	X	X
Interior Columbia	Columbia Plateau	X	X	X	X	X	X
	Columbia Cascade	X	X	X	X	X	X
	Blue Mountain	X	X	X	X	X	X
	Mountain Snake	X	X	X	X	X	X
N/A[3]	Coastal Washington, Oregon, and California		X	X			
N/A	British Columbia, Canada		X	X			
N/A	Puget Sound/Strait of Juan de Fuca		X	X			
N/A	Southeast Alaska		X	X			

[1] See Table 2.1 in Chapter 2 (Alternatives) for a list of subbasins within each ecological province.

[2] Socioeconomic effects are reported by economic impact regions, which in some cases have different boundaries than the geographic areas included in this table. Please see Section 3.3 (Socioeconomics) for details.

[3] N/A = not applicable.

3.2 Fish

3.2.1 Introduction

This section describes current baseline conditions for fish within the analysis area that may be affected by the alternatives. Fish species are grouped into two categories: 1) salmon and steelhead and 2) other fish species that have a relationship to salmon and steelhead (i.e., predators and prey of salmon. This discussion also describes the ongoing and current general risks and benefits of hatchery programs to salmon and steelhead species so that the reader has context for the effects analysis found in Section 4.3, Fish. The risks and benefits related to salmon and steelhead are described first (Section 3.2.3) followed by discussions on each evolutionarily significant unit (ESU) or distinct population segment (DPS) (Section 3.2.3.2). Other fish species are discussed after the salmon and steelhead risk/benefit and ESU/DPS sections (Section 3.2.4).

3.2.2 Analysis Area

The analysis area for fish in this EIS is the same as the project area as described in Section 2.2, Description of Project Area. Information presented in Sections 3.2, Fish, and 4.2, Fish, is organized according to species. For salmon and steelhead species, the analysis is further subdivided by ESU and DPS (Box 1-1). The boundaries of each salmon ESU and steelhead DPS cover several subbasins and one or more ecological provinces (Section 2.2, Description of Project Area). Maps of the ESU and DPS boundaries can be found at http://www.nwr.noaa.gov/ESA-Salmon-Listings/Salmon-Populations/Maps/Index.cfm.

3.2.3 Salmon and Steelhead

3.2.3.1 General Risks and Benefits of Hatchery Programs to Salmon and Steelhead Species

Data on current risks and benefits of hatchery programs to salmon and steelhead were developed from existing literature and through modeling. Information on the methods used to model genetic, hatchery facility, predation, and competition risks is found in Section 4.2.2, Methods for Analyzing Effects. Because baseline conditions are assumed to remain constant under Alternative 1, modeled data in this section are identical to modeled data for Alternative 1 in Section 4.2, Fish.

3.2.3.1.1 Genetic Risks

Salmon and steelhead often differ genetically from population to population because of their strong tendency to return to spawn in their home stream. This behavior allows the forces of natural selection, mutation, and random genetic drift to operate in relative isolation in different streams or subbasins, resulting in genetic differences. In many instances, these differences are adaptive, allowing a local population to have a greater ability to survive and persist in that environment than would another population (Taylor 1991; McElhany et al. 2000).

The biological mechanisms controlling genetic change in hatchery-origin fish are the same as those that cause change in natural-origin populations (i.e., selection, drift, mutation, and gene flow), but the hatchery environment and the manner in which hatchery operations are conducted can cause these mechanisms to have effects that differ in magnitude or direction from their operation in the natural environment. Therefore, local adaptation can be disrupted, and unique patterns of genetic diversity can be lost if the natural-origin population interbreeds with hatchery-origin fish. The three important elements determining the severity of this effect are 1) the extent of genetic dissimilarity between the hatchery-origin fish and the receiving natural-origin population, 2) the difference between the hatchery and natural environments, and 3) the relative amount of genetic material from hatchery-origin fish that enters the natural-origin population and vice versa.

The degree to which natural-origin fish differ genetically from natural-origin fish can depend a great deal on the way the hatchery program is operated. Choice of hatchery broodstock can be very important, because it can result in gene flow that changes the genetic character of the population. Some level of gene flow between populations, expressed as “stray” fish, is natural; in a hatchery operation, however, large numbers of fish from a totally different population can be released by a hatchery program and return to spawn with the native fish. The greater the geographic separation between the source and recipient population, the greater the likelihood of genetic differences between the two populations (Interior Columbia Technical Recovery Team [ICTRT] 2007) and the greater the risk to the genetic character of the recipient population.

Berejikian and Ford (2004) summarize evidence from many studies that hatchery-origin fish do not reproduce as well under natural conditions as natural-origin fish. The magnitude of this difference is quite large when the hatchery-origin fish are of a non-local source, with reproductive rates from 2 percent to 37 percent of what was observed for natural-origin fish under the same conditions. Evidence that the presence of hatchery-origin fish can have a depressing impact on the productivity (progeny produced per parent) of natural-origin populations has been demonstrated in steelhead (Chilcote 2003), coho salmon (Nickelson 2003; Buhle et al. 2009), and Chinook salmon (Hoekstra et al. 2007). However, it is not clear, in most cases, how much of this poor reproductive performance might have been the product of non-genetic factors (Berejikian and Ford 2004). Nickelson (2003) suggests that the effect he measured was largely due to ecological interactions between hatchery-origin and natural-origin smolts during their seaward migration. Other scientists suggest hatchery-origin fish may learn behaviors in the hatchery facility that impair their future performance as spawners (Fleming and Einum 1997; Berejikian et al. 1997).

In contrast to the study findings described above, there is some evidence that differences between hatchery-origin and natural-origin fish may not that large, especially when the source of the hatchery broodstock was from a local natural-origin population. For example, Berejikian et al. (2009) found that the reproductive success of naturally spawning hatchery-origin chum salmon was 83 percent of that for their natural-origin counterparts. Araki et al. (2007) found that the natural reproductive success of first generation hatchery-origin steelhead whose parents were natural-origin fish was 70 percent to 88 percent of that for natural-origin fish spawning in the same basin.

In summary, the bulk of the evidence suggests that hatchery-origin fish likely differ genetically from natural-origin fish in ways that can result in differences in reproductive performance when they spawn in the natural environment. When hatchery-origin fish interbreed with natural-origin fish, the productivity of the naturally spawning population may be reduced.

3.2.3.1.2 Current Approaches for Reducing Genetic Risks

The current approaches for reducing genetic risks include three key strategies: 1) controlling gene flow between hatchery-origin and natural-origin fish, 2) altering hatchery practices to minimize genetic change, and 3) limiting the number of years that a hatchery program is operated. Controlling gene flow between hatchery-origin and natural-origin fish is the most certain strategy to reduce genetic impacts. This is generally done by limiting the proportion of natural-origin spawners that are of hatchery origin (pHOS) and increasing the proportion of natural-origin fish in the broodstock (pNOB).

The Hatchery Scientific Review Group (HSRG) (2009) and Grant (1997) recommend that pHOS be 0.05 or less when non-local broodstocks are used in a hatchery program. When the hatchery-origin fish have been developed from the local natural-origin population, pHOS should still be limited. In developing guidelines for integrated hatchery programs, the HSRG (2009) uses a concept called proportionate natural influence (PNI), a metric describing the relative influence of hatchery and natural selective forces on the composite population. PNI is approximately pNOB/(pNOB+pHOS). It can range from 0 to 1; the higher the value, the greater the relative influence of natural selective forces.

Specific actions to reduce the fraction of naturally spawning hatchery-origin fish include the following:

1) Reduce the number of juveniles released.

2) Increase the number of natural-origin fish produced through habitat restoration actions.

3) Release hatchery-origin smolts in a manner that when they return as adults they will return back to the hatchery facility and not natural spawning areas.

4) Implement selective fisheries to target hatchery-origin fish.

5) Operate weirs to trap and remove a portion of the returning hatchery-origin fish before they spawn.

A weir is a barrier to fish movement. The biological risks associated with weirs include the following:

- Isolation of formerly connected populations
- Limiting or slowing movement of non-target fish species
- Alteration of stream flow
- Alteration of streambed and riparian habitat
- Alteration of the distribution of spawning within a population
- Increased mortality or stress due to capture and handling
- Impingement of downstream migrating fish
- Forced downstream spawning by fish that do not pass through the weir
- Increased straying due to either trapping adults that were not intending to spawn above the weir, or displaying adults into other tributaries

By blocking migration and concentrating salmon into a confined area, weirs may also increase predation efficiency of mammalian predators (Recovery Implementation Science Team [RIST] 2009). In considering the use of a weir to control movement of hatchery-origin fish, it is important to conduct a realistic assessment of weir performance and the likelihood of weir failure. An inverse relationship often exists between the ecological impacts of a weir and its performance as a fish-sorting tool (RIST 2009). Due to the potential negative impacts of weirs, more passive measures (such as geographic isolation of hatchery programs from natural-origin populations or reducing hatchery production) should be considered as potential methods for controlling the number of hatchery-origin spawners. However, there may be cases where controlling hatchery-origin fish through the use of weirs is the best management alternative (RIST 2009).

Other important actions that should be taken to limit genetic risks include 1) use native rather than imported broodstock; 2) if using imported broodstock, minimize the spawning of these fish in the natural environment; 3) reduce the difference between the hatchery and natural environments; and 4) make sure the fish sampled for broodstock are collected and spawned randomly with respect to age, size, and timing so that genetic variation is not lost from the population[1].

As discussed in Chapter 2, Alternatives, stronger and intermediate performance standards were applied to the action alternatives to reduce impacts on natural-origin salmon and steelhead. Performance metrics are identified in Table 3-2.

TABLE 3-2. PERFORMANCE METRICS APPLIED FOR EACH HATCHERY PERFORMANCE GOAL.

HATCHERY PERFORMANCE GOAL	PERFORMANCE METRICS FOR AFFECTED POPULATIONS
Stronger Performance Goal	• Integrated populations maintain a PNI greater than or equal to 0.67. • Segregated, natural-origin populations maintain a pHOS of less than or equal to 0.05.
Intermediate Performance Goal	• Integrated populations maintain a PNI greater than or equal to 0.50. • Segregated, natural-origin populations maintain a pHOS of less than or equal to 0.10.

Under baseline conditions, the percentage of primary and contributing populations[2] by ESU/DPS that meet stronger performance metrics ranges from zero for the Upper Columbia Spring-run Chinook Salmon ESU, the Snake River Fall-run Chinook salmon ESU, and the Upper Columbia River Steelhead DPS to 100 percent for the Deschutes River Summer/Fall-run Chinook Salmon ESU (Table 3-3). The percentage of populations by ESU/DPS that fail to meet both stronger and intermediate performance metrics also ranges from zero for the Deschutes River Summer/Fall-run Chinook Salmon ESU to 100 percent for the Upper Columbia River Spring-run Chinook Salmon ESU, the Snake River Fall-run Chinook salmon ESU, and the Upper Columbia River Steelhead DPS (Table 3-3). Fifty percent of all primary and contributing populations in the analysis area

[1] Currently there is some debate about the wisdom of random mating have shown that random mating may have selective effects, creating populations of smaller and younger fish.

[2] Primary, contributing, and stabilizing populations are terms that were used by the Lower Columbia Fish Recovery Board (LCFRB) in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS (Section 2.4, Alternative Development).

meet stronger metrics, 8 percent meet intermediate metrics, and 42 percent meet weaker than intermediate metrics under baseline conditions (Table 3-3).

TABLE 3-3. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS OF SALMON AND STEELHEAD THAT MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS BY ESU/DPS UNDER BASELINE CONDITIONS.

ESU/DPS	Number of Populations that Meet Stronger Metrics[1]	Number of Populations that Meet Intermediate Metrics	Number of Populations that Meet Weaker than Intermediate Metrics	Percent of Populations that Meet Stronger Metrics	Percent of Populations that Meet Intermediate Metrics	Percent of Populations that Meet Weaker than Intermediate Metrics
Lower Columbia River Chinook Salmon	4	0	15	21	0	79
Mid-Columbia River Spring-run Chinook Salmon	6	1	3	60	10	30
Deschutes River Summer/Fall-run Chinook Salmon	1	0	0	100	0	0
Upper Columbia River Spring-run Chinook Salmon	0	0	6	0	0	100
Upper Columbia River Summer/Fall-run Chinook Salmon	2	0	4	33	0	67
Upper Willamette River Chinook Salmon	2	0	3	40	0	60
Snake River Spring/Summer-run Chinook Salmon	17	4	8	59	14	28
Snake River Fall-run Chinook Salmon	0	0	1	0	0	100
Lower Columbia River Steelhead	15	0	4	79	0	21
Middle Columbia River Steelhead	11	1	4	69	6	25
Snake River Basin Steelhead	14	2	6	56	8	24
Southwest Washington Steelhead	2	1	0	67	33	0
Upper Columbia River Steelhead	0	0	4	0	0	100
Upper Willamette River Steelhead	3	0	1	75	0	25
Lower Columbia River Coho Salmon	3	3	11	18	18	65
Columbia River Chum Salmon	9	2	4	60	13	27
Snake River Sockeye Salmon	0	0	1	0	0	100
Total	89	14	75	50	8	42

Under baseline conditions, the number of weirs that are used in each in each ecological province to control the number of hatchery-origin fish that spawn naturally ranges from zero for the Columbia Estuary and Columbia Gorge to six in the Lower Columbia (Table 3-4).

TABLE 3-4. THE NUMBER OF WEIRS BY ECOLOGICAL PROVINCE THAT ARE USED TO CONTROL THE NUMBER OF HATCHERY-ORIGIN FISH THAT SPAWN NATURALLY UNDER BASELINE CONDITIONS.

RECOVERY DOMAIN	ECOLOGICAL PROVINCE	NUMBER OF WEIRS
Willamette/ Lower Columbia	Columbia Estuary	0
	Lower Columbia	6
	Columbia Gorge	4
Interior Columbia	Columbia Gorge	0
	Columbia Plateau	5
	Columbia Cascade	3
	Blue Mountain	4
	Mountain Snake	5
Total		**27**

3.2.3.1.3 Hatchery Facility Risks

Potential risks to natural-origin salmon and steelhead associated with the operation of hatchery facilities include the following:

- Hatchery facility failure (power or water loss leading to catastrophic fish losses)
- Hatchery facility water intake effects (stream de-watering and fish entrainment)
- Hatchery facility effluent discharge effects (deterioration of downstream water quality)

The first risk affects natural-origin fish being held in the hatchery facility; the second and third risks affect natural-origin fish in the stream.

Hatchery Facility Failure. This risk is of particular concern when facilities rear listed species, but it must be addressed to ensure meeting hatchery program goals and objectives. Factors such as flow reductions, flooding, and poor fish culture practices may cause hatchery facility failure or the catastrophic loss of fish under propagation.

Hatchery Facility Water Intake Effects. Water withdrawals for hatcheries within spawning and rearing areas can diminish stream flow, impeding migration and affecting the spawning behavior of salmon and steelhead. In addition, that portion of a hatchery facility's water supply that comes from a water source containing natural-origin fish must have an intake structure with adequate screening such that fish mortality whether from impingement or permanent removal, is avoided.

Hatchery Facility Effluent Discharge Effects. Effluent discharges can change water temperature, pH, suspended solids, ammonia, organic nitrogen, total phosphorus, and chemical oxygen demand in the receiving stream's mixing zone (Kendra 1991). It is usually not known how a hatchery facility's effluent affects listed salmon and steelhead and other stream-dwelling organisms. The level of impact depends on the amount of discharge and the flow volume of the receiving stream. Any adverse effects probably occur at the immediate point of discharge, because effluent dilutes rapidly. The Clean Water Act requires hatcheries (i.e., aquatic animal production facilities) with annual production greater than 20,000 lbs to obtain a National Pollutant Discharge Elimination System (NPDES) permit in order to discharge effluent to surface waters. These permits are intended to protect aquatic life and public health and ensure that every facility treats its wastewater. The effects from the releases are analyzed prior to the issuance of the permit, and site-specific discharge limits are set. Additionally, monitoring and reporting requirements for the permits and are subject to enforcement actions (U.S. Environmental Protection Agency [EPA] 1999). In addition, hatcheries in the Columbia River basin operate under the policies and guidelines developed by the Integrated Hatchery Operations Team (IHOT 1995) to reduce hatchery facility effects, including effluent discharge, on listed fish.

3.2.3.1.4 Current Approaches for Reducing Hatchery Facility Risks

The following measures are considered important in reducing the risk of catastrophic loss resulting from hatchery facility failures and reducing risks associated with hatchery facility intakes and other structures:

- Minimize the time adult fish are held in traps.
- Minimize hatchery facility failure through 24-hour-per-day staffing and on-site residence by hatchery facility personnel to allow rapid response to power or facility failures.
- Use low-pressure/low-water-level alarms on water supplies so personnel are notified of water emergencies.
- Use backup generators to respond to power loss.
- Train all hatchery facility personnel in standard fish propagation and fish health maintenance methods.

- Hatchery facilities should be designed to be non-consumptive regarding water resources. That is, water used in the hatchery facility can be returned near the point where it was withdrawn to minimize effects on natural-origin fish and other aquatic fauna.
- The risks associated with water withdrawals can generally be minimized by complying with water rights permits and meeting NMFS screening criteria (NMFS 1995, 1996, 2004). These screening criteria for water withdrawal devices set forth conservative standards that help minimize the risk of harming natural-origin salmon and steelhead and other aquatic fauna.
- Risks can also be reduced through the use of well water sources for the operation of all or a portion of the hatchery facility production.
- All hatchery facilities should operate within the limits established in NPDES permits (if required). If production from the hatchery facility falls below the minimum production requirements for an NPDES permit, the hatchery facility would operate in compliance with state or Federal regulations for discharge.
- Hatchery facilities should also operate to allow all migrating species of all ages to by pass or pass through hatchery related structures.

Currently, 100 percent of the hatchery facilities that require an NPDES permit operate within the limits established in NPDES permits (Table 3-5). One hundred percent of hatchery facilities that fall below the minimum production requirements for an NPDES permit operate in compliance with state or Federal regulations for discharge (Table 3-5). Seventy-one percent of hatchery facilities in the Columbia River basin allow all migrating species to bypass through hatchery related structures (Table 3-5).

For more information on the effects of hatchery facilities on water quality and quantity, refer to Section 3.6, Water Quality and Quantity. Effects of weirs and approaches for reducing risk associated with weirs are described in Section 3.2.3.1.1, Genetic Risks.

TABLE 3-5. COMPLIANCE WITH BMPS FOR REDUCING HATCHERY FACILITY EFFECTS UNDER BASELINE CONDITIONS.

BMP	PERCENT (%) OF HATCHERY PROGRAMS IN COMPLIANCE WITH BMPS
Hatcheries are operated to allow all migrating species of all ages to bypass or pass through hatchery related structures.	71
Screens on water intakes would be compliant with IHOT, NMFS, or other agency standards.	53
Water supplies are protected by alarms and backup power generators. Staff would be notified of emergency situations through the use of alarms, auto-dialers, and/or pagers.	66
All facilities operate within the limits established in NPDES permits. If production from the facility falls below the minimum production requirements for an NPDES permit, the facility would operate in compliance with state or Federal regulations for discharge.	100

3.2.3.1.5 Risks from Competition with Hatchery-origin Fish

Although competition and predation are treated as separate effects in this document, they are related to each other and, as a consequence, are frequently lumped together and described in the scientific literature as "ecological" effects. Competition is an interaction among members of the same species or different species utilizing a limited resource (e.g., food or space). Competition typically results in winners and losers. Competition between hatchery-origin and natural-origin fish may result from direct interactions, in which hatchery-origin fish interfere with access to limited resources by natural-origin fish, or indirect interactions, as when utilization of a limited resource by hatchery-origin fish reduces the amount available for natural-origin fish (Species Interaction Work Group [SIWG] 1984). Specific types of competition include competition for food, competition for territory among stream rearing juveniles, competition for mates, and competition for spawning sites.

For adult salmon and steelhead, effects from competition between hatchery-origin and natural-origin fish are assumed to be greatest in the spawning areas where competition for mates and spawning habitat occurs (U.S. Fish & Wildlife Service [USFWS] 1994). Hatchery-origin females compete with natural-origin females for spawning sites and hatchery-origin males compete with natural-origin males for female mates. Although there is evidence that natural-origin fish have a competitive advantage over hatchery-origin fish in these situations (Fleming and Gross 1993; Berejikian et al. 1997), it is likely that the cost of this interaction, in terms of lower survival of spawners and deposited eggs, will be higher when hatchery-origin fish are present in substantial numbers.

Juvenile hatchery-origin fish released into the natural environment may compete with natural-origin fish for resources as they migrate downstream. Steelhead, coho salmon, and spring Chinook salmon typically will migrate downstream rapidly once they make a complete physiological transition to the smolt life history stage. Therefore, the hatchery programs posing the least risk from competition are those that consistently produce full-term, rapidly migrating smolts that use river corridors as a “highway” to the ocean with minimal foraging and competition with natural-origin fish along the way. This ideal is difficult to achieve. Not all individuals in a population will undergo the smolt transformation at the same time. Evidence suggests that the timing of smoltification can vary by 45 or more days within a single population (Quinn 2005). Most hatchery programs, however, release fish over a shorter period (e.g., 2 weeks). Such releases will include fish that have not yet smolted, as well as fish for which the peak smolt condition has passed. Juveniles released too early or too late with respect to smoltification are likely to migrate slowly, if at all. Because of their prolonged period in freshwater, such fish have a much greater opportunity to compete with natural-origin fish for food and space. Competition is heightened if hatchery-origin fish are more numerous and are of equal or greater size. Although non-migratory, hatchery-origin juveniles (residuals) may eventually die, there will be a period when there may be significant competition with natural-origin fish.

Migrant juvenile chum salmon and fall Chinook salmon spend an extended period in the estuarine environment feeding and growing before they move into marine waters (Quinn 2005). Hatchery programs that release sub-yearling juveniles are thus more likely to create a competitive environment for natural-origin fall Chinook salmon and chum salmon. This situation may be particularly acute in the Columbia River, where the estuary has suffered a major loss of shallow water rearing habitat in the past century (Bottom et al. 2005). These habitat losses are likely to have reduced the capacity of these areas to support juvenile salmon, therefore exacerbating competition between hatchery-origin and natural-origin fish for the remaining habitat.

Competition may also occur within stream habitats when young, pre-migratory fish are released, regardless of the species involved. Release of large numbers of fry or pre-smolts in a small area has great potential for competitive effects because interactions can occur for long periods, up to three years in the case of steelhead. The potential effect of competition on the behavior, and hence survival, of natural-origin fish depends on the degree of spatial and temporal overlap, relative sizes, and relative abundance of the two groups (Steward and Bjornn 1990). Effects would also depend on the degree of dietary overlap, food availability, size-related differences in prey selection, foraging tactics, and differences in microhabitat use (Steward and Bjornn 1990).

In addition to the freshwater and estuarine environments, competition between hatchery-origin and natural-origin fish may extend into the marine environment. Evidence exists for density-dependent ocean survival affecting pink and chum salmon hatchery programs in Alaska, Russia, and Japan (Pearcy 1992). However, it is unclear whether density-dependent survival is a factor for coho salmon, steelhead, and Chinook salmon. Competition risk in marine waters is difficult to assess because of a lack of data collected at times when hatchery-origin fish and natural-origin fish likely interact and because competition depends on a variety of specific circumstances, including location, fish size, and food availability (SIWG 1984). In marine waters, food is the main limiting resource for natural-origin fish that could be affected by competition posed from hatchery-origin fish. Concentration of fish in a relatively small area during the early marine life stage may create short-term instances where food is in short supply, and growth and survival decline as a result (SIWG 1984). The degree to which food is limiting after the early marine portion of a natural-origin fish's life depends upon the density of prey species. Competition may also occur in more seaward areas.

3.2.3.1.6 Current Approaches for Reducing Risks from Competition with Hatchery-origin Fish

The following measures are taken to reduce competition between hatchery-origin and natural-origin fish:

- Release fish as smolts rather than at younger or older ages (Steward and Bjornn 1990).
- Operate hatcheries so that hatchery-origin fish are reared to sufficient size, and smoltification occurs within nearly the entire population.
- Release smolts in lower river areas, below the upstream areas used for natural-origin salmon and steelhead rearing.

3.2.3.1.7 Risks of Predation from Hatchery-origin Fish

The same situations that lead to competition between hatchery-origin and natural-origin juveniles can cause predation risk. Direct predation occurs when hatchery-origin fish eat natural-origin fish; indirect predation occurs when predation from other sources increases as a result of the increased abundance of juvenile salmon and steelhead.

In direct predation, released smolts may prey on natural-origin fry and fingerlings they encounter during downstream migration. Hatchery-origin smolts, sub-adults, and adults may also prey on natural-origin fish of susceptible sizes and life stages (smolt through sub-adult) in estuarine and marine areas. In general, natural-origin salmon and steelhead populations will be most vulnerable to predation when 1) natural-origin populations are depressed and predator abundance is high, 2) in small streams, 3) where migration distances are long, and 4) when environmental conditions favor high visibility. Some reports suggest that hatchery-origin fish can prey on fish that are one half their length (Pearsons and Fritts 1999), but other studies have concluded that hatchery-origin predators prefer fish one third or less their length (Horner 1978; Hillman and Mullan 1989; Beauchamp 1990; Cannamela 1993; Columbia Basin Fish and Wildlife Authority [CBFWA] 1996). Because chum salmon and most fall Chinook salmon migrate to the ocean as sub-yearlings, they are much smaller than and more vulnerable to predation by hatchery-origin fish when they mix in the mainstem Columbia River. This vulnerability to predation by hatchery-origin fish in the mainstem Columbia is lower for the other species (coho salmon, steelhead, and spring Chinook salmon) because juveniles rear longer in freshwater and pass through the mainstem Columbia River en route to the ocean as older and larger fish.

In indirect predation, large concentrations of migrating fish may attract other predators (e.g., birds, fish, and seals). There are two types of predator response: 1) numerical, in which the predators increase in abundance and 2) functional, in which they switch preferred prey types. Hatchery-origin releases, by increasing the size of an outmigration event (often multifold), may consequently cause increased predation pressure on natural-origin outmigrants (Steward and Bjornn 1990). Nickelson (2003) concluded that large releases of coho salmon smolts thus increased predation on natural-origin coho salmon and likely caused reduced productivity in several populations. Large numbers of hatchery-origin fish may also alter natural-origin salmon behavioral patterns, potentially influencing their vulnerability and susceptibility to predation (Hillman and Mullan 1989; USFWS 1994). Hatchery-origin salmon and steelhead released into natural-origin salmon and steelhead production areas, or into migration areas during natural-origin salmon and steelhead emigration periods, may, therefore, pose an elevated, indirect predation risk to natural-origin salmon and steelhead. On the other hand, a mass of hatchery-origin salmon and steelhead migrating through an area may overwhelm established predator populations, providing a beneficial, protective effect to co-occurring natural-origin salmon and steelhead.

Estuaries are important for providing rearing habitat for growth, serving as a refuge from predation, and providing a physiological transition before fish emigrate to higher saline waters in the marine environment (Quinn 2005; Thorpe 1994). In the case of the Columbia River basin, this is especially the case for fall Chinook salmon and chum salmon because their life history strategies require a longer period of estuarine resident than other species such as coho salmon, steelhead, and spring Chinook salmon (Bottom et al. 2005). Therefore, chum salmon and fall Chinook salmon are more vulnerable to predation in the estuary than coho salmon, steelhead, and spring Chinook salmon.

3.2.3.1.8 Current Approaches for Reducing Risks of Predation from Hatchery-origin Fish

The following strategies are used to reduce the predation by hatchery-origin fish on natural-origin fish:

- Release fish as smolts rather than at younger or older ages (Steward and Bjornn 1990).
- Operate hatcheries so that hatchery-origin fish are reared to sufficient size, and smoltification occurs within nearly the entire population.
- Release smolts in lower river areas, below the upstream areas used for natural-origin salmon and steelhead rearing.
- Minimize size differences between hatchery-origin fish and their natural-origin counterparts.
- When possible, time the release of hatchery-origin fish to avoid peak outmigration times of natural-origin salmon and steelhead.

3.2.3.1.9 Risks Associated with Masking

Returning unidentifiable adult hatchery-origin fish straying into natural spawning areas confounds the ability to determine the status of the population. Abundance and productivity of the natural-origin population can be overestimated, and the productivity and capacity of the habitat can be imprecisely assessed. The abundance and productivity of the natural-origin fish and the condition of the habitat that sustains these fish is, therefore, “masked” by the continued infusion of hatchery-origin fish.

Attempts to identify and remedy anthropogenic factors adversely affecting fish habitat may be impeded through masking of natural-origin fish status. For example, instability and degradation of spawning gravel areas through flooding during critical spawning or egg incubation periods may not be recognized as a limiting factor to natural-origin production if annual spawning ground censuses are subsidized by returning adults from annual hatchery program releases.

In recent years, the masking problem has been greatly alleviated by the implementation of mass marking, the marking of a hatchery program's entire release, usually by adipose clip (Figure 2-2). Driven by state legislation in Washington and by Federal direction in the Federal budgetary process[3], all Chinook salmon, coho salmon, and steelhead in the Columbia basin intended explicitly for harvest, with the exception of the Priest Rapids fall Chinook salmon hatchery program, are currently marked. Hatchery-origin fish released for conservation purposes do not have to be marked (Section 2.3.2, Purpose of Hatchery Programs).

3.2.3.1.10 Current Approaches for Reducing the Risks of Masking

The following strategies are used to minimize the impact of masking:

- Mark hatchery-origin salmon and steelhead so they can be differentiated from natural-origin salmon and steelhead. Although 100 percent marking and sampling are not essential; accuracy of the number of hatchery-origin fish decreases rapidly as either marking rates or sampling rates are reduced.
- Monitor the spawning grounds to determine the proportion of hatchery-origin salmon and steelhead.
- Remove hatchery-origin salmon and steelhead through selective fisheries and at weirs and dams.
- Imprint hatchery-origin fish to return areas not used by natural-origin salmon and steelhead for spawning.

3.2.3.1.11 Risks Associated with Fisheries that Target Hatchery-origin Fish

Salmon fisheries, even when they target hatchery-origin fish, can have a large impact on survival and persistence of natural-origin salmon and steelhead populations (Flagg et al. 1995; Myers et al. 1998). Efforts to focus the fishing effort on harvest of hatchery-origin fish can lead to the incidental harvest of natural-origin fish in excess of levels compatible with their survival and recovery (National Research Council [NRC] 1996). In recent years, harvest management has undergone reform, and some concerns have been addressed. For example, most steelhead fisheries now target hatchery-origin fish and regulations require all natural-origin fish be released unharmed. Likewise, fisheries for coho salmon are managed to limit the impact on natural-origin

[3] Interior Appropriations Bill, 2003

fish while encouraging the harvest of hatchery-origin fish. In both cases, these actions have benefited the status of the species. In many areas, fisheries have been closed to protect natural-origin populations. For example, before 2005, upper Salmon River spring Chinook salmon fisheries were closed to non-treaty recreational fishing for more than 20 years.

3.2.3.1.12 Current Approaches for Reducing Risks Associated with Fisheries that Target Hatchery-origin Fish

The following strategies are used to reduce the impacts of fisheries on natural-origin salmon and steelhead:

- Externally mark hatchery-origin salmon and steelhead so that they can be differentiated from unmarked natural-origin fish.
- Conduct fisheries in areas or at times that target hatchery-origin fish and avoid natural-origin fish.
- Require all unmarked natural-origin fish to be released unharmed.
- Manage fisheries for the cumulative harvest rate from all fisheries to ensure total effects are not higher than expected
- Monitor fisheries to ensure an accurate accounting of harvest and effects on natural-origin fish.
- Manage fisheries based on the abundance and status of natural-origin salmon and steelhead, not the number of hatchery-origin fish available for catch in any one year.
- Adjust fishery impact limits annually based on parental escapements, ocean survivals, run-size forecasts, or other indicators that can gauge natural-origin population status and the ability of these populations to accept fishery related mortalities.

3.2.3.1.13 Benefits of Nutrient Cycling

The flow of energy and biomass from productive marine environments to relatively unproductive terrestrial environments supports high productivity where the two ecosystems meet (Polis and Hurd 1996). Salmon and steelhead are a major vector for transporting marine nutrients across ecosystem boundaries (i.e., from marine to freshwater and terrestrial ecosystems). Because of the long migrations of some stocks of Pacific salmon, the link between marine and terrestrial production may be extended hundreds of miles inland. Nutrients and biomass extracted from the milt, eggs, and decomposing carcasses of spawning salmon stimulate growth and restore the nutrients of aquatic ecosystems. Experiments have shown that carcasses of hatchery-produced salmon can be an important source of nutrients for juvenile salmon rearing in streams (Bilby et al. 1998).

3.2.3.1.14 Risks Associated with Disease Transfer

Interactions between hatchery-origin fish and natural-origin fish in the environment may result in the transmission of pathogens, if either the hatchery-origin or the natural-origin fish are harboring fish disease (Table 3-6). This impact may occur in tributary areas where hatchery-origin fish are released and throughout the migration corridor where hatchery-origin and natural-origin fish may interact. As the pathogens responsible for fish diseases are present in both hatchery-origin and natural-origin populations, there is some uncertainty associated with determining the source of the pathogen (Williams and Amend 1976; Hastein and Lindstad 1991). Hatchery-origin fish may have an increased risk of carrying fish disease pathogens because of relatively high rearing densities that increase stress and can lead to greater manifestation and spread of disease within the hatchery-origin population. Consequently, it is possible that the release of hatchery-origin salmon and steelhead may lead to an increase of disease in natural-origin salmon and steelhead populations.

TABLE 3-6. SOME COMMON FISH PATHOGENS FOUND IN COLUMBIA RIVER HATCHERY FACILITIES.

PATHOGEN	DISEASE	SPECIES AFFECTED
Renibacterium salmoninarum	Bacterial Kidney Disease (BKD)	Chinook salmon, chum salmon, coho salmon, steelhead and sockeye salmon
Ceratomyxa shasta	Ceratomyxosis	Chinook salmon, steelhead, coho salmon and chum salmon
Flavobacterium psychrophilum	Coldwater Disease	Chinook salmon, chum salmon, coho salmon, steelhead and sockeye salmon
Flavobacterium columnare	Columnaris	Chinook salmon, chum salmon, coho salmon, steelhead and sockeye salmon
Yersinia ruckeri	Enteric Redmouth	Chinook salmon, chum salmon, steelhead and sockeye salmon
Aermonas salmonicida	Furunculosis	Chinook salmon, chum salmon, coho salmon, steelhead and sockeye salmon
Infectious hematopoetic necrosis	IHN	Chinook salmon, steelhead, chum salmon sockeye salmon
Saprolegnia parasitica	Saprolegniasis	Chinook salmon, coho salmon, steelhead, chum salmon, sockeye salmon
Vibrio anguillarum	Vibriosis	Chinook salmon, coho salmon and chum salmon

Sources: IHN database http://gis.nacse.org/ihnv/; http://www.nwr.noaa.gov/Salmon-HarvestHatcheries/Hatcheries/Hatchery-Genetic-Mngmnt-Plans.cfm

3.2.3.1.15 Current Approaches for Reducing Risks of Disease Transfer

Hatchery operators have established fish pathology labs and a number of fish health policies in the Columbia River basin. These policies establish guidelines to ensure that fish health is monitored, sanitation practices are applied, and hatchery-origin fish are reared and released in healthy conditions (Pacific Northwest Fish Health Protection Committee 1989; IHOT 1995). Fish health policies include the following two strategies:

- Maintain low densities of fish in the hatchery facilities to reduce fish stress.
- Conduct monthly and pre-release checks of hatchery-origin salmon and steelhead by a fish health specialist.

3.2.3.1.16 Effects on Viable Salmonid Concept (VSP)

McElhany et al. (2000) developed the VSP as a means to evaluate the conservation status of Pacific salmon and steelhead. A key part of this approach was the identification of four measurable indicators of population health that should be considered in performing conservation status assessments. These indicators of population status are abundance (the number of natural-origin spawners), productivity (the ratio of natural-origin offspring produced per parent), diversity (the genetic variety among population members), and spatial structure (the distribution of population members across a subbasin or subbasins). Hatchery programs benefit from some of these VSP parameters under certain circumstances.

One main benefit potentially conferred by hatchery programs is an increase in the total abundance of a salmon population that returns to spawn naturally. Freshwater, habitat-related factors limiting the survival and productivity of a natural-origin population can be circumvented by spawning, incubating, rearing, and releasing fish from the population in a hatchery facility. Short-term success in increasing the number of naturally spawning fish has been demonstrated for some hatchery programs (e.g., Hood Canal summer chum salmon supplementation and reintroduction hatchery programs). However, the long-term success in perpetuating a successful naturally spawning population is unproven and unlikely without commensurate improvements in the condition of natural habitat.

In addition, spatial structure may be expanded if hatchery programs release fish into previously uninhabited parts of a subbasin, and, in some cases, diversity may be increased. Productivity may also be increased if the hatchery-origin fish improve the condition of the spawning gravel or add nutrients to the system.

However, the impacts of hatchery programs on natural-origin salmon and steelhead can also negatively impact VSP indicators because they can lead to additional mortality of natural-origin fish through competition, predation, disease, and fisheries; they can unfavorably alter the genetic character of the natural-origin population; or they can restrict the distribution of a population across its habitat. Mortality will most directly affect the VSP indicators abundance and productivity. Substantial increases in mortality will be readily observable as reduced numbers of naturally spawning fish. Increased mortality will also result in a less efficient reproductive conversion of spawning adults to surviving offspring. This will be detectable as reductions in productivity, measured as the ratio of offspring to parents.

Indirectly, mortality may reduce a population's spatial structure. As the mortality rates increase, those portions of basin that are less favorable to the production of salmon may become vacated because not enough offspring survive to repopulate such areas. Fish production, as evidenced by the presence of spawners homing to their natal area, may collapse to only those portions of the basin where the habitat conditions are best. Hatchery programs can also directly affect spatial structure through a number of actions. These include the operation of weirs that impede upstream migration of returning adults or the construction of migration barriers to prevent the entry of spawners into portions of the watershed to ensure that the hatchery facility's water supply is less prone to carrying disease.

Hatchery programs can also cause adverse genetic changes in populations that are measurable via VSP indicators. Poorly adapted hatchery-origin fish that interbreed with natural-origin populations can result in significant genetic changes (a diversity indicator) that are maladaptive for natural-origin fish reproducing in the natural environment. In addition to affecting population diversity, it is likely such changes would adversely impact the reproductive efficiency of natural-origin populations, lowering productivity. Further, reductions in population productivity will likely produce a cascade of events that results in declines in population abundance and spatial structure. These effects will be most pronounced when highly domesticated and/or non-native hatchery-origin fish interbreed at excessive levels in segregated hatchery programs, but even the best-run integrated hatchery program using native fish can be expected to result in declines in productivity and diversity.

Table 3-7 shows the mean adjusted productivity and abundance of salmon and steelhead populations in each Columbia River basin ESU and DPS. The abundance and productivity numbers in this table were generated with the all-H analyzer (AHA) model using best available data. Abundance ranges from 1,104 Chinook salmon in the Upper Columbia Spring Chinook

Salmon ESU to 46,160 Chinook salmon in the Upper Columbia Summer/Fall Chinook Salmon. Productivity ranges from a low of 0.07 for the Redfish Lake sockeye salmon population up to 4.5 for the Southwest Washington Steelhead DPS (Table 3-7).

TABLE 3-7. MEAN ADJUSTED PRODUCTIVITY AND TOTAL NATURAL-ORIGIN SPAWNERS FOR ALL POPULATIONS IN AN ESU/DPS UNDER BASELINE CONDITIONS.

ESU/DPS	MEAN ADJUSTED PRODUCTIVITY	TOTAL NATURAL-ORIGIN SPAWNERS (NOS) ABUNDANCE
Lower Columbia River Chinook Salmon	2.3	25,042
Mid-Columbia River Spring-run Chinook Salmon	2.6	10,156
Deschutes River Summer/Fall-run Chinook Salmon	2.4	8,840
Upper Columbia River Spring-run Chinook Salmon	1.4	1,104
Upper Columbia River Summer/Fall-run Chinook Salmon	1.7	46,160
Upper Willamette River Chinook Salmon	1.6	6,935
Snake River Spring/Summer-run Chinook Salmon	1.4	7,887
Snake River Fall-run Chinook Salmon	0.7	1,602
Lower Columbia River Steelhead	2.6	12,540
Middle Columbia River Steelhead	2.0	16,010
Snake River Basin Steelhead	1.9	14,039
Southwest Washington Steelhead	4.5	1,886
Upper Columbia River Steelhead	0.7	1,390
Upper Willamette River Steelhead	4.4	7,336
Lower Columbia River Coho Salmon	1.9	21,854
Columbia River Chum Salmon	1.8	20,027
Snake River Sockeye Salmon	0.07	13

Source: Appendix C though Appendix F. Data were generated with the AHA model using best available data.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia River Fish Recovery Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS (Section 2.4, Alternative Development).

Table 3-8 shows the number of percentage of populations with abundance greater than 500 and productivity greater than 1.0. These metrics are used in this EIS as a rough indicator of diversity and spatial structure. The abundance and productivity numbers in this table were generated with the AHA model using best available data. The percentage of populations with both productivity greater than 1.0 and natural-origin abundance greater than 500 ranges from zero percent in the Upper Columbia River Spring-run Chinook Salmon and Snake River Fall-run Chinook Salmon ESUs to 100 percent in the Deschutes River Summer/Fall-run Chinook Salmon ESU and Upper Willamette River Steelhead DPS (Table 3-8).

3.2.3.2 Status of Salmon ESUs and Steelhead DPSs

The following status summaries were obtained from two primary sources: 1) the FCRPS biological opinion for baseline information on listed salmon and steelhead (NMFS 2008) and 2) NMFS status reviews for non-listed salmon and steelhead (http://www.nwr.noaa.gov/Publications/Biological-Status-Reviews/Salmon.cfm). Within the analysis area, there are four species of salmon (Chinook salmon, chum salmon, coho salmon, and sockeye salmon) plus steelhead. All chum salmon within the analysis area are found in one ESU, and all coho salmon in the analysis area are found in one ESU. Chinook salmon, sockeye salmon, and steelhead have multiple ESUs within analysis area (Box 1-1). When available, additional information is provided on limiting factors and threats. Limiting factors are physical, biological, or chemical features (e.g., inadequate spawning habitat, high water temperature, insufficient prey resources) experienced by the fish that result in reductions in abundance, productivity, spatial structure, and diversity. Threats are human actions or natural events (e.g., forest management, mining activities, fishery management, artificial propagation, agricultural practices, climate change, etc.) that cause or contribute to limiting factors. Threats may be caused by the continuing results of past events and actions as well as by present and anticipated future events and actions.

TABLE 3-8. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING EACH ESU/DPS THAT HAVE AN ADJUSTED PRODUCTIVITY ($PROD_{ADJ}$) GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH UNDER BASELINE CONDITIONS.

ESU/DPS	Number of Populations with $PROD_{ADJ}$ > 1.0	Number of Populations with NOS > 500	Number of Populations with both $PROD_{ADJ}$ > 1.0 and NOS > 500	Percent of Populations with $PROD_{ADJ}$ > 1.0	Percent of Populations with NOS > 500	Percent of Populations with both $PROD_{ADJ}$ > 1.0 and NOS > 500
Lower Columbia River Chinook Salmon	13	9	8	68	47	42
Mid-Columbia River Spring-run Chinook Salmon	10	6	6	100	60	60
Deschutes River Summer/Fall-run Chinook Salmon	1	1	1	100	100	100
Upper Columbia River Spring-run Chinook Salmon	3	0	0	50	0	0
Upper Columbia River Summer/Fall-run Chinook Salmon	3	5	3	50	83	50
Upper Willamette River Chinook Salmon	3	3	2	60	60	40
Snake River Spring/Summer-run Chinook Salmon	21	5	5	72	17	17
Snake River Fall-run Chinook Salmon	0	1	0	0	100	0
Lower Columbia River Steelhead	19	7	7	100	37	37
Middle Columbia River Steelhead	13	11	11	81	69	69
Snake River Basin Steelhead	17	11	11	77	50	50
Southwest Washington Steelhead	3	2	2	100	67	67
Upper Columbia Steelhead	1	1	1	25	25	25
Upper Willamette River Steelhead	4	4	4	100	100	100
Lower Columbia River Coho Salmon	12	11	9	71	65	53
Columbia River Chum Salmon	13	7	7	87	47	47
Snake River Sockeye Salmon	0	0	0	0	0	0

Source: Appendix C though Appendix F. Data were generated with the AHA model using best available data. N/A = not available.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish &Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS (Section 2.4, Alternative Development).

3.2.3.2.1 Lower Columbia River Chinook Salmon ESU

Background

The Lower Columbia River Chinook Salmon ESU includes all naturally spawned populations from the mouth of the Columbia River upstream to and including White Salmon River in Washington and the Hood River in Oregon. Additionally, this ESU includes the Willamette River upstream to Willamette Falls (exclusive of the spring-run Chinook salmon in the Clackamas River), as well as 17 hatchery programs (http://www.nwr.noaa.gov/ESA-Salmon-Listings/Salmon-Populations/Maps/Chinook-ESU-Maps.cfm for a map of ESU location). There are three components based on run timing: spring Chinook salmon, early fall Chinook salmon (tules), and late fall Chinook salmon (brights). There are six major population groups in this ESU. They include 32 historical populations, seven of which are extirpated or nearly so. Lower Columbia River Chinook salmon numbers began to decline by the early 1900s because of habitat degradation and harvest rates and were listed under the ESA as threatened in 1999. The listing was reaffirmed in 2005 (70 Fed. Reg. 37160, June 28, 2005).

Current Status and Trends

Many of the populations in this ESU for which data are available currently have low abundances, and many of the long- and short-term trends in abundance are negative, some severely so. Some of the natural runs largely have been replaced by hatchery program production.

Limiting Factors and Threats

Human effects and limiting factors for the Lower Columbia River Chinook salmon include habitat degradation (including tributary hydropower development), hatchery program effects, fishery management and harvest decisions, and predation. Lower Columbia River Chinook salmon populations began declining in the early 1900s because of habitat changes and high harvest rates. FCRPS effects have been limited, but are most substantial for the five populations that spawn in tributaries above Bonneville Dam. These populations are affected by upstream and downstream passage and the inundation of spawning habitat for fall-run Chinook salmon in the lower reaches of the tributaries to the reservoir.

For populations originating in tributaries below Bonneville Dam, migration and habitat conditions in the mainstem and estuary have been affected by hydrosystem flow operations. Tributary habitat degradation is pervasive due to development and other land uses, and Federal

Energy Regulatory Commission (FERC) licensed hydroelectric projects have blocked some spawning areas. Hatchery program production for Lower Columbia River Chinook salmon has reduced the diversity and productivity of natural populations throughout the ESU. Predators take a substantial number of juveniles and adults, particularly from spring-run populations.

3.2.3.2.2 Mid-Columbia River Spring-run Chinook Salmon ESU

Background

Included in this ESU are spring-run Chinook salmon spawning in the Klickitat, Deschutes, John Day, and Yakima Rivers. There are no fall-run Chinook salmon in this ESU. Historically, spring-run populations from the Walla Walla and Umatilla Rivers may have also belonged in this ESU, but these populations are now considered extinct. NMFS evaluated whether the Mid-Columbia River Spring-run Chinook salmon ESU should be listed under the ESA and concluded, in 1998, that Chinook salmon in this ESU are not presently in danger of extinction, nor are they likely to become endangered in the foreseeable future (63 Fed. Reg. 11497, March 9, 1998). As a result, this ESU was not listed.

Current Status and Recent Trends

Although Chinook salmon in this ESU are not in danger of extinction, habitat problems are common in the range of this ESU. Spawning and rearing habitat are affected by agriculture including water withdrawals, grazing, and riparian vegetation management. Mainstem Columbia River hydroelectric development has resulted in a major disruption of migration corridors and affected flow regimes and estuarine habitat. Hatchery production accounts for a substantial proportion of total escapement to the region. However, there is no hatchery production in John Day basin. Stocks in this ESU experience very low ocean harvest rates and only moderate instream harvest (Pacific Salmon Commission [PSC] 1996).

Recent escapement estimates in the Deschutes and John Day River basins indicate relatively stable populations, exceeding the estimated 30-year average between 2000 and 2004 (Oregon Department of Fish and Wildlife [ODFW] 2005). These populations also generally exhibit limited hatchery influences, typically with less than 10 percent of hatchery-origin fish spawning naturally. Similarly, the annual number of adult spring Chinook salmon counted at Bonneville, Priest Rapids, and Ice Harbor Dams between 1998 and 2006 were approximately one to five times, two to seven times, and one to three times greater than the 5-year (1992 to 1996) geometric mean abundance estimate of about 25,000 adults, respectively, (Fish Passage Center [FPC] 2007).

Limiting Factors and Threats

Limiting factors and threats have not been identified for this ESU because it is not ESA-listed.

3.2.3.2.3 Deschutes River Summer/Fall-run Chinook Salmon ESU

Background

This ESU includes all naturally spawned populations of Chinook salmon from the Deschutes River. NMFS evaluated whether the Deschutes River Summer/Fall-run Chinook Salmon ESU should be listed under ESA and, in 1999, concluded that Chinook salmon in this ESU are not presently in danger of extinction, nor are they likely to become endangered in the foreseeable future (64 Fed. Reg. 50409, September 16, 1999). As a result, this ESU was not listed.

Current Status and Recent Trends

Updated information on the abundance of fall-run Chinook salmon in the Deschutes River indicates that the run continues to remain relatively stable, although the 2008 Deschutes River basin return of 7,700 adults was only 68 percent of the recent 10-year average of 11,200 adults (ODFW and WDFW 2009). This is about a 30 percent decrease compared to the estimated 5-year geometric mean abundance of over 16,000 fish in the late 1990s, when the short-term trend was increasing by 18 percent per year (West Coast Chinook Salmon Biological Review Team 1999). However, there is considerable uncertainty associated with the run-size estimates of Chinook salmon in the Deschutes River (Beaty 1996).

Limiting Factors and Threats

Limiting factors and threats have not been identified for this ESU because it is not ESA-listed.

3.2.3.2.4 Upper Columbia River Spring-run Chinook Salmon ESU

Background

The Upper Columbia River Spring-run Chinook Salmon ESU consists of one major population group composed of three existing and one extinct population. These fish spawn and rear in the mainstem Columbia River and its tributaries between Rock Island and Chief Joseph Dams. The Chief Joseph Dam, completed in 1961, now blocks the upriver migration of this species. For 20 years prior to that, migration was blocked by the Grand Coulee Dam. Upper Columbia River spring-run Chinook salmon were listed as endangered under the ESA in 1999, and reaffirmed in 2005 (70 Fed. Reg. 37160, June 28, 2005).

Current Status and Recent Trends

Abundance for most populations declined to extremely low levels in the mid-1990s, increased to levels above (Wenatchee and Methow Rivers) or near (Entiat River) the recovery abundance thresholds in the early 2000s, and are now at levels intermediate to those of the mid-1990s and early 2000s. Jack counts in 2007, an indicator of future adult returns, were at the highest level since 1977.

Limiting Factors and Threats

The key limiting factors and threats for the Upper Columbia River Spring-run Chinook Salmon ESU include hydropower projects, predation, harvest, hatchery program effects, degraded estuary habitat, and degraded tributary habitat. Ocean conditions, which have also affected the status of this ESU, generally have been poor over the last 20 years, improving only recently.

3.2.3.2.5 Upper Columbia River Summer/Fall-run Chinook Salmon ESU

Background

This ESU was first identified as the Middle-Columbia River Summer/Fall-run Chinook Salmon ESU. Previously, Waknitz et al. (1995) and NMFS (1994) identified an ESU that included all ocean-type Chinook salmon spawning in areas between McNary Dam and Chief Joseph Dam (59 Fed. Reg. 48855, September 23, 1994). However, NMFS recently concluded that the boundaries of this ESU do not extend downstream from the Snake River. In particular, NMFS concluded that Deschutes River fall-run Chinook salmon are not part of this ESU. In 1998, NMFS concluded that Chinook salmon in this ESU are not presently in danger of extinction, nor are they likely to become endangered in the foreseeable future (63 Fed. Reg. 11497, March 9, 1998).

Current Status and Recent Trends

Recent run-size estimates of the Upper Columbia River Summer/Fall-run Chinook Salmon ESU have been relatively stable. Between 2003 and 2008, the adult returns have ranged between 114,500 and 373,200 fish (ODFW and WDFW 2009). However, a steady declining trend occurred from a high of 373,000 fish in 2003 to a low of 114,000 fish in 2007, while the 2008 return was higher at 197,300 fish.

Limiting Factors and Threats

Limiting factors and threats have not been identified for this ESU because it is not ESA-listed.

3.2.3.2.6 Upper Willamette River Chinook Salmon ESU

Background

The Upper Willamette River Chinook Salmon ESU includes all naturally spawned populations of spring-run Chinook salmon residing in the Clackamas River and in the Upper Willamette River above Willamette Falls, but below impassable natural barriers, as well as seven artificial propagation programs. There is only one major population group in this ESU; it consists of seven historical demographically independent populations. Substantial natural production occurs only in the Clackamas and McKenzie Rivers. Upper Willamette River Chinook salmon were listed under the ESA as threatened in 1995. This listing was reaffirmed in 2005 (70 Fed. Reg. 37160, June 28, 2005).

Current Status and Recent Trends

Historically, the Upper Willamette supported large numbers (perhaps exceeding 275,000 fish) of spring Chinook salmon. Current abundance of natural-origin fish is estimated to be less than 10,000, with substantial natural production occurring in only two populations—the Clackamas and McKenzie River populations. While counts of hatchery- and natural-origin adult spring Chinook salmon over Willamette Falls have increased since 1946, approximately 90 percent of the return is now composed of hatchery-origin fish. Most of the natural-origin populations in this ESU have very low current abundances (less than a few hundred fish). Many of the natural runs largely have been replaced by hatchery program production.

Limiting Factors

Human effects and limiting factors for Upper Willamette River Chinook salmon include habitat loss and degradation (including tributary hydropower development), hatchery program effects, fishery management and harvest decisions, and predation. Federal Columbia River Power System (FCRPS) effects are limited to habitat conditions in the mainstem below the confluence of the Willamette River and in the Columbia River estuary, which have been affected by hydrosystem flow operations. Habitat degradation has been pervasive in the Willamette River mainstem and the lower reaches of its tributaries, and both U.S. Army Corps of Engineers (USACE) and FERC-licensed hydroelectric projects have blocked some spawning areas. Habitat loss due to blockages has been especially severe in the North Santiam, Calapooia, and Middle Fork Willamette River subbasins.

3.2.3.2.7 Snake River Spring/Summer-run Chinook Salmon ESU

Background

The Snake River Spring/Summer-run Chinook Salmon ESU consists of five major population groups that spawn and rear in the tributaries of the Snake River between the confluence of the Snake and Columbia Rivers and the Hells Canyon Dam. The factors that contributed to their decline include intensive harvest and habitat degradation in the early and mid 1900s, high harvest in the 1960s and early 1970s, and Federal and private hydropower development, as well as poor ocean productivity from the late 1970s through the late 1990s. Snake River spring/summer-run Chinook salmon were listed under the ESA as threatened in 1992 (70 Fed. Reg. 37160, June 28, 2005).

Current Status and Recent Trends

The Snake River Spring/Summer-run Chinook Salmon ESU's five major population groups are further composed of 28 extant populations. Abundance has been stable or increasing on average over the last 20 years. In 2007, jack counts (a qualitative indicator of future adult returns) were the second highest on record. However, on average, the natural-origin components of Snake River spring/summer-run Chinook salmon populations have not replaced themselves.

Limiting Factors and Threats

Limiting factors for the Snake River Spring/Summer-run Chinook Salmon ESU include Federal and private hydropower projects, predation, harvest, the estuary, and tributary habitat. Ocean conditions have also affected the status of this ESU. These conditions have been generally poor for this ESU over at least the last four brood cycles, improving only in the last few years. Although hatchery program management is not identified as a limiting factor for the ESU as a whole, the ICTRT has indicated potential hatchery program effects for a few individual populations.

3.2.3.2.8 Snake River Fall-run Chinook Salmon ESU

Background

The Snake River Fall-run Chinook Salmon ESU consists of a single population that spawns and rears in the mainstem Snake River and its tributaries below Hells Canyon Dam. The decline of this ESU was due to heavy fishing pressure beginning in the 1890s and loss of habitat with the construction of Swan Falls Dam in 1901 and the Hells Canyon Complex from 1958 to 1967, which extirpated two of the historical populations. Only 10 to 15 percent of the historical range of this ESU remains. Hatcheries have played a major role in the production of Snake River fall-run Chinook salmon since the 1980s. Snake River fall-run Chinook salmon were listed under the ESA as threatened in 1992 (70 Fed. Reg. 37160, June 28, 2005).

Current Status and Recent Trends

The average abundance (1,273 fish) of Snake River fall-run Chinook salmon over the most recent 10-year period is below the 3,000 natural-origin spawner average abundance thresholds that the ICTRT identified as a minimum for recovery. Total returns to Lower Granite Dam have increased steadily from the mid-1990s to the present. Natural-origin returns have increased at roughly the same rate as hatchery-origin returns (through run year 2000); since then, however, hatchery-origin returns have increased disproportionate to natural-origin returns. On average, over the last 23 full brood year returns (1977 to 1999, which includes adult returns through 2004), the natural-origin component of the population has not replaced itself.

Limiting Factors and Threats

Limiting factors for Snake River fall-run Chinook salmon include mainstem hydroelectric projects in the Columbia and Snake Rivers, predation, harvest, hatcheries, the estuary, and tributary habitat. Ocean conditions have also affected the status of this ESU. Generally, ocean conditions have been poor for this ESU over the past 20 years, improving only recently.

3.2.3.2.9 Lower Columbia River Steelhead DPS

Background

The Lower Columbia River Steelhead DPS includes 23 historical anadromous populations in four major population groups located from the Cowlitz River up to and including the Wind

River in Washington and from the mouth of the Willamette River up to the Hood River in Oregon, excluding steelhead above Willamette Falls. This DPS includes both summer- and winter-run types. The Lower Columbia River Steelhead DPS was listed as threatened under the ESA in 1998, reaffirmed in 2006 (71 Fed. Reg. 834, January 5, 2006).

Current Status and Recent Trends

Most of the populations comprising this DPS are small, and many of the long- and short-term trends in abundance of individual populations are negative, some severely so. A number of the populations have a substantial fraction of hatchery-origin spawners. Exceptions are the Kalama, North and South Fork Toutle, and East Fork Lewis winter-run populations, which have few hatchery-origin fish spawning in natural spawning areas. These populations have relatively low recent abundance estimates; the largest is the Kalama River with 726 spawners.

Limiting Factors

Human effects and limiting factors include habitat degradation (including tributary hydropower development), hatchery program effects, fishery management and harvest decisions, and ecological factors, including predation. Tributary habitat has been degraded by extensive development and other effects of changing land use. This has adversely affected stream temperatures and reduced the habitat diversity needed for steelhead spawning, incubation, and rearing. Steelhead access to tributary headwaters has been restricted or blocked by FERC-licensed dams built without passage facilities or facilities that were inadequate and caused injury and delay. Four populations (Wind River summer-run, Hood River summer-run, Upper Gorge River winter-run, and Hood River winter-run) are subject to FCRPS effects involving passage at Bonneville Dam, and all populations are affected by habitat alterations in the Columbia River mainstem and estuary. Preservation and recovery of this DPS will require concerted and substantial efforts by many parties.

3.2.3.2.10 Middle Columbia River Steelhead DPS

Background

The Middle Columbia River Steelhead DPS includes anadromous populations in Oregon and Washington subbasins upstream of the Hood and Wind River systems to and including the Yakima River. There are four major population groups with 17 populations in this DPS. Almost all populations are summer-run fish; two winter-run populations return to the Klickitat and Fifteenmile Creek watersheds. Blockages have prevented access to sizable historical production areas in the Deschutes, White Salmon, and White Salmon Rivers. The Middle Columbia River Steelhead DPS was listed as threatened under the ESA in 1999, reaffirmed in 2006 (71 Fed. Reg. 834, January 5, 2006).

Current Status and Recent Trends

During the most recent 10-year period for which trends in abundance could be estimated, the population trends were positive for approximately half of the populations and negative for the remainder. On average, when only natural production is considered, most of the Middle Columbia River steelhead populations have replaced themselves.

Limiting Factors and Threats

Historically, the key limiting factors for Middle Columbia River steelhead include mainstem hydropower projects, tributary habitat and hydropower, water storage projects, predation, hatchery program effects, harvest, and estuary conditions. Ocean conditions have been generally poor over most of the last 20 years, improving only in the last few years.

3.2.3.2.11 Snake River Basin Steelhead DPS

Background

The Snake River Basin Steelhead DPS includes all anadromous populations that spawn and rear in the mainstem Snake River and its tributaries between Ice Harbor and the Hells Canyon hydro complex. There are five major population groups with 24 populations. Inland steelhead in the Columbia River basin are commonly referred to as either A-run or B-run, based on migration timing and differences in age and size at return. A-run steelhead are believed to occur throughout the steelhead streams in the Snake River basin, and B-run are thought to produce only in the Clearwater and Salmon Rivers. This DPS was listed as threatened under the ESA in 1997, and the listing was reaffirmed in 2006 (71 Fed. Reg. 834, January 5, 2006).

Current Status and Recent Trends

The abundance of Snake River basin steelhead has been stable or increasing for most A-run and B-run populations during the last 20 brood cycles. On average, the natural-origin components of the A-run populations have replaced themselves, whereas the natural-origin components of the B-run populations have not.

Limiting Factors and Threats

Limiting factors identify the most important biological requirements of the species. Historically, the key limiting factors for the Snake River basin steelhead include hydropower projects, predation, harvest, hatchery program effects, and tributary habitat. Ocean conditions have also affected the status of this DPS. These ocean conditions generally have been poor over at least the last 20 years, improving only in the last few years.

3.2.3.2.12 Southwest Washington Steelhead DPS

Background

This coastal steelhead DPS occupies the river basins and tributaries to Grays Harbor, Willapa Bay, and the Columbia River below the Cowlitz River in Washington and below the Willamette River in Oregon. NMFS evaluated whether the Southwest Washington Steelhead DPS should be listed under the ESA and concluded in 1996 that steelhead in this DPS are not presently in danger of extinction, nor are they likely to become endangered in the foreseeable future (61 Fed. Reg. 41544, August 9, 1996). As a result, this DPS was not listed.

Current Status and Trends

In NMFS' 1996 status review, it was concluded that all but one (Wynoochee River) of the 12 independent stocks have been declining over the available data series, with a range from 7 percent annual decline to 0.4 percent annual increase. Six of the downward trends were significantly different from zero. For Washington streams, these trends are for the late run ''wild'' component of winter steelhead populations; Oregon data included all stock components. Most of the Oregon trends are based on angler catch, and they may not reflect trends in underlying population abundance. In general, stock condition appears to be healthier in southwest Washington than in the lower Columbia River basin.

The Biological Review Team (BRT) concluded that the Southwest Washington Steelhead DPS is neither presently in danger of extinction nor likely to become endangered in the foreseeable future. However, the general downward trends, coupled with introductions of hatchery-origin fish from outside the DPS, could threaten the species. Almost all stocks for which data are available have been declining in the recent past, although this may be largely due to recent climate conditions.

The BRT also had a strong concern about genetic introgression from hatchery-origin stocks within the DPS, and a great concern for the status of summer steelhead in this DPS. There is widespread production of hatchery-origin steelhead within this DPS, largely from parent stocks outside the DPS. This production could substantially change the genetic composition of the resource, despite management efforts to minimize introgression of the hatchery-origin gene pool into natural-origin populations. Estimates of the proportion of hatchery-origin fish on natural spawning grounds range from 9 percent in the Chehalis River, the largest producer of steelhead in the DPS, to 82 percent in the Clatskanie River.

Limiting Factors and Threats

Limiting factors and threats have not been identified for this DPS because it is not ESA-listed.

3.2.3.2.13 Upper Columbia River Steelhead DPS

Background

The Upper Columbia River Steelhead DPS includes all anadromous populations that spawn and rear in the middle reaches of the rivers and tributaries draining the eastern slope of the Cascade Mountains upstream of Rock Island Dam. There are four populations in a single major population group. The Upper Columbia River Steelhead DPS was listed under the ESA as threatened on January 5, 2006 (71 Fed. Reg. 834).

Hatchery-origin steelhead have been released into the Methow and Okanogan Rivers since the late 1960s and into the Wenatchee and Entiat River systems since the 1970s. Through the 1980s, operations were designed to accommodate harvest, and there was no attempt to limit introgression of hatchery-origin fish into the native populations. In many cases, the hatchery program broodstock originated from outside the upper Columbia River region. Naturally spawning hatchery-origin fish were not adapted to local conditions, which most likely limited their effectiveness and depressed the production of the population as a whole. While there are no precise means to measure the full effect of these practices, they likely contributed substantially to the current low recruits-per-spawner (R/S) productivities for naturally spawning fish.

Since the early 1990s, hatchery programs that operate in the Wenatchee, Methow, and Okanogan River basins have implemented reforms to support steelhead conservation and recovery. No hatchery-origin fish are currently released into the Entiat River system, and the hatchery program broodstock in other watersheds is now composed exclusively of steelhead from the Upper Columbia River Steelhead DPS. The hatchery programs are managed to preserve natural genetic resources.

Current Status and Recent Trends

The Upper Columbia River Steelhead DPS consists of four anadromous populations. For all populations, abundance over the most recent 10-year period is below the thresholds that the ICTRT has identified as a minimum for recovery. Abundance for most populations declined to extremely low levels in the mid-1990s, increased to levels above or near the recovery abundance thresholds (all populations except the Okanogan) in a few years in the early 2000s, and is now at levels intermediate to those of the mid-1990s and early 2000s. Abundance since 2001 has substantially increased for the DPS as a whole.

Limiting Factors and Threats

The key limiting factors and threats for Upper Columbia River steelhead include hydropower projects, predation, harvest, hatchery program effects, degraded tributary habitat, and degraded estuary habitat. Ocean conditions generally have been poor for this DPS over the last 20 years, improving only in the last few years.

3.2.3.2.14 Upper Willamette River Steelhead DPS

Background

The Upper Willamette River Steelhead DPS includes all naturally spawned anadromous steelhead populations below natural and manmade impassable barriers in the Willamette River, Oregon, and its tributaries upstream from Willamette Falls to the Calapooia River (inclusive). There are four populations in this DPS. All four remain extant and produce moderate numbers of natural-origin steelhead each year. The hatchery-origin, summer-run steelhead that occur in the Willamette River basin are an out-of-basin stock that is not part of the DPS. Upper Willamette River steelhead were listed as threatened under the ESA in 1999. This listing was reaffirmed in 2006 (71 Fed. Reg. 834, January 5, 2006).

Current Status and Recent Trends

The abundance and productivity of Upper Willamette River steelhead populations are depressed from historical levels, but to a much lesser extent than for Upper Willamette River Chinook salmon. All of the historical populations produce moderate numbers of steelhead each year. DPS long-term abundance and productivity trends are stable to slightly decreasing, and short-term trends are stable to slightly increasing. The long-term risk of extinction is considered moderate for all four populations.

Limiting Factors

Human effects and limiting factors for Upper Willamette River steelhead include habitat loss and degradation (including tributary hydropower development), hatchery program effects, fishery management and harvest decisions, and predation. FCRPS effects are limited to habitat conditions in the mainstem below the confluence of the Willamette River and in the Columbia River estuary, which have been affected by hydrosystem flow operations. Mainstem Willamette River and tributary habitat degradation have been pervasive, particularly in the lower reaches of tributaries to the Willamette River, and both USACE and privately owned dams have blocked some important spawning areas. Habitat loss due to blockages has been especially severe in the North Santiam and Calapooia subbasins.

3.2.3.2.15 Lower Columbia River Coho Salmon ESU

Background

The Lower Columbia River Coho Salmon ESU includes all naturally spawned coho salmon populations in streams and tributaries to the Columbia River within Washington and Oregon, from the mouth of the Columbia River up to and including the White Salmon and Hood Rivers; the Willamette River to Willamette Falls, Oregon; and 25 artificial propagation programs. The ESU includes 24 historical populations in three major population groups. The Lower Columbia River Coho Salmon ESU was listed as threatened under the ESA in 2005 (70 Fed. Reg. 37160, June 28, 2005).

Current Status and Recent Trends

Data on the status of natural-origin Lower Columbia River coho salmon are very limited. Most populations have low or very low numbers. Most of the natural runs largely have been replaced by hatchery program production.

Limiting Factors

Human effects and limiting factors for the Lower Columbia River coho salmon include habitat degradation (including tributary hydropower development), hatchery program effects, fishery management and harvest decisions, and predation. Lower Columbia River coho salmon populations have been in decline for the last 70 years. FCRPS effects have been limited, but most substantial for the two populations that spawn in tributaries above Bonneville Dam. These populations are affected by upstream and downstream passage and, for Oregon populations, by inundation of some historical habitat by the Bonneville Dam pool.

For populations originating in tributaries below Bonneville Dam, migration and habitat conditions in the mainstem and estuary have been affected by hydrosystem flow operations. Tributary habitat degradation is pervasive due to development and other land uses, and FERC-licensed hydroelectric projects have blocked some spawning areas. Coho salmon populations in the lower Columbia River have been heavily influenced by extensive hatchery program releases. While those releases represent a threat to the genetic, ecological, and behavioral diversity of the ESU, some of the hatchery-origin stocks at present also protect a substantial portion of the ESU's remaining genetic resources.

3.2.3.2.16 Columbia River Chum Salmon ESU

Background

The Columbia River Chum Salmon ESU includes all naturally spawned populations of chum salmon in the Columbia River and its tributaries, as well as three artificial propagation programs. There were 16 historical populations in three major population groups in Oregon and Washington between the mouth of the Columbia River and the Cascade crest. Substantial spawning now occurs for two of the historical populations, meaning that 88 percent of the historical populations are extirpated or nearly so. Because chum salmon spend only a short time in natal streams before emigration, the loss or impairment of rearing habitat in the Columbia River estuary may have been an important factor in their decline. Another important factor was the inundation of historical spawning areas by Bonneville Reservoir. The Columbia River Chum Salmon ESU was listed as threatened under the ESA in 2005 (70 Fed. Reg. 37160, June 28, 2005).

Current Status and Recent Trends

Most of the populations in this ESU are extirpated or nearly so. Estimates of abundance and trends are available only for the Grays River and Lower Gorge populations. Abundance for these two populations was low, but trends were relatively stable in the decade beginning 1990. Since then the populations increased for several years before declining.

Limiting Factors

Human effects and limiting factors for the Columbia River Chum Salmon ESU have come from multiple sources, including mainstem and tributary hydropower development and loss or impairment of tributary and estuarine habitat.

3.2.3.2.17 Snake River Sockeye Salmon ESU

Background

The Snake River Sockeye Salmon ESU includes all anadromous and residual sockeye salmon from the Snake River basin, Idaho, as well as artificially propagated sockeye salmon from the Redfish Lake Captive Broodstock Program. Sockeye salmon were historically numerous in many areas of the Snake River basin prior to the European westward expansion. However, intense commercial harvest of sockeye salmon along with other salmon species beginning in the mid-1880s, the existence of Sunbeam Dam as a migration barrier between 1910 and the early 1930s, the eradication of sockeye salmon from Sawtooth Valley lakes in the 1950s and 1960s, the development of mainstem hydropower projects on the lower Snake and Columbia Rivers in the 1970s and 1980s, and poor ocean conditions in 1977 through the late 1990s probably combined to reduce the stock to a very small remnant population. Snake River sockeye salmon are now found predominantly in a captive broodstock program associated with Redfish Lake and the other Sawtooth Valley lakes. The Snake River Sockeye Salmon ESU was listed as endangered in 1991, and the listing was reaffirmed in 2005 (70 Fed. Reg. 37160, June 28, 2005). At the time of listing, one, one, and zero fish had returned to Redfish Lake in the three preceding years, respectively.

Current Status and Recent Trends

This species has a very high risk of extinction. Between 1991 and 1998, all 16 of the natural-origin adult sockeye salmon that returned to the weir at Redfish Lake were incorporated into the captive broodstock program. The program used multiple rearing sites to minimize chances of catastrophic loss of broodstock and produced several hundred thousand eggs and juveniles, as well as several hundred adults, for release into the wild. Between 1999 and 2007, more that 355 adults returned from the ocean from captive broodstock releases—almost 20 times the number of natural-origin fish that returned in the 1990s. In addition, about 1,000 adults returned in 2008 and more than 800 adults in 2009. The captive broodstock hatchery program has been successful in its goals of preserving important lineages of Redfish Lake sockeye salmon for genetic variability and in preventing extinction in the near term. The Stanley Basin Sockeye Technical Oversight Committee has determined that the next step toward meeting the goal of amplifying the natural-origin population is to increase the number of smolts released.

Limiting Factors and Threats

By the time Snake River sockeye salmon were listed in 1991, the species had declined to the point that there was no longer a self-sustaining, naturally spawning anadromous sockeye salmon population. This has been the largest factor limiting the recovery of this ESU, important in terms of risks due to catastrophic loss and genetic diversity. It is not yet clear whether the existing population retains sufficient genetic diversity to adapt successfully to the range of variable conditions that occur within its natural habitat. However, unpublished data from geneticists for the Stanley Basin Sockeye Technical Oversight Committee indicate that the captive broodstock has similar levels of diversity as other sockeye salmon populations in the Pacific Northwest and that the hatchery program has been able to maintain rare alleles in the population over time.

3.2.4 Other Fish Species that Have a Relationship with Salmon and/or Steelhead

This section includes native Columbia River basin fish species that have a relationship with salmon and steelhead either as prey, predators, or competitors (Table 3-9). Federally listed fish include Oregon chub, eulachon, and green sturgeon. Species discussed in this section are organized first by listing status (endangered and then threatened) followed by the remaining species in alphabetical order.

This section is organized by species, which includes four sections: background information, current status and trends, limiting factors and threats, and subject species interaction with salmon and steelhead. Information for these discussions was taken from best available literature, and no new species-related studies were conducted as part of this EIS. Use of the terms “limiting factors” and “threats” varied among authors; the terms are represented in these discussions as presented by each author.

TABLE 3-9. RANGE AND STATUS OF OTHER MARINE AND FRESHWATER SPECIES THAT MAY INTERACT WITH SALMON AND STEELHEAD IN THE ANALYSIS AREA.

SPECIES	RANGE IN COLUMBIA RIVER BASIN	FEDERAL/STATE LISTING STATUS	TYPE OF INTERACTION WITH SALMON AND STEELHEAD
Oregon chub *(Oregonichthys crameri)*	Willamette Valley	Federally endangered, Oregon State sensitive species	Freshwater prey of salmon and steelhead
Bull trout *(Salvelinus confluentus)*	Throughout the Columbia River basin	Federally threatened, Oregon State sensitive species	Predator of salmon and steelhead
Eulachon *(Thaleichthys pacificus)*	Lower Columbia River and tributaries	Southern DPS federally threatened, Washington State species of concern	Freshwater prey of salmon and steelhead
Green Sturgeon (*Acipenser medirostris*)	Columbia River estuary	Southern DPS federally threatened	By-catch in salmon fisheries
Coastal Cutthroat trout (*Oncorynchus clarki clarki)*	Throughout the Columbia River basin	Not listed but southwestern Washington and Lower Columbia River DPS a Federal species of concern, coastal cutthroat trout an Oregon State sensitive species	Similar habitat and prey requirements, but interspecific competition avoided by altering behavior and life history traits, predators of salmon and steelhead young, coastal cutthroat trout can hybridize with steelhead and rainbow trout
Lake chub (*Couseius plumbeus*)	Lakes and tributaries of Okanagan County	Not federally listed, Washington State species of concern	Freshwater prey of salmon and steelhead
Lamprey (Pacific [*Lampetra tridentata*], river [*L. ayresi],* and brook [*L. richardsoni*])	All accessible reaches in the Columbia River basin	Not listed. Pacific lamprey and river lamprey are Federal species of concern, river lamprey is a Washington State candidate species, Pacific lamprey is an Oregon State sensitive species and an Idaho State endangered species	Freshwater predator species of salmon and steelhead, juvenile lamprey prey of young salmon and steelhead
Leopard dace *(Rhinichthys falcatus)*	Columbia River basin	Not federally listed, Washington State candidate species	Freshwater prey of salmon and steelhead
Margined sculpin *(Cottus marginatus)*	Tucannon, Walla Walla and Umatilla River basins	Federal species of concern, Washington State sensitive species	Prey on eggs and young of salmon and steelhead
Mountain sucker *(Catostomus platyrhynchus)*	Middle-Columbia and Upper Columbia River watersheds	Not federally listed, Washington State candidate species	Occurs in similar freshwater habitats, but is a bottom feeder and has a different ecological niche

TABLE 3-9. RANGE AND STATUS OF OTHER MARINE AND FRESHWATER SPECIES THAT MAY INTERACT WITH SALMON AND STEELHEAD IN THE ANALYSIS AREA (CONTINUED).

SPECIES	RANGE IN COLUMBIA RIVER BASIN	FEDERAL/STATE LISTING STATUS	TYPE OF INTERACTION WITH SALMON AND STEELHEAD
Northern pikeminnow *(Ptychocheilus oregonensis)*	Throughout the Columbia River basin	Not listed	Freshwater predator species
Pygmy whitefish (*Prosopium coulteri)*	Cle Elum and Kachess Lakes in Yakima basin; Priest Lake	Federal species of concern, Washington State sensitive species	Freshwater prey of salmon and steelhead
Rainbow trout (*Oncorhynchus mykiss)*	Throughout the Columbia River basin	Not listed	Hatchery-origin fish are competitors, also feed on salmon and steelhead, can hybridize with cutthroat trout (both coastal and westslope) and steelhead
Umatilla dace (*Rhinichthys Umatilla)*	Columbia, Kootenay, Slocan, and Snake Rivers	Not federally listed, Washington State candidate species	Freshwater prey of salmon and steelhead
Westslope cutthroat trout *(Oncorhynchus clarki lewisi)*	Upper Columbia River basin and Snake River	Federal species of concern, Idaho State threatened species, Oregon State sensitive species	Similar habitat requirements, can feed on salmon and steelhead (rare occurrences), can hybridize with rainbow trout and steelhead

Sources: USFWS, WDFW, ODFW, IDFG classifications

3.2.4.1 Oregon Chub

3.2.4.1.1 Background

The Oregon chub is a resident minnow (average of 3.5 inches) that is endemic to the Willamette River drainage of western Oregon. The species is found in the Santiam, Middle Fork Willamette, Coast Fork Willamette, and McKenzie Rivers, as well as several tributaries to the Willamette River downstream of the Coast Fork/Middle Fork confluence. Their habitat is off-channel and slack water areas (such as beaver ponds, oxbows, stable backwater soughs, and flooded marshes), which typically have little or no water flow, silty and organic substrate, and aquatic vegetation and cover for hiding and spawning. The species occurs in aquatic habitats where the average water depth is less than 6 feet and where summer water temperatures exceed 61°F (74 Fed. Reg. 10413, March 10, 2009).

The Oregon chub has a typical lifespan of up to 3 years, although some individuals can live up to 9 years. Spawning occurs from April to September in dense aquatic vegetation. The diet of juvenile and adult Oregon chub consists of rotifers (very small worms), copepods (small animals with a hard shell, antennae, and jointed legs), cladocerans (commonly referred to as water fleas), and chironobid (minute mosquito-like flies) larvae. Outside of spawning, the species is social and non-aggressive with fish of similar size (USFWS 1998a).

3.2.4.1.2 Current Status and Trends

The Oregon chub is listed as endangered under the ESA and is an Oregon State sensitive species (Table 3-9). In 2009, the USFWS proposed to reclassify the Oregon chub from endangered to threatened (74 Fed. Reg., 22870, May 15, 2009). To date, however, the chub are still listed as endangered. Currently, there are 36 Oregon chub populations; 19 of these populations have more than 500 adults each. Sixteen of these populations are stable or increasing (74 Fed. Reg., May 15, 2009). On March 10, 2010, the USFWS published a final rule regarding designation of critical habitat for the Oregon chub (75 Fed. Reg. 11010, March 10, 2010, which was later corrected for typographical errors (75 Fed. Reg. 18107, April 9, 2010). Critical habitat for Oregon chub is located in Polk, Benton, Linn, Marion, and Lane Counties.

3.2.4.1.3 Limiting Factors and Threats

The USFWS (2010a) indicates that construction of flood control projects and dams has changed the Willamette River significantly and has prevented the formation of Oregon chub habitat (off-channel slack waters) and natural dispersal of the species. Other factors responsible for the decline of the Oregon chub include habitat alteration and/or loss; accidental chemical spills; runoff from herbicide or pesticide application on farms and timberlands or along roadways, railways, and power line rights-of-way; application of rotenone to manage sport fisheries; unauthorized water withdrawals; diversions or fill and removal activities; sedimentation resulting from timber harvesting in the watershed; and, possibly, demographic risks that result from a fragmented distribution of small, isolated populations.

The introduction of non-native fish and amphibians continues to threaten existing populations of Oregon chub; many non-native species occur in the same habitat type as the Oregon chub and eat small fish, including the Oregon chub (USFWS 2010a). Introduction of non-native fish species in areas of connected floodplains has also impacted the occurrence of Oregon chub, which more frequently occurs in isolated habitats with fewer non-native fish (Scheerer 2002).

3.2.4.1.4 Interaction with Salmon and Steelhead

Oregon chub, salmon, and steelhead all occur in the Willamette River basin. When rearing in freshwater streams, Oregon chub, salmon, and steelhead feed on terrestrial and aquatic insects, amphipods, and other crustaceans. The small size of Oregon chub makes them vulnerable to predation by salmon and steelhead. In addition, there is potential for overlap among prey resources among Oregon chub, salmon, and steelhead. However, Oregon chub have coevolved with salmon and steelhead over time, and the different species have likely developed different ecological niches when occurring in the same locations, such as relative abundance, size, spawning, and microhabitat preferences (Hearn 1987; Essington et al. 2000). Inter-specific competition between Oregon chub, salmon, and steelhead has not been identified as a factor impacting Oregon chub (USFWS 2008a). Thus, the most likely interaction between Oregon chub and salmon and steelhead is predation of Oregon chub by adult salmon and steelhead.

3.2.4.2 Bull Trout

3.2.4.2.1 Background

The bull trout is known to occur from the Yukon River in the Northwest Territories of Canada south to northern Nevada. Within the analysis area, bull trout occur throughout the Columbia River basin. The bull trout is a char, which includes several fish species of the genus *Salvelinus* that are related to trout and salmon (such as brook trout, lake trout, arctic char, and Dolly Varden). These species are adapted to living in colder water than other salmon species. Bull trout exhibit two forms: resident and migratory. Resident bull trout spend their entire lives in the same stream, while migratory bull trout spend most of their time in lakes or reservoirs (adfluvial), large rivers (fluvial), or the ocean (anadromous), but they spawn in headwater or tributary streams. Resident and juvenile bull trout size range up to 10 inches long while migratory forms may range up to 35 inches (Natural Resources Conservation Service [NRCS] 2006; USFWS 2010b).

Bull trout reach sexual maturity at between 4 and 7 years of age and are known to live as long as 12 years. Bull trout occur in streams with abundant cover, such as cut banks, root wads, debris jams, and boulders), and clean gravel and cobble beds. Adult bull trout spawn from August to November as water temperatures decrease. Their eggs require long gravel resident times (100 to 145 days) dependent on water temperatures. Bull trout may spawn every year or every other year. Both juvenile and adult bull trout tend to remain near stream bottoms and are closely associated with the bottom substrate, submerged wood, and undercut banks. Adults use large cobble and boulder substrates, larger pools, and areas with accumulations of large wood. A complex habitat characterized by a variety of pools, riffles, and water depths and velocities is important to meet the diverse needs of all bull trout life stages (NRCS 2006; USFWS 2010b).

Young bull trout feed on aquatic invertebrates, including mayflies, stone flies, caddisflies, and beetles. As they grow larger, they begin to feed heavily upon other fish, including various trout and salmon species, minnows, suckers, dace, whitefish, and sculpin. Large adults have also been known to eat frogs, snakes, mice, and waterfowl (NRCS 2006).

3.2.4.2.2 Current Status and Trends

The bull trout is listed as a threatened species under the ESA (64 Fed. Reg. 58909, November 1, 1999) and is an Oregon State sensitive species (Table 3-9). In 2002, USFWS published a draft recovery plan for bull trout that included the Columbia River basin and areas identified as critical habitat for bull trout (67 Fed. Reg. 71439, November 22, 2002). Critical habitat was then finalized in 2004 (69 Fed. Reg. 5999, October 6, 2004), revised in 2005 (70 Fed. Reg. 56212, September 26, 2005), and is currently proposed for additional revisions with recommended bull trout recovery units (75 Fed. Reg. 2270, January 13, 2010). Historically, bull trout were found in about 60 percent of the Columbia River basin. They now occur in less than half their historic range, and they have been eliminated from the mainstem of most large rivers. Populations remain in portions of Oregon, Washington, Idaho, Montana, and Nevada (USFWS 1998b, 2010b).

Twenty-two recovery units support bull trout listed in the Columbia River basin, 13 of which are potentially affected by hatchery production of salmon and steelhead. Table 3-10 provides a description of each of the bull trout recovery units that are potentially affected by Columbia River anadromous fish hatchery program operations. Recovery units are specific geographic areas that provide habitat for a local population of bull trout.

3.2.4.2.3 Limiting Factors and Threats

Both the distribution and abundance of bull trout have declined. Causes of the decline have been attributed to degraded or fragmented aquatic habitats throughout its historical range and the introduction of non-native species. Bull trout habitat degradation has occurred from land use actions (timber harvest, road development, agriculture/livestock production, and urbanization) and instream water uses (which have blocked or restricted access to critical habitat). Temperature is a major factor influencing bull trout distribution, especially for spawning and early rearing. Bull trout require temperatures below 48°F for spawning initiation, 39°F for optimal egg incubation, and 50°F for juvenile rearing. Optional adult rearing temperature ranges from 50 to 54°F. Other limiting factors leading to population declines include degradation of complex structural habitat, loss of refugia, altered stream flow regimes, sedimentation of spawning grounds, red scouring, loss of habitat connectivity, harvest, and loss of juvenile salmon prey. Although hybridization with the introduced brook trout can dilute the genetic integrity of bull trout populations; most hybrid offspring are sterile, which alternatively depresses local populations through unsuccessful reproductive efforts (NRCS 2006; USFWS 2008b, 2010b).

TABLE 3-10. COLUMBIA RIVER BASIN BULL TROUT RECOVERY UNITS THAT MAY BE AFFECTED BY COLUMBIA RIVER BASIN ANADROMOUS FISH HATCHERY FACILITIES.

RECOVERY UNIT	DESCRIPTION OF RECOVERY UNIT
Willamette River Basin	The Willamette River Basin Recovery Unit encompasses the entire Willamette River basin and part or all of ten counties in northwestern Oregon. Two core areas were defined: Upper Willamette River and Clackamas River.
Lower Columbia River basin	The Lower Columbia River Basin Recovery Unit includes the Lewis River and Klickitat River core areas in Washington. The Lewis River Core Area consists of the mainstem Lewis River and tributaries downstream to the confluence with the Columbia River, with the exclusion of the East Fork of the Lewis River. The Klickitat River Core Area includes the Klickitat River and all tributaries downstream to the confluence with the Columbia River.
Hood River	The Hood River Recovery Unit includes the Hood and Sandy River basins, which are located within northern Oregon. The Hood River Recovery Unit Team identified one core area containing two bull trout populations (known as the Clear Branch and Hood River local populations) that will be the center of recovery efforts.
Deschutes River	The Deschutes Recovery Unit encompasses the entire Deschutes River basin and its tributaries, except for Odell Lake, which is its' own recovery unit. It is located in central Oregon. The primary tributaries include the Little Deschutes, Crooked, Metolius, Warm Springs, and White Rivers, as well as Shitike and Trout Creeks.
John Day River	The John Day River Recovery Unit contains the entire John Day basin, including the John Day mainstem and the North, Middle, and South forks of the John Day River.
Umatilla/Walla Walla	The Umatilla-Walla Walla Recovery Unit is located in northeastern Oregon and southeastern Washington. The unit includes streams extending across portions of Umatilla, Union, and Wallowa Counties in Oregon, as well as Walla Walla and Columbia Counties in Washington.
Grande Ronde	The Grande Ronde River Recovery Unit is located in northeast Oregon and southeast Washington and encompasses 4,632 miles of streams in the Grande Ronde River basin. This unit includes two main core areas: the Grande Ronde River and the Little Minam River.
Imnaha-Snake River	The Imnaha-Snake River Recovery Unit encompasses the entire Imnaha River sub-basin located in northeastern Oregon. Three core areas identified for the purpose of bull trout recovery are the Imnaha River, Sheep Creek, and Granite Creek.
Clearwater River	The Clearwater River Recovery Unit lies in north central Idaho and extends from the Idaho/Montana border near Missoula, Montana, to the Idaho/Washington border at Lewiston, Idaho. Major tributaries in the recovery unit include the Clearwater, North Fork Clearwater, Middle Fork Clearwater, South Fork Clearwater, Lochsa, and Selway Rivers.
Salmon River	The Salmon River Recovery Unit encompasses the entire Salmon River basin. Major tributaries to the Salmon River include Yankee Fork Salmon River, East Fork Salmon River, Lemhi River, Pahsimeroi River, North Fork Salmon River, Panther Creek, Middle Fork Salmon River, South Fork Salmon River and Little Salmon River.
Middle Columbia River	The Middle Columbia River Unit includes the Yakima River Basin in south central Washington to its confluence with the Columbia River near Richland, Washington. Thirteen local populations of bull trout occur in this unit.
Upper Columbia	The Upper Columbia River Recovery Unit Team identified three core areas including the mainstem and tributaries of the Wenatchee, Entiat, and Methow Rivers.
Snake River Basin	The Snake River Basin Recovery unit encompasses selected tributaries of the Snake River from Lower Monumental Dam (River Mile [RM] 42) upstream to the mouth of the Grande Ronde River (RM 169). There are two core areas in this recovery unit: the Tucannon River, which contains eight local populations; and Asotin Creek, which contains two local populations.

3.2.4.2.4 Interaction with Salmon and Steelhead

Bull trout, salmon, and steelhead can occur in similar aquatic habitat types; however, bull trout are more sensitive than salmon and steelhead to increased water temperatures, poor water quality, habitat conditions, and low flow conditions; thus, they more often occur in higher elevations with less disturbed habitats. Bull trout also require colder water temperatures than other salmon and trout; therefore, bull trout are more likely to occur in headwater streams (where a stream begins – its origin) where temperatures tend to be cooler . Because bull trout feed primarily on fish (referred to as piscivorous) as subadults and adults, they can be a substantial predator of young salmon and steelhead. Juvenile bull trout feed on similar prey as salmon and steelhead (NRCS 2006; USFWS 2008b, 2010b).

3.2.4.3 Eulachon

3.2.4.3.1 Background

The eulachon (also known as Columbia River smelt, candlefish, or hooligan) is a small, 9-inch anadromous ocean fish that occurs in the eastern North Pacific Ocean. The southern eulachon DPS consists of populations spawning in rivers from the Nass River in British Columbia south to the Mad River in California. The southern eulachon DPS includes core populations in the Columbia and Fraser Rivers and may have historically included the Klamath River. This DPS is listed as a threatened species under the ESA throughout its range due to habitat loss and degradation; hydroelectric dams blocking access to historical eulachon spawning grounds and affecting the quality of spawning substrates through flow management, altered delivery of coarse sediments, and siltation; dredging activities; and global climate change where warming trends may have altered prey, spawning, and rearing success (74 Fed. Reg. 10857, March 12, 2009).

In addition to regular returns to mainstem Columbia River spawning areas (up to Bonneville Dam), eulachon spawn in Skamokawa Creek, as well as the Cowlitz, Grays, Elochoman, Kalama, Lewis, and Sandy Rivers (NMFS 2010). The Columbia River and its tributaries are believed to support the largest eulachon run in the world (NMFS 2008).

Eulachon spend most of their lives in salt water, but return to fresh water to spawn at 3 to 5 years of age. Adult eulachon enter fresh water from December to March, and the young migrate downstream shortly after hatching. Eulachon then rear in near-shore marine areas from shallow to moderate depths. Larval and juvenile eulachon are planktivorous (feed on small plants and animals that float in the water column), while adult eulachon feed on euphausiids (shrimp-like marine invertebrate animals) and copepods (NMFS 2010).

As eulachon mature, they are eaten by many predators including other fish, marine mammals, ducks, and birds. Adult spawning eulachon are also harvested. Columbia-River-caught eulachon are sold for bait and as fresh food fish. Sport fishing for eulachon primarily occurs in tributaries, although the mainstem is also open for sport fishing. Native Americans have fished for eulachon for centuries. Currently, the Yakama Nation harvest eulachon for subsistence purposes.

3.2.4.3.2 Current Status and Trends

The southern eulachon DPS is a listed as a threatened species under the ESA and is a Washington State species of concern (Table 3-9). Based on commercial catch data, Columbia River eulachon populations declined dramatically in the 1990s before increasing between 2001 and 2003. However, the returns dropped slightly in 2004 and then dropped dramatically in 2005, which is reflected in both the commercial landings and catch per unit effort data collected from 2001 to 2007. The decline in the early 1990s appears to coincide with a decline of eulachon in British Columbia, suggesting that a common cause, such as changing ocean conditions (see below), was responsible for declines (NMFS 2010).

3.2.4.3.3 Limiting Factors and Threats

NMFS (2008 and 75 Fed. Reg. 13012, March 18, 2010) suggests that eulachon may be unable to tolerate the relatively recent rapid climate changes in both the ocean and freshwater environment. The eulachon is a cold-water species adapted to feed on a northern suite of copepods (small zooplankton) in the ocean during the critical transition period from larvae to juvenile. Its recent recruitment (incoming young for future generations) failure may be traced to mortality during this critical period. Climate change may contribute to a mismatch between eulachon life history and their primary prey species. Other limiting factors include commercial harvest of eulachon, bycatch of eulachon in commercial fisheries, and the potential for natural or manmade events to impact its habitat (75 Fed. Reg. 13012, March 18, 2010). In addition, the historical hydropower development on the Columbia River decreased the long-term spawning habitat available for eulachon. Their spawning habitat can also be impacted from dredging by making the substrate unstable for incubation of eulachon eggs. Eulachon are considered sensitive to pollutants in fresh water. Eulachon are weak swimmers and concentrate in low-velocity waters making them especially vulnerable to predators (NMFS 2010).

3.2.4.3.4 Interaction with Salmon and Steelhead

Eulachon are important in the food chain as a prey species of salmon and steelhead. Newly hatched and juvenile eulachon are food for a variety of larger marine fish species including salmon and steelhead. Spawned-out and decomposing eulachon also contribute to the nutrient cycle of freshwater streams (NMFS 2010).

3.2.4.4 Green Sturgeon

3.2.4.4.1 Background

The green sturgeon is a long-lived, slow-growing anadromous fish (average length of 50 to 55 inches) that ranges from the Bering Sea, Alaska to Ensenada, Mexico. A NMFS BRT (2005) determined that the species consists of a northern DPS and southern DPS. The southern green sturgeon DPS is listed as a threatened species under the ESA throughout its range (71 Fed. Reg. 17757, April 7, 2006) (Table 3-9), and critical habitat for this DPS was identified (74 Fed. Reg. 52300, October 9, 2009); the critical habitat includes the Columbia River estuary.

Based on genetic evidence, the southern DPS consists of populations originating from coastal watersheds south of the Eel River and the Central Valley of California. Tracking data, genetic mixed stock analysis, and direct observation indicate that the southern green sturgeon DPS occurs in freshwater rivers and coastal estuaries and bays along the west coast of North America, including estuaries of Oregon and Washington and the lower Columbia River (74 Fed. Reg. 52300, October 9, 2009). The only known spawning population for the southern green sturgeon DPS is the Sacramento River. Outside of their natal system, subadult and adult southern green sturgeon DPS migrate to the lower Columbia River estuary for feeding and optimization of growth (NMFS 2009). The DPS is known to aggregate in the Columbia River estuary and Washington estuaries in the late summer (NMFS 2009). During this period, the Columbia River estuary is believed to have the largest concentration of southern DPS green sturgeon.

Green sturgeon are believed to spawn every 2 to 4 years. Beginning in late February, adult green sturgeon migrate from the ocean into fresh water to begin spawning migration, which occurs from March to July. Eggs and larvae develop in fresh water, and juvenile green sturgeon rear and feed in both fresh and estuarine waters from 1 to 4 years prior to dispersing into marine waters as subadults. The subadult male and females spend at least 6 to 10 years, respectively, at sea before reaching reproductive maturity and returning to fresh water to spawn for the first time. Adults spend as many as 2 to 4 years at sea between spawning events and they spawn for multiple times (71 Fed. Reg. 17757, April 7, 2006). Green sturgeon have been documented as living up to 42 years of age (Nakamoto and Kisanuki 1995), though some fish biologists believe they may have a maximum life span of 60 to 70 years (NMFS 2005). Green sturgeon are known to feed on benthic invertebrates including shrimp, mollusks, amphipods, as well as small fish, although salmon and steelhead have not been documented as part of their diet (NMFS 2005, 2009).

3.2.4.4.2 Current Status and Trends

The southern green sturgeon DPS is a threatened species under the ESA (Table 3-9). No reliable data on current population size exist, and data on population trends are lacking. The rationale for the southern green sturgeon DPS listing is that 1) the majority of spawning adults are concentrated into one spawning river (i.e., Sacramento River), thus increasing their risk of extirpation due to catastrophic events; 2) information exists that threats to this species are severe and have not been adequately addressed by conservation measures currently in place; 3) there is evidence of lost spawning habitat in the Sacramento River; and 4) fishery-independent data exhibit a negative trend in juvenile green sturgeon abundance (71 Fed. Reg. 17757, April 7, 2006).

3.2.4.4.3 Limiting Factors and Threats

The principal factor in the decline of the southern green sturgeon DPS is the reduction of the southern DPS spawning area to a limited section of the Sacramento River that supports this habitat. This remains a limiting factor due to the increased risk of extirpation from catastrophic events. Other limiting factors and threats include insufficient freshwater flow rates in spawning areas, contaminants (e.g., pesticides), bycatch of green sturgeon in fisheries, potential poaching (e.g., for caviar), entrainment by water projects, influence of exotic species, small population size, impassable barriers, and elevated water temperatures (71 Fed. Reg. 17757, April 7, 2006).

3.2.4.4.4 Interaction with Salmon and Steelhead

Green sturgeon occur in similar estuary habitat as salmon and steelhead; however, green sturgeon are considered bottom-dwelling fish that feed on crustaceans and benthic invertebrates on the bottom of estuaries and the ocean. Thus, interactions among green sturgeon and salmon and steelhead are limited to the Columbia River estuary and Pacific Ocean marine waters. The primary interaction between green sturgeon and salmon and steelhead is green sturgeon bycatch in salmon and steelhead fisheries (NMFS 2009).

3.2.4.5 Coastal Cutthroat Trout

3.2.4.5.1 Background

The cutthroat trout is native to western North America and has evolved through geographic isolation into 10 subspecies. Of these subspecies, both the coastal cutthroat trout (*O. clarki*

clarki) and westslope cutthroat trout (*O. clarki lewisi*) are two subspecies with the potential to interact with salmon and steelhead. The coastal cutthroat is discussed below, and the westslope cutthroat is discussed in Section 3.2.4.15, Westslope Cutthroat Trout.

The native range of coastal cutthroat trout extends from as far north as Prince William Sound in Alaska south to the Eel River of California. The southwestern Washington/lower Columbia River DPS of the coastal cutthroat trout occurs in western Oregon and Washington, including the Columbia River basin. Within the analysis area, the geographic range of the DPS is from the Columbia River estuary upstream to the mouth of the Klickitat River. This DPS was proposed for listing and reviewed by the USFWS in 1999, 2002, 2005, and 2008. On February 25, 2010, the USFWS withdrew its proposal to list the DPS as threatened under the ESA citing that threats to the coastal cutthroat trout as analyzed under the five listing factors described in section 4(a)(1) of the ESA are not likely to endanger the DPS now or into the foreseeable future (USFWS 2010c).

Four general life-history forms of coastal cutthroat trout are recognized: 1) nonmigratory coastal cutthroat trout that occur in small streams and headwater tributaries and exhibit little instream movement, 2) fluvial fresh water-migratory coastal cutthroat trout that migrate entirely within fresh water, 3) adfluvial coastal cutthroat trout migrate between freshwater spawning tributaries and lakes, and 4) saltwater-migratory coastal cutthroat trout (also known as sea-run trout) that migrate between the ocean or estuary for usually less than 1 year before returning to fresh water. The relationship among these four populations is unknown. The average length of coastal cutthroat trout ranges from 6 to 20 inches, with smaller resident forms (NMFS 1999).

Cutthroat trout typically spawn from December through June, with peak spawning in February (ODFW 1997). Most anadromous coastal cutthroat trout rear in streams for 2 to 3 years before emigrating to salt water. Anadromous coastal cutthroat trout typically spawn in upper tributary areas where the emerging fry have little competition from salmon and steelhead. Unlike other anadromous salmon and steelhead that spend multiple years feeding far out at sea, coastal cutthroat trout prefer to remain within a few miles of the coast, with some overwintering in freshwater streams and feeding at sea only during the warmer months. In rivers with extensive estuary systems, coastal cutthroat trout may move to the intertidal environment to feed. They may also move upriver or out to sea on feeding migrations. Their lifespan is typically 6 to 8 years, and they may spawn more than once (ODFW 2005a).

Coastal cutthroat trout feed on aquatic and terrestrial invertebrates, primarily insects (Romero 2004). As they mature into adults, however, they will prey on fish in a variety of freshwater and estuarine habitats including salmon and steelhead (NMFS 1999).

3.2.4.5.2 Current Status and Trends

The coastal cutthroat trout southwestern Washington and Lower Columbia River DPS is a Federal species of concern and an Oregon State sensitive species (Table 3-9). The southwestern Washington-lower Columbia River area historically supported highly productive coastal cutthroat trout populations, and nonmigratory coastal cutthroat trout were widespread. Populations appear to be currently stable, but they are believed to be lower in abundance than historical levels due to habitat loss and competition for food and habitat with introduced rainbow trout. Fluvial and adfluvial coastal cutthroat trout are believed to have healthy populations, although the status of some populations is unknown. Sea-run coastal cutthroat trout are believed to have undergone a substantial decline in population size, most likely due to unfavorable ocean conditions (ODFW 2005a).

3.2.4.5.3 Limiting Factors and Threats

Activities that have the potential to affect coastal cutthroat trout habitat include forest management practices, agriculture and livestock management, dams and barriers, urban and industrial development, mining, and estuary degradation (ODFW 2005a). Other impacts to anadromous coastal cutthroat trout include effects on genetics and fisheries from widespread use of hatchery-origin, sea-run cutthroat trout in coastal Oregon and lower Columbia River streams (ODFW 2005a). To decrease this latter impact, ODFW terminated hatchery-origin trout stocking in coastal and Columbia River streams inhabited with native sea-run cutthroat trout and placed restrictive angling regulations (ODFW 1997; USFWS 2009a). Predation also occurs from sea lions and harbor seals within the lower Columbia River (NMFS 1999) (Section 3.5.5, Marine Mammals).

3.2.4.5.4 Interaction with Salmon and Steelhead

NMFS (1999) reviewed the interactions of coastal cutthroat trout with other salmon species stating that coastal cutthroat trout are less affected by interspecific competition when in contact with salmon because coastal cutthroat trout have developed a variety of habitat-partitioning techniques and life histories that are different from other salmonids, which is believed to reduce the potential for hybridization. NMFS (1999) summarizes several studies demonstrating that, when in the presence of other salmonids, coastal cutthroat trout have altered their behavior and life history traits to avoid interspecific competition for the same food and resources. For example, their small size at maturity may give coastal cutthroat trout an adaptive advantage for using small streams for spawning and rearing and reduce interspecific competition with other anadromous spawning salmonids. Conversely, post-spawning coastal cutthroat trout or those on feeding migrations are larger than outmigrating juveniles of other Pacific salmon species, which allows coastal cutthroat trout to prey on these fish in a variety of freshwater and estuarine habitats (NMFS 1999).

Previous studies regarding the presence of coastal cutthroat trout and steelhead in the same stream locations have shown that these species have different behaviors (e.g., feeding on different prey) when sympatric (occupying the same or overlapping geographic areas without interbreeding), which can help in avoid and/or minimize interspecific competition (Pearcy et al. 1990). However, an additional important interaction with salmon and steelhead is hybridization of coastal cutthroat trout with steelhead and rainbow trout (NMFS 1999; Ostberg et al. 2004).

3.2.4.6 Lake Chub

3.2.4.6.1 Background

The freshwater lake chub has a wide range of distribution throughout much of Canada and the northern U.S. However, its distribution pertinent to the analysis area is limited to lakes and their tributaries in Okanagan County. The lake chub is a minnow (4 to 6 inches long) and bottom dweller most frequently found in shallow water of large lakes and rivers with a preference for clear water and gravel bottoms of glacial scour lakes and tributary rivers. Its habitat consists of clear and cool water, substrate composed of large sand or gravel, deep pools, presence of large woody debris, overstream vegetation, and absence of large species of predacious fishes (Roberge et al. 2002; Stasiak 2006).

Lake chub live to an average life span of 5 years. They spawn in the spring, usually April to May, when they move to shallow waters of rivers and streams that have rocky or gravelly bottoms. Prey of lake chub include insect larvae, mobile aquatic and terrestrial insects, freshwater shrimp, algae, zooplankton, and fish eggs. Large chub will also consume small fish (Roberge et al. 2002; Stasiak 2006).

3.2.4.6.2 Current Status and Trends

The lake chub is not a listed species under the ESA, but is a Washington State species of concern (Table 3-9). The lake chub is considered stable throughout most of the main portion of its range in Canada and in the north central U.S. and New England regions. However, some populations found in headwater streams and in areas of groundwater seepage are not as stable (Stasiak 2006).

3.2.4.6.3 Limiting Factors and Threats

The primary threats to lake chub include habitat alteration, declining water quality and quantity, and introduction of non-native fish species. Water development activities that alter natural flow regimes have led to habitat degradation and stream fragmentation. Non-native species negatively affect lake chub through the combined pressures of predation, competition, potential for new parasites and disease, and altering behavior components of the native fish assemblage (Stasiak 2006).

3.2.4.6.4 Interaction with Salmon and Steelhead

Stream-dwelling lake chub are vulnerable to predation from salmon and steelhead wherever the two species coexist (Stasiak 2006).

3.2.4.7 Lamprey

3.2.4.7.1 Background

Three lamprey species are native to the Columbia River basin: Pacific lamprey, river lamprey, and western brook lamprey. The Pacific lamprey (15 to 25 inches in length) is the most widely distributed lamprey species on the west coast of the U.S. and its range includes Japan, Russia, Alaska, Canada, U.S., and Mexico. The river lamprey (6 to 28 inches in length) occurs from near Juneau, Alaska, south to San Francisco Bay, California. The western brook lamprey (4 to 7 inches in length) is widespread on the West Coast, occurring from Alaska south to California (USFWS 2004). All three species occur in the Columbia River basin.

The Pacific and river lamprey are both anadromous and parasitic species, and the western brook lamprey is non-anadromous and nonparasitic. After spending 1 to 3 years in the marine environment, adult Pacific and river lamprey cease feeding and migrate to fresh water between February and June. They are believed to overwinter and remain in freshwater habitat for about 1 year before spawning. Pacific lamprey spawning occurs between March and July. Young eventually move downstream, reaching the ocean between late fall and spring where they mature into adults. Very little is known about river lamprey. They are believed to spawn from April to May in California and likely have a similar life history as Pacific lamprey. For western brook lamprey, young (referred to as ammocoetes), feed mostly on diatoms and other microscopic plant and animal matter. When mature, in 3 to 5 years, western brook lamprey spawn from mid-April to May and die shortly thereafter (Confederated Tribes of the Umatilla Indian Reservation 2004; USFWS 2004, 2009b).

Young Pacific and river lamprey are filter feeders. As they mature and move over larger areas, they feed on bottom fauna and fish. As adults, Pacific and river lampreys attach themselves to the side of fish (including salmon and steelhead) and whales and feed on their skin and muscles. In comparison, adult western brook lamprey do not eat. They live only a few months for breeding purposes and may shrink up to 20 percent in size as nonfeeding adults (USFWS 2004, 2008c; ODFW 2005b).

3.2.4.7.2 Current Status and Trends

The Pacific lamprey and the river lamprey are Federal species of concern. The river lamprey is also a Washington candidate species, and the Pacific lamprey is an Oregon State sensitive species and an Idaho State endangered species (Table 3-9). Although lamprey were believed to have distributions similar to salmon, recent data indicate that their distribution has been reduced throughout the region. There is currently no commercial harvest allowed for lamprey, although tribal harvest occurs for Pacific lamprey.

Abundance of western brook lamprey appears to be maintaining, while Pacific lamprey are believed to be declining (Kostow 2002). Within the Columbia River basin, Pacific lamprey are believed to have declined to only a remnant of their population prior to human development, and river lamprey are considered to be at “dangerously low numbers” and not present at many historical sites they previously occupied (Kostow 2002). ODFW (2005b) reports declining western brook lamprey throughout its range in Oregon. Thus, all three species are believed to be declining in at least one area of their overall range (Kostow 2002; Butte County Association of Governments 2007; USFWS 2008c, 2009b).

3.2.4.7.3 Limiting Factors and Threats

Lamprey are susceptible to many of the same limiting factors and threats facing listed salmon and steelhead: barriers to passage, reduced access to spawning habitat, degradation of spawning and rearing areas, loss of emigrating juveniles to turbine entrainment, and the presence of non-indigenous predators (Kostow 2002; Columbia River Basin Lamprey Technical Workgroup 2010). Data suggest that lamprey in the Columbia River experience poor recruitment in the uppermost reaches of rivers where this fish historically has been captured (Moser and Close 2003).

3.2.4.7.4 Interaction with Salmon and Steelhead

Lamprey prey on a variety of fish and marine mammals (whales), including salmon. However, adult lamprey have been considered an important buffer for upstream migrating adult salmon from predation by seals and sea lions. As prey of seals and sea lions, lamprey are easier to capture than adult salmon; they have a higher caloric value per unit weight than salmonids, and their migration in schools provides fertile feeding patches for their predators. Additionally, lamprey are richer in fats compared to salmon and are, therefore, preferred prey of seals and sea lions over salmon and steelhead (Confederated Tribes of the Umatilla Indian Reservation 2004). Thus, while the primary interaction among lamprey and salmon and steelhead in the analysis area is the potential food source of salmon and steelhead for lamprey, this interaction may be mitigated by the presence of seals and sea lions preferably feeding on lamprey.

3.2.4.8 Leopard Dace

3.2.4.8.1 Background

The freshwater leopard dace is a small (2 to 5 inches in length) cyprinid (carps and minnows) freshwater fish that is restricted to the Columbia and Frasier River systems of the Cascade Mountains, as well as the Snake River basin below Shoshone Falls. Leopard dace inhabit slower and deeper water streams with clean substrates of rock, bounders, and cobble where water velocity is strong enough to prevent siltation from embedding interspaces (NatureServe Explorer 2010a; IDFG 2010a).

The life span of leopard dace is believed to be about 5 years. Leopard dace spawning occurs from May to August, dependent on location. Their eggs are adhesive and attach to gravel and stones. Young-of-the-year feed on aquatic insect larvae during June and July, switching to terrestrial insects in September. Adults also feed on aquatic insect larvae, algae, terrestrial insects, and earthworms (Roberge et al. 2002; FishBase 2010; Idaho Fisheries Society 2010; NatureServe Explorer 2010a).

3.2.4.8.2 Current Status and Trends

The leopard dace is not listed under the ESA but is a Washington State species of concern due to its limited distribution (Table 3-9). However, current status and trends are unknown.

3.2.4.8.3 Limiting Factors and Threats

Dace, in general, are threatened by reduced water flows, increasing water demands, and barriers to movement, which have isolated leopard dace populations. Historic land and water management practices have altered stream habitats, resulting in reduced flows and sedimentation. Introduction of non-native fish species has also impacted leopard dace populations by increased predation (IDFG 2010a).

3.2.4.8.4 Interaction with Salmon and Steelhead

Leopard dace, salmon, and steelhead occur in similar habitat types and feed on insects; thus, there is a potential for interspecific competition for prey. However, insects or other prey have not been identified as a limiting factor that has impacted leopard dace survival. Dace are known to be prey of salmon and steelhead (as well as bull trout), due to their small size; thus, the primary interaction between leopard dace and salmon and steelhead is predation.

3.2.4.9 Margined Sculpin

3.2.4.9.1 Background

The margined sculpin is a small (average length of 3 inches) freshwater sculpin that is currently found in the Columbia River basin from the Walla Walla River system in Washington to the Umatilla River system in Oregon. The margined sculpin has the most limited distribution of all freshwater sculpins (Lonzarich 1996). Within the analysis area, the margined sculpin occurs in the Tucannon and Walla Walla drainages. The species is primarily a pool dweller within streams and is normally found in cooler waters less than 68°F. Adults occur in deeper water than juveniles (WDFW 1998a).

Little is known about margined sculpin reproduction and life span. Under laboratory observation, gravid margined sculpin occur during May and June, and eggs are deposited under rocks. Young of the year appear in electrofishing samples in the fall. As a bottom feeder, its food preferences are unknown, although other species of sculpin feed on aquatic invertebrates, young fish (including salmon), and fish eggs (WDFW 1998a).

3.2.4.9.2 Current Status and Trends

The margined sculpin is a Federal species of concern and a Washington State sensitive species (Table 3-9). The margined sculpin has a limited distribution, and much of the stream habitat where it occurs has been degraded. The species has also been included in Washington's Priority

Species Program and has been identified for priority management and preservation (WDFW 1998a).

3.2.4.9.3 Limiting Factors and Threats

The primary threats to margined sculpin are agricultural practices (grazing, channelization, and chemical use), logging and associated roads, shoreline development including removal of native vegetation, chemical use and septic problems, and the margined sculpin's limited distribution. These human activities have resulted in reduced pool habitats, unstable banks, associated sedimentation of bottom substrate, and elevated stream temperatures (WDFW 1998a).

3.2.4.9.4 Interaction with Salmon and Steelhead

Margined sculpin are known to prey on salmon and steelhead eggs and young (WDFW 1998a). Sculpin are also prey of bull trout.

3.2.4.10 Mountain Sucker

3.2.4.10.1 Background

The freshwater mountain sucker occurs throughout large portions of Canada and the western U.S., including Washington, Oregon, Idaho, Montana, South Dakota, North Dakota, Wyoming, Utah, Colorado, and California. Within the analysis area, the mountain sucker occurs within the Middle-Columbia and Upper Columbia River watersheds. Mountain suckers are found primarily in small headwater streams, but they have also been collected in rivers, such as the Columbia River and its tributaries (Snake, Yakima, and Willamette Rivers). Within streams, mountain suckers are most common in low-gradient, mountain stream segments that consist of a mixture of riffles, pools, and runs. During the non-breeding period, mountain suckers are usually found in deep parts of streams with lower current velocities. Mountain suckers spawn in riffle habitats, and young of the year use shallow and low velocity habitats (Belica and Nibbelink 2006).

The mountain sucker is a small (6 to 8 inches) moderately long-lived sucker with a maximum age of 9 years (Belica and Nibbelink 2006). Spawning generally occurs between May and mid-August. The mountain sucker is a benthic feeder, browsing on stream bottoms for diatoms, algae, small invertebrates, and organic matter (Roberge et al. 2002; Belica and Nibbelink 2006).

3.2.4.10.2 Current Status and Trends

The mountain sucker is not a listed species under the ESA, but is a Washington State candidate species (Table 3-9). At the regional scale, several researches have commented on perceived declines in mountain sucker populations. However, there is insufficient monitoring of the mountain sucker to confirm population trends (Belica and Nibbelink 2006).

3.2.4.10.3 Limiting Factors and Threats

Limiting factors to mountain sucker are habitat isolation due to passage barriers and habitat degradation (such as sedimentation). Non-native fish also prey on the mountain sucker. Hybridization with other suckers is a concern in some areas (Belica and Nibbelink 2006).

3.2.4.10.4 Interaction with Salmon and Steelhead

Mountain suckers and salmon coexist in headwater streams. Due to their small size, mountain suckers can be prey of salmon and steelhead. Mountain sucker feeding behavior and diet is different than salmon and steelhead because mountain suckers primarily feed by scraping algae off rocks and consuming other diatoms and small invertebrates on stream bottoms (Belica and Nibbelink 2006), thus avoiding interspecific competition with native salmon and steelhead.

3.2.4.11 Northern Pikeminnow

3.2.4.11.1 Background

The northern pikeminnow is native to the Pacific slope of western North America from the Nass River in British Columbia south to Oregon (LCFRB 2004). The species has successfully adapted to a relatively large range of spawning and habitat conditions. The northern pikeminnow is considered a trophic generalist (able to feed on a wide variety of prey and food sources).

Northern pikeminnow are a long-lived, slow-growing freshwater fish species with a maximum age of 16 years and an average length of 23 inches. Spawning occurs in June and July within rivers and lake tributaries of the Columbia River basin, coastal areas, and Puget Sound. Newly-emerged larvae drift downriver during July where they reside within rivers and reservoirs throughout their lifespan. Northern pikeminnow are generally scavengers, and their diet varies from small insects to sculpins, minnows, and larger fish. Young feed on insects until they grow larger. Northern pikeminnow that are in the middle size range feed on plankton and small fish, such as salmonid fries and minnows. Large northern pikeminnow that live offshore feed only on fish. During the salmon spawning season, they also feed on eggs that are being deposited in redds (LCFRB 2004).

Adult northern pikeminnow preferred prey is the American shad (*Alosa sapidissima*) (a non-native fish species first observed in the Columbia River in 1876), but they also prey on other fish species, including perch, suckers, salmon, and steelhead. Increases in American shad are believed to help augment the overall abundance and productivity of northern pikeminnow (USGS 2009).

3.2.4.11.2 Current Status and Trends

The northern pikeminnow is not a listed species under the ESA (Table 3-9). Since 1990, a controlled harvest program within the Columbia River has been in place to decrease the northern pikeminnow's predatory effect on salmon and steelhead. Although over 2 million northern pikeminnow have been removed by controlled harvest, the population continues to have high productivity throughout the Columbia River basin. It is especially abundant in specific locations, such as the estuary to Bonneville and the following reservoirs: Bonneville, The Dalles, John Day, McNary, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite (LCFRB 2004).

3.2.4.11.3 Limiting Factors and Threats

Outside of the controlled harvest program, the northern pikeminnow population could be affected by competition for food and habitat from other species. Although the northern pikeminnow is the only native piscivorous fish (a fish species that preys on other fish) in Columbia River reservoirs, other non-native predatory fish species have been introduced into the Columbia River basin (e.g., walleye [*Sander vitreus*], smallmouth bass [*Micropterus dolomeui*], and channel catfish [*Ictalurus punctatus*]) (LCFRB 2004). Zimmerman (1999) examined diets of smallmouth bass, walleye, and northern pikeminnow and found that juvenile salmonids represented the majority of fish prey consumed by northern pikeminnow, whereas sculpins, minnows, suckers, trout, and perch were more commonly consumed by smallmouth bass and walleye. In a study conducted by Ward and Zimmerman (1999), there was no change in the number of smallmouth bass based on removal of northern pikeminnow. Thus, competition between the northern pikeminnow and non-native species is not likely a dominant force limiting northern pikeminnow populations and its predation on native fish. Predation of northern pikeminnow is also not considered a limiting factor on their populations (LCFRB 2004).

3.2.4.11.4 Interaction with Salmon and Steelhead

The northern pikeminnow is an important predator of juvenile salmon and steelhead within the Columbia River basin. An adult can feed on as many as 15 salmon or steelhead smolts in a single day while these prey move downstream to the Columbia River estuary (USGS 2009).

3.2.4.12 Pygmy Whitefish

3.2.4.12.1 Background

The pygmy whitefish is a small (5 to 6 inches in length) forage freshwater fish that occurs throughout western Canada, Southeast Alaska, Russia, Washington State (which represents the southern edge of their native range in North America), and Priest Lake, Idaho. The species occurs in deep waters of cool lakes and streams (moderate to swift currents) of mountainous regions and is believed to have a limited distribution within Washington. Pygmy whitefish are most frequently captured at depths from 23 to 300 feet and in water temperatures below 50°F. The species inhabits cold water with a narrow range of temperature requirements (WDFW 1998b).

Pygmy white fish are generally short-lived and grow slowly. Most pygmy whitefish live to be 3 years of age, although the oldest known pygmy whitefish is 9 years. Pygmy whitefish spawn from late summer to early winter and are believed to scatter their eggs over coarse gravel. Pygmy whitefish prey consists of crustaceans, aquatic insect larvae and pupae, fish eggs, and small mollusks (WDFW 1998b).

3.2.4.12.2 Current Status and Trends

Pygmy whitefish are a Federal species of concern and Washington State sensitive species (Table 3-9). Pygmy whitefish have been eliminated from 40 percent of their range in Washington. Because of their limited distribution and short life span, the species is vulnerable to population losses during poor recruitment years. The species is included in Washington State's Priority Species Program and has been identified for priority management and preservation (WDFW 1998b).

3.2.4.12.3 Limiting Factors and Threats

Water temperatures greater than 50°F and dissolved oxygen less than 5 mg/l in deep water zones may limit pygmy whitefish habitat. In addition, water quality degradation and siltation that occur from forest management practices and increased development may impact stream dwelling pygmy whitefish. Construction of bridges and other in-stream structures near pygmy whitefish spawning areas may cause abandonment of spawning areas or disruption of spawning migration. Other threats are the use of piscicides (chemical substance poisonous to fish) and exotic fish introductions (WDFW 1998b).

3.2.4.12.4 Interaction with Salmon and Steelhead

Stream-dwelling pygmy whitefish occupy similar habitats as salmon and steelhead and likely feed on similar prey**.** There is potential for overlap among prey of the different species. However, pygmy whitefish have coevolved with salmon and steelhead over time, and the different species have likely developed different ecological niches when occurring in the same locations, such as relative abundance, size, spawning, and microhabitat preferences (Hearn 1987; Essington et al. 2000). Interspecific competition between pygmy whitefish and salmon and steelhead has not been identified as a factor affecting pygmy whitefish (WDFW 1998b). Thus, the primary interaction between pygmy whitefish and salmon and steelhead is believed to be predation on pygmy whitefish due to their small size (5 to 6 inches).

3.2.4.13 Rainbow Trout

3.2.4.13.1 Background

The rainbow trout represents the same species as steelhead (*Oncorhynchus mykiss*). Both rainbow trout and steelhead spawn in gravel-bottomed, fast-flowing, well-oxygenated rivers and streams; however, rainbow trout remain in fresh water throughout their entire life. Juvenile steelhead may spend up to 7 years in freshwater before migrating to estuarine areas as smolts and then into the ocean to feed and mature. They can then remain at sea for up to 3 years before returning to freshwater to spawn. Some steelhead populations return to freshwater after their first season in the ocean, but do not spawn, and then return to the sea after one winter season in freshwater (NRCS 2000).

Within North America, the historic range of rainbow trout extends from Alaska to Mexico, the eastern coast of Asia, and the waters of the Pacific Ocean, including the Columbia River basin. The species exhibits an extremely diverse suite of life-history strategies, ranging from completely freshwater resident to anadromy. The resident form typically is referred to as rainbow trout (within the inland Columbia River basin, the resident form is referred to as redband trout [*Oncorhynchus mykiss gairdneri*]; west of the Cascade/Sierra Mountain divide, the resident form of rainbow trout [*O. mykiss irideus*)] is referred to as the coastal rainbow trout). The anadromous form is referred to as steelhead (Sections 3.2.3.2.9 through 3.2.3.2.14, Steelhead DPS) (NRCS 2000; Thurow et al. 2007).

At least three life history patterns of rainbow trout have been identified: adfluvial (migrate from lakes to rivers), fluvial (move from low-order tributaries to large rivers), and resident (restricted movements). Maximum life span for resident rainbow trout is typically 6 years.

Rainbow trout are a coldwater species (average length of 20 to 23 inches) that spawn in moving water over gravel or cobble substrate. If migratory, young will move out of natal streams from 1 to 2 years after birth. Rainbow trout feed on insects, crayfish, and other crustaceans. Adults feed on fish eggs, alevin (newly hatched salmon), fry, smolts, and salmon carcasses. Introduced rainbow trout also interbreed with native rainbow trout, cutthroat trout (several subspecies), and steelhead (Kozfkay et al. 2007). Extensive release of hatchery-origin rainbow trout has also occurred throughout their range, thereby increasing competition for food and habitat and impacting genetic integrity (NRCS 2000).

3.2.4.13.2 Current Status and Trends

The rainbow trout is not a Federal or state listed species (Table 3-9). Despite the wide distribution of redband trout, local extirpation and declines have occurred. Strong redband trout populations were reported in 17 percent of their potential range (Thurow et al. 2007). However, because of the likelihood of hybridization with other hatchery-origin rainbow trout and other salmon species, genetic integrity of some large populations may be questionable. Habitat degradation, fragmentation, and the pervasive introduction of non-native species suggest that further declines are likely throughout the range of redband trout. Interior Columbia River basin redband trout have mostly absent, depressed, or unknown populations (Thurow et al. 2007). Coastal rainbow trout have decreased in population where pollution from urbanization or industrial activities occurs and/or where stream temperatures have increased, either from harvest activities and/or urbanization (Thurow et al. 2007).

3.2.4.13.3 Limiting Factors and Threats

Rainbow trout have declined within specific areas of their range. Limiting factors and threats contributing to their decline include habitat loss from dams, habitat degradation, habitat fragmentation, and non-native species introductions. In addition, hybridization has also impacted populations (Thurow et al. 2007).

3.2.4.13.4 Interaction with Salmon and Steelhead

Introduced, non-native rainbow trout are a highly adaptable species that, when released as hatchery-origin fish, have the ability to outcompete native fish for food resources (including insects, crustaceans, mollusks, frogs, and small fish) and habitat space (Gawrylewski 2004). Adult rainbow trout also prey on young salmon and steelhead, although this is not their only prey source (NRCS 2000). When occurring in areas where they are native fish species, rainbow trout tend to occupy a wider range of environmental conditions than other native salmonids. They are found in more extreme conditions than those associated with other salmon species, including warmer waters and more heavily disturbed habitats, although, as described above, the species has also been shown to be sensitive to human disturbances (Thurow et al. 2007). Interspecific competition is not believed to occur when native rainbow trout, salmon, and steelhead are found in the same locations. Rainbow trout can hybridize with coastal cutthroat trout, westslope cutthroat trout, and steelhead (NMFS 1999; NRCS 2007).

3.2.4.14 Umatilla Dace

3.2.4.14.1 Background

The small (2 to 5 inches) freshwater Umatilla dace occurs from British Columbia south to Oregon and Idaho, including the Columbia River basin. Within the analysis area, the Umatilla dace is restricted to the Columbia, Kootenay, Slocan, and Snake Rivers. The Umatilla dace is a low-elevation riverine cyprinid (belonging to the carp and minnow fish family) that prefers cover provided by cobbles and larger stones where the current is fast enough to prevent siltation. The species is found along riverbanks at depths less than 1 meter and occurs in rivers that are relatively warm and productive. The species is absent from cold-water tributaries (IDFG 2010b).

There is a lack of information on Umatilla dace life history, distribution, and populations. Mature fish have been observed to spawn in July to early August. The species is considered a bottom feeder that preys on aquatic insects, as well as feeding on plant material and zooplankton (NatureServe Explorer 2010b; IDFG 2010b).

3.2.4.14.2 Current Status and Trends

The Umatilla dace is not a listed species under the ESA, but is a Washington State candidate species (Table 3-9). There is a lack of information on its population distribution, status, and life history requirements.

3.2.4.14.3 Limiting Factors and Threats

Historical land and water management practices have altered stream habitats resulting in reduced flows and sedimentation, which impacts Umatilla dace habitat. Isolation of Umatilla dace populations has occurred due to dam construction, diversions, and road crossings. Non-native fish introduction have also been cited as impacting this species because of predation (IDFG 2010b).

3.2.4.14.4 Interaction with Salmon and Steelhead

Umatilla dace, and salmon and steelhead occur in similar habitat types and feed on insects; thus, there is a potential for interspecific competition for prey. However, the Umatilla dace is a bottom feeder typically using a different ecological niche to find its prey. Dace, in general, are also known to be prey of salmon and steelhead (as well as bull trout) due to their small size (2 to 5 inches).

3.2.4.15 Westslope Cutthroat Trout

3.2.4.15.1 Background

The westslope cutthroat trout is a freshwater species that occurs from British Columbia and Alberta south through Washington, Montana, Oregon, and Idaho. Within the analysis area, the species occurs in the Upper Columbia River and northern tributaries of the Snake River. Generally, the species occurs in cold-water streams west of the Rocky Mountains. Westslope cutthroat trout require well-oxygenated water; clean, well-sorted gravels with minimal fine sediments for successful spawning; temperatures less than 70°F; and a complexity of instream habitat structure, such as large woody debris, pools, backwater, and overhanging banks. Other requirements include secure connected habitats and protection from introduced non-native fish (Shepard et al. 2003).

The westslope cutthroat trout has an average length of 8 to 12 inches and matures within 4 to 6 years, although it may live as long as 12 years. The species spawns between March and July. Their diet is primarily aquatic invertebrates (insects and zooplankton) with larger trout occasionally preying on other fish (IDFG 2010c).

3.2.4.15.2 Current Status and Trends

The westslope cutthroat trout is a Federal species of concern, and Oregon State sensitive species, and an Idaho State threatened species (Table 3-9). The species occupies 59 percent of their historical range in the U.S., while the Columbia River basin contains approximately 48 percent of its historical range (Shepard et al. 2003). A status review by the USFWS (2003) determined that the westslope trout does not warrant listing as a federally threatened species under the ESA. Although not listed in Washington State, the species is included in Washington's Priority Species Program and has been identified for priority management and preservation.

3.2.4.15.3 Limiting Factors and Threats

Westslope cutthroat trout populations are in decline due to land-use activities that isolate previously connected habitats, habitat loss, hybridization with introduced rainbow trout, overfishing, and competition/predation from other introduced non-native salmonids (McIntyre and Rieman 1995; Shepard et al. 2003; NRCS 2007). Other limiting factors to the westslope cutthroat trout include isolation of existing populations through barriers (such as blocked culverts) (IDFG 2010c). Warming of stream temperatures due to removal of shoreline riparian vegetation has also attributed to habitat loss and a decrease in spawning, hatching, and rearing survival (WDFW 1992).

3.2.4.15.4 Interaction with Salmon and Steelhead

Westslope trout have similar habitat, reproduction, and feeding requirements as native salmon and steelhead. They directly compete with non-native salmonids (rainbow, brook, and brown trout) for food and habitat, while hybridizing with rainbow trout (Shepard et al. 2003; Kozfkay et al. 2007). Westslope cutthroat trout are prey of bull trout, lake trout, brook trout, and sculpins (McIntyre and Rieman 1995). Interspecific competition with native salmonids and steelhead has not been cited as a threat to the species. Westslope cutthroat trout have been rarely observed feeding on salmon (IDFG 2010c).

3.3 Socioeconomics

3.3.1 Introduction

Socioeconomics is defined as the study of the relationship between economics and social interactions with affected regions, communities, and user groups. Issues addressed in this section include socioeconomic effects related to hatchery operations, gross and net economic values derived from production and harvest of hatchery-origin fish, and the ways hatcheries and the fish produced from Columbia River basin hatcheries affect personal income and employment. Information on socioeconomic conditions related to tribal harvests is provided in Section 3.4, Environmental Justice.

This section describes recent trends and baseline conditions for hatchery program costs, harvest, economic values associated with commercial (tribal and non-tribal) and recreational fisheries, and regional economic conditions. A historical overview of salmon and steelhead harvest is also included to provide the reader with context for the description of baseline conditions. Harvest data from 2002 and 2006 are presented, representing a recent period in which final harvest data are available for most affected fisheries. Economic values and effects are evaluated for average conditions over this period. Table values and corresponding values in the sections are not rounded to aid in finding corresponding numbers between tables and text. However, the use of unrounded numbers should not be interpreted as suggestive of unusually high levels of precision in the estimates. All numbers represent a best estimate of the underlying values. Last, harvest numbers reported for each economic impact region represent the total number of salmon and steelhead harvested in that economic impact region, not just those from the Columbia River basin.

3.3.2 Analysis Area

The analysis area for socioeconomics includes the project area (Section 2.2, Description of Project Area) plus the following areas: 1) coastal areas of Washington, Oregon, and California; 2) British Columbia (Canada); 3) the Puget Sound/Strait of Juan de Fuca; and 4) Southeast Alaska (Figure 3-1). The analysis area includes sites outside the project area because salmon that are produced within the project area can migrate outside the project area and contribute to fisheries in these areas. Changes in salmon fisheries may lead to socioeconomic effects. The contribution of salmon to fisheries outside the project area is shown in Table 3-11. Chinook and coho salmon are the only two salmon species that contribute meaningfully to fisheries outside the project area. Columbia River basin steelhead are not generally caught in fisheries outside the project area.

TABLE 3-11. ESTIMATED CATCH OF COLUMBIA RIVER BASIN STOCKS AS A PERCENTAGE OF TOTAL HARVEST BY AREA AND FISHERY.

SPECIES	FISHERY LOCATION				
	SOUTHEAST ALASKA	BRITISH COLUMBIA	PUGET SOUND/ STRAIT OF JUAN DE FUCA (WA)	NORTH OF CAPE FALCON[1] (NORTHERN OR AND WA COAST)	SOUTH OF CAPE FALCON[2] (OR, CA COAST)
Chinook Salmon					
Commercial (%)	28	7	1	32	0
Recreational (%)	22	1	6	47	0
Tribal (%)	N/A[3]	N/A	N/A	22	0
Coho Salmon					
Commercial (%)	0	<1	0	1	11
Recreational (%)	0	<1	0	47	40
Tribal (%)	N/A	N/A	N/A	6	N/A

Source: Appendix I

[1] North of Garibaldi, Oregon. Does not include Washington coast net fishery for Chinook salmon.

[2] South of Garibaldi, Oregon.

[3] N/A = not available.

Information in Section 3.3 (Socioeconomics) and Section 4.3 (Socioeconomics) is organized according to the following economic impact regions: lower Columbia River, mid Columbia River, upper Columbia River, lower Snake River, Oregon coast, Washington coast, California coast, Puget Sound/Strait of Juan de Fuca, British Columbia, and Southeast Alaska. Four of these economic impact regions occur in the Columbia River basin (lower Columbia River, mid Columbia River, upper Columbia River, and lower Snake River) (Figure 3-2). These four economic impact regions encompass the seven ecological provinces and two recovery domains that make up the project area (Section 2.2, Description of Project Area). The remaining six ecological impact regions (Oregon coast, Washington coast, California coast, Puget Sound/Strait of Juan de Fuca, British Columbia, and Southeast Alaska) are in the Pacific Ocean and Puget Sound.

Prepared by Parametix, Inc. April 29, 2010 (DEIS_Figure_3-1_20100429.mxd).

Figure 3-1. Analysis area for socioeconomics by economic impact region.

Prepared by Parametix, Inc. April 29, 2010 (DEIS_Figure_3-2_20100429.mxd).

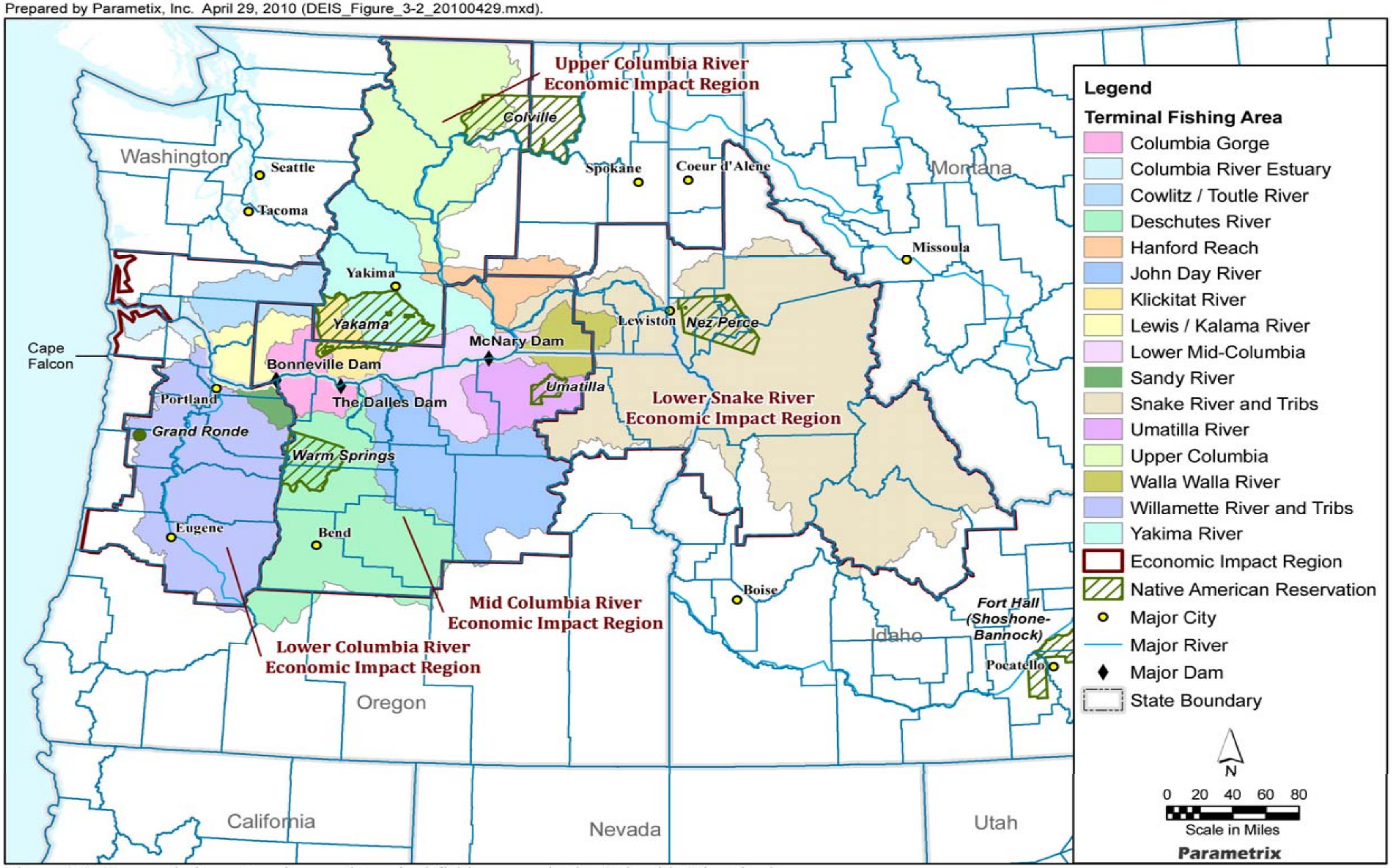


Figure 3-2. Economic impact regions and terminal fishing areas in the Columbia River basin.

3.3.3 Hatchery Program Costs

In addition to providing fish for harvest, hatchery programs in the Columbia River basin directly affect socioeconomic conditions in the economic impact regions where the hatcheries operate. Hatcheries generate economic activity (personal income and jobs) by providing employment opportunities and through local procurement of goods and services for hatchery operations. Hatchery-related spending affects regional economies where hatchery operations occur and where the businesses that provide materials and services are located. This spending also extends to communities where hatchery administration and management decisions are made (sometimes referred to as headquarter costs).

Salmon and steelhead hatchery programs have operated in the states of Oregon and Washington for more than 100 years. Currently, 178 salmon and steelhead hatchery programs operate at 80 hatcheries and associated artificial production facilities in the Columbia River basin (Section 1.5.1, Hatchery Facilities in the Columbia River Basin) (Figure 1-2) (Table 1-4). Slightly more than one-third of the hatchery programs (62 hatchery programs) in the Columbia River basin are funded through the Mitchell Act (Table 1-2) (Table 1-4). The remaining 116 hatchery programs are primarily funded through the Bonneville Power Administration (BPA), the USACE, U.S. Bureau of Reclamation, USFWS, public utility districts, and private power companies (Appendix A). The hatchery programs are operated by the Confederated Tribes of the Colville Reservation, Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes of Warm Springs, Idaho Fish and Game, Nez Perce Tribe, ODFW, USFWS, Washington Department of Fish and Wildlife, and Yakama Nation. (Appendix A).

In 2007, approximately 144 million hatchery-origin salmon and steelhead were produced in the Columbia River basin (Table 3-12). Slightly less than half of the estimated hatchery-origin smolt production (71 million smolts) was either wholly or partially funded by the Mitchell Act in recent years (Table 2-7). As shown in Table 3-12, the most common species produced in Columbia River basin hatchery programs are fall Chinook salmon and coho salmon in the Willamette/Lower Columbia recovery domain, and fall Chinook salmon, spring Chinook salmon. and summer steelhead in the Interior Columbia recovery domain. Chum salmon, sockeye salmon, winter steelhead, and summer Chinook salmon are the least common species produced at Columbia River basin hatchery facilities (Table 3-12).

TABLE 3-12. HATCHERY PRODUCTION (NUMBER OF FISH) OF SALMON AND STEELHEAD WITHIN THE COLUMBIA RIVER BASIN IN 2007.

	RECOVERY DOMAIN		
SPECIES	**WILLAMETTE/ LOWER COLUMBIA**	**INTERIOR COLUMBIA**	**TOTAL**
Fall Chinook Salmon	46,968,000	22,976,000	**69,944,000**
Spring Chinook Salmon	12,480,000	20,019,000	**32,499,000**
Summer Chinook Salmon	0	3,733,000	**3,733,000**
Coho Salmon	16,985,000	4,787,000	**21,773,000**
Winter Steelhead	1,992,000	20,000	**2,012,000**
Summer Steelhead	1,968,000	10,986,000	**12,953,000**
Chum Salmon	300,000	0	**300,000**
Sockeye Salmon	0	363,000	**363,000**
TOTAL	**80,693,000**	**62,884,000**	**143,577,000**

Hatchery program costs include production costs, headquarters administrative and management costs, acclimation and liberation costs, and hatchery facility and other fixed costs. Information pertinent to estimating hatchery facility costs (Appendix I) includes the following:

- **Hatchery production costs**. Hatchery production costs include expenses accrued at the primary hatchery facility as well as other hatchery facilities where the fish might be taken for rearing. Unit cost information includes the following:
  - Time spent in the hatchery facility affects production costs. Most released smolts range in size from 10 to 15 smolts per pound for spring Chinook salmon and coho salmon to between 20 to 25 smolts per pound for fall Chinook salmon. The spring Chinook salmon and coho salmon spend about 18 months in the hatchery system, and the fall Chinook salmon spend about 9 months in hatcheries.
  - Feed costs range from $0.40 to $0.80 per pound of feed.
  - Marking hatchery-origin fish is a Federal directive. The two most common methods to mark hatchery-origin fish are with an adipose fin clip and/or a coded wire tag (CWT). Marking costs are about $0.05 per smolt, depending on the proportion of smolts receiving CWT inserts, which are about $0.20 per smolt.
  - Labor costs (excluding labor overhead) are the largest component of production costs, usually comprising about 50 percent of production costs.

- **Headquarters administrative and management costs.** Headquarters administrative and management costs include indirect expenses for central office overhead, including management and administration, ranging from about $0.03 to $0.40 per smolt produced by Mitchell Act-funded hatchery programs. Similar headquarters cost would be assumed for hatchery programs funded through other entities.
- **Acclimation and liberation costs.** Some hatchery programs produce fish at a hatchery facility and then move the fish to a different location before release. Fish are then acclimated to the water at the new site before release. There are additional costs associated with this process.
- **Hatchery facility and other fixed costs**. This includes the cost of maintaining and/or improving hatchery facilities.

Although information on the cost to operate the 80 hatcheries in the Columbia River basin is limited, production cost information is available (Table 3-13) from some of the operating entities. Average cost information from Table 3-13 was used along with facility-specific budget information to estimate the total cost of production at all hatchery facilities in the Columbia River basin (Table 4-85).

TABLE 3-13. AVERAGE COST PER SMOLT FROM MITCHELL ACT-FUNDED HATCHERY PROGRAMS.

AGENCY/SPECIES	AVERAGE COST PER SMOLT ($)[1,2]
ODFW	
Coho Salmon	1.179
Chinook Salmon	0.743
Steelhead	2.147
USFWS	
Coho Salmon	1.283
Chinook Salmon	1.174
Steelhead	3.260
WDFW	
Coho Salmon	0.683
Chinook Salmon	1.095
Steelhead	2.696
Yakama Nation	
Coho Salmon	0.462
Chinook Salmon	0.829

Source: Compiled by TCW Economics (Appendix J) from hatchery program budget data obtained by The Research Group (Appendix J)
[1] All dollar values are expressed in 2007 dollars.
[2] Includes operation costs, headquarters' overhead costs, amortized capital costs, and acclimation and transport costs, where applicable.

For the 2008 fiscal year, the budget for operating WDFW hatchery facilities above the Bonneville Dam that produce salmon or steelhead was $6.1 million, and the number of full-time equivalent (FTE) jobs was 61.4 positions. For the 12 WDFW hatchery facilities below Bonneville Dam that produce salmon or steelhead, the annual 2008 fiscal year budget was $6.2 million, and the number of FTE jobs was 64 positions.

Budget and jobs information also are available for hatchery facilities operated by the ODFW and the Yakama Nation. For 2009, ODFW identified a projected budget of $5.2 million for six Columbia River basin hatcheries (Big Creek, Bonneville, Cascade, Clackamas, Oxbow, and Sandy) that produce salmon and steelhead and an estimated 31 FTE jobs. For the Klickitat hatchery facility operated by the Yakama Nation, a budget of $521,400 was projected for 2007 and an estimated 5.5 FTE jobs.

Based on the available smolt production and budgetary information (Tables 3-12 and 3-13) from the USFWS, WDFW, ODFW, and Yakama Nation on their hatchery programs that are funded through the Mitchell Act, hatchery production costs at all salmon and steelhead hatchery facilities in the Columbia River basin are estimated to total about $123.1 million. These costs are used to characterize hatchery program costs for Alternative 1, as described in Section 4.3, Socioeconomics.

3.3.4 Historical Overview

3.3.4.1 Columbia River Basin

Historically, salmon and steelhead extensively used the Columbia River and its tributaries. Chinook salmon migrated nearly 1,200 miles up the Columbia River to Lake Windemere, Canada, and 600 miles up the Snake River to Shoshone Falls near Twin Falls, Idaho. Adult salmon and steelhead runs, before development in the Columbia River basin, are estimated to have ranged between 10 and 16 million fish annually.

For thousands of years, Native Americans have fished for salmon and steelhead, as well as other species, in the tributaries and mainstem of the Columbia River. Native Americans fish for ceremonial, subsistence, and economic (commercial) purposes. A wide variety of gears and methods has been used over the years, including hoop and dip nets, spears, weirs, and traps (usually in smaller streams and headwater areas).

The development of non-tribal fisheries began about 1830, and by 1861, commercial fishing had become an important economic activity in the Columbia River basin. Commercial fishing developed rapidly with the arrival of European settlers and the advent of canning technologies in the late 1800s. Although harvest activity spiked during the late 1980s, and there was a brief uptick between 2001 and 2004, the overall trend in commercial salmon landings has been downward since the late 1930s. With the value of salmon harvested in the Columbia River basin appearing to have bottomed out in the $5 to $10 million range, recent harvest levels are a fraction of historical levels.

Fishing pressure, especially in the late 19th and early 20th centuries, has long been recognized as a significant factor in the decline of Columbia River salmon runs. Hydropower development and habitat degradation are other factors contributing to the decline (NRC 1999). As salmon stocks began to decline, salmon hatcheries were constructed to replace and/or supplement natural production.

Present-day treaty fisheries consist primarily of set gillnets, but dip net fishing still occurs on the Columbia River and tributary locations. Tribal fisheries generally take place above Bonneville Dam, but other locations are sometimes used to fulfill treaty and trust responsibilities. Catch is allocated first for ceremonial purposes, next for subsistence (ceremonial and subsistence are sometimes considered together), and last for commercial purposes. No fish of any stock are sold for commercial purposes until ceremonial and subsistence needs are met. As recently as 1995, spring Chinook salmon were available for ceremonial purposes only. Fall Chinook salmon are routinely harvested for commercial sale. Total tribal harvest (including commercial, ceremonial, and subsistence) of spring and fall run salmon has averaged about 25,000 and 110,000 fish, respectively, during the early 2000 period (Mann 2004).

Harvesting and canning salmon has played a key role in the economic development of the Pacific Northwest. In 2007, 61 processor businesses purchased tribal and non-tribal salmon caught in the Columbia River basin (Appendix I). These processor businesses can be characterized in the following terms:

- Buyers who purchase fish that they then market themselves (includes buyers from retail markets or farmer's markets from the Seattle, Washington, and Portland, Oregon, areas)
- Buyers who purchase fish mainly for smoking or canning
- Tenders/buyers who purchase fish mostly for resale to larger processors
- Medium and large processors (includes buyers who purchase fish and then sell them to distributors or haul them to Seattle, Washington, for further processing and marketing)

While the Astoria, Oregon, and Ilwaco, Washington, port areas were historically important salmon processing centers, declining harvests in the Columbia River have led to major declines in these industries. Groundfish, shrimp, and crab fisheries that occur off the coast support most processing or buying operations in the lower Columbia River. There are two salmon buyers/processors in Cathlamet, Washington, and one each in Longview and Vancouver, Washington. In the early 2000s, there were 35 salmon buyers/processors identified in Astoria, but fewer than five had substantial operations. Salmon purchasing agents range up and down the Columbia River, but processing operations are limited to Astoria. Very little product is processed into fillets in the Astoria area. Most purchases are hauled to cold storage and processing facilities in the Seattle and Bellingham, Washington, areas (Appendix I).

Processors of Columbia River basin salmon supply products to a growing market for wild-caught fish. In addition to seafood products, one local processor in the Astoria area produces a salmon byproduct from carcasses. This byproduct is used in the manufacture of fishmeal and oil. It has also been used at Columbia River basin hatcheries as fish food.

3.3.4.2 Pacific Ocean and Puget Sound

Commercial fisheries in Pacific Ocean waters are limited to trolling, a method where a vessel tows numerous lines with attached lures or baits through the water. Vessels range in size from less than 20 feet to more than 50 feet. Trollers target salmon on salmon migration and feeding grounds, which extend from shore out to approximately 25 miles. Many trollers (typically the larger ones) are also used in Dungeness crab, albacore, sablefish, halibut, and rockfish fisheries. Some troll vessels hold permits in more than one state and travel to areas distant from their homeports to take advantage of season openings when their own area is closed or better fishing opportunities.

Commercial trolling has been practiced in Pacific Coast salmon fisheries since 1912. The Pacific Coast troll fleet grew rapidly in the 1970s, simultaneous with rising hatchery production of coho salmon, peaking at 11,239 vessels in 1980. By the mid-1970s, fishery managers believed the fleet was overcapitalized and initiated license limitation programs to control participation in salmon fisheries. Permits were first required in Washington in 1974 and in Oregon in 1980. Tribal fishers who participate in ocean trolling are not subject to state license requirements or limitations.

The proportion of salmon harvested in west coast fisheries by commercial and recreational fishers has changed over the years in response to abundance conditions and perceived social and economic priorities. From the mid-1970s to 1990, the commercial fleet took approximately 64 percent of the coho salmon and 81 percent of the Chinook salmon. During the1990s, the commercial fleet harvested approximately 40 percent of the coho and 73 percent of the Chinook salmon. This pattern of allocating increasing amounts of harvest to recreational fisheries appears to have continued into the decade following 2000.

The commercial harvest in the Pacific Fishery Management Council (PFMC) management area (i.e., in Federal waters off the coasts of Washington, Oregon, and California), is allocated between tribal and non-tribal fishers in accordance with judicial interpretations of state treaty obligations. Tribal harvest is primarily taken for commercial purposes, but some fish are also harvested off the Washington coast for ceremonial and subsistence needs.

Before and during much of the 1970s, fishing seasons for ocean trollers were open from April through September for Chinook salmon and from June through September for coho, with relatively few restrictions. During the 1980s, increased conservation concerns led to cutbacks in season lengths and increased area restrictions. Species-specific fishing regulations became common,, and retention of Chinook salmon or coho salmon was limited or prohibited according to time and area.

Ocean troll fisheries became increasingly restricted in the 1990s. Some of the major changes in seasons in recent years, compared to the 1980s, include the elimination of coho salmon fishing south of Cape Falcon, Oregon, and increased closures in the Klamath Management Zone and nearby areas. The most severe ocean fishing cutbacks occurred in 1984 in response to poor ocean salmon survival attributed to El Niño ocean conditions, and then again recently (2008 and 2009) in California.

A relatively small number of large processor/buyer firms process most of the ocean salmon catch on the Pacific Coast. Between 1995 and 1997, more than 1,900 firms had state processor/buyer licenses. These firms included both operators of processing plants and buyers that may do little more than hold the fish before their shipment to a processor or market. In some cases, the buyers may be owners of vessels who also own licenses, thus allowing them to sell fish directly to the public or retail markets. The largest salmon buyers tend to buy salmon from four to eight ports. In California, salmon buyers/processors are largely concentrated in the Monterey/Santa Cruz and San Francisco areas. In past years, a substantial number of buyers/processors were located in Humboldt County.

3.3.5 Commercial Harvest and Economic Value

3.3.5.1 Columbia River Basin

The Columbia River mainstem salmon and steelhead fishery is currently divided into a non-tribal commercial fishery, which is located downstream of Bonneville Dam, and a tribal commercial fishery, which is located upstream of Bonneville Dam. The tribal commercial fishery is also called the Zone 6 fishery. The upstream boundary of the Zone 6 fishery is McNary Dam.

Commercial fishing also occurs in terminal areas of the Columbia River basin, such as tributaries and bays. Commercial fisheries in terminal areas are designated as non-tribal below Bonneville Dam and tribal above Bonneville Dam. For additional details on harvest by Columbia River tribes, refer to Section 3.4.4, Environmental Justice Populations Reviewed.

For tribal and non-tribal commercial harvests in the Columbia River basin, more salmon are harvested from the lower Columbia River economic impact region than from any of the other three economic impact regions (Table 3-14 and Table 3-15). This harvest is primarily from non-tribal commercial fisheries for coho salmon. With an average (2002 through 2006) annual harvest of about 139,620 fish, the coho salmon non-tribal commercial fishery accounts for 75 percent of the total salmon harvest in the mainstem of the Lower Columbia River (187,179 fish) (Table 3-14). Chinook salmon account for the remaining non-tribal commercial fishing harvest because steelhead are not commercially harvested by non-tribal commercial fishers.

Coho salmon also dominate the non-tribal commercial harvest in the terminal areas of the Lower Columbia River region, accounting for 89 percent (67,873 fish) of the annual average salmon harvest in these areas (75,817 fish) (Table 3-14). Some (less than 1,000 annually) chum salmon are also caught in the mainstem, but these catches are incidental to the coho salmon and Chinook salmon harvest.

TABLE 3-14. COLUMBIA RIVER BASIN IN-RIVER HISTORICAL (2002 THROUGH 2006) CATCH FOR NON-TRIBAL COMMERCIAL FISHERIES.

ECONOMIC IMPACT REGION/AREA/SPECIES	NON-TRIBAL COMMERCIAL FISHERIES (NUMBER OF FISH)					
	2002	2003	2004	2005	2006	ANNUAL AVERAGE
Lower Columbia River						
Mainstem (Zones 1-5)						
Chinook Salmon	51,819	59,279	55,095	34,030	37,574	47,559
Coho Salmon	163,000	257,300	119,700	94,700	63,400	139,620
TOTAL	**214,819**	**316,579**	**174,795**	**128,730**	**100,974**	**187,179**
Terminal Areas						
Chinook Salmon	11,699	7,806	10,562	2,406	7,245	7,944
Coho Salmon	69,373	114,440	51,993	65,847	37,713	67,873
TOTAL	**81,072**	**122,246**	**62,555**	**68,253**	**44,958**	**75,817**
CHINOOK SALMON	**63,518**	**67,085**	**65,657**	**36,436**	**44,819**	**55,503**
COHO SALMON	**232,373**	**371,740**	**171,693**	**160,547**	**101,113**	**207,493**
TOTAL	**295,891**	**438,825**	**237,350**	**196,983**	**145,932**	**262,996**

Source: Catch data are from Joint Columbia River Management Staff (2008a, 2008b, 2009a, 2009b)

In the tribal commercial fisheries above Bonneville Dam, the harvest of Chinook salmon dominates the catch in the mainstem between Bonneville Dam and McNary Dam (which represents the mid Columbia River economic impact region) (Table 3-15). Of the 160,620 salmon and steelhead, on average, caught in this economic impact region between 2002 and 2006 (Table 3-15), Chinook salmon accounted for 86 percent (138,642 fish) of the total tribal harvest. Tribal commercial fishing in the terminal areas in the Mid Columbia River is more balanced between species compared to the mainstem, with coho salmon accounting for about 60 percent (7,997 fish) of the average annual harvest (total of 13,342 fish), Chinook salmon about 25 percent (3,290 fish), and steelhead about 15 percent (2,055 fish) (Table 3-15). The tribal commercial fisheries in the upper Columbia River and lower Snake River economic impact regions are mostly Chinook salmon fisheries, although small numbers of coho salmon are also caught in the upper Columbia River economic impact region (Table 3-15).

TABLE 3-15. COLUMBIA RIVER BASIN IN-RIVER HISTORICAL (2002 THROUGH 2006) CATCH FOR TRIBAL COMMERCIAL FISHERIES.

	TRIBAL COMMERCIAL FISHERIES (NUMBER OF FISH)					
ECONOMIC IMPACT REGION/AREA/SPECIES	2002	2003	2004	2005	2006	ANNUAL AVERAGE
Lower Columbia River						
TOTAL	**0**	**0**	**0**	**0**	**0**	**0**
Mid Columbia River						
Mainstem (Zone 6)						
Chinook Salmon	165,226	146,192	153,478	127,306	101,010	138,642
Coho Salmon	1,600	5,800	10,300	5,400	7,577	6,135
Steelhead	13,878	15,688	14,670	13,708	21,269	15,843
TOTAL	**180,704**	**167,680**	**178,448**	**146,414**	**129,856**	**160,620**
Terminal Areas						
Chinook Salmon	5,424	4,441	4,722	1,359	502	3,290
Coho Salmon	11,656	10,558	5,828	4,730	7,214	7,997
Steelhead[1]	N/A	N/A	N/A	N/A	N/A	2,055
TOTAL	**17,080**	**14,999**	**10,550**	**6,089**	**7,716**	**13,342**
Upper Columbia River						
Chinook Salmon	2,157	1,767	1,877	541	200	1,308
Coho Salmon	129	117	65	52	80	89
Steelhead	0	0	0	0	0	0
TOTAL	**2,286**	**1,884**	**1,942**	**593**	**280**	**1,397**
Lower Snake River						
Chinook Salmon	5,425	4,443	4,722	1,361	503	3,291
Coho Salmon	0	0	0	0	0	0
Steelhead	0	0	0	0	0	0
TOTAL	**5,425**	**4,443**	**4,722**	**1,361**	**503**	**3,291**
CHINOOK SALMON	**178,232**	**156,843**	**164,799**	**130,567**	**102,215**	**146,531**
COHO SALMON	**13,385**	**16,475**	**16,193**	**10,182**	**14,871**	**14,221**
STEELHEAD	**13,878**	**15,688**	**14,670**	**13,708**	**21,269**	**17,898**
TOTAL	**205,495**	**189,006**	**195,662**	**154,457**	**138,355**	**178,650**

Source: Catch data, with the exception of steelhead for terminal areas, are from Joint Columbia River Management Staff (2008a, 2008b, 2009a, 2009b).

[1] N/A = not available. Steelhead average annual values for the mid Columbia (tribal terminal areas) economic impact region are based on modeled harvest estimates developed by the Mitchell Act Fishery Modeling Team for Alternative 1.

In terms of economic value, the average annual harvest value (known as the ex-vessel value, which is the price received for the product 'at the dock') of salmon caught in the non-tribal commercial fisheries in the lower Columbia River economic impact region was $7,612,240 (Table 3-16). The harvest value of salmon and steelhead caught by tribal commercial fishers was $9,729,723 in the Mid Columbia River, $87,437 in the upper Columbia River economic impact region, and $218,601 in the lower Snake River economic impact region (Table 3-16). Based on net economic value factors derived by The Research Group (Appendix I), the net income to tribal and non-tribal commercial fishers associated with the annual (2002 through 2006) average harvest of salmon and steelhead in the Columbia River basin is estimated at about $6.1 million.

TABLE 3-16. AVERAGE ANNUAL (2002 THROUGH 2006) CATCH AND COMMERCIAL EX-VESSEL VALUE FOR TRIBAL AND NON-TRIBAL COMMERCIAL FISHERIES IN THE COLUMBIA RIVER BASIN.

	TRIBAL		NON-TRIBAL COMMERCIAL	
ECONOMIC IMPACT REGION/SPECIES	AVERAGE CATCH (NUMBER OF FISH)	EX-VESSEL VALUE ($)[1]	AVERAGE CATCH (NUMBER OF FISH)	EX-VESSEL VALUE ($)[1]
Lower Columbia River				
Chinook Salmon	0	0	55,503	5,075,638
Coho Salmon	0	0	207,493	2,536,602
Steelhead	0	0	0	0
TOTAL	**0**	**0**	**262,996**	**7,612,240**
Mid Columbia River				
Chinook Salmon	141,932	9,427,691	0	0
Coho Salmon	14,132	87,972	0	0
Steelhead	17,898	214,060	0	0
TOTAL	**173,962**	**9,729,723**	**0**	**0**
Upper Columbia River				
Chinook Salmon	1,308	86,883	0	0
Coho Salmon	89	554	0	0
Steelhead	0	0	0	0
TOTAL	**1,397**	**87,437**	**0**	**0**
Lower Snake River				
Chinook Salmon	3,291	218,601	0	0
Coho Salmon	0	0	0	0
Steelhead	0	0	0	0
TOTAL	**3,291**	**218,601**	**0**	**0**
CHINOOK SALMON	**146,531**	**9,733,175**	**55,503**	**5,075,638**
COHO SALMON	**14,221**	**88,526**	**207,493**	**2,536,602**
STEELHEAD	**17,898**	**214,060**	**0**	**0**
TOTAL	**178,650**	**10,035,761**	**262,996**	**7,612,240**

Sources: Average catch estimates are 2002 through 2006 historical averages (Table 3-14 and Table 3-15). See Appendix Jfor how ex-vessel values were derived.
[1] All dollar values are expressed in 2007 dollars.

3.3.5.2 Pacific Ocean and Puget Sound

This section describes historical harvest conditions and associated economic values for commercial salmon fisheries in the Pacific Ocean and Puget Sound. Catch values and associated economic values presented in this section are for all salmon stocks, not just salmon stocks from the Columbia River basin.

As previously indicated, Columbia River stocks of Chinook salmon and coho salmon contribute to recreational and commercial fisheries in the Pacific Ocean and Puget Sound. Almost half of the Chinook salmon harvested in tribal commercial fisheries and about 22 percent of the Chinook salmon harvested in recreational fisheries north of Cape Falcon consists of Columbia River stocks (Table 3-11). For coho salmon, Columbia River stocks account for about 47 percent of the recreational harvest of salmon north of Cape Falcon (Table 3-11). South of Cape Falcon, which is located on the Oregon coast south of Garibaldi, Columbia River coho salmon contribute substantially to the recreational fisheries, accounting for 40 percent of the coho salmon harvested but only about 6 percent of the tribal commercial fishery and about 1 percent of the non-tribal commercial fishery (Table 3-11).

Columbia River stocks account for about 28 percent of Chinook salmon harvested in the Southeast Alaska commercial fishery and 22 percent of the Chinook salmon caught in the Southeast Alaska recreational fishery. Columbia River Chinook salmon also account for about 7 percent of the commercial harvest of Chinook salmon harvested in British Columbia (Table 3-11).

As previously stated in Section 3.3.2, Analysis Area, Chinook salmon leaving the Columbia River basin generally turn north in Pacific Coast waters and coho salmon turn south, although fish of both species can migrate in either direction (NMFS 2003). Non-tribal commercial fishing along the Oregon coast (basically, the Astoria area) is mostly a Chinook salmon fishery, accounting for, on average, 69 percent (9,375 fish) of the commercial salmon harvest in Oregon (13,540 fish) (Table 3-17). Along the Washington coast, a similar pattern occurs, with Chinook salmon comprising most (88 percent [39,446 fish]) of the salmon harvest in non-tribal commercial [45,058 fish], and much (55 percent [36,309 fish]) of the tribal commercial [65,693 fish] fishery (Table 3-17 and Table 3-18, respectively). Further north in the British Columbia economic impact region, where the fisheries are more affected by local river systems and less by Columbia River stocks, Columbia River Chinook salmon is the only substantial contributor to local fisheries. In Southeast Alaska, Columbia River stocks are substantial contributors to the Chinook salmon commercial fisheries, accounting for about 28 percent of the commercial harvest (Table 3-11).

TABLE 3-17. HISTORICAL (2002 THROUGH 2006) SALMON CATCH IN NON-TRIBAL PACIFIC OCEAN AND PUGET SOUND FISHERIES SUPPORTED BY COLUMBIA RIVER STOCKS.

	NON-TRIBAL COMMERCIAL FISHERIES (NUMBER OF FISH)					
ECONOMIC IMPACT REGION/SPECIES	**2002**	**2003**	**2004**	**2005**	**2006**	**ANNUAL AVERAGE**
Oregon Coast (Astoria)						
Chinook Salmon	12,797	10,384	3,118	10,085	10,489	9,375
Coho Salmon	1,515	6,441	8,839	2,618	1,414	4,165
TOTAL	**14,312**	**16,825**	**11,957**	**12,703**	**11,903**	**13,540**
Washington Coast						
Chinook Salmon	53,819	56,202	35,372	35,066	16,769	39,446
Coho Salmon	180	8,957	13,293	1,442	1,265	5,613
TOTAL	**53,999**	**65,159**	**48,665**	**36,508**	**18,034**	**45,058**
Puget Sound/Strait of Juan de Fuca						
Chinook Salmon	13,019	4,469	1,576	2,572	4,521	5,231
Coho Salmon	24,386	17,619	39,070	19,422	9,605	22,020
TOTAL	**37,405**	**22,088**	**40,646**	**21,994**	**14,126**	**27,251**
British Columbia						
Chinook Salmon	275,192	299,270	320,856	280,821	208,295	276,887
Coho Salmon	0	0	0	5,989	2,399	4,194
TOTAL	**275,192**	**299,270**	**320,856**	**286,810**	**210,694**	**281,081**
Southeast Alaska						
Chinook Salmon	292,450	311,300	354,941	316,667	287,100	312,492
Coho Salmon	-[1]	-	-	-	-	-
TOTAL	**292,450**	**311,300**	**354,941**	**316,667**	**287,100**	**312,492**
CHINOOK SALMON	**647,277**	**681,624**	**715,863**	**645,212**	**527,174**	**643,430**
COHO SALMON	**26,081**	**33,017**	**61,202**	**29,471**	**14,683**	**35,992**
TOTAL	**673,358**	**714,641**	**777,065**	**674,683**	**541,857**	**679,422**

Sources: Catch data for the Oregon and Washington coasts are from the PFMC (2003, 2004, 2005, 2006, 2007). Catch data for Puget Sound/Strait of Juan de Fuca are from Pacific States Marine Fisheries Commission (2008). Catch data for Southeast Alaska are from the PSC (2003, 2004, 2005, 2006, 2007).

[1] Dashes mean data not available or unreported because no effects from EIS alternatives are expected.

Note: Catch values reported in this table are for all stocks, not just Columbia River basin stocks.

TABLE 3-18. HISTORICAL (2002 THROUGH 2006) SALMON CATCH IN TRIBAL PACIFIC OCEAN AND PUGET SOUND FISHERIES SUPPORTED BY COLUMBIA RIVER STOCKS.

ECONOMIC IMPACT REGION/SPECIES	TRIBAL FISHERIES (NUMBER OF FISH)					
	2002	2003	2004	2005	2006	ANNUAL AVERAGE
Washington Coast						
Chinook Salmon	38,451	35,141	42,627	37,439	27,888	36,309
Coho Salmon	17,502	11,125	62,305	24,041	31,945	29,384
TOTAL	**55,953**	**46,266**	**104,932**	**61,480**	**59,833**	**65,693**
Puget Sound/Strait of Juan de Fuca						
Chinook Salmon	31,685	25,171	53,998	39,431	42,463	38,550
Coho Salmon	123,522	121,674	317,161	184,156	140,670	177,437
TOTAL	**155,207**	**146,845**	**371,159**	**223,587**	**183,133**	**215,986**
British Columbia						
Chinook Salmon	-[1]	-	-	-	-	-
Coho Salmon	-	-	-	-	-	-
TOTAL	**-**	**-**	**-**	**-**	**-**	**-**
Southeast Alaska						
Chinook Salmon	-	-	-	-	-	-
Coho Salmon	-	-	-	-	-	-
TOTAL	**-**	**-**	**-**	**-**	**-**	**-**
CHINOOK SALMON	**75,754**	**66,297**	**103,999**	**83,769**	**75,811**	**81,126**
COHO SALMON	**141,024**	**132,799**	**379,466**	**208,197**	**172,615**	**206,820**
TOTAL	**216,778**	**199,096**	**483,465**	**291,966**	**248,426**	**287,946**

Sources: Catch data for the Oregon and Washington coasts are from the PFMC (2003, 2004, 2005, 2006, 2007). Catch data for Puget Sound/Strait of Juan de Fuca are from Pacific States Marine Fisheries Commission (2008). Catch data for Southeast Alaska are from the PSC (2003, 2004, 2005, 2006, 2007).

[1] Dashes mean data not available or unreported because no effects from Mitchell Act actions are expected.

Note: Catch values reported in this table are for all stocks, not just Columbia River basin stocks.

In terms of economic value, the average annual harvest value (ex-vessel value) of Chinook salmon caught along the Washington coast by tribal commercial fishers was $1,202,851, and by non- tribal commercial fishers was $1,694,916 (Table 3-19). The average annual harvest value of coho salmon caught in non-tribal commercial fisheries along the Oregon and Washington coasts combined was $109,030 (Table 3-19). Based on the non-tribal and tribal harvest identified in Table 3-17 and Table 3-18 and on net economic value factors identified in Appendix J, the net income associated with the annual average harvest of salmon along the Oregon and Washington coasts to non-tribal commercial fishers was $32,560, and to tribal commercial fishers was $397,300.

TABLE 3-19. AVERAGE ANNUAL (2002 THROUGH 2006) CATCH AND COMMERCIAL EX-VESSEL VALUE FOR TRIBAL AND NON-TRIBAL COMMERCIAL FISHERIES FOR THE PACIFIC OCEAN AND PUGET SOUND.

	Tribal		Non-tribal Commercial	
Economic Impact Region	Average Catch (number of fish)[1]	Ex-vessel Value ($)[2]	Average Catch (number of fish)[1]	Ex-vessel Value ($)[2]
California Coast				
Chinook Salmon	0	0	0	0
Coho Salmon	0	0	0	0
TOTAL	**0**	**0**	**0**	**0**
Oregon Coast				
Chinook Salmon	0	0	9,375	548,888
Coho Salmon	0	0	4,165	53,237
TOTAL	**0**	**0**	**13,540**	**602,125**
Washington Coast				
Chinook Salmon	36,309	1,202,851	39,446	1,694,916
Coho Salmon	29,384	267,391	5,613	55,793
TOTAL	**65,693**	**1,470,242**	**45,059**	**1,750,709**
Puget Sound/Strait of Juan de Fuca				
Chinook Salmon	38,550	799,373	5,231	108,470
Coho Salmon	177,437	1,839,667	22,020	228,303
TOTAL	**215,987**	**2,639,040**	**27,251**	**336,773**
British Columbia				
Chinook Salmon	-[3]	-	276,887	15,780,898
Coho Salmon	-	-	4,194	31,140
TOTAL	**-**	**-**	**281,081**	**15,812,038**
Southeast Alaska				
Chinook Salmon	-	-	312,492	14,655,875
Coho Salmon	-	-	0	0
TOTAL	**-**	**-**	**312,492**	**14,655,875**
CHINOOK SALMON	**81,126**	**2,359,405**	**643,431**	**32,789,046**
COHO SALMON	**206,821**	**2,107,058**	**35,992**	**368,474**
TOTAL	**287,947**	**4,466,463**	**679,423**	**33,157,520**

Sources: Average catch estimates are 2002 through 2006 historical averages (Table 3-17 and Table 3-18). See Appendix J for a description of how ex-vessel values were derived.

[1] Catch values reported in this table are for all stocks, not just Columbia River basin stocks.

[2] All dollar values are expressed in 2007 dollars.

[3] Dashes mean data not available or unreported because no effects from the EIS alternatives are expected.

3.3.6 Recreational Harvest and Economic Value

3.3.6.1 Columbia River Basin

The recreational fishery on the mainstem Columbia River below Bonneville Dam includes two main management areas; the mainstem Columbia River extending from Bonneville Dam downstream to the Astoria-Megler Bridge, and the Buoy 10 area extending from below the Astoria-Megler Bridge to Buoy 10, which marks the ocean/in-river boundary. About 66 percent (39,697,033 fish) of the annual (2002 through 2006) average recreational harvest of salmon and steelhead in the Columbia River basin (59,707,540 fish) occurred in the Lower Columbia River and tributaries (Table 3-20). This percentage was previously reported to be 80 percent in the final EIS for Pacific Salmon Fisheries Management off the Coasts of Southeast Alaska, Washington, Oregon, and California, and in the Columbia River basin (NMFS 2003), but recent data show that the percentage has decreased. The recreational fisheries above Bonneville Dam, which account for the remainder of the harvest, are geographically widespread but socially important. Much of the recreational harvest in both the lower and upper Columbia River occurs in tributaries (NMFS 2003).

TABLE 3-20. AVERAGE ANNUAL (2002 THROUGH 2006) CATCH, NUMBER OF TRIPS, AND TRIP EXPENDITURES FOR RECREATIONAL FISHERIES FOR THE COLUMBIA RIVER BASIN.

ECONOMIC IMPACT REGION/SPECIES	AVERAGE CATCH (NUMBER OF FISH)	NUMBER OF TRIPS	TRIP EXPENDITURES ($)[1]
Lower Columbia River			
Chinook Salmon	78,892	272,041	21,333,485
Coho Salmon	24,671	85,072	6,671,379
Steelhead	46,220	149,097	11,692,169
TOTAL	**149,783**	**506,211**	**39,697,033**
Mid Columbia River			
Chinook Salmon	12,243	39,494	3,097,084
Coho Salmon	2,666	8,600	674,412
Steelhead	5,406	17,439	1,367,544
TOTAL	**20,315**	**65,532**	**5,139,040**
Upper Columbia River			
Chinook Salmon	1,344	4,335	339,989
Coho Salmon	29	94	7,336
Steelhead	1,770	5,710	447,753
TOTAL	**3,143**	**10,139**	**795,078**
Lower Snake River			
Chinook Salmon	3,291	10,616	832,517
Coho Salmon	0	0	0
Steelhead	52,354	168,884	13,243,873
TOTAL	**55,645**	**179,500**	**14,076,390**
CHINOOK SALMON	**95,770**	**326,487**	**25,603,075**
COHO SALMON	**27,366**	**93,766**	**7,353,127**
STEELHEAD	**105,750**	**341,129**	**26,751,339**
TOTAL	**228,886**	**761,382**	**59,707,540**

Sources: Average catch estimates are 2002 through 2006 historical averages (Table 3-18). See Appendix J for how the number of trips and trip expenditures was derived.

[1] All dollar values are expressed in 2007 dollars.

According to NMFS (2003), the Cowlitz, Lewis, Kalama, and Elochoman Rivers in Washington and the Willamette, Sandy, and Santiam Rivers in Oregon account for approximately 45 percent of the Lower Columbia River basin salmon and steelhead harvest. Above Bonneville Dam, the Klickitat, White Salmon, and Little White Salmon tributaries in Washington, the Deschutes in Oregon, and other tributaries account for approximately 60 percent of the salmon and steelhead harvest (NMFS 2003). The Snake River and its main tributaries, the Clearwater and Salmon, account for 35 percent of the upriver steelhead harvest from the Columbia River system (NMFS 2003).

Recent harvest and trends in recreational fisheries in the Columbia River basin are shown in Table 3-21. Within the lower Columbia River economic impact region, about 48 percent (71,558 fish) of the total salmon and steelhead harvest (149,783 fish) occurred in the terminal areas (Table 3-21). Recreational fisheries in the mainstem accounted for about 33 percent (48,914 fish) of the total harvest in the lower Columbia River economic impact region, and Buoy 10 fisheries accounted for about 19 percent (29,311 fish) (Table 3-21). Overall, Chinook salmon is the dominant species caught by recreational anglers in the lower Columbia River economic impact region (accounting for 53 percent [78,892 fish] of all salmon and steelhead harvested), although harvest of steelhead dominates the catch in the terminal areas (Table 3-21).

In the mid Columbia River economic impact region, Chinook salmon dominates the recreational harvest in the mainstem but steelhead is more important in the terminal areas (Table 3-21). Steelhead is important in the Upper Columbia River recreational fisheries, and dominates the harvest in the lower Snake River economic impact region (Table 3-21). An estimated 52,354 steelhead are predicted to be caught annually in the Lower Snake River recreational fisheries. Steelhead account for about 46 percent (105,750 fish) of all salmon and steelhead caught in recreational fisheries in the Columbia River basin (228,886 fish) (Table 3-21).

Based on an estimated 3.2 fishing days per fish caught and $78.42 per day in trip-related expenditures (The Research Group 2009), it is estimated that anglers expend $59,707,540 in trip-related expenditures to catch the annual average number of salmon and steelhead (228,886 fish) (Table 3-20) caught in recreational fisheries in the Columbia River basin. Based on the average annual number of salmon and steelhead (228,886 fish) caught and on average net economic values reported in Appendix J, anglers are estimated to have accrued $35.8 million in total net economic values, which represent anglers’ expected willingness to pay over and above expenditures for these fishing opportunities. Willingness to pay is a concept used to measure the value of a non-market good, such as a recreational fishing experience.

TABLE 3-21. COLUMBIA RIVER BASIN IN-RIVER HISTORICAL (2002 THROUGH 2006) CATCH FOR RECREATIONAL FISHERIES.

ECONOMIC IMPACT REGION/AREA/SPECIES	RECREATIONAL FISHERIES (NUMBER OF FISH)					
	2002	2003	2004	2005	2006	ANNUAL AVERAGE
Lower Columbia River						
Buoy 10						
Chinook Salmon	18,273	14,873	15,201	9,983	1,725	12,011
Coho Salmon	6,200	54,500	15,200	6,900	3,700	17,300
Steelhead	0	0	0	0	0	0
TOTAL	**24,473**	**69,373**	**30,401**	**16,883**	**5,425**	**29,311**
Mainstem (Zones 1-5)						
Chinook Salmon	44,700	45,753	42,749	32,546	23,621	37,874
Coho Salmon	3,100	1,200	1,300	600	1,200	1,480
Steelhead[1]	11,900	9,600	8,800	7,400	10,100	9,560
TOTAL	**59,700**	**56,553**	**52,849**	**40,546**	**34,921**	**48,914**
Terminal Areas						
Chinook Salmon	32,816	35,121	42,270	19,660	15,168	29,007
Coho Salmon	8,586	7,777	4,293	3,483	5,315	5,891
Steelhead[1]	41,400	29,300	49,000	28,100	35,500	36,660
TOTAL	**82,802**	**72,198**	**95,563**	**51,243**	**55,983**	**71,558**
Mid Columbia River						
Mainstem (Zone 6)						
Chinook Salmon	12,408	10,559	11,636	9,558	1,248	9,082
Coho Salmon	0	0	0	0	0	0
Steelhead[2]	N/A	N/A	N/A	N/A	N/A	879
TOTAL	**12,408**	**10,559**	**11,636**	**9,558**	**1,248**	**9,961**
Terminal Areas						
Chinook Salmon	5,213	4,268	4,538	1,306	482	3,161
Coho Salmon	3,886	3,520	1,942	1,576	2,404	2,666
Steelhead[2]	N/A	N/A	N/A	N/A	N/A	4,527
TOTAL	**9,099**	**7,788**	**6,480**	**2,882**	**2,886**	**10,354**
Upper Columbia River						
Chinook Salmon	2,216	1,816	1,929	556	205	1,344
Coho Salmon	42	39	21	17	26	29
Steelhead[2]	N/A	N/A	N/A	N/A	N/A	1,770
TOTAL	**2,258**	**1,855**	**1,950**	**573**	**231**	**3,143**
Lower Snake River						
Chinook Salmon	5,425	4,443	4,722	1,361	503	3,291
Coho Salmon	0	0	0	0	0	0
Steelhead[2]	N/A	N/A	N/A	N/A	N/A	52,354
TOTAL	**5,425**	**4,443**	**4,722**	**1,361**	**503**	**55,645**
CHINOOK SALMON	**121,051**	**116,833**	**123,045**	**74,970**	**42,952**	**95,770**
COHO SALMON	**21,814**	**67,036**	**22,756**	**12,576**	**12,645**	**27,366**
STEELHEAD SALMON	**53,300**	**38,900**	**57,800**	**35,500**	**45,600**	**105,750**
TOTAL	**196,165**	**222,769**	**203,601**	**123,046**	**101,197**	**228,886**

Source: Catch data, with the exception of steelhead for the mid Columbia, upper Columbia, and lower Snake River economic impact regions, are from Joint Columbia River Management Staff (2008a, 2008b, 2009a, 2009b).

[1] Steelhead catch is harvest of summer steelhead only (lower river and upper river origin fish); no winter steelhead included.

[2] N/A= not available. Steelhead average annual values for mid Columbia, upper Columbia, and lower Snake River economic impact regions are based on modeled harvest estimates developed by the Mitchell Act Fishery Modeling Team for Alternative 1.

3.3.6.2 Pacific Ocean and Puget Sound

Recreational fishing for salmon in Pacific Coast waters is limited to hook-and-line gear and is conducted mostly from privately owned pleasure craft and charter boats. There is little shore-based angling in the ocean for salmon. Coho salmon and Chinook salmon contribute fairly evenly to recreational salmon fisheries along the western U.S. coast (including Southeast Alaska), with 232,048 coho salmon caught and 241,251 Chinook salmon caught (Table 3-22). Coho salmon accounts for 96 percent (50,263 fish) of the recreational salmon harvest along the Oregon coast (52,545 fish), 72 percent (82,804 fish) of recreational salmon harvest along the Washington coast (115,594 fish), and 100 percent (1,038 fish) of recreational salmon harvest along the California coast (Table 3-22). In the Puget Sound/Strait of Juan de Fuca economic impact region, coho salmon accounts for 71 percent (68,860 fish) of the recreational harvest (96,673 fish) (Table 3-22), but few if any of these coho salmon originate from the Columbia River basin (Table 3-11). Columbia River stocks contribute more substantially to the Puget Sound Chinook salmon recreational fishery although the number of fish is still small (6 percent) (Table 3-11). In British Columbia and Southeast Alaska, Chinook salmon recreational fisheries are dominant (Table 3-22), and Columbia River stocks are substantial contributors to the Southeast Alaska Chinook salmon recreational fisheries (accounting for an estimated 22 percent of the total recreational harvest) (Table 3-11).

Based on an estimated 1.1 fishing days per fish caught and an average of $74.42 per day in trip-related expenditures (Appendix I), anglers incurred $13,027,958 in trip-related expenditures to catch coho salmon and Chinook salmon (168,138 fish) in recreational fisheries along the Washington and Oregon coasts (Table 3-23). Coho salmon accounts for about 82 percent ($10,746,581) of trip-related recreational expenditures along the Washington and Oregon coasts ($13,027,958) (Table 3-23). For British Columbia and Southeast Alaska, the average recreational catch was 138,334 and 69,116 fish, respectively, resulting in $27,214,181 and $13,597,057, respectively, in trip-related expenditures (Table 3-23).

TABLE 3-22. HISTORICAL (2002 THROUGH 2006) SALMON CATCH IN RECREATIONAL PACIFIC OCEAN AND PUGET SOUND FISHERIES SUPPORTED BY COLUMBIA RIVER STOCKS.

ECONOMIC IMPACT REGION/SPECIES	RECREATIONAL FISHERIES (NUMBER OF FISH)[1]					
	2002	2003	2004	2005	2006	ANNUAL AVERAGE
California Coast						
Chinook Salmon	-[2]	-	-	-	-	
Coho Salmon	828	613	1,424	699	1,626	1,038
TOTAL	**828**	**613**	**1,424**	**699**	**1,626**	**1,038**
Oregon Coast						
Chinook Salmon	2,754	2,330	2,183	3,635	509	2,282
Coho Salmon	36,537	113,659	71,835	13,706	15,577	50,263
TOTAL	**39,291**	**115,989**	**74,018**	**17,341**	**16,086**	**52,545**
Washington Coast						
Chinook Salmon	57,821	34,183	24,907	36,369	10,667	32,789
Coho Salmon	74,134	139,096	112,936	51,770	36,087	82,804
TOTAL	**131,955**	**173,279**	**137,843**	**88,138**	**46,754**	**115,593**
Puget Sound/Strait of Juan de Fuca						
Chinook Salmon	29,562	29,538	23,305	23,864	32,794	27,813
Coho Salmon	66,923	92,006	91,617	63,976	29,780	68,860
TOTAL	**96,485**	**121,544**	**114,922**	**87,840**	**62,574**	**96,673**
British Columbia						
Chinook Salmon	107,089	114,172	129,902	106,599	88,493	109,251
Coho Salmon	11,889	34,589	40,229	41,874	16,834	29,083
TOTAL	**118,978**	**148,761**	**170,131**	**148,473**	**105,327**	**138,334**
Southeast Alaska						
Chinook Salmon	64,683	68,852	78,505	70,040	63,500	69,116
Coho Salmon	-	-	-	-	-	-
TOTAL	**64,683**	**68,852**	**78,505**	**70,040**	**63,500**	**69,116**
CHINOOK SALMON	**261,909**	**249,076**	**258,802**	**240,506**	**195,963**	**241,251**
COHO SALMON	**190,311**	**379,963**	**318,041**	**172,025**	**99,904**	**232,048**
TOTAL	**452,220**	**629,039**	**576,843**	**412,531**	**295,867**	**473,299**

Sources: Catch data for the California, Oregon, and Washington coasts are from the PFMC (2003, 2004, 2005, 2006, 2007). Catch data for Puget Sound/Strait of Juan de Fuca are from WDFW (2008). Catch data for Southeast Alaska are from the PSC (2003, 2004, 2005, 2006, 2007).

[1] Catch values reported in this table are for all stocks, not just Columbia River basin stocks.

[2] Dashes mean data not available or unreported because no effects from EIS alternatives are expected.

Table 3-23. Average Annual (2002 through 2006) Catch, Number of Trips, and Trip Expenditures for Recreational Fisheries for the Pacific Ocean and Puget Sound.

Economic Impact Region	Average Catch (Number of Fish)[1]	Number of Trips	Trip Expenditures ($)[2]
California Coast			
Chinook Salmon	-[3]	-	-
Coho Salmon	1,038	736	79,602
TOTAL	**1,038**	**736**	**79,602**
Oregon Coast			
Chinook Salmon	2,282	3,260	255,649
Coho Salmon	50,263	71,804	5,630,892
TOTAL	**52,545**	**75,064**	**5,886,541**
Washington Coast			
Chinook Salmon	32,789	28,762	2,025,727
Coho Salmon	82,804	72,635	5,115,689
TOTAL	**115,593**	**101,397**	**7,141,417**
Puget Sound/Strait of Juan de Fuca			
Chinook Salmon	27,813	24,397	1,718,307
Coho Salmon	68,860	60,404	4,254,219
TOTAL	**96,673**	**84,801**	**5,972,526**
British Columbia			
Chinook Salmon	109,251	95,834	21,492,738
Coho Salmon	29,083	25,511	5,721,442
TOTAL	**138,334**	**121,346**	**27,214,181**
Southeast Alaska			
Chinook Salmon	69,116	60,628	13,597,057
Coho Salmon	-	-	-
TOTAL	**69,116**	**60,628**	**13,597,057**
CHINOOK SALMON	**241,251**	**212,882**	**39,089,479**
COHO SALMON	**232,048**	**231,090**	**20,801,845**
TOTAL	**473,299**	**443,972**	**59,891,324**

Source: Average catch estimates are 2002 through 2006 historical averages (Table 3-22). See Appendix J for a description of how number of trips and trip expenditures were derived.

[1] Catch values reported in this table are for all stocks, not just Columbia River basin stocks

[2] All dollar values are expressed in 2007 dollars.

[3] Dashes mean data not available or unreported because no effects from EIS alternatives are expected.

3.3.7 Regional Economic Conditions

3.3.7.1 Columbia River Basin

Commercial and recreational fisheries generate personal income and support jobs in regional and local economies throughout the Columbia River basin. Commercial landings of salmon and steelhead are frequently sold directly, or after processing, to persons or businesses located outside the region. This transfer of money supports payments to labor, which are then re-spent regionally (i.e., the multiplier effect). Similarly, non-local recreational anglers (i.e., anglers who live outside the local area) spend money on guide services, lodging, and other goods and services that generate income for local communities. Last, money spent on hatchery operations and management, which often comes from state or Federal sources located outside the local area, provides an additional infusion of income to local economies.

The amount of personal income and the number of jobs supported in Columbia River basin economic impact regions by all Columbia River basin stocks (both hatchery-origin and natural-origin salmon and steelhead) is shown in Table 3-24. These estimates are based on average annual harvest conditions for all salmon and steelhead caught in each economic impact region. The lower Columbia River economic impact region has the greatest economic benefits from the harvest of salmon and steelhead, accounting for $30,326,988 in personal income generated and about 794 jobs. These economic effects include direct, indirect, and induced effects on personal income and jobs in the affected economic impact regions. Harvest conditions in the Lower Snake River, which are almost entirely driven by steelhead harvest, also generate substantial regional economic effects, estimated at $10,521,653 in personal income and supporting about 415 jobs (Table 3-24).

Hatchery operations in the Columbia River basin also generate direct, indirect, and induced economic effects within the basin's four economic impact regions, as shown in Table 3-24. Hatchery production spending on labor and procurement of goods and services is estimated to generate a total of $61,253,275 in personal income and about 1,225 jobs in the basin (Table 3-24). Hatchery-generated economic activity is greatest in the lower Snake River economic impact region, where $22,589,900 in personal income and 452 jobs are estimated to be supported by hatchery operations (Table 3-24).

TABLE 3-24. REGIONAL ECONOMIC EFFECTS OF COLUMBIA RIVER BASIN HATCHERY OPERATIONS AND ASSOCIATED HARVEST.

	HATCHERY OPERATIONS[1]			HARVEST-RELATED EFFECTS[1]	
ECONOMIC IMPACT REGION	OPERATING COSTS ($)[2]	PERSONAL INCOME ($)[2]	NUMBER OF JOBS[3]	PERSONAL INCOME ($)[2]	NUMBER OF JOBS[3]
Lower Columbia River					
Tribal	-[4]	-	-	0	0.0
Non-tribal commercial	-	-	-	693,422	18.2
Recreational	-	-	-	29,633,567	775.7
TOTAL	**27,900,000**	**21,452,745**	**429**	**30,326,988**	**793.9**
Mid Columbia River					
Tribal	-	-	-	730,519	22.5
Non-tribal commercial	-	-	-	0	0.0
Recreational	-	-	-	3,836,258	118.4
TOTAL	**13,300,000**	**10,247,039**	**205**	**4,566,778**	**140.9**
Upper Columbia River					
Tribal	-	-	-	5,887	0.2
Non-tribal commercial	-	-	-	0	0.0
Recreational	-	-	-	593,520	20.3
TOTAL	**9,000,000**	**6,963,591**	**139**	**599,407**	**20.5**
Lower Snake River					
Tribal	-	-	-	13,723	0.5
Non-tribal commercial	-	-	-	0	0.0
Recreational	-	-	-	10,507,930	414.0
TOTAL	**29,300,000**	**22,589,900**	**452**	**10,521,653**	**414.5**
TOTAL (ALL ECONOMIC IMPACT REGIONS)	**79,500,000**	**61,253,275**	**1,225**	**46,014,826**	**1,369.8**

[1] Source: Hatchery operation costs are from Table 4-85 and number of jobs was estimated using jobs per million dollars of production cost factors described in Appendix J. Harvest-related effects on personal income and jobs are based on average annual harvest estimates (Table 3-14, Table 3-15, Table 3-17, Table 3-18, and Table 3-21), and on application of personal income and jobs factors identified in Appendix J.

[2] All dollar values are expressed in 2007 dollars.

[3] Jobs are expressed in full- and part-time jobs.

[4] Dashes mean unknown because funding for hatchery operations is not allocated among user groups.

3.3.7.2 Pacific Ocean and Puget Sound

Columbia River stocks support fisheries that contribute generate personal income and support jobs in affected economic impact regions and local economies throughout the Columbia River basin and Pacific Coast. However, unlike the Columbia River basin, economic impact regions and local economies outside the Columbia River basin (that are within the Pacific Ocean and Puget Sound) are generally more dependent on fish originating from their local river systems, even though Columbia River stocks contribute to the fisheries. Fisheries that affect the Oregon and Washington coast, however, are exceptions. As shown in Table 3-11, fisheries in these areas are substantially dependent on Columbia River basin stocks. The amount of personal income and the number of jobs supported in these economic impact regions by all salmon and steelhead stocks (not just Columbia River basin stocks) is as follows:

- Average annual harvest of salmon in commercial and recreational fisheries along the Washington coast generates $9,207,800 in personal income and supports an estimated 278 jobs.
- Commercial and recreational salmon fisheries along the Oregon coast generates $4,490,463 in personal income and 142 jobs.

These reported values for personal income and jobs on the Washington and Oregon coasts represent average annual conditions over the 2002 through 2006 period. These numbers, therefore, do not match the modeled values for Alternative 1 (Table 4-96) (Table 4-97). Additional socioeconomic and demographic information for western U.S. coast fishing communities can be found on the NMFS Northwest Fisheries Science Center website at: http://www.nwfsc.noaa.gov/research/divisions/sd/communityprofiles/index.cfm.

3.4 Environmental Justice

3.4.1 Introduction

The EPA defines environmental justice as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies" (http://www.epa.gov/compliance/basics/ejbackground.html). Under Executive Order (EO) 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, the EPA states that "each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." Further, EPA guidance recommends that the environmental justice analysis also determine whether such populations or communities have been sufficiently involved in the decision-making process (EPA 1998).

Generally, minority and low income target populations are defined as follows:

- **Minority** – All people of the following origins: Black, Asian, American Indian and Alaska Native, Native Hawaiian or Other Pacific Islander, and Hispanic (considered an ethnic and cultural identity and not the same as race)
- **Low income** – Persons whose household income is at or below the U.S. Department of Health and Human Services poverty guidelines (EPA 1998)

As it pertains to environmental justice, the affected environment presented in this section includes an overview of policy and regulatory considerations, the analysis area for environmental justice, a description of methodology for conducting the environmental justice analysis, identification of communities and groups of concern for the analysis based on existing demographic data and established thresholds, and a summary of the public outreach process. In Section 4.4, Environmental Justice, the analysis of environmental justice effects is based on changes in selected indicators that affect communities and groups of concern.

3.4.2 Analysis Area

The analysis area for environmental justice includes the project area (Section 2.2, Description of Project Area), plus the following areas: 1) coastal areas of Washington, Oregon, and Idaho; 2) British Columbia (Canada); 3) the Puget Sound/Strait of Juan de Fuca; and 4) Southeast Alaska. The analysis area for environmental justice is the same as the analysis area for socioeconomics (Figure 3-1). The analysis area includes areas outside the project area because salmon and steelhead that are produced within the project area can migrate outside the project area and contribute to fisheries in these areas. Changes in salmon and steelhead fisheries may lead to environmental justice effects.

Most of the information presented in this section is at the county level. However, for consistency with the socioeconomic conditions presented in Section 3.3 (Socioeconomics), and the related analysis in Section 4.3 (Socioeconomics), information is organized according to the following economic impact regions: lower Columbia River, mid Columbia River, upper Columbia River, lower Snake River, Oregon coast, Washington coast, California coast, Puget Sound/Strait of Juan de Fuca, British Columbia, and Southeast Alaska. However, the geographic scale of these economic impact regions is too large to use in an environmental justice analysis.

3.4.3 Environmental Justice Methodology

The environmental justice methodology considers the range of analytical procedures identified in EPA's guidelines on environmental justice analysis (EPA 1998), particular circumstances related to the affected economic impact regions, and alternative approaches used to evaluate environmental justice issues for Federal fishery management programs and projects in the Pacific Northwest.

3.4.3.1 Approach for Identifying Environmental Justice User Groups and Communities of Concern

The methodology used for this EIS analysis to identify affected groups and communities of concern from an environmental justice perspective is outlined below. This methodology was applied to user groups and communities of concern in Washington, Oregon, California, and Idaho. User groups and communities of concern in Puget Sound/Strait of Juan de Fuca, British Columbia, and Southeast Alaska were identified and discussed qualitatively because data are not available to determine the specific user groups and communities of concern that would be affected by EIS alternatives.

Step 1: Establish the Target Area. A target area is the geographical study area that is potentially affected by the Proposed Action or EIS alternatives. For this assessment, the target area is the same as the analysis area (Section 3.4.2, Analysis Area). A complete list of counties comprising the target area, organized by economic impact region, is presented in Table 3-25.

Step 2: Identify the Population Areal Unit. A population areal unit is the geopolitical unit containing populations that, in aggregate, define the target area. When analyzing environmental justice effects at the regional scale, the population areal unit used is mostly the county for the

Columbia River basin economic impact regions. However, when assessing distinct user groups, sub-economic impact regions may be considered. For commercial fish harvesters and processors, the population areal units are the affected fishing ports and communities where these user groups are concentrated. Along the Pacific coast, included are Neah Bay, La Push, Westport, and Ilwaco in Washington; Astoria, Tillamook, Newport, Coos Bay, and Brookings in Oregon; and Crescent City, Eureka, Fort Bragg, San Francisco, and Monterey in California State. In the inland areas of the lower Columbia River, the commercial fishing fleet is concentrated in smaller ports of St. Helens-Rainier, Clatskanie, and Dodson, Oregon; and the Washington communities of Cathlamet, Skamokawa, Kalama, Longview, and Vancouver (inland fishing communities were derived from NMFS [2003]). For Native American tribes, the population areal unit is the reservation.

TABLE 3-25. ECONOMIC IMPACT REGIONS AND MAJOR COUNTIES AND RESERVATIONS.

ECONOMIC IMPACT REGION	COUNTY (STATE)	NATIVE AMERICAN RESERVATION
Lower Columbia River	Benton (OR), Clackamas (OR), Clatsop (OR)[1], Columbia (OR), Lane (OR), Linn (OR), Marion (OR), Multnomah (OR), Polk (OR), Washington (OR), Yamhill (OR), Clark (WA), Cowlitz (WA), Lewis (WA), Pacific (WA)[1], Wahkiakum (WA)	Grand Ronde Reservation
Mid Columbia River	Crook (OR), Deschutes (OR), Gilliam (OR), Grant (OR), Hood River (OR), Jefferson (OR), Morrow (OR), Sherman (OR), Umatilla (OR), Wasco (OR), Wheeler (OR), Benton (WA), Franklin (WA), Grant (WA), Klickitat (WA), Skamania (WA), Walla Walla (WA)	Warm Springs and Umatilla Reservations
Upper Columbia River	Chelan (WA), Douglas (WA), Kittitas (WA), Okanogan (WA), Yakima (WA)	Yakama and Colville Reservations
Lower Snake River	Adams (ID), Clearwater (ID), Custer (ID), Idaho (ID), Latah (ID), Lemhi (ID), Lewis (ID), Nez Perce (ID), Shoshone (ID), Valley (ID), Union (OR), Wallowa (OR), Asotin (WA), Columbia (WA), Garfield (WA), Whitman (WA)	Nez Perce Reservation
Washington Coast	Clallam (WA), Grays Harbor (WA), Jefferson (WA), Pacific (WA)[1]	
Oregon Coast	Clatsop (OR)[1], Coos (OR), Curry (OR), Lincoln (OR), Tillamook (OR)	
California Coast	Del Norte (CA), Humboldt (CA), Mendocino (CA), Monterey (CA), San Francisco (CA)	
Puget Sound/Strait of Juan de Fuca	Regional analysis only	
British Columbia	Regional analysis only	
Southeast Alaska	Regional analysis only	

[1] Included in two economic impact regions.

Note: economic impact regions are included in this table so that the reader can cross reference between Section 3.3 (Socioeconomics) and Section 3.4 (Environmental Justice). However, the geographic scale of the economic impact regions is too large to be used in an environmental justice analysis.

Step 3: Identify the Target Population. The target population includes the potentially affected residents of each county, port, community, or reservation. Because this EIS analyzes hatchery management activities in the Columbia River basin that affect fish harvests, the primary target populations for analysis are the non-tribal commercial and sport fishers and tribal members harvesting these stocks. Once salmon are landed, there may be secondary effects on people within the target area, such as fish processors (commercial harvests), recreation-serving business operators (recreational harvests), and tribal members who consume the salmon harvested.

Step 4: Identify the Reference Area. A reference area is the area used as a benchmark of comparison when identifying whether a target population has minority or low-income population that may be subject to disproportionate environmental and economic effects, thereby warranting further consideration in the context of environmental justice. The reference areas for this analysis are the states where each county, fishing port, community, or reservation is located. The states include Washington, Oregon, Idaho, and California.

Step 5: Establish Thresholds to Identify Environmental Justice User Groups and Communities of Concern. Quantitative thresholds were established to determine whether a target area has a significantly higher minority or low-income population relative to the reference area. The environmental justice thresholds used in this analysis are described in Section 3.4.3.2, Environmental Justice Thresholds.

Step 6: Identify Environmental Justice User Groups and Communities of Concern. In this step, socio-demographic data for target populations and applicable reference areas were compared to the thresholds established in Step 5 and, if the affected population within a target area had minority or low-income populations exceeding the thresholds, the population was identified as an environmental justice user group or community of concern. The environmental justice user groups and communities of concern were evaluated in more detail in the impact analyses to determine if, and to what extent, they would experience disproportionate environmental and economic effects.

3.4.3.1.1 Environmental Justice Approach for Native American Tribes

EPA guidance regarding environmental justice extends beyond statistical threshold analyses to consider explicit environmental justice effects on Native American tribes (EPA 1998). Federal duties under the Environmental Justice Executive Order, the presidential directive on government-to-government relations, and the trust responsibility to Indian tribes may merge when the action proposed by another federal agency or the

EPA potentially affects the natural or physical environment of a tribe. The natural or physical environment of a tribe may include resources reserved by treaty or lands held in trust; sites of special cultural, religious, or archaeological importance, such as sites protected under the National Historic Preservation Act or the Native American Graves Protection and Repatriation Act; and other areas reserved for hunting, fishing, and gathering (usual and accustomed [U&A]), which may include "ceded" lands that are not within reservation boundaries. Potential effects of concern may include ecological, cultural, human health, economic, or social impacts when those impacts are interrelated to impacts on the natural or physical environment (EPA 1998).

A number of Native American tribes either have treaty fishing rights or otherwise demonstrated historic linkages with fishery management in the analysis area. Based on the close relationship between fishery management and the welfare of Native American populations, all tribes potentially affected by the EIS alternatives were considered an environmental justice group of concern, and accordingly, tribal effects were a specific focus of the environmental justice analysis.

3.4.3.1.2 Environmental Justice Approach for Non-tribal User Groups and Communities

When determining whether affected user groups are an environmental justice group of concern, the demographic characteristics specific to these groups must be considered. For this analysis, two key non-tribal user groups could be affected by hatchery management: 1) commercial fishers and processors and 2) recreational anglers and support businesses. The prevalence of significant minority and low-income populations among commercial fishers and processors in the economic impact regions requires demographic data for those groups that is not readily available. Consequently, available data for coastal fishing communities in Washington, Oregon, and California were used as a proxy for the demographic makeup of these user groups and compared to the environmental justice thresholds presented in Section 3.4.3.2, Environmental Justice Thresholds.

For recreational anglers, demographic data are also limited and available only at the state level. For this group, demographic data were obtained from the *2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation* (USFWS 2006). In this study, race and ethnicity data were organized based on four minority groups: Black, Asian, Other, and Hispanic. Further, income-related data were presented based on income brackets, rather than poverty rates or per-capita income levels. As a result, the methodology used for recreational anglers in this study deviated slightly from the USFWS (2006) approach as described below.

For recreational anglers, two minority categories were used: percent non-white and percent Hispanic. The minority percentages for recreational anglers within a particular state were compared to the corresponding values for the general population in that same state (i.e., reference area) to determine if these groups were an environmental justice group of concern. Due to the organization of the USFWS (2006) income data (Appendix J), determining whether recreational anglers are classified as low-income populations was based on comparing the percentage of recreational anglers in the two lowest income brackets (less than $10,000 annually and $10,000 to $20,000 annually) relative to the annual income of the state's population. If the percentage of recreational anglers in these two low-income brackets was higher than the corresponding state value, then the group was identified as an environmental justice group of concern. Potential environmental justice effects on recreational support businesses were considered as part of the assessment of county-wide local income effects.

3.4.3.2 Environmental Justice Thresholds

Guidance on defining minority and low income areas was established by the CEQ in *Environmental Justice Guidance under the National Environmental Policy Act (*1997). CEQ's guidance states the following:

> Minority populations should be identified where either (a) the minority population of the affected area exceeds 50 percent or (b) the population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographical analysis… The selection of the appropriate unit of geographical analysis may be a governing body's jurisdiction, a neighborhood, a census tract, or other similar unit that is chosen so as not to artificially dilute or inflate the affected minority population (CEQ 1997).

The CEQ guidelines do not specifically state the percentage considered meaningful in the case of low-income populations.

For this study, the approach used to identify environmental justice areas and groups of concern was based on the determination of whether minority and low-income populations in affected counties (Table 3-25) and across user groups were meaningfully greater than the reference population (i.e., states where each county, fishing port, community, and/or reservation is located). Five minority and low-income categories were considered in the analysis: 1) percent non-white population, 2) percent Native American population, 3) percent Hispanic population, 4) per capita income, and 5) poverty rate. Based on 2000 census data, thresholds for each of the environmental justice categories were established and used to determine if the proportion of minority or low-income populations characterizing an affected county or user group was sufficiently different from these same populations within the reference area. Table 3-26 shows the total population, number of counties, and threshold values for the five environmental justice categories for each of the four reference areas used in the analysis, These reference areas were established so that environmental justice user groups and communities of concern could be identified (Section 3.4.3.1, Approach for Identifying Environmental Justice User Groups and Communities of Concern). The reference areas are the states of Washington, Oregon, California, and Idaho. Based on these thresholds, counties and user groups in the affected economic impact regions with minority populations and poverty rates exceeding the threshold values and income levels below the thresholds were determined to be environmental justice user groups or communities of concern.

TABLE 3-26. ENVIRONMENTAL JUSTICE THRESHOLDS FOR REFERENCE AREAS.

			THRESHOLD VALUES				
REFERENCE AREA (STATE)	TOTAL POPULATION	NUMBER OF COUNTIES	NON-WHITE (%)	NATIVE AMERICAN (%)	HISPANIC (%)	POVERTY RATE (%)	PER CAPITA INCOME ($)
California	33,871,648	58	41.74	2.65	37.52	19.50	15,815
Idaho	1,293,953	44	13.53	1.97	13.65	15.59	13,990
Oregon	3,421,399	36	17.95	2.55	10.57	14.69	16,410
Washington	5,894,121	39	18.41	3.03	13.41	17.69	15,829

3.4.3.2.1 Native American Tribal Thresholds

As indicated above in Section 3.4.3.1.1, Environmental Justice Approach for Native American Tribes, all Native American tribes with a vested interest in fishery management along the Columbia River qualify as environmental justice communities of concern, as do affected tribes in the Columbia River basin, Puget Sound/Strait of Juan de Fuca, British Columbia, and Southeast Alaska. Note that while individual tribes may not meet traditional environmental justice analysis thresholds for minority or low-income populations, they are, nonetheless, regarded as affected groups for environmental justice purposes by defined EPA guidance (EPA 1998).

3.4.3.2.2 Minority Thresholds

The threshold values for non-white populations ranged between 14 percent of the population in Idaho to 42 percent of the population in California. For Native American populations, the thresholds ranged from 2 percent of the population in Idaho to 3 percent of the population in Washington. Last, the threshold values for Hispanic populations ranged from 11 percent of the population in Oregon to 38 percent of the population in California (Table 3-26).

3.4.3.2.3 Low-Income Thresholds

Environmental justice thresholds for low-income populations were based on poverty rates and annual per-capita income levels. For poverty rates, threshold values ranged from 15 percent of the population being below the poverty rate in Oregon to 20 percent in California. For annual per-capita income, the threshold value was lowest in Idaho at $13,990 and highest in Oregon at $16,410 (Table 3-26).

3.4.4 Environmental Justice Populations Reviewed

Using the methodology outlined in Section 3.4.3, Environmental Justice Methodology, 35 communities and 11 user groups (in addition to Native American tribes), were identified as environmental justice concerns and were carried forward for further analysis as part of the environmental justice impact assessment in Section 4.4, Environmental Justice. Summaries of potentially affected communities and groups are presented in the following sections.

3.4.4.1 Native American Tribes of Concern

The EIS alternatives may affect eight groups of Native Americans within the Columbia River basin: the Nez Perce Tribe, Confederated Tribes of Umatilla Indian Reservation, Confederated Tribes of Warm Springs Reservation, Yakama Nation, Confederated Tribes of the Colville Reservation, Cowlitz Indian Tribe, Confederated Tribes of the Grand Ronde, and Shoshone-Bannock Tribes. Below is a brief overview of each tribal group obtained from NMFS (2003), from a tribal website, or through personal communication (refer to Figure 3-2 for the mapped location of tribal reservations).

- **Nez Perce Tribe.** The Nez Perce Indian Reservation covers approximately 138,000 acres across Idaho, of which about 35 percent is tribally owned. The tribe has approximately 3,250 tribal members. The Nez Perce Tribe participates in commercial, ceremonial, and subsistence fisheries in Zone 6, as well as in fisheries in much of the Snake River basin. Fisheries in the Snake River and its tributaries are typically ceremonial and/or subsistence, but the tribe may authorize commercial fisheries in this area, usually targeting abundant returning hatchery-origin fish (NMFS 2003).

- **Confederated Tribes of the Umatilla Indian Reservation.** Three tribes make up the Confederated Tribes of the Umatilla Indian Reservation: Cayuse, Umatilla, and Walla Walla. The Umatilla Indian Reservation is approximately 172,000 acres, comprising approximately 8 percent of Umatilla County, Oregon. There are approximately 2,800 tribal members. Approximately half of the tribal members live on or near the reservation, in conjunction with about 300 American Indians from other tribes and 1,500 non-American Indians. Salmon and steelhead fishing remains the foundation of the Tribe's culture and religion. The tribe typically harvests spring, summer, and fall Chinook salmon; coho salmon; sockeye salmon; and steelhead (NMFS 2003).

  Tribal members fish in the Columbia River and its tributaries located in southeastern Washington and northeastern Oregon. Approximately 30 tribal members conduct commercial fishing activities for about 60 days each year, typically in Zone 6 (between Bonneville and McNary Dams) of the Columbia River, harvesting Chinook salmon in the fall and steelhead and sturgeon in the winter. In addition, as many as 100 tribal members participate in ceremonial and subsistence fisheries (NMFS 2003).

- **Confederated Tribes of Warm Springs.** Three tribes make up the Confederated Tribes of Warm Springs: the Warm Springs, Wasco, and Paiute Tribes. The Warm Springs Indian Reservation covers more than 641,000 acres in parts of Jefferson and Wasco Counties, Oregon. It is characterized by both forest and rangeland. The tribe has 3,755 members; approximately 3,200 members live on the reservation along with 460 non-members (NMFS 2003).

  Salmon and steelhead fishing is important to the way of life of the Warm Springs Tribes. Tribal harvests typically occur from March through October and include spring, summer, and fall Chinook salmon; sockeye salmon; and steelhead. Tribal members fish primarily in Zone 6 of the Columbia River, the Deschutes River, and the Willamette River, with some additional harvests in the Hood and John Day Rivers. Warm Springs tribal members share the Columbia River with the Yakama Nation, Confederated Tribes of Umatilla, and Nez Perce Tribe. They share the John Day River with the Confederated Tribes of Umatilla. Approximately 15 tribal members conduct commercial fishing activities for fall Chinook salmon in Zone 6 (between Bonneville and McNary Dams) of the Columbia River. Further, several hundred tribal members conduct ceremonial and subsistence harvests in the Columbia and Deschutes Rivers. Tribal members conduct ceremonial and subsistence fishing activities regularly over a 6-month period and intensively for 4 to 6 weeks within that period (NMFS 2003).

- **Yakama Nation.** The Yakama Nation consists of 14 bands and tribes: Palouse, Pisquose, Yakama, Wenatchapam, Klinquit, Oche Chotes, Kow way saye ee, Sk'in-pah, Kah-miltpah, Klickitat, Wish ham , See ap Cat, Li ay was, and Shyiks. The Yakama Indian Reservation covers about 1.4 million acres in Klickitat and Yakima Counties in south-central Washington. The reservation includes agricultural land, range or grazing land, and forested areas. There are 8,870 tribal members (NMFS 2003).

  Tribal members have historically depended on the Columbia River and salmon for their subsistence. The tribe places greatest cultural importance on harvesting wild salmon for ceremonial uses. Subsistence fishing is permitted year-round in the mainstem Columbia River unless closed by tribal regulation to meet management guidelines. Tribal harvests typically occur all year and include spring, summer, and fall Chinook salmon; coho salmon; sockeye salmon; and summer and winter steelhead. The Yakama Nation harvests fish primarily in Zone 6 (between Bonneville and McNary Dams) of the Columbia River, its tributaries (Yakima and Klickitat Rivers), and Icicle Creek (which is a tributary to the Wenatchee River (NMFS 2003).

  Commercial salmon and steelhead fishing provides a means for continuing with parts of the Tribe's historical lifestyle and represents a main source of livelihood for some tribal members. Tribal commercial fishing is permitted in Zone 6 of the Columbia River except in specific areas where closures are established to protect stocks. The Yakama Nation also occasionally authorizes commercial fisheries in some tributaries and terminal fishing areas such as the Klickitat River and Drano Lake. In addition, salmon are an essential part of tribal ceremonies and subsistence and are considered an important part of tribal members' diets. The ceremonial and subsistence fisheries can occur at any time of the year on the Columbia River and from early April until the end of October on the various tributaries (NMFS 2003).

- **Shoshone-Bannock Tribes.** The Shoshone-Bannock Tribes are made up of four distinct bands of Shoshone and one northern Paiute band, the Bannocks. The Fort Hall Indian Reservation, home of the Shoshone-Bannock Tribes, covers approximately 544,000 acres in southeastern Idaho. The reservation lies partially in Bingham, Bannock, Power, and Caribou Counties. There are approximately 5,400 tribal members. The tribes are the second-largest employer in southeast Idaho employing both tribal members and non-tribal individuals.

The Shoshone-Bannock Tribes have a long history of salmon fishing (which their treaty refers to as *hunting*) in the Columbia River basin, and this has been judicially affirmed. One of the names for the Shoshone-Bannock Tribes is the Agaidikas, (Salmon-Eater Shoshone). Currently, tribal members do not fish the Zone 6 commercial tribal fishery (located between Bonneville and McNary Dams). Tribal members fish mostly in the Salmon and Snake Rivers in Idaho, but they plan to continue to develop fisheries in northeast Oregon and southwest Washington (K. Kutchins, pers. comm., Former Anadromous Fisheries Biologist, Shoshone-Bannock Tribes, February 17, 2010) (C. Broncho, pers. comm., Policy Representative, Shoshone-Bannock Tribes, February 17, 2010) (L. Denny, pers. comm., Fisheries Biologist, Shoshone-Bannock Tribes, February 17, 2010).

- **Confederated Tribes of the Colville Reservation.** Twelve bands comprise the Confederated Tribes of the Colville Reservation: Wenatchee (Wenatchi), Nespelem, Moses-Columbia, Methow, Colville, Okanogan, Palus, San Poil, Entiat, Chelan, Nez Perce, and Lake. The size of the reservation is about 1.4 million acres (2,100 square miles), and total tribal enrollment is 9,365 people. Although salmon fishing remains an important food source, salmon runs are restricted due to the construction of Grand Coulee and Chief Joseph Dams on the Columbia River, but tribal members continue to fish on the numerous lakes and streams on the reservation, often for subsistence.

The Confederated Tribes of the Colville Reservation have a long-established fisheries program involved in on- and off-reservation salmon and steelhead fisheries management. They are specifically involved in the following activities (K. Kutchins, pers. comm., Upper Columbia United Tribes, February 17, 2010) (D.R. Michel, pers. comm., Executive Director, Upper Columbia United Tribes, February 17, 2010) (J. Peone, pers. comm., Director of Fish and Wildlife, Confederated Tribes of the Colville Reservation, February 17, 2010):

- The tribes have received Pacific Coastal Salmon Recovery Funds since 2001 to reestablish salmon runs on the Columbia and Okanogan Rivers.
- The tribes have worked with Federal, state, and local governments, as well as Canada First Nations, to reestablish runs in the Okanogan River subbasin.

- For the past several years, the tribes have tested various selective fishing techniques to increase the availability of natural-origin fish on the spawning grounds while reducing negative effects of hatchery-origin fish.
- The tribes are part of the technical management team for the Leavenworth National Fish Hatchery.
- The tribes have negotiated production and harvest agreements with the state of Washington to protect their interest and needs.
- The tribes are in the process of developing, constructing, and operating a hatchery facility for salmon and steelhead as part of the original mitigation due to the construction of the Grand Coulee Dam and the continued operation of the rest of the FCRPS.

- **Cowlitz Indian Tribe.** The Cowlitz Tribe consists of approximately 3,600 members. Tribal members are located throughout western Washington and Oregon. Today, the enrolled members of the Cowlitz Indian Tribe continue traditional observances related to religion and food, especially involving salmon.

  The Cowlitz Tribe has expressed particular interest in salmon and steelhead in the lower Columbia estuary and associated tributaries and has participated in the development of the salmon recovery plan in southwest Washington. The Cowlitz Tribe receives Pacific Coastal Salmon Recovery Funds for salmon restoration efforts (T. Aalvik, pers. comm., Tribal Director of Natural Resources, Cowlitz Tribe, February 17, 2010).

- **Confederated Tribes of the Grand Ronde.** The Confederated Tribes of the Grand Ronde include the Umpqua, Mololla, Rogue River, Kalapuya, and Chasta Tribes. Their reservation is located in the coast range of Oregon (http://www.grandronde.org). When the tribes' Federal recognition was restored in 1983, there remained some potential conflicts with the state of Oregon regarding fishing rights (K. Dirksen, pers. comm., Tribal Fish and Wildlife Program Manager, Cowlitz Tribe, February 17, 2010). In 1986, the tribe and the state of Oregon signed a consent decree, which identified and explained, in part, how the tribe would manage and fish for salmon. Tribal members engage in ceremonial and subsistence fishing throughout original ceded lands. The tribe has participated in salmon recovery planning covering the reservation and ceded lands.

In addition to tribes described above, tribes along the Washington coast and Puget Sound/Strait of Juan de Fuca, British Columbia, and Southeast Alaska would be potentially affected by hatchery management activitie,s but to a lesser extent than the Columbia River tribes described above. Of the tribes that are not located in the Columbia River basin, the Makah, Quileute, and Quinault Tribes would be most impacted. Other tribes that may be impacted include, but are not limited to, the Lower Elwha, Jamestown S'kallam, Port Gamble S'Kallam, Suquamish, Lummi, Nooksack, Swinomish, and Tulalip. A complete discussion of these tribes and their salmon and steelhead fisheries can be found in the Puget Sound Salmon Harvest EIS (NMFS 2004).

In British Columbia, the primary native groups that would be affected by changes in salmon harvests would be the bands of the First Nations of Canada. Alaska Natives fish either subsistence fish (which would mostly be in the tributaries where they would not likely intercept Columbia River fish) or commercial fish (which is a limited entry fishery and is not designated as a tribal or non-tribal fishery) (B. Allee, pers. comm., NMFS, May 25, 2010).

3.4.4.1.1 Fish Harvests and Tribal Values

Historical tribal harvests are provided in Table 3-11 and Table 3-17. Most tribal harvest of Columbia River salmon occurs in the mid Columbia River economic impact region. There are also substantial levels of tribal harvest along the Washington coast and in the Puget Sound/Strait of Juan de Fuca, but only a very small percentage of the fish taken in Puget Sound originate from the Columbia River basin (W. Beattie, pers. comm., Conservation Planning Coordinator, Northwest Indian Fisheries Commission, May 22, 2009). No quantifiable tribal harvests occur in the Lower Columbia River or along the Oregon and California coasts.

3.4.4.1.2 Ceremonial and Subsistence Harvests

Ceremonial and subsistence harvest of salmon, primarily Chinook salmon and coho salmon, plays a key role in the cultural viability of tribes in the affected economic impact regions. Harvest of salmon for ceremonial and subsistence purposes typically occurs before fish are taken for commercial purposes (W. Beattie, pers. comm., Conservation Planning Coordinator, Northwest Indian Fisheries Commission, May 22, 2009). In general, salmon and steelhead produced in the Columbia River basin contribute to ceremonial and subsistence harvest for Columbia River tribes, but do not contribute meaningfully to ceremonial and subsistence harvest for tribes outside the Columbia River basin because few Columbia River fish are located in areas where most ceremonial and subsistence fishing occurs. As a result, the number of Columbia River salmon contributing to ceremonial and subsistence harvest was not estimated for tribes outside of the Columbia River basin.

The number of salmon and steelhead taken in the Columbia River basin for ceremonial and subsistence purposes in recent years was estimated based on the following assumptions (L. Lastelle, pers. comm., Biostream Environmental, April 8, 2009):

- Of all summer Chinook salmon caught by the tribes, 64.3 percent is taken for ceremonial and subsistence purposes.
- Of all spring Chinook salmon caught by the tribes, 65.9 percent is taken for ceremonial and subsistence purposes.
- If all fall Chinook salmon caught by the tribes, 0.5 percent is taken for ceremonial and subsistence purposes.
- Of all coho salmon caught by the tribes, 7.1 percent is taken for ceremonial and subsistence purposes.

Based on these assumptions, the annual number of salmon taken for ceremonial and subsistence was determined by using recent 5-year ceremonial and subsistence harvest amounts from the Columbia River basin, resulting in 12,976 salmon taken by the following economic impact regions:

- In the lower Columbia River economic impact region, zero salmon are taken.
- In the mid Columbia River economic impact region, 9,481 salmon are taken.
- In the upper Columbia economic impact region, 1,357 salmon are taken.
- In the lower Snake economic impact region, 2,138 salmon are taken.

Note that the ceremonial and subsistence harvests shown here are in addition to the commercial tribal harvest estimates shown in Table 4-87.

3.4.4.1.3 Tribal Salmon Fishing and Hatchery Program Revenue

Tribal revenues from salmon harvest are provided in Table 3-16 and were determined using ex-vessel values. The mid Columbia River economic impact region has the highest revenue ($9,729,723) followed by the Puget Sound/Strait of Juan de Fuca ($2,639,040) and the Washington Coast ($1,470,242). Other economic impact regions generate less than 2 percent of total tribal fishing revenue (Table 3-19).

Costs associated with fish hatcheries operated by the Yakama Nation, Nez Perce Tribe, and Confederated Tribes of the Umatilla Indian Reservation total $3.0 million on an annual basis. Note that this total does not include costs associated with hatchery programs that that are jointly operated with other agencies. These costs include employee salaries and operation and maintenance costs.

3.4.4.2 Non-tribal User Groups of Concern

The analysis of non-tribal user groups, more specifically commercial fishers, is focused on port communities along the coast, as well as the mainstem Columbia River and its tributaries in the lower Columbia River economic impact region. Based on community-level data, commercial fishers in 11 port and fishing communities were identified as environmental justice user groups of concern based on minority and/or low-income criteria (Table 3-27). Of these, four user groups are located in the California coast economic impact region, three user groups in the Washington coast economic impact region, three user groups in the Oregon coast economic impact region, and one user group in the lower Columbia River economic impact region (Table 3-27).

TABLE 3-27. SUMMARY OF ENVIRONMENTAL JUSTICE USER GROUPS OF CONCERN (COMMERCIAL FISHERS).

ECONOMIC IMPACT REGION / COMMUNITY	MINORITY (%)	NATIVE AMERICAN (%)	HISPANIC (%)	POVERTY RATE (%)	PER CAPITA INCOME ($)	FISHING NET REVENUES ($)
Washington Coast						
La Push	90.6[1]	83.0		34.5	9,589	76,791
Neah Bay	85.8	78.2		29.9	11,338	258,612
Westport		3.1				273,837
Oregon Coast						
Astoria				15.9		253,269
Coos Bay				16.5		N/A[2]
Tillamook			11.1	15.4	15,160	N/A
California Coast						
Crescent City		6.1		34.6	12,833	N/A
Eureka		4.2		23.7		N/A
Fort Bragg				40.9		N/A
San Francisco	50.3					N/A
Lower Columbia River						
Dodson		3.9		16.6	16,083	54,080

[1] Gray highlight indicates that these values exceed threshold values for a low income or minority, making them a user group of concern.

[2] N/A means information not available for these communities.

In addition, the analysis of user groups also considered recreational anglers in the 10 economic impact regions. The analysis of recreational anglers was conducted at the state level based on lack of data at the local level. The statewide analysis shows that there are no recreational angler groups in any state that qualify as environmental justice groups of concern. As a result, recreational anglers were not carried forward as a group subject to further environmental justice analysis.

3.4.4.3 Communities of Concern

Counties become communities of concern if they exceeded the environmental justice thresholds for either low-income or minority populations (Table 3-28) (Section 3.4.3.2, Environmental Justice Thresholds). Some counties qualify as both low-income and minority communities of concern. Thirty-five counties qualify as low-income and/or minority communities of concern (Table 3-28).

3.4.4.3.1 Low-income Communities of Concern

Counties were identified as low-income if the poverty rate and/or per-capita income level were below threshold levels established for the applicable reference area. Fifteen counties in the affected economic impact regions qualify as low-income communities (Table 3-28). Across economic impact regions, five of the counties are located within the mid Columbia River economic impact region (Jefferson, Morrow, Wheeler, Franklin, and Grant), four within the lower Snake River economic impact region (Idaho, Latah, Shoshone, and Whitman), three within the upper Columbia River economic impact region (Kittitas, Okanogan, and Yakima), two within the California coast economic impact region (Del Norte and Humboldt), and one within the Oregon coast economic impact region (Coos) (Table 3-28).

3.4.4.3.2 Minority Communities of Concern

Three minority categories were used to determine if a particular county was considered a minority community of concern: non-white, Native American, and Hispanic. Minority communities of concern were identified when the percentage in each category exceeded threshold levels established for the applicable reference area.

Twenty-nine counties were considered minority communities in the context of the environmental justice analysis (Table 3-28). Some of these minority communities of concern are also low-income communities of concern (e.g., Morrow and Franklin Counties). Of the minority communities, nine are located in the mid Columbia River economic impact region (Hood, Jefferson, Morrow, Umatilla, Wasco, Wheeler, Franklin, Klickitat, Walla Walla, and Grant), five within the California coast economic impact region (Del Norte, Humboldt, Mendocino, Monterey, and San Francisco), four within the upper Columbia River economic impact region (Chelan, Douglas, Okanogan, and Yakima), four within the lower Columbia River economic

TABLE 3-28. SUMMARY OF ENVIRONMENTAL JUSTICE COMMUNITIES OF CONCERN.

ECONOMIC IMPACT REGION / COUNTY[1]	NON-WHITE (%)	NATIVE AMERICAN (%)	HISPANIC (%)	POVERTY RATE (%)	PER CAPITA INCOME ($)
Lower Columbia River					
Marion Co. (OR)	18.4[2]		17.1		18,408
Multnomah Co. (OR)	20.8				22,606
Washington Co. (OR)			11.2		24,969
Yamhill Co. (OR)			1.6		18,951
Mid Columbia River					
Hood River Co. (OR)	21.1		25.0		17,877
Jefferson Co. (OR)	31.0	15.7	17.7		15,675
Morrow Co. (OR)	23.7		24.4	14.8	15,802
Umatilla Co. (OR)	18.0	3.4	16.1		16,410
Wasco Co. (OR)		3.8			17,195
Wheeler Co. (OR)				15.6	15,884
Franklin Co. (WA)	38.1		46.7	19.2	15,459
Klickitat Co. (WA)		3.5			16,502
Walla Walla Co.(WA)			15.7		16,509
Grant Co. (WA)	23.5		30.1		15,037
Upper Columbia River					
Chelan Co. (WA)			19.3		19,273
Douglas Co. (WA)			19.7		17,148
Kittitas Co. (WA)				19.6	18,928
Okanogan Co. (WA)	24.7	11.5	14.4	21.3	14,900
Yakima Co. (WA)	34.4	4.5	35.9	19.7	15,606
Lower Snake River					
Clearwater Co. (ID)		2.0			15,463
Idaho Co. (ID)		2.9		16.3	14,411
Latah Co. (ID)				16.7	16,690
Lewis Co. (ID)		3.8			15,942
Nez Perce Co. (ID)		5.3			18,544
Shoshone Co. (ID)				16.4	15,934
Whitman Co. (WA)				25.6	15,298
Washington Coast					
Clallam Co.		5.1			19,517
Grays Harbor Co.		4.7			16,799
Oregon Coast					
Coos Co.				15.0	17,547
Lincoln Co.		3.1			18,692
California Coast					
Del Norte Co.		6.4		20.2	14,573
Humboldt Co.		5.7		19.5	17,203
Mendocino Co.		4.8			19,443
Monterey Co.	44.1		46.8		20,165
San Francisco Co.	50.3				34,556

[1] Includes both low-income and minority communities of concern within designated counties.

[2] Shading in boxes represents those counties that exceed the threshold for a low income or minority, making them a community of concern.

impact region (Marion, Multnomah, Washington, and Yamhill), four within the lower Snake River economic impact region (Clearwater, Idaho, Lewis, and Nez Perce), two in the Washington coast economic impact region (Clallam and Grays Harbor), and one in the Oregon coast economic impact region (Lincoln) (Table 3-28).

3.4.5 Public Outreach

The goal of public outreach activities is to inform local community members of the project and to solicit input about community-based concerns regarding the proposed project and its potential environmental and socioeconomic effects. In the context of environmental justice, the public outreach process can be used to assess whether environmental justice populations are present in the affected economic impact region. It also provides a forum to obtain information on the potential effects on specific environmental justice communities of concern, including Native American tribes.

Throughout the EIS process, NMFS will ensure that the requirements of EO 12898 regarding environmental justice are implemented, including appropriate tribal consultation activities. As part of the public scoping process for this EIS, NMFS directly notified non-tribal commercial and recreational fishers. NMFS sent a letter to Columbia River, Puget Sound/Strait of Juan de Fuca, and Washington coastal tribes asking them to participate in an EIS scoping meeting. Non-tribal commercial and recreational fishing groups were also contacted through phone calls and/or emails to invite them to participate in an EIS scoping meeting. Additional notices were published in local newspapers and regional electronic newsletters. In addition, emails were sent to individuals that NMFS was able to identify as non-tribal commercial, recreational, or tribal fishers. Additionally, all groups notified during scoping are included on the EIS distribution list and will receive direct information about commenting on the draft and final EISs.

In this way, a diverse population located over a broad geographic area was identified and reached during scoping and will be notified during draft and final review periods.

3.5 Wildlife

3.5.1 Introduction

Hatchery operations have the potential to affect wildlife by changing the total abundance of salmon and steelhead in aquatic and marine environments. Changes in the abundance of salmon and steelhead can affect wildlife through predator/prey interactions. In addition, hatcheries could affect wildlife through transfer of toxic contaminants or pathogens from hatchery-origin fish to wildlife, operation of weirs (which could block or entrap wildlife), or predator control programs (which may harass or kill wildlife preying on juvenile salmon at hatchery facilities). Key wildlife groups of concern are 1) ESA listed aquatic, marine, and terrestrial wildlife species, 2) non-listed birds, 3) non-listed marine mammals, and 4) other non-listed aquatic, marine, and terrestrial wildlife species. This section describes current baseline conditions and key factors affecting the distribution and abundance of each of the wildlife groups. Baseline conditions were developed from existing literature for wildlife species (including habitats, prey choice, and availability) that may be affected by the EIS alternatives.

3.5.2 Analysis Area

The analysis area for fish in this EIS is the same as the project area as described in Section 2.2 (Description of Project Area). Information in Section 3.5 (Wildlife) and Section 4.5 (Wildlife) is organized according to species, although some species are grouped when appropriate. Some wildlife species are found throughout the analysis area, while others are only found in part of the analysis area (Table 3-29, Table 3-30, and Table 3-31).

3.5.3 ESA-listed Species

Four ESA-listed wildlife species (southern resident killer whale, Steller sea lion, brown pelican, and marbled murrelet) occur within the analysis area and may feed on salmon and steelhead produced within the Columbia River basin (Table 3-29). Although the grizzly bear is ESA-listed as threatened in the contiguous U.S., its presence is limited to the North Cascades population within the analysis area where it feeds primarily on plants. In the North Cascades, less than 10 percent of the grizzly bear’s diet is meat (winter killed deer and elk) (North Cascades Grizzly Bear Outreach Project 2010). Thus, the grizzly bear is not discussed further in this EIS. Two additional ESA-listed species (spotted owl and Canada lynx) occur in the analysis area, but rarely interact with salmon and steelhead and are not discussed further in this EIS. Production of salmon and steelhead (including hatchery-origin and natural-origin fish) could affect distribution and abundance of southern resident killer whale, Steller sea lion, brown pelican, and marbled murrelet through effects on prey abundance and distribution and through transfer of toxins and pathogens from fish to wildlife species. Because none of the listed wildlife species feeds on hatchery-origin fish while the fish are in the hatchery facility, practices implemented at the hatcheries to control predators would not affect listed wildlife species.

Other federal and state listed amphibian and invertebrate (insect) species and their relationship with salmon and steelhead are discussed in Section 3.5.6, Other Aquatic and Terrestrial Wildlife.

3.5.3.1 Distribution of ESA-listed Species and their Food Resources

Salmon and steelhead from the Columbia River basin provide a source of prey for southern resident killer whales, Steller sea lions, brown pelicans, and marbled murrelets. Most of the consumption of salmon and steelhead by these ESA-listed species occurs in ocean waters outside the analysis area, but some consumption does occur in the Columbia River estuary (Watson et al. 1991; Krahn et al. 2002; McShane et al. 2004; NMFS 2008a). In addition, Steller sea lions forage on salmonids along the lower Columbia River, especially where adult hatchery-origin fish congregate such as tailraces of dams (NMFS 2008a).

3.5.3.1.1 Killer Whale (Southern Resident Stock)

The southern resident killer whale stock (ESA-listed as endangered and protected under the Marine Mammal Protection Act [MMPA]) has been observed in ocean waters of Washington and Oregon and near the mouth of the Columbia River during winter and early spring months (Ford et al. 2000; Wiles 2004; Zamon et al. 2007; NMFS 2008b,c). Transient killer whales are not listed under the ESA, and no verified records were found of transient killer whales in ocean waters near the Columbia River. In addition, available information on the diet of transient killer whales in Washington waters indicates that marine mammals are their primary prey (NMFS 2008b). Because this EIS is focused on salmon and steelhead production effects on wildlife, and because the transient killer whale is not expected to occur in the Columbia River basin, only the southern resident killer whale stock is discussed further in this EIS. The total estimated population of southern resident killer whales is 89 individuals as of 2010 (L. Barre, pers. comm., NMFS, Northwest Regional Office, April 23, 2010). Considering the analysis area, the southern resident killer whale has been observed feeding near the Columbia River estuary during winter months at the time of spring Chinook salmon migration (Zamon et al. 2007).

TABLE 3-29. STATUS, DISTRIBUTION, ASSOCIATIONS, AND TRENDS FOR ESA-LISTED WILDLIFE IN THE ANALYSIS AREA POTENTIALLY AFFECTED BY THE EIS ALTERNATIVES.

SPECIES	FEDERAL (F) AND STATE (S) STATUS[1]	DISTRIBUTION AND HABITAT ASSOCIATIONS WITHIN THE ANALYSIS AREA	OCCURRENCE AT, AND ASSOCIATION WITH, COLUMBIA RIVER BASIN HATCHERY FACILITIES[2]	ASSOCIATION WITH HATCHERY-ORIGIN AND NATURAL-ORIGIN SALMON IN ANALYSIS AREA[3]	RELATIONSHIP WITH SALMON IN OREGON AND WASHINGTON[4]	LIFE STAGE OR HABITAT WHERE INTERACTIONS OCCUR[5]	TRENDS IN ABUNDANCE
Southern resident killer whale	F: Endangered S: Endangered in WA	Occasionally occur in mouth of the Columbia River.	Does not occur at Columbia River basin hatchery facilities.	Occasionally forage on salmon in the mouth of the Columbia River (Zamon et al. 2007).	Strong	Saltwater habitats	Periods of increasing, as well as decreasing, population trends over the last several decades; current population estimate is around 89 individuals (L. Barre, pers. comm., NMFS, Northwest Regional Office, April 23, 2010)
Steller sea lion	F: Threatened S: Threatened in WA, sensitive in OR	Present year-round in Columbia River estuary and river up to Bonneville Dam (NMFS 2008a). A haul-out site is present at the South Jetty on the Columbia River (Jeffries et al. 2000).	Does not occur at Columbia River basin hatchery facilities.	Forage on salmon along lower Columbia River and estuary (NMFS 2008d).	Recurrent	Saltwater, freshwater	Stable or increasing for the population segment that ranges from southeastern Alaska to California (Carretta et al. 2007).
Brown pelican	F: Endangered S: Endangered in WA and OR	Occur in the Columbia River estuary, where a large roosting site is present at East Sand Island.	Does not occur at Columbia River basin hatchery facilities.	May forage on salmon in the Columbia River estuary.	Rare	Saltwater	Unknown in Washington/Oregon.
Marbled murrelet	F: Threatened S: Threatened in WA and OR	Rarely forage in Columbia River estuary (McShane et al. 2004). Areas of mature and old-growth forest near lower Columbia River provide potential nesting habitat.	No hatchery facility properties contain mature or old-growth forest to support the birds. No documented nesting or foraging at hatcheries.	Generally, murrelets forage on salmon in saltwater and freshwater rearing areas (Cederholm et al. 2001). However, foraging marbled murrelets are rarely observed within the Columbia River estuary, and there is no evidence that murrelets forage in freshwater habitats in the analysis area (Varoujean and Williams 1995, McShane et al. 2004, U.S. Forest Service [USFS] 2008).	Recurrent	Saltwater, freshwater	Declining in both Washington and Oregon (McShane et al. 2004).

[1] For state status, if a state is not listed, either the species does not occur in the area, or the species has no state listing status.

[2] Hatchery facilities include acclimation ponds.

[3] Refers to entire analysis area, including, but not limited to, fish rearing areas and release sites.

[4] Definitions from Cederholm et al. (2001). Strong relationship means that salmon play an important role in this species' distribution, viability, abundance, and/or population status. Recurrent means that the relationship between salmon and this species is characterized as routine, albeit occasional, and often tends to be in localized areas. Rare means that salmon play a very minor role in the diet of these species.

[5] Definitions from Cederholm et al. (2001). Saltwater means smolt or, subadult, adult.

TABLE 3-30. STATUS, DISTRIBUTION, HABITAT ASSOCIATIONS, AND TRENDS FOR BIRD SPECIES IN THE ANALYSIS AREA THAT PREY ON SALMON.

SPECIES[1]	FEDERAL (F) AND STATE (S) STATUS[2]	DISTRIBUTION AND HABITAT ASSOCIATIONS WITHIN THE ANALYSIS AREA[4]	RELATIONSHIP WITH SALMON IN OREGON AND WASHINGTON[5]	LIFE STAGE OR HABITAT WHERE INTERACTIONS OCCUR[5]	USGS BREEDING BIRD SURVEY, WASHINGTON 1983 – 2007 (SAUER ET AL. 2008)[6]	USGS BREEDING BIRD SURVEY, OREGON 1983 – 2007 (SAUER ET AL. 2008)[6]	USGS BREEDING BIRD SURVEY, IDAHO 1983 – 2007 (SAUER ET AL. 2008)[6]	OTHER TREND INFORMATION
Bald eagle	F: Protected under Bald Eagle and Golden Eagle Protection Act S: Threatened[3] for WA and OR	Nests, forages, and winters along analysis area rivers and in Columbia River estuary. No recorded nesting at hatchery facilities.	Strong	Freshwater; carcasses, saltwater	Increasing trend	Increasing trend	Increasing trend	
Osprey	F: none S: monitor for WA	Fairly common breeder in the analysis area, particularly where large shoreline trees and artificial structures are available.	Strong[5] Not documented in Columbia River basin	Freshwater rearing, saltwater, spawning	Increasing trend	Increasing trend	No trend	
Great blue heron	F: none S: monitor for WA	Common resident of shorelines and shallow waters in the analysis area, associated with hatchery facilities.	Recurrent	Freshwater rearing, saltwater	No trend	No trend	No trend	
Gulls and Terns								
Gulls (glaucous-winged, ring-billed, California, and western)	F: none S: for California gulls	Common throughout analysis area. Large nesting colony of glaucous-winged/western gulls on Rice Island and East Sand Island in the Columbia River estuary; ring-billed and California gull colonies above The Dalles Dam.	Strong	Incubation, freshwater rearing, saltwater, spawning, carcass	Decreasing trend for California gulls. No trend for any of the species	Decreasing trend for ringed-billed gulls. No trend for any of the species	No data for western gull and glaucous-winged gull. No trend for ring-billed gull and California gull	
Caspian tern	F: none S: monitor for WA	Large nesting population in the Columbia River estuary. Population in estuary is being managed to reduce predation on salmon. Large colony on East Sand Island, also colonies on other small islands in the Columbia River basin.	Strong	Freshwater rearing, saltwater	Increasing trend	No trend	No trend	Increasing in Washington (Shuford and Craig 2002)
Cormorant Species								
Double-crested cormorant	F: none S: none	Occurs year-round in the Columbia River estuary and around reservoirs in the midColumbia River. Large nesting colonies on islands in the estuary and upstream from McNary Dam.	Strong	Freshwater rearing, saltwater	No trend	No trend	No trend	
Brandt's cormorant	F: none S: candidate for WA	Occurs year-round in Columbia River estuary. Small colony on East Sand Island in the estuary.	Recurrent	Freshwater rearing, saltwater	No trend	No data	N/A[8]	
Pelagic cormorant	F: none S: none	Occurs year-round in Columbia River estuary.	Recurrent	Freshwater rearing, saltwater	No trend	No data	N/A[8]	
Loon Species								
Common loon	F: None S: Sensitive in WA	Fairly common migrant, winter resident on Columbia and Snake River (especially reservoirs) and in the Columbia River estuary. Rare in summer in analysis area.	Recurrent	Freshwater rearing, saltwater[7]	No data	No data	No data	No apparent trend for wintering common loons in Washington (Richardson et al. 2000)
Red-throated loon	F: none S: none	Rare migrant and winter resident throughout analysis area.	Recurrent	Freshwater rearing, saltwater	N/A[8]	N/A[8]	N/A[8]	
Pacific loon	F: none S: none	Present during fall and spring migration; rare in winter along Columbia River and Snake River and the Columbia River estuary.	Recurrent	Saltwater	N/A[8]	N/A[8]	N/A[8]	
Grebe Species								
Western grebe	F: None S: Candidate in WA	Common winter resident in Columbia River estuary; uncommon in Columbia River basin in winter. Breeds on large ponds and reservoirs in Columbia River basin.	Recurrent	Freshwater rearing, saltwater	No data	No data	No data	

TABLE 3-30. STATUS, DISTRIBUTION, HABITAT ASSOCIATIONS, AND TRENDS FOR BIRD SPECIES IN THE ANALYSIS AREA THAT PREY ON SALMON (CONTINUED).

SPECIES[1]	FEDERAL (F) AND STATE (S) STATUS[2]	DISTRIBUTION AND HABITAT ASSOCIATIONS WITHIN THE ANALYSIS AREA[4]	RELATIONSHIP WITH SALMON IN OREGON AND WASHINGTON[5]	LIFE STAGE OR HABITAT WHERE INTERACTIONS OCCUR[5]	USGS BREEDING BIRD SURVEY, WASHINGTON 1983 – 2007 (SAUER ET AL. 2008)[6]	USGS BREEDING BIRD SURVEY, OREGON 1983 – 2007 (SAUER ET AL. 2008)[6]	USGS BREEDING BIRD SURVEY, IDAHO 1983 – 2007 (SAUER ET AL. 2008)[6]	OTHER TREND INFORMATION
Clark's grebe	F: none S: monitor for WA	Common breeder along Snake River. Rare migrant and winter resident in reservoirs and the Columbia River estuary.	Recurrent	Saltwater	N/A[8]	N/A[8]	No data	
Red-necked grebe	F: none S: monitor for WA	Rare migrant along Columbia River and rare winter resident in the Columbia River estuary.	Rare	Spawning, carcass	Declining trend	No data	No trend	
Pied-billed grebe	F: none S: none	Uncommon to common year-round resident in wetlands and other shallow areas throughout analysis area.	Recurrent	Freshwater rearing	Increasing trend	No trend	No trend	
Duck Species								
Harlequin duck	F: sp. of concern S: none	Winter resident in the Columbia River estuary. Breeds in fast flowing, mountain streams in the upper Columbia and Snake River basins.	Strong[5] However, not documented in Columbia River basin	Incubation, saltwater	No data	No data	No data	
Common goldeneye	F: none S: none	Common winter resident and migrant along major streams in the Columbia River basin.	Recurrent	incubation, spawning, carcass	No data	No data	No data	
Barrow's goldeneye	F: none S: none	Common winter resident and migrant in the estuary and along mainstem of Columbia and Snake Rivers. Some breeding birds occur on Snake River.	Recurrent	incubation, spawning, carcass	No trend	No data	No data	
Common merganser	F: none S: none	Common winter resident in the estuary and major streams in the Columbia River basin; uncommon breeder on eastside of Cascades. Breeds in lakes and rivers on Westside of Cascades.	Strong	carcass	No trend	Increasing trend	No trend	
Red-breasted merganser	F: none S: none	Present in winter in the Columbia River estuary; uncommon migrant along the mainstem Columbia River.	Strong,[5] however, not documented in Columbia River basin	incubation, freshwater rearing, saltwater	N/A[8]	N/A[8]	N/A[8]	
Other Fish-eating Bird Species								
Belted kingfisher	F: none S: none	Year-round resident in the Columbia River estuary and along the tributaries in the Columbia River basin.	Recurrent	freshwater rearing, saltwater	No trend	No trend	No trend	
Osprey	F: none S: monitor for WA	Fairly common breeder in the analysis area, particularly where large shoreline trees and artificial structures are available.	Strong[5] But salmon as its prey source is not documented within the Columbia River basin	Freshwater rearing, saltwater, spawning	Increasing trend	Increasing trend	No trend	
Great blue heron	F: none S: monitor for WA	Common resident of shorelines and shallow waters in the analysis area.	Recurrent	Freshwater rearing, saltwater	No trend	No trend	No trend	
American/ northwestern crow	F: none S: none	Common year-round resident throughout analysis area.	Recurrent	freshwater rearing,[9] carcass	No trend	Increasing trend for American crow. No data for northwestern crow.	No trend for American crow. No information for northwestern crow.	
Common raven	F: none S: none	Common year-round resident throughout much of analysis area.	Recurrent	freshwater rearing,[9] carcass	Increasing trend	No trend	Increasing trend	

[1] Species include those that regularly occur within the analysis area or nearby coastal waters and that have a strong, consistent or recurrent relationship with salmon, as identified by Cederholm et al. (2001).
[2] For state status, if a state is not listed, either the species doesn't occur in the area, or the species has no state listing status.
[3] Bald eagles have been proposed for Washington State delisting.
[4] Sources: Opperman (2003), Christmas Bird Count (2004), Portland Audubon Society (2008), USDI and BLM (2007), USFWS (2007a,b).
[5] Source: Cederholm et al. (2001). If data are not available for the Columbia River basin, relationship is listed as *not documented in Columbia River basin.*
[6] Trends are indicated if P < 0.1.
[7] Definitions from Cederholm et al. (2001). Strong relationship means that salmon play an important role in this species' distribution, viability, abundance, and/or population status. Recurrent means that the relationship between salmon and this species is characterized as routine, albeit occasional, and often tends to be in localized areas. Rare means that salmon play a very minor role in the diet of these species. Incubation means egg and alevin; freshwater rearing means fry, fingerling, or parr; saltwater means smolt or, subadult, adult.
[8] Not applicable because species does not breed in the state (Gilligan et al. 1994:, Smith et al. 1997).
[9] Crows and ravens prey on juvenile salmon that are stranded in shallow water.

TABLE 3-31. STATUS, DISTRIBUTION, HABITAT ASSOCIATIONS, AND TRENDS FOR MARINE MAMMALS OF CONCERN.

SPECIES	FEDERAL (F) AND STATE (S) STATUS	DISTRIBUTION AND HABITAT ASSOCIATIONS WITHIN THE ANALYSIS AREA	RELATIONSHIP WITH SALMON IN OREGON AND WASHINGTON[1]	TRENDS IN ABUNDANCE
California sea lion	F: MMPA S: none	Occurs in Columbia River estuary and Columbia River up to the Bonneville dam primarily during the non-breeding season (September to May) (NMFS 1997). Large haul-out at the South Jetty on the Columbia River (Jeffries et al. 2000).	Strong; saltwater, spawning	The population off the west coast of the U.S. has shown an overall increasing trend since the mid-1970s, with an average annual rate of increase of over 5 percent (NMFS 1997). However, periodic declines within this period have occurred due to El Nino events (Carretta et al. 2007).
Harbor seal	F: MMPA S: monitor in WA; none in OR	Occurs year-round in the Columbia River estuary and the lower Columbia River to Bonneville Dam (NMFS 2008f). Numerous haul-out sites, and also pupping sites, in the estuary (Jeffries 1986; Jeffries et al. 2000).	Recurrent; saltwater, spawning, carcass	The harbor seal population on the Oregon/Washington coast is stable and very close to carrying capacity (Jeffries et al. 2003).
Harbor Porpoise	F: MMPA S: none	Occurs in coastal waters of Oregon and Washington.	Rare: saltwater	

[1] Definitions from Cederholm et al. (2001): Strong relationship means that salmon play an important role in this species' distribution, viability, abundance, and/or population status. Recurrent means that the relationship between salmon and this species is characterized as routine, albeit occasional, and often tends to be in localized areas. Rare means that salmon play a very minor role in the diet of these species. Saltwater means smolt or, subadult, adult.

Although the prey base of southern resident killer whales that forage near the mouth of the Columbia River is unknown, prey of southern resident killer whales that forage elsewhere in the Pacific Northwest has been recorded. Feeding records for southern resident killer whales show a strong preference for Chinook salmon during May to October (Ford and Ellis 2006; Hanson et al. 2010). Chum salmon are taken in substantial amounts, especially in autumn (Ford and Ellis 2006). For all southern resident killer whale samples collected by Ford and Ellis (2006), other salmon represented 10 percent of identified samples, including chum salmon (3 percent), coho salmon (3 percent), sockeye salmon (1 percent), and steelhead (3 percent). Ford and Ellis (2006) found that killer whales captured older (i.e., larger) than average Chinook salmon. From May to September, when southern resident killer whales spend a high proportion of their time in the San Juan Islands (considered a core summer area by authors), their diet consists of approximately 85 to 86 percent Chinook salmon and 14 to 15 percent other salmon species (steelhead, chum salmon, sockeye salmon, and coho salmon) (Hanson et al. 2007; Hanson et al. 2010).

Other results indicated that, during fall months in inland waters, southern resident killer whales foraging within Puget Sound shift their diet to primarily chum salmon (Hanson et al. 2007;). The diet of southern resident killer whales is poorly known during the remaining months of the year (January through April), when they range in ocean waters from British Columbia to central California, although this stock is thought to feed on salmon and steelhead year-round (Krahn et al. 2002; Krahn et al. 2007; Ford and Ellis 2006; NMFS 2008c).

The preference of southern resident killer whales for Chinook salmon in inland waters, even when other species are more abundant, combined with information indicating that these whales consume salmon year-round, makes it reasonable to expect that southern resident killer whales likely prefer Chinook salmon when available in coastal waters. Furthermore, Ford et al. (2009) found that southern resident killer whale survival rates correlated directly with availability of Chinook salmon.

Based on recent estimates, the southern resident killer whale stock requires, in total, approximately 221,000 Chinook salmon annually in coastal waters of their range (NMFS 2008b), but the extent to which they depend on specific salmon runs is not known. At different times of the year, southern resident killer whales may consume Chinook salmon that originate in the Fraser River, Puget Sound, Washington and Oregon coastal streams, the Columbia River, and central California streams (NMFS 2008b; Hanson et al. 2005 *in* NMFS 2008b), but data are insufficient to identify the proportion of different stocks in the year-round southern resident killer whale diet. Sightings of resident killer whales off Westport, Washington, and in the Columbia River mouth may coincide with the spring Chinook salmon run in the Columbia River (Krahn et al. 2004; Zamon et al. 2007; NMFS 2008b).

There is no evidence that southern resident killer whales distinguish between hatchery-origin and natural-origin salmon (NMFS 2008c). Partial compensation by Columbia River hatcheries for declines in natural-origin salmon populations may have benefitted southern resident killer whales (NMFS 2008b).

3.5.3.1.2 Steller Sea Lion

The eastern stock of Steller sea lions, an ESA-threatened species and protected under MMPA, is resident year-round on the coasts of Oregon and Washington, and from the mouth of the Columbia River up to Bonneville Dam (NMFS 2008d,e). No Steller sea lion rookeries (i.e., mating areas) exist near the Columbia River, but individuals use the South Jetty at the mouth of the river as a haul-out site year-round (Jeffries et al. 2000). Numbers vary seasonally, with peak counts of approximately 1,000 individuals during fall and winter months (NMFS 2008a).

Steller sea lions forage opportunistically on a wide variety of fishes in response to seasonal abundance. From foraging studies in the lower Columbia River and at Pacific Northwest coastal sites, authors describe a variety of Steller sea lion prey species, including Pacific whiting, rockfish, eulachon, Pacific hake, anchovy, Pacific herring, staghorn sculpin, salmonids, octopus, and lamprey (Jeffries 1984; NMFS 2008e).

The western stock of Steller sea lions does not occur farther south than northeast Alaska, but its prey base is better known than prey of the eastern stock. Studies of western stock Steller sea lions' recorded prey consisted of walleye pollock (46 percent frequency of occurrence), Atka mackerel (40 percent), salmonids (20 percent), and Pacific cod (16 percent), and prey were primarily adults and late stage juveniles (Sinclair and Zeppelin 2002). The proportion of different salmonid species in their diet was not recorded.

Historically, eastern stock Steller sea lions were rarely observed upstream of the mouth of the Cowlitz River (Columbia RM 70), but in recent years, they have appeared in increasing numbers at Bonneville Dam (RM 144). First observed in the dam's tailrace in 2003, 10 Steller sea lions were observed at this location in 2007 (NMFS 2008a). Although Steller sea lion presence is concurrent with salmon migrations to Bonneville Dam, this sea lion species appears to feed primarily on white sturgeon at this location (NMFS 2008a). Recent prey studies at Bonneville Dam reported that adult salmonid remains were found in 25 percent of Steller sea lion scat samples, American shad were found in 25 percent of samples, and sturgeon were found in 50 percent of samples (NMFS 2008f).

3.5.3.1.3 Brown Pelican

Non-breeding brown pelicans occur along the Pacific Northwest coast from June to October where they feed opportunistically in shallow marine waters including bays and estuaries and near offshore islands, spits, breakwaters, and open sand beaches (Seattle Audubon Society 2005). In Washington, their numbers are highest at communal roosts at the mouth of the Columbia River, and on the coastline at Gray's Harbor, Ocean Shores, and Copalis, Washington (Opperman 2003; Seattle Audubon Society 2005). Their diet on the west coast consists of schooling anchovies, eulachon, herring, Pacific mackerel, minnow, and sardines (Monterey Bay Aquarium 2003; Seattle Audubon Society 2005; NatureServe 2008). Although available information does not indicate that brown pelicans prey on salmon and steelhead, it is possible that the opportunistic foraging behavior of brown pelicans would result in consumption of some salmon and steelhead.

3.5.3.1.4 Marbled Murrelet

Marbled murrelets range along the Pacific coast from Alaska to California; the southern end of their breeding range is central California (USFWS 1997). Most recent population estimates in 2008 were 18,000 birds distributed throughout their range (USFWS 2009). Marbled murrelets are less abundant near the Columbia River than in other parts of coastal Oregon and Washington and inland waters of Puget Sound (Thompson 1999; McShane et al. 2004).

Marbled murrelets are opportunistic feeders that consume a wide variety of fishes in marine habitats (Burkett 1995). The diet of marbled murrelets includes forage fish (such as immature Pacific herring, sand lance, northern anchovy, capelin, and eulachon species), squid, and large pelagic crustaceans (such as euphausiids, mysids, and amphipods) (Burkett 1995; Ostrand et al. 2004). Salmon smolts (not identified to species), immature rockfish, and eulachon are also taken, but no information was found specific to marbled murrelet prey base within the Columbia River basin. Evidence of predation on salmonids in freshwater habitats was reviewed by McShane et al. (2004), but the examples cited were not in the Columbia River basin, and there is no evidence indicating that marbled murrelets forage in freshwater habitats in the analysis area. Varoujean and Williams (1995) observed few than 10 marbled murrelets during aerial surveys in salt water Columbia estuary, and the USFS (2008) does not indicate the presence of marbled murrelets within the Columbia River basin in their mapping of populations in Washington and northern Oregon.

3.5.3.2 Transfer of Toxic Contaminants and Pathogens

Wildlife that consume salmonid and steelhead could be affected by the transfer of toxins and/or pathogens from the fish. Use of disinfectants, therapeutic chemicals, anesthetics, and pesticides at hatchery facilities is regulated by the Food and Drug Administration (FDA) and the EPA and subject to permit approval. As described in Section 3.6, Water Quality and Quantity, and Section 3.7, Human Health, safety measures specific to these chemical products along with Federal and state Occupational Safety and Health Administration regulations serve to limit human exposure to potentially hazardous concentrations. By extension, exposure of wildlife species to chemicals used in hatchery facilities would also be minimized.

There is considerable evidence of bioaccumulation of persistent organic pollutants, including dichlorodiphenyltrichloroethane (DDT) and polychlorinated biphenyls (PCBs), in fish-eating birds and other wildlife that use the Columbia River estuary, including bald eagles and osprey (Anthony et al. 1993; Henney et al. 2003; Buck et al. 2005). High levels of PCBs and DDT are also documented in southern resident killer whales (Ross et al. 2000; Ylitalo et al. 2001), which are at the top of the food chain and have a long life expectancy. Available information does not indicate that fish hatcheries introduce these contaminants into the environment, but hatchery-origin, as well as natural-origin, salmon and steelhead may pass contaminants on to wildlife predators (Lower Columbia River Estuary Partnership [LCREP] 2005). Both hatchery-origin and natural-origin salmon ingest contaminants that occur in rivers (LCREP 2005), and several stream segments in the Columbia River basin are on the Washington, Oregon, and Idaho state 303(d) lists for dieldrin, total PCBs, mercury, dichlorodiphenyldichloroethylene (4,4'DDE) and other contaminants (http://www.ecy.wa.gov/programs/wq/303d/index.html and http://www.deq.state.or.us/wq/assessment/assessment.htm and http://deq.state.id.us/water) (Section 3.6.3.2.1, Federal Regulations).

PCBs, dieldrin, and mercury have been found in fish tissue collected in river segments of the Columbia River basin (Section 3.6, Water Quality and Quantity). Direct uptake of organic contaminants from water to fish is a minor accumulation pathway, and the major source of contamination in salmon and steelhead is probably their diet (NMFS 1993). In a recent study, contaminants in prey of out-migrant juvenile Chinook salmon in the Columbia River estuary appear to have contributed substantially to levels of DDTs and PCBs (Johnson et al. 2007). The prey base for natural-origin salmonid and steelhead would be the same as for hatchery-origin fish following release. There is some potential for elevated contaminant loads to occur in hatchery-origin fish prior to their release due to their ingestion of fish feed; however, data are insufficient to determine if fish feed increases contaminant loading in hatchery-origin fish compared to natural-origin salmonid (Johnson et al. 2007).

Diseases of hatchery-origin fish are caused by viral, bacterial, and parasite pathogens that are also present in natural-origin salmonid populations (McVicar et al. 2008). Little information was found in the literature indicating that fish diseases injure or kill wildlife, although some fish diseases or parasites utilize wildlife as intermediate disease hosts or vectors (McVicar et al. 2008). One exception is salmon poisoning disease, a rickettsial disease borne by salmonids that sickens dogs, wild canids, and possibly other carnivores that ingest infected raw fish (Ettinger and Feldman 1995). Hatchery facilities and hatchery practices have not been identified as contributing to this disease.

3.5.4 Non-listed Birds

A variety of birds (including , bald eagles, gulls and terns, cormorants, loons, grebes, ducks, and other fish-eating birds) forage on salmon and steelhead in various life stages including salmon carcasses along the Columbia River and in the Columbia River estuary (Table 3-30). Some species (such as the double-crested cormorant) are year-round residents, while others (such as the common goldeneye) occur primarily during winter and migration. Trends in abundance for these birds vary by species (Table 3-30). With regard to hatchery operations, factors that affect distribution and abundance of non-listed bird species include prey sources and distribution of food resources, transfer of toxins and pathogens, and hatchery predator control programs.

3.5.4.1 Distribution of Non-listed Birds and their Food Resources

Hatchery-origin fish provide a source of prey to avian predators, particularly in areas where the fish congregate, including release sites, tailraces of dams, and the Columbia River estuary. Some of the consumption of hatchery-origin salmon by predators occurs in ocean waters outside the analysis area, but much of the consumption occurs in the Columbia River estuary and interior regions. Within hatcheries, hatchery-origin fish are protected from predators by a variety of methods (e.g., bird netting and electric wires) (Section 3.5.4.3, Hatchery Predator Control Programs).

3.5.4.1.1 Bald Eagle

Bald eagles (protected under the Bald Eagle and Golden Eagle Protection Act) are common along the Washington and Oregon coast and freshwater rivers and streams at lower elevations (Marshall et al. 2006; Smith et al. 1997). Bald eagles that breed along the lower Columbia River are year-round residents and do not migrate. These bald eagles exhibited low reproductive success characteristic of a declining population (Anthony et al. 1993). High contaminant concentrations (DDE, PCBs, and dioxins) were thought to account for this population's low productivity (Anthony et al. 1993). Nonetheless, the resident population has recently increased, likely as a result of recruitment of new adults from other areas (Watson et al. 2002). In addition to the resident population, migrant bald eagles from other regions overwinter on the lower Columbia River.

Breeding bald eagles are uncommon in eastern Washington, Oregon, and Idaho, although scattered pairs nest along lakes, reservoirs, and rivers (Stinson et al. 2007; Pacific Biodiversity Institute 2008). In winter, migrant bald eagles move into the region, focusing on salmon spawning streams and waterfowl wintering areas. In eastern Washington and Idaho, the reservoirs and major tributaries of the Columbia River and Snake River are important wintering habitats (Stinson et al. 2001).

The diet of bald eagles is diverse, in part because eagles can be active predators, scavengers, and carrion feeders, and they often steal prey from other predators (Stinson et al. 2007). Their diet can also vary by season and geographic location. Information on bald eagle prey within the Columbia River estuary is sparse, but one study found that prey delivered to nests consisted primarily of fish, of which suckers, American shad, carp, and salmonids were the most common items (Watson et al. 1991). Evidence of bald eagle predation on juvenile salmonids (not identified to species) during June coincided with juvenile outmigration through the estuary. Historically, bald eagles fed on salmon carcasses near the mouth of the Columbia River in late summer and fall, but it is unknown which species were consumed (Stinson et al. 2007).

Information on bald eagle diet in Interior Columbia River basin is also limited, but available studies indicate that a diverse array of fish, birds, and mammals are taken. Prey delivered to nests at Lake Roosevelt consisted primarily of fish, including suckers, hatchery-origin rainbow trout, and kokanee (Stinson et al. 2001). Food habits of wintering bald eagles at reservoirs on the Columbia River from John Day Dam to the confluence of the Yakima River consisted primarily of waterfowl and gallinaceous birds, carrion, and a variety of mostly non-salmonid fish (Knight et al. 1979; Fielder 1982). However, salmon carcasses may be consumed when available (Fitzner et al. 1980; Fitzner and Hanson 1979).

Salmon carcasses are likely to be an important bald eagle food source on spawning streams. In addition to natural-origin salmon and hatchery-origin salmon that die in streams in the analysis area, hatchery operators also distribute hatchery-origin salmon carcasses from their hatchery facilities. In Washington State, hatchery employees distribute approximately 160,000 to

180,000 salmon carcasses annually to upstream river reaches (A. Appleby, pers. comm., WDFW, February 24, 2004). Hatchery programs in Oregon also have placed over 10,000 hatchery-origin salmon carcasses in Willamette River tributaries and other lower Columbia River tributaries (T. Friesen, pers. comm., ODFW, November 10, 2008). However, outplanted hatchery-origin carcasses comprise a small proportion of the total available carcasses in freshwater streams.

3.5.4.1.2 Other Birds

Gull species are common throughout the analysis area and nest on islands in the Columbia River estuary where they consume substantial numbers of juvenile salmon and steelhead, with proportions in their diet apparently a function of the nesting location (Collis et al 2001). Glaucous-winged gulls and western gulls nesting on Rice Island (at RM 21) consumed mostly non-salmonid riverine fishes but also consumed salmonids (11 percent of their diet in the late 1990s). Gulls nesting on East Sand Island consumed primarily marine fishes and a smaller percentage of salmon and steelhead smolts (4.2 percent of the diet in the late 1990s). Other larger colonies include ring-billed gull and California gull colonies above the Dalles Dam (Collis et al. 2001). Glaucous-winged gulls, western gulls, California gulls, and ring-billed gulls are predators of salmon (Roby and Collis 2008; Cederholm et al. 2001). California gulls and ring-billed gulls consumed relatively few fish in the late 1990s, with the exception of one California gull colony that is no longer extant, in which birds were known to prey on juvenile salmonids in the tailrace of The Dalles Dam (Roby and Collis 2008).

Caspian terns and double-crested cormorants are also important avian predators of salmon and steelhead in the Columbia River basin, in terms of the number of juvenile fishes consumed and the proportions they comprise in the predators’ diets. Most information on diet comes from studies of Caspian terns and double-crested cormorants in the Columbia River estuary (reviewed in LCFRB 2004; Roby and Collis 2008) and their nesting colonies on the middle Columbia River (Roby and Collis 2008). Caspian terns are not ESA-listed species but are of concern because breeding Caspian terns are concentrated at relatively few sites and because they consume large proportions of outmigrating juvenile salmon and steelhead in the Columbia River (Roby and Collis 2008; LCFRB 2004). The Caspian tern colony on East Sand Island in the Columbia River estuary (RM 5) is the largest nesting colony of Caspian terns in the world, consisting of approximately 10,000 breeding pairs in 2007 and 2008 (Portland Audubon Society 2008; NW Fishletter 2009). Small colonies located on islands farther upstream in the Columbia River include Rock Island (John Day Pool) with less than 100 pairs and Crescent Island (McNary Pool) with fewer than 500 pairs (Roby and Collis 2008).

Breeding Caspian terns eat almost exclusively fish, including anchovy, herring, salmonids, shiner perch, sand lance, sculpins, eulachon, and flatfish (Roby and Collis 2008). The proportion of salmon and steelhead in their diet varies depending on location of the nesting colony. In a recent study, juvenile salmon and steelhead comprised about 30 percent of prey items taken by East Sand Island terns, and the remainder of the diet included marine forage fishes, such as northern anchovy, shiner perch, and Pacific herring (Roby and Collis 2008). Predation rates on steelhead were 2 to 12 times higher than those for other salmon species and run-types. In comparison, salmon and steelhead juveniles accounted for 74 percent of the diet of a similar-sized Caspian tern nesting colony on Rice Island (RM 21) (Collis et al. 2002). This colony was relocated in 1999/2000 through habitat removal to reduce predation intensity on outmigrating salmon and steelhead.

A smaller Caspian tern colony on Crescent Island in the McNary Pool (RM 318) also consumed a large proportion of juvenile salmon and steelhead: 63 and 69 percent of identified prey items were salmonid smolts in 2006 and 2007, respectively (Roby and Collis 2008). In 2008, the USACE began implementation of a program to disperse the Columbia River estuary nesting population on East Sand Island to alternate nesting sites in California and Oregon with the objective of reducing the predation impact on Columbia River salmon and steelhead stocks (USACE 2008).

The double-crested cormorant colony on East Sand Island consisted of about 13,770 breeding pairs in 2007, making it the largest known nesting concentration of this species in the world (Portland Audubon Society 2008). Prey items identified at this colony included a small portion (9 percent) of salmonids; marine forage fish (northern anchovy) and estuarine resident fish (sculpin, flounder) comprised over 50 percent of the diet. All species of anadromous salmonids from all run types (fall, winter, summer, and spring) and all tagged ESUs were represented in the prey of the East Sand Island cormorant colony in proportion to their relative availability (Roby and Collis 2008). As reported in the same study, smaller cormorant colonies above McNary Dam on the middle Columbia River and at the Potholes Reservoir, in eastern Washington also consumed salmon smolts. Limited diet data for Foundation Island (RM 323) cormorants showed that salmonid smolts comprised 16 to 18 percent of their diet (Roby and Collis 2008). The diet of overwintering cormorants in the upper Columbia River basin (including the Snake River) is less well known. In one recent pilot study, juvenile salmonids comprised about 12 percent of the diet of overwintering cormorants that forage at dams on the lower Snake River (Roby and Collis 2008). Brandt's cormorant and pelagic cormorant are residents within the

Columbia River estuary and are believed to feed on salmon and steelhead in this area (Cederholm et al. 2001).

Other predators on juvenile salmon and steelhead include loons, grebes, and ducks. Cederholm et al. (2001) considered that harlequin ducks have a strong relationship with salmonid eggs, alevins, and smolts, although available information in the Columbia River basin did not indicate that salmon and steelhead were an important component of their diet. This migratory species breeds in fast-flowing mountain streams in the upper Columbia and Snake River basins, where most prey consists of aquatic insects, although some alevins and salmon eggs are also eaten (Robertson and Goudie 1999). Their winter range includes the Columbia River estuary where their prey is benthic invertebrates.

Although Cederholm et al. (2001) indicated that goldeneyes have a recurrent relationship with salmon, no additional information on the proportion of salmon and steelhead in their diet has been published. Common and red-breasted mergansers are considered important predators of salmon and steelhead, based on studies in British Columbia (Cederholm et al. 2001); however, the importance of salmon and steelhead in the diet of mergansers within the Columbia River basin has not been well documented. Salmon and steelhead comprised 20 percent of common merganser prey on the Yakima River only in fall and winter; in spring, common mergansers consumed primarily sculpin and chiselmouth (Phinney et al. 1998).

Osprey nest in large shoreline trees and other tall artificial structures that occur along the lower Columbia River in spring and summer, feeding almost exclusively on fish in proportion to their availability. In the lower Columbia and Willamette Rivers, largescale suckers and northern pikeminnow accounted for approximately 90 percent of the biomass in the osprey diet (Henny et al. 2003; LCFRB 2004). Other predators of salmon and steelhead include great blue herons, which are residents of shorelines and shallow waters (including at fish hatcheries), as well as resident belted kingfishers, crows, and ravens that occur throughout the analysis area and have a recurrent relationship with salmon and steelhead (Cederholm et al. 2001).

Numbers of avian predators of salmon and steelhead have increased as a result of nesting habitat and feeding opportunities created by dredge spoil deposition in or near estuaries (which creates nesting habitat), reservoir impoundments, and tailrace bypass outfalls associated with hydroelectric projects (NMFS 2008a). Because the birds’ breeding seasons coincide with outmigrating juvenile salmon, the birds can easily exploit this prey base. Stream-type juvenile salmon, especially yearling smolts from spring-run populations, are vulnerable to bird predation in the estuary because they tend to use the deeper, less turbid water over the channel, which is located near habitat preferred by piscivorous birds (Fresh et al. 2005). Recent research shows that subyearlings from the Lower Columbia River Chinook Salmon ESU are especially subject to tern predation, probably because of their long estuarine resident time (Ryan et al. 2003). Hatchery-origin yearling Chinook salmon and steelhead are more vulnerable to tern predation than their natural-origin counterparts in some years because they tend to reside closer to the water surface where terns forage (Collis et al. 2001).

3.5.4.2 Transfer of Toxic Contaminants and Pathogens

The potential for transfer of toxins and pathogens to avian predators is the same as described for ESA-listed species (Section 3.5.3.2, Transfer of Toxins and Pathogens).

3.5.4.3 Hatchery Predator Control Programs and Weirs

The primary avian predators associated with operation of hatchery facilities are bald eagles, great blue herons, kingfishers, gulls, mergansers, cormorants, and osprey (A. Appleby, pers. comm., WDFW, February 24, 2004; J. Kerwin, pers. comm., WDFW, February 18, 2004). To minimize fish predation at hatcheries, wildlife officials employ techniques to deter and control predators. These techniques include non-lethal, passive, exclusionary devices (such as bird netting and electric wires). In some cases, harassment of the birds, using pyrotechnics or a trained falconer, is also employed. These control programs are used at hatchery rearing ponds and net pens at the discretion of hatchery operator. To date, no bald eagle injuries or fatalities from the predator control devices and techniques have been documented. Records on the number of injuries and deaths to other avian predators from control measures at the hatcheries are not available. Weirs currently exist at some Columbia River basin hatcheries; however, their effect on wildlife has not been documented.

3.5.5 Marine Mammals

In addition to the killer whale and Steller sea lion (Section 3.5.3, ESA-listed Species), two other marine mammal species, California sea lion and harbor seal, forage on salmon in the analysis area (Table 3-31). A third marine mammal species, the harbor porpoise, occurs in the analysis area, but because no information was found in the literature indicating that the harbor porpoise feeds on salmon and steelhead, the species is not discussed further in this EIS.

Trends in abundance indicate that California sea lion and harbor seal populations have increased overall in recent years (Table 3-31). Relevant to hatchery operations, factors that affect distribution and abundance of California sea lions and harbor seals include prey resources and distribution of food resources, transfer of toxins and pathogens, and hatchery predator control programs.

3.5.5.1 Distribution of Marine Mammals and their Food Resources

Salmon benefit California sea lions and harbor seals by providing a source of prey. Marine mammals are known to change their distribution in response to salmon abundance and distribution. Similar to other species that forage on salmon, foraging success of California sea lions and harbor seals is expected to be particularly high where fish congregate, such as dam tailraces and estuaries.

3.5.5.1.1 California Sea Lion

California sea lions (protected under MMPA) range from the Pacific coast of Central Mexico north to British Columbia, Canada. Their primary breeding range is from the Channel Islands in Southern California to Central Mexico (Lowry and Forney 2005). California sea lions have increased in abundance and distribution in the Columbia River since the 1980s (Carretta et al. 2007). Male sea lions (and a few non-breeding females) appear in the river seasonally from January through late May, ranging upriver as far as Bonneville Dam at RM 146. A 2006 survey WDFW conducted estimated up to 1,200 California sea lions in the Columbia River below Bonneville Dam, and approximately 271 individuals have been counted annually immediately below Bonneville Dam since 2004 (NMFS 2008f). California sea lions do not breed within the Columbia River; during the breeding season, they leave the river and move south to breeding grounds in California.

California sea lions are opportunistic feeders, and consumption of salmon by these pinnipeds varies by location, season, and year (NMFS 1997). NMFS (2008c) has summarized recent information on the diet of California sea lions in the Columbia River as follows. The diet of California sea lions in the estuary includes 10 to 30 percent salmonids and a variety of marine and estuarine prey, including squid, eulachon, herring, flatfish, perch, Pollock, hake, and rockfish. During spring migrations of eulachon, lamprey, salmon, and steelhead, California sea lions commonly follow prey upriver as far as the Bonneville Dam. At the tailrace of the Bonneville Dam, direct observations from 2002 to 2007 indicate that close to 79 percent of the fish that pinnipeds (primarily California sea lions) preyed upon were salmon, with the remainder consisted of lamprey (9.3 percent), sturgeon (4 percent), shad (1.2 percent), and unknown prey (6.6 percent) (NMFS 2008f).

3.5.5.1.2 Harbor Seal

Harbor seals are abundant, year-round residents of coastal and estuarine waters in Washington and Oregon. They are present in the lower reaches of the Columbia River up to the Bonneville Dam year-round (Jeffries 1984). Harbor seal populations in Washington and Oregon have recovered from low levels in the 1960s following removal of the harbor seal bounty program and passage of the MMPA. The current population estimate for the Oregon/Washington coast stock of harbor seals is 24,732 harbor seals (Carretta et al. 2007).

Harbor seals are nomadic and move from estuaries to coastal areas in response to seasonally abundant prey. Haul-out sites are located on sandbars and intertidal flats from the mouth of the Columbia River to as far inland as the Cowlitz River at Longview, Washington (RM 57) (Jeffries et al. 2000). Rookeries are in coastal estuaries, including the Columbia River estuary. Peak numbers of harbor seals are present at haul-out sites in the Columbia River from mid-December to April (Jeffries et al. 2000). These numbers and movements appear correlated with spawning runs of eulachon (LCFRB 2004). By May, use of most upriver haul-out ceases, and harbor seals return to the estuary and marine coastal areas.

Similar to the California sea lion, the diet of harbor seals in the Columbia River varies by season, including eulachon in the winter, and anchovy, Pacific herring, staghorn sculpin, starry flounder, and lamprey at other times of the year (Beach et al. 1985; Riemer and Brown 1997; NMFS 1997; Browne et al. 2002). NMFS (1997) summarized food habits studies in the Columbia River as follows: "Salmonids appear to be targeted as prey by harbor seals primarily in the spring and fall, possibly because they are abundant and available in the river at the time in contrast to the winter when eulachon are much more abundant." Juvenile Chinook salmon were taken in the spring (Reimer and Brown 1997; Browne et al. 2002), and Reimer and Brown (1997) also found that juvenile Chinook salmon were taken in the fall. Numerically, about 1 percent of the harbor seal diet was composed of salmon in an older study along the Oregon coast, although total biomass would be about 10 percent because salmon are larger than other prey species (Park 1993).

In studies on the Columbia River, most salmonids consumed by harbor seals were juvenile Chinook salmon taken during the spring (frequency of occurrence in samples 19 percent), and adult salmon were consumed during the fall to a lesser extent (frequency of occurrence in samples was 10 percent) (Browne et al. 2002). During summer months, the frequency of occurrence of adult and juvenile salmon in harbor seal scat samples was 4 percent and 5 percent, respectively. Like California sea lions, harbor seals follow prey upriver as far as the Bonneville Dam (NMFS 2008f).

3.5.5.2 Transfer of Toxic Contaminants and Pathogens

The potential for transfer of toxins and pathogens to marine mammals is the same as described for ESA-listed wildlife species (Section 3.5.3.2, Transfer of Toxins and Pathogens).

3.5.6 Other Aquatic and Terrestrial Wildlife

In addition to the listed species and other birds and marine mammals discussed in the sections above, other wildlife species interact with salmon and steelhead (Table 3-32). Some of these animals (river otter and mink) are predators of salmon and steelhead, while others (marine invertebrates and insects) are prey. Some wildlife species are not direct predators or prey of salmon, but may be affected by prey availability and hatchery practices through effects on water quality, stream flow, nutrient and salmon carcass availability, or other factors.

Relevant to hatchery operations, factors that affect distribution and abundance of other aquatic and terrestrial wildlife include prey resources and distribution of food resources and hatchery predator control programs.

3.5.6.1 Distribution of Other Aquatic and Terrestrial Wildlife and their Food Resources

As described for listed species, avian predators, and marine mammals, hatcheries may benefit other salmon predators by providing a source of prey, particularly where hatchery-origin fish congregate outside of the hatchery facilities (e.g., release sites, dam tailraces, and estuaries). At the hatcheries, predation success is expected to be generally low, due to implementation of predator control measures (Section 3.5.4.3, Hatchery Predator Control Programs and Weirs). Listed amphibians and invertebrates (Table 3-32) have not been cited as having a relationship with salmon and steelhead. Although salmon prey studies have not demonstrated salmon consumption of snails, there is anecdotal information that snails could be part of the diet of salmon, although minor, if occurring at all.

The river otter is a top predator of a wide variety of aquatic food chains from marine environments to montane lakes. It is found throughout the analysis area (LCFRB 2004). Otter prey vary seasonally, but the species is heavily dependent on a wide variety of fish species, including salmonids (Melquist 1997; River Otter Journal 2003). Cederholm et al. (2001) considered river otters to have a strong relationship with juvenile salmon, spawning salmon, and salmon carcasses. Mink also occur throughout the analysis area (Maser 1998). Mink consume salmon and steelhead, but they also consume other prey, and they are less specialized as fish predators than are otters (Melquist 1997).

TABLE 3-32. STATUS AND HABITAT ASSOCIATIONS OF OTHER WILDLIFE IN THE ANALYSIS AREA WITH DIRECT OR INDIRECT RELATIONSHIPS WITH HATCHERY-ORIGIN SALMON.

	STATUS	HABITAT[1]			RELATIONSHIP WITH SALMON[2]		
SPECIES	FEDERAL (F) AND STATE (S) STATUS	FRESHWATER	ESTUARINE/ MARINE	RIPARIAN	PREDATOR	PREY	SCAVENGER
River otter	F: none S: none	√	√		√		
Mink	F: none S: none	√	√		√		√
Amphibians (e.g., salamanders)	Varies by species[3]	√		√	√		
Aquatic/terrestrial/ riparian zone invertebrates[3] (e.g., insects)	N/A	√	√	√		√	√
Marine invertebrates (e.g., zooplankton)[4]	F: none S: varies by species		√			√	

Source: Cederholm et al. (2001).

[1] Includes those habitats most relevant for evaluating interactions with salmon; does not include all habitats used by each species.

[3] Applicable listed species include federally listed frogs (Columbia spotted frog, *Rana luteiventris,* (Federal species of concern); Oregon spotted frog, *Rana pretiosa* (Federal species of concern and Washington State endangered species); large mountain salamander, *Plethodon larselli* (Federal species of concern and Washington state endangered species); northern leopard frog, *Rana pipiens* (Federal species of concern); western pond turtle, *Actinemys marmorata* (Federal species of concern)).

[4] Applicable listed species include federally listed snails (Bliss Rapids snail, *Taylorconcha serpenticola,* (federally threatened); Banbury Springs lanx, *Lanx* sp.,(federally endangered); Idaho springsnail, *Pyrgulopsis idahoensis* (federally endangered); Snake River physa snail, *Physa natricina* (federally endangered); Utah valvata, *Valvata utahensis* (federally endangered)).

Cederholm et al. (2001) identified two salamander species (which are amphibians) as having a recurrent relationship with salmonids in freshwater. The Pacific giant salamander is a common predator in its larval stage in headwater and mid-sized streams in western Washington and Oregon, consuming invertebrates, larval amphibians, and small fish, which may include salmonid fry (Cederholm et al. 2001). Cope's giant salamander, a species that spends its entire life in small, steep-gradient streams in the Olympic Peninsula and southwestern Washington, may also prey on salmonids. Pacific giant salamanders have been found in small streams with juvenile coho salmon and steelhead, but their relationship (predator/prey or competitor) is unknown (Roni 2002). Neither species is a Federal or state listed species (Table 3-32).

Marine invertebrates that occur in the Columbia River estuary are consumed by juvenile salmon to an extent determined by each species' life history. For example, subyearling Chinook salmon have a long residence time in the Columbia River estuary (with peak numbers from May through September) and, thus, would be important predators on marine invertebrates. While in the estuary, Chinook salmon consume emergent insects, epibenthic crustaceans (e.g., mysids and amphipods), and freshwater pelagic zooplankton (Pearcy 1992; Bottom et al. 2005). These species are not listed as either Federal or state listed species (Table 3-32).

Aquatic insects and terrestrial insects (which are invertebrates) are prey of salmon fry. Upon emergence from stream gravels, all species of salmon fry actively feed on dipterans, and chum salmon and Chinook salmon fry feed on stonefly and mayfly nymphs. Coho salmon fry are suspension and surface feeders whose diet is predominately terrestrial insects. In turn, aquatic insects (such as caddisflies, stoneflies, and midges) feed on salmon carcasses.

Macroinvertebrate communities in streams with salmon runs can increase in response to spawning activity because substrate disturbance during spawning opens niche space for blackflies, stonefly nymphs, and midge larvae, all of which are potential prey items for salmon. Nutrient enrichment from carcasses (Cederholm et al. 2001) and increases in aquatic invertebrate density from the introduction of salmon carcasses support feeding by early life stages of salmon species (Cederholm et al. 2001).

3.5.6.2 Transfer of Toxic Contaminants and Pathogens

The potential for transfer of toxins and pathogens to other aquatic and terrestrial wildlife is the same as described for ESA-listed wildlife species (Section 3.5.3.2, Transfer of Toxins and Pathogens).

3.5.6.3 Hatchery Predator Control Programs

In addition to the avian predators discussed in previous sections, river otters and mink are common predators at hatchery facilities (J. Kerwin, pers. comm., WDFW Wildlife Biologist, February 18, 2004). The hatcheries employ non-lethal, passive, exclusionary devices (e.g., otter fencing), as well as trapping, to inhibit or prevent these predators from taking hatchery-origin salmon (Section 3.5.4.3, Hatchery Predator Control Programs and Weirs).

3.5.6.4 Hatchery Facility Effects

Hydrology is an important factor in determining the suitability of a given area to provide habitat for amphibians and aquatic invertebrates. The operation of hatchery facilities affects water volume and flow, particularly in bypass areas. Depending on existing habitat, timing, and degree of water flow alterations, habitat availability for stream-breeding amphibians (e.g., salamanders), crustaceans (a marine invertebrate), and aquatic insects could be affected.

Most of the hatchery facilities contain rearing ponds with asphalt or other lined walls. While amphibians can enter these types of ponds, in some instances, they cannot escape from the ponds and eventually drown. Susceptibility of amphibians to this type of mortality depends upon the occurrence of the animals in the hatchery facility vicinity, the mobility of the species, the steepness of the rearing pond walls, and the elevation of the pond water relative to the height of the walls. Other potential sources of mortality at the hatchery facilities include entrapment in fish screens, weirs, and other exclusionary devices.

3.5.6.5 Nutrients/Distribution of Salmon Carcasses

Recent research indicates the importance of spawned-out salmon carcasses to ecosystem function (Kline et al. 1993; Cederholm et al. 2000; Quamme and Slaney 2002). Salmon carcasses provide a carrion food source for wildlife and a source of nutrients for other aquatic and terrestrial species through the decomposition of carcasses. Distributing hatchery-origin salmon carcasses to upstream river reaches can replace some of the nutrients in nutrient-deficient areas where spawning salmon and steelhead are limited or lacking. As mentioned above, hatcheries distribute approximately 160,000 to 180,000 salmon carcasses annually to upstream river reaches in Washington State (WDFW 2008). Similar practices also occur in Oregon, where carcasses are placed in a large number of Columbia River tributaries each year (ODFW 2007; T. Friesen, pers. comm., ODFW Biologist, November 10 2008), as well as in Idaho (NMFS 2008b).

3.6 Water Quality and Quantity

3.6.1 Introduction

Successful operation of Federal, state, and tribal hatcheries depends on a constant supply of high-quality surface, spring, or groundwater that, after use in the hatchery facility, is discharged to adjacent receiving environments. Operation of hatchery facilities may affect water quality parameters (e.g., temperature, pH, and nutrients) (Section 3.6.3.1, Water Quality Parameters) and/or the diversion and consumption of water (Section 3.6.4, Water Quantity).

This section describes 1) the water quality parameters that could be affected by hatchery operations, 2) applicable water quality regulations for hatchery facilities, and 3) how hatchery operations could affect surface and groundwater near hatchery facilities.

3.6.2 Analysis Area

The analysis area for water quality and quantity is the same as the project area (Section 2.2, Description of Project Area). Information presented in Section 3.6, Water Quality and Quantity, and is organized according to issue.

3.6.3 Water Quality

3.6.3.1 Water Quality Parameters

Hatchery production could affect several water quality parameters in the aquatic system. Concentrating large numbers of fish within hatcheries could produce effluent with elevated temperature, ammonia, organic nitrogen, total phosphorus, biochemical oxygen demand (BOD), pH, and suspended solids levels (Sparrow 1981; Washington State Department of Ecology [Ecology] 1989; Kendra 1991; Cripps 1995; Bergheim and Åsgård 1996; Michael 2003). Chemical use within hatcheries could result in the release of antibiotics (a therapeutic), fungicides, and disinfectants into receiving waters (Boxall et al. 2004; Pouliquen et al. 2008; Martinez-Bueno et al. 2009). Other chemicals and organisms that could potentially be released by hatchery operations are PCBs, DDT and its metabolites (Missildine et al. 2005; HSRG 2009), pathogens (HSRG 2005; HSRG 2009), steroid hormones (Kolodziej et al. 2004), anesthetics, pesticides, and herbicides. Hatchery production could also affect stream flow near facilities through removal and release of existing water resources.

Each of the following sections describes the water quality parameters, explains how the parameter is transported from hatcheries into the aquatic system, and discusses potential effects on receiving waters. The water quality parameters discussed could be transported from hatcheries to the aquatic system through discharges of hatchery water used for operations (referred to as effluent), decomposition of hatchery-origin salmon carcasses placed in streams to enhance nutrient levels, and releases of large numbers of hatchery-origin salmon into receiving streams.

Hatchery facility waste products include uneaten food, fecal matter, soluble metabolites (e.g., ammonia), algae, parasitic microorganisms, drugs, and other chemicals (Kendra 1991; Bergheim and Åsgård 1996; IDEQ 2008). Fish hatchery facility wastewater commonly includes suspended solids and settleable solids (those that settle out of suspension), as well as nutrients, such as various forms of nitrogen (e.g., ammonia) and phosphorus (Michael 2003). Effluent water quality could affect the health and productivity of receiving waters. Some of the chemical or physical parameters having the greatest potential to impact receiving waters are temperature, nitrogen, phosphorus, dissolved oxygen, pH, and sediment, as described below (IDEQ 2002).

Some water quality parameters could also be affected by decomposition of salmon carcasses. Spawned-out salmon could occur either directly at the facility site (from hatchery-origin adults that return to a hatchery facility or net pen) or indirectly away from the facility site (from hatchery-origin adults that spawn naturally or from hatchery-origin carcasses that are deliberately placed in streams by hatchery operators). The direct placement of spawned-out carcasses in a watershed is, in part, a response to research demonstrating that carcass-derived nutrients historically represented a critical contribution of marine-derived nutrients (particularly phosphorus) to the overall productivity of both aquatic and terrestrial components of the ecosystem (Section 3.2.3.1, General Risks and Benefits of Hatchery Programs on Salmon and Steelhead Species, Section 3.5.6.5, Nutrients/Distribution of Salmon Carcasses) (Cederholm et al. 2001).

3.6.3.1.1 Temperature

The temperature of receiving waters adjacent to hatcheries could be affected by the discharge of warmer or colder water from these facilities. Salmon and steelhead require specific temperatures for growth, maintenance, and reproduction at the hatcheries. Water temperatures that fluctuate dramatically or move beyond the optimal range for each salmon life stage can impart stress, thereby reducing production efficiency, increasing disease susceptibility, and altering waste generation within the facility (IDEQ 2002). Thus, hatcheries may release water with a temperature that is optimum for hatchery operations, but differs from the receiving environment.

In addition, some hatchery facility effluents are diverted to settling basins before discharge to receiving waters. With little or no flow, water temperature within these settling basins could be increased by solar insulation prior to discharge (Kendra 1991), with the amount of increase dependent on the retention time of water in the basin. When these hatchery facility effluents are released into nearby water bodies, there may be impacts on the receiving water bodies if the effluent is warmer than the receiving water. The extent of the effect would depend on the absolute temperature difference, the volume of effluent released, and the size (water volume) of the receiving water body. To minimize this effect, effluent discharge permits for hatcheries specify effluent temperature limits, either just prior to discharge, or at the downstream end of a mixing zone in the receiving water. Recent monitoring of several hatcheries in Washington indicated that effluent from hatchery facilities would not have a reasonable potential to exceed water quality standards for temperature (Ecology 2005a).

3.6.3.1.2 Nutrients

Nutrients, such as various forms of nitrogen and phosphorus, are a commonly recognized constituent of hatchery facility wastewater (Michael 2003). Nitrogen and phosphorus are recognized as potential limiting factors in many aquatic systems (Michael 2003); the amount of these nutrients in an aquatic system could determine the amount of aquatic plant growth. Elevated levels of these nutrients encourage the growth of aquatic plants, which then changes the habitat. In addition, the growth of the aquatic plants results in oxygen consumption that fish and other native plants need to survive (IDEQ 2008; Kendra 1991). An increase in nutrients could also change macrobenthic (e.g., insect) communities (species presence and/or abundance) downstream from effluent discharges, potentially affecting the availability of preferred prey resources (Camargo 1992).

In addition to nutrient concentrations in discharged effluent, nutrient levels in the receiving environment could also be affected through the release of organic matter (uneaten food, feces, and dead fish) in hatchery facility effluent, as well as the decomposition of spawned-out or deliberately placed salmon carcasses. As this organic matter decomposes, it consumes oxygen in the process and releases additional nutrients (nitrogen [as nitrate-nitrite and ammonia] and phosphorus) to the environment. Ammonia forms ammonium ion (NH_4^+) and un-ionized ammonia (NH_3), which could be harmful or lethal to aquatic organisms. This toxic, un-ionized fraction varies with pH, temperature, and salinity, and it increases as the pH and temperature increase (IDEQ 2002). The decomposition of spawning salmon carcasses also results in the release of nutrients (primarily phosphorus) (WDFW 2004); however, such releases are considered beneficial because they are gradual, spread out over larger areas, and only occur around the spawning season (Cederholm et al. 2001). In contrast, hatcheries operate throughout the year, and the effluent discharge typically occurs at a single location. Thus, there are temporal and spatial components to natural delivery of these nutrients by spawning fish that nutrient delivery through wastewater does not duplicate (Michael 2003).

Most of the nutrients of concern in hatchery facility effluent are associated with solids (i.e., they are the result of organic matter from uneaten food and feces) in the effluent (Ecology 2005a). Investigations of treatment options have identified the process of settling solids (which would allow you to remove them) as the most cost-effective method to reduce the amount of nutrients in the effluent to an acceptable level (McLaughlin 1981, Michael 2003). Hatchery facilities typically use settling ponds to reduce the solids in their discharge effluent. With the removal of solids, there is a low risk of water quality violations from nutrients with adequate dilution by receiving water (Ecology 2005a).

3.6.3.1.3 Dissolved Oxygen

By far, oxygen is the most important dissolved gas in an aquatic environment because it is necessary to support life. Depleted dissolved oxygen levels could adversely affect receiving waters by reducing the productivity and usable habitat for aquatic species. Tolerances for dissolved oxygen conditions vary widely by aquatic species. While most aquatic organisms could survive brief periods at low oxygen levels, prolonged exposure could have adverse effects on organisms not adapted for such conditions (IDEQ 2002). Reduced dissolved oxygen could cause stress, making organisms less competitive and productive, and in severe cases, could result in direct mortality (Ecology 2005a).

Dissolved oxygen levels in an aquatic system could be reduced directly through the release of nutrients (nitrogen and phosphorus) from organic matter into the water column (Piedrahita et al. 1996). Indirectly, dissolved oxygen could be reduced by the decomposition of organic matter in hatchery facility effluent discharged into receiving waters or through the decomposition of salmon carcasses. The decomposition process uses oxygen, which is typically referred to as BOD. While not a specific compound, BOD is a measure of the amount of oxygen consumed by this biological process. It is used in modeling to assess the potential reduction of dissolved oxygen in receiving water, caused by effluent discharge (Ecology 2005a).

Recently, Ecology initiated specific monitoring for dissolved oxygen in hatchery facility effluent and concluded that hatchery facilities do not have reasonable potential to exceed water quality standards for dissolved oxygen (Ecology 2005a). Recent changes in Washington’s NPDES permit requirements also established individual BMPs and waste handling plans that, when complied with, help ensure that water quality criteria for dissolved oxygen are not exceeded. Similarly, Idaho and Oregon NPDES permits for hatcheries no longer include limits for dissolved oxygen.

3.6.3.1.4 pH

pH is a measure of hydrogen ion concentration. It is important because aquatic organisms could be harmed when conditions lead to pH levels outside their normal tolerance range in their environment (IDEQ 2002). Changes in pH likely arise from primary production (algal growth via photosynthesis) within hatcheries (Kendra 1991). Effluent with a lower pH than the receiving water is more acidic, while effluent with a higher pH is more basic than the receiving water. Decreases in pH can lead to increased toxicity of certain chemicals, including ammonia and nitrite. However, all hatcheries in the Columbia River basin must comply with specific Federal, state, and or tribal water quality regulations that include pH in hatchery facility effluent. All hatchery facilities in the analysis area are currently in compliance with these regulations (Section 3.6.3.2, Applicable Hatchery Facility Regulations and Compliance).

3.6.3.1.5 Sediment (Turbidity, Total Suspended Solids, and Settleable Solids)

Turbidity is the measure of light blocked and scattered by particles (cloudiness), and total suspended solids (TSS) are the amount (mass) of particles suspended in the water column. Settleable solids are particles that fall out of suspension and accumulate at the bottom of a water body (sedimentation). Effluent discharged from the operation and maintenance of hatcheries could increase sediments in downstream water (turbidity and TSS), as well as sedimentation rates, by flushing uneaten feed, feces, and dead fish when cleaning raceways and holding ponds to the downstream receiving environment (Kendra 1991; Williams et al. 2003).

Settling nutrients (i.e., allowing them to fall to the bottom of a holding basin) have been shown to be an effective method to reduce solids in effluent (Michael 2003). Hatcheries typically use settling ponds to reduce the turbidity and TSS levels in their discharge effluent. Relative to the dissolved components of waste, such as phosphorus and ammonia, solids are much easier to capture and remove from the aquaculture operation prior to effluent discharge (IDEQ 2002). Offline settling basins are used to capture particles of organic matter and prevent such releases into receiving waters.

3.6.3.1.6 PCBs and DDTs (Fish Tissue)

While in the marine environment, salmon could ingest PCBs and store them in their body fats (BPA and CTCR 2007). NMFS (2001) indicated that juvenile salmon could accumulate toxicants, including PCBs and DDTs, during downstream migration and smolting. Feed or supplements used by hatcheries may also be a source of PCBs and DDTs (Maule et al. 2007; Maule 2009), although not enough research has been conducted to confirm this association. Distribution of hatchery-origin carcasses in streams could result in the release of PCBs and DDTs into the freshwater aquatic system as the carcasses decompose (Missildine et al. 2005). However, the likelihood of PCB and DDT release from salmon carcasses would likely be similar between hatchery-origin and natural-origin salmon and steelhead since these fish would be exposed to the same toxicants in river, estuary, and ocean environments. Section 3.7, Human Health, provides a detailed discussion of toxic contaminants in hatchery-origin fish, including PCBs and DDTs.

3.6.3.1.7 Pathogens

While hatcheries conduct regular screening for pathogens and diseases (parasites, viruses, and bacteria), and follow prescriptive measures to control the spread of such pathogens, some pathogens are released in hatchery facility effluent or from the inadvertent release of affected fish. Pathogens that are potentially harmful to human health are discussed in Section 3.7, Human Health. Fish pathogens include infectious pancreatic necrosis virus, infectious hematopoietic necrosis virus, viral hemorrhagic septicemia virus, furunculosis (*Aeromonas salmonicida*), enteric redmouth (*Yersinia ruckeri*), whirling disease (*Myxobolus cerebralis*), salmonid ceratomyxosis (*Ceratomyxa shasta*), and *Renibacterium salmoninarum* (causative agent of BKD) (Naylor et al. 2005; NWIFC et al. 2006).

Salmon carcasses could also result in the introduction of pathogens into the aquatic system (HSRG 2005; HSRG 2009; LaPatra 2003; Naylor et al. 2005; USFWS 1999), although little evidence is available to demonstrate that this is a common occurrence (LaPatra 2003; USWFS 1999). Salmon carcasses with pathogens may increase the susceptibility of salmon to a variety of diseases (Pearsons et al. 2003). However, as discussed above, outside of the hatchery facility, hatchery-origin and natural-origin salmon would be exposed to the same pathogens; thus, the likelihood of pathogens being in hatchery-origin carcasses would be about the same as that which occurs in natural-origin carcasses. Additionally, hatchery-origin carcasses comprise a small proportion of the total available carcasses compared to naturally spawning salmon in freshwater streams.

3.6.3.1.8 Steroid Hormones

Hatchery facility effluent may also contribute steroid hormones to receiving waters. Like other vertebrate animals, salmon naturally produce and excrete steroid hormones, and wastewater treatment practices employed by most aquaculture facilities are unlikely to remove these hormones (Kolodziej et al. 2004). Kolodziej et al. (2004) detected the endogenous steroids estrone, testosterone, and androstenedione in the raceways and effluents of three fish hatcheries at concentrations near 1 mg/L. Such concentrations may be high enough to affect fish behaviors in the hatcheries (Colman et al. 2009). However, there are no data that suggest that these hormones would affect water quality of the receiving waters. As a result, there are no current effluent discharge limits or water quality standards for steroid hormones.

3.6.3.1.9 Chemicals Used in Hatchery Programs

Fish hatcheries use a broad spectrum of chemicals such as commercial antibiotics, fungicides, and disinfectants for the control of bacterial and fungal disease agents associated with fish aquaculture. The types and amounts of chemicals used at a hatchery facility depend on site-specific conditions, fish culture practices, species of fish, and types of parasites or disease organisms being treated. For more information on hatchery facility use of antibiotics, fungicides, and disinfectants, refer to Section 3.7, Human Health.

The discharge of treated waters in raceways to receiving environments could result in the release of these chemicals to downstream receiving waters. Several of the antibiotics used in aquaculture have been detected in receiving waters and sediment downstream of fish farms (Boxall et al. 2004; Pouliquen et al. 2008; Martinez-Bueno et al. 2009). Although concentrations observed in the water column are usually well below those toxic to fish and invertebrates, they could be toxic to naturally occurring algae and bacteria (Boxall et al. 2004). Additionally, there are some reports of antibiotic resistance and other problems in river systems with high inputs of these compounds, as discussed in Section 3.7, Human Health. As discussed in Section 3.6.3.2, Applicable Hatchery Facility Regulations and Compliance, several Federal agencies have approved hatchery facilities to use a broad spectrum of commercial antibiotics, fungicides, and disinfectants. The use of these federally regulated products requires hatchery personnel to follow manufacturer-identified conditions under which the product is expected to be effective and safe.

3.6.3.2 Applicable Hatchery Facility Regulations and Compliance

Hatchery facilites must comply with all applicable Federal, state, and tribal water quality standards for effluent discharges and Federal and state regulations on use of chemicals and fish food. This section discusses the Federal, state, and tribal regulations applicable to water quality and describes how hatcheries in the Columbia River basin (i.e., analysis area) comply with these regulations.

3.6.3.2.1 Federal Regulations

The direct discharge of hatchery facility effluent is regulated by the EPA under the Clean Water Act through NPDES permits. For discharges from hatcheries not located on Federal or tribal lands within Oregon and Washington, the EPA has delegated its regulatory oversight to the states. Oregon, Washington, and Idaho are all responsible for certifying that NPDES-permitted projects not located on Federal or tribal lands comply with state water quality standards. This is accomplished through Clean Water Act Section 401 water quality certification. As a result of this certification, hatcheries that are in compliance with water quality standards, and, thus, their NPDES permits, are considered not to cause or contribute to a violation of water quality standards.

Oregon (Oregon Department of Environmental Quality [ODEQ]) and Washington (Ecology) are also responsible for issuing and enforcing NPDES permits. In Idaho, the EPA is responsible for issuing and enforcing NPDES permits. The EPA administers NPDES permits for all projects on Federal and tribal lands; however, Native American tribes may adopt their own water quality standards for permits on tribal lands. State and tribal water quality standards are discussed separately below. The EPA (2004) designates salmon hatchery programs as concentrated aquatic animal production facilities and established national effluent limitation guidelines for these facilities that address the discharge of TSS, BOD, and nutrients (69 Fed. Reg. 51891, August 23, 2004). It determined that narrative guidelines were most appropriate and chose not to establish nationwide quantitative limits. This decision, in part, was to allow greater flexibility for states that had already adopted suspended sediment and BOD limits for hatchery operations. Additionally, the EPA chose not to establish numeric discharge limits for any antibiotics, fungicides, or disinfectants used in hatchery operations, choosing instead to require concentrated aquatic animal production facilities to follow existing Federal and state guidance concerning the safe handling and storage of these materials.

Fish hatcheries are approved by several Federal agencies to use a broad spectrum of commercial antibiotics, fungicides, and disinfectants to control bacterial and fungal disease agents associated with fish aquaculture. The use of these federally regulated products requires hatchery personnel to follow manufacturer-identified conditions under which the product could be expected to be effective and safe. Labels for approved products describe uses allowed by law. Any departure from the directions and conditions on the product label or on special state labels could be a legal violation. The use of hatchery treatment chemicals is closely regulated by the EPA, and each hatchery operation has reporting requirements concerning their use. Additional discussion about regulation of hatchery treatment chemicals is provided in Section 3.7, Human Health. State-specific water quality standards for hatchery treatment chemicals are discussed below.

As part of administering elements of the Clean Water Act, Washington, Oregon, and Idaho are required to assess water quality in streams, rivers, and lakes. These assessments are published in what are referred to as the 305(d) report and the 303(d) list (the numbers referring to the relevant sections of the original Clean Water Act text). The 305(d) report reviews the quality of all waters of the state, while the 303(d) list identifies specific water bodies considered impaired (based on a specific number of exceedances of state water quality criteria in a specific segment of a water body). Of the specific parameters impairing water quality in segments of the Columbia and Snake Rivers, several are potentially associated with hatchery production (Table 3-33). As stated above, hatcheries that are in compliance with their NPDES permits, and thus water quality standards, are considered not to cause or contribute to a violation of water quality standards. However, the amounts of these chemicals being discharged into receiving waters from hatcheries do contribute to the total loads of those receiving waters and downstream waters.

3.6.3.2.2 State Regulations

The states of Washington, Oregon, and Idaho each have primary responsibility for the health and protection of their state's water quality. Each state has established water quality standards, which consist of 1) designated uses for the water body, 2) water quality criteria (numeric pollutant concentrations and narrative requirements) to protect designated uses, 3) an antidegradation policy, and 4) general policies addressing implementation issues, such as low flows, mixing zones, and variances. While these states depend primarily on EPA to develop and promulgate proposed water quality standards, the states' water quality standards differ, both qualitatively (narrative standards) and quantitatively (numeric standards).

The following sections provide state-specific information regarding the states' NPDES permits, including criteria, monitoring requirements, and compliance. For all three states, there are currently no specific water quality criteria for steroid hormones. In general, none of the states has specific water quality criteria for hatchery treatment chemicals and considers applications following manufacturer and Federal guidelines as meeting water quality objectives. All hatcheries within the Columbia River basin are currently in compliance with their NPDES permits.

Washington

Ecology reissued its Upland Fin-Fish Hatching and Rearing NPDES Waste Discharge General Permit effective June 1, 2005. This permit covers every upland fin-fish hatching or rearing facility within the jurisdiction of Ecology and sets specific limits on days of operation and pounds of fish produced per year. This general permit established monthly averages and instantaneous maxima for settleable solids and TSS in the rearing ponds, raceway discharges, and any offline settling basin discharges.

TABLE 3-33. 303(D) WATER QUALITY PARAMETERS POTENTIALLY AFFECTED BY HATCHERY FACILITIES IN THE COLUMBIA AND SNAKE RIVERS.

	POTENTIALLY ASSOCIATED WITH HATCHERY FACILITIES?	
IMPAIRING POLLUTANT[1]	NO	YES
4,4'-DDD		X
4,4'-DDE		X
4,4'-DDT		X
Aldrin	X	
Algae		X
Alpha-BHC	X	
Ammonia		X
Bacteria	X	
Chlordane	X	
Chromium	X	
Copper	X	
Dieldrin (fish tissue)	X	
Dissolved oxygen		X
Fecal coliform	X	
Flow alteration		X
Iron	X	
Manganese	X	
Mercury	X	
Mercury (fish tissue)	X	
Nutrients		X
Pathogens		X
Pesticides	X	
pH		X
Sediment (suspended solids)		X
Sedimentation (settleable solids)		X
Temperature		X
Total PCBs (fish tissue)		X
Total phosphorus		X
Zinc	X	

[1] Identified from monitored river segments in the Lower Columbia, Middle Columbia, Upper Columbia, Lower Snake, and Middle Snake Rivers, as reported in Ecology (2004), ODEQ (2009a), IDEQ (2009).

The Upland Fin-Fish Hatching and Rearing Permit does not allow violation of the state's groundwater standards (Chapter 173-200 WAC). Ecology has determined that a properly operated upland fin-fish hatching and rearing facility poses little potential to impact state groundwater quality standards; however, this permit does not authorize a violation of these standards. Ecology may require facilities with the potential to violate these standards to obtain coverage under an individual permit, require additional sampling and groundwater monitoring, and/or require rearing and pollution abatement ponds to be lined, if necessary (Ecology 2005a).

Washington has adopted surface water quality standards for temperature, ammonia, dissolved oxygen, and pH. The numeric standards (both upper and lower in the case of pH) have been revised for these parameters in the last 5 years to be more protective of salmonids. Nutrient standards are primarily narrative and are aimed at minimizing production of algae when excess nitrates and phosphorus are present. Washington also regulates turbidity and TSS in hatchery facility effluent discharges. For water bodies identified as having impaired water quality, Washington requires discharge permittees, including hatchery operators, to comply with state water quality standards for each pollutant considered to be causing a violation of water quality.

Washington requires effluent monitoring, recording, and reporting for each hatchery facility to verify that its treatment process is functioning correctly and effluent limitations are being achieved. In a 1988 survey of 19 trout and salmon hatchery facilities, Ecology found levels of BOD that sometimes exceeded state water quality standards. This survey spurred modifications of the general upland NPDES permit under which these facilities operate (Ecology 2005a; Ecology 2005b), resulting in the application of effluent limits for solids (both settleable solids and TSS), to reduce the levels of organic matter introduced to the environment and minimize the downstream BOD levels. Due to concerns raised by this study (Ecology 1989; Kendra 1991), Ecology initiated specific monitoring for temperature and dissolved oxygen in hatchery facility effluent. The results of this additional monitoring showed that these facilities do not have reasonable potential to exceed water quality standards for these parameters (Ecology 2005a). This led Ecology to drop temperature and dissolved oxygen as monitoring requirements from the current NPDES permit (Ecology 2005a; Ecology 2005b).

Ecology's current NPDES permit does require monitoring of TSS (Ecology 2005a). Effects from hatchery facility effluent discharges on the downstream macrobenthic community have been observed in other salmon and trout rearing facilities in the U.S. and internationally (Kendra 1991; Camargo 1992; Selong and Helfrich 1998). Partly in response to these types of studies, investigations of treatment options have identified settling solids as the most cost-effective method to improve effluent quality to acceptable levels (McLaughlin 1981; Michael 2003). Most of the nutrients of concern are associated with solids, which are effectively removed in settling ponds. Washington's NPDES permits have instituted requirements for controlling sediment discharges, believing that solids in effluent are the best indication of how well a facility is complying with its permit (Ecology 2005b).

The type and amount of salmon carcasses that could be placed in the environment are under the control of specific state programs independent of hatchery program funding and management. In Washington, the WDFW has a specific nutrient supplementation program aimed at placing salmon carcasses in selected streams based on historical levels of salmon escapement (WDFW 2004). While this program establishes guidelines for carcass distribution, the actual number distributed is independent of individual hatchery program production.

Oregon

Oregon's General NPDES Permit 300J (fish hatcheries) establishes waste discharge limitations for TSS, temperature, and pH (both monthly averages and daily maxima) for normal and cleaning operations at upland hatcheries. This general permit sets minimum monitoring and reporting requirements for effluent discharges, receiving streams, and influent supply water.

Like Washington, Oregon has adopted surface water quality standards for temperature, ammonia, dissolved oxygen, and pH, and the numeric standards for these parameters have been revised in the last 5 years to be more protective of salmonids. Nutrient standards are primarily narrative and aimed at minimizing production of algae when excess nitrates and phosphorus are present. Oregon also regulates turbidity and TSS in hatchery facility effluent discharges; however, limits for TSS are basin-specific.

Oregon's NPDES Permit 300J does not authorize any discharges from fish hatcheries to groundwater, including discharges to an underground injection control system. ODEQ administers a number of groundwater protection programs, and Oregon hatcheries are required to comply with these programs in their operations (ODEQ 2009b).

ODEQ regulates salmon carcass distribution as a discharge to waters of the state. It requires a separate NPDES permit with stream chemistry monitoring before these distributions could occur (Oregon Plan 1999).

ODFW's Fish Health Management Policy describes measures that minimize the impact of fish diseases on the state's fish resources (ODFW 2003). In addition to supporting the primary objective of producing healthy smolts, ODFW has implemented both disease control and disease prevention programs at all of its hatchery facilities to prevent the introduction, amplification, or spread of fish pathogens that might negatively affect the health of both hatchery-origin and natural-origin reproducing stocks.

Idaho

Idaho's NPDES permit for cold-water aquaculture facilities not subject to waste load allocations (total maximum daily loads [TMDLs]) contains effluent limits and monitoring requirements for cold water raceways and associated full-flow, settling basin discharges (General Permit IDG-131000). Idaho General Permit IDG-130000 applies to aquaculture facilities subject to waste load allocations. Additionally, The Idaho Department of Agriculture licenses commercial fish facilities under Title 22, Section 4601 of the Idaho Code. The Idaho Department of Water Resources regulates commercial aquaculture under Title 42 of the Idaho Code when water is appropriated for fish propagation (Idaho Department of Environmental Quality [IDEQ] 2002).

The Idaho Water Quality Standards and Wastewater Treatment Requirements (Title 1, Chapter 2) regulate aquaculture waste management and the protection of designated or existing uses of state waters, which IDEQ determined under the state Water Quality Act (Idaho Code 39-3601 *et seq.)*. A best management practice (BMP) plan, as outlined in the Idaho Waste Management Guidelines for Aquaculture Operations (IDEQ 2002), is required for a facility to be covered under Idaho's general NPDES permit for aquaculture (IDEQ 2008).

As for Washington and Oregon, Idaho has adopted standards for temperature, ammonia, dissolved oxygen, and pH, and the numeric standards have been revised for these parameters in the last 5 years to be more protective of salmonids. Nutrient standards are primarily narrative and are aimed at minimizing production of algae when excess nitrates and phosphorus are present. Idaho regulations state that "surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths" (Idaho Administrative Procedures Act [IDAPA] 58, Title 01, Chapter 02). Idaho's water quality standards also include limits on turbidity.

The current aquaculture facility NPDES permits for Idaho require monitoring of effluent flow, TSS, total phosphorus, pH, temperature, and total ammonia as nitrogen, but do not require monitoring for dissolved oxygen or BOD (EPA 2007a). Idaho hatcheries discharging under waste load allocations assigned as part of receiving environment TMDL programs are required to monitor effluent flow, TSS, net TSS, net total phosphorus, temperature, total copper, hardness, total inorganic nitrogen, and total nitrogen, dependent on receiving water conditions (EPA 2007b).

Idaho's general NDPES permits for cold-water aquaculture facilities in the state contain provisions for monitoring groundwater diversions, but no specific requirements for the protection of groundwater quality. Each Idaho fish hatchery facility is required to comply with the conditions of the Idaho Administrative Rule 58.01.11 – Ground Water Quality Rule (http://adm.idaho.gov/adminrules/rules/idapa58/0111.pdf).

Regarding the distribution of salmon carcasses, Idaho is currently developing new measures for improving fish habitats, including nutrient supplementation and fish supplementation measures, to incorporate into the Northwest Power and Conservation Council's Fish and Wildlife Program (Idaho Department of Fish and Game [IDFG] 2008). As for Washington and Oregon, this program establishes guidelines for carcass distribution, but the actual number distributed is independent of individual hatchery program production.

The Fisheries Management Plan 2007-2012 (IDFG 2006) describes Idaho's fisheries management on a statewide basis, including department policies and fisheries management programs. This plan incorporates goals, objectives, and strategies from IDFG's strategic plan (IDFG 2005), which includes a goal to eliminate the effects of fish and wildlife diseases on fish and wildlife populations, livestock, and humans. Plan strategies to accomplish this goal include monitoring fish and wildlife populations for disease; ensuring that propagation, stocking, and translocation of fish and wildlife do not contribute to the introduction or transmission of diseases; enhancing and enforcing laws to protect fish and wildlife populations from disease; reducing or eliminating the risk of transmission of disease between captive and free-ranging fish and wildlife; developing risk assessment, public information, and response strategies for fish and wildlife disease threats; and collaborating with other agencies and educational institutions on disease control, prevention, and research.

3.6.3.2.3 Tribal Water Quality Standards

Five Native American Tribes manage hatcheries and satellite facilities located within the Columbia River basin: the Yakama Indian Nation, Confederated Tribes of the Umatilla Indian Reservation, Nez Perce Tribe, Confederate Tribes of the Warm Springs Reservation of Oregon, and Confederated Tribes of the Colville Reservation. Of these, the Confederated Tribes of the Umatilla Indian Reservation (2001) have set water quality standards that are the same as Oregon state standards, and the Confederated Tribes of the Colville Reservation (2005) have adopted water quality standards set by EPA.

The Tribal Fish Health Manual (Northwest Indian Fisheries Commission [NWIFC] 2006), which includes *The Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State* (NWIFC et al. 2006), provides guidance to tribal hatchery staff for producing healthy, quality fish and reducing the discharge of pollutants (solids, drugs, and chemicals) in tribal hatchery effluent.

3.6.4 Water Quantity

By their very nature and function, hatcheries use large quantities of water. This requirement often influences hatchery facility site selection, in terms of quality of the resource (particularly the temperature and dissolved oxygen) and availability and hydrology of the source. Hatchery facility use of water is both consumptive and non-consumptive, depending on the following: 1) the manner in which the water is withdrawn and returned to the environment and 2) whether water is stored over time in the hatchery facility (such as a pond) where evaporative losses could occur. Hatchery facilities that divert water from an adjacent stream to flow through the hatchery facility or pond system, and then return that water to the source at some location downstream of its diversion point, are considered a consumptive use, requiring a water right, since some portion of the source river is dewatered (has less water between the point of diversion and discharge return to the river).

3.6.4.1 Surface Water Diversion and Consumption

Water use by hatchery facilities consists of filling and maintaining ponds and raceways (static) or flow-through (dynamic) systems. As mentioned above, static ponds and offline settling basins require storing water over time with the subsequent loss of water to the local surface water from evaporation or infiltration. Streams, lakes, and groundwater could also be affected through the construction, operation, and maintenance of diversion structures (weirs, intake pipes, and wells) that would remove or divert water into hatcheries or rearing ponds.

The location of hatchery facility discharge relative to the intake point is used by Washington State to determine whether a water use is considered consumptive and requires a water right to guarantee year-round operations (Washington Water Resources Program Policy 1020). Under this interpretation, withdrawing and discharging water at the same location (intake = outflow) is not a consumptive use and does not require a water right (a special allowance is made for one-time filling of the system over a short period). Similarly, withdrawal of well water that is allowed to percolate back into the soil at the point of extraction is not considered a consumptive use.

For both Oregon (Water Resources 536.295) and Idaho (House Bill 636), any use of water resulting in a substantial return of the diverted stream to the waters of the state is considered a non-consumptive use and does not require a water right. Water diversions or wells that do not meet this criterion would be considered consumptive uses and would require a water right.

Diversion of water from streams for use in hatchery operations, as well as in-water structures such as weirs, could alter stream flow between the points of withdrawal and discharge when they are not at the same location. Flow alteration, either between intake and outflow locations or from diversion to discharge location, could affect both water quantity and quality, thereby potentially affecting aquatic species. The volume of water in a flow-altered stream segment could be reduced, resulting in the potential for larger changes in temperature (due to shallower water and slower flow) and reduced ability to dilute chemicals introduced from discharged effluent.

Use of surface water for hatchery operations is typically non-consumptive, with water being returned to approximately the same location at which it was withdrawn. Consequently, any stream segment in the analysis area potentially affected by such a diversion would likely be small. Additionally, where states have established low-flow limits (minimum required flows during summer months), hatchery facilities cannot divert water in amounts that would result in a violation of those limits.

3.6.4.2 Groundwater Diversion and Consumption

Hatchery operations may affect the quantity of underlying groundwater through withdrawal of well water for use. This would be considered a consumptive water use, requiring a water right. As for surface water diversions, hatcheries cannot divert groundwater in amounts that would contribute to violations of any low-flow limits set for specific river segments.

3.7 Human Health

3.7.1 Introduction

Hatchery facilities routinely use chemicals in the management of their facilities. These chemicals include therapeutics (e.g., antibiotics), fungicides, disinfectants, anesthetics, pesticides, and herbicides (Section 3.6.3.1, Water Quality Parameters). These chemicals are not considered hazardous to human health when safety precautions and regulations are followed (Section 3.7.3, Safe Handling of Hatchery Chemicals). However, some chemicals (e.g., antibiotics) do not have established water quality criteria and, therefore, may be discharged to surface waters near hatchery facilities and pose a threat to human health (Section 3.7.4.2, Therapeutics).

Hatchery facility workers may also be exposed to diseases while handling fish. A number of parasites, viruses, and bacteria are potentially harmful to human health and may be transmitted from fish species (Section 3.7.6, Relevant Disease Vectors and Transmission). Many of these are transmitted primarily through seafood consumption (i.e., improperly or under-cooked fish). However, exposure to these pathogens may also occur through skin contact with fish or accidental needle-stick injuries during vaccination of fish (Section 3.7.6, Relevant Disease Vectors and Transmission). Concerns have also been raised that farm- or hatchery-raised fish may contain toxic contaminants that pose a health risk to consumers (Section 3.7.5, Toxic Contaminants in Hatchery-origin Fish).

This section summarizes the following topics: safe handling of hatchery chemicals, common chemicals used in hatchery programs, potentially toxic contaminants in hatchery-origin fish, and potentially transmitted viruses/bacteria transmitted from handling hatchery-origin fish. The human health issues addressed in the following sections are considered representative of all hatchery facilities and are not specific to a particular hatchery facility.

3.7.2 Analysis Area

The analysis area for human health is the same as the project area (Section 2.2, Description of Project Area). Information presented in Section 3.7, Human Health, is organized according to issue.

3.7.3 Safe Handling of Hatchery Chemicals

Hatchery facilities typically follow Occupational Safety and Health Administration (OSHA) regulations and institute chemical control programs to protect their employees. Employers must train employees on the potential hazards (e.g., chemical or physical) that are present at the site. Typically, hazard communication programs are implemented to train employees to recognize hazards, to use protective measures (e.g., personal protective equipment), and to perform proper actions during an emergency. Medical surveillance may be necessary if overexposure to chemicals becomes apparent. Chemical safety and handling is also addressed by maintaining: 1) a general reduced chemical use policy, 2) current chemical information, 3) first aid training and materials, 4) symptom awareness training, and 5) proper procedures for chemical storage and disposal. Specific state and Federal programs or rules developed for worker safety or use of chemicals protect hatchery facility workers from exposure to chemicals at potentially hazardous concentrations. Therefore, chemicals described in the following sections are not considered hazardous to human health when safety precautions and regulations are followed.

3.7.4 Chemicals Used in Hatchery Facilities

Hatchery facilities use a variety of chemicals to maintain a clean environment for the production of disease-free fish. Common chemical classes include disinfectants, therapeutics, anesthetics, pesticides/herbicides, and feed additives. The production of these chemicals for the protection of public health and the environment is governed by the EPA (through the Federal Insecticide, Fungicide, and Rodenticide Act [FIFRA]) and FDA (through the Federal Food, Drug, and Cosmetic Act [FFDCA]). Use of chemical products in the workplace is not considered a threat to human health when label warnings and directions are followed as established by EPA or FDA. Chemicals used in hatcheries are typically disposed of according to label requirements or discharged as effluents to receiving waters according to established water quality guidelines developed through Federal or state regulations. However, some chemicals (e.g., antibiotics) do not have established water quality criteria and, therefore, may be discharged to surface waters near hatchery facilities. A brief description of commonly used chemicals in hatchery facilities is provided below.

3.7.4.1 Disinfectants

Disinfectants are primarily used to clean equipment throughout the hatchery facility and may also be used to treat diseases. Hatchery facility workers would typically be exposed to these chemicals through skin contact or inhalation during cleaning. However, Federal and state occupational health and safety programs (e.g., OSHA, Washington State Industrial Safety and Health Act [WISHA], Oregon OSHA) ensure a safe workplace and require personal protective equipment and procedures (e.g., gloves, use of proper ventilation procedures, and/or respiratory protection in enclosed spaces, etc.). Following product label use directions and using other hatchery-specific safety measures results in reduced chemical exposure to a safe level. Some common disinfectants used in aquaculture are described below and in Table 3-34.

- **Chlorine (Sodium Hypochlorite).** Hypochlorite is used for cleaning tanks and equipment and is the active component in chlorine. This compound may also be used to destroy fry that are infected with a disease.
- **Chloramine T.** Chloamine T is used for disinfecting tanks and equipment, and the treatment of bacterial gill diseases in salmonids. The active component is chlorine.
- **Formalin.** Formalin is a saturated aqueous solution of formaldehyde, and is used as a general disinfectant and is effective against fungal or parasitic infections.
- **Hydrogen peroxide.** Hydrogen peroxide is used as a general disinfectant and is effective against fish parasites (e.g., sea lice).
- **Iodophor.** Iodophor is a form of stabilized iodine employed as a general disinfectant and is used to disinfect fish eggs and is effective against some bacteria and viruses.
- **Quaternary ammonium compounds (Hyamine).** Ammonium compounds or topical disinfectants used to remove parasites from fish and have detergent and antibacterial properties.

TABLE 3-34. PROPERTIES OF CHEMICALS COMMONLY USED AT HATCHERY FACILITIES.

CHEMICAL	HAZARD RANK[1]	LD50 (MG/KG)[2]	SKIN OR LUNG IRRITANT	CARCINOGENIC RATING[3] (INTERNATIONAL AGENCY FOR RESEARCH ON CANCER [IARC] -- INTEGRATED RISK INFORMATION SYSTEM [IRIS])
DISINFECTANTS				
Chloramine-T	1	935_{rat}	Corrosive to skin and respiratory irritant	N/A -- N/A[4]
Formalin	2	100_{rat}	Skin and respiratory irritant	2A -- B1
Hydrogen Peroxide	1	700_{rat}	Mildly irritating to skin or lungs	3 -- N/A
Iodophor	0	$10{,}000_{rabbit}$	Skin irritant	N/A -- N/A
Quaternary Ammonia (Hyamine)	2	350_{rat}	Skin and respiratory irritant	N/A -- N/A

TABLE 3-34. PROPERTIES OF CHEMICALS COMMONLY USED AT HATCHERY FACILITIES (CONTINUED).

CHEMICAL	HAZARD RANK[1]	LD50 (MG/KG)[2]	SKIN OR LUNG IRRITANT	CARCINOGENIC RATING[3] (INTERNATIONAL AGENCY FOR RESEARCH ON CANCER [IARC] -- INTEGRATED RISK INFORMATION SYSTEM [IRIS])
Chlorine (Sodium Hypochlorite)	0	$5,800_{mouse}$	Skin and respiratory irritant	3 -- N/A
THERAPAUTICS				
Amoxicillin	NA	NA	Skin irritant	N/A -- N/A
Erythromycin	NA	NA	Mild skin, eye and respiratory irritant	N/A -- N/A
Florfenicol	1	800_{rat}	Mild skin, eye and respiratory irritant	N/A -- N/A
Oxytetracycline (terramycin)	0	$7,200_{mouse}$	Mild skin, eye and respiratory irritant	N/A -- N/A
Penicillin	NA	NA	Skin irritant	N/A -- N/A
Potassium Permanganate	1	750_{rat}	Skin, eye and respiratory irritant	N/A -- N/A
Sulfamethoxazole Trimethoprim	0	$5,513_{mouse}$	Skin irritant	N/A -- N/A
ANESTHETICS				
Benzocaine	NA	NA	NA	N/A -- N/A
Tricaine Methanesulfonate (MS-222)	NA	NA	Skin, eye and respiratory irritant	N/A -- N/A
PESTICIDES/HERBICIDES				
2,4-Dichlorophenoxyacetic Acid	2	443_{rat}	Skin, eye and respiratory irritant	2B -- N/A
2-Butoxyethyl 2,4-Dichlorophenoxy Acetate	1	831_{rat}	Skin, eye and respiratory irritant	2B -- N/A
Chelated Copper	NA	NA	Skin, eye and respiratory irritant	N/A -- N/A
Dichlobenil	1	$3,160_{rat}$	Mild skin and respiratory irritant	N/A -- N/A

TABLE 3-34. PROPERTIES OF CHEMICALS COMMONLY USED AT HATCHERY FACILITIES (CONTINUED).

CHEMICAL	HAZARD RANK[1]	LD50 (MG/KG)[2]	SKIN OR LUNG IRRITANT	CARCINOGENIC RATING[3] (INTERNATIONAL AGENCY FOR RESEARCH ON CANCER [IARC] -- INTEGRATED RISK INFORMATION SYSTEM [IRIS])
Diquat	2	130_{rat}	Skin, eye and respiratory irritant	N/A -- N/A
Endothall	3	$>38_{rat}$	Skin, eye and respiratory irritant	N/A -- N/A
Fluridone	0	$>10{,}000_{rat}$	Mild skin and respiratory irritant	N/A -- N/A
Glyphosate	1	$4{,}320_{rat}$	Skin, eye and respiratory irritant	N/A -- D
Rotenone	2	132_{rat}	Skin, eye and respiratory irritant	N/A -- N/A
MISCELLANEOUS				
Alcohol Anhydrous (ethyl alcohol)	1	$3{,}450_{mouse}$	Skin, eye and respiratory irritant	N/A -- N/A
Lime (calcium hypochlorite)	1	850_{rat}	Skin, eye and respiratory irritant	N/A -- N/A
Salt (NaCl)	1	$3{,}000_{rat}$	Mild eye irritant	N/A -- N/A
Sodium Thiosulfate	NA	NA	Skin, eye and respiratory irritant	N/A -- N/A

Source: Information in this table was compiled from the Hazardous Substance DataBank (HSDB 2007).

[1] Hazard ranking based on oral toxicity (LD50) as follows: 0-non-hazardous (LD50>5000), 1-Practically non-hazardous (LD50=500-5000), 2-Slightly hazardous (LD50=50-500), 3-Moderately hazardous (LD50=5-50), and 4-highly hazardous (LD50=<5) (Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection [GESAMP] 1997).

[2] LD50 means median lethal dose, concentration that results in mortality of 50 percent of the animals tested after exposure to one oral dose. Typically reported for mammalian species.

[3] Potential for exposure to result in the development of cancer based on 1) International Agency for Research on Cancer (IARC) (1-carcinogenic to humans, 2A-Probably carcinogenic to humans, 2B-Possibly carcinogenic to humans, 3-Unclassifiable (insufficient information), 4-Probably not carcinogenic to humans) or 2) EPA (2007) (Group A - Human carcinogen, Group B - Probable human carcinogen, B1 - Indicates limited human evidence.
B2 - Indicates sufficient evidence in animals and inadequate or no evidence in humans, Group C - Possible human carcinogen, Group D - Not classifiable as to human carcinogenicity, Group E - Evidence of noncarcinogenicity for humans).

[4] N/A means data not available to assess carcinogenic potential.

3.7.4.2 Therapeutics

Therapeutics consist of chemicals or veterinary medicines that are designed to be effective against parasitic, bacterial, or viral infections in fish. The most commonly used therapeutics in salmonid aquaculture are listed below:

- **Amoxicillin.** Generally used as a veterinary antibiotic.
- **Erythromycin.** Generally used as a veterinary antibiotic.
- **Florfenicol.** Generally used as a veterinary antibiotic.
- **Oxytetracycline (Terramycin).** Widely used as an antibiotic. Oxytetracycline may be applied orally in fish feed or as a bath and is effective against a wide range of bacteria.
- **Potassium permanganate.** Primarily used as a bath treatment for fungal infections of finfish. It may also be used to alleviate acute oxygen shortage and to remove organic contaminants in fish ponds.
- **Penicilllin.** Generally used as a veterinary antibiotic.
- **Romet.** Typically applied in fish feed and is used to control a variety of bacterial infections.
- **Sulfamethazole trimethoprim.** Generally used as a veterinary antibiotic.
- **Vaccines.** Generally used to treat viral diseases. There are a variety of vaccines available to treat animals in aquaculture. Salmonids may be given vaccines to treat furunculosis, vibriosis, or yersiniosis. These are generally not considered a potential risk for human health since viral diseases of fish are typically not pathogenic to humans (World Health Organization [WHO] 1999), and the potential for exposure is minimal. The primary exposure pathway tends to be through accidental needle-stick injury (Douglas 1995; Leira and Baalsrud 1997).

Therapeutics typically are only applied when a fish health specialist has determined that a disease is present in the fish stocks. Human exposure to these chemicals typically would occur through skin contact during application of the compound or through accidental needle pricks during vaccinations. However, state and Federal occupational safety regulations (e.g., Occupational Safety and Health Act of 1970 [29 USC 651 *et seq.])* are in place to prevent these types of accidents.

Outside of the use of therapeutic chemicals in the workplace, there are two primary environmental concerns with the use of therapeutics in salmon aquaculture:

1. Therapeutic substances are not 100 percent absorbed by the fish and may be excreted into the holding water (Milewski 2001; GESAMP 1997; Texas Agricultural Extension Service 1994). Government agencies typically do not regulate disposal of chemicals in fish waste products; therefore, there is a potential for these chemicals to enter the environment surrounding the hatcheries (Milewski 2001; GESAMP 1997; Texas Agricultural Extension Service 1994). Clean Water Act and state surface water regulations (Table 3-29) prevent the discharge of chemicals at concentrations that may pose a threat to human health. However, water quality regulations currently do not exist for all veterinary products, medicines, or their by-products when incompletely metabolized. The environmental persistence of therapeutic substances varies, and some may degrade in a few hours to a few months (GESAMP 1997). Antibiotics used by hatcheries have been detected in receiving waters downstream of aquaculture operations (Boxall et al. 2004; Pouliquen et al. 2008; Martinez-Bueno et al. 2009). Moreover, recent studies suggest these compounds may persist in sediments (Pouliquen et al. 2008; Martinez-Bueno et al. 2009).

   Therapeutics are typically applied infrequently and at low doses (GESAMP 1997). The use of therapeutics is governed by the FDA through the Animal Medicinal Drug Use Clarification Act of 1994 (21 CFR 530), which does not permit extra-label use of a drug that is administered through feed (MacMillan et al. 2006). Currently, the volume of therapeutics released from hatcheries and the potential risks associated with these releases are unknown. Concentrations that have been reported in receiving waters near fish farms and hatcheries in other parts of the U.S. and in Europe are usually well below those toxic to fish and invertebrates (Boxall et al. 2004). It is expected that limited use of veterinary medicines following label instructions in U.S. fish hatcheries poses minimal risk to human health and the environment (GESAMP 1997; MacMillan et al. 2006), although locally high concentrations could arise depending on the nature of the receiving environment.

2. The use of antibiotics may increase the potential for the development of resistance in certain strains of bacteria (GESAMP 1997; Burka et al. 1997; WHO 1999). Therefore, overuse of antibiotics could render them ineffective for some bacteria. Resistant bacteria that infect fish have the potential to transfer resistant genetic material to bacteria that

infect non-fish organisms (e.g., humans). Genetic bacterial resistance may occur by the movement of plasmids (i.e., genetic elements independent of the chromosome) between bacteria. This type of transfer has been demonstrated in a number of microorganisms (GESAMP 1997; Burka et al. 1997; WHO 1999; Cabello 2006). Therefore, the improper use of antibacterials may cause resistance in bacterial pathogens that can infect humans (GESAMP 1997; Burka et al. 1997; WHO 1999; Cabello 2006). The use of therapeutics is governed by the FDA through the Animal Medicinal Drug Use Clarification Act of 1994 (21 CFR 530), which does not permit therapeutics for uses not specified in the drug's label (MacMillan et al. 2006). Adhering to this regulation and drug label recommendations minimizes the potential for the development of antibiotic resistance.

3.7.4.3 Anesthetics

Anesthetics are commonly used to immobilize brood fish during egg or milt collection, to calm fish during transportation, or during treatment with other therapeutics. They are typically applied or used at low concentrations and, thus, represent a low risk to human health (GESAMP 1997) when handled using general safety precautions (i.e., Federal or state OSHA regulations) and following label requirements. Some common anesthetics used in aquaculture are listed below:

- **Benzocaine.** Anesthetic used during egg or milt stripping or during preparation for transport
- **Tricaine methanesulfonate (MS-222).** Used as a general sedative and applied as a bath in the holding tanks

3.7.4.4 Pesticides/Herbicides

A wide variety of pesticides and herbicides is used globally in aquaculture to protect fish stocks from parasites and remove nuisance organisms, weeds, or algae. Due to their toxicity, a number of these chemicals are not approved for use in the U.S. For hatcheries, pesticides and herbicides are typically highly toxic and are used in small concentrations to control algae growth or aquatic weed growth. Commonly used algaecides approved for use in the U.S. may contain various forms of copper. Some common aquatic herbicides include dichlobenil, diquat, endothall, fluridone, glyphosate, 2,4-dichlorophenoxyacetic acid, and 2-butoxyethyl ester. These products may be hazardous to human health if prolonged or accidental exposure (i.e., inhalation, ingestion, or dermal contact) occurs because these compounds may be toxic at certain concentrations. Some of these products have bacteria as the active ingredient (e.g., Microbe Lift and Liquid Live Micro-organism) rather than a chemical ingredient to reduce the growth of pests. These products are typically less toxic to human health than synthetic chemicals. Safety measures on the product label and the material safety data sheet (MSDS) provide directions for proper use and applications. These safety measures along with Federal and state OSHA regulations, serve to limit human exposure to potentially hazardous concentrations. Chemical properties of pesticides and herbicides are provided in Table 3-34.

3.7.4.5 Feed Additives

Hatcheries may provide their stock with feed supplemented with a variety of dietary additives. Fish raised in hatcheries are only fed supplements while they are juveniles, which differs from farm-raised fish that consume feeds and additives throughout their life. These additives may consist of artificial or natural pigments, fish oils, and/or vitamins. For example, astaxanthin and canthaxanthin are carotenoids commonly used to artificially color the flesh of salmonids during the later stages of growth. Vitamin C and Vitamin E are widely used to enhance the disease resistance of fish stocks. Exposure to feed additives from hatchery-origin fish is considered to be of low risk to human health because the concentrations used in hatcheries are typically below levels that would result in adverse health effects (GESAMP 1997).

In comparison, Hites et al. (2004) found that farm raised salmon contained substantially more chemical pollutants than fish caught in the wild. Their study suggested that these pollutants were originating from fish pellets that contain the dried and compressed body parts and toxins from several whole fish, which they compared to a natural-origin salmon that eats a few bites of a single fish. In recent studies completed by Johnson et al. (2007a,b), high concentrations of both PCBs and DDTs, comparable to those observed in farmed salmon, were found in hatchery-origin Chinook salmon. The authors attributed this effect to high body fat levels in hatchery-reared juveniles, which facilitate the uptake of lipid soluble contaminants, and concluded that contaminant concentrations in different lots of feed and in fish from different hatcheries were too variable to determine how fish feed affects hatchery-origin fish. The authors stated that more comprehensive sampling of fish and feed from hatcheries is needed to determine the extent of the problem in the Pacific Northwest (which includes this analysis area) (Box 3-1). In a more recent study (Johnson et al. 2009), which sampled subyearling Chinook salmon from eight hatcheries that release juvenile salmon into the Columbia River, concentrations of PCBs and DDTs were lower than in the fish sampled earlier (i.e., in Johnson et al. 2007a,b) and generally comparable to levels observed in juvenile salmon from minimally contaminated rural estuaries. Contaminant concentrations were higher in the Chinook salmon from the earlier study, in part, because those fish were older and larger than those sampled in Johnson et al. (2009), but the differences could also be related to differences in contaminant concentrations in feed or in the hatchery environment.

Box 3-1. What is the difference between hatchery-origin and farm-raised salmon?

Farm-raised salmon spend their entire lives in captivity compared to hatchery-origin salmon, which are reared in hatchery facilities as juveniles (generally for periods less than 1 year) and then released into the wild where they spend the remainder of their lives. When in captivity, both hatchery-origin and farm-raised salmon are fed pellets of concentrated fish products (that may contain high levels of chemical toxins); however, hatchery-origin fish are exposed to these chemicals for a shorter time than are farm-raised fish.

3.7.4.6 Miscellaneous Chemicals

Varieties of other chemicals are typically used at salmonid hatcheries. Some of these chemicals are described below and in Table 3-34. These chemicals are practically nonhazardous (see Table 3-34) and, when used within the product label requirements and following OSHA regulations, are not expected to pose a risk to human health.

- **Anhydrous (Ethyl) alcohol.** This compound is one of two chemicals used in a solution used to check the fertilization of eggs.
- **Lime (Type S).** Lime is widely used to neutralize acidity and increase total alkalinity of grow-out ponds.
- **Salt (NaCl).** Salt can be used to remove parasites or prevent stress during transport of fish.
- **Sodium thiosulfate.** Sodium thiosulfate is used to neutralize chlorine and iodophor prior to discharging wastewater.

3.7.5 Toxic Contaminants in Hatchery-origin Fish

Seafood consumption by humans is generally promoted due to the nutritional value of fish products. For example, fish contain elevated levels of omega-3 fatty acids, which are considered beneficial to the cardiovascular system (Mayo Clinic 2010). However, concerns have been raised that farm raised and hatchery-origin fish may contain toxic contaminants (WHO 1999; Hites et al. 2004; Jacobs et al. 2002a; Jacobs et al. 2002b; Easton et al. 2002) that pose a health risk to consumers. Sources of contaminants in the fish include chemicals or therapeutics, contamination of the nutritional supplements or feeds, and/or contamination of the environment where the fish are reared or released (Jacobs et al. 2002a; Jacobs et al. 2002b; Easton et al. 2002; Hites et al. 2004; Carlson and Hites 2005; Johnson et al. 2007b; Johnson et al. 2009; Maule et al. 2007; Kelly et al. 2008). The contaminants of primary concern are those that are persistent in the environment and are known to accumulate in the tissues of fish (e.g., methylmercury, dioxins, DDTs, or PCBs) (Jacobs et al. 2002a; Jacobs et al. 2002b; Easton et al. 2002; Hites et al. 2004; Johnson et al. 2007b; Johnson et al. 2009; Maule et al. 2007; Kelly et al. 2008).

While in the hatchery facilities, hatchery-origin fish are fed with commercial diets containing fish oil and fish meal that can be derived from anywhere in the world. These feeds are known sources of toxic contaminants (Carlson and Hites 2005; Jacobs et al. 2002a). As described above, contaminant concentrations (e.g., pesticides, PCBs) measured in farmed fish are higher than in natural-origin fish (Hites et al. 2004; Hamilton et al. 2005). The use of commercial feed in hatchery facilities may also contribute to higher concentrations of organic pollutants in hatchery-reared fish compared to their natural-origin counterparts (Johnson et al. 2007b).

Recent investigations examined the amount of organic contaminants in commercial fish feeds and found elevated levels of PCBs, polychlorinated aromatic hydrocarbons, and pesticides (Jacobs et al. 2002a; Jacobs et al. 2002b; Easton et al. 2002; Hites et al. 2004; Neergaard 2004; Carlson and Hites 2005). The U.S. Geological Survey (USGS) and USFWS recently completed a study of contaminants in fish feeds used in National Fish Hatcheries (Maule et al. 2007) and also found contaminants in these feeds, although generally at lower concentrations than those reported by the investigators cited above. The USGS and USFWS are developing a program to better manage contaminants in hatchery feeds (http://wfrc.usgs.gov/research/contaminants/STSeelye4.htm). The aim of this program is to develop a handbook for distribution to USFWS hatchery facility personnel (USGS does not operate any hatchery programs). This handbook is likely to include data on contaminant analysis, recommendations for chemical sampling of feed, a summary of the toxicity literature, toxicity threshold reference values for fish, and pathological symptoms. The handbook will be distributed to Federal, state, tribal, and local hatcheries. Therefore, practices are being developed to limit exposure of hatchery-origin fish to contaminants in fish feeds.

While hatchery-origin fish may contain chemicals of concern, the risk from consuming contaminants in hatchery-origin fish remains uncertain. The potential for human exposure to contaminants in fish is directly tied to the frequency of consuming fish (EPA 1999). Thus, groups that consume large amounts of fish may have a higher potential for exposure to contaminants. Current information on consumption patterns suggests that some populations may consume greater quantities of fish than the general population (often termed ‘subsistence consumers’) (EPA 1999). However, information is not available to determine what proportion of the diet of subsistence consumers comes from hatchery-origin or farm-raised fish. In addition, not all the contaminants in hatchery-origin fish are derived from the hatchery facility.

Migrating salmonids encounter and accumulate additional contaminants in the rivers, estuaries, and oceans that they inhabit (Johnson et al. 2007a; Johnson et al. 2007b; Missildine et al. 2005). Therefore, it is unknown what proportion of contaminants present in hatchery-origin fish originates from hatcheries or what proportion is accumulated after release. It is also unknown whether those contaminant levels pose a risk to human health. One recent study (Johnson et al. 2009) suggested that, for juvenile salmon that feed and rear in urban areas, contaminants accumulated after release account for the majority of their body burdens, although hatcheries could be a primary source if fish reared only in uncontaminated rural areas. However, contaminants taken up during hatchery rearing would probably contribute very little to body concentrations of adult, returning salmon, since concentrations would be diluted so much by growth of the fish. Some recent studies suggest that, for returning adult salmon, most of their contaminant body burden was acquired during their time at sea (Kelly et al. 2007; Cullon et al. 2009; O’Neill and West 2009).

Another potential source of contaminants for hatchery-origin fish includes construction materials found within hatcheries. In one recent event, PCBs were identified in fish from the Leavenworth National Fish Hatchery and found to be related to the paint lining fish tanks (Cornwall 2005). Some hatchery facilities were constructed in the early to mid 1900s and may contain chemicals in historical building materials (e.g., paint) that are banned in current materials. Testing of other National Fish Hatcheries for toxic substances is ongoing (Cornwall 2005). While there is a potential for exposure to contaminants in building materials, these are likely isolated as further incidents have not been reported.

3.7.6 Relevant Disease Vectors and Transmission

A number of parasites, viruses, and bacteria are potentially harmful to human health and may be transmitted from fish species (Durborow 1999; Leira and Baalsrud 1997; Lehane and Rawlin 2000). Many of these are transmitted primarily through seafood consumption (i.e., improperly or under-cooked fish). However, exposure to these pathogens may also occur through skin contact with fish or accidental needle-stick injuries during vaccination of fish (Leira and Baalsrud 1997; Durborow 1999; Lehane and Rawlin 2000).

Some common bacterial or viral species transmittable to humans through contact with fish include the following (Durborow 1999):

- Mycobacterium marinum
- Streptococcus iniae
- Vibrio species
- Aeromonas species
- Erysipelothirx rhusiopathiae
- Cryptosporidosium

The transmission of fish-borne pathogens to humans is rare and can be controlled with the proper safety measures (i.e., wearing protective clothing when handling fish and thoroughly cooking fish). In addition, FDA regulations (21 CFR 123) require processors of fish and fishery products to develop and implement Hazard Analysis Critical Control Point (HACCP) systems for their operations to prevent and limit the potential for exposure and spread of pathogens and contaminants. Safety precautions that limit the spread of disease include the following:

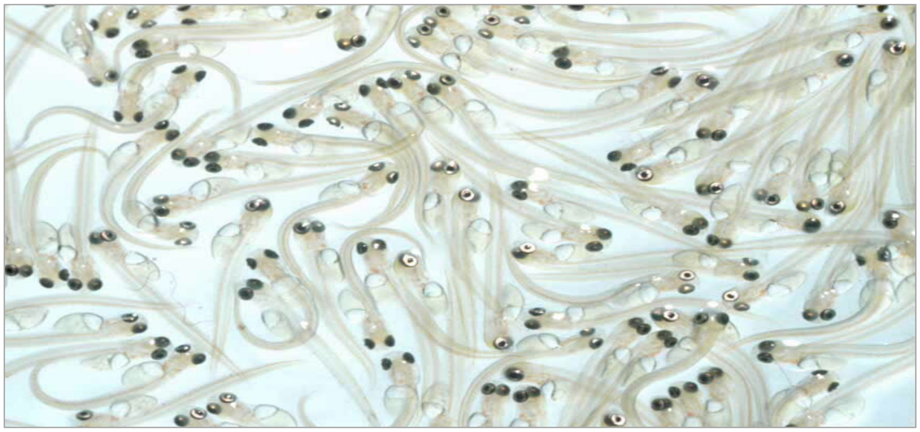
- Using gloves when handling animals
- Covering cuts and sores with bandages before working
- Immediately washing cuts/abrasions with soap and water/or an antiseptic
- Keeping work areas clean with detergents or disinfectants
- Ensure hygienic disposal of effluent or wastes

Compliance with safety programs, applicable rules and regulations, and the use of personal protective equipment limits the spread of parasites, viruses, or bacteria.

Science, Service, Stewardship

Chapter 4

Environmental Consequences



4.0 ENVIRONMENTAL CONSEQUENCES

4.1 Introduction

The five alternatives being evaluated in this Environmental Impact Statement (EIS) are described in Chapter 2, Alternatives. The alternatives are based on goals and principles that together form a policy direction. In order to be able to evaluate the effects of the alternatives, specific implementation scenarios were identified in Chapter 2, Alternatives. Implementation scenarios for Alternative 2 through Alternative 5 include implementation measures that would reduce negative effects on salmon and steelhead. However, these implementations measures may also affect other resources within the analysis area (Table 4-1).

TABLE 4-1. RESOURCES THAT MAY BE AFFECTED BY IMPLEMENTATION MEASURES INCLUDED UNDER THE ALTERNATIVES' IMPLEMENTATION SCENARIOS.

IMPLEMENTATION MEASURES INCORPORATED IN ONE OR MORE OF THE ALTERNATIVES' IMPLEMENTATION SCENARIOS	RESOURCES THAT MAY BE AFFECTED					
	FISH	SOCIOECONOMICS	ENVIRONMENTAL JUSTICE	WILDLIFE	WATER QUALITY AND QUANTITY	HUMAN HEALTH
Change production levels in hatchery programs.	X	X	X	X	X	X
Change broodstock collection protocols in hatchery programs.	X	X				
Update water intake screens at hatchery facilities.	X	X				
Update hatchery facilities to allow all salmon and steelhead of all ages to bypass or pass through hatchery-related structures.	X	X				
Improve rearing and release protocols in hatchery programs.	X	X				
Correct water quality issues at hatchery facilities.	X	X		X	X	X
Install new temporary weirs.	X	X		X	X	
Install new permanent weirs.	X	X		X	X	
Establish new selective fisheries in terminal areas.	X	X	X			
Change hatchery program goals (i.e., harvest or conservation).	X					
Change hatchery program's operational strategy (i.e., segregated or integrated).	X					
Establish new hatchery programs.	X	X	X	X	X	X
Terminate hatchery programs that support harvest if they fail to meet performance goals.	X	X	X	X	X	X

These changes apply to hatchery programs funded through the Mitchell Act and hatchery programs receiving funding from other sources.

The baseline conditions for the six resources (fish, socioeconomics, environmental justice, wildlife, water quality and quantity, and human health) that may be affected by the proposed action and alternatives are described in Chapter 3, Affected Environment. This chapter provides an analysis of the direct and indirect environmental effects associated with the alternatives on these six resources Section 4.8 at the end of this chapter presents a summary table of environmental effects by resource and alternative. Cumulative effects are presented in Chapter 5, Cumulative Effects. The specific section sequence for Chapter 4 is as follows:

- Introduction (Section 4.1)
- Fish (Section 4.2)
- Socioeconomics (Section 4.3)
- Environmental Justice (Section 4.4)
- Wildlife (Section 4.5)
- Water Quality and Quantity (Section 4.6)
- Human Health (Section 4.7)
- Summary of Environmental Consequences (Section 4.8)

4.1.1 Analysis Area

As discussed in Section 3.1, Introduction, the analysis area varies by resource and is defined at the beginning of each resource discussion in Chapter 3.

4.1.2 Mitigation

Mitigation includes actions that avoid the potential impact, minimize the impact, rectify the impact, reduce or eliminate the impact, and/or compensate for the impact by replacing or providing substitute resources (40 Code of Federal Regulations [CFR] 1508.20). Mitigation analyzed in this EIS is in the form of best management practices (BMPs) applied at hatchery programs throughout the basin under all alternatives.

In essence, hatchery operators in the basin have been applying mitigation principles under Alternative 1 (No Action) by implementing BMPs into their hatchery programs. Hatchery operators use BMPs to increase the efficiency of hatchery programs and to reduce negative effects on natural-origin salmon and steelhead. BMPs include a suite of management practices available to hatchery operators to improve hatchery production, but are also goals aimed at improved resource conditions such as water quality conditions. By incorporating a suite of BMPs into their programs, hatchery operators in the basin also indirectly contribute to some resource improvements for salmon and steelhead, such as water quality conditions under Alternative 1. BMPs evolve as science improves; as such, hatchery management practices can progress with best available science, which is a useful mitigation tool.

While BMPs applied by hatchery operators would not specifically be intended to mitigate for negative effects on salmon and steelhead (the result of many basin-wide causes in addition to hatcheries, Section 2.6, Identifying an Implementation Scenario), several BMPs would improve conditions for natural-origin salmon and steelhead populations. Although BMPs would not be applied identically across alternatives (i.e., the adherence of each hatchery program to Hatchery Scientific Review Group [HSRG] BMPs would increase under Alternative 2 through Alternative 5 compared to Alternative 1), each hatchery program would be applying some BMPs across all alternatives. Therefore, some degree of mitigation would occur under all alternatives. The effectiveness of such mitigation would be measured through monitoring and evaluation.

4.2 Fish

4.2.1 Introduction

This section presents the expected effects on fish as a result of implementing any of the five alternatives. This section first analyzes hatchery effects on salmon and steelhead related to the nine categories of effects that are generally associated with hatchery operations (Section 3.2.3.1, General Risks and Benefits of Hatchery Programs to Salmon and Steelhead Species). For the analysis, effects from competition and predation are combined. The analysis of effects on salmon and steelhead is followed by an analysis of the effects of the alternatives on other fish species that have a relationship with salmon and steelhead in the analysis area (Section 3.2.4, Other Fish Species that Have a Relationship with Salmon and/or Steelhead).

As described in Chapter 2, Alternatives, one implementation scenario has been identified for each alternative so that the effects of each alternative can be understood and compared. A combination of Implementation measures are combined under each alternative to create an implementation scenario (Table 2-6). Table 4-2 shows the implementation measures that may affect fish species. Each implementation measure is expected to affect one or more species of fish. All implementation measures are expected to affect salmon and steelhead.

As described in Section 3.2.2, Analysis Area, the analysis area for fish in this EIS is the same as the project area as described in Section 2.2, Description of Project Area. Information presented in Section 3.2, Fish, and Section 4.2, Fish, is organized according to species. For salmon and steelhead species, the analysis is further subdivided by evolutionarily significant unit (ESU) and distinct population segment (DPS) (Box 1-1). The boundaries of each salmon ESU and steelhead DPS cover several subbasins and one or more ecological provinces (Section 2.2, Description of Project Area). Maps of the ESU and DPS boundaries can be found at http://www.nwr.noaa.gov/ESA-Salmon-Listings/Salmon-Populations/Maps/Index.cfm.

4.2.2 Methods for Analyzing Effects

Two analytical tools are used to estimate effects on salmon and steelhead from implementation scenarios associated with the action alternatives: the All-H (AHA) and the Hatchery Population Viewer (HPV) (Section 2.5, Identifying an Implementation Scenario). AHA is a tool for evaluating individual hatchery programs in the context of harvest rates, habitat conditions, and fish passage through the Columbia River hydroelectric system. The AHA model allows users to input data reflecting current habitat productivity/capacity, harvest rates, and hatchery facility operations. Outputs from AHA are used to make relative comparisons of genetic, competition, predation, and Viable Salmonid Population (VSP) effects across the alternatives (Table 4-3). AHA was designed to allow fish managers to compare alternative

TABLE 4-2. FISH SPECIES THAT MAY BE AFFECTED BY IMPLEMENTATION MEASURES INCLUDED UNDER THE ALTERNATIVES' IMPLEMENTATION SCENARIOS.

IMPLEMENTATION MEASURES INCORPORATED IN ONE OR MORE OF THE ALTERNATIVES' IMPLEMENTATION SCENARIOS	FISH SPECIES THAT MAY BE AFFECTED					
	SALMON AND STEELHEAD	OREGON CHUB, LAKE CHUB, PYGMY WHITEFISH,	BULL TROUT, COASTAL CUTTHROAT TROUT, LAMPREY, RAINBOW TROUT, WESTSLOPE CUTTHROAT TROUT	EULACHON, LEOPARD DACE, UMATILLA DACE, MARGINED SCULPIN, MOUNTAIN SUCKER	GREEN STURGEON	NORTHERN PIKE-MINNOW
Change production levels in hatchery programs.	X	X	X	X	X	X
Change broodstock collection/mating protocols in hatchery programs.	X					
Update water intake screens at hatchery facilities[1]	X	X		X		
Update hatchery facilities to allow all salmon and steelhead of all ages to bypass or pass through hatchery-related structures.	X					
Improve rearing and release protocols in hatchery programs.	X					
Correct water quality issues at hatchery facilities.	X	X	X	X		X
Install new temporary weirs.	X		X			
Install new permanent weirs.	X	X				
Establish new selective fisheries in terminal areas.	X					
Change hatchery program goals (i.e., harvest or conservation).	X					
Change hatchery program's operational strategy (i.e., segregated or integrated).	X					
Establish new hatchery programs.	X	X	X	X	X	X
Terminate hatchery programs that support harvest if they fail to meet performance goals.	X	X	X	X	X	X

These changes apply to hatchery programs funded through the Mitchell Act and hatchery programs receiving funding from other sources. Implementation measures that were not applied under any of the alternatives were not included in this table.

[1] Screens on water intakes to the hatchery facilities are generally designed to prevent juvenile, natural-origin salmon, and steelhead from being pulled into the hatchery facility. Updated water intake screens will benefit salmon and steelhead, and may also benefit other fish species depending on their size.

TABLE 4-3. METHODS USED TO ESTIMATE EFFECTS ON SALMON AND STEELHEAD.

	General Risks and Benefits of Hatchery Programs to Salmon and Steelhead Species							
Method for Evaluation	**Genetic Risks**	**Hatchery Facility Risks**	**Risks from Competition and Predation**	**Masking Risks**	**Fisheries Related Risks[1]**	**Nutrient Cycling Benefits**	**Disease Transfer Risks**	**VSP Effects**
AHA	X		X					X
HPV		X	X					
Ratios of Hatchery-origin to Natural-origin Smolts			X					
Qualitative Comparison					X	X	X	
Not Evaluated Because Effects Will Not Vary by Alternative				X				
Analyzed in Basin-wide Summary	X	X	X		X	X	X	
Analyzed by ESU/DPS	X		X					X

[1] Exploitation rates on natural-origin fish would not vary among the implementation scenarios for alternatives.

management scenarios and understand how each scenario would perform relative to other scenarios. It is not a tool designed to predict the number of fish that would result from different management actions.

Most assumptions and data used in the AHA have been obtained from the Columbia River fish managers and from readily available documents. Assumptions and information sources are summarized below:

- Habitat conditions are assumed to represent the current situation in each subbasin. For most subbasins, characterization of current habitat conditions has been completed by the region's fish managers using the Ecosystem Diagnosis and Treatment model (http://ecosystems.icfi.com/ebp/Ecosystems/EDT.aspx) and reported in individual subbasin plans prepared for the Northwest Power and Conservation Council (http://www.nwcouncil.org/fw/subbasinplanning/Default.htm).
- Fish passage conditions in the Columbia River hydroelectric system are assumed to represent those described for current operations in the 2004 Federal Columbia River Power System (FCRPS) biological opinion (http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/Final-BOs.cfm). Survival numbers from the 2004 FCRPS biological opinion were drawn from the most current fish passage conditions when EIS modeling occurred. More current estimates of survival through the FCRPS are now available in the 2008 FCRPS biological opinion and are higher than in the 2004 FCRPS biological opinion, so natural-origin abundance and productivity for salmon and steelhead populations may be underestimated in this analysis.
- Harvest conditions are assumed to represent recent average conditions. In its original form, the AHA model incorporates simple assumptions about overall harvest effects. However, a harvest model has been developed for this EIS to replace these simple assumptions (Appendix K). The harvest model relies on the same datasets that are employed by the Pacific Fisheries Management Council (PFMC) and the Pacific Salmon Commission models to characterize stock-specific fishery exploitation patterns.

The HPV is used for this fish analysis to determine adherence of hatchery programs to BMPs identified by the HSRG (Chapter 1, Purpose and Need). Outputs from the HPV are used to make relative comparisons of effects from hatchery facilities, fish collection, masking, and competition and predation across the alternatives. The HPV determines the adherence of each hatchery program to HSRG BMPs. The BMPs address broodstock management, genetic introgression, density-dependent effects (e.g., predation and competition), and facility effects (e.g., juvenile entrainment in hatchery water intake facilities and blocked passage of natural-origin fish). A list of BMPs can be found in Appendix H, and individual HPV files for each hatchery program can be found at http://hatcheryreform.us/hrp/tools/hpv/welcome_show.action.

Qualitative comparisons are made among alternatives when quantitative data are not available – this is the case for effects on nutrient cycling and fish health. One category of hatchery effects (fisheries-related risks) is described in Section 3.2.3.1, General Risks and Benefits of Hatchery Programs to Salmon and Steelhead Species, but is not analyzed in Chapter 4 because effects would remain the same across alternatives since exploitation rates would be held constant. The following sections provide additional information on the methods used to assess effects from/on genetics, competition, and predation, and VSP.

Effects from fish collection, masking effects, nutrient cycling effects, and fish health effects are evaluated on a Columbia River basinwide scale (i.e., effects on all ESUs and DPSs are combined). The ESU/DPS-level analysis focuses on genetic effects, competition and predation effects, and effects on VSP.

4.2.2.1 Methods for Determining Genetic Effects on Salmon and Steelhead

AHA is used to determine the number of populations meeting proportionate natural influence (PNI) and percent hatchery-origin spawners (pHOS) criteria identified under each alternative's implementation scenario. In general, high PNI values and low pHOS values may lead to less domestication and loss of population diversity than low PNI values and high pHOS values (Section 3.2.3.1.1, Genetic Risks). Although PNI and pHOS are not directly related to other categories of genetic effects (e.g., inbreeding depression), they serve as useful metrics for considering the relative genetic effects of the alternatives.

4.2.2.2 Methods for Determining Competition and Predation Effects on Salmon and Steelhead

Although AHA and the HPV consider effects from competition and predation, two additional analyses are done in this EIS. One analysis computes the ratio of hatchery-origin juveniles that would be released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS. A higher ratio may indicate greater competition for food or habitat or greater predation caused by hatchery-origin fish. Ratios do not consider several important factors such as the capacity of the habitat, spatial and temporal overlap of hatchery-origin and natural-origin fish, and the status of natural-origin populations. The exact form of interaction (i.e., competition or predation) depends on the hatchery-origin species released and the natural-origin species in question. For example, predation is more likely than competition when considering the effects of larger hatchery-origin coho salmon on smaller natural-origin chum salmon fry. Competition would be more likely among populations of the same species because they would be more likely to occupy the same macro and microhabitats and compete for the same food resources (Section 3.2.3.1.5, Risks from Competition with Hatchery-origin Fish). The potential form of interaction and the magnitude of its effect on the conservation of natural-origin populations are discussed in more detail in each ESU section.

The second way that ecological interactions are assessed is by considering the ratio of natural-origin and hatchery-origin smolts (as provided by AHA) that emigrate through the Columbia River estuary. These ratios, along with a consideration of the spatial and temporal overlap of salmon and steelhead smolts in the estuary, roughly indicate the cumulative risk of hatchery programs to salmon and steelhead in the Columbia River basin. These results are reported on a basinwide scale instead of by ESU/DPS. An additional and broader assessment of the cumulative effects of the proposed action can be found in Chapter 5 (Cumulative Effects).

4.2.2.3 Methods for Determining Effects on VSP for Salmon and Steelhead

AHA is used to compare the alternatives' effects on abundance, productivity, spatial structure, and diversity for each ESU/DPS. In this EIS, these parameters are similar but not identical to those defined by the National Marine Fisheries Service (NMFS) in Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units (McElhaney et al. 2000) (Section 3.2.3.1.14, Effects on VSP). For this EIS analysis, the parameters are expressed as follows:

- Abundance is expressed as the average number of adult natural-origin spawners based on the last 80 generations of the AHA simulation.
- Productivity is expressed in terms of changes to the Beverton-Holt productivity parameter (Beverton and Holt 1957), which quantifies the maximum possible adult recruitment rate (adult produced per spawner) in the absence of density dependent effects.
- Spatial structure and diversity are indexed by two different metrics: the change in the proportion of populations within an ESU for which adjusted productivity is greater than 1.0 and the change in the proportion of populations with mean abundance greater than 500 natural-origin spawners. The Interior Columbia Technical Recovery Team (ICTRT) does not consider any population with fewer than 500 individuals to be viable, regardless of its productivity (ICTRT 2007). A necessary (but not sufficient) condition for the rebuilding of a population is that each spawner produces at least one returning adult in the next generation. If such populations are considered marginally viable, a comparison across alternatives of the proportion of populations meeting these standards within an ESU is a coarse index of spatial structure and diversity.

The numbers shown in tables and figures are, for the most part, raw model output numbers and should not be viewed as specific predictions; they should only be used for comparison purposes among alternatives. AHA is not a tool designed to predict the number of fish that will result from different management actions. Instead, it was designed to allow fish managers to make relative comparisons of alternative management scenarios and understand how each scenario would perform relative to other scenarios.

For more background information on methods, assumptions, and application of AHA, refer to the AHA User Guide (Appendix G). AHA datasets for individual populations are provided at http://hatcheryreform.us/hrp/tools/aha/welcome_show.action.

4.2.3 Effects on Salmon and Steelhead

The analysis of effects on salmon and steelhead is separated into two sections: 1) Section 4.2.3.1, Basinwide Effects on Salmon and Steelhead and 2) Section 4.2.3.2, Effects on Salmon ESUs and Steelhead DPSs.

4.2.3.1 Basinwide Effects on Salmon and Steelhead

As described in Chapter 2, Alternatives, the implementation scenarios for each alternative incorporates measures (i.e., implementation measures) that would allow Columbia River basin hatchery programs to be operated consistent with the goals of each alternative (Section 2.5, Alternatives Analyzed in Detail). The application of implementation measures varies across alternatives (Table 2-6). That is, the implementation scenarios differ in the implementation measures that are used to meet goals of each alternative. For example, new weirs can be installed under the implementation scenarios for Alternative 3 through Alternative 5, but not under the implementation scenario for Alternative 2. By varying the implementation measures used within the implementation scenarios, this EIS presents an evaluation of a greater range of options for operating hatchery programs in the Columbia River basin than if the same implementation measure were used under all five of the alternative's implementation scenarios.

The following discussion compares risks and benefits of the alternatives on salmon and steelhead. Risks and benefits are organized into categories consistent with Section 3.2.3.1, General Risks and Benefits of Hatchery Programs on Salmon and Steelhead. However, for this analysis, effects from competition and predation are combined into one section. As described in Section 4.2.2, Methods for Analyzing Effects, fisheries-related risks were described in Section 3.2.3.1, General Risks and Benefits of Hatchery Programs to Salmon and Steelhead Species, but are not analyzed in Chapter 4, Environmental Consequences, because effects would not vary across alternatives since exploitation rates would be held constant. Therefore, the anticipated effects from fisheries-related risks would be the same as under baseline conditions described in Section 3.2.3.1.10, Risks Associated with Fisheries that Target Hatchery-origin Fish.

4.2.3.1.1 Genetic Risks

Evidence suggests that hatchery-origin fish likely differ genetically from natural-origin fish in ways that can result in differences in reproductive performance when they spawn in the natural environment. When hatchery-origin fish interbreed with natural-origin fish, the productivity of the naturally spawning population may be reduced. Controlling gene flow between hatchery-origin and natural-origin fish is the most certain strategy to reduce genetic risks, and this is generally done by limiting pHOS and increasing PNI (Section 3.2.3.1.1, Genetic Risks).

As discussed in Chapter 2, Alternatives, stronger and intermediate hatchery performance goals are applied to the action alternatives to reduce genetic risks on natural-origin salmon and steelhead from operating hatchery programs. Table 2-5 identifies performance metrics (pHOS and PNI values) for each hatchery performance goal. As shown in Table 4-4, the following implementation measures would be used under one or more of the alternative implementation scenarios to reduce genetic risks and to meet target performance goals:

- Change production levels in hatchery programs.
- Change broodstock collection/mating protocols in hatchery programs.
- Install new temporary weirs.
- Install new permanent weirs.
- Establish new selective fisheries in terminal areas.
- Change hatchery program goals (i.e., harvest or conservation).
- Change hatchery program’s operational strategy (i.e., segregated or integrated).
- Establish new hatchery programs.
- Terminate hatchery programs that support harvest if they fail to meet performance goals.

Four of these implementation measures would change production levels (change production levels in hatchery programs, establish new hatchery programs, and terminate hatchery programs that support harvest if they fail to meet performance goals). Three additional implementation measures would reduce the number of hatchery-origin salmon and steelhead spawning naturally: install new temporary weirs, install new permanent weirs, and establish new selective fisheries in terminal areas. The remaining implementation measures would change broodstock collection and/or mating protocols in hatchery programs, change hatchery program goals, and change a hatchery program’s operational strategy. All of these implementation measures would be used under one or more implementation scenarios to increase PNI and/or reduce pHOS, which would reduce genetic risks compared to baseline conditions (Section 3.2.3.1.1, Genetic Risks).

TABLE 4-4. SALMON AND STEELHEAD INDICATORS THAT MAY BE AFFECTED BY IMPLEMENTATION MEASURES INCLUDED UNDER THE ALTERNATIVES' IMPLEMENTATION SCENARIOS.

IMPLEMENTATION MEASURES INCORPORATED IN ONE OR MORE OF THE ALTERNATIVES' IMPLEMENTATION SCENARIOS	SALMON AND STEELHEAD INDICATORS THAT MAY BE AFFECTED						
	GENETIC RISKS	HATCHERY FACILITY RISKS	RISKS FROM COMPETITION AND PREDATION	MASKING RISKS	NUTRIENT CYCLING BENEFITS	DISEASE TRANSFER RISKS	VSP EFFECTS
Change production levels in hatchery programs.	X	X	X	X	X	X	X
Change broodstock collection/mating protocols in hatchery programs.	X		X				X
Update water intake screens at hatchery facilities*.		X					X
Update hatchery facilities to allow all salmon and steelhead of all ages to bypass or pass through hatchery-related structures.		X			X		X
Improve rearing and release protocols in hatchery programs.			X			X	X
Correct water quality issues at hatchery facilities.		X					
Install new temporary weirs.	X		X	X	X		X
Install new permanent weirs.	X		X	X	X		X
Establish new selective fisheries in terminal areas.	X		X	X	X		X
Change hatchery program goals (i.e., harvest or conservation).	X						X
Change hatchery program's operational strategy (i.e., segregated or integrated).	X		X				
Establish new hatchery programs.	X	X	X	X	X	X	X
Terminate hatchery programs that support harvest if they fail to meet performance goals.	X	X	X	X	X	X	X

These changes apply to hatchery programs funded through the Mitchell Act and hatchery programs receiving funding from other sources.

Alternative 1 (No Action)

The implementation scenario for Alternative 1 (No Action) represents a future scenario of continuing existing operations with no policy changes. No additional implementation measures would be taken to reduce negative effects on natural-origin salmon and steelhead (Section 2.7.1, Implementation Scenario for Alternative 1). As under baseline conditions, 41 percent of all populations would meet stronger metrics[1], and 48 percent would meet intermediate metrics (Table 3-3 and Table 4-5). No additional weirs would be installed compared to baseline conditions (Table 4-6).

Alternative 2

Under the implementation scenario for Alternative 2, a higher percentage of populations would meet stronger and intermediate performance metrics compared to Alternative 1 (67 percent of all populations would meet stronger metrics, and 83 percent would meet intermediate metrics) (Table 4-5), which would likely reduce genetic risks of hatchery programs on natural-origin salmon and steelhead populations relative to Alternative 1. No new weirs would be installed under the implementation scenario for Alternative 2 (Table 4-6), so there would be no additional weir effects compared to Alternative 1.

Alternative 3

Under the implementation scenario for Alternative 3, a higher percentage of populations would meet stronger and intermediate performance metrics compared to Alternative 1 (51 percent of all populations would meet stronger metrics, and 72 percent would meet intermediate metrics) (Table 4-5), which would likely reduce genetic risks of hatchery programs on natural-origin salmon and steelhead populations relative to Alternative 1. Thirteen new temporary weirs would be installed under the implementation scenario for Alternative 3 when compared to Alternative 1 (Table 4-6), which would increase the following weir effects relative to Alternative 1: isolation of formerly connected populations, limiting or slowing movement of non-target fish species, alteration of stream flow, alteration of streambed and riparian habitat, alteration of the distribution of spawning within a population, increased mortality or stress due to capture and handling, impingement of downstream migrating fish, forced downstream spawning by fish that do not pass through the weir, and increased straying due to either

[1] The terms “stronger metrics,” “intermediate metrics,” and “weaker than intermediate metrics” are deliberately phrased as relative indices to avoid a determination on their adequacy or inadequacy under the ESA or other legal standards. A determination as to whether a specific hatchery program meets ESA requirements will be made in a separate NMFS review (Section 2.4, Alternative Development).

trapping adults that were not intending to spawn above the weir, or displacing adults into other tributaries (Section 3.2.3.1.1, Genetic Risks).

Alternative 4

Under the implementation scenario for Alternative 4, a higher percentage of populations would meet stronger and intermediate performance metrics compared to Alternative 1 (53 percent of all populations would meet stronger metrics, and 68 percent would meet either stronger or intermediate metrics) (Table 4-5), which would likely reduce genetic risks of hatchery programs on natural-origin salmon and steelhead populations relative to Alternative 1. Sixteen new temporary and permanent weirs would be installed under the implementation scenario for Alternative 3 when compared to Alternative 1 (Table 4-6), which would increase the following weir effects relative to Alternative 1: isolation of formerly connected populations, limiting or slowing movement of non-target fish species, alteration of stream flow, alteration of streambed and riparian habitat, alteration of the distribution of spawning within a population, increased mortality or stress due to capture and handling, impingement of downstream migrating fish, forced downstream spawning by fish that do not pass through the weir, and increased straying due to either trapping adults that were not intending to spawn above the weir, or displacing adults into other tributaries (Section 3.2.3.1.1, Genetic Risks).

Alternative 5

Under the implementation scenario for Alternative 5, a higher percentage of populations would meet stronger and intermediate performance metrics compared to Alternative 1 (58 percent of all populations would meet stronger metrics, and 71 percent would meet either stronger or intermediate metrics) (Table 4-5), which would likely reduce genetic risks of hatchery programs on natural-origin salmon and steelhead populations relative to Alternative 1. Seventeen new temporary and permanent weirs would be installed under the implementation scenario for Alternative 3 when compared to Alternative 1 (Table 4-6), which would increase the following weir effects relative to Alternative 1: isolation of formerly connected populations, limiting or slowing movement of non-target fish species, alteration of stream flow, alteration of streambed and riparian habitat, alteration of the distribution of spawning within a population, increased mortality or stress due to capture and handling, impingement of downstream migrating fish, forced downstream spawning by fish that do not pass through the weir, and increased straying due to either trapping adults that were not intending to spawn above the weir, or displacing adults into other tributaries (Section 3.2.3.1.1, Genetic Risks).

TABLE 4-5. NUMBER OF POPULATIONS THAT WOULD MEET PERFORMANCE METRICS (PNI AND pHOS) BY ALTERNATIVE.

		ALTERNATIVE 1 (NO ACTION)			ALTERNATIVE 2			ALTERNATIVE 3			ALTERNATIVE 4			ALTERNATIVE 5		
RECOVERY DOMAIN		STRONGER METRICS[1]	INTERMEDIATE METRICS[2]	WEAKER THAN INTERMEDIATE METRICS[3]	STRONGER METRICS	INTERMEDIATE METRICS	WEAKER THAN INTERMEDIATE METRICS	STRONGER METRICS	INTERMEDIATE METRICS	WEAKER THAN INTERMEDIATE METRICS	STRONGER METRICS	INTERMEDIATE METRICS	WEAKER THAN INTERMEDIATE METRICS	STRONGER METRICS	INTERMEDIATE METRICS	WEAKER THAN INTERMEDIATE METRICS
Willamette/Lower Columbia																
Primary Populations	Target		No Targets Set (No Action)			55			55			55			55	
	Result	29	3	23	42	9	4	32	18	5	53		2	32	18	5
Contributing Populations	Target		No Targets Set (No Action)			27			27			27			27	
	Result	9	3	15	19	4	4	15	5	7	11	8	8	16	4	7
Stabilizing Populations	Target		No Targets Set (No Action)			Maintain Current Status			Maintain Current Status			Maintain Current Status			Maintain Current Status	
	Result	6	2	28	28	2	6	8	2	26	6	3	27	8	2	26
Interior Columbia																
Primary Populations	Target		No Targets Set (No Action)			75			75			75			75	
	Result	43	7	25	56	15	4	55	16	4	45	15	4	71		4
Contributing Populations	Target		No Targets Set (No Action)			22			22			22			22	
	Result	9	1	12	10	7	5	10	9	3	10	9	3	8	9	5
Stabilizing Populations	Target		No Targets Set (No Action)			Maintain Current Status			Maintain Current Status			Maintain Current Status			Maintain Current Status	
	Result	2		23	6		19	3		22	3		22	3		22

[1] PNI greater than 0.67 for integrated populations; pHOS less than 0.05 for naturally spawning populations.

[2] PNI between 0.50 and 0.67 for integrated populations; pHOS of between 0.05 and 0.10 for naturally spawning populations.

[3] PNI less than 0.50 for integrated populations; pHOS greater than 0.10 for naturally spawning populations.

[4] Number of populations that would meet or exceed target performance metrics is in green. Number of populations that would not meet target performance metrics is in red. Note that this EIS does not evaluate habitat improvements or other measures unrelated to hatchery programs that could contribute improved conditions for these or any populations.

TABLE 4-6. NEW WEIRS BY EACH ALTERNATIVE'S IMPLEMENTATION SCENARIO AND ECOLOGICAL PROVINCE.

		ALTERNATIVE				
RECOVERY DOMAIN	ECOLOGICAL PROVINCE	1 (NO ACTION)	2	3	4	5
Willamette/ Lower Columbia	Columbia Estuary	0	0	6	7	6
	Lower Columbia	0	0	2	4	2
	Columbia Gorge	0	0	0	0	0
Interior Columbia	Columbia Gorge	0	0	0	0	0
	Columbia Plateau	0	0	2	2	5
	Columbia Cascade	0	0	1	1	1
	Blue Mountain	0	0	0	0	0
	Mountain Snake	0	0	2	2	3
Total		**0**	**0**	**13**	**16**	**17**

4.2.3.1.2 Hatchery Facility Risks

Potential risks to natural-origin salmon and steelhead associated with the operation of hatchery facilities include the following:

- Hatchery facility failure (power or water loss leading to catastrophic fish losses)
- Hatchery facility water intake effects (stream dewatering and fish entrainment)
- Hatchery facility effluent discharge effects (deterioration of downstream water quality)

The first risk affects natural-origin fish being held in the hatchery facility; the second and third affect natural-origin fish in the stream (Section 3.2.3.1.3, Hatchery Facility Risks). Several implementation measures would be incorporated under one or more of the alternatives' implementation scenarios and would affect risks on natural-origin salmon and steelhead as result of operating hatchery facilities (Table 4-4):

- Change production levels in hatchery programs.
- Update water intake screens at hatchery facilities.
- Update hatchery facilities to allow all salmon and steelhead of all ages to bypass or pass through hatchery-related structures.
- Correct water quality issues.

- Install new temporary weirs.
- Install new permanent weirs.
- Establish new hatchery programs.
- Terminate hatchery programs that support harvest if they fail to meet performance goals.

Four of these implementation measures may affect water quality and quantity (change production levels in hatchery programs, correct water quality issues, establish new hatchery programs, and terminate hatchery programs that support harvest if they fail to meet performance goals). Although reductions in water quantity and quality are a hatchery facility risk (i.e., there may be effluent discharge effects), they are not discussed here because they are analyzed in Section 4.6, Water Quality and Quantity. Effects of weirs are discussed in Section 4.2.3.1.1, Genetic Risks. As a result, the analysis in this section focuses on water intake effects and hatchery facility failure (Section 3.2.3.1.3, Hatchery Facility Risks).

Alternative 1 (No Action)

The implementation scenario for Alternative 1 (No Action) represents a future scenario of continuing existing operations with no policy changes. No additional implementation measures would be applied (Section 2.7.1, Implementation Scenario for Alternative 1), and the same percentage of hatchery programs within the analysis area would meet BMPs aimed at reducing water intake effects and avoiding hatchery facility failure as under baseline conditions (Table 3-5 and Table 4-7). As a result, hatchery facility risks related to screening and hatchery facility failure would be the same as under baseline conditions.

Alternative 2

Under the implementation scenario for Alternative 2, all hatchery programs in the analysis area would meet BMPs aimed at reducing water intake effects and avoiding hatchery facility failure (Table 4-7). As a result, hatchery facility risks related to screening and hatchery facility failure would be reduced compared to Alternative 1.

Alternative 3

Under the implementation scenario for Alternative 3, all hatchery programs in the analysis area would meet BMPs aimed at reducing water intake effects and avoiding hatchery facility failure (Table 4-7). As a result, hatchery facility risks related to screening and hatchery facility failure would be reduced compared to Alternative 1.

Alternative 4

Under the implementation scenario for Alternative 4, all hatchery programs in the analysis area would meet BMPs aimed at reducing water intake effects and avoiding hatchery facility failure (Table 4-7). As a result, hatchery facility risks related to screening and hatchery facility failure would be reduced compared to Alternative 1.

Alternative 5

Under the implementation scenario for Alternative 5, all hatchery programs in the analysis area would meet BMPs aimed at reducing water intake effects and avoiding hatchery facility failure (Table 4-7). As a result, hatchery facility risks related to screening and hatchery facility failure would be reduced compared to Alternative 1.

TABLE 4-7. COMPARISON OF THE PERCENTAGE OF HATCHERY PROGRAMS WITHIN THE ANALYSIS AREA MEETING BMPS TO MINIMIZE HATCHERY FACILITY EFFECTS.

	ALTERNATIVE (PERCENT [%] OF HATCHERY PROGRAMS)				
BMP	1 (NO ACTION)	2	3	4	5
Hatcheries are operated to allow all migrating species of all ages to by-pass or pass through hatchery-related structures.	71	100	100	100	100
Screens on water intakes would be compliant with Integrated Hatchery Operations Team, NMFS, or other agency standards.	53	100	100	100	100
Water supplies are protected by alarms and back-up power generators. Staff are notified of emergencies through the use of alarms, auto-dialers, and/or pagers.	66	100	100	100	100
All facilities operate within the limits established in National Pollutant Discharge Elimination System (NPDES) permits. If production from the facility fall below the minimum production requirements for an NPDES permit, the facility would operate in compliance with state or federal regulations for discharge.	100	100	100	100	100

A list of BMPs can be found in Appendix H, and individual HPV files for each hatchery program can be found at http://hatcheryreform.us/hrp/tools/hpv/welcome_show.action.

4.2.3.1.3 Risk of Competition with and Predation from Hatchery-origin Fish

Competition between hatchery-origin and natural-origin fish may result from direct interactions, in which hatchery-origin fish interfere with access to limited resources by natural-origin fish, or indirect interactions, as when utilization of a limited resource by hatchery-origin fish reduces the amount available for natural-origin fish (Section 3.2.3.1.5, Risks from Competition with Hatchery-origin Fish). The same situations that lead to competition between hatchery-origin and natural-origin juveniles can cause predation risk. Direct predation occurs when hatchery-origin fish eat natural-origin fish; indirect predation occurs when predation from other sources increases as a result of the increased abundance of juvenile salmon and steelhead (Section 3.2.3.1.6, Risks of Predation from Hatchery-origin Fish). Several implementation measures would be incorporated under one or more of the alternatives' implementation scenarios that may reduce competition and predation risks compared to baseline conditions (Table 4-4):

- Change production levels in hatchery programs.
- Improve rearing and release protocols in hatchery programs.
- Install new temporary weirs.
- Install new permanent weirs.
- Establish new selective fisheries in terminal areas.
- Terminate hatchery programs that support harvest if they fail to meet performance goals.

Five of these implementation measures may reduce pHOS relative to baseline conditions (change production levels in hatchery programs, install new temporary weirs, install new permanent weirs, establish new selective fisheries in terminal areas, and terminate hatchery programs that support harvest if they fail to meet performance goals). If pHOS is reduced compared to baseline conditions, then competition between adult hatchery-origin and natural-origin salmon and steelhead for mates and spawning sites may be reduced compared to baseline conditions. Two of these implementation measures may reduce the number of hatchery-origin fish released from the hatchery facilities compared to baseline conditions (change production levels in hatchery programs and terminate hatchery programs that support harvest if they fail to meet performance goals). If the number of hatchery-origin fish being released from the hatchery facilities is reduced, then competition between hatchery-origin and natural-origin juveniles for food and space may be reduced compared to baseline conditions in areas where they co-occur. Likewise, any predation on natural-origin juveniles from hatchery-origin juveniles may also be reduced.

Finally, one implementation measure (improve rearing and release protocols in hatchery programs) may lead to reduction in competition with and predation on natural-origin salmon and steelhead juveniles because one or more of the following measures would be taken: 1) more hatchery-origin fish would be released from the hatcheries ready to migrate, 2) a larger proportion of the hatchery-origin fish would be released in lower river areas, 3) size differences between natural-origin and hatchery-origin juveniles would be minimized, and/or 4) when possible, the release of hatchery-origin fish would be timed to avoid peak outmigration times of natural-origin salmon and steelhead.

Alternative 1 (No Action)

The implementation scenario for Alternative 1 (No Action) represents a future scenario of continuing existing operations with no policy changes. Production levels would remain the same as under baseline conditions, and no additional implementation measures would be used (Section 2.7.1, Implementation Scenario for Alternative 1). As under baseline conditions, almost 126 million salmon and steelhead smolts would emigrate through the estuary (86 percent of those smolts would be of hatchery-origin) (Table 4-8). As a result, the risks of predation on and competition with natural-origin salmon and steelhead would be the same under Alternative 1 as under baseline conditions.

Alternative 2

Under the implementation scenario for Alternative 2, production levels would be reduced by 64 percent relative to Alternative 1 (Table 2-7), and the number of smolts (natural-origin and hatchery-origin) emigrating through the estuary would be reduced by 59 percent relative to Alternative 1 (Table 4-8). These changes may reduce competition with and predation on natural-origin salmon and steelhead juveniles compared to Alternative 1. Because there would likely be fewer hatchery-origin adults on the spawning grounds, reduced competition for mates and spawning sites would also be expected compared to Alternative 1. Finally, rearing and release protocols would be improved where needed throughout the analysis area (Section 2.7.2, Implementation Scenario for Alternative 2), and these changes may reduce the risks of competition and predation compared to Alternative 1.

Alternative 3

Under the implementation scenario for Alternative 3, production levels would be reduced by 26 percent relative to Alternative 1 (Table 2-7), and the number of smolts (natural-origin and hatchery-origin) emigrating through the estuary would be reduced by 22 percent relative to Alternative 1 (Table 4-8). These changes may reduce competition with and predation on natural-origin salmon and steelhead juveniles compared to Alternative 1. Because there would likely be fewer hatchery-origin adults on the spawning grounds, reduced competition for mates and spawning sites would also be expected compared to Alternative 1. Finally, rearing and release protocols would be improved where needed throughout the analysis area (Section 2.7.3, Implementation Scenario for Alternative 3), and these changes may reduce the risks of competition and predation compared to Alternative 1.

Alternative 4

Under the implementation scenario for Alternative 4, production levels would be reduced by 18 percent relative to Alternative 1 (Table 2-7), and the number of smolts (natural-origin and hatchery-origin) emigrating through the estuary would be reduced by 12 percent relative to Alternative 1 (Table 4-8). These changes may reduce competition with and predation on natural-origin salmon and steelhead juveniles compared to Alternative 1. Because there would likely be fewer hatchery-origin adults on the spawning grounds, reduced competition for mates and spawning sites would also be expected compared to Alternative 1. Finally, rearing and release protocols would be improved where needed throughout the analysis area (Section 2.7.4, Implementation Scenario for Alternative 4), and these changes may reduce the risks of competition and predation compared to Alternative 1.

Alternative 5

Under the implementation scenario for Alternative 4, production levels would be reduced by 23 percent relative to Alternative 1 (Table 2-7), and the number of smolts (natural-origin and hatchery-origin) emigrating through the estuary would be reduced by 21 percent relative to Alternative 1 (Table 4-8). These changes may reduce competition with and predation on natural-origin salmon and steelhead juveniles compared to Alternative 1. Because there would likely be fewer hatchery-origin adults on the spawning grounds, reduced competition for mates and spawning sites would also be expected compared to Alternative 1. Finally, rearing and release protocols would be improved where needed throughout the analysis area (Section 2.7.5, Implementation Scenario for Alternative 5), and these changes may also reduce the risks of competition and predation compared to Alternative 1.

TABLE 4-8. NUMBERS AND PERCENTAGES OF NATURAL-ORIGIN AND HATCHERY-ORIGIN SALMON AND STEELHEAD EMIGRATING THROUGH THE COLUMBIA RIVER ESTUARY BY ALTERNATIVE.

	ALTERNATIVE				
	1	**2**	**3**	**4**	**5**
Hatchery-origin Fish in the Estuary					
Number of Fish	108,116,762	31,041,101	78,561,307	89,983,638	80,047,152
Percent (%)	86	60	80	81	80
Natural-origin Fish in the Estuary					
Number of Fish	17,821,190	20,278,900	19,905,640	21,261,391	19,987,755
Percent (%)	14	40	20	19	20
TOTAL (Number of Fish)	125,937,952	51,320,001	98,466,947	111,245,029	100,034,907
Percent (%) Reduction Compared to Alternative 1		59	22	12	21

Source: AHA model

4.2.3.1.4 Risks of Masking

Returning unidentifiable adult hatchery-origin fish straying into natural spawning areas confounds NMFS' ability to determine the status of the population. Abundance and productivity of the natural-origin population can be overestimated, and the productivity and capacity of the habitat can be imprecisely assessed. The abundance and productivity of the natural-origin fish and the condition of the habitat that sustains these fish is therefore masked by the continued infusion of hatchery-origin fish (Section 3.2.3.1.8, Risks Associated with Masking). In recent years, the masking problem has been greatly alleviated by the implementation of mass marking, the marking of a hatchery program's entire release, usually by adipose fin clip (Figure 2-2). However, several implementation measures would be incorporated under one or more of the alternatives' implementation scenarios that may further reduce the chances of masking by reducing the number of hatchery-origin salmon and steelhead on the spawning grounds:

- Change production levels in hatchery programs.
- Install new temporary weirs.
- Install new permanent weirs.
- Establish new selective fisheries in terminal areas.
- Terminate hatchery programs that support harvest if they fail to meet performance goals.

Alternative 1 (No Action)

The implementation scenario for Alternative 1 (No Action) represents a future scenario of continuing existing operations with no policy changes. Production levels would remain the same as under baseline conditions, and no additional implementation measures would be used (Section 2.7.1, Implementation Scenario for Alternative 1). As a result, the risks of masking would be the same under Alternative 1 as under baseline conditions.

Alternative 2

Under the implementation scenario for Alternative 2, production levels would be reduced by 64 percent relative to Alternative 1 (Table 2-7). These production reductions may further reduce the risks of masking the abundance and population of natural-origin salmon and steelhead populations relative to Alternative 1.

Alternative 3

Under the implementation scenario for Alternative 3, production levels would be reduced by 26 percent relative to Alternative 1 (Table 2-7). These production reductions may further reduce the risks of masking the abundance and population of natural-origin salmon and steelhead populations relative to Alternative 1.

Alternative 4

Under the implementation scenario for Alternative 3, production levels would be reduced by 18 percent relative to Alternative 1 (Table 2-7). These production reductions may further reduce the risks of masking the abundance and population of natural-origin salmon and steelhead populations relative to Alternative 1.

Alternative 5

Under the implementation scenario for Alternative 3, production levels would be reduced by 23 percent relative to Alternative 1 (Table 2-7). These production reductions may further reduce the risks of masking the abundance and population of natural-origin salmon and steelhead populations relative to Alternative 1.

4.2.3.1.5 Benefits of Nutrient Cycling

Salmon and steelhead are major vectors for transporting marine nutrients across ecosystem boundaries (i.e., from marine to freshwater and terrestrial ecosystems). Experiments have shown that carcasses of hatchery-produced salmon can be an important source of nutrients for juvenile salmon rearing in streams (Section 3.2.3.1.11, Benefits of Nutrient Cycling). Several implementation measures would be incorporated under one or more of the alternatives' implementation scenarios and would affect the number of salmon and steelhead returning to the spawning ground and contributing nutrients to the freshwater system:

- Change production levels in hatchery programs.
- Update hatchery facilities to allow all salmon and steelhead of all ages to by-pass or pass through hatchery-related structures.
- Install new temporary weirs.
- Install new permanent weirs.
- Establish new selective fisheries in terminal areas.
- Establish new hatchery programs.
- Terminate hatchery programs that support harvest if they fail to meet performance goals.

Three of these implementation measures would affect hatchery production levels (change production levels in hatchery programs, establish new hatchery programs, and terminate hatchery programs that support harvest if they fail to meet performance goals). Four of these implementation measures would affect the proportion of fish that escape to the spawning grounds (update hatchery facilities to allow all salmon and steelhead of all ages to bypass or pass through hatchery-related structures, install new temporary weirs, establish new permanent weirs, and establish new selective fisheries in terminal areas). Changing hatchery production and/or the proportion of fish returning to the spawning grounds would change the contribution of nutrients from salmon and steelhead to the freshwater system. A reduction in the number of salmon and steelhead carcasses may negatively affect juvenile salmon since hatchery carcasses are an important source of nutrients for them (Section 3.2.3.1.11, Benefits of Nutrient Cycling).

Alternative 1 (No Action)

The implementation scenario for Alternative 1 (No Action) represents a future scenario of continuing existing operations with no policy changes. Production levels would remain the same as under baseline conditions, and no additional implementation measures would be used (Section 2.7.1, Implementation Scenario for Alternative 1). As a result, the benefits of nutrient cycling to juvenile salmon and steelhead would be the same under Alternative 1 as under baseline conditions.

Alternative 2

There would be a 43 percent reduction in total adult salmon and steelhead abundance (hatchery-origin and natural-origin) under the implementation scenario for Alternative 2 relative to Alternative 1 (Appendix C through Appendix F). As a result, the benefits of nutrient cycling to juvenile salmon and steelhead would be reduced compared to Alternative 1.

Alternative 3

There would be an 18 percent reduction in total adult salmon and steelhead abundance (hatchery-origin and natural-origin) under the implementation scenario for Alternative 2 relative to Alternative 1 (Appendix C through Appendix F). As a result, the benefits of nutrient cycling to juvenile salmon and steelhead would be reduced compared to Alternative 1.

Alternative 4

There would be a 10 percent reduction in total adult salmon and steelhead abundance (hatchery-origin and natural-origin) under the implementation scenario for Alternative 2 relative to Alternative 1 (Appendix C through Appendix F). As a result, the benefits of nutrient cycling to juvenile salmon and steelhead would be reduced compared to Alternative 1.

Alternative 5

There would be a 15 percent reduction in total adult salmon and steelhead abundance (hatchery-origin and natural-origin) under the implementation scenario for Alternative 2 relative to Alternative 1 (Appendix C through Appendix F). As a result, the benefits of nutrient cycling to juvenile salmon and steelhead would be reduced compared to Alternative 1.

4.2.3.1.6 Risks Associated with Disease Transfer

Interactions between hatchery-origin fish and natural-origin fish in the environment may result in the transmission of pathogens, if either the hatchery-origin or natural-origin fish are harboring fish disease (Section 3.2.3.1.13, Risks Associated with Disease Transfer). Several implementation measures would be incorporated under one or more of the alternatives' implementation scenarios and would affect risks associated with disease transfer from hatchery-origin to natural-origin salmon and steelhead (Table 4-4). The following implementation measures could be used to reduce risks associated with disease transfer:

- Change production levels in hatchery programs.
- Improve rearing and release protocols in hatchery programs.
- Establish new hatchery programs.
- Terminate hatchery programs that support harvest if they fail to meet performance goals.

These implementation measures would affect the number of fish being reared in the hatchery facilities and/or the density of fish in the hatchery. Maintaining low densities of fish in the hatchery facilities reduces fish stress, which reduces the incidence of disease. Reducing production levels may reduce the number of diseased hatchery-origin fish that are released into the natural environment.

Alternative 1 (No Action)

The implementation scenario for Alternative 1 (No Action) represents a future scenario of continuing existing operations with no policy changes. As under baseline conditions, hatchery facilities would continue following fish health guidelines, but no additional implementation measures would be taken to reduce the transfer of disease from hatchery-origin to natural-origin salmon and steelhead (Section 2.7.1, Implementation Scenario for Alternative 1). As a result, the risks for transfer of disease from hatchery-origin to natural-origin fish would be the same under Alternative 1 as under baseline conditions.

Alternative 2

Under the implementation scenario for Alternative 2, production levels would be reduced by 64 percent relative to Alternative 1 (Table 2-7), and rearing and release protocols would be improved as needed to meet the goals of the alternative (Section 2.7.2, Implementation Scenario for Alternative 2). These changes may reduce the risk of transferring disease from hatchery-origin to natural-origin salmon and steelhead relative to Alternative 1 because reducing the densities of fish in the hatchery facilities may reduce fish stress, which may reduce the incidence of disease. In addition, reducing production levels 64 percent relative to Alternative 1 may reduce the number of diseased hatchery-origin fish that are released into the natural environment relative to Alternative 1.

Alternative 3

Under the implementation scenario for Alternative 3, production levels would be reduced by 26 percent relative to Alternative 1 (Table 2-7), and rearing and release protocols would be improved as needed to meet the goals of the alternative (Section 2.7.3, Implementation Scenario for Alternative 3). These changes may reduce the risk of transferring disease from hatchery-origin to natural-origin salmon and steelhead relative to Alternative 1 because reducing the densities of fish in the hatchery facilities may reduce fish stress, which may reduce the incidence of disease. In addition, reducing production levels 26 percent relative to Alternative 1 may reduce the number of diseased hatchery-origin fish that are released into the natural environment relative to Alternative 1.

Alternative 4

Under the implementation scenario for Alternative 3, production levels would be reduced by 18 percent relative to Alternative 1 (Table 2-7), and rearing and release protocols would be improved as needed to meet the goals of the alternative (Section 2.7.4, Implementation Scenario for Alternative 4). These changes may reduce the risk of transferring disease from hatchery-origin to natural-origin salmon and steelhead relative to Alternative 1 because reducing the densities of fish in the hatchery facilities may reduce fish stress, which may reduce the incidence of disease. In addition, reducing production levels 18 percent relative to Alternative 1 may reduce the number of diseased hatchery-origin fish that are released into the natural environment relative to Alternative 1.

Alternative 5

Under the implementation scenario for Alternative 3, production levels would be reduced by 23 percent relative to Alternative 1 (Table 2-7), and rearing and release protocols would be improved as needed to meet the goals of the alternative (Section 2.7.5, Implementation Scenario for Alternative 5). These changes may reduce the risk of transferring disease from hatchery-origin to natural-origin salmon and steelhead relative to Alternative 1 because reducing the densities of fish in the hatchery facilities may reduce fish stress, which may reduce the incidence of disease. In addition, reducing production levels

23 percent relative to Alternative 1 may reduce the number of diseased hatchery-origin fish that are released into the natural environment relative to Alternative 1.

4.2.3.1.7 Effects on VSP

The VSP concept was developed by McElhany et al. (2000) as a way to evaluate the conservation status of Pacific salmon and steelhead. A key part of this approach was the identification of four measurable indicators of population health that should be considered in performing conservation status assessments. These indicators of population status are abundance (the number of natural-origin spawners), productivity (the ratio of natural-origin offspring produced per parent), diversity (the genetic variety among population members), and spatial structure (the distribution of population members across a subbasin or subbasins). See each ESU/DPS section for a discussion of effects of the alternatives on VSP.

4.2.3.2 Effects on Salmon ESUs and Steelhead DPSs

Basinwide effects on salmon and steelhead are discussed in Section 4.2.3.1, Basinwide Effects on Salmon and Steelhead. This section evaluates effects specific to each ESU or DPS. Conditions under Alternative 1 are expected to be the same as under current conditions, so this analysis focuses on the effects of Alternative 2 through Alternative 4 relative to the effects of Alternative 1. The analysis includes a comparison of genetic risks, competition and predation risks, and effects on VSP. Effects on other categories of risks (e.g., masking) are the same at an ESU and DPS level as described in the basinwide analysis (Section 4.2.3.1, Basinwide Effects on Salmon and Steelhead).

4.2.3.2.1 Lower Columbia River Chinook Salmon ESU

Genetic Risks for All Alternatives

Under the implementation for Alternative 1, 21 percent of primary and contributing Chinook salmon populations for the Lower Columbia River Chinook Salmon ESU would meet stronger metrics, and 79 percent would meet weaker than intermediate metrics. The number of populations meeting stronger metrics improves under the implementation scenarios for Alternative 2 through Alternative 5, with the highest percentage of populations meeting stronger metrics under the implementation scenario for Alternative 4 (Table 4-9). Thus, genetic risks as described in Section 3.2.3.1.1, Genetic Risks, would be reduced under the implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1 through application of measures such as changing production levels, improving broodstock collection protocols, installing temporary and permanent weirs, establishing selective fisheries in terminal areas, changing program goals or type, and terminating programs that fail to meet performance criteria.

Specific PNI and pHOS values for each population in this ESU across the alternatives' implementation scenarios can be found in Appendix C.

TABLE 4-9. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE LOWER COLUMBIA RIVER CHINOOK SALMON ESU THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	4	0	15	21	0	79
2	12	3	4	63	16	21
3	6	7	6	32	37	32
4	13	1	5	68	5	26
5	6	7	6	32	37	32

Source: Appendix C. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the Lower Columbia Fish Recovery Board (LCFRB) in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS (Section 2.4, Alternative Development).

No new weirs would be installed under the implementation scenarios for Alternative 1 or Alternative 2, but five new weirs would be installed under the implementation scenarios for Alternative 3 and Alternative 5, and seven new weirs would be installed under the implementation scenario for Alternative 4 to achieve PNI and pHOS objectives (Table 4-10). As a result, the following weir effects may be greater under the implementation scenarios for Alternative 3 through Alternative 5 compared to Alternative 1: isolation of formerly connected populations, limiting or slowing movement of non-target fish species, alteration of stream flow, alteration of streambed and riparian habitat, alteration of the distribution of spawning within a population, increased mortality or stress due to capture and handling, impingement of downstream migrating fish, forced downstream spawning by fish that do not pass through the weir, and increased straying due to either trapping adults that were not intending to spawn above the weir, or displacing adults into other tributaries (Section 3.2.3.1.1, Genetic Risks). The weirs under the implementation scenario for Alternative 4 would be permanent structures necessary to achieve a high effectiveness and presumably would have higher effects on native-origin fish species compared to effects from temporary (seasonal) weirs under implementation scenarios for Alternative 3 and Alternative 5.

TABLE 4-10. LOCATION AND EFFECTIVENESS OF WEIRS REQUIRED TO ACHIEVE PHOS AND PNI OBJECTIVES FOR THE LOWER COLUMBIA RIVER CHINOOK SALMON ESU.

		ALTERNATIVE (PERCENT [%] EFFECTIVENESS)				
LOCATION	POPULATION	1 (NO ACTION)[1]	2	3	4	5
Clatskanie	Columbia Estuary Clatskanie Fall Chinook Salmon	0	0	50	95	50
Elochoman	Elochoman Fall Chinook Salmon	0	0	50	95	50
Grays	Grays Fall Chinook Salmon	0	0	50	95	50
Kalama	Kalama Fall Chinook Salmon	0	0	50	95	50
Lewis	Lewis EF Lewis Fall Chinook Salmon (Tule)	0	0	0	95	0
Washougal	Washougal Fall Chinook Salmon	0	0	50	95	50
Mill-Aber-Germ	Columbia Estuary Mill-Aber-Germ Fall Chinook Salmon	0	0	0	95	0

[1] If effectiveness value is greater than 0 percent in Alternative 1, a weir currently exists, and new weirs would not have to be constructed in the other alternatives. All other populations in the table would require a new or upgraded weir.

Competition and Predation Risks for All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish.

Table 4-11 shows the ratio of hatchery-origin to natural-origin smolts by species for each alternative's implementation scenario. Ratios would generally be reduced under implementation scenarios for Alternative 2 through Alternative 5 when compared to Alternative 1. Ratios would be lowest under the implementation scenario for Alternative 2 compared to other alternatives, suggesting that competition with and predation on natural-origin salmon and steelhead would be lowest under the implementation scenario for Alternative 2. One anomaly to the reduced ratios found under implementation scenarios for Alternative 2 through Alternative 5 is that the implementation scenario for Alternative 4 would have an increased ratio of hatchery-origin chum to natural-origin Chinook salmon when compared to Alternative 1. However, since hatchery-origin chum are released as fry, interspecific predation effects from chum salmon on natural-origin Chinook salmon would not be expected since the hatchery-origin chum salmon being released would be smaller than the natural-origin Chinook salmon with which they are intermingling. However, increased production of hatchery-origin chum salmon may increase competition between chum salmon and fall Chinook salmon in the estuary because they would be of similar size and using similar habitats and food (Section 3.2.3.1.5, Risks from Competition with Hatchery-origin Fish).

TABLE 4-11. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN CHINOOK SALMON SMOLT PRODUCTION, BY ALTERNATIVE, IN THE LOWER COLUMBIA RIVER CHINOOK SALMON ESU.

ALTERNATIVE	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN CHINOOK SALMON
1 (No Action)	13.4	0.7	3.2	0.1
2	1.2	0.3	0.4	0.0
3	9.3	0.6	1.6	0.1
4	10.7	0.6	2.1	0.3
5	9.3	0.6	1.6	0.1

Source: Appendix C

Effects on VSP for All Alternatives

Abundance of natural-origin spawners in the Lower Columbia River Chinook Salmon ESU would increase under the implementation scenarios for Alternative 2 through Alternative 5 when compared to Alternative 1 due to reduced genetic, predation, and competition risks (Table 4-12). Abundance would be highest under the implementation scenario for Alternative 2 compared to the other alternatives. Natural-origin spawner abundance would not increase under the implementation scenario for Alternative 4 to the same degree as under the implementation scenario for Alternative 2 because a portion of the natural-origin return would be taken as broodstock to better integrate hatchery programs, particularly those in the Washougal subbasin.

Mean adjusted productivity would also increase under implementation scenarios for Alternative 2 through Alternative 5 when compared to Alternative 1 due to reduced genetic, predation, and competition risks (Table 4-12). Productivity would be highest under the implementation scenario for Alternative 4 compared to the other alternatives because genetic risks would be reduced more under the implementation scenario for Alternative 4 when compared to the others. Strategies would be implemented to control the number of hatchery-origin fish spawning naturally (i.e., weirs), hatchery programs would be better integrated (i.e., higher proportion of natural-origin fish in the broodstock [pNOB] and/or lower pHOS), and more hatchery-origin fish would be released from areas removed from primary and contributing natural-origin populations.

TABLE 4-12. MEAN PERCENT CHANGE IN ADJUSTED PRODUCTIVITY ($PROD_{ADJ}$) AND IN ABUNDANCE OF NATURAL-ORIGIN SPAWNERS (NOS) PER POPULATION (PRIMARY AND CONTRIBUTING POPULATIONS ONLY) BY ALTERNATIVE IN THE LOWER COLUMBIA RIVER CHINOOK SALMON ESU.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	2.3	25,042	N/A[1]	N/A
2	3.2	28,365	38	13
3	2.8	26,540	19	6
4	3.3	26,657	42	6
5	2.8	26,523	19	6

Source: Appendix C. Data were generated with the AHA model using best available data.

[1] N/A = Not applicable.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS (Section 2.4, Alternative Development).

The number and percent of primary and contributing populations that would have adjusted productivity greater than 1.0 and 500 or more NOS would increase under the implementation scenarios for Alternative 2 and Alternative 4 when compared to Alternative 1, suggesting that diversity and spatial structure would be greater under Alternative 2 and Alternative 4 when compared to Alternative 1 (Table 4-13).

TABLE 4-13. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE LOWER COLUMBIA RIVER CHINOOK SALMON ESU THAT WOULD HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS >500 AND $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ}$ > 1.0 AND NOS > 500
1 (No Action)	13	9	8	68	47	42
2	15	11	11	79	58	58
3	14	8	8	74	42	42
4	15	9	9	79	47	47
5	14	8	8	74	42	42

Source: Appendix C. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS (Section 2.4, Alternative Development).

The symbol ">" = "greater than."

4.2.3.2.2 Mid-Columbia River Spring-run Chinook Salmon ESU

Genetic Risks for All Alternatives

Under the implementation scenario for Alternative 1, 60 percent of primary and contributing Chinook salmon populations would meet stronger metrics, 10 percent would meet intermediate metrics, and 30 percent would meet weaker than intermediate metrics (Table 4-14). The implementation scenarios for Alternative 2 through Alternative 5 would increase the number of primary and contributing populations that meet either the stronger or intermediate metrics compared to Alternative 1, and all primary and contributing populations in this ESU would meet either the stronger or intermediate metrics under the implementation scenarios for Alternative 3 through Alternative 5. As a result, genetic risks as described in Section 3.2.3.1.1, Genetic Risks, would be reduced under the implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1 through the application of measures such as changing production levels, improving broodstock collection protocols, installing temporary and permanent weirs, establishing selective fisheries in terminal areas, changing program goals or type, and terminating programs that fail to meet performance criteria. Specific PNI and pHOS values for each population in this ESU across the alternatives' implementation scenarios can be found in Appendix C.

TABLE 4-14. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE MID-COLUMBIA RIVER SPRING-RUN CHINOOK SALMON ESU THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	6	1	3	60	10	30
2	7	1	2	70	10	20
3	6	4	0	60	40	0
4	7	3	0	70	30	0
5	8	2	0	80	20	0

[1] Source: Appendix C. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

As described in Section 3.2.3.1.1, Genetic Risks, weir effects include isolation of formerly connected populations, limiting or slowing movement of non-target fish species, alteration of stream flow, alteration of streambed and riparian habitat, alteration of the distribution of spawning within a population, increased mortality or stress due to capture and handling, impingement of downstream migrating fish, forced downstream spawning by fish that do not pass through the weir, and increased straying due to either trapping adults that were not intending to spawn above the weir, or displacing adults into other tributaries. No new weirs would be required to meet PNI and pHOS objectives for any of the alternatives, although existing weirs in the Deschutes and upper Yakima Rivers would have to be maintained (Table 4-15). As a result, weir effects would be the same under the implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1.

TABLE 4-15. LOCATION AND EFFECTIVENESS OF WEIRS REQUIRED TO ACHIEVE pHOS AND PNI OBJECTIVES FOR THE MID-COLUMBIA RIVER SPRING-RUN CHINOOK SALMON ESU.

		ALTERNATIVE (PERCENT [%] EFFECTIVENESS)				
LOCATION	POPULATION	1 (NO ACTION)[1]	2	3	4	5
Deschutes	Deschutes Spring Chinook Salmon	50	50	50	50	50
Yakima	Upper Yakima Spring Chinook Salmon	95	95	95	95	95

[1] If effectiveness value is greater than 0 percent in Alternative 1, a weir currently exists, and new weirs would not have to be constructed in the other alternatives. All other populations in the table would require a new or upgraded weir.

Competition and Predation Risks for All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish.

Table 4-16 shows the ratio of hatchery-origin to natural-origin smolts by species for each alternative's implementation scenario. Ratios of hatchery-origin to natural-origin fish would generally be reduced under the implementation scenarios for Alternative 2 through Alternative 5 when compared to Alternative 1, suggesting that competition and predation risks would be less under the implementation scenarios for Alternative 2 through Alternative 5 when compared to Alternative 1. Ratios of hatchery-origin to natural-origin fish would be lowest under the implementation scenario for Alternative 2 compared to the other alternatives, suggesting that competition and predation risks on the Mid-Columbia River Spring-run Chinook Salmon ESU would be lowest under the implementation scenario for Alternative 2 compared to the other alternatives.

TABLE 4-16. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN CHINOOK SALMON SMOLT PRODUCTION, BY ALTERNATIVE, IN THE MID-COLUMBIA RIVER SPRING-RUN CHINOOK SALMON ESU.

ALTERNATIVE	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN CHINOOK SALMON
1 (No Action)	77.7	2.9	22.0	0.0
2	37.6	1.3	0.0	0.0
3	66.2	2.3	13.1	0.0
4	66.7	2.2	12.9	0.0
5	67.3	2.2	13.1	0.0

Source: Appendix C

Effects on VSP for All Alternatives

Mean adjusted productivity in the Mid-Columbia Spring-run Chinook Salmon ESU would increase under implementation scenarios for Alternative 2 through Alternative 5 when compared to Alternative 1 (Table 4-17). Abundance would be highest under the implementation scenario for Alternative 4 compared to the other alternatives. Abundance would both increase and decrease under the implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1. Abundance would decrease slightly under the implementation scenarios for Alternative 3 and Alternative 5 when compared to Alternative 1 due to improved integration of hatchery programs in the Deschutes, Walla Walla, and Umatilla subbasins, which would require more natural-origin fish to be taken into the hatchery broodstock. Abundance would increase under the implementation scenario for Alternative 4 compared to Alternative 1 due to reduced genetic, competition, and predation risks.

TABLE 4-17. MEAN PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS PER POPULATION (PRIMARY AND CONTRIBUTING POPULATIONS ONLY) BY ALTERNATIVE IN THE MID-COLUMBIA RIVER SPRING-RUN CHINOOK SALMON ESU.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	2.6	10,156	N/A[1]	N/A
2	2.7	10,108	4	0
3	2.9	10,098	10	-1
4	3.0	10,309	15	2
5	3.0	10,004	14	-1

Source: Appendix C. Data were generated with the AHA model using best available data.
[1] N/A = Not applicable.
Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

The number of populations that would achieve an adjusted productivity greater than 1.0 and an NOS greater than 500 was equal under the implementation scenarios for Alternative 1 through Alternative 3, suggesting that diversity and spatial structure would not vary between these alternatives (Table 4-18). The number of populations that would achieve an adjusted productivity greater than 1.0 and an NOS greater than 500 would increase under the implementation scenarios for Alternative 4 and Alternative 5 when compared to Alternative 1 (Table 4-18), suggesting that diversity and spatial structure would improve under the implementation scenarios for Alternative 4 and Alternative 5 when compared to Alternative 1. The higher NOS would result from an increase in NOS abundance for Klickitat spring Chinook salmon due to improved broodstock management.

TABLE 4-18. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE MID-COLUMBIA RIVER SPRING-RUN CHINOOK SALMON ESU THAT WOULD HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS >500 AND $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ}$ > 1.0 AND NOS > 500
1 (No Action)	10	6	6	100	60	60
2	10	6	6	100	60	60
3	10	6	6	100	60	60
4	10	7	7	100	70	70
5	10	7	7	100	70	70

Source: Appendix C. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

The symbol ">" = "greater than."

4.2.3.2.3 Deschutes River Summer/Fall-run Chinook Salmon ESU

Genetic Risks under All Alternatives

There is only one primary or contributing population in this ESU, and it would meet the stronger metrics under implementation scenarios for all of the alternatives (Table 4-19). Therefore, there would be no expected differences in genetic effects between alternatives. Weirs would not be required in any of the alternatives' implementation scenario to achieve PNI and pHOS objectives, so weir effects would not vary among the alternatives. Specific PNI and pHOS values for each population in this ESU across the alternatives' implementation scenarios can be found in Appendix C.

TABLE 4-19. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE DESCHUTES RIVER SUMMER/FALL-RUN CHINOOK SALMON ESU THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	1	0	0	100	0	0
2	1	0	0	100	0	0
3	1	0	0	100	0	0
4	1	0	0	100	0	0
5	1	0	0	100	0	0

[1] Source: Appendix C. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

Competition and Predation Risks under All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish.

Table 4-20 shows the ratio of hatchery-origin to natural-origin smolts by species for each alternative's implementation scenario. Ratios would be slightly lower under the implementation scenario for Alternative 2 compared to Alternative 1 for hatchery-origin Chinook salmon to natural-origin Chinook salmon, but ratios for hatchery-origin steelhead on natural-origin Chinook salmon would remain constant (Table 4-20). This suggests that there would be slight reductions in intraspecific (among the same species) competition and predation risk for the Deschutes River Summer/Fall-run Chinook Salmon ESU under the implementation scenario for Alternative 2 when compared to Alternative 1.

There would not be any changes in the ratio of hatchery-origin to natural-origin salmon and steelhead smolts under implementation scenarios for Alternative 3 through Alternative 5 when compared to Alternative 1, suggesting that competition and predation risks would be similar (Table 4-20).

TABLE 4-20. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN CHINOOK SALMON SMOLT PRODUCTION, BY ALTERNATIVE, IN THE DESCHUTES RIVER SUMMER/FALL-RUN CHINOOK SALMON ESU.

ALTERNATIVE	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN CHINOOK SALMON
1 (No Action)	1.3	0.2	0.0	0.0
2	1.2	0.2	0.0	0.0
3	1.3	0.2	0.0	0.0
4	1.3	0.2	0.0	0.0
5	1.3	0.2	0.0	0.0

Source: Appendix C

Effects on VSP under All Alternatives

Mean adjusted productivity and abundance would be greater under the implementation scenario for Alternative 2 and slightly less under the implementation scenarios for Alternative 3 through Alternative 5 when compared to Alternative 1 (Table 4-21). Intraspecific competition and predation would be slightly reduced under the implementation scenario for Alternative 2 compared to Alternative 1 and may lead to increased in abundance and productivity. However, differences in abundance and productivity among the alternatives would probably be more affected by differences in the genetic risk posed by hatchery-origin Chinook salmon straying into the Deschutes from outside the Deschutes River basin. There are no direct releases of summer/fall Chinook salmon into the Deschutes River.

TABLE 4-21. MEAN PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS PER POPULATION (PRIMARY AND CONTRIBUTING POPULATIONS ONLY) BY ALTERNATIVE IN THE DESCHUTES RIVER SUMMER/FALL-RUN CHINOOK SALMON ESU.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	2.4	8,840	N/A[1]	N/A
2	2.8	10,194	15	15
3	2.4	8,702	-1	-2
4	2.4	8,651	-2	-2
5	2.4	8,673	-2	-2

Source: Appendix C. Data were generated with the AHA model using best available data.

[1] N/A = Not applicable.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

The number and percent of primary and contributing populations that would have an adjusted productivity of greater than 1.0 and 500 or more NOS did not vary among implementation scenarios for the alternatives, suggesting that diversity and spatial structure would not vary among implementation scenarios for the alternatives (Table 4-22).

Table 4-22. Number and Percent of Primary and Contributing Populations Comprising the Deschutes River Summer/Fall-run Salmon ESU that Would Have a $PROD_{ADJ}$ Greater than 1.0, 500 or More NOS, or Both.

Alternative	Number of Populations with $PROD_{ADJ} >$ 1.0	Number of Populations with NOS > 500	Number of Populations with Both NOS > 500 and $PROD_{ADJ}$ >1.0	Percent of Populations with $PROD_{ADJ}$ >1.0	Percent of Populations with NOS >500	Percent of Populations with Both $PROD_{ADJ} >$ 1.0 and NOS > 500
1 (No Action)	1	1	1	100	100	100
2	1	1	1	100	100	100
3	1	1	1	100	100	100
4	1	1	1	100	100	100
5	1	1	1	100	100	100

Source: Appendix C. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

The symbol ">" = "greater than."

4.2.3.2.4 Upper Columbia River Spring-run Chinook Salmon ESU

Genetic Risks under All Alternatives

Under the implementation scenario for Alternative 1, no primary and contributing Chinook salmon populations would meet the stronger or intermediate metrics (Table 4-23). Under the implementation scenarios for Alternative 2 through Alternative 5, more populations would meet stronger and intermediate metrics compared to Alternative 1, suggesting that genetic effects would be less under the implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1 (Table 4-23). The implementation scenario for Alternative 5 resulted in all primary and contributing populations meeting the stronger metrics. The only population that would not meet stronger metrics under the implementation scenario for Alternative 5 would be the Okanogan population, but it is classified as a stabilizing population for this analysis using terms from the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004) and, thus, is not shown in Table 4-23. As a result, the implementation scenario for Alternative 5 would likely have the fewest genetic effects of all of the other alternatives. Specific PNI and pHOS values for each population in this ESU across the alternatives' implementation scenarios can be found in Appendix C.

TABLE 4-23. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE UPPER COLUMBIA RIVER SPRING-RUN CHINOOK SALMON ESU THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	0	0	6	0	0	100
2	2	3	1	33	50	17
3	2	4	0	33	67	0
4	2	4	0	33	67	0
5	6	0	0	100	0	0

[1] Source: Appendix C. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

As described in Section 3.2.3.1.1, Genetic Risks, weir effects include isolation of formerly connected populations, limiting or slowing movement of non-target fish species, alteration of stream flow, alteration of streambed and riparian habitat, alteration of the distribution of spawning within a population, increased mortality or stress due to capture and handling, impingement of downstream migrating fish, forced downstream spawning by fish that do not pass through the weir, and increased straying due to either trapping adults that were not intending to spawn above the weir, or displacing adults into other tributaries. No new weirs would be installed under the implementation scenarios for Alternative 1 and Alternative 2, but a new weir would be required in the Entiat River to achieve the PNI and pHOS objectives under the implementation scenarios for Alternative 3 through Alternative 5 (Table 4-24). Under the implementation scenarios for Alternative 3 and Alternative 4, the Entiat River weir would be temporary and would have a lower level of effectiveness than under the implementation scenario for Alternative 5, under which the Entiat River weir would be permanent. Under the implementation scenarios for Alternative 2 through Alternative 5, the existing fish trap at Tumwater Dam on the Wenatchee River would be used to manage escapement composition for the three natural-origin populations in the Wenatchee River. As a result, weir effects would be greatest under the implementation scenario for Alternative 5 compared to the other alternatives' implementation scenarios.

TABLE 4-24. LOCATION AND EFFECTIVENESS OF WEIRS REQUIRED TO ACHIEVE pHOS AND PNI OBJECTIVES FOR THE UPPER COLUMBIA SPRING-RUN CHINOOK SALMON ESU.

		Alternative (percent [%] effectiveness)				
Location	**Population**	**1 (No Action)[1]**	**2**	**3**	**4**	**5**
Entiat	Entiat Spring Chinook Salmon	0	0	60	60	95
Wenatchee	Wenatchee (Chiwawa) Spring Chinook Salmon	0	95	95	95	95
	Wenatchee (Nason) Spring Chinook Salmon	0	95	95	95	95
	Wenatchee (White) Spring Chinook Salmon	0	95	95	95	95

[1] If effectiveness value is greater than 0 percent in Alternative 1, a weir currently exists, and new weirs would not have to be constructed in the other alternatives. All other populations in the table would require a new weir.

Competition and Predation Risks under All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish.

Table 4-25 shows the ratio of hatchery-origin to natural-origin smolts by species for each alternative's implementation scenario. Ratios would be reduced under the implementation scenarios for Alternative 2 through Alternative 5 when compared to Alternative 1. Ratios would be lowest under the implementation scenarios for Alternative 3 and Alternative 4 when compared to the other alternatives, which suggests that competition and predation effects would be lowest under the implementation scenarios for Alternative 3 and Alternative 4, compared to the other alternatives. This is mostly due to reductions in steelhead hatchery programs under the implementation scenarios for Alternative 2 through Alternative 4 in order to meet PNI and/or pHOS goals. Steelhead hatchery programs would not have to be reduced to the same extent under the implementation scenario for Alternative 5 because there would be improved broodstock management in the Wenatchee and Methow Rivers, and a portion of the steelhead releases would be relocated to areas removed from natural-origin steelhead populations.

TABLE 4-25. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN CHINOOK SALMON SMOLT PRODUCTION, BY ALTERNATIVE, IN THE UPPER COLUMBIA RIVER SPRING-RUN CHINOOK SALMON ESU.

ALTERNATIVE	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN CHINOOK SALMON
1 (No Action)	20.9	4.2	6.6	0.0
2	19.2	1.8	6.5	0.0
3	18.8	1.7	6.3	0.0
4	18.8	1.7	6.3	0.0
5	19.5	4.2	6.3	0.0

Source: Appendix C

Effects on VSP for All Alternatives

Mean adjusted productivity would increase, and abundance would decrease slightly under the implementation scenarios for Alternative 2 through Alternative 4 when compared to Alternative 1 (Table 4-26). These changes would be due to the incorporation of more natural-origin broodstock into the Methow and Wenatchee spring Chinook integrated hatchery programs, operation of the Tumwater Canyon Fish Trap in the Wenatchee to control pHOS, and a reduction in hatchery production in the Methow spring Chinook salmon hatchery program. Productivity and abundance would both increase under the implementation scenarios for Alternative 5 when compared to Alternative 1 because, in addition to the actions that would be taken under the implementation scenarios for Alternative 2 through Alternative 4, a permanent weir would be installed in the Entiat River to manage escapement composition in this subbasin, which would further reduce genetic risks.

TABLE 4-26. MEAN PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS PER POPULATION (PRIMARY AND CONTRIBUTING POPULATIONS ONLY) BY ALTERNATIVE IN THE UPPER COLUMBIA RIVER SPRING-RUN CHINOOK SALMON ESU.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	1.4	1,104	N/A[1]	N/A
2	2.1	1,072	49	-3
3	2.1	1,099	52	0
4	2.1	1,099	52	0
5	2.3	1,214	65	10

Source: Appendix C. Data were generated with the AHA model using best available data.
[1] N/A = Not applicable.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB

2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

The number and percent of primary and contributing populations that would have an adjusted productivity of greater than 1.0 and 500 or more NOS did vary among implementation scenarios for the alternatives, suggesting that diversity and spatial structure would not vary among implementation scenarios for the alternatives (Table 4-27).

TABLE 4-27. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE UPPER COLUMBIA RIVER SPRING-RUN CHINOOK SALMON ESU THAT WOULD HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS > 500 AND $PROD_{ADJ}$ >1.0	PERCENT OF POPULATIONS WITH $PROD_{ADJ}$ >1.0	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ}$ >1.0 AND NOS > 500
1 (No Action)	3	0	0	50	0	0
2	5	0	0	83	0	0
3	6	0	0	100	0	0
4	6	0	0	100	0	0
5	6	0	0	100	0	0

Source: Appendix C. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

The symbol “>” = “greater than.”

4.2.3.2.5 Upper Columbia River Summer/Fall-run Chinook Salmon ESU

Genetic Risks for All Alternatives

Under the implementation scenario for Alternative 1, 33 percent of primary and contributing Chinook populations would meet stronger metrics, no populations would meet the intermediate metrics, and 67 percent would meet weaker than intermediate metrics (Table 4-28). Under Alternative 2 through Alternative 5, more primary and contributing populations would meet stronger and intermediate metrics compared to Alternative 1 (Table 4-28). The number of primary and contributing populations meeting stronger metrics improves to 50 percent for Alternative 2 through Alternative 5 (Table 4-28). In addition, between 17 and 33 percent of primary and contributing populations would meet intermediate metrics for these alternatives, compared to zero percent for Alternative 1 (Table 4-28). As a result, genetic effects would be reduced under the implementation scenarios for Alternative 2 through Alternative 5 when compared to Alternative 1. Specific PNI and pHOS values for each population in this ESU across the alternatives' implementation scenarios can be found in Appendix C. No weirs would be operated under any of the alternatives' implementation scenarios to help achieve PNI and pHOS objectives, so weir effects would not vary among the alternatives' implementation scenarios.

TABLE 4-28. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE UPPER COLUMBIA RIVER SUMMER/FALL-RUN CHINOOK SALMON ESU THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	2	0	4	33	0	67
2	3	1	2	50	17	33
3	3	2	1	50	33	17
4	3	2	1	50	33	17
5	3	2	1	50	33	17

[1] Source: Appendix C. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by theLCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

Competition and Predation Risks for All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish.

Table 4-29 shows the ratio of hatchery-origin to natural-origin smolts by species for each alternative's implementation scenario. Ratios for hatchery-origin Chinook to natural-origin Chinook and hatchery-origin coho to natural-origin Chinook would be reduced under the implementation scenarios for Alternative 2 through Alternative 5 when compared to Alternative 1. This suggests that competition and predation risks would be lowest under the implementation scenario for Alternative 2 compared to the other alternatives.

The low ratios of hatchery-origin to natural-origin fish under implementations scenarios for all alternatives would be due to the large number of natural-origin Chinook juveniles (8 to 12 million) in this ESU. The majority (around 80 percent) of the natural-origin production would be from fall Chinook originating in the Hanford Reach of the Columbia River and summer Chinook from the Wenatchee and Okanogan Rivers. No hatchery-origin chum salmon would be released in this ESU under any alternative (Appendix C).

TABLE 4-29. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN CHINOOK SALMON SMOLT PRODUCTION, BY ALTERNATIVE, IN THE UPPER COLUMBIA RIVER SUMMER/FALL-RUN CHINOOK SALMON ESU.

ALTERNATIVE	HATCHERY-ORIGIN TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN CHINOOK SALMON
1 (No Action)	2.5	0.1	0.7	0.0
2	1.1	<0.1	0.1	0.0
3	1.7	0.1	0.4	0.0
4	1.7	0.1	0.4	0.0
5	1.7	0.1	0.4	0.0

Source: Appendix C

Effects on VSP for All Alternatives

Mean adjusted productivity would increase under implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1 (Table 4-30). The increase for all alternatives would be the result of decreased hatchery production and an increase in the fitness of Hanford Reach Upriver Bright population by better integrating the Priest Rapids hatchery program. This would be achieved by using a higher proportion of natural-origin adults in the broodstock. Abundance would be slightly less under the implementation scenarios for Alternative 5 compared to the implementation scenarios for Alternative 2 through Alternative 4 because more natural-origin fish would be taken as broodstock so that hatchery production could be increased in the Okanogan River to improve harvest benefits under this alternative (Table 4-30).

TABLE 4-30. MEAN PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS PER POPULATION (PRIMARY AND CONTRIBUTING POPULATIONS ONLY) BY ALTERNATIVE IN THE UPPER COLUMBIA RIVER SUMMER/FALL-RUN CHINOOK SALMON ESU.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	1.7	46,160	N/A[1]	N/A
2	2.0	65,373	20	42
3	2.0	64,993	21	41
4	2.1	65,927	27	43
5	2.0	64,653	21	40

[1] N/A = Not applicable.

Source: Appendix C. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

Mean adjusted productivity increased for the implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1 (Table 4-30) largely due to improved hatchery program broodstock management at Priest Rapids Hatchery that would benefit the Hanford Reach population.

The number of populations that would achieve an adjusted productivity greater than 1.0 and an NOS greater than 500 would not change among the alternatives' implementation scenarios, suggesting that viability and spatial structure would be similar among all alternatives (Table 4-31).

TABLE 4-31. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE UPPER COLUMBIA RIVER SUMMER/FALL-RUN CHINOOK SALMON ESU THAT WOULD HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ} >$ 1.0	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS >500 AND $PROD_{ADJ} >$ 1.0	PERCENT OF POPULATIONS WITH $PROD_{ADJ} >$ 1.0	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ} >$ 1.0 AND NOS > 500
1 (No Action)	3	5	3	50	83	50
2	3	5	3	50	83	50
3	3	5	3	50	83	50
4	3	5	3	50	83	50
5	3	5	3	50	83	50

Source: Appendix C. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

The symbol ">" = "greater than."

4.2.3.2.6 Upper Willamette River Chinook Salmon ESU

Genetic Risks for All Alternatives

Under the implementation scenario for Alternative 1, 40 percent of primary and contributing populations would meet stronger metrics, none would meet the intermediate metrics, and 60 percent would meet weaker than intermediate metrics (Table 4-32). The percent of populations meeting stronger metrics would be the same for all alternatives' implementation scenarios, but under the implementation scenarios for Alternative 2 through Alternative 5, more primary and contributing populations would meet intermediate metrics, suggesting that genetic risks would be slightly reduced under the implementation scenario for Alternative 2 through Alternative 5 compared to Alternative 1.

TABLE 4-32. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE UPPER WILLAMETTE RIVER CHINOOK SALMON ESU THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1	2	0	3	40	0	60
2	2	1	2	40	20	40
3	2	1	2	40	20	40
4	2	1	2	40	20	40
5	2	1	2	40	20	40

[1] Source: Appendix C. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

Reduced genetic risks under implementation scenarios for Alternative 2 through Alternative 5 would be due to improved broodstock management in the South Santiam River. The two populations that would meet weaker than intermediate metrics under all alternatives would be the Middle Fork Willamette and North Santiam River populations. Hatchery programs in these rivers would be operated primarily for conservation (gene banking) purposes since most high quality spring Chinook habitat is blocked by upstream dams (McElhany et al. 2003). Broodstook management in these hatchery programs could not be improved to meet intermediate or stronger metrics, but this situation may change if fish passage was provided in these rivers because natural-origin abundance would likely improve compared to existing conditions. Specific PNI and pHOS values for each population in this ESU across the alternatives' implementation scenarios can be found in Appendix C.No new weirs were required to meet alternative objectives (Table 4-33). However, an existing adult trap at the North Fork Dam in the Clackamas River would be used to exclude marked hatchery-origin spring Chinook salmon from the upper watershed under implementation scenarios for all alternatives. As a result, weir effects would not likely vary across the alternatives' implementation scenarios.

TABLE 4-33. LOCATION AND EFFECTIVENESS OF WEIRS REQUIRED TO ACHIEVE pHOS AND PNI OBJECTIVES FOR THE UPPER WILLAMETTE RIVER CHINOOK SALMON ESU.

		ALTERNATIVE (PERCENT [%] EFFECTIVENESS)				
LOCATION	POPULATION	1 (NO ACTION)[1]	2	3	4	5
Willamette	Willamette Clackamas Spring Chinook Salmon	95	95	95	95	95

[1] If effectiveness value is greater than 0 percent in Alternative 1, a weir currently exists, and new weirs would not have to be constructed in the other alternatives. All other populations in the table would require a new weir.

Competition and Predation Risks for All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish.

Table 4-34 shows the ratio of hatchery-origin to natural-origin smolts by species for each alternative's implementation scenario. Ratios would generally be reduced under implementation scenarios for Alternative 2 through Alternative 5 when compared to Alternative 1. Ratios would be lowest under the implementation scenario for Alternative 2 compared to the other alternatives, suggesting that competition and predation risks would be lowest under the implementation scenario for Alternative 2 compared to the other alternatives. This would be due to reductions in hatchery production associated with closing hatchery programs funded through the Mitchell Act (e.g., the Eagle Creek coho salmon hatchery program) and reducing production in other hatchery programs to meet performance goals (e.g., the South Santiam spring Chinook salmon hatchery program).

TABLE 4-34. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN CHINOOK SALMON SMOLT PRODUCTION, BY ALTERNATIVE, IN THE UPPER WILLAMETTE RIVER CHINOOK SALMON ESU.

ALTERNATIVE	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN CHINOOK SALMON
1 (No Action)	20.3	4.0	1.3	0.0
2	15.4	3.0	0.0	0.0
3	19.4	3.6	1.2	0.0
4	19.5	3.6	1.2	0.0
5	19.5	3.6	1.2	0.0

Source: Appendix C

Effects on VSP for All Alternatives

Abundance and mean adjusted productivity would increase slightly in implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1 (Table 4-35). Implementation scenarios for Alternative 2 through Alternative 5 would lead to fewer hatchery-origin fish on the spawning grounds compared to Alternative 1, which would likely result in higher natural-origin Chinook population productivity and abundance.

TABLE 4-35. MEAN PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS PER POPULATION (PRIMARY AND CONTRIBUTING POPULATIONS ONLY) BY ALTERNATIVE IN THE UPPER WILLAMETTE RIVER CHINOOK SALMON ESU.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	1.6	6,935	N/A[1]	N/A
2	1.7	7,419	7	7
3	1.7	7,157	7	3
4	1.7	7,139	7	3
5	1.7	7,139	7	3

Source: Appendix C. Data were generated with the AHA model using best available data.

[1] N/A = Not applicable.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

The number of populations that achieved an adjusted productivity greater than 1.0 and an NOS greater than 500 was higher under implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1 (Table 4-36) because more natural-origin spawners returned to the South Santiam River. This suggests that diversity and spatial structure would be higher under implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1.

4.2.3.2.7 Snake River Spring/Summer-run Chinook Salmon ESU

Genetic Risks for All Alternatives

Under the implementation scenario for Alternative 1, 59 percent of primary and contributing populations would meet stronger metrics, 14 percent would meet the intermediate metrics, and 28 percent would meet weaker than intermediate metrics (Table 4-37). The number of populations meeting stronger and intermediate metrics would increase under implementation scenarios for Alternative 2 through Alternative 5 when compared to Alternative 1, suggesting that genetic risks would be reduced under the implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1.

TABLE 4-36. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE UPPER WILLAMETTE RIVER CHINOOK SALMON ESU THAT WOULD HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS > 500 AND $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ}$ > 1.0 AND NOS > 500
1 (No Action)	3	3	2	60	60	40
2	3	4	3	60	80	60
3	3	4	3	60	80	60
4	3	4	3	60	80	60
5	3	4	3	60	80	60

Source: Appendix C. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

The symbol ">" = "greater than."

TABLE 4-37. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE SNAKE RIVER SPRING/SUMMER-RUN CHINOOK SALMON ESU THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	17	4	8	59	14	28
2	21	6	2	72	21	7
3	21	6	2	72	21	7
4	21	6	2	72	21	7
5	22	3	4	76	10	14

[1] Source: Appendix C. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

Two primary and contributing populations would meet weaker than intermediate metrics under the implementation scenarios for all alternatives. This is because hatchery-origin steelhead released for conservation purposes in the upper Salmon River would lead to a greater than 10 percent stray level in populations in the Salmon River downstream of Redfish Lake and the lower Middle Fork Salmon River. Specific PNI and pHOS values for each population in this ESU across the alternatives' implementation scenarios can be found in Appendix C.

There are eight weirs currently operating within the boundaries of this ESU, and these eight weirs would continue to operate under the implementation scenario for Alternative 1 through Alternative 5 (Table 4-38). Under the implementation scenarios for Alternative 3 through Alternative 5, existing weirs in the Lostine and Imnaha Rivers would receive additional investments to improve efficiency and to ensure broodstock collection over the entire run timing. A new weir would be required in the Lemhi River under the implementation scenario for Alternative 5 to manage escapement composition in this stream. As a result, the following weir effects may be greater under the implementation scenario for Alternative 5 compared to implementation scenarios for Alternative 1 through Alternative 4: isolation of formerly connected populations, limiting or slowing movement of non-target fish species, alteration of stream flow, alteration of streambed and riparian habitat, alteration of the distribution of spawning within a population, increased mortality or stress due to capture and handling, impingement of downstream migrating fish, forced downstream spawning by fish that do not pass through the weir, and increased straying due to either trapping adults that were not intending to spawn above the weir, or displacing adults into other tributaries (Section 3.2.3.1.1, Genetic Risks).

TABLE 4-38. LOCATION AND EFFECTIVENESS OF WEIRS REQUIRED TO ACHIEVE PHOS AND PNI OBJECTIVES FOR THE SNAKE RIVER SPRING/SUMMER-RUN CHINOOK SALMON ESU.

		Alternative (percent [%] effectiveness)				
Location	**Population**	**1 (No Action)[1]**	**2**	**3**	**4**	**5**
Salmon River	Lemhi River Spring Chinook Salmon	0	0	0	0	50
	South Fork Salmon River Summer Chinook Salmon	70	70	70	70	70
	East Fork-South Fork Salmon (Johnson Creek) Summer Chinook Salmon	50	50	50	50	50
	Pahsimeroi Summer Chinook Salmon	95	95	95	95	95
	Upper Salmon Mainstem Spring Chinook Salmon	95	95	95	95	95
Clearwater River	South Fork Clearwater Newsome Creek Spring Chinook Salmon	95	95	95	95	95
Grande Ronde River	Lostine Spring Chinook Salmon	50	50	90	90	90
	Catherine Creek Spring Chinook Salmon	55	55	55	55	55
Imnaha River	Imnaha Spring Chinook Salmon	20	20	70	70	70

[1] If effectiveness value is greater than 0 percent in Alternative 1, a weir currently exists, and new weirs would not have to be constructed in the other alternatives. All other populations in the table would require a new weir.

Competition and Predation Risks for All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish.

Table 4-39 shows the ratio of hatchery-origin to natural-origin smolts by species for each alternative's implementation scenario. Ratios would generally be reduced under implementation scenarios for Alternative 2 through Alternative 5 when compared to Alternative 1. Ratios would be lowest under the implementation scenario for Alternative 2 compared to the other alternatives, suggesting that competition and predation risks would be lowest under the implementation scenario for Alternative 2 compared to the other alternatives.

TABLE 4-39. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN CHINOOK SALMON SMOLT PRODUCTION, BY ALTERNATIVE, IN THE SNAKE RIVER SPRING/SUMMER-RUN CHINOOK SALMON ESU.

ALTERNATIVE	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN CHINOOK SALMON
1 (No Action)	15.8	7.9	0.7	0.0
2	8.5	5.4	0.0	0.0
3	8.6	6.3	0.6	0.0
4	8.6	6.3	0.6	0.0
5	9.8	6.7	0.6	0.0

Source: Appendix C

Effects on VSP for All Alternatives

Mean adjusted productivity and abundance would be greater under the implementation scenarios for Alternative 2 through Alternative 5 when compared to Alternative 1 (Table 4-40). Increases in abundance and productivity relative to Alternative 1 would occur in multiple populations in the Salmon, Clearwater, and Grande Ronde Rivers. These increases would result from improved broodstock management (i.e., improving integration by including more natural-origin adults in the broodstock) and better control of the number of hatchery-origin adults allowed to spawn naturally in key populations.

The number and percent of primary and contributing populations that would have an adjusted productivity of greater than 1.0 and 500 or more NOS did not vary among implementation scenarios for the alternatives, suggesting that diversity and spatial structure would not vary among implementation scenarios for the alternatives (Table 4-41).

Table 4-40. Mean Percent Change in PROD$_{ADJ}$ and in Abundance of NOS per Population (primary and contributing populations only) by Alternative in the Snake River Spring/Summer-run Chinook Salmon ESU.

Alternative	Mean PROD$_{ADJ}$	Total NOS Abundance	Change in Mean PROD$_{ADJ}$ from Alternative 1 (%)	Change in Total NOS Abundance from Alternative 1 (%)
1 (No Action)	1.4	7,887	N/A[1]	N/A
2	1.5	9,007	13	14
3	1.5	8,951	13	13
4	1.5	8,951	13	13
5	1.5	8,947	12	13

[1] N/A = Not applicable.

Source: Appendix C. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

Table 4-41. Number and Percent of Primary and Contributing Populations Comprising the Snake River Spring/Summer-run Chinook Salmon ESU that Would Have a PROD$_{ADJ}$ Greater than 1.0, 500 or More NOS, or Both.

Alternative	Number of Populations with PROD$_{ADJ}$ > 1.0	Number of Populations with NOS > 500	Number of Populations with Both NOS > 500 and PROD$_{ADJ}$ > 1.0	Percent of Populations with PROD$_{ADJ}$ > 1.0	Percent of Populations with NOS > 500	Percent of Populations with Both PROD$_{ADJ}$ > 1.0 and NOS > 500
1 (No Action)	21	5	5	72	17	17
2	24	5	5	83	17	17
3	24	5	5	83	17	17
4	24	5	5	83	17	17
5	20	5	5	69	17	17

Source: Appendix C. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

The symbol “>” = “greater than.”

4.2.3.2.8 Snake River Fall-run Chinook Salmon ESU

Genetic Risks for All Alternatives

The Snake River Fall-run Chinook Salmon ESU consists of a single natural-origin population consisting of spawning components in the Snake River mainstem, the Clearwater River, and the lower portions of the Grande Ronde and Imnaha Rivers (Section 3.2.3.2.8, Snake River Fall-run Chinook Salmon ESU). This population would meet weaker than intermediate metrics under the implementation scenario for

Alternative 1 (Table 4-42). Under the implementation scenario for Alternative 2 through Alternative 4, this population would meet intermediate metrics (Table 4-42). Under the implementation scenario for Alternative 5, this population would meet stronger metrics (Table 4-42). As a result, genetic risks would be reduced under the implementation scenarios for Alternative 2 through Alternative 5 compared to the implementation scenario for Alternative 1, with the fewest genetic risks occurring under the implementation scenarios for Alternative 5. Specific PNI and pHOS values for each population in the ESU across the alternatives' implementation scenarios can be found in Appendix C.

TABLE 4-42. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE SNAKE RIVER FALL-RUN CHINOOK SALMON ESU THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	0	0	1	0	0	100
2	0	1	0	0	100	0
3	0	1	0	0	100	0
4	0	1	0	0	100	0
5	1	0	0	100	0	0

[1] Source: Appendix C. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

No weirs currently exist or were needed to achieve PNI and pHOS objectives for any of the alternatives, so weir effects would not vary among the alternatives' implementation scenarios.

Competition and Predation Risks for All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish.

Table 4-43 shows the ratio of hatchery-origin to natural-origin smolts by species for each alternative's implementation scenario. For hatchery-origin Chinook salmon to natural-origin Chinook, salmon ratios would be greatly reduced under implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1 (Table 4-43) because there would be a large reduction in the number of hatchery-origin fall Chinook released under the implementation scenarios for these alternatives. Ratios would be lowest under the implementation scenarios for Alternative 5 (Table 4-43), suggesting that intraspecific competition and predation risks would be lowest under the implementation scenario for Alternative 5 compared to all other alternatives.

TABLE 4-43. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN CHINOOK SALMON SMOLT PRODUCTION, BY ALTERNATIVE, IN THE SNAKE RIVER FALL-RUN CHINOOK SALMON ESU.

ALTERNATIVE	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN CHINOOK SALMON	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN CHINOOK SALMON
1 (No Action)	17.3	1.5	2.4	0.0
2	2.8	2.3	0.0	0.0
3	2.8	2.3	3.6	0.0
4	2.8	2.3	3.6	0.0
5	1.5	1.9	3.1	0.0

Source: Appendix C

The ratio of hatchery-origin steelhead to natural-origin Chinook salmon would increase slightly under the implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1 (Table 4-43) because there would be decreased natural-origin production of Chinook salmon under the implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1. As a result, interspecific competition and predation risks would increase under the implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1.

The ratio of hatchery-origin coho salmon to natural-origin Chinook salmon would be reduced under the implementation scenario for Alternative 2 compared to Alternative 1 (Table 4-43) because a Mitchell Act-funded coho salmon program in the Clearwater River would be terminated. However, ratios of hatchery-origin coho salmon to natural-origin Chinook would increase under the implementation scenario for Alternative 3 through Alternative 5 compared to Alternative 1 (Table 4-43). This is because natural-origin Chinook salmon production would be reduced under the implementation scenarios for Alternative 2 through Alternative 5 because more natural-origin Chinook salmon would be taken as broodstock for the hatchery program. This suggests that interspecific competition and predation between hatchery-origin coho and natural-origin Chinook salmon would be higher under the implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1.

Effects on VSP for All Alternatives

Mean adjusted productivity would increase under implementation scenarios for Alternative 2 through Alternative 5 when compared to Alternative 1 (Table 4-44). Under the implementation scenario for

Alternative 1, the adjusted productivity would be less than 1.0. The adjusted productivity would increase slightly under the implementation scenarios for Alternative 2 through Alternative 4, although the productivity would still be about 1.0 (Table 4-44). The implementation scenario under Alternative 5 would have the highest productivity level of all the alternatives, with an adjusted productivity of 1.3 (Table 4-44). This increase in adjusted productivity would be due to higher PNI values under Alternative 5's implementation scenario.

Table 4-44. Mean Percent Change in $PROD_{ADJ}$ and in Abundance of NOS per Population (primary and contributing populations only) by Alternative in the Snake River Fall-run Chinook Salmon ESU.

Alternative	Mean $PROD_{ADJ}$	Total NOS Abundance	Change in Mean $PROD_{ADJ}$ from Alternative 1 (%)	Change in Total NOS Abundance from Alternative 1 (%)
1 (No Action)	0.7	1,602	N/A[1]	N/A
2	1.0	1,091	41	-32
3	1.0	1,115	39	-30
4	1.0	1,115	39	-30
5	1.3	1,432	80	-11

Source: Appendix C. Data were generated with the AHA model using best available data.

[1] N/A = Not applicable.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

Average abundance would decrease by at least 11 percent under implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1 (Table 4-44). Although the productivity increases under implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1, the abundance decreases because more natural-origin fish would be taken into the Hells Canyon fall Chinook salmon hatchery program.

The number and percent of populations that would have an adjusted productivity of greater than 1.0 and 500 or more NOS would increase under the implementation scenarios for Alternative 2 through Alternative 5 when compared to Alternative 1 (Table 4-45), suggesting that diversity and spatial structure would be greater under implementation scenarios for Alternative 2 through Alternative 4 when compared to Alternative 1 (Table 4-45).

TABLE 4-45. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE SNAKE RIVER FALL-RUN CHINOOK SALMON ESU THAT WOULD HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS > 500 AND $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ}$ > 1.0 AND NOS > 500
1 (No Action)	0	1	0	0	100	0
2	1	1	1	100	100	100
3	1	1	1	100	100	100
4	1	1	1	100	100	100
5	1	1	1	100	100	100

Source: Appendix C. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

The symbol “>” = “greater than.”

4.2.3.2.9 Lower Columbia River Steelhead DPS

Genetic Risks for All Alternatives

Under the implementation scenario for Alternative 1, 79 percent of primary and contributing populations would meet stronger metrics, and 21 percent would meet weaker than intermediate metrics (Table 4-46). The percent of primary and contributing populations meeting either stronger or intermediate metrics increases under Alternative 2 through Alternative 5 compared to Alternative 1 (Table 4-46). This suggests that genetic risks would be reduced under the implementation scenarios for Alternative 2 to Alternative 5 compared to Alternative 1, with the fewest genetic effects occurring under the implementation scenario for Alternative 4. Specific PNI and pHOS values for each population in this DPS across the alternatives’ implementation scenarios can be found in Appendix D.

No new weirs would be required to meet PNI and pHOS objectives for any of the alternatives, although existing weirs in the Willamette, Wind, Cowlitz, and Hood Rivers would need to be maintained (Table 4-47). As a result, weir effects would not vary among the alternatives’ implementation scenarios.

TABLE 4-46. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE LOWER COLUMBIA RIVER STEELHEAD DPS THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	15	0	4	79	0	21
2	17	2	0	89	11	0
3	14	5	0	74	26	0
4	18	1	0	95	5	0
5	15	4	0	79	21	0

[1] Source: Appendix D. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

TABLE 4-47. LOCATION AND EFFECTIVENESS OF WEIRS REQUIRED TO ACHIEVE pHOS AND PNI OBJECTIVES FOR THE LOWER COLUMBIA RIVER STEELHEAD DPS.

LOCATION	POPULATION	ALTERNATIVE (PERCENT [%] EFFECTIVENESS)				
		1 (NO ACTION)[1]	2	3	4	5
Willamette	Upper Clackamas Winter Steelhead (Late)	95	95	95	95	95
Wind	Wind Summer Steelhead	95	95	95	95	95
Cowlitz	Upper Cowlitz Winter Steelhead (Late)	95	95	95	95	95
Hood	Hood Summer Steelhead	95	95	95	95	95
Hood	Hood Winter Steelhead	95	95	95	95	95

[1] If effectiveness value is greater than 0 percent in Alternative 1, then a weir currently exists, and new weirs would not have to be constructed in the other alternatives.

Competition and Predation Risks for All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish. Table 4-48 shows the ratio of hatchery-origin to natural-origin smolts by species for each alternative's implementation scenario.

Ratios would generally be reduced under the implementation scenarios for Alternative 2 through Alternative 5 when compared to Alternative 1. One anomaly would be the ratio of hatchery-origin chum salmon to natural-origin steelhead under the implementation scenario for Alternative 4. The ratio of hatchery-origin chum salmon to natural-origin steelhead would be 0.5 under the implementation scenarios for Alternative 1, Alternative 2, Alternative 3, and Alternative 5, but the ratio would increase to 3.2 under Alternative 4 (Table 4-48). However, because chum salmon would be released from hatcheries as fry and immediately migrate to the ocean, their release probably would not lead to competition with or predation on the larger natural-origin steelhead juveniles. As a result, competition and predation risks would be lower under implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1.

TABLE 4-48. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN STEELHEAD SMOLT PRODUCTION, BY ALTERNATIVE, IN THE LOWER COLUMBIA RIVER STEELHEAD DPS.

ALTERNATIVE	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN STEELHEAD
1 (No Action)	18.8	215.3	42.6	0.5
2	11.1	38.9	7.6	0.5
3	16.2	146.3	16.2	0.5
4	16.4	162.3	22.8	3.2
5	16.2	146.5	16.2	0.5

Source: Appendix D

Effects on VSP for All Alternatives

Average abundance and mean adjusted productivity would increase under the implementation scenarios for Alternative 2 through Alternative 5 when compared to Alternative 1 (Table 4-49). Average abundance and mean adjusted productivity would be highest under the implementation scenario for Alternative 2 when compared to the other alternatives (Table 4-49) because this alternative's implementation scenario would release the fewest hatchery-origin steelhead of all the alternatives, which would lead to higher PNI and lower pHOS values among Lower Columbia River steelhead populations, reducing genetic risks.

The number of populations that would achieve an adjusted productivity greater than 1.0 and NOS greater than 500 would be higher under the implementation scenarios for Alternative 2 through Alternative 4 relative to Alternative 1 because abundance would increase under each of these alternatives (Table 4-50). The results suggest that diversity and spatial structure would be greater under the implementation scenarios for Alternative 2 through Alternative 4 compared to the other alternatives. The number of populations that would achieve an adjusted productivity greater than 1.0 and an NOS greater than 500 would be similar under the implementation scenario for Alternative 5 when compared to Alternative 1 (Table 4-50), suggesting that diversity and spatial structure would be similar between these two alternatives.

TABLE 4-49. MEAN PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS PER POPULATION (PRIMARY AND CONTRIBUTION POPULATIONS ONLY) BY ALTERNATIVE IN THE LOWER COLUMBIA RIVER STEELHEAD DPS.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	2.6	12,540	N/A[1]	N/A
2	3.0	14,147	15	13
3	2.7	12,919	3	3
4	2.9	13,435	11	7
5	2.7	12,861	3	3

Source: Appendix D. Data were generated with the AHA model using best available data.

[1] N/A = Not applicable.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

TABLE 4-50. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE LOWER COLUMBIA RIVER STEELHEAD DPS THAT WOULD HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS > 500 AND $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ}$ > 1.0 AND NOS > 500
1 (No Action)	19	7	7	100	37	37
2	19	13	13	100	68	68
3	19	8	8	100	42	42
4	19	10	10	100	53	53
5	19	7	7	100	37	37

Source: Appendix D. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

The symbol ">" = "greater than."

4.2.3.2.10 Middle Columbia River Steelhead DPS

Genetic Risks for All Alternatives

Under the implementation scenario for Alternative 1, 69 percent of primary and contributing steelhead populations would meet the stronger metric, 6 percent would meet the intermediate metrics, and 25 percent would meet the weaker than intermediate metrics (Table 4-51). The number of primary and contributing populations meeting stronger metrics would increase under the implementation scenarios for

Alternative 2 through Alternative 5, and the number of populations meeting weaker than intermediate metrics would decrease under the implementation scenarios for Alternative 2 through Alternative 5. This suggests that genetic risks would be reduced under the implementation scenarios for Alternative 2 through Alternative 5 compared to the implementation scenario for Alternative 1. All primary and contributing populations in the Middle Columbia River Steelhead DPS would meet the stronger metric under the implementation scenario for Alternative 5 (Table 4-51), suggesting that genetic risks would be lowest under this alternative's implementation scenario. Specific PNI and pHOS values for each population in this DPS across the alternatives' implementation scenarios can be found in Appendix D.

TABLE 4-51. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE MIDDLE COLUMBIA RIVER STEELHEAD DPS THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	11	1	4	69	6	25
2	13	2	1	81	13	6
3	12	3	1	75	19	6
4	12	3	1	75	19	6
5	16	0	0	100	0	0

[1] Source: Appendix D. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

No new weirs would be installed under the implementation scenarios for Alternative 1 and Alternative 2, but two new weirs would be installed under the implementation scenarios for Alternative 3 and Alternative 4, and five new weirs would be installed under the implementation scenarios for Alternative 5 to meet PNI and pHOS goals (Table 4-52). Weirs would be installed in the John Day River only under Alternative 5 because these weirs would be needed to meet the stronger metrics identified under the goals of this alternative. Although there are no hatchery programs in the John Day River, many hatchery fish from other watersheds stray into the John Day River. These weirs would be seasonal weirs that would only be installed and operated when steelhead are moving upstream. As a result, the following weir effects may be greater under the implementation scenarios for Alternative 3 through Alternative 5 compared to Alternative 1: isolation of formerly connected populations, limiting or slowing movement of non-target fish species, alteration of stream flow, alteration of streambed and riparian habitat, alteration of the distribution of spawning within a population, increased mortality or stress due to capture and handling, impingement of downstream migrating fish, forced downstream spawning by fish that do not pass through the weir, and increased straying due to either trapping adults that were not intending to spawn above the weir, or displacing adults into other tributaries (Section 3.2.3.1.1, Genetic Risks).

TABLE 4-52. LOCATION AND EFFECTIVENESS OF WEIRS REQUIRED TO ACHIEVE pHOS AND PNI OBJECTIVES FOR THE MIDDLE COLUMBIA RIVER STEELHEAD DPS.

		ALTERNATIVE (PERCENT [%] EFFECTIVENESS)				
LOCATION	**POPULATION**	**1 (NO ACTION)[1]**	**2**	**3**	**4**	**5**
Deschutes	Deschutes East-side Tributaries Summer Steelhead	0	0	60	60	85
Deschutes	Deschutes West-side Tributaries Summer Steelhead	0	0	60	60	85
John Day	John Day Lower Mainstem Summer Steelhead	0	0	0	0	50
John Day	John Day Middle Fork Summer Steelhead	0	0	0	0	50
John Day	John Day North Fork Summer Steelhead	0	0	0	0	50
Walla Walla	Walla Walla Summer Steelhead	95	95	95	95	95

[1] If effectiveness value is greater than 0 percent in Alternative 1, a weir currently exists, and new weirs would not have to be constructed in the other alternatives. All other populations in the table would require a new weir under some of the alternatives.

Competition and Predation Risks for All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish. Table 4-53 shows the ratio of hatchery-origin to natural-origin smolts by species for each alternative's implementation scenario.

Ratios would be reduced under implementation scenarios for Alternative 2 through Alternative 5 when compared to Alternative 1. Ratios would be lowest under the implementation scenario for Alternative 2 compared to the other alternatives, suggesting that competition and predation risks would be lowest under the implementation scenario for Alternative 2 compared to the other alternatives.

TABLE 4-53. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN STEELHEAD SMOLT PRODUCTION, BY ALTERNATIVE, IN THE MIDDLE COLUMBIA RIVER STEELHEAD DPS.

ALTERNATIVE	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN STEELHEAD
1 (No Action)	1.6	25.7	14.4	0.0
2	0.7	6.7	0.0	0.0
3	1.1	17.8	8.3	0.0
4	1.1	18.5	8.3	0.0
5	1.2	15.4	6.9	0.0

Source: Appendix D.

Effects on VSP for All Alternatives

Average abundance and mean adjusted productivity would increase under the implementation scenarios for Alternative 2 to Alternative 5 when compared to Alternative 1 (Table 4-54). Average abundance and mean adjusted productivity would be greatest under the implementation scenario for Alternative 5 when compared to implementation scenarios for the other alternatives (Table 4-54).

TABLE 4-54. MEAN PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS PER POPULATION (PRIMARY AND CONTRIBUTION POPULATIONS ONLY) BY ALTERNATIVE IN THE MIDDLE COLUMBIA RIVER STEELHEAD DPS.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	2.0	16,010	N/A[1]	N/A
2	2.4	18,783	18	17
3	2.1	16,412	2	3
4	2.1	16,414	2	3
5	2.5	20,346	21	27

Source: Appendix D. Data were generated with the AHA model using best available data.

[1] N/A = Not applicable.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

The number and percent of primary and contributing populations that would have an adjusted productivity of greater than 1.0 and 500 or more NOS would be greatest under the implementation scenarios for Alternative 5 when compared to the implementation scenarios for all other alternatives (Table 4-55), suggesting that diversity and spatial structure would also be greatest under Alternative 5 compared to the other alternatives.

TABLE 4-55. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE MIDDLE COLUMBIA RIVER STEELHEAD DPS THAT WOULD HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS > 500 AND $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ}$ > 1.0 AND NOS > 500
1 (No Action)	13	11	11	81	69	69
2	15	11	11	94	69	69
3	15	11	11	94	69	69
4	15	11	11	94	69	69
5	16	13	13	100	81	81

Source: Appendix D. The abundance and productivity numbers in this table were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

The symbol ">" = "greater than."

4.2.3.2.11 Snake River Basin Steelhead DPS

Genetic Risks for All Alternatives

Under the implementation scenario for Alternative 1, 56 percent of the primary and contributing populations would meet stronger metrics, 8 percent would meet intermediate metrics, and 24 percent would meet weaker than intermediate metrics (Table 4-56). All primary and contributing populations would meet stronger or intermediate metrics under the implementation scenario for Alternative 2 through Alternative 5 (Table 4-56), suggesting that genetic risks would be reduced under the implementation scenarios for Alternative 2 through Alternative 5 compared to the implementation scenario for Alternative 1. Specific PNI and pHOS values for each population in this DPS across the alternatives' implementation scenarios can be found in Appendix D.

No new weirs would be installed under the implementation scenarios for Alternative 1 and Alternative 2, but two new weirs would be installed under the implementation scenarios for Alternative 3 through Alternative 5 to meet PNI and pHOS goals (Table 4-57). Under the implementation scenarios for Alternative 3 and Alternative 4, these weirs would only have to capture 50 percent of the migrating fish; thus, seasonal/temporary weirs would likely be installed only during times when steelhead are actively migrating. Because the implementation scenario for Alternative 5 would have a lower target pHOS, permanent weirs would be installed in the Lemhi and Pahsimeroi Rivers. As a result, the following weir effects may be greater under the implementation scenarios for Alternative 3 through Alternative 5 compared to Alternative 1: isolation of formerly connected populations, limiting or slowing movement of non-target fish species, alteration of stream flow, alteration of streambed and riparian habitat, alteration of the distribution of spawning within a population, increased mortality or stress due to capture and handling, impingement of downstream migrating fish, forced downstream spawning by fish that do not pass through the weir, and increased straying due to either trapping adults that were not intending to spawn above the weir, or displacing adults into other tributaries (Section 3.2.3.1.1, Genetic Risks).

TABLE 4-56. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE SNAKE RIVER BASIN STEELHEAD DPS THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	14	2	6	56	8	24
2	17	5	0	68	20	0
3	17	5	0	68	20	0
4	17	5	0	68	20	0
5	19	3	0	76	12	0

[1] Source: Appendix D. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

TABLE 4-57. LOCATION AND EFFECTIVENESS OF WEIRS REQUIRED TO ACHIEVE PHOS AND PNI OBJECTIVES FOR THE SNAKE RIVER BASIN STEELHEAD DPS.

		ALTERNATIVE (PERCENT [%] EFFECTIVENESS)				
LOCATION	POPULATION	1 (NO ACTION)[1]	2	3	4	5
Salmon	Lemhi Summer Steelhead (A-run)	0	0	50	50	95
Salmon	Pahsimeroi Summer Steelhead (A-run)	0	0	50	50	95

[1] If effectiveness value is greater than 0 percent in Alternative 1, then a weir currently exists, and new weirs would not have to be constructed in the other alternatives. All other populations in the table would require a new weir.

Competition and Predation Risks for All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish. Table 4-58 shows the ratio of hatchery-origin to natural-origin smolts by species.

TABLE 4-58. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN STEELHEAD SMOLT PRODUCTION, BY ALTERNATIVE, IN THE SNAKE RIVER BASIN STEELHEAD DPS.

ALTERNATIVE	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN STEELHEAD
1 (No Action)	12.1	24.1	1.1	0.0
2	9.1	14.1	0.0	0.0
3	10.6	14.3	1.1	0.0
4	10.6	14.3	1.1	0.0
5	11.2	16.2	1.0	0.0

Source: Appendix D

Ratios would generally be reduced under implementation scenarios for Alternative 2 through Alternative 5 when compared to Alternative 1. Ratios would be lowest under the implementation scenario for Alternative 2 compared to the other alternatives, suggesting that competition and predation risks would be lowest under the implementation scenario for Alternative 2 compared to the other alternatives.

Effects on VSP for All Alternatives

Mean adjusted productivity would increase under the implementation scenarios for Alternative 2 through Alternative 5 when compared to Alternative 1 and would be highest under the implementation scenario for Alternative 5 (Table 4-59). Abundance would also be higher under the implementation scenarios for Alternative 2 through Alternative 5 when compared to Alternative 1 with the highest abundance under the implementation scenario for Alternative 2. Although mean adjusted productivity is greatest under the implementation scenario for Alternative 5, abundance is not greatest under this implementation scenario because more natural-origin fish would be taken into the hatchery program as broodstock.

Table 4-59. Mean Percent Change in $PROD_{ADJ}$ and in Abundance of NOS per Population (primary and contribution populations only) by Alternative in the Snake River Basin Steelhead DPS.

Alternative	Mean $PROD_{ADJ}$	Total NOS Abundance	Change in Mean $PROD_{ADJ}$ from Alternative 1 (%)	Change in Total NOS Abundance from Alternative 1 (%)
1 (No Action)	1.9	14,039	N/A[1]	N/A
2	2.0	14,609	7	4
3	2.0	14,542	6	4
4	2.0	14,545	6	4
5	2.1	15,258	11	9

1 N/A = Not applicable.

Source: Appendix D. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

The number of populations that would achieve an adjusted productivity greater than 1.0 and an NOS greater than 500 was the same under the implementation scenarios for Alternative 2 through Alternative 4 when compared to Alternative 1 but was greater under the implementation scenario for Alternative 5 (Table 4-60). This suggests that diversity and spatial structure would be greatest under the implementation scenario for Alternative 5 compared to implementation scenarios for the other alternatives.

Table 4-60. Number and Percent of Primary and Contributing Populations Comprising the Snake River Basin Steelhead DPS that Would Have a $PROD_{ADJ}$ Greater than 1.0, 500 or More NOS, or Both.

Alternative	Number of Populations with $PROD_{ADJ}$ > 1.0	Number of Populations with NOS > 500	Number of Populations with Both NOS > 500 and $PROD_{ADJ}$ > 1.0	Percent of Populations with $PROD_{ADJ}$ > 1.0	Percent of Populations with NOS > 500	Percent of Populations with Both $PROD_{ADJ}$ > 1.0 and NOS > 500
1 (No Action)	17	11	11	77	50	50
2	21	11	11	95	50	50
3	21	11	11	95	50	50
4	21	11	11	95	50	50
5	20	12	12	91	55	55

Source: Appendix D. The abundance and productivity numbers in this table were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

The symbol “>” = “greater than.”

4.2.3.2.12 Southwest Washington Steelhead DPS

Genetic Risks for All Alternatives

Under the implementation scenario for Alternative 1, 67 percent of primary and contributing steelhead populations in the Southwest Washington Steelhead DPS would meet stronger metrics, and 33 percent would meet intermediate metrics (Table 4-61). The implementation scenarios for Alternative 2 and Alternative 4 would increase the percent of populations meeting the stronger metrics to 100 percent (Table 4-61). There would be no differences in the number of populations meeting stronger and intermediate metrics under the implementation scenarios for Alternative 3 and Alternative 5 when compared to Alternative 1 (Table 4-61), Specific PNI and pHOS values for each population in this DPS can be found in Appendix D.

TABLE 4-61. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE SOUTHWEST WASHINGTON STEELHEAD DPS THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	2	1	0	67	33	0
2	3	0	0	100	0	0
3	2	1	0	67	33	0
4	3	0	0	100	0	0
5	2	1	0	67	33	0

[1] Source: Appendix D. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

The symbol ">" = "greater than."

No weirs currently exist or would be installed to control the number of hatchery-origin fish returning to the spawning grounds in the Southwest Washington Steelhead DPS under implementation scenarios for any of the alternatives, so weir effects would not vary across the alternatives' implementation scenarios.

Competition and Predation Risks for All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish. Relative to Alternative 1, only the implementation scenario for Alternative 2 would result in a substantial (97 percent) reduction in the proportion of hatchery-origin to natural-origin spawners (HOS/NOS), suggesting that there would be a reduction in competitive risk (Figure 4-4). Under the implementation scenario for Alternative 3 through Alternative 5, the proportion of hatchery-origin to natural-origin spawners would be similar to or slightly lower than under Alternative 1.

Table 4-62 shows the ratio of hatchery-origin to natural-origin smolts by species for each alternative's implementation scenario. Ratios would be reduced to zero under the implementation scenario for Alternative 2 compared to Alternative 1, suggesting that competition and predation risks would be eliminated under the implementation scenario for Alternative 2. Ratios of hatchery-origin fish to natural-origin fish would generally be reduced under the implementation scenarios for Alternative 3 through Alternative 5 compared to Alternative 1 (Table 4-62), but the degree of reduction varies according the species of hatchery-origin fish. The ratio of hatchery-origin Chinook salmon to natural-origin steelhead would be high for all implementation scenarios but Alternative 2 (Table 4-62). These high ratios suggest that there would be high risk of competition for food or habitat as smolts migrate downstream. The size differences between hatchery-origin Chinook salmon and natural-origin steelhead would not be great enough for predation to occur (Section 3.2.3.1.6, Risks of Predation from Hatchery-origin Fish). The ratios between natural-origin steelhead and hatchery-origin coho salmon would decrease under implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1, although substantial reductions would only occur under implementation scenarios for Alternative 2, Alternative 3, and Alternative 5 (Table 4-62).

TABLE 4-62. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN STEELHEAD SMOLT PRODUCTION, BY ALTERNATIVE, IN THE SOUTHWEST WASHINGTON STEELHEAD DPS.

ALTERNATIVE	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN STEELHEAD
1 (No Action)	9.8	241.3	32.4	6.1
2	0.0	0.0	0.0	0.0
3	9.8	178.0	6.1	6.1
4	9.7	179.2	26.3	9.0
5	9.9	178.8	6.1	6.1

Source: Appendix D

Effects on VSP for All Alternatives

Mean adjusted productivity would increase under implementation scenarios for Alternative 2 and Alternative 4 when compared to Alternative 1 (Table 4-63). Mean adjusted productivity would be the same under implementation scenarios for implementation scenarios for Alternative 3 and Alternative 5 when compared to Alternative 1 (Table 4-63). Abundance would increase under the implementation scenarios for Alternative 2 compared to Alternative 1, but abundance under the implementation scenarios for Alternative 3 through Alternative 5 would be similar to Alternative 1 (Table 4-63).

TABLE 4-63. MEAN PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS PER POPULATION (PRIMARY AND CONTRIBUTION POPULATIONS ONLY) BY ALTERNATIVE IN THE SOUTHWEST WASHINGTON STEELHEAD DPS.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	4.5	1,886	N/A[1]	N/A
2	5.4	2,047	20	9
3	4.5	1,885	0	0
4	4.7	1,911	4	1
5	4.5	1,884	0	0

Source: Appendix D. Data were generated with the AHA model using best available data.

1 N/A = Not applicable.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

The number of populations that would achieve an adjusted productivity greater than 1.0 and an NOS greater than 500 was the same under implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1, suggesting that diversity and spatial structure would not vary among the alternatives' implementation scenarios (Table 4-64). Changing hatchery production would have relatively little effect on the viability of this DPS because natural-origin productivity is high.

TABLE 4-64. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE SOUTHWEST WASHINGTON STEELHEAD DPS THAT WOULD HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS > 500 AND $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ}$ > 1.0 AND NOS > 500
1 (No Action)	3	2	2	100	67	67
2	3	2	2	100	67	67
3	3	2	2	100	67	67
4	3	2	2	100	67	67
5	3	2	2	100	67	67

Source: Appendix D. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

The symbol ">" = "greater than."

4.2.3.2.13 Upper Columbia River Steelhead DPS

Genetic Risks for All Alternatives

Under the implementation scenario for Alternative 1, all four of the populations in this DPS would fail to meet stronger or intermediate performance metrics (Table 4-65). The implementation scenarios for Alternative 2 through Alternative 4 would result in one population meeting stronger metrics, and one population meeting intermediate metrics. The implementation scenario for Alternative 5 would result in two populations meeting stronger metrics, suggesting that genetic risks would be lowest under this alternative compared to the other alternatives. Two populations failed to meet stronger or intermediate performance metrics under any of the alternatives. These two populations were the Entiat and Okanogan populations. The Entiat River population is small and unable to reach intermediate performance metrics. The Okanogan River steelhead population is being reintroduced into the subbasin. Specific PNI and pHOS values for each population in this DPS across the alternatives' implementation scenarios can be found in Appendix D.

TABLE 4-65. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE UPPER COLUMBIA RIVER STEELHEAD DPS THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	0	0	4	0	0	100
2	1	1	2	25	25	50
3	1	1	2	25	25	50
4	1	1	2	25	25	50
5	2	0	2	50	0	50

[1] Source: Appendix D. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

No weirs currently exist or would be used under any of the alternatives' implementation scenarios to control the number of hatchery-origin steelhead spawning naturally in this DPS, so weir effects would not likely vary across the alternatives' implementation scenarios.

Competition and Predation Risks for All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish.

Table 4-66 shows the ratio of hatchery-origin to natural-origin smolts by species for each alternative's implementation scenario. Ratios of hatchery-origin fish to natural-origin fish generally decrease under the implementation scenario for Alternative 2 but increase under the implementation scenario for Alternative 3 through Alternative 5 (Table 4-66). This suggests that overall competition and predation risks may decrease under the implementation scenario for Alternative 2 but increase under the implementation scenarios for Alternative 3 through Alternative 5 compared to Alternative 1.

Table 4-66. Ratio of Hatchery-origin Smolt Production by Species to Natural-origin Steelhead Smolt Production, by Alternative, in the Upper Columbia River Steelhead DPS.

Alternative	Hatchery-origin Steelhead to Natural-origin Steelhead	Hatchery-origin Chinook Salmon to Natural-origin Steelhead	Hatchery-origin Coho Salmon to Natural-origin Steelhead	Hatchery-origin Chum Salmon to Natural-origin Steelhead
1 (No Action)	3.4	46.0	4.6	0.0
2	1.4	39.5	5.2	0.0
3	2.0	51.2	5.2	0.0
4	2.0	51.2	5.2	0.0
5	3.4	51.6	5.1	0.0

Source: Appendix D

Effects on VSP for All Alternatives

Mean adjusted productivity would increase under implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1, while abundance would decrease under implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1 (Table 4-67). The implementation scenario for Alternative 5 shows the greatest increases in mean adjusted productivity for this DPS as a result of reducing the hatchery program production by approximately 130,000 steelhead smolts and better integrating hatchery-origin broodstock in several programs. However, by incorporating more natural-origin fish into the broodstock, abundance was reduced under the implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1. While mean adjusted productivity would increase from 0.7 under Alternative 1 to 0.9 under Alternative 2 through Alternative 4, and 1.0 for Alternative 5, the mean adjusted productivity would remain low.

One population (Wenatchee River) in the Upper Columbia River Steelhead DPS would have an adjusted productivity greater than 1.0 and an NOS of greater than 500 under the implementation scenario for Alternative 1, and the number would not change under the implementation scenarios for Alternative 2 through Alternative 5 (Table 4-68). This suggests that there would be no change in spatial structure or diversity across the alternatives’ implementation scenarios.

TABLE 4-67. MEAN PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS PER POPULATION (PRIMARY AND CONTRIBUTION POPULATIONS ONLY) BY ALTERNATIVE IN THE UPPER COLUMBIA RIVER STEELHEAD DPS.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	0.7	1,390	N/A[1]	N/A
2	0.9	1,216	21	-12
3	0.9	1,216	21	-12
4	0.9	1,216	21	-12
5	1.0	1,297	33	-7

Source: Appendix D. Data were generated with the AHA model using best available data.

1 N/A = Not applicable.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

TABLE 4-68. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE UPPER COLUMBIA RIVER STEELHEAD DPS THAT HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS >500 AND $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ}$ > 1.0 AND NOS > 500
1 (No Action)	1	1	1	25	25	25
2	1	1	1	25	25	25
3	1	1	1	25	25	25
4	1	1	1	25	25	25
5	1	1	1	25	25	25

Source: Appendix D. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

The symbol “>” = “greater than.”

4.2.3.2.14 Upper Willamette River Steelhead DPS

Genetic Risks for All Alternatives

Under the implementation scenario for Alternative 1, 75 percent of the primary and contributing populations in the Upper Willamette Steelhead DPS would meet stronger metrics, and 25 would meet weaker than intermediate metrics (Table 4-69). Under the implementation scenarios for Alternative 2 through Alternative 5, none of the populations would meet weaker than intermediate metrics; under the implementation scenario for Alternative 4, all populations would meet stronger metrics. These results suggest that genetic risks would be reduced under implementation scenarios for all action alternatives relative to Alternative 1, but would be most reduced under the implementation scenario for Alternative 4. Specific PNI and pHOS values for each population in this DPS across the alternatives' implementation scenarios can be found in Appendix D.

TABLE 4-69. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE UPPER WILLAMETTE RIVER STEELHEAD DPS THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	3	0	1	75	0	25
2	3	1	0	75	25	0
3	3	1	0	75	25	0
4	4	0	0	100	0	0
5	3	1	0	75	25	0

[1] Source: Appendix D. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

No weirs currently exist or would be used under any of the alternatives' implementation scenarios to control the number of hatchery-origin steelhead spawning naturally in this DPS, so weir effects would not likely vary across the alternatives' implementation scenarios.

Competition and Predation Risks for All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish.

Table 4-70 shows the ratio of hatchery-origin to natural-origin fish by species and the alternatives' implementation scenarios. Ratios are reduced under the implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1 (Table 4-70), suggesting that competition and predation risks would be reduced under the implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1.

TABLE 4-70. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN STEELHEAD SMOLT PRODUCTION, BY ALTERNATIVE, IN THE UPPER WILLAMETTE RIVER STEELHEAD DPS.

ALTERNATIVE	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN STEELHEAD	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN STEELHEAD
1 (No Action)	6.1	31.4	2.0	0.0
2	4.6	23.9	0.0	0.0
3	5.6	30.2	1.9	0.0
4	5.0	27.4	1.8	0.0
5	5.6	30.2	1.9	0.0

Source: Appendix D

All hatchery-origin steelhead released in this DPS would be summer-run steelhead. All natural-origin steelhead would be native winter-run steelhead.

Effects on VSP for All Alternatives

Mean adjusted productivity and abundance would increase under the implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1 (Table 4-71). There would be no difference in the number of populations with an NOS greater than 500 and a mean adjusted productivity greater than 1.0 across the alternatives implementation scenarios (Table 4-72), suggesting that spatial structure and diversity would not vary across alternatives. All four primary and contributing populations would have an adjusted productivity greater than 1 and more than 500 natural-origin spawners (Table 4-72).

TABLE 4-71. MEAN PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS PER POPULATION (PRIMARY AND CONTRIBUTION POPULATIONS ONLY) BY ALTERNATIVE IN THE UPPER WILLAMETTE RIVER STEELHEAD DPS.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	4.4	7,336	N/A[1]	N/A
2	4.6	7,602	4	4
3	4.5	7,491	3	2
4	5.0	8,299	14	13
5	4.5	7,491	3	2

1 N/A = Not applicable.

Source: Appendix D. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

TABLE 4-72. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE UPPER WILLAMETTE RIVER STEELHEAD DPS THAT WOULD HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS > 500 AND $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ}$ > 1.0 AND NOS > 500
1 (No Action)	4	4	4	100	100	100
2	4	4	4	100	100	100
3	4	4	4	100	100	100
4	4	4	4	100	100	100
5	4	4	4	100	100	100

Source: Appendix D. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

The symbol “>” = “greater than.”

4.2.3.2.15 Lower Columbia River Coho Salmon ESU

Genetic Effects for All Alternatives

Under the implementation scenario for Alternative 1, 18 percent of the populations would meet stronger metrics, 18 percent would meet intermediate metrics, and 65 percent would fail to meet intermediate performance metrics (Table 4-73). The percent of populations meeting stronger and intermediate metrics would increase under the implementation scenarios for Alternative 2 through Alternative 5, with all populations meeting stronger or intermediate metrics under Alternative 2 (Table 4-73). These results suggest that genetic risks would be reduced under the implementation scenarios for Alternative 2 through Alternative 5 relative to Alternative 1, with the fewest genetic risks occurring under the implementation scenario for Alternative 2.

TABLE 4-73. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE LOWER COLUMBIA RIVER COHO SALMON ESU THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	3	3	11	18	18	65
2	13	4	0	76	24	0
3	9	6	2	53	35	12
4	11	4	2	65	24	12
5	9	6	2	53	35	12

[1] Source: Appendix D. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

No new weirs would be used under the implementation scenario for Alternative 2 compared to Alternative 1 (Table 4-74). However, two weirs would continue to be used to control the number of hatchery-origin spawners in the Willamette and Cowlitz River coho salmon populations (Table 4-74). Under the implementation scenarios for Alternative 3 and Alternative 5, three new weirs would be installed compared to Alternative 1 (Table 4-74), Under the implementation scenario for Alternative 4, four new weirs would be installed compared to Alternative 1 (Table 4-74). As a result, the following weir effects would be greater under the implementation scenarios for Alternative 3 through Alternative 5, with the greatest weir effects occurring under the implementation scenario for Alternative 4: isolation of formerly connected populations, limiting or slowing movement of non-target fish species, alteration of stream flow, alteration of streambed and riparian habitat, alteration of the distribution of spawning within a population, increased mortality or stress due to capture and handling, impingement of downstream migrating fish, forced downstream spawning by fish that do not pass through the weir, and increased straying due to either trapping adults that were not intending to spawn above the weir, or displacing adults into other tributaries (Section 3.2.3.1.1, Genetic Risks).

TABLE 4-74. LOCATION AND EFFECTIVENESS OF WEIRS REQUIRED TO ACHIEVE PHOS AND PNI OBJECTIVES FOR THE LOWER COLUMBIA RIVER COHO SALMON ESU (PRIMARY AND CONTRIBUTING POPULATIONS ONLY).

		ALTERNATIVE (PERCENT [%] EFFECTIVENESS)				
LOCATION	POPULATION	1 (NO ACTION)[1]	2	3	4	5
Columbia Estuary	Scappoose Coho Salmon	0	0	50	90	50
Elochoman	Elochoman Coho Salmon (Late-Type N)	0	0	60	90	60
Grays	Grays Coho Salmon (Late-Type N)	0	0	60	90	60
Willamette	Upper Clackamas Coho Salmon	95	95	95	95	95
Kalama	Kalama Coho Salmon (Natural)	0	0	0	90	0
Cowlitz	Upper Cowlitz Coho Salmon	95	95	95	95	95

[1] If effectiveness value is greater than 0 percent in Alternative 1, a weir currently exists, and new weirs would not have to be constructed for the other alternatives. All other populations in the table would require a new weir.

Competition and Predation Risks for All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish.

Table 4-75 shows the ratio of hatchery-origin to natural-origin fish by species and the alternatives' implementation scenarios. Ratios are generally reduced under the implementation scenarios for Alternative 2 through Alternative 5 (Table 4-75), suggesting that competition and predation risks would be reduced under the implementation scenario for Alternative 2 through Alternative 5 compared to Alternative 1. However, there is one exception: the ratio of hatchery-origin chum salmon to natural-origin coho salmon would increase under the implementation scenario for Alternative 3 through Alternative 5 when compared to Alternative 1 (Table 4-75). Hatchery-origin chum salmon would be released as fry, and there may be competition for food and habitat between hatchery-origin chum salmon and natural-origin juvenile coho salmon. However, the competition risks are expected to be minor because of different habitat use between the two species and because interactions would be for a very brief period. Hatchery-origin chum salmon juveniles would be too small to prey on natural-origin coho salmon juveniles, so there would be no difference in the predation risk of hatchery-origin chum salmon on natural-origin coho salmon across the alternatives' implementation scenarios.

TABLE 4-75. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN STEELHEAD SMOLT PRODUCTION, BY ALTERNATIVE, IN THE LOWER COLUMBIA RIVER COHO SALMON ESU.

ALTERNATIVE	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN COHO SALMON	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN COHO SALMON	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN COHO SALMON	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN COHO SALMON
1 (No Action)	25.1	5.7	81.5	0.4
2	2.4	3.2	11.5	0.1
3	12.5	5.3	62.2	0.5
4	15.8	5.2	67.5	1.8
5	12.5	5.4	62.7	0.5

Source: Appendix D

Effects on VSP for All Alternatives

Mean adjusted productivity would increase under the implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1 (Table 4-76). Abundance would increase under the implementation scenarios for Alternative 2 and Alternative 4 but would decrease under the implementation scenarios for Alternative 3 and Alternative 5 compared to Alternative 1 (Table 4-76).

TABLE 4-76. MEAN PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS PER POPULATION (PRIMARY AND CONTRIBUTING POPULATIONS ONLY) BY ALTERNATIVE IN THE LOWER COLUMBIA RIVER COHO SALMON ESU.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	1.9	21,854	N/A[1]	N/A
2	2.8	26,582	51	22
3	2.3	20,770	24	-5
4	2.5	23,237	35	6
5	2.3	20,770	24	-5

[1] N/A = Not applicable.

Source: Appendix D. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

The percent of populations with productivity greater than 1.0 and NOS greater than 500 increases under the implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1 (Table 4-77), suggesting that spatial structure and diversity would increase under the implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1.

TABLE 4-77. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE LOWER COLUMBIA RIVER COHO SALMON ESU THAT WOULD HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS > 500 AND $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ}$ > 1.0 AND NOS > 500
1 (No Action)	12	11	9	71	65	53
2	17	11	11	100	65	65
3	15	11	11	88	65	65
4	15	11	11	88	65	65
5	15	11	11	88	65	65

Source: Appendix D. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

The symbol ">" = "greater than."

4.2.3.2.16 Columbia River Chum Salmon ESU

Genetic Risks for All Alternatives

Under the implementation scenario for Alternative 1, 60 percent of the populations would meet stronger metrics, 13 percent would meet intermediate metrics, and 27 percent would fail to meet intermediate performance metrics (Table 4-78). The percent of populations meeting stronger and intermediate metrics would increase under the implementation scenarios for Alternative 2, Alternative 3, and Alternative 5 (Table 4-78), suggesting that genetic risks would be reduced under the implementation scenarios for these alternatives compared to Alternative 1. The percent of populations meeting stronger metrics would be lower under the implementation scenario for Alternative 4 compared to Alternative 1 although the number of populations meeting intermediate metrics increases and the number of populations that meet weaker than intermediate metrics decreases compared to Alternative 1 (Table 4-78). As a result, it is difficult to predict how genetic risk would change under the implementation scenario for Alternative 4 compared to Alternative 1. PNI and pHOS values for each Columbia River chum salmon population can be found in Appendix E.

No weirs currently exist or would be used under any of the alternatives' implementation scenarios to control the number of hatchery-origin steelhead spawning naturally in this ESU, so weir effects would not likely vary across the alternatives' implementation scenarios.

TABLE 4-78. PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE COLUMBIA RIVER CHUM SALMON ESU THAT WOULD MEET STRONGER METRICS, INTERMEDIATE METRICS, OR WEAKER THAN INTERMEDIATE METRICS BY ALTERNATIVE.

ALTERNATIVE	NUMBER OF POPULATIONS THAT MEET STRONGER METRICS[1]	NUMBER OF POPULATIONS THAT MEET INTERMEDIATE METRICS	NUMBER OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET STRONGER METRICS	PERCENT OF POPULATIONS THAT MEET INTERMEDIATE METRICS	PERCENT OF POPULATIONS THAT MEET WEAKER THAN INTERMEDIATE METRICS
1 (No Action)	9	2	4	60	13	27
2	13	1	1	87	7	7
3	9	2	4	60	13	27
4	8	4	3	53	27	20
5	9	2	4	60	13	27

[1] Source: Appendix E. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife and Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

Competition and Predation Risks for All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish.

Table 4-79 shows the ratio of hatchery-origin to natural-origin fish by species and the alternatives' implementation scenarios. Ratios are generally reduced under the implementation scenarios for Alternative 2 through Alternative 5 (Table 4-79), suggesting that competition and predation risks would be reduced under the implementation scenario for Alternative 2 through Alternative 5 compared to Alternative 1.

TABLE 4-79. RATIO OF HATCHERY-ORIGIN SMOLT PRODUCTION BY SPECIES TO NATURAL-ORIGIN CHUM SALMON JUVENILE PRODUCTION, BY ALTERNATIVE, IN THE COLUMBIA RIVER CHUM SALMON ESU.

ALTERNATIVE	HATCHERY-ORIGIN CHUM SALMON TO NATURAL-ORIGIN CHUM SALMON	HATCHERY-ORIGIN STEELHEAD TO NATURAL-ORIGIN CHUM SALMON	HATCHERY-ORIGIN CHINOOK SALMON TO NATURAL-ORIGIN CHUM SALMON	HATCHERY-ORIGIN COHO SALMON TO NATURAL-ORIGIN CHUM SALMON
1 (No Action)	2.7	0.7	9.5	0.1
2	1.4	0.5	1.7	0.0
3	1.4	0.6	6.5	0.1
4	1.5	0.5	6.2	0.2
5	1.4	0.6	6.5	0.1

Source: Appendix E

Effects on VSP for All Alternatives

Mean adjusted productivity would increase slightly under the implementation scenario for Alternative 2, compared to Alternative 1 (Table 4-80). There would be no change in the mean adjusted productivity under the implementation scenarios for Alternative 3 through Alternative 5 compared to Alternative 1 (Table 4-80). Abundance would be similar under the implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1 (Table 4-80).

TABLE 4-80. MEAN PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS PER POPULATION (PRIMARY AND CONTRIBUTING POPULATIONS ONLY) BY ALTERNATIVE IN THE COLUMBIA RIVER CHUM SALMON ESU.

ALTERNATIVE	MEAN $PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN MEAN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	1.8	20,027	N/A[1]	N/A
2	1.9	19,923	7	-2
3	1.8	20,008	1	0
4	1.8	23,136	0	17
5	1.8	20,008	1	0

Source: Appendix E. Data were generated with the AHA model using best available data.

[1] N/A = Not applicable.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

The percent of populations that would have a productivity greater than 1.0 and NOS greater than 500 would be the same under the implementation scenarios for Alternative 2, Alternative 3, and Alternative 5 compared to Alternative 1 (Table 4-81), The percent of populations that would have a productivity greater than 1.0 and NOS greater than 500 would increase under the implementation scenario for Alternative 4 compared to Alternative 1 (Table 4-81), suggesting that diversity and spatial structure would be greatest under the implementation scenario for Alternative 4 compared to the other alternatives.

TABLE 4-81. NUMBER AND PERCENT OF PRIMARY AND CONTRIBUTING POPULATIONS COMPRISING THE COLUMBIA RIVER CHUM SALMON ESU THAT WOULD HAVE A $PROD_{ADJ}$ GREATER THAN 1.0, 500 OR MORE NOS, OR BOTH.

ALTERNATIVE	NUMBER OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	NUMBER OF POPULATIONS WITH NOS > 500	NUMBER OF POPULATIONS WITH BOTH NOS > 500 AND $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH $PROD_{ADJ}$ > 1.0	PERCENT OF POPULATIONS WITH NOS > 500	PERCENT OF POPULATIONS WITH BOTH $PROD_{ADJ}$ > 1.0 AND NOS > 500
1 (No Action)	13	7	7	87	47	47
2	15	7	7	100	47	47
3	13	7	7	87	47	47
4	13	10	10	87	67	67
5	13	7	7	87	47	47

Source: Appendix E. Data were generated with the AHA model using best available data.

Primary, contributing, and stabilizing populations are terms that were used by the LCFRB in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and are applied in this draft EIS.

The symbol ">" = "greater than."

4.2.3.2.17 Snake River Sockeye Salmon ESU

Genetic Risks for All Alternatives

The Snake River Sockeye Salmon ESU consists of one population (Section 3.2.3.2.17, Snake River Sockeye Salmon ESU). This population would fail to meet intermediate metrics under the implementation scenarios for all alternatives except for Alternative 2 (Appendix F). Under Alternative 2, the Redfish Lake sockeye salmon hatchery program would be eliminated because it receives Mitchell Act funding. Without the Redfish Lake hatchery program, the Snake River sockeye salmon population would meet PNI and pHOS metrics, but the ESU would likely go extinct since the number of spawners would be critically low (Appendix F). As a result, genetic risks would be greatest under Alternative 2 compared to the other alternatives.

No weirs currently exist or would be used under any of the alternatives' implementation scenarios to control the number of hatchery-origin steelhead spawning naturally in this ESU, so weir effects would not vary across the alternatives' implementation scenarios.

Competition and Predation Risks for All Alternatives

As described in Section 4.2.2.2, Methods for Determining Competition and Predation Effects on Salmon and Steelhead, a comparison of the ratio of hatchery-origin juveniles released within an ESU's/DPS' geographic boundaries to the number of estimated natural-origin juveniles in the ESU/DPS may indicate relative competition for food or habitat or relative predation caused by hatchery-origin fish. Modeling was not applied to the Snake River Sockeye Salmon ESU since there are too few fish to produce meaningful results. However, because production levels would be reduced under the implementation scenarios for Alternative 2 through Alternative 5 relative to Alterative 1, competition and predation risks on the Snake River Sockeye Salmon ESU would likely be reduced under the implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1, with the lowest risks for competition and predation risks with hatchery-origin fish under the implementation scenario for Alternative 2.

Effects on VSP for All Alternatives

There would be minimal differences in the abundance and productivity of natural-origin spawners among implementation scenarios for the alternatives (Table 4-82). Although abundance of natural-origin spawners would increase under the implementation scenarios for Alternative 3 through Alternative 5 compared to Alternative 1, the population abundance would remain at critically low levels. Although not shown here, the number of hatchery-origin adults in the population is a better measure of success for the gene banking hatchery program, which would increase from approximately 200 under Alternative 1 to over 1,300 adults under the implementation scenarios for Alternative 3 through Alternative 5 (Appendix F). The increase in hatchery-origin adults would be due to increased releases of hatchery-origin fish under the implementation scenarios for Alternative 3 through Alternative 5 when compared to Alternative 1.

TABLE 4-82. PERCENT CHANGE IN $PROD_{ADJ}$ AND IN ABUNDANCE OF NOS BY ALTERNATIVE IN THE SNAKE RIVER SOCKEYE SALMON ESU.

ALTERNATIVE	$PROD_{ADJ}$	TOTAL NOS ABUNDANCE	CHANGE IN $PROD_{ADJ}$ FROM ALTERNATIVE 1 (%)	CHANGE IN TOTAL NOS ABUNDANCE FROM ALTERNATIVE 1 (%)
1 (No Action)	0.07	13	N/A[1]	N/A
2	0.14	0	99	-100
3	0.07	27	0	104
4	0.07	27	0	104
5	0.07	27	0	104

Source: Appendix F. Data were generated with the AHA model using best available data.
[1] N/A = Not applicable.

4.2.4 Effects on Other Fish Species that have a Relationship to Salmon and Steelhead

Described below are other fish species that have a relationship with salmon and steelhead as discussed in Section 3.2.4, Other Fish Species that Have a Relationship with Salmon and/or Steelhead. For this section, species are combined for the analysis when they have a similar relationship with salmon and steelhead, and the effects from the alternatives would likely be the same.

4.2.4.1 Oregon Chub, Lake Chub, and Pygmy Whitefish Effects under All Alternatives

Oregon chub, lake chub, and pygmy whitefish can be prey species of salmon and steelhead (Section 3.2.4.1.4, Oregon Chub, Interaction with Salmon and Steelhead; Section 3.2.4.6.4, Lake Chub, Interaction with Salmon and Steelhead; Section 3.2.4.12.4, Pygmy Whitefish, Interaction with Salmon and Steelhead). This is the primary reason for analyzing interactions of Oregon chub, lake chub, pygmy whitefish with salmon and steelhead under each of the alternatives. As hatchery production and the number of natural-origin salmon and steelhead change under the alternatives, the extent of predation on Oregon chub, lake chub, and pygmy whitefish by salmon and steelhead would also change.

Implementation measures designed to improve hatcheries may also benefit Oregon chub and pygmy whitefish by minimizing entrainment of juvenile fish at hatchery water intake screens and by improving water quality conditions in streams where hatcheries are located and these fish may reside. Critical habitat for Oregon chub is located in Polk, Benton, Linn, Marion, and Lane Counties (Section 3.2.4.1.2, Oregon Chub, Current Status and Trends). Some hatcheries are also located in these counties; thus, these implementation measures would help improve critical habitat conditions for Oregon chub. Lake chub do not occur near hatchery facilities.

Under the implementation scenario for Alternative 1, there would be no change in hatchery-origin and natural-origin salmon and steelhead adult recruits compared to baseline conditions (Table 4-83). Thus, predation on Oregon chub, lake chub, and pygmy whitefish by salmon and steelhead would not likely change compared to baseline conditions, and hatchery improvements regarding updating hatchery water intake screens and correcting water quality conditions would not occur.

TABLE 4-83. PERCENT DECREASE IN SALMON AND STEELHEAD ABUNDANCE RELATIVE TO ALTERNATIVE 1 BY ACTION ALTERNATIVE.

AGE CLASS	ALTERNATIVE (PERCENT [%] DECREASE RELATIVE TO ALTERNATIVE 1)			
	2	3	4	5
Total Hatchery-origin and Natural-origin Smolts (All Species/ESUs)	52	19	12	17
Total Hatchery-origin and Natural-origin Adult Recruits (All Species/ESUs)	43	18	10	16

The implementation scenarios for all action alternatives would likely result in less predation on Oregon chub, lake chub, and pygmy white fish due to reductions in salmon and steelhead adult recruits when compared to Alternative 1. Under the implementation scenario for Alternative 2, the 43 percent decrease in hatchery-origin and natural-origin salmon and steelhead adult recruits (Table 4-83) may result in a benefit to Oregon chub, lake chub, and pygmy whitefish in reducing predation on these species. Updating hatchery water intake screens and correcting water quality issues would also benefit Oregon chub and pygmy whitefish.

The implementation scenarios for Alternative 3 through Alternative 5 would also decrease salmon and steelhead adult recruits by 18, 10, and 16 percent, respectively (Table 4-83), which would also likely result in less predation on Oregon chub, lake chub, and pygmy whitefish by salmon and steelhead, but not as substantial a decrease as under the implementation scenario for Alternative 2 compared to Alternative 1. The benefits of updating hatchery water intake screens and correcting water quality issues would also occur under the implementation scenarios for Alternative 3 through Alternative 5 when compared to Alternative 1.

Although reduced predation on Oregon chub, lake chub, and pygmy whitefish by salmon and steelhead would likely occur under implementation scenarios for all alternatives compared to Alternative 1, predation on Oregon chub, lake chub, and pygmy whitefish by natural-origin salmon and steelhead has not been identified as a reason for Oregon chub, lake chub, and pygmy whitefish declines (Section 3.2.4.1.3, Oregon Chub, Limiting Factors and Threats; Section 3.2.4.6.3, Lake Chub, Limiting Factors and Threats; Section 3.2.4.12.3, Pygmy Whitefish, Limiting Factors and Threats). Similarly, entrainment of Oregon chub, lake chub, and pygmy white fish at hatchery water intake screens and water quality conditions at operating hatcheries have not been identified as threats to these species. Consequently, none of the alternatives, including Alternative 1, would likely change the Oregon chubs' status as endangered (58 Fed. Reg. 53800, October 18, 1993).

Reasons for Oregon chub declines are habitat alteration and lack of available habitat from flood controls and dams; water quality degradation from runoff containing herbicides and pesticides, use of rotenone to manage recreational fisheries, and accidental chemical spills; unauthorized water withdrawals; sedimentation; and introduction of non-native fish and amphibians (Section 3.2.4.1.3, Oregon Chub, Limiting Factors and Threats). Such threats would not be mitigated by any of the alternatives, including Alternative 1, because hatchery production and activities would have no relationship to these threat sources. However, although none of the alternatives would have any effect on the threats to Oregon chub described here, as stated in 74 Fed. Reg. 22870 (May 15, 2009), the status of the Oregon chub has greatly improved since it was listed in 1993 due to implementation of its recovery plan and reestablishing and protecting Oregon chub populations (U.S. Fish and Wildlife Service [USFWS] 1998a). Action alternatives that improve predator-prey relationships among salmon and steelhead and Oregon chub enhance habitat conditions in areas designated as Oregon chub critical habitat and minimize entrainment at hatchery water intake screens.

Reasons for lake chub declines are habitat alteration, declining water quality and quantity, and the introduction of non-native species (Section 3.2.4.6.3, Lake Chub, Limiting Factors and Threats). Such threats would not be mitigated by any of the alternatives, including Alternative 1, because hatchery production and hatchery improvement activities would have no relationship to these threat sources. It is likely that these threats would continue to negatively affect lake chub populations regardless of implementation of any alternative. Predation of lake chub by salmon and steelhead has not been cited as a threat to this species.

Reasons for pygmy whitefish declines include changing water temperature and oxygen conditions, water quality degradation, siltation, non-native fish introductions, use of pesticides, and increased development activities, including over-water and in-water structures (Section 3.2.4.12.3, Pygmy Whitefish, Limiting Factors and Threats). Such threats would not be mitigated by any of the alternatives, including Alternative 1, because hatchery production and activities would have no relationship to these threat sources. It is likely that these threats would continue to affect pygmy whitefish populations negatively regardless of implementation of any alternative. Predation of pygmy whitefish by salmon and steelhead has not been cited as a threat to this species.

4.2.4.2 Bull Trout Effects for All Alternatives

The primary interaction between bull trout and salmon and steelhead is that bull trout, as subadults and adults, prey on salmon and steelhead. In addition, juvenile bull trout can compete with salmon and steelhead for food resources and potentially for space/habitat, since bull trout use similar aquatic habitats as salmon and steelhead (Section 3.2.4.2.4, Bull Trout, Interaction with Salmon and Steelhead). Although bull trout can interbreed with brook trout, the species does not hybridize with other salmon and steelhead species. Thus, predation and interspecific competition (for prey and habitat) are the primary effects for analysis of interactions between bull trout and salmon and steelhead. As hatchery production and the number of natural-origin salmon and steelhead change under the alternatives, the extent of predation and competition would also change.

Implementation measures designed to improve hatcheries may also affect bull trout by improving water quality conditions in streams where hatcheries are located and where bull trout may pass during migration or spawn closeby. However, new temporary or permanent weirs planned under some of the action alternatives have the potential of isolating bull trout populations, limiting or delaying movement of migrating bull trout, impacting stream flow, altering streambed and riparian habitats, altering spawning locations, increasing fish mortality and stress by handling, forcing downstream spawning where fish cannot pass a weir, and increasing predation of bull trout when caught within a weir. To minimize these effects, hatchery operators conduct continuous weir monitoring during fish migrations, develop practices to minimize handling of fish, and remove weirs when not needed to trap hatchery-origin fish so that unintentional trapping of other fish is avoided.

Under the implementation scenario for Alternative 1, there would be no change in hatchery-origin and natural-origin salmon and steelhead smolt production and adult recruits produced compared to baseline conditions (Table 4-83). Thus, bull trout predation on salmon and steelhead and competition for prey and habitat would not likely change compared to baseline conditions. In addition, water quality conditions at hatcheries would not improve, and bull trout would not be affected by the placement of new weirs.

The implementation scenarios for all action alternatives would likely result in a reduction in prey resources of bull trout and competition for prey resources and aquatic habitat. Under Alternative 2, the 52 percent decrease in hatchery-origin and natural-origin salmon and steelhead smolt production (Table 4-83) would negatively impact an important prey resource of bull trout. However, other food sources would remain available (e.g., insects [primarily to juveniles], other fish species, frogs, snake, mice, and waterfowl), since hatchery production and activities would not affect these resources. Competition for available prey and habitat would be substantially reduced under Alternative 2 compared to Alternative 1 since fewer juvenile salmon and steelhead would compete with juvenile bull trout for prey, and fewer salmon and steelhead smolts and adult recruits (43 percent, Table 4-83) would compete with bull trout for prime habitat space. Correcting water quality issues at hatcheries would also benefit bull trout under the implementation scenario for Alternative 2 compared to Alternative 1.

The implementation scenarios for Alternative 3 through Alternative 5 would also decrease salmon and steelhead smolt production by 19, 12, and 17 percent, respectively, compared to Alternative 1 (Table 4-83) resulting in a salmon and steelhead adult recruit decrease of 18, 10, and 16 percent, respectively. These reductions would represent similar effects on bull trout as described under the implementation scenario for Alternative 2. However, such reductions in expected risks (i.e., decreased prey base) or increases in benefits (i.e., decreases in competition for habitat and food resources) would not be as substantial under the implementation scenarios for these action alternatives as under Alternative 2. The benefits of improving water quality conditions at hatcheries would also occur under the implementation scenarios for Alternative 3 through Alternative 5 when compared to Alternative 1. In contrast, new temporary weirs (Alternative 3 through Alternative 5) and permanent weirs (Alternative 4 and Alternative 5) have the potential of adversely impacting bull trout through habitat alteration and fragmentation, fish handling, and slowing bull trout migratory movements when compared to Alternative 1.

Bull trout are listed as threatened. Recently, additional critical habitat protecting bull trout was proposed, which includes areas within the Columbia River basin (Section 3.2.4.2.2, Bull Trout, Current Status and Trends). All the action alternatives would result in adverse effects onon bull trout through reduced prey resources for subadults and adults and the potential creation of migratory barriers from new weirs; the action alternatives could also benefit bull trout through reduced competition for habitat and juvenile prey resources and improved habitat conditions.

The decrease in juvenile salmon and steelhead populations that serve as prey for bull trout has been cited as a limiting factor that affects the distribution and abundance of bull trout, while competition for prey and habitat with salmon and steelhead has not been cited as a threat to bull trout (Section 3.2.4.2.3, Bull Trout, Limiting Factors and Threats). In addition, instream water uses that block or restrict access to critical habitat (such as weirs) have also been cited as a threat to bull trout. Habitat degradation, introduction of non-native fish species, and restricted access to bull trout critical habitat from other sources (such as culverts, irrigation diversions, and streambed alterations) would continue under all alternatives because these limiting factors and threats to bull trout would not be affected by hatchery production levels. In addition to these ongoing limiting factors, all of the action alternatives would result in a decrease of the potential prey resource for bull trout, and Alternative 3 through Alternative 5 would result in potential adverse effects from new weirs when compared to Alternative 1. Combined, these adverse effects could continue to limit improvements in the 22 bull trout recovery units in the short term; however, improvements in habitat conditions are anticipated in the long term as a result of recovery efforts.

4.2.4.3 Eulachon Effects for All Alternatives

Newly hatched and juvenile eulachon are prey of salmon and steelhead (Section 3.2.4.3.4, Eulachon, Interaction with Salmon and Steelhead), and this is the primary reason for analyzing interactions between eulachon and salmon and steelhead under the implementation scenarios for each of the alternatives. As hatchery production and the number of natural-origin salmon and steelhead change under the alternatives, the extent of predation on eulachon from these species would also change.

Implementation measures designed to improve hatcheries may also benefit eulachon by minimizing entrainment of juvenile fish at hatchery water intake screens and correcting water quality conditions in streams where hatcheries occur and eulachon pass through during migration or may spawn nearby. Under the implementation scenario for Alternative 1, there would be no change in the number of hatchery-origin and natural-origin salmon and steelhead adult recruits compared to baseline conditions (Table 4-83). Thus, salmon and steelhead predation on eulachon would not likely change compared to baseline conditions, and hatchery improvements regarding updating hatchery water intake screens and improving water quality conditions would not occur.

The implementation scenarios for all action alternatives would likely result in a decrease in eulachon predation from reductions in salmon and steelhead adult recruits. The implementation scenarios would also serve to improve water quality conditions near hatcheries, as well as decreasing the potential for juvenile entrainment at hatchery water intake screens when compared to Alternative 1. However, these reductions in predation and the subsequent benefit to eulachon populations may be minimized by predation from other species (e.g., a wide variety of fish, marine mammals, ducks, and seabirds) that would continue under the implementation scenario for any alternative (Section 3.2.4.3.1, Eulachon, Background). Under the implementation scenario for Alternative 2, the 43 percent decrease in hatchery-origin and natural-origin salmon and steelhead adult recruits (Table 4-83) may benefit eulachon through decreased predation on the species by substantially reducing predation pressure on the population from salmon and steelhead compared to Alternative 1. Updating hatchery water intake screens and correcting water quality issues would also benefit eulachon under the implementation scenario for Alternative 2 when compared to Alternative 1.

The implementation scenarios for Alternative 3 through Alternative 5 would also decrease salmon and steelhead adult recruits by 18, 10, and 16 percent, respectively (Table 4-83), which would also likely result in less predation on eulachon, but not as much of a decrease as under the implementation scenario for Alternative 2 when compared to Alternative 1. The benefits of updating water intake screens and correcting water quality issues would also occur under the implementation scenarios for Alternative 3 through Alternative 5 when compared to Alternative 1.

Although reduced predation upon eulachon would likely occur under implementation scenarios for all alternatives compared to Alternative 1, predation of eulachon by salmon and steelhead has not been cited as a reason for eulachon declines (Section 3.2.4.3.3, Eulachon, Limiting Factors and Threats). Similarly, entrainment of eulachon at hatchery water intake screens and water quality conditions at operating hatcheries have not been identified as threats to this species. Consequently, none of the alternatives, including Alternative 1, would likely change the eulachon southern DPS status as threatened (75 Fed. Reg. 13012, March 18, 2010).

The reason for recent declines in eulachon stocks within the southern DPS includes loss and modification of its habitat (particularly climate change leading to warmer water and less productive ocean regimes), commercial harvest of eulachon, bycatch of eulachon in commercial fisheries, and the potential for natural or manmade events to impact its habitat (75 Fed. Reg. 13012, March 18, 2010). Reduced salmon and steelhead adult recruits as a result of all action alternatives may help with this DPS recovery because of reduced predation on eulachon, however, other species are known to prey on eulachon. Furthermore, other threats would likely remain on the population, such as changing ocean conditions, bycatch, and habitat degradation (Section 3.2.4.3.3, Eulachon, Limiting Factors and Threats). Such threats would not be mitigated by any of the alternatives, including Alternative 1, because hatchery production and activities would have no relationship to these threat sources, except the potential for decreased salmon and steelhead harvest resulting in less eulachon bycatch.

It is likely that habitat conditions resulting from climate change in conjunction with other, ongoing threats described above would continue to affect eulachon populations negatively and would be contrary to recovery efforts. Continued declines in eulachon populations would also negatively affect recreation and commercial fishing for this species, including tribal eulachon fisheries (Section 3.2.4.3.1, Eulachon, Background).

4.2.4.4 Green Sturgeon Effects for All Alternatives

The primary interaction between green sturgeon and salmon and steelhead is green sturgeon bycatch in salmon and steelhead fisheries (Section 3.2.4.4.4, Green Sturgeon, Interaction with Salmon and Steelhead). This is the primary reason for analyzing interactions between green sturgeon and salmon and steelhead under each of the alternatives. As hatchery production and the number of salmon and steelhead adult recruits decrease under the action alternatives, harvest would likely decrease, as well as bycatch of green sturgeon.

Under the implementation scenario for Alternative 1, there would be no change in the number of hatchery-origin and natural-origin salmon and steelhead adult recruits compared to baseline conditions (Table 4-83). Therefore, bycatch of green sturgeon would not likely change compared to baseline conditions.

The implementation scenarios for all action alternatives would likely result in a reduction in green sturgeon bycatch due to reductions in salmon and steelhead adult recruits when compared to Alternative 1. The implementation scenario under Alternative 2 would likely result in the greatest benefit to green sturgeon because a 43 percent decrease in hatchery-origin and natural-origin salmon and steelhead adult recruits (Table 4-83) would likely result in a decrease in salmon and steelhead harvest and, therefore, a decrease in bycatch of green sturgeon assuming that a harvest would decrease concurrent with the reduced hatchery production. Otherwise, if harvest does not decrease, bycatch may be the same or increase if fishing pressure increases with decreased salmon and steelhead availability.

The implementation scenarios under Alternative 3 through Alternative 5 would also decrease salmon and steelhead adult recruits by 18, 10, and 16 percent, respectively, compared to Alternative 1 (Table 4-83).

Corresponding reductions in salmon and steelhead harvest would likely result in bycatch reductions of green sturgeon (assuming fishing pressure also decreases), but not as much of a bycatch decrease as the implementation scenario under Alternative 2. However, as cited by NMFS (71 Fed. Reg. 17757, April 7, 2006), the principal factor in the decline of the green sturgeon southern DPS is their limited spawning area in the Sacramento River. Consequently, none of the adult recruit decreases and subsequent expected bycatch decreases under the alternatives would likely help to recover the green sturgeon southern DPS. Additionally, existing production levels under the implementation scenario for Alternative 1 in the Columbia River basin would not likely lead to recovery of the green sturgeon southern DPS because of the spawning habitat limitations in the Sacramento River.

In addition to spawning habitat limitations and bycatch, green sturgeon populations are threatened by other sources, including insufficient freshwater flow rates in spawning areas, contaminants (e.g., pesticides), potential poaching (e.g., for caviar), entrainment by water projects, influence of exotic species, small population size, impassable barriers, and elevated water temperatures (Section 3.2.4.4.3, Green Sturgeon, Limiting Factors and Threats). All of these threats would likely continue under any of the implementation scenarios for the alternatives, including Alternative 1, because hatchery production and activities would have no relationship to, or effect on, these threat sources.

4.2.4.5 Coastal Cutthroat Trout Effects for All Alternatives

Coastal cutthroat trout primarily compete with salmon and steelhead in protected estuaries that support prime food and habitat resources (NMFS 1999) (Section 3.2.4.5.4, Coastal Cutthroat Trout, Interaction with Salmon and Steelhead). Post-spawning coastal cutthroat trout also feed on smaller salmon and steelhead in freshwater and estuarine habitats. Finally, coastal cutthroat trout hybridize with steelhead. Competition, predation, and hybridization are the primary effects for analysis of interactions between coastal cutthroat trout and salmon and steelhead under each of the alternatives. A decrease in hatchery-origin and natural-origin salmon and steelhead smolt production would benefit coastal cutthroat trout by reducing interspecific competition for food and habitat resources in estuaries and reducing opportunities for hybridization. However, such decreases may also negatively affect coastal cutthroat trout by limiting juvenile salmon and steelhead as a prey source.

Implementation measures designed to improve hatcheries may also affect coastal cutthroat trout by correcting water quality conditions in streams where hatcheries are located, where coastal cutthroat trout may pass through during migration, or where coastal cutthroat trout spawn nearby. However, new temporary or permanent weirs planned under some of the action alternatives may isolate coastal cutthroat trout populations, limiting or slowing migration movement, impacting stream flow, altering streambed and riparian habitats, altering spawning locations, increasing fish mortality and stress by handling, forcing downstream spawning where fish cannot pass a weir, and increasing predation when coastal cutthroat trout are caught within a weir. To minimize these effects, hatchery operators conduct continuous weir monitoring during fish migrations, develop practices to minimize handling of fish, and remove weirs when not needed to trap hatchery-origin fish so that unintentional trapping of other fish is avoided.

Under the implementation scenario for Alternative 1, there would be no change in hatchery-origin and natural-origin salmon and steelhead smolt production compared to baseline conditions (Table 4-83). Therefore, competition, predation, and hybridization between coastal cutthroat trout and salmon and steelhead would not likely change compared to baseline conditions, and available juvenile salmon and steelhead prey would remain consistent with current availability. In addition, water quality conditions at hatcheries would not improve, and coastal cutthroat trout would not be affected by the placement of new weirs.

The implementation scenarios for all action alternatives would likely reduce interspecific competition, predation, and hybridization between coastal cutthroat trout and salmon and steelhead. Under the implementation scenario for Alternative 2, the 52 percent decrease in hatchery-origin and natural-origin salmon and steelhead smolt production (Table 4-83) may result in a greater benefit to coastal cutthroat trout by reducing interspecific competition for food and habitat, predation, and hybridization when compared to Alternative 1. However, this substantial decrease in salmon and steelhead smolt production would also decrease the available juvenile prey base of salmon and steelhead for coastal cutthroat trout. This prey base decrease may be mitigated by the availability of other species upon which cutthroat prey, such as other fish and aquatic and terrestrial insects (Section 3.2.4.5.1, Coastal Cutthroat Trout, Background). Correcting water quality issues at hatcheries would also benefit coastal cutthroat trout under the implementation scenario for Alternative 2 compared to Alternative 1.

The implementation scenarios for Alternative 3 through Alternative 5 would also decrease salmon and steelhead smolt production by 19, 12, and 17 percent, respectively, compared to Alternative 1 (Table 4-83). While this decrease in smolt production would also benefit coastal cutthroat trout by reducing interspecific competition for food and habitat resources, predation, and hybridization, it would not be as substantial of a benefit as the implementation scenario for Alternative 2. Conversely, the negative effect of a reduced prey base under these alternatives would not be as substantial as the reduced prey base under the implementation scenario for Alternative 2, particularly when combined with the continued availability of other species that coastal cutthroat prey upon (e.g., other fish and insects). The benefits of improving water quality conditions at hatcheries would also occur under the implementation scenarios for Alternative 3 though Alternative 5 when compared to Alternative 1. The new temporary weirs (Alternative 3 through Alternative 5) and permanent weirs (Alternative 4 and 5) have the potential of adversely impacting coastal cutthroat trout through habitat alteration and fragmentation, fish handling, and slowing coastal cutthroat trout migratory movements when compared to Alternative 1.

Genetic effects from interactions between coastal cutthroat trout, steelhead, and rainbow trout (Section 3.2.4.5.3, Coastal Cutthroat Trout Limiting Factors and Threats) would likely continue under the implementation scenarios for any alternative. Other threats to coastal cutthroat trout from marine mammal predation and unfavorable ocean conditions would also continue under the implementation scenarios for all of the alternatives since hatchery production and activities would have no relationship to these threat sources (Section 3.2.4.5.3, Coastal Cutthroat Trout, Limiting Factors and Threats).

Reduced competition with salmon and steelhead, under the implementation scenarios for any of the action alternatives compared to Alternative 1, would be an overall benefit to nonmigratory, fluvial, adfluvial, and anadromous coastal cutthroat trout because of the availability of more food resources in estuary areas. However, while this benefit may occur, other limitations on the coastal cutthroat trout's prey base and degradation of their habitat would likely continue under all alternatives, including habitat effects from forest management practices, agriculture and livestock management, dams and barriers, urban and industrial development, mining, and estuary degradation (Oregon Department of Fish and Wildlife [ODFW] 2005) (Section 3.2.4.5.3, Coastal Cutthroat Trout, Limiting Factors and Threats). Such threats would not be mitigated by any of the alternatives, including Alternative 1, because hatchery production and activities would have no relationship to these threat sources.

4.2.4.6 Lamprey Effects for All Alternatives

While the primary interaction between lamprey and salmon and steelhead in the analysis area is predation of salmon and steelhead by Pacific and river lamprey, this interaction may be mitigated by the presence of marine mammals feeding on lamprey (Section 3.2.4.7.4, Lamprey, Interaction with Salmon and Steelhead). Along with salmon and steelhead, all lamprey species are prey of seals and sea lions; however, lamprey are considered preferred prey over salmon and steelhead because of their higher caloric value. The primary reason for analyzing interactions between lamprey and salmon and steelhead is Pacific and river lamprey predation on salmon and steelhead. Brook lamprey do not feed as adults (Section 3.2.4.7.1, Lamprey, Background). As hatchery production and the number of natural-origin salmon and steelhead change under the alternatives, the extent of available salmon and steelhead for lamprey would also change.

Implementation measures designed to improve hatcheries may also affect lamprey by improving water quality conditions in streams where hatcheries are located, where lamprey may pass through during migration, or where lamprey spawn nearby. However, new temporary or permanent weirs planned under some of the action alternatives may isolate lamprey populations, limiting or slowing migration movement, impacting stream flow, altering streambed and riparian habitats, altering spawning locations, increasing fish mortality and stress by handling, forcing downstream spawning where fish cannot pass a weir, and increasing predation when lamprey trout are caught within a weir. To minimize these effects, hatchery operators conduct continuous weir monitoring during fish migrations, develop practices to minimize handling of fish, and remove weirs when not needed to trap hatchery-origin fish so that unintentional trapping of other fish is avoided.

Under the implementation scenario for Alternative 1, there would be no change in hatchery-origin and natural-origin salmon and steelhead smolt production compared to baseline conditions (Table 4-83). Therefore, predation on salmon and steelhead by Pacific and river lamprey would not likely change compared to baseline conditions, and available juvenile salmon and steelhead prey would remain consistent with current availability. In addition, water quality conditions at hatcheries would not improve, and bull trout would not be affected by the placement of new weirs.

The implementation scenarios for all action alternatives would likely result in a reduction of salmon and steelhead available as a food source for lamprey. Under the implementation scenario for Alternative 2, the 52 percent decrease in hatchery-origin and natural-origin salmon and steelhead smolt production and the 43 percent decrease in adult recruits (Table 4-83) would result in a reduction of Pacific and river lamprey prey resources when compared to Alternative 1. This prey base decrease may be mitigated by the availability of other species upon which lamprey prey, such as other fish and whales. In addition, hatchery improvements that would help passage of lamprey through fish entrainment structures may occur under Alternative 2 when BMPs are implemented. Correcting water quality issues at hatcheries would also be benefit lamprey under the implementation scenario for Alternative 2 when compared to Alternative 1.

The implementation scenarios for Alternative 3 through Alternative 5 would also decrease salmon and steelhead smolt production by 19, 12, and 17 percent, respectively, compared to Alternative 1, and a decrease in salmon and steelhead adult recruits by 18, 10, and 16 percent, respectively (Table 4-83). While this decrease in smolt production and adult recruits would also decrease food resources for Pacific and river lamprey, it would not be as substantial a decrease as the implementation scenario for Alternative 2. Conversely, the negative effect of a reduced prey base under these alternatives would not be as substantial as the reduced prey base under the implementation scenario for Alternative 2, particularly when combined with the continued availability of other species upon which lamprey prey (e.g., other fish and marine mammals). In addition, salmon and steelhead hatchery improvement BMPs may benefit lamprey through the development of fish entrainment structures that do not prevent the movement of lamprey into streams. The benefits of improving water quality conditions at hatcheries would also occur under the implementation scenarios for Alternative 3 through Alternative 5 when compared to Alternative 1. In contrast, the new temporary weirs (Alternative 3 through Alternative 5) and permanent weirs (Alternative 4 and Alternative 5) may adversely impact lamprey through habitat alteration and fragmentation, fish handling, and slowing lamprey migratory movements when compared to Alternative 1.

Pacific lamprey, western brook lamprey, and river lamprey are experiencing reduced access to spawning habitat, degradation of spawning and rearing areas, loss of emigrating juveniles to turbine entrainment and fish passage structures, poor recruitment, and the presence of non-indigenous predators (Section 3.2.4.7.3, Lamprey, Limiting Factors and Threats). These limiting factors and threats on lamprey populations would occur under the implementation scenarios for all of the action alternatives. They would continue to occur under Alternative 1, because hatchery production and hatchery activities would have no interaction with lamprey habitat, turbine entrainment, or recruitment, other than decreasing food resources (salmon and steelhead) for Pacific lamprey and river lamprey. Considering lamprey benefits and disadvantages that may occur under the alternatives, it is not expected that any of the alternatives, including the implementation scenario under Alternative 1, would help with the recovery of brook lamprey and may result in an impact on Pacific lamprey and river lamprey due to the decrease of a food resource (salmon and steelhead) (although these lamprey species also feed on other fish and marine mammals), and potential migratory barriers from new weirs.

4.2.4.7 Leopard Dace and Umatilla Dace Effects for All Alternatives

Leopard dace and Umatilla dace can be prey species of salmon and steelhead in freshwater environments (Section 3.2.4.8.4, Leopard Dace, Interaction with Salmon and Steelhead; Section 3.2.4.14.4, Umatilla dace, Interaction with Salmon and Steelhead). This is the primary reason for analyzing interactions between leopard dace and Umatilla dace and salmon and steelhead. As hatchery production and the number of natural-origin salmon and steelhead change under the alternatives, the extent of predation on leopard dace and Umatilla dace would also change. Implementation measures designed to improve hatcheries may also benefit leopard dace and Umatilla dace by minimizing entrainment of juvenile fish at hatchery water intake screens and improving water quality conditions in streams where hatcheries occur and dace spawn nearby.

Under the implementation scenario for Alternative 1, there would be no change in the number of hatchery-origin and natural-origin salmon and steelhead adult recruits compared to baseline conditions (Table 4-83). Thus, salmon and steelhead predation on leopard dace and Umatilla dace would likely not change compared to baseline conditions, and hatchery improvements to update hatchery water intake screens and to correct water quality conditions would not occur.

All action alternatives would likely result in a reduction of predation on leopard dace and Umatilla dace from reductions in salmon and steelhead production when compared to Alternative 1. However, these reductions in predation and subsequent benefit to leopard dace and Umatilla dace may be minimized by predation from other species (such as bull trout and non-native fish), which would continue under any alternative. Under the implementation scenario for Alternative 2, the 43 percent decrease in hatchery-origin and natural-origin salmon and steelhead adult recruits compared to Alternative 1 (Table 4-83) may benefit leopard dace and Umatilla dace through decreased predation on these two species. Updating hatchery water intake screens and correcting water quality issues would also benefit leopard dace and Umatilla dace.

The implementation scenarios for Alternative 3 through Alternative 5 would also decrease salmon and steelhead adult recruits by 18, 10, and 16 percent, respectively (Table 4-83). In addition, the benefits of updating hatchery water intake screens and correcting water quality issues would also occur under the implementation scenarios for Alternative 3 through Alternative 5.

Implementation scenarios for all action alternatives would likely result in less predation on leopard dace and Umatilla dace, and the implementation scenario for Alternative 2 would likely result in the greatest benefit to leopard dace and Umatilla dace. However, predation of leopard dace and Umatilla dace by salmon and steelhead has not been cited as a reason for their declines, nor have water quality issues or entrainment at water intake structures. Leopard dace and Umatilla dace declines have been attributed to reduced water flows, increasing water demands, barriers to movement, sedimentation, and introduction of non-native species that prey on dace (Section 3.2.4.8.3, Leopard Dace, Limiting Factors and Threats; Section 3.2.4.14.3, Umatilla Dace, Limiting Factors and Threats). Such threats would not be mitigated by any of the alternatives, including Alternative 1, because hatchery production and activities would have no relationship to these threat sources. It is likely that the threats described above would continue to negatively impact leopard dace and Umatilla dace populations regardless of alternative implementation.

4.2.4.8 Margined Sculpin Effects for All Alternatives

The margined sculpin is a predator of salmon and steelhead eggs and young (Section 3.2.4.9.4, Margined Sculpin, Interaction with Salmon and Steelhead), and this is the primary reason for analyzing interactions between margined sculpin and salmon and steelhead. A decrease in smolt production of both hatchery-origin and natural-origin salmon and steelhead would, thus, impact the prey resources of the margined sculpin. As hatchery production and the number of hatchery-origin and natural-origin salmon and steelhead change under the alternatives, the extent of available salmon and steelhead for margined sculpin predation would also change. Implementation measures designed to improve hatcheries may also benefit margined sculpin by minimizing entrainment of juvenile fish at hatchery water intake screens and improving water quality conditions in streams where hatcheries occur and margined sculpin may reside.

Under the implementation scenario for Alternative 1, there would be no change in hatchery-origin and natural-origin salmon and steelhead smolt production compared to baseline conditions (Table 4-83). Thus, margined sculpin predation on salmon and steelhead would not change compared to baseline conditions, and hatchery improvements to update water intake screens and to correct water quality conditions would not occur.

The implementation scenarios for all action alternatives would likely result in a reduction of prey resources (salmon and steelhead smolts) when compared to Alternative 1. Under the implementation scenario for Alternative 2, the 52 percent decrease in hatchery-origin and natural-origin salmon and steelhead smolt production (Table 4-83) would impact the food resources of margined sculpin, which would result in less prey availability for margined sculpin, but not as much of a decrease as would occur under Alternative 1. Updating water intake screens and correcting water quality issues would also benefit margined sculpin.

The implementation scenarios for Alternative 3 through Alternative 5 would likely result in a decrease in salmon and steelhead smolt production by 19, 12, and 17 percent, respectively (Table 4-83), which would also likely result in less prey resources for margined sculpin, but not as much of a decrease as under the implementation scenario for Alternative 2 when compared to Alternative 1. The benefits of updating water intake screens and correcting water quality issues would also occur under the implementation scenarios for Alternative 3 through Alternative 5 when compared to Alternative 1.

The implementation scenarios for all action alternatives would result in an impact on the prey resources of margined sculpin, and the implementation scenario for Alternative 2 would result in the greatest impact. However, sculpins, in general, feed on a variety of aquatic invertebrates, young fish (including salmon and steelhead), and fish eggs (Section 3.2.4.9.1, Margined Sculpin, Background). It is not known if margined sculpins depend on salmon and steelhead as a primary food resource. Based on this diverse diet of sculpins, however, it is likely that margined sculpins would alter their feeding habits to prey on other available resources if salmon and steelhead populations declined. Thus, their populations are not expected to decline as a result of implementing any of the action alternatives.

The reason for declines in margined sculpin populations includes human-induced activities that have impacted margined sculpin habitat (e.g., grazing, channelization, chemical use, logging, shoreline development, chemical use, and septic problems) and its limited distribution (Section 3.2.4.9.3, Margined Sculpin, Limiting Factors and Threats). Such threats would not be mitigated by any of the alternatives, including Alternative 1, because hatchery production and activities have no relationship to these threat sources. It is likely that habitat conditions resulting from ongoing threats would continue to affect margined sculpin populations negatively regardless of alternative implementation. However, updating water intake screens and improving water quality conditions in streams associated with hatcheries would help to improve its survival at hatchery locations.

4.2.4.9 Mountain Sucker Effects for All Alternatives

Due to its small size (6 to 8 inches), mountain suckers can be prey of salmon and steelhead (Section 3.2.4.10.4, Mountain Sucker, Interaction with Salmon and Steelhead), and this is the primary reason for analyzing interactions between mountain suckers and salmon and steelhead under each of the alternatives. As hatchery production and the number of hatchery-origin and natural-origin salmon and steelhead change under the alternatives, the extent of predation on mountain suckers would also change.

Implementation measures designed to improve hatcheries may also benefit mountain sucker by minimizing entrainment of juvenile fish at hatchery water intake screens and improving water quality conditions in streams where hatcheries occur and mountain sucker may reside.

Under the implementation scenario for Alternative 1, there would be no change in hatchery-origin and natural-origin salmon and steelhead smolt production compared to baseline conditions (Table 4-83). Thus, predation on mountain suckers by salmon and steelhead would not likely change compared to baseline conditions, and hatchery improvements to update water intake screens and to correct water quality conditions would not occur.

The implementation scenarios under all action alternatives would likely result in a reduction of predation on mountain suckers when compared to Alternative 1. Under the implementation scenario for Alternative 2, the 43 percent decline in adult recruits (Table 4-83) may benefit mountain suckers through decreased predation on the species by salmon and steelhead compared to Alternative 1. Updating water intake screens and correcting water quality issues would also benefit mountain sucker.

The implementation scenarios for Alternative 3 through Alternative 5 would also decrease salmon and steelhead adult recruits by 18, 10, and 16, percent respectively (Table 4-83), which would likely result in less predation on mountain sucker, but not as much of a decrease as under the implementation scenario for Alternative 2 when compared to Alternative 1. The benefits of updating water intake screens and correcting water quality issues would also occur under the implementation scenarios for Alternative 3 through Alternative 5 compared to Alternative 1.

Although reduced predation upon mountain sucker would likely occur under implementation scenarios for all alternatives compared to Alternative 1, predation of mountain suckers by salmon and steelhead has not been cited as a reason for mountain sucker declines (Section 3.2.4.10.3, Mountain Sucker, Limiting Factors and Threats). Similarly, entrainment of mountain suckers at hatchery water intake screens and water quality conditions at existing hatcheries have not been identified as threats to these species. Primary threats to mountain suckers are from habitat isolation due to passage barriers, habitat degradation (sedimentation), predation by non-native salmon, and hybridization with other suckers (Belica and Nibbelink 2006). Such threats would not be mitigated by any of the alternatives, including Alternative 1, because hatchery production and activities would have no relationship to these threat sources. It is likely that ongoing threats described above would continue to affect mountain sucker populations negatively regardless of alternative implementation.

4.2.4.10 Northern Pikeminnow Effects for All Alternatives

The northern pikeminnow is an important predator of juvenile salmon and steelhead (i.e., smolts) within the Columbia River basin (Section 3.2.4.11.4, Northern Pikeminnow, Interaction with Salmon and Steelhead), and this is the primary reason for analyzing interaction between northern pikeminnow and salmon and steelhead under each of the alternatives. A decrease in smolt production of both hatchery-origin and natural-origin salmon and steelhead would, therefore, decrease the available prey resources of the northern pikeminnow.

Implementation measures designed to improve hatcheries may also benefit northern pikeminnow by correcting water quality conditions in streams where hatcheries occur and northern pikeminnow may reside.

Under the implementation scenario for Alternative 1, there would be no change in hatchery-origin and natural-origin salmon and steelhead smolt production compared to baseline conditions (Table 4-83). Therefore, northern pikeminnow predation on salmon and steelhead would not change compared to baseline conditions, and hatchery improvements to correct water quality conditions would not occur.

The implementation scenarios for all of the action alternatives would result in a negative impact on northern pikeminnow populations compared to Alternative 1 because of declines in salmon and steelhead smolt production, which would decrease an important food source for northern pikeminnow (although its preferred prey is American shad [Section 3.2.4.11.1, Northern Pikeminnow, Background]). Correcting water quality issues would benefit northern pikeminnow.

The implementation scenario under Alternative 2 would result in the greatest negative impact because a 52 percent decrease in hatchery-origin and natural-origin salmon and steelhead smolt production

(Table 4-83) would be a substantial decrease in the salmon and steelhead food sources of northern pikeminnow. Correcting water quality issues would benefit northern pikeminnow.

The implementation scenarios under Alternative 3 through Alternative 5 would likely result in a decrease in salmon and steelhead smolt production by 19, 12, and 17 percent, respectively, compared to Alternative 1 (Table 4-83). Such decreases in smolt production would lead to similar negative effects on northern pikeminnow populations as those occurring under the implementation scenario for Alternative 2, but the decrease in this food source would not be as substantial. The benefits of correcting water quality issues would also occur under the implementation scenarios for Alternative 3 through Alternative 5 compared to Alternative 1.

While there would be substantial declines of an important food source for northern pikeminnow under the implementation scenario for Alternative 2 and lower amounts of decline under the other action alternatives compared to Alternative 1, the northern pikeminnow is not a listed species. The species is abundant in the analysis area and is currently controlled through a harvest program to limit its presence in the Columbia River basin (LCFRB 2004) (Section 3.2.4.11.2, Northern Pikeminnow, Current Status and Trends). In the short term, a reduction in salmon and steelhead smolt production may result in increased predation pressure by northern pikeminnow until control measures help to stabilize the population. In the long term, the northern pikeminnow population would likely stabilize based on salmon and steelhead production decreases under the implementation scenarios for the action alternatives, and with baseline conditions expected to occur under Alternative 1, when combined with effects of the northern pikeminnow control program.

4.2.4.11 Rainbow Trout Effects for All Alternatives

The primary interaction between rainbow trout and salmon and steelhead is the ability of rainbow trout to outcompete natural-origin fish for available food resources, such as insects, amphibians, and small fish (Section 3.2.4.13.4, Rainbow Trout, Interaction with Salmon and Steelhead). Introduced rainbow trout can also outcompete natural-origin salmon and steelhead for available habitat, prey on young salmon, and they are a genetic threat by interbreeding with natural-origin salmon and steelhead (Section 3.2.4.13.1, Rainbow Trout, Background). Interspecific competition, rainbow trout predation on salmon and steelhead, and genetic integrity of natural-origin salmon populations are the primary reasons to analyze interactions between rainbow trout and salmon and steelhead. As hatchery production and the number of natural-origin salmon and steelhead change under the alternatives, the extent of competition, predation, and interbreeding would also change.

Implementation measures designed to improve hatcheries may also affect rainbow trout by correcting water quality conditions in streams where hatcheries are located, where rainbow trout may pass through during migration, or where rainbow trout spawn nearby. However, new temporary or permanent weirs planned under some of the action alternatives may isolate rainbow trout populations, limiting or slowing movement of migrating rainbow trout, impacting stream flow, altering streambed and riparian habitats, altering spawning locations, increasing fish mortality and stress by handling, forcing downstream spawning where fish cannot pass a weir, and increasing predation when westslope cutthroat trout are caught within a weir. To minimize these effects, hatchery operators conduct continuous weir monitoring during fish migrations, develop practices to minimize handling of fish, and remove weirs when not needed to trap hatchery fish so that unintentional trapping of other fish is avoided.

A reduction in hatchery-origin and natural-origin salmon and steelhead smolt production and a decrease in the number of adult recruits under the action alternatives, compared to Alternative 1, would have an adverse impact on the food resources of rainbow trout (but this may be mitigated by use of other food resources by rainbow trout). Such decreases would also likely reduce competition for rainbow trout habitat and may reduce the risk of genetic interactions of rainbow trout with salmon and steelhead through interbreeding. In addition, water quality conditions at hatcheries would not improve, and rainbow trout would not be affected by the placement of new weirs.

Under the implementation scenario for Alternative 1, there would be no change in hatchery-origin and natural-origin salmon and steelhead smolt production and adult recruits produced compared to baseline conditions (Table 4-83). Thus, rainbow trout predation on salmon and steelhead, competition for habitat, and compromises in genetic integrity through interbreeding would not likely change compared to baseline conditions. Additionally, other sources of prey for rainbow trout would remain available as described under baseline conditions. In addition, water quality conditions at hatcheries would not improve, and rainbow trout would not be affected by the placement of new weirs.

The implementation scenarios for all action alternatives would likely reduce prey resources of rainbow trout, competition for habitat, and genetic risks between rainbow trout and salmon and steelhead. Correcting water quality issues at hatcheries would also benefit rainbow trout under the implementation scenario for Alternative 2 compared to Alternative 1.

Under the implementation scenario for Alternative 2, the 52 percent decrease in hatchery-origin and natural-origin salmon and steelhead smolt production (Table 4-83) would negatively impact a prey resource of rainbow trout. However, other food sources would remain available (e.g., insects, amphibians, other small fish) since hatchery production and activities would not affect these resources. Competition for available habitat would be substantially reduced under Alternative 2 compared to Alternative 1 since less salmon and steelhead adult recruits (43 percent, Table 4-83) would be compete with rainbow trout for prime habitat space. Furthermore, there would be a substantial decrease in the risk for compromised genetic integrity through interbreeding under the implementation scenario for Alternative 2 compared to Alternative 1 because a large percentage of the current salmon and steelhead population would not be introduced into the analysis area. Correcting water quality issues at hatcheries would also benefit rainbow trout under the implementation scenario for Alternative 2 compared to Alternative 1.

The implementation scenarios for Alternative 3 through Alternative 5 would also decrease salmon and steelhead smolt production by 19, 12, and 17 percent, respectively, compared to Alternative 1 (Table 4-83), resulting in a salmon and steelhead adult recruit decrease of 18, 10, and 16 percent, respectively. These reductions would represent similar effects on rainbow trout as described under the implementation scenario for Alternative 2. However, such reductions in expected risks (i.e., decreased prey base) or increases in benefits (i.e., decreases in competition for habitat and compromised genetic integrity) would not be as substantial under the implementation scenarios for these action alternatives as under Alternative 2. The benefits of improving water quality conditions at hatcheries would also occur under the implementation scenarios for Alternative 3 through Alternative 5 when compared to Alternative 1. In contrast, the new temporary weirs (Alternative 3 through Alternative 5) and permanent weirs (Alternative 4 and Alternative 5) may adversely impact rainbow trout through habitat alteration and fragmentation, fish handling, and slowing rainbow trout migratory movements when compared to Alternative 1.

Rainbow trout are not listed, but populations have decreased over time due to various threats (Section 3.2.4.13.2, Rainbow Trout, Current Status and Trends). While all the action alternatives would result in benefits to rainbow trout through less competition for habitat and less opportunity to compromise genetic integrity, this species would continue to experience threats from other sources. In addition to interbreeding and competition, habitat degradation and fragmentation, non-native species introductions, and hybridization would continue under all of the alternatives, including Alternative 1 (Section 3.2.4.13.2, Rainbow Trout, Current Status and Trends; Section 3.2.4.13.3, Rainbow Trout, Limiting Factors and Threats). Hatchery production levels and activities under the implementation scenarios for any alternative would have no relationship to the activities that threaten rainbow trout, with the exception of the potential for decreased genetic interbreeding, decreased competition for food and habitat, and increased habitat fragmentation through new weir placement.

4.2.4.12 Westslope Cutthroat Trout Effects for All Alternatives

Westslope cutthroat trout directly compete with salmon and steelhead for habitat use and prey consumed (Section 3.2.4.15.4, Westslope Cutthroat Trout, Interactions with Salmon and Steelhead). They also hybridize with steelhead. These constitute the primary effects for analysis of interactions between westslope cutthroat trout and salmon and steelhead. As hatchery production and the number of natural-origin salmon and steelhead change under the alternatives, the extent of competition and hybridization between westslope cutthroat trout and salmon and steelhead would also change.

Implementation measures designed to improve hatcheries may also affect westslope cutthroat trout by correcting water quality conditions in streams where hatcheries are located, where westslope cutthroat trout may pass through during migration, or where westslope cutthroat trout spawn nearby. However, new temporary or permanent weirs planned under some of the action alternatives may isolate westslope cutthroat trout populations, limiting or slowing movement of migrating westslope cutthroat trout, impacting stream flow, altering streambed and riparian habitats, altering spawning locations, increasing fish mortality and stress by handling, forcing downstream spawning where fish cannot pass a weir, and increasing predation when westslope cutthroat are caught within a weir. To minimize these effects, hatchery operators conduct continuous weir monitoring during fish migrations, develop practices to minimize handling of fish, and remove weirs when not needed to trap hatchery fish so that unintentional trapping of other fish is avoided.

Under the implementation scenario for Alternative 1, there would be no change in hatchery-origin and natural-origin salmon and steelhead smolt production and adult recruits compared to baseline conditions (Table 4-83). Thus, competition and hybridization between westslope cutthroat trout and salmon and steelhead would not likely change compared to baseline conditions. In addition, water quality conditions at hatcheries would not improve, and westslope cutthroat trout would not be affected by the placement of new weirs.

The implementation scenarios for all action alternatives would likely result in less competition and hybridization between westslope cutthroat trout and salmon and steelhead when compared to Alternative 1. Under the implementation scenario for Alternative 2, the 52 percent decrease in hatchery-origin and natural-origin salmon and steelhead smolt production and the 43 percent decrease in adult recruits (Table 4-83) may benefit westslope cutthroat trout by reducing interspecific competition and hybridization. Correcting water quality issues at hatcheries would also benefit westslope cutthroat trout under the implementation scenario for Alternative 2 compared to Alternative 1.

The implementation scenarios for Alternative 3 through Alternative 5 would also decrease salmon and steelhead smolt production by 19, 12, and 17 percent, respectively, and decrease adult recruits by 18, 10, and 16 percent, respectively (Table 4-83). This would likely decrease interspecific competition and hybridization, but would not be as much of a decline as under the implementation scenario for Alternative 2 when compared to Alternative 1. The benefits of improving water quality conditions at hatcheries would also occur under the implementation scenarios for Alternative 3 through Alternative 5 when compared to Alternative 1. In contrast, the new temporary weirs (Alternative 3 through Alternative 5) and permanent weirs (Alternative 4 and Alternative 5) may adversely impact westslope cutthroat trout through habitat alteration and fragmentation, fish handling, and slowing coastal cutthroat trout migratory movements when compared to Alternative 1.

Although reduced interspecific competition would likely occur under implementation scenarios for all alternatives compared to Alternative 1, interspecific competition has not been cited as a reason for westslope cutthroat trout declines (Section 3.2.4.15.3, Westslope Cutthroat Trout, Limiting Factors and Threats). Interspecific competition studies between westslope cutthroat trout and other natural-origin salmon and steelhead have not yet been conducted, however, NMFS (1999) summarizes several studies demonstrating that, when in the presence of other salmonids, coastal cutthroat trout have altered their behavior and life history traits to avoid interspecific competition for the same food and resources. Previous studies regarding the presence of coastal cutthroat trout and steelhead in the same stream locations have shown that these species have different behaviors (e.g., feeding on different prey) when sympatric (living nearby, but not interbreeding), which can help in avoiding and/or minimizing interspecific competition (Pearcy et al. 1990).

The reason for recent declines in westslope cutthroat trout populations has been isolation of previously connected habitats, habitat loss, hybridization and competition with non-native salmonids, overfishing, and warming stream temperatures (Section 3.2.4.15.3, Westslope Cutthroat Trout, Limiting Factors and Threats). Outside of a decrease in the potential for hybridization and potential isolation of connected habitats through new weir placement, these threats would not be mitigated by any of the alternatives, including Alternative 1, because hatchery production and activities would have no relationship to these other threat sources. It is likely that ongoing threats, outside of hybridization, described above would continue to affect westslope cutthroat populations negatively regardless of alternative implementation.

4.3 Socioeconomics

4.3.1 Introduction

This assessment of the socioeconomic effects of the alternatives evaluates predicted changes in values for key socioeconomic indicators, including hatchery program costs, harvest and economic values, and regional economic conditions. The effects from implementation scenarios associated with Alternative 2 through Alternative 5 are compared to effects expected under Alternative 1 (No Action), which represents a continuation of current hatchery practices. The harvest estimates provided in this section (both modeled values and average annual values) are considered reasonable estimates of average annual harvest over time and are shown in 2007 U.S. dollars for consistency. Although the analysis focuses on harvest-related effects from expected changes in Columbia River basin hatchery production, other operational effects (such as effects on hatchery jobs and personal income generation from hatchery production changes) are also considered. For readability of the Socioeconomics section, all 11-by-17 fold-out tables are included at the end of this section.

As described in Chapter 2, Alternatives, one implementation scenario has been identified for each alternative so that the effects of each alternative can be understood and compared. Implementation measures are combined under each alternative to create an implementation scenario (Table 2-6). Table 4-84 shows the implementation measures that may affect socioeconomic indicators. Ten implementation measures may affect hatchery program costs because they may cost money to implement (Section 4.3.2.2, Hatchery Program Costs):

- Change production levels in hatchery programs.
- Change broodstock collection protocols in hatchery programs.
- Update water intake screens at hatchery facilities.
- Update hatchery facilities to allow all salmon and steelhead of all ages to bypass or pass through hatchery-related structures.
- Improve rearing and release protocols in hatchery programs.
- Correct water quality issues at hatchery facilities.
- Install new temporary weirs.
- Install new permanent weirs.
- Change hatchery program goals (i.e., harvest or conservation).
- Change hatchery program's operational strategy (i.e., segregated or integrated).
- Establish new hatchery programs.
- Terminate hatchery programs that support harvest if they fail to meet performance goals.

Four implementation scenarios would affect harvest and economic values for fisheries (recreational and commercial) and three would affect regional economic conditions because they would influence harvest levels (Section 4.3.2.1, Harvest Estimates):

- Change production levels in hatchery programs.
- Establish new selective fisheries in terminal areas.
- Establish new hatchery programs.
- Terminate hatchery programs that support harvest if they fail to meet performance goals.

Table 4-84. Socioeconomic Indicators that May be Affected by Implementation Measures Included under the Alternatives' Implementation Scenarios.

Implementation Measures Incorporated in One or More of the Alternatives' Implementation Scenarios	Socioeconomic Indicators that May be Affected				
	Hatchery Program Costs	Harvest and Economic Values for Recreational Fisheries	Harvest and Economic Values for Commercial Fisheries	Regional Economic Conditions Columbia River Basin	Regional Economic Conditions Pacific Ocean and Puget Sound
Change production levels in hatchery programs.	X	X	X	X	X
Change broodstock collection protocols in hatchery programs.	X				
Update water intake screens at hatchery facilities.	X				
Update hatchery facilities to allow all salmon and steelhead of all ages to bypass or pass through hatchery-related structures.	X				
Improve rearing and release protocols in hatchery programs.	X				
Correct water quality issues at hatchery facilities.	X				
Install new temporary weirs.	X				
Install new permanent weirs.	X				
Establish new selective fisheries in terminal areas.		X			
Change hatchery program goals (i.e., harvest or conservation).	X				
Change hatchery program's operational strategy (i.e., segregated or integrated).	X				
Establish new hatchery programs.	X	X	X	X	X
Terminate hatchery programs that support harvest if they fail to meet performance goals.	X	X	X	X	X

These changes apply to hatchery programs funded through the Mitchell Act and hatchery programs receiving funding from other sources.

As described in Section 3.3.2, Analysis Area, the analysis area for socioeconomics includes the project area (Section 2.2, Description of Project Area) plus the following areas: 1) coastal areas of Washington, Oregon, and California; 2) British Columbia (Canada); 3) the Puget Sound/Strait of Juan de Fuca; and 4) Southeast Alaska (Figure 3-1). The analysis area includes areas outside the project area because salmon produced within the project area can migrate outside the project area and contribute to fisheries in these areas.

Information is organized according to the following economic impact regions: lower Columbia River, mid Columbia River, upper Columbia River, lower Snake River within the Columbia River basin and Oregon coast, Washington coast, California coast, Puget Sound/Strait of Juan De Fuca, British Columbia, and Southeast Alaska within the Pacific Ocean and Puget Sound. Four of these economic impact regions occur in the project area (lower Columbia River, mid Columbia River, upper Columbia River, and lower Snake River) (Figure 3-2). These four economic impact regions encompass the seven ecological provinces and two recovery domains that make up the project area (Section 2.2, Description of Project Area).

4.3.2 Methods for Analysis

The analysis of socioeconomic effects considers predicted harvest-related effects within the Columbia River basin, the Pacific Ocean, and Puget Sound, where Columbia River stocks contribute to hatchery operations-related effects. A comparative evaluation approach focusing on key socioeconomic indicators, including hatchery program costs, harvest and economic values, and regional economic conditions, is used to assess these effects. A cost-benefit analysis of the alternatives is not considered because the focus of this analysis is to compare the alternatives based on evaluation of key socioeconomic indicators.

As indicated in Section 3.3.1, Introduction, table values and corresponding values in the sections are not rounded. This is to aid the reader in finding table numbers within the text. The use of unrounded numbers, however, should not be interpreted as suggestive of unusually high levels of precision in the estimates. All numbers represent a best estimate of the underlying values.

4.3.2.1 Harvest Estimates

The Mitchell Act Fishery Modeling Team provided estimates of salmon and steelhead harvest for all economic impact regions under baseline conditions, which also represent Alternative 1 (No Action), as well as for the action alternatives (Alternative 2 through Alternative 5). Historical data were used, wherever possible, as input data for developing a harvest simulation model that was based on steady-state analysis. Key elements considered in the model for evaluating fishery effects included variation in abundance for Columbia River stocks, representative exploitation rates, regulations over baseline periods, and prescriptive rules that govern the conduct of fisheries (Appendix K).

The harvest simulation model was developed to predict approximate numerical differences in harvest among the implementation scenarios for the alternatives. Although the harvest simulation model was successfully applied for predicting baseline harvest (representing Alternative 1, No Action) in most regions, the model was unable to accurately predict baseline harvest for the Puget Sound/Strait of Juan de Fuca, British Columbia, and Southeast Alaska economic impact regions. Fisheries in these areas are primarily affected by local fish stocks, which were not explicitly modeled in the harvest simulation model. Consequently, estimates of baseline harvests for these economic impact regions represent average annual harvest conditions over the 2002 through 2006 period, as presented in Section 3.3, Socioeconomics.

For alternatives other than Alternative 1, the predicted number of fish caught in tribal, non-tribal commercial, and recreational fisheries from the harvest simulation model was used to estimate harvest for the mainstem Columbia River, terminal areas within the Columbia River basin, and for the Oregon, Washington, and California coast economic impact regions. For the Southeast Alaska, British Columbia, and Puget Sound economic impact regions, catch estimates provided by the Mitchell Act Fishery Modeling Team were used as scale factors and applied to the baseline harvest estimates to calculate harvest for commercial (non-tribal and tribal) and recreational fisheries.

For the Southeast Alaska, British Columbia, and Puget Sound economic impact regions, estimates of total catch provided by the Mitchell Act Fishery Modeling Team were allocated among the different fisheries. Catch estimates were then assigned to the economic impact regions corresponding to the location of the fisheries (Appendix J).

4.3.2.2 Hatchery Program Costs

As summarized in Section 3.3.3, Hatchery Program Costs, and described in more detail in Appendix J, estimates of hatchery program costs are based on existing and proposed hatchery budgets (primarily hatchery programs funded by the Mitchell Act) in the Columbia River basin. Included in Appendix J are average smolt production costs for hatchery programs funded by the Mitchell Act. These costs were used to estimate expenditures for all other hatchery programs in the Columbia River basin. Smolt production expenses include headquarters' administrative and management, acclimation and release, and hatchery facility maintenance costs. Additional hatchery program costs would be associated with the action alternatives. These costs would be accrued through implementation of BMPs and installation of new weirs. Key considerations and assumptions when developing costs can be found in Appendix J. BMP costs do not include fish passage, and new weir costs do not include costs of operating new weirs.

4.3.2.3 Harvest and Economic Values

The comparative evaluation of harvest and economic values analyzed effects of alternative-specific harvest and its effect on gross and net economic values for commercial and recreational fisheries affected by Columbia River basin hatchery production. Economic factors used to estimate the gross and net economic values of changes in harvest were derived from different sources, assumptions, and data sources and are provided in Appendix J.

4.3.2.4 Regional Economic Conditions

The comparative analysis of regional economic conditions estimates the amount of personal income and number of jobs generated by harvest and hatchery production activity under the alternatives. In terms of harvest, there are three fishery components: 1) economic activity from tribal commercial harvests, 2) economic activity from non-tribal commercial harvests, and 3) economic activity generated by recreational fishing. In terms of hatchery production, the amount of personal income and estimated number of jobs are based on smolt production costs estimated for each alternative.

4.3.3 Hatchery Program Costs

Hatchery program expenses include headquarters' administrative and management, acclimation and release, hatchery facility maintenance, implementation of BMPs, and new weir installation costs (Section 4.3.2.2, Hatchery Program Costs).

4.3.3.1 Alternative 1 (No Action)

Under Alternative 1, 143,577,000 smolts would be produced in the Columbia River basin, which would be the same as under baseline conditions (Table 2-7). Forty-nine percent of the smolts would be released from Mitchell Act-funded hatchery programs, and 51 percent would be released from non-Mitchell Act-funded hatchery programs (Table 2-7). Estimated hatchery program costs would be $79.5 million (Table 4-85). No additional BMPs would be implemented under Alternative 1, and no new weirs would be constructed, so all hatchery program costs would be from smolt production costs (Section 4.3.2.2, Hatchery Program Costs).

4.3.3.2 Alternative 2

Under the implementation scenario for Alternative 2, Mitchell Act-funded hatchery programs would be terminated as described in Section 2.5, Alternatives Analyzed in Detail, reducing annual production by 70,894,000 smolts. In addition, annual production in non-Mitchell Act-funded hatchery programs would be reduced by about 20,787,559 smolts compared to Alternative 1 (Table 2-7) so that hatchery programs meet the performance goals of the Alternative 2 (Section 2.5, Alternatives Analyzed in Detail). As under Alternative 1, there would be no costs associated with installing new weirs under the implementation scenario for Alternative 2 (Section 2.5, Alternatives Analyzed in Detail). Unlike Alternative 1, however, additional BMPs would be implemented for hatchery programs not funded by the Mitchell Act (Section 2.5, Alternatives Analyzed in Detail). As a result, there would be $5.1 million in new costs associated with implementing BMPs (Table 4-85). Because production levels would be decreased by 64 percent relative to Alternative 1 (Table 2-7), smolt production costs would be reduced by $32.7 million compared to Alternative 1 (Table 4-85). As a result, total hatchery program costs in the Columbia River basin would be reduced by $27.6 million annually under the implementation scenario for Alternative 2 compared to Alternative 1 (Table 4-85).

4.3.3.3 Alternative 3

Under the implementation scenario for Alternative 3, annual hatchery production would be reduced by 17,734,184 smolts for hatchery programs funded by the Mitchell Act and by 18,914,388 smolts for hatchery programs not funded by the Mitchell Act compared to Alternative 1 (Table 2-7). These decreases in smolt production would help all Columbia River basin hatchery programs meet intermediate performance goals (Section 2.5, Alternatives Analyzed in Detail). Unlike the implementation scenarios for Alternative 1 and Alternative 2, seasonal weirs would be installed under the implementation scenario for Alternative 3 to help meet performance goals. Similar to Alternative 2, new BMPs would be implemented. The costs to implement BMPs and install seasonal weirs would be an estimated $8.44 million annually (Table 4-85), but because production levels would be decreased by 26 percent relative to Alternative 1 (Table 2-7), smolt production costs would be reduced by $11 million compared to Alternative 1 (Table 4-85). As a result, total hatchery program costs in the Columbia River basin would be reduced by $2.6 million annually under the implementation scenario for Alternative 3 compared to Alternative 1 (Table 4-85).

4.3.3.4 Alternative 4

Under the implementation scenario for Alternative 4, annual hatchery production would be reduced by 10,104,181 smolts for hatchery programs funded by the Mitchell Act and by 15,110,703 smolts for hatchery programs not funded by the Mitchell Act in the Columbia River basin compared to Alternative 1 (Table 2-7). These decreases in smolt production would help Columbia River basin hatchery programs meet intermediate and stronger performance goals (Section 2.5, Alternatives Analyzed in Detail). Similar to the implementation scenario for Alternative 3, new BMPs would be implemented, and new weirs would be installed. However, the weirs under the implementation scenario for Alternative 3 would be seasonal weirs, and the weirs under the implementation scenario for Alternative 4 would be a combination of seasonal and permanent weirs (Box 2-8). In general, permanent weirs are more expensive than seasonal weirs (Box 2-8). The costs to implement BMPs and install seasonal weirs under the implementation scenario for Alternative 4 would be an estimated $8.54 million annually (Table 4-85), but because production levels would be decreased by 18 percent relative to Alternative 1 (Table 2-7), smolt production costs would be reduced by $8.6 million compared to Alternative 1 (Table 4-85). As a result, total hatchery program costs in the Columbia River basin would be reduced by almost $100,000 annually under the implementation scenario for Alternative 4 compared to Alternative 1 (Table 4-85).

4.3.3.5 Alternative 5

Under the implementation scenario for Alternative 5, annual hatchery production would be reduced by 12,750,494 smolts for hatchery programs funded by the Mitchell Act and by 20,196,402 smolts for hatchery programs not funded by the Mitchell Act in the Columbia River basin compared to Alternative 1 (Table 2-7). These decreases in smolt production would help Columbia River basin hatchery programs meet intermediate and stronger performance goals (Section 2.5, Alternatives Analyzed in Detail). Similar to the implementation scenario for Alternative 4, new BMPs would be implemented, and a combination of seasonal and permanent weirs would be installed (Box 2-8). The costs to implement BMPs and install seasonal weirs under the implementation scenario for Alternative 5 would be an estimated $8.64 million annually, and total hatchery program costs would increase $2 million compared to Alternative 1 (Table 4-85). The implementation scenario for Alternative 5 is the only implementation scenario that would increase hatchery program costs. Although hatchery production levels would be reduced more under the implementation scenario for Alternative 5 than under the implementation scenario for Alternative 4 when compared to Alternative 1, the costs of producing fish under the implementation scenario for Alternative 5 would be slightly higher than under the implementation scenario for Alternative 4. This is because a higher proportion of fish species such as spring Chinook salmon and steelhead would be produced, and these fish species are more costly per smolt than fish species such as chum salmon and fall Chinook salmon (Appendix J).

4.3.4 Harvest and Economic Values

Commercial and recreational fishers are consumptive users of fishery resources, and they place monetary value on their fishing activities. For commercial fishers (including both tribal and non-tribal), the ex-vessel value (i.e., the price received for the product at the dock) of salmon and steelhead provides a measure of its gross economic value. If the cost of fishing (e.g., equipment, fuel, boats, insurance, etc.) that commercial fishers incur is considered, the resulting net income (ex-vessel value minus costs) provides a measure of net economic value.

Recreational fishers' willingness to pay for their recreational fishing experience represents a measure of gross economic value associated with fishing for salmon or steelhead. Because recreational anglers also incur costs to fish (e.g., bait, tackle, lodging, guide fees, boat-related expenses, travel expenses, etc.), subtracting out these costs provides a measure of net economic value (i.e., net willingness to pay) for fishing opportunities.

This section provides estimates of the incremental changes in gross and net economic values of the action alternatives relative to Alternative 1. Although the analysis focuses on estimating changes in value to users of fish resources (i.e., commercial and recreation fishers), salmon and steelhead resources also have economic (monetary) value to people who do not directly use or consume the resources (i.e., people who place value on protecting salmon resources in the Columbia River basin but do not fish). These values are typically referred to as non-use or passive-use values. Although non-use values associated with the recovery of listed salmon and steelhead are theoretically measurable, and likely differ to some extent among the alternatives, data on the economic value to the general public associated with protecting or enhancing salmon resources in the Columbia River basin are too limited to make reliable estimates of these values. As such, only use values are quantitatively evaluated in this assessment.

4.3.4.1 Alternative 1 (No Action)

4.3.4.1.1 Commercial Harvest and Economic Values

As explained in Section 4.3.2.1, Harvest Estimates, the number of salmon harvested and harvest values provided under Alternative 1 are modeled estimates to allow for comparison with the action alternatives and may not directly relate to baseline estimates provided in Section 3.3, Socioeconomics. Refer to table footnotes in this section where Alternative 1 values were obtained through computer modeling.

Under Alternative 1, the ex-vessel value of harvesting 158,885 salmon and steelhead in the Columbia River basin (Table 4-86) would be an estimated $6,188,673 (Table 4-87). About 49 percent ($3,025,164 in ex-vessel value) of the salmon and steelhead harvest in the Columbia River basin would occur in the tribal commercial fisheries of the mid Columbia River economic impact region, and about 44 percent

($2,704,003 in ex-vessel value) would occur in the non-tribal commercial fisheries in the lower Columbia River economic impact region (Table 4-87). The upper Columbia River and the lower Snake River regions combined would only account for about 7 percent of the commercial harvest ($459,506 in ex-vessel value) in the Columbia River basin (Table 4-87).

The net economic values (net income) to commercial fishers associated with harvest in the Columbia River basin would be an estimated $2,115,979, with Chinook salmon accounting for $1,557,396 (73 percent) of this total (Table 4-88 – for this table, tribal fisheries were combined with non-tribal fisheries). As shown in Table 3-12, Chinook salmon also represents 74 percent of all hatchery-origin fish produced at hatcheries.

In the Pacific Ocean and Puget Sound, where stocks from other river systems substantially contribute to harvest (Table 3-11), the ex-vessel value of 986,298 Chinook salmon, coho salmon, sockeye salmon, and steelhead landed in commercial fisheries would be an estimated $36,594,962 (Table 4-89 and Table 4-90). Along the Washington and Oregon coasts, where the contribution of Columbia River stocks is substantial (Table 3-11), the ex-vessel value of all salmon commercially landed (149,487 fish) would be an estimated $3,151,236 under Alternative 1 (Table 4-89 and Table 4-90).

In the Puget Sound/Strait of Juan de Fuca economic impact region, where Columbia River stocks contribute only about 1 percent of the non-tribal commercial fisheries (Table 3-11), the ex-vessel value of the commercial harvest of all salmon (including non-Columbia River stocks) would be estimated at about $2,975,813 (Table 4-90). Last, in British Columbia and Southeast Alaska, the ex-vessel value of the commercial harvest of all salmon would be an estimated $30,467,913 for both areas (Table 4-90), but Columbia River stocks only meaningfully contribute to the Southeast Alaska Chinook commercial salmon fishery (28 percent) (Table 3-11).

In terms of net economic values, total net income to commercial fishers (non-tribal and tribal) from the harvest of all salmon in the Pacific Ocean and Puget Sound is estimated at $13,474,389 under Alternative 1, with most of this value ($9,706,566) going to commercial fishers in the Southeast Alaska and British Columbia economic impact regions (Table 4-88).

4.3.4.1.2 Recreational Harvest and Economic Value

Under Alternative 1, the estimated recreational catch of salmon and steelhead in the Columbia River basin would be 183,660 fish (Table 4-91). Anglers would make an estimated 605,410 trips and spend about $47,476,271 in trip-related expenditures (Table 4-91). Recreational catch and associated trips and expenditures would be highest in the lower Columbia River economic impact region, where an estimated 101,282 salmon and steelhead (55 percent of total catch) would be caught and $26,637,294 in trip-related expenditures made (Table 4-91). Recreational catch and related spending would be second highest in the lower Snake River economic impact region (Table 4-91), where steelhead is the primary target species. An estimated 58,245 fish would be caught by recreational anglers in the lower Snake River economic impact region, generating 187,887 trips and $14,734,106 in expenditures (Table 4-91). The mid Columbia and upper Columbia economic impact regions combined contribute only 13 percent of the total recreational catch and 13 percent of expenditures (Table 4-91). Recreational anglers in the Columbia River basin would accrue an estimated $35,791,853 in net economic values under Alternative 1, with steelhead accounting for $19,559,757, Chinook salmon accounting for $9,172,182, and coho salmon accounting for $7,059,914 (Table 4-92).

In the Pacific Ocean and Puget Sound, total recreational catch would be an estimated 429,979 fish (Table 4-92), which includes harvest in distant recreational fisheries, such as Puget Sound/Strait of Juan de Fuca and British Columbia, where Columbia River contributions would be minor (Table 3-11). For recreational fisheries along the Washington coast where the Columbia River species (Chinook salmon and coho salmon) substantially contribute (Table 3-11), the recreational catch would be 86,525 fish, generating 75,899 trips and $5,345,575 in trip-related spending (Table 4-93). Along the Oregon coast, recreational fisheries would harvest about 38,791 salmon, generating 55,416 trips and $4,345,700 in trip-related expenditures (Table 4-93). Salmon recreational fisheries along the California coast would be minor, with about 540 fish being caught by recreational anglers (Table 4-93). Net economic values to salmon recreational anglers throughout the Pacific Ocean and Puget Sound would be an estimated $22,380,896, with the primary contributors being Southeast Alaska and British Columbia with an estimated net economic value of $9,581,494 (43 percent) (Table 4-92).

4.3.4.2 Alternative 2

4.3.4.2.1 Commercial Harvest and Economic Values

In comparison to Alternative 1, the commercial harvest of salmon and steelhead in the Columbia River basin under the implementation scenario for Alternative 2 would decline by about 97,136 fish (61 percent), reducing ex-vessel value by about $2,453,174 (Table 4-86 and Table 4-87). The reduction in ex-vessel value would be almost evenly split between tribal and non-tribal commercial fishers with tribal fishers seeing a total revenue reduction of about $1,128,940, and non-tribal fishers experiencing a total reduction of about $1,324,234 compared to Alternative 1 (these reductions assume that current harvest rates consistent with existing management agreements would be adhered to by both tribal and non-tribal fishers) (Table 4-87).

The lower Columbia River economic impact region would experience the greatest declines in ex-vessel values ($1,324,234), followed by the mid Columbia River economic impact region ($1,062,908), the lower Snake River economic impact region ($49,552), and the upper Columbia River economic impact region ($16,479) compared to Alternative 1 (Table 4-87).

Under the implementation scenario for Alternative 2, net economic values to commercial fishers in the Columbia River basin would decline by about $970,774 compared to Alternative 1, with Chinook salmon and coho salmon accounting for more than 98 percent of this decline ($959,008) (Table 4-88). This decline in commercial fisheries is due to reduced production associated with the closure of hatchery facilities that receive Mitchell Act funding. Chinook salmon is the most valuable commercial fishery in the Columbia River basin. As shown in Table 3-8, Chinook salmon represent 74 percent of all hatchery-origin fish produced at hatcheries in the basin and the net economic value of this fishery would decrease by 31 percent ($491,219) under the implementation scenario for Alternative 2 compared to Alternative 1 (Table 4-88).

In the Pacific Ocean and Puget Sound, the decline in commercial harvest and ex-vessel value associated with reduced Columbia River hatchery production under the implementation scenario for Alternative 2 is estimated at 59,395 fish (Chinook salmon, coho salmon, sockeye salmon, and steelhead) and $2,215,887, respectively, compared to Alternative 1 (Table 4-89 and Table 4-90). The largest reduction in ex-vessel values would occur in the commercial fisheries of British Columbia ($1,009,634), followed by the Washington coast ($711,642), Southeast Alaska ($263,322), Oregon coast ($153,710), and Puget Sound/Strait of Juan de Fuca ($77,578) (Table 4-90).

Under the implementation scenario for Alternative 2, reductions in net economic values in the Pacific Ocean and Puget Sound would be $937,311 compared to Alternative 1, with the regional distribution of declines generally following the pattern for reduced ex-vessel values (Table 4-88). Similar to the Columbia River basin, Chinook salmon is the most valuable commercial fishery in the Pacific Ocean and Puget Sound. The net economic value of this fishery would decrease by 7 percent ($865,497) under the implementation scenario for Alternative 2 compared to Alternative 1 (Table 4-88).

4.3.4.2.2 Recreational Harvest and Economic Values

The implementation scenario for Alternative 2 would result in the recreational catch of salmon and steelhead in the Columbia River basin to decline by 75,103 fish, a reduction of 41 percent compared to Alternative 1 (Table 4-91). Recreational fishing trips would decline by 249,087 trips, and trip-related expenditures would be reduced by an estimated $19,533,393 compared to Alternative 1 (Table 4-91). The largest changes would occur in the lower Columbia River economic impact region, with the catch of salmon and steelhead reduced by 47,740 fish and trip-related expenditures reduced by $12,611,436 (47 percent) compared to Alternative 1 (Table 4-91). Other economic impact regions would experience decreases in expenditures of $3,380,914 (67 percent) for the mid Columbia River economic impact region, $3,178,287 (22 percent) for the lower Snake River economic impact region, and $362,756 (34 percent) for the upper Columbia River economic impact region compared to Alternative 1 (Table 4-91).

Net economic values associated with recreational fishing for salmon and steelhead in the Columbia River basin would be reduced by $14,726,016 under the implementation scenario for Alternative 2 compared to Alternative 1 (Table 4-92). Steelhead is the most valuable recreational fishery in the Columbia River basin. Under the implementation scenario for Alternative 2, the net economic value of this fishery would decline by 33 percent ($6,451,518) compared to Alternative 1 (Table 4-92). The coho salmon recreational fishery would closely follow with a net economic value decline of $5,675,474 (Table 4-92).

Under the implementation scenario for Alternative 2, the change in recreational catch in the Pacific Ocean and Puget Sound attributable to changes in hatchery production in the Columbia River basin would be an overall reduction of 56,938 fish (Table 4-93), reducing recreational fishing trips by 57,955 trips and trip-related expenditures by $5,342,309 compared to Alternative 1 (Table 4-93). The largest changes would be in the Washington coast economic impact region, where the catch declines would be an estimated 32,724 fish, recreational fishing trips would decline by 28,705 trips, and trip-related spending by $2,021,712 (Table 4-93).

Other economic impact regions with expected substantial reductions compared to Alternative 1 would include the Oregon coast economic impact region (14,588 fish and $1,634,273 in trip-related expenditures) and British Columbia economic impact region (6,835 fish and $1,344,634 trip-related expenditures) (Table 4-93). Southeast Alaska and California would experience the least changes in recreational catch: a reduction in 1,232 fish and 199 fish harvested, respectively, and reduction of $242,459 and $15,261, respectively, in expenditures (Table 4-93).

In comparison to Alternative 1, net economic values to recreational anglers throughout the Pacific Ocean and Puget Sound that are associated with production declines in Columbia River hatchery programs would be reduced region-wide by an estimated $3,405,336 under the implementation scenario for Alternative 2, with the biggest declines along the Washington coast ($1,697,055) (Table 4-92).

4.3.4.3 Alternative 3

4.3.4.3.1 Commercial Harvest and Economic Values

Under the implementation scenario for Alternative 3, the salmon and steelhead harvest in commercial fisheries in the Columbia River basin would decline by about 38,583 fish, reducing ex-vessel value by about $752,118 compared to Alternative 1 (Table 4-86 and Table 4-87). Non-tribal commercial fishers in the lower Columbia River economic impact region would experience the largest reduction in revenues at $620,358 compared to Alternative 1 (Table 4-87). Other ex-vessel value declines in the Columbia River basin would include a reduction of $77,691 for the mid Columbia River economic impact region, $42,644 for the lower Snake River economic impact region, and $11,425 for the upper Columbia River economic impact region compared to Alternative 1 (Table 4-87).

Net economic values to commercial fishers would decline by $322,273, with about 67 percent ($216,645) due to reductions in the harvest of coho salmon (Table 4-88). The net economic value of the Chinook salmon fishery would decline by 7 percent ($106,116) under the implementation scenario for Alternative 3 compared to Alternative 1 (Table 4-88).

In the Pacific Ocean and Puget Sound, the decline in harvest and ex-vessel value under the implementation scenario for Alternative 3 associated with changes in Columbia River hatchery production is estimated at 16,487 fish and $425,009 in ex-vessel value compared to Alternative 1 (Table 4-89 and Table 4-90). The largest reduction in ex-vessel values ($270,313) would occur along the Washington coast (Table 4-90). The non-tribal Chinook salmon fishery in Southeast Alaska would experience increased harvest (2,411 fish), and ex-vessel values would increase by $113,067 (Table 4-89 and Table 4-90). Other declines in ex-vessel values would include a reduction of $188,040 for the British Columbia economic impact region, $113,067 for the Southeast Alaska economic impact region, $66,870 for the Oregon coast economic impact region, and $12,853 for the Puget Sound/Strait of Juan de Fuca economic impact region compared to Alternative 1 (Table 4-90).

Under the implementation scenario for Alternative 3, net economic values in the Pacific Ocean and Puget Sound overall would likely decrease by about $211,732 compared to Alternative 1 (Table 4-88). Chinook salmon is the most valuable commercial fishery in the Pacific Ocean and Puget Sound; the net economic value of this fishery would decline by 1 percent ($167,947) under the implementation scenario for Alternative 3 compared to Alternative 1 (Table 4-88).

4.3.4.3.2 Recreational Harvest and Economic Values

Under the implementation scenario for Alternative 3, the recreational catch of salmon and steelhead in the Columbia River basin would be reduced by 35,171 fish, a reduction of 19 percent relative to catch conditions for Alternative 1 (Table 4-91). Recreational fishing trips would decline by 117,572 trips, and trip-related expenditures would be reduced by an estimated $9,219,968 (Table 4-91).

Similar to the implementation scenario for Alternative 2, the largest changes would occur in the lower Columbia River economic impact region, where about 65 percent (expenditures) of the total changes in the Columbia River basin would occur (22,461 fish, $6,004,748, 22 percent) in trip-related spending) (Table 4-91). Other economic impact regions would experience decreases in expenditures of $1,676,164 (11 percent) for the lower Snake River economic impact region, $1,221,834 (24 percent) for the mid Columbia River economic impact region, and $317,222 (29 percent) for the upper Columbia River economic impact region compared to Alternative 1 (Table 4-91).

Net economic values associated with recreational fishing for salmon and steelhead in the Columbia River basin would be reduced by $6,950,835 under the implementation scenario for Alternative 3 compared to Alternative 1 (Table 4-92). Steelhead is the most valuable recreational fishery in the Columbia River basin; the net economic value of this fishery would decline by 13 percent ($2,511,074) under the implementation scenarios for Alternative 3 compared to Alternative 1; however, the coho salmon recreational fishery would result in the greatest net economic value decline ($3,496,524 [50 percent]) when compared to Alternative 1 (Table 4-92).

The implementation scenario for Alternative 3 would result in a reduction in the recreational catch in the Pacific Ocean and Puget Sound by 26,915 fish (Table 4-93), with 27,792 fewer recreational fishing trips and $2,133,694 less in trip-related expenditures compared to Alternative 1 (Table 4-93) (this change would be entirely attributable to changes in hatchery production in the Columbia River basin). Similar to the implementation scenario for Alternative 2, the largest changes would be in the Washington coast economic impact region, where the recreational catch would decline by an estimated 18,315 fish, and trip-related spending would decline by $1,131,514 (Table 4-93).

Other economic impact regions with expected substantial reductions compared to Alternative 1 would include the Oregon coast (7,614 fish and $852,986 in trip-related expenditures) and British Columbia (1,173 fish and $230,746 in trip-related expenditures) (Table 4-93). Similar to Alternative 2, Southeast Alaska and California would experience the least changes: an increase of 529 fish and a decrease of

94 fish harvested, respectively, and an increase of $104,108 and decrease of $7,209 in expenditures, respectively.

Net economic values to recreational anglers throughout the Pacific Ocean and Puget Sound would decline region-wide by an estimated $1,652,085 under the implementation scenario for Alternative 3 compared to Alternative 1 (Table 4-92).

4.3.4.4 Alternative 4

4.3.4.4.1 Commercial Harvest and Economic Values

For the Columbia River basin, the implementation scenario for Alternative 4 would have the smallest reductions in ex-vessel values and net economic values of the action alternatives based on a decrease of 18,528 fish compared to Alternative 1 (Table 4-86, Table 4-87, and Table 4-88). Non-tribal commercial fishers in the Columbia River basin would experience an increase of $118,144 in total ex-vessel value compared to Alternative 1 (Table 4-87). This increase would result from an increase in Chinook salmon harvest. The increase in values to non-tribal commercial fishers compared to Alternative 1, however, would be offset by reductions to tribal commercial fishers of $137,754 (Table 4-87).

The greatest ex-vessel value change compared to Alternative 1 would be within the lower Columbia River economic impact region (which would be an increase of $118,144), followed by ex-vessel value decreases in the mid Columbia River economic impact region ($65,150), lower Snake River economic impact region ($42,644), and upper Columbia River economic impact region ($29,959) (Table 4-87). The lower Columbia River economic impact region ex-vessel value increase would be a non-tribal increase, whereas decreases in the remaining Columbia River economic impact regions would all be tribal decreases.

For the Columbia River basin overall, ex-vessel values would decline by about $19,609 (Table 4-87), and net economic values would decrease by $99,308 under the implementation scenario for Alternative 4 compared to Alternative 1 (Table 4-88). The net economic value of the Chinook salmon fishery for the Columbia River basin would increase under the implementation scenario for Alternative 4 by 2 percent ($27,659) compared to Alternative 1 (Table 4-88).

In the Pacific Ocean and Puget Sound, the decline in harvest and ex-vessel value under the implementation scenario for Alternative 4 associated with changes in Columbia River hatchery production under the implementation scenario for Alternative 4 are estimated at 6,248 fish and $33,319 in ex-vessel value compared to Alternative 1 (Table 4-89 and Table 4-90). Increases in ex-vessel value in the Southeast Alaska Chinook salmon fishery ($253,515) would mostly offset the predicted decreases elsewhere in the economic impact regions, most notably in the Washington coast economic impact region

($207,890) (Table 4-90). Net economic values in the Pacific Ocean and Puget Sound would decrease under the implementation scenario for Alternative 4 by an estimated $65,769 overall compared to Alternative 1 (Table 4-88). The net economic value of the Chinook salmon fishery would decline under the implementation scenario for Alternative 4 by less than 1 percent ($35,681) compared to Alternative 1 (Table 4-88).

4.3.4.4.2 Recreational Harvest and Economic Values

As with commercial fisheries, the implementation scenario for Alternative 4 would have the least effects on recreational harvest, associated trips, and spending in the Columbia River basin compared to Alternative 1 (Table 4-91). The recreational catch would be reduced by 22,199 fish with a reduction in expenditures of $5,804,415 compared to Alternative 1 (Table 4-91). Catch reductions in the lower Columbia River economic impact region (9,267 fish) would account for about 42 percent of this decline with an expenditure decline of $2,533,036 (9 percent), followed by expenditure reductions in the lower Snake River economic impact region ($1,675,911, 11 percent), the mid Columbia River economic impact region ($1,199,826, 24 percent), and the upper Columbia River ($395,642, 37 percent) (Table 4-91). Region-wide, recreational fishing would decline by an estimated 74,017 trips, and trip-related expenditures would decrease by an estimated $5,804,415 compared to Alternative 1 (Table 4-91).

Net economic values of recreational anglers in the Columbia River basin would be reduced by about $4,375,886 under the implementation scenario for Alternative 4 compared to Alternative 1 (Table 4-92). Steelhead is the most valuable recreational fishery in the Columbia River basin; the net economic value of this fishery would decline under the implementation scenario for Alternative 4 by 8 percent ($1,482,196); however, the coho salmon recreational fishery would result in the greatest net economic value decrease ($2,138,572) (Table 4-92).

In the Pacific Ocean and Puget Sound, the recreational catch of Columbia River salmon under the implementation scenario for Alternative 4 would decline by 26,480 fish, a region-wide reduction of 6 percent compared to Alternative 1 (Table 4-93). The most substantial changes would occur along the Washington coast, where the recreational catch of salmon would decline by 22,888 fish, and trip-related expenditures would decrease by $1,414,037 (Table 4-93). The Oregon coast economic impact region would experience the next-highest declines, with 4,579 fewer fish, 6,541 fewer trips, and $512,979 less in trip-related expenditures (Table 4-93). Similar to commercial fisheries, recreational fisheries in Southeast Alaska would experience an increase in recreational catch (1,187 fish) and associated numbers of recreational fishing trips (1,041 trips) compared to Alternative 1 (Table 4-93). For the Pacific Ocean and

Puget Sound, net economic values would decline by about $1,542,219 region-wide under the implementation scenario for Alternative 4 compared to Alternative 1 (Table 4-92).

4.3.4.5 Alternative 5

4.3.4.5.1 Commercial Harvest and Economic Values

Under the implementation scenario for Alternative 5, the salmon and steelhead harvest in commercial fisheries in the Columbia River basin would decline by about 28,418 fish, resulting in a reduction in ex-vessel value of $33,622 compared to Alternative 1(Table 4-86 and Table 4-87). Tribal commercial fisheries in the mid Columbia River would increase by $554,624 in ex-vessel values, whereas the non-tribal commercial fisheries in the lower Columbia River would be reduced by $597,678 (Table 4-87). Tribal commercial fisheries in the upper Columbia River would experience a small decrease ($13,882) in ex-vessel values, and tribal fisheries in the lower Snake River would have a small increase ($23,315) compared to Alternative 1 (Table 4-87).

Overall, net economic value for commercial fishers in the Columbia River basin would decline by $90,345 under the implementation scenario for Alternative 5 compared to Alternative 1 (Table 4-88). The net economic value of the Chinook salmon fishery would increase by 8 percent ($130,653) compared to Alternative 1 (Table 4-88).

In the Pacific Ocean and Puget Sound, the decline in harvest and ex-vessel values associated with reduced Columbia River hatchery production under the implementation scenario for Alternative 5 are estimated at 15,355 fish and $366,189 in ex-vessel value compared to Alternative 1 (Table 4-89 and Table 4-90). The largest reduction in ex-vessel values ($271,693) would occur in the commercial fisheries along the Washington coast (Table 4-90).

Overall, net economic values in the Pacific Ocean and Puget Sound under the implementation scenarios for Alternative 5 would likely decrease by about $193,395 compared to Alternative 1 (Table 4-88). Chinook salmon is the most valuable commercial fishery in the Pacific Ocean and Puget Sound; the net economic value of this fishery would decline under the implementation scenario for Alternative 5 by 1 percent ($149,611) compared to Alternative 1 (Table 4-88).

4.3.4.5.2 Recreational Harvest and Economic Values

Under the implementation scenario for Alternative 5, declines in recreational catch, trips, and spending in the Columbia River basin would be more than under the implementation scenario for Alternative 4, but less than under the implementation scenarios for Alternative 2 and Alternative 3 compared to Alternative 1 (which was 605,410 trips and $47,476,271) (Table 4-91). Total recreational catch of salmon and steelhead would decline by about 26,181 fish (14 percent) compared to Alternative 1, with recreational fishing trips declining by 88,376 trips, and trip-related expenditures declining by $6,930,418 compared to Alternative 1 (Table 4-91).

About 78 percent in the catch decline (20,219 fish) and reduction in expenditures ($5,422,224, which is 20 percent, compared to Alternative 1) would occur in the lower Columbia River economic impact region (Table 4-91). Other economic impact regions would experience decreases in expenditures of $944,076 (19 percent) for the mid Columbia River economic impact region, $535,280 (4 percent) for the lower Snake River economic impact region, and $28,838 (3 percent) for the upper Columbia River economic impact region (Table 4-91).

Net economic values in the Columbia River basin would be reduced by an estimated $5,224,768, with declines in the coho salmon recreational fishery responsible for about $3,496,524 of this decline (Table 4-92). Steelhead is the most valuable recreational fishery in the Columbia River basin; the net economic value of this fishery would decline under the implementation scenario for Alternative 5 by 6 percent ($1,232,175) compared to Alternative 1 (Table 4-92).

In the Pacific Ocean and Puget Sound, the recreational catch of salmon under Alternative 5 would decline by 26,574 fish, recreational fishing trips would decrease by 27,494 trips, and trip-related expenditures would decrease by $2,064,109 compared to Alternative 1 (Table 4-93). Most of the reductions in expenditures would occur in the Washington coast economic impact region ($1,132,502, 21 percent) of the overall declines, followed by Oregon ($853,098, 20 percent), British Columbia ($187,958, less than 1 percent), Puget Sound/Strait of Juan de Fuca ($15,461, less than 1 percent), and California ($17,209, 17 percent) (Table 4-93). In contrast, expenditures for Southeast Alaska would increase by $132,119 (1 percent) (Table 4-93). Puget Sound and Southeast Alaska net economic values under the implementation scenario for Alternative 5 would decline by an estimated $1,636,855 region-wide compared to Alternative 1 (Table 4-92).

4.3.5 Regional Economic Conditions

The assessment of regional economic conditions incorporates changes in personal income and jobs as key indicators of the direction and magnitude of economic effects (note that personal income differs from net economic value, as described in Section 4.3.4, Harvest and Economic Values). Commercial and recreational fisheries generate personal income and jobs in regional economies through the export of products and services to outside economies (Section 3.3.7, Regional Economic Conditions). Commercial catch is frequently sold directly, or after processing, to individuals or businesses located outside the regional economy. Similarly, non-local recreational anglers (i.e., anglers who do not live in a local area) spend money on guide services, lodging, and other goods and services. These expenditures generate household income and employment in many sectors of the regional economy (Section 3.3.7, Regional Economic Conditions). This regional transfer of money supports payments to labor, and those payments are then re-spent regionally, resulting in a multiplier effect. Additionally, hatchery facility operations, including employment of hatchery workers and procurement of goods and services, directly and indirectly generate economic impacts in the Columbia River basin. The following sections identify the expected incremental changes in regional economic activity by alternative, as represented by income and employment levels.

4.3.5.1 Alternative 1 (No Action)

4.3.5.1.1 Columbia River Basin

Under Alternative 1 for the Columbia River basin, hatchery operations and related fisheries operations for the four economic impact regions combined would contribute $103,988,544 to the regional economy and 2,541 jobs (Table 4-94 and Table 4-95). The income would be derived by commercial fisheries ($7,294,554, 7 percent), recreational fisheries ($35,440,715, 34 percent), and hatchery facility operations and maintenance ($61,253,275, 59 percent) (Table 4-94). Most of this income would be from the lower Columbia River economic impact region ($43,674,176, which represents 42 percent of the income), followed by the lower Snake River economic impact region ($34,040,815, 33 percent), mid Columbia River economic impact region ($18,418,862, 18 percent), and upper Columbia River economic impact region ($7,854,692, 8 percent) (Table 4-94)[2].

Under Alternative 1, hatchery production spending on labor and procurement of goods and services is estimated to generate a total of $61,253,275 in personal income and about 1,225 jobs in the Columbia River basin (Table 4-94 and Table 4-95). Hatchery-generated economic impacts would be greatest in the lower Snake River economic impact region, where $22,589,900 in personal income and 452 jobs are estimated to be supported by hatchery facility operations closely followed by the lower Columbia River economic impact region where $21,452,745 in personal income and 429 jobs support hatchery facility operations (Table 4-94 and Table 4-95).

[2] For a description of how personal income and employment were derived, refer to Appendix J.

4.3.5.1.2 Pacific Ocean and Puget Sound

For the Pacific Ocean and Puget Sound, over 60 percent ($71,147,232) of harvest-related income (commercial and recreational total would be $115,961,205) would be derived from recreational fishing activity (Table 4-96). Income under Alternative 1 is estimated to be the largest in the British Columbia and Southeast Alaska economic impact regions, which contribute $53,594,078 and $33,053,096, respectively (Table 4-96). As shown in Table 3-11, however, the contribution of Columbia River stocks to British Columbia and Southeast Alaska fisheries would be relatively small, particularly in British Columbia. The commercial and recreational fishery personal income in the British Columbia region is estimated to support about 958 jobs (Table 4-97). In the Southeast Alaska economic impact region, total salmon catch is estimated to generate 591 jobs (Table 4-97). In the Puget Sound/Strait of Juan de Fuca economic impact region, the marine salmon fisheries would generate an estimated $14,013,654 in personal income and 251 jobs (Table 4-96 and Table 4-97). The effects in this economic impact region would be almost evenly divided between those generated by commercial fishing and those generated by recreational fishing under Alternative 1 (Table 4-96 and Table 4-97). Columbia River stocks would contribute less than 1 percent of the total harvest in all Puget Sound/Strait of Juan de Fuca marine fisheries except the Chinook salmon recreational fishery (6 percent) (Table 3-11). Thus, changes in hatchery production under Alternative 1 would have less effect on the Puget Sound/Strait of Juan de Fuca economic impact region compared to other economic impact regions (such as the Washington and Oregon coasts) within the Pacific Ocean and Puget Sound.

In Washington and Oregon coast economic impact regions, where Columbia River stocks substantially contribute to the fish caught in most fisheries (Table 3-11), overall regional economic effects would be smaller than in the Columbia River basin, including $11,619,122 in personal income and 352 jobs in the Washington coast economic impact region, and $3,654,964 in personal income and 112 jobs in the Oregon coast economic impact region (Table 4-96).

4.3.5.2 Alternative 2

4.3.5.2.1 Columbia River Basin

Under the implementation scenario for Alternative 2, commercial and recreational harvest would decrease in all Columbia River basin economic impact regions relative to Alternative 1, resulting in reduced personal income and employment within all economic impact regions for these two catch types (Table 4-94 and Table 4-95). In addition, changes in hatchery operations would reduce hatchery costs in all Columbia River basin economic impact regions, thereby resulting in reduced personal income and employment within all economic impact regions (Table 4-94 and Table 4-95). This decline would be driven largely by the decrease in hatchery production.

Based on salmon catch estimates and hatchery operations, the overall decline would likely be greatest in the lower Columbia River economic impact region, where income and employment would decrease by $22,091,715 and 508 jobs (Table 4-94 and Table 4-95). On a percentage basis, however, the decline would be largest in the mid Columbia River economic impact region, where income and employment would decrease an estimated 61and 60 percent, respectively, ($11,227,636 and 275 jobs) relative to Alternative 1 (Table 4-94 and Table 4-95).

4.3.5.2.2 Pacific Ocean and Puget Sound

Under Alternative 2, personal income and employment would decrease overall and in all coastal economic impact regions under the implementation scenario compared to Alternative 1 (Table 4-96 and Table 4-97). These reductions would be largest in the Washington coast economic impact region ($3,883,875 and 118 jobs) and British Columbia (a decrease of $2,903,485 in personal income and a loss of 52 jobs) (Table 4-96 and 4-97). For the Washington and Oregon coast economic impact regions, personal income and employment would decline by about 33 to 37 percent, respectively, in these two coastal economic impact regions compared to the implementation scenario under Alternative 1 (Table 4-96 and Table 4-97). Personal income and employment also would decrease in California, but, relative to Alternative 1, the declines would be minor, resulting in the loss of $9,678 in income and no jobs (Table 4-96 and Table 4-97).

Although the total personal income loss would be $2,903,485 from 52 fewer jobs in the British Columbia economic impact region under the implementation scenario for Alternative 2, this amounts to a decrease of only 5 percent compared to the implementation scenario under Alternative 1 (Table 4-96 and Table 4-97). The impact on the Southeast Alaska economic impact region would be less than 2 percent ($591,429 in personal income and 11 jobs) (Table 4-96 and Table 4-97). In the Puget Sound/Strait of Juan de Fuca economic impact region, regional economic impacts of the implementation scenario for Alternative 2 would be small ($387,331 in personal income, 7 jobs, 3 percent) relative to Alternative 1 (Table 4-96 and Table 4-97).

4.3.5.3 Alternative 3

4.3.5.3.1 Columbia River Basin

Under the implementation scenario for Alternative 3, personal income and employment related to harvest would decrease in all economic impact regions within the Columbia River basin, relative to Alternative 1 (Table 4-94 and Table 4-95). These reductions, however, would not be as large as under the implementation scenario for Alternative 2 (Table 4-94 and Table 4-95). In absolute terms, the reduction in harvest-related regional economic activity would be greatest in the lower Columbia River economic impact region, where personal income would be reduced by $10,144,401 (23 percent) and employment would decrease by 234 jobs (23 percent) (Table 4-94 and Table 4-95). The three other Columbia River basin economic impact regions would have personal income losses of less than 10 percent and job losses of less than 11 percent, with the upper Columbia River economic impact region having the least impacts (Table 4-94 and Table 4-95).

Under the implementation scenario for Alternative 3, economic activity supported by hatchery facility operations and maintenance would decrease in the Columbia River basin, resulting in the total loss of an estimated $5,116,406 in personal income and 102 jobs (8 percent) compared to Alternative 1 (Table 4-94 and Table 4-95). Hatchery facility operation income and job losses, which would be lower than under the implementation scenario for Alternative 2, would occur in three of the basin's four economic impact regions (Table 4-94 and Table 4-95). Relative to Alternative 1, these reductions would be largest in the lower Columbia River economic impact region, where personal income and employment would decline by an estimated $5,065,077 and 101 jobs, a 24 percent reduction (Table 4-94 and Table 4-95). Hatchery production, relative to Alternative 1, would increase in the upper Columbia River and lower Snake River economic impact regions, resulting in an estimated increase of $118,706 in personal income and 2 jobs in the upper Columbia River economic impact region, and an increase of $95,775 in personal income and 2 jobs in the lower Snake River economic impact region (Table 4-94 and Table 4-95).

4.3.5.3.2 Pacific Ocean and Puget Sound

Under the implementation scenario for Alternative 3, harvest-related reductions in personal income and jobs relative to Alternative 1 would be less than half the reduction that would occur under the implementation scenario for Alternative 2 (Table 4-96 and 4-97). For the Puget Sound/Strait of Juan de Fuca, British Columbia, and Southeast Alaska economic impact regions, the reductions would be 1 percent or less (Table 4-96 and Table 4-97). In the Oregon and Washington coast economic impact regions, where contributions of Columbia River stocks are substantial, harvest-related reductions in personal income and jobs would be larger, at 19 percent ($686,559 and 21 jobs) and 16 percent ($1,904,227 and 58 jobs), respectively. compared to Alternative 1 (Table 4-96 and Table 4-97). Although the percentage loss in California would be similar (17 percent), the loss in income would be low ($4,562, and no jobs) compared to Alternative 1 (Table 4-96 and Table 4-97).

4.3.5.4 Alternative 4

4.3.5.4.1 Columbia River Basin

The decrease in personal income ($4,936,470) and jobs (156 jobs) under the implementation scenario for Alternative 4 compared to Alternative 1 would be lower (a 5 percent decrease for income and 6 percent decrease for jobs) than the decrease projected under the implementation scenarios for Alternative 2 and Alternative 3 and would be consistently lower for commercial (except for the lower Columbia River economic impact region), recreational, and hatchery facility operations (Table 4-94 and Table 4-95). Within economic impact regions, the percentage decrease in commercial and recreational harvest under the implementation scenario for Alternative 4 would be greatest for the upper Columbia River economic impact region compared to Alternative 1, with economic activity based on the commercial harvest expected to decrease by 42 percent ($35,865 in personal income and 1 job) and economic activity based on the recreational harvest expected to decrease by 37 percent ($295,344 in personal income, 10 jobs, 37 percent) compared to Alternative 1 (Table 4-94 and Table 4-95). Decreases in hatchery facility operation and maintenance would be greatest for the mid Columbia River economic impact region ($218,901 in personal income, 4 jobs, 2 percent), followed by the lower Columbia River economic impact region ($30,396 in personal income, 1 job, less than 1 percent) (Table 4-94 and Table 4-95). The greatest regional income decrease would be in the lower Columbia River economic impact region, where the implementation scenario for Alternative 4 would result in an income loss of $1,898,778 (4 percent) and a loss of 50 jobs (5 percent) compared to Alternative 1 (Table 4-94 and Table 4-95).

4.3.5.4.2 Pacific Ocean and Puget Sound

The overall decrease in income and employment under the implementation scenario for Alternative 4 would be $1,993,908 and 70 compared to the implementation scenario for Alternative 1 (Table 4-96 and Table 4-97). Similar to regional economic effects under the implementation scenario for Alternative 3, effects under the implementation scenario for Alternative 4 in the Puget Sound/Strait of Juan de Fuca, British Columbia, and Southeast Alaska economic impact regions would be relatively minor, with personal income and jobs changing less than 2 percent when compared to Alternative 1 (Table 4-96 and Table 4-97). In the Oregon coast economic impact region, regional economic activity (personal income and jobs) generated by salmon harvest would decrease by 12 percent relative to Alternative 1 (Table 4-96 and Table 4-97). This reduction represents an estimated loss of $429,161 in personal income and 13 jobs (Table 4-96 and Table 4-97).

Reductions in regional economic activity (personal income and jobs) within the Washington coast economic impact region are estimated at 18 to 19 percent, respectively, with personal income reduced by $2,077,393 and employment decreasing by 66 jobs compared to Alternative 1 (Table 4-96 and Table 4-97). For California, the reduction in personal income is estimated at 9 percent, with personal income reduced by $2,413 with no job losses (Table 4-96 and Table 4-97).

4.3.5.5 Alternative 5

4.3.5.5.1 Columbia River Basin

Under the implementation scenario for Alternative 5, the change in personal income and jobs for the Columbia River basin related to the commercial harvest would be less severe than under the implementation scenarios for Alternative 2 and Alternative 3, and similar to the expected economic effects under the implementation scenario for Alternative 4 (Table 4-94 and Table 4-95). This alternative would have the least effects on commercial fisheries than any of the action alternatives compared to Alternative 1 (Table 4-94 and Table 4-95).

Under the implementation scenario for Alternative 5, overall regional impacts would be greatest in the lower Columbia River economic impact region, with a 15 percent reduction in economic activity, including a $6,634,815 loss in personal income and the loss of 161 jobs (Table 4-94 and Table 4-95). About 30 percent of this reduction ($2,004,533 in personal income and 40 jobs) would be attributable to hatchery facility operations (Table 4-94 and Table 4-95). Economic activity associated with hatchery facility operations and maintenance under the implementation scenario for Alternative 5 would increase in three of the four economic impact regions in the Columbia River basin, but the primary increase would occur in the lower Snake River economic impact region ($2,391,283 and 48 jobs) (Table 4-94 and Table 4-95).

4.3.5.5.2 Pacific Ocean and Puget Sound

The overall income and employment effects under the implementation scenario for Alternative 5 would be similar as under the implementation scenario for Alternative 3 (Table 4-96 and Table 4-97). Under the implementation scenario for Alternative 5, regional economic effects in the Puget Sound/Strait of Juan de Fuca, British Columbia, and Southeast Alaska economic impact regions would be similar to the relatively minor effects under the other action alternatives, with economic activity affecting these economic impact regions under this alternative by 1 percent or less (Table 4-96 and Table 4-97). Impacts would be greater in the Oregon and Washington coast economic impact regions where Columbia River stocks are important compared to Puget Sound/Strait of Juan de Fuca, British Columbia, and Southeast Alaska (Table 4-96 and Table 4-97). Regional economic activity related to salmon catch would decrease by

19 percent in the Oregon coast economic impact region and by 16 to 17 percent in the Washington coast economic impact region, compared to Alternative 1 (Table 4-96 and Table 4-97).

Within the Oregon coast economic impact region, personal income under the implementation scenario for Alternative 5 is estimated to decrease by $687,006 and employment by 21 jobs compared to Alternative 1 (Table 4-96 and Table 4-97). Estimated impacts within the Washington coast economic impact region include $1,908,275 in reduced income and 58 fewer jobs compared to Alternative 1 (Table 4-96 and Table 4-97). As with the other alternatives, regional economic effects within the California coast economic impact region would be negligible, with income related to recreational fishing decreasing by $4,562 (Table 4-96).

This page left blank intentionally.

Table 4-85. Estimates of Annual Hatchery Facility Costs (millions of U.S. dollars) by Alternative.

Hatchery Operator	Alternative 1 (No Action)		Alternative 2			Alternative 3				Alternative 4				Alternative 5			
	Smolt Production Costs U.S. Dollars ($)[2]	Total Cost U.S. Dollars ($)	Smolt Production Costs U.S. Dollars ($)	BMP Costs U.S. Dollars ($)	Total Cost U.S. Dollars ($)	Smolt Production Costs U.S. Dollars ($)	BMP Costs[1] U.S. Dollars ($)	New Weir Costs[1] U.S. Dollars ($)	Total Cost U.S. Dollars ($)	Smolt Production Costs U.S. Dollars ($)	BMP Costs[1] U.S. Dollars ($)	New Weir Costs[1] U.S. Dollars ($)	Total Cost U.S. Dollars ($)	Smolt Production Costs U.S. Dollars ($)	BMP Costs[1] U.S. Dollars ($)	New Weir Costs[1] U.S. Dollars ($)	Total Cost U.S. Dollars ($)
WDFW																	
MA Hatchery Programs	7.0		0.0			4.0				5.9				5.2			
Non-MA Hatchery Programs	16.6		12.1			12.4				12.2				11.8			
All Hatchery Programs	23.6	23.6	12.1	0.9	13.0	16.4	1.3		17.7	18.1	1.3		19.4	17.0	1.3		18.3
ODFW																	
MA Hatchery Programs	6.8		0.0			6.4				6.6				7.1			
Non-MA Hatchery Programs	10.4		8.7			9.8				10.0				9.4			
All Hatchery Programs	17.2	17.2	8.7	0.5	9.2	16.2	0.6		16.8	16.6	0.6		17.2	16.5	0.6		17.1
USFWS																	
MA Hatchery Programs	7.1		0.0			6.9				6.9				7.8			
Non-MA Hatchery Programs	5.7		5.1			5.1				5.1				4.6			
All Hatchery Programs	12.8	12.8	5.1	2.8	7.9	12.0	5.5		17.5	12.0	5.5		17.5	12.4	5.5		17.9
IDFG																	
MA Hatchery Programs	0.0		0.0			0.0				0.0				1.8			
Non-MA Hatchery Programs	17.0		14.8			15.7				15.7				16.0			
All Hatchery Programs	17.0	17.0	14.8	0.7	15.5	15.7	0.7		16.4	15.7	0.7		16.4	17.8	0.7		18.5
Yakama Nation																	
MA Hatchery Programs	0.9		0.0			0.8				0.8				0.8			
Non-MA Hatchery Programs	0.6		0.6			0.6				0.6				0.6			
All Hatchery Programs	1.5	1.5	0.6	0.1	0.7	1.4	0.1		1.5	1.4	0.1		1.5	1.4	0.1		1.5
Nez Perce Tribe																	
MA Hatchery Programs	0.0		0.0			0.0				0.0				0.0			
Non-MA Hatchery Programs	0.9		0.9			0.9				0.9				0.9			
All Hatchery Programs	0.9	0.9	0.9		0.9	0.9			0.9	0.9			0.9	0.9			0.9
Confederated Tribes of the Umatilla Indian Reservation (CTUIR)																	
MA Hatchery Programs	0.0		0.0			0.0				0.0				0.0			
Non-MA Hatchery Programs	0.6		0.3			0.3				0.3				0.3			
All Hatchery Programs	0.6	0.6	0.3		0.3	0.3			0.3	0.3			0.3	0.3			0.3
Jointly Funded Hatchery Programs																	
MA Hatchery Programs	0.8		0.0			1.6				1.6				1.8			
Non-MA Hatchery Programs	5.1		4.3			4.2				4.2				4.8			
All Hatchery Programs	6.0	6.0	4.3	0.04	4.34	5.8	0.04		5.84	5.8	0.04		5.84	6.6	0.04		6.64
ALL OPERATORS (TOTAL)																	
MA Hatchery Programs	22.5		0.0			19.6				21.8				24.5			
NON-MA Hatchery Programs	57.0		46.8			48.9				49.1				48.4			
ALL Hatchery Programs	79.5	79.5	46.8	5.1	51.9	68.5	8.24	0.2	76.9	70.9	8.24	0.3	79.4	72.9	8.24	0.4	81.5

[1] BMP and new weir costs are annualized.

[2] All dollar values are expressed in 2007 dollars.

MA = Funded by the Mitchell Act.

Non-MA = Funded by a source other than the Mitchell Act.

Source: Estimates are based on average costs per smolt available from selective hatchery programs (Appendix J), and on BMP and weir cost estimates provided by D.J. Warren and Associates (D. Warren, pers. comm., D.J. Warren and Associates, June 13, 2009). Refer to Appendix J for additional methodology details.

TABLE 4-86. EFFECTS ON COMMERCIAL HARVEST IN THE COLUMBIA RIVER BASIN BY ALTERNATIVE.

	ALTERNATIVE 1 (NO ACTION)[1]	ALTERNATIVE 2			ALTERNATIVE 3			ALTERNATIVE 4			ALTERNATIVE 5		
			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1	
ECONOMIC IMPACT REGION	NUMBER OF FISH	NUMBER OF FISH	NUMBER OF FISH	PERCENT (%)	NUMBER OF FISH	NUMBER OF FISH	PERCENT (%)	NUMBER OF FISH	NUMBER OF FISH	PERCENT (%)	NUMBER OF FISH	NUMBER OF FISH	PERCENT (%)
Lower Columbia River													
Non-tribal	79,557	25,230	-54,327	-68.3	56,600	-22,957	-28.9	76,863	-2,694	-3.4	56,848	-22,709	-28.5
Tribal	0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
TOTAL	**79,557**	**25,230**	**-54,327**	**-68.3**	**56,600**	**-22,957**	**-28.9**	**76,863**	**-2,694**	**-3.4**	**56,848**	**-22,709**	**-28.5**
Mid Columbia River													
Non-tribal	0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Tribal	72,190	30,434	-41,756	-57.8	57,436	-14,754	-20.4	57,488	-14,702	-20.4	66,397	-5,793	-8.0
TOTAL	**72,190**	**30,434**	**-41,756**	**-57.8**	**57,436**	**-14,754**	**-20.4**	**57,488**	**-14,702**	**-20.4**	**66,397**	**-5,793**	**-8.0**
Upper Columbia River													
Non-tribal	0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Tribal	1,247	940	-307	-24.6	1,017	-230	-18.4	757	-490	-39.3	980	-267	-21.4
TOTAL	**1,247**	**940**	**-307**	**-24.6**	**1,017**	**-230**	**-18.4**	**757**	**-490**	**-39.3**	**980**	**-267**	**-21.4**
Lower Snake River													
Non-tribal	0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Tribal	5,891	5,145	-746	-12.7	5,249	-642	-10.9	5,249	-642	-10.9	6,242	351	6.0
TOTAL	**5,891**	**5,145**	**-746**	**-12.7**	**5,249**	**-642**	**-10.9**	**5,249**	**-642**	**-10.9**	**6,242**	**351**	**6.0**
ALL COLUMBIA RIVER BASIN													
NON-TRIBAL	**79,557**	**25,230**	**-54,327**	**-68.3**	**56,600**	**-22,957**	**-28.9**	**76,863**	**-2,694**	**-3.4**	**56,848**	**-22,709**	**-28.5**
TRIBAL	**79,328**	**36,519**	**-42,809**	**-54.0**	**63,702**	**-15,626**	**-19.7**	**63,494**	**-15,834**	**-20.0**	**73,619**	**-5,709**	**-7.2**
TOTAL	**158,885**	**61,749**	**-97,136**	**-61.1**	**120,302**	**-38,583**	**-24.3**	**140,357**	**-18,528**	**-11.7**	**130,467**	**-28,418**	**-17.9**

Source: All harvest values in this table were developed by the Mitchell Act Fishery Modeling Team. Refer to Appendix K for harvest modeling details.

[1] All values for Alternative 1 are modeled values; consequently, these values do not match the average annual (2002 through 2006) values presented in Section 3.3, Socioeconomics, which are substantially greater because of a surge in run size between 2002 and 2006.

TABLE 4-87. EFFECTS ON COMMERCIAL GROSS (EX-VESSEL) VALUE IN THE COLUMBIA RIVER BASIN BY ALTERNATIVE.

ECONOMIC IMPACT REGION	ALTERNATIVE 1 (NO ACTION)[1]	ALTERNATIVE 2			ALTERNATIVE 3			ALTERNATIVE 4			ALTERNATIVE 5		
			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1	
	U.S. DOLLARS ($)[2]	U.S. Dollars ($)	U.S. Dollars ($)	PERCENT (%)	U.S. Dollars ($)	U.S. Dollars ($)	PERCENT (%)	U.S. Dollars ($)	U.S. Dollars ($)	PERCENT (%)	U.S. Dollars ($)	U.S. Dollars ($)	Percent (%)
Lower Columbia River													
Non-tribal	2,704,003	1,379,769	-1,324,234	-49.0	2,083,645	-620,358	-22.9	2,822,147	118,144	4.4	2,106,325	-597,678	-22.1
Tribal	0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
TOTAL	**2,704,003**	**1,379,769**	**-1,324,234**	**-49.0**	**2,083,645**	**-620,358**	**-22.9**	**2,822,147**	**118,144**	**4.4**	**2,106,325**	**-597,678**	**-22.1**
Mid Columbia River													
Non-tribal	0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Tribal	3,025,164	1,962,256	-1,062,908	-35.1	2,947,473	-77,691	-2.6	2,960,014	-65,150	-2.2	3,579,788	554,624	18.3
TOTAL	**3,025,164**	**1,962,256**	**-1,062,908**	**-35.1**	**2,947,473**	**-77,691**	**-2.6**	**2,960,014**	**-65,150**	**-2.2**	**3,579,788**	**554,624**	**18.3**
Upper Columbia River													
Non-tribal	0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Tribal	68,202	51,723	-16,479	-24.2	56,778	-11,425	-16.8	38,243	-29,959	-43.9	54,320	-13,882	-20.4
TOTAL	**68,202**	**51,723**	**-16,479**	**-24.2**	**56,778**	**-11,425**	**-16.8**	**38,243**	**-29,959**	**-43.9**	**54,320**	**-13,882**	**-20.4**
Lower Snake River													
Non-tribal	0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
Tribal	391,304	341,751	-49,552	-12.7	348,660	-42,644	-10.9	348,660	-42,644	-10.9	414,619	23,315	6.0
TOTAL	**391,304**	**341,751**	**-49,552**	**-12.7**	**348,660**	**-42,644**	**-10.9**	**348,660**	**-42,644**	**-10.9**	**414,619**	**23,315**	**6.0**
ALL COLUMBIA RIVER BASIN													
NON-TRIBAL	**2,704,003**	**1,379,769**	**-1,324,234**	**-49.0**	**2,083,645**	**-620,358**	**-22.9**	**2,822,147**	**118,144**	**4.4**	**2,106,325**	**-597,678**	**-22.1**
TRIBAL	**3,484,670**	**2,355,730**	**-1,128,940**	**-32.4**	**3,352,910**	**-131,760**	**-3.8**	**3,346,917**	**-137,754**	**-4.0**	**4,048,727**	**564,057**	**16.2**
TOTAL	**6,188,673**	**3,735,500**	**-2,453,174**	**-39.6**	**5,436,555**	**-752,118**	**-12.2**	**6,169,064**	**-19,609**	**-0.3**	**6,155,051**	**-33,622**	**-0.5**

Source: All values were derived based on modeled harvest estimates (Table 4-86) provided by the Mitchell Act Fishery Modeling Team and application of ex-vessel value factors identified in Appendix J.

[1] All values for Alternative 1 are based on modeled harvest values (Table 4-86); consequently, these values do not match the average annual (2002 through 2006) values presented in Section 3.3, Socioeconomics.

[2] All dollar values are expressed in 2007 dollars.

Table 4-88. Net Economic Value of Commercial Fisheries (Tribal and Non-Tribal) in which Columbia River Stocks Contribute by Alternative.

	Alternative 1 (No Action)[1]		Alternative 2		Alternative 3		Alternative 4		Alternative 5	
Economic Impact Region/Species	Number of Fish	Net Economic Value in U.S. Dollars ($)[2]	Number of Fish	Net Economic Value in U.S. Dollars ($)	Number of Fish	Net Economic Value in U.S. Dollars ($)	Number of Fish	Net Economic Value in U.S. Dollars ($)	Number of Fish	Net Economic Value in U.S. Dollars ($)
COLUMBIA RIVER BASIN										
Chinook Salmon	71,342	1,557,396	-22,502	-491,219	-4,861	-106,116	1,267	27,659	5,985	130,653
Coho Salmon	84,863	543,972	-72,978	-467,789	-33,798	-216,645	-19,755	-126,630	-33,798	-216,645
Sockeye Salmon	625	4,006	-11	-70	75	481	75	481	75	481
Steelhead	2,055	14,611	-1,645	-11,696	1	7	-115	-818	-680	-4,835
TOTAL	**158,885**	**2,115,979**	**-97,136**	**-970,774**	**-38,583**	**-322,273**	**-18,528**	**-99,308**	**-28,418**	**-90,345**
PACIFIC OCEAN AND PUGET SOUND										
California Coast										
Chinook Salmon	0	0	0	0	0	0	0	0	0	0
Coho Salmon	0	0	0	0	0	0	0	0	0	0
Steelhead	0	0	0	0	0	0	0	0	0	0
TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Oregon Coast										
Chinook Salmon	5,190	167,481	-1,696	-54,730	-597	-19,265	-469	-15,135	-601	-19,394
Coho Salmon	11,915	85,788	-4,257	-30,650	-2,497	-17,978	-1,668	-12,010	-2,497	-17,978
Steelhead	0	0	0	0	0	0	0	0	0	0
TOTAL	**17,105**	**253,269**	**-5,953**	**-85,380**	**-3,094**	**-37,244**	**-2,137**	**-27,144**	**-3,098**	**-37,373**
Washington Coast										
Chinook Salmon	50,934	1,141,940	-16,642	-373,114	-5,853	-131,224	-4,600	-103,132	-5,889	-132,031
Coho Salmon	81,448	313,575	-8,007	-30,827	-4,906	-18,888	-3,388	-13,044	-4,906	-18,888
Steelhead	0	0	0	0	0	0	0	0	0	0
TOTAL	**132,382**	**1,455,515**	**-24,649**	**-403,941**	**-10,759**	**-150,112**	**-7,988**	**-116,176**	**-10,795**	**-150,919**
Puget Sound/Strait of Juan de Fuca										
Chinook Salmon	43,781	770,546	-3,232	-56,876	-270	-4,754	-45	-794	-275	-4,845
Coho Salmon	199,457	1,288,492	-1,019	-6,584	-699	-4,519	-517	-3,343	-699	-4,519
Steelhead	0	0	0	0	0	0	0	0	0	0
TOTAL	**243,238**	**2,059,038**	**-4,251**	**-63,460**	**-970**	**-9,272**	**-563**	**-4,137**	**-975**	**-9,363**
Southeast Alaska/British Columbia										
Chinook Salmon	589,379	9,695,285	-23,148	-380,777	-772	-12,704	5,069	83,380	405	6,660
Coho Salmon	4,194	11,282	-1,395	-3,753	-892	-2,399	-629	-1,692	-892	-2,399
Steelhead	0	0	0	0	0	0	0	0	0	0
TOTAL	**593,573**	**9,706,566**	**-24,543**	**-384,530**	**-1,664**	**-15,103**	**4,440**	**81,688**	**-487**	**4,260**
ALL PACIFIC OCEAN AND PUGET SOUND										
CHINOOK SALMON	**689,284**	**11,775,252**	**-44,717**	**-865,497**	**-7,492**	**-167,947**	**-45**	**-35,681**	**-6,360**	**-149,611**
COHO SALMON	**297,014**	**1,699,137**	**-14,678**	**-71,814**	**-8,994**	**-43,784**	**-6,202**	**-30,088**	**-8,994**	**-43,784**
STEELHEAD	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
TOTAL	**986,298**	**13,474,389**	**-59,395**	**-937,311**	**-16,486**	**-211,732**	**-6,248**	**-65,769**	**-15,355**	**-193,395**

Source: Catch (number of fish) values for the Columbia River basin, California coast, Oregon coast, and Washington coast are modeled estimates provided by the Mitchell Act Fishery Modeling Team; catch values for Puget Sound and Southeast Alaska/British Columbia are average annual values; net economic value factors identified in Appendix J were applied to these catch estimates.

[1] Alternative 1 values for the Columbia River basin, California coast, Oregon coast, and Washington coast are based on modeled harvest values provided by the Mitchell Act Fishery Modeling Team; consequently, harvest (number of fish) values for these regions in this table do not match average annual harvest values presented in Section 3.3, Socioeconomics.

[2] All dollar values are expressed in 2007 dollars.

TABLE 4-89. EFFECTS ON COMMERCIAL HARVEST IN THE PACIFIC OCEAN AND PUGET SOUND BY ALTERNATIVE.

	Alternative 1 (No Action)[1]	Alternative 2			Alternative 3			Alternative 4			Alternative 5		
			Change from Alternative 1			Change from Alternative 1			Change from Alternative 1			Change from Alternative 1	
Economic Impact Region	Number of Fish	Number of Fish	Number of Fish	Percent (%)	Number of Fish	Number of Fish	Percent (%)	Number of Fish	Number of Fish	Percent (%)	Number of Fish	Number of Fish	Percent (%)
California Coast													
TOTAL	**0**	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**0**	**0**	**0.0**
Oregon Coast (Astoria)													
Non-tribal	17,105	11,152	-5,953	-34.8	14,011	-3,094	-18.1	14,968	-2,137	-12.5	14,007	-3,098	-18.1
Tribal	0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
TOTAL	**17,105**	**11,152**	**-5,953**	**-34.8**	**14,011**	**-3,094**	**-18.1**	**14,968**	**-2,137**	**-12.5**	**14,007**	**-3,098**	**-18.1**
Washington Coast													
Non-tribal	40,268	26,671	-13,597	-33.8	34,278	-5,990	-14.9	35,916	-4,352	-10.8	34,259	-6,009	-14.9
Tribal	92,114	81,062	-11,052	-12.0	87,345	-4,769	-5.2	88,478	-3,636	-3.9	87,328	-4,786	-5.2
TOTAL	**132,382**	**107,733**	**-24,649**	**-18.6**	**121,623**	**10,759**	**-8.1**	**124,394**	**-7,988**	**-6.0**	**121,587**	**-10,795**	**-8.2**
Puget Sound/Strait of Juan de Fuca													
Non-tribal	27,251	26,692	-559	-2.1	27,091	-160	-0.6	27,151	-100	-0.4	27,091	-160	-0.6
Tribal	215,987	212,295	-3,692	-1.7	215,177	-810	-0.4	215,525	-462	-0.2	215,173	-814	-0.4
TOTAL	**243,238**	**238,987**	**-4,251**	**-1.7**	**242,268**	**-970**	**-0.4**	**242,675**	**-563**	**-0.2**	**242,263**	**-975**	**-0.4**
British Columbia (Non-tribal)	281,081	262,153	-18,928	-6.7	277,006	-4,075	-1.4	280,115	-966	-0.3	277,534	-3,547	-1.3
TOTAL	**281,081**	**262,153**	**-18,928**	**-6.7**	**277,006**	**-4,075**	**-1.4**	**280,115**	**-966**	**-0.3**	**277,534**	**-3,547**	**-1.3**
Southeast Alaska (Non-tribal)	312,492	306,877	-5,615	-1.8	314,903	2,411	0.8	317,897	5,405	1.7	315,551	3,059	1.0
TOTAL	**312,492**	**306,877**	**-5,615**	**-1.8**	**314,903**	**2,411**	**0.8**	**317,897**	**5,405**	**1.7**	**315,551**	**3,059**	**1.0**
ALL PACIFIC OCEAN AND PUGET SOUND													
NON-TRIBAL	**678,197**	**633,545**	**-44,652**	**-6.6**	**667,289**	**-10,908**	**-1.6**	**676,047**	**-2,150**	**-0.3**	**668,442**	**-9,755**	**-1.4**
TRIBAL	**308,101**	**293,357**	**-14,744**	**-4.8**	**302,522**	**-5,579**	**-1.8**	**304,003**	**-4,098**	**-1.3**	**302,501**	**-5,600**	**-1.8**
TOTAL	**986,298**	**926,903**	**-59,395**	**-6.0**	**969,811**	**-16,487**	**-1.7**	**980,050**	**-6,248**	**-0.6**	**970,943**	**-15,355**	**-1.6**

Source: Catch (number of fish) values for the Columbia River basin, California coast, Oregon coast, and Washington coast are modeled estimates provided by the Mitchell Act Fishery Modeling Team; catch values for Puget Sound, Southeast Alaska, and British Columbia are average annual values.

[1] Alternative 1 values for the California coast, Oregon coast, and Washington coast are based on modeled harvest values provided by the Mitchell Act Fishery Modeling Team; consequently, harvest (number of fish) values for these regions in this table do not match average annual harvest values presented in Section 3.3, Socioeconomics.

TABLE 4-90. EFFECTS ON COMMERCIAL GROSS (EX-VESSEL) VALUE IN THE PACIFIC OCEAN AND PUGET SOUND BY ALTERNATIVE.

	ALTERNATIVE 1 (NO ACTION)[1]	ALTERNATIVE 2			ALTERNATIVE 3			ALTERNATIVE 4			ALTERNATIVE 5		
			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1	
ECONOMIC IMPACT REGION	U.S. DOLLARS ($)[2]	U.S. DOLLARS ($)	U.S. DOLLARS ($)	PERCENT (%)	U.S. DOLLARS ($)	U.S. DOLLARS ($)	PERCENT (%)	U.S. DOLLARS ($)	U.S. DOLLARS ($)	PERCENT (%)	U.S. DOLLARS ($)	U.S. DOLLARS ($)	PERCENT (%)
California Coast													
TOTAL	**0**	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**0**	**0**	**0.0**	**0**	**0**	**0.0**
Oregon Coast													
Non-tribal	456,162	302,451	-153,710	-33.7	389,292	-66,870	-14.7	407,382	-48,779	-10.7	389,058	-67,104	-14.7
Tribal	0	0	0	0.0	0	0	0.0	0	0	0.0	0	0	0.0
TOTAL	**456,162**	**302,451**	**-153,710**	**-33.7**	**389,292**	**-66,870**	**-14.7**	**407,382**	**-48,779**	**-10.7**	**389,058**	**-67,104**	**-14.7**
Washington Coast													
Non-tribal	1,254,335	840,127	-414,208	-33.0	1,096,668	-157,667	-12.6	1,133,956	-120,379	-9.6	1,095,852	-158,483	-12.6
Tribal	1,440,740	1,143,305	-297,435	-20.6	1,328,093	-112,647	-7.8	1,353,228	-87,511	-6.1	1,327,530	-113,210	-7.9
TOTAL	**2,695,074**	**1,983,432**	**-711,642**	**-26.4**	**2,424,761**	**-270,313**	**-10.0**	**2,487,184**	**-207,890**	**-7.7**	**2,423,382**	**-271,693**	**-10.1**
Puget Sound/Strait of Juan de Fuca													
Non-tribal	336,773	327,123	-9,651	-2.9	334,795	-1,978	-0.6	335,679	-1,095	-0.3	334,783	-1,991	-0.6
Tribal	2,639,040	2,571,112	-67,927	-2.6	2,628,165	-10,874	-0.4	2,633,834	-5,206	-0.2	2,628,070	-10,969	-0.4
TOTAL	**2,975,813**	**2,898,235**	**-77,578**	**-2.6**	**2,962,960**	**-12,853**	**-0.4**	**2,969,512**	**-6,301**	**-0.2**	**2,962,853**	**-12,960**	**-0.4**
British Columbia (Non-tribal)	15,812,038	14,802,404	-1,009,634	-6.4	15,623,999	-188,040	-1.2	15,788,174	-23,864	-0.2	15,654,120	-157,918	-1.0
TOTAL	**15,812,038**	**14,802,404**	**-1,009,634**	**-6.4**	**15,623,999**	**-188,040**	**-1.2**	**15,788,174**	**-23,864**	**-0.2**	**15,654,120**	**-157,918**	**-1.0**
Southeast Alaska (Non-tribal)	14,655,875	14,392,553	-263,322	-1.8	14,768,941	113,067	0.8	14,909,390	253,515	1.7	14,799,362	143,487	1.0
TOTAL	**14,655,875**	**14,392,553**	**-263,322**	**-1.8**	**14,768,941**	**113,067**	**0.8**	**14,909,390**	**253,515**	**1.7**	**14,799,362**	**143,487**	**1.0**
ALL PACIFIC OCEAN AND PUGET SOUND													
NON-TRIBAL	**32,515,183**	**30,664,658**	**-1,850,525**	**-5.7**	**32,213,695**	**-301,488**	**-0.9**	**32,574,580**	**59,398**	**0.2**	**32,273,173**	**-242,009**	**-0.7**
TRIBAL	**4,079,779**	**3,714,417**	**-365,362**	**-9.0**	**3,956,258**	**-123,521**	**-3.0**	**3,987,062**	**-92,717**	**-2.3**	**3,955,600**	**-124,179**	**-3.0**
TOTAL	**36,594,962**	**34,379,075**	**-2,215,887**	**-6.1**	**36,169,953**	**-425,009**	**-1.2**	**36,561,643**	**-33,319**	**-0.1**	**36,228,773**	**-366,189**	**-1.0**

Source: Table developed from harvest estimates from Table 4-89 and application of ex-vessel value factors identified in Appendix J.

[1] Alternative 1 values for the California coast, Oregon coast, and Washington coast are based on modeled harvest values provided by the Mitchell Act Fishery Modeling Team; consequently, harvest (number of fish) values for these regions in this table do not match average annual harvest values presented in Section 3.3, Socioeconomics.

[2] All dollar values are expressed in 2007 dollars.

TABLE 4-91. EFFECTS ON RECREATIONAL CATCH, RECREATIONAL FISHING TRIPS, AND EXPENDITURES IN THE COLUMBIA RIVER BASIN BY ALTERNATIVE.

		ALTERNATIVE 2			ALTERNATIVE 3			ALTERNATIVE 4			ALTERNATIVE 5		
	ALTERNATIVE 1 (NO ACTION)[1]		CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1	
ECONOMIC IMPACT REGION	NUMBER	NUMBER	NUMBER	PERCENT (%)	NUMBER	NUMBER	PERCENT (%)	NUMBER	NUMBER	PERCENT (%)	NUMBER	NUMBER	PERCENT (%)
Lower Columbia River													
Catch (number of fish)	101,282	53,542	-47,740	-47.1	78,821	-22,461	-22.2	92,015	-9,267	-9.1	81,063	-20,219	-20.0
Trips (number of trips)	339,675	178,856	-160,819	-47.3	263,103	-76,572	-22.5	307,374	-32,301	-9.5	270,531	-69,143	-20.4
U.S. Dollar Expenditures ($)[2]	26,637,294	14,025,858	-12,611,436	-47.3	20,632,546	-6,004,748	-22.5	24,104,258	-2,533,036	-9.5	21,215,070	-5,422,224	-20.4
Mid Columbia River													
Catch (number of fish)	19,869	6,504	-13,365	-67.3	15,039	-4,830	-24.3	15,126	-4,743	-23.9	16,137	-3,732	-18.8
Trips (number of trips)	64,094	20,981	-43,113	-67.3	48,513	-15,581	-24.3	48,794	-15,300	-23.9	52,055	-12,039	-18.8
U.S. Dollar Expenditures ($)	5,026,216	1,645,302	-3,380,914	-67.3	3,804,382	-1,221,834	-24.3	3,826,390	-1,199,826	-23.9	4,082,140	-944,076	-18.8
Upper Columbia River													
Catch (number of fish)	4,264	2,830	-1,434	-33.6	3,010	-1,254	-29.4	2,700	-1,564	-36.7	4,150	-114	-2.7
Trips (number of trips)	13,755	9,129	-4,626	-33.6	9,710	-4,045	-29.4	8,710	-5,045	-36.7	13,387	-368	-2.7
U.S. Dollar Expenditures ($)	1,078,654	715,899	-362,756	-33.6	761,433	-317,222	-29.4	683,013	-395,642	-36.7	1,049,816	-28,838	-2.7
Lower Snake River													
Catch (number of fish)	58,245	45,681	-12,564	-21.6	51,619	-6,626	-11.4	51,620	-6,625	-11.4	56,129	-2,116	-3.6
Trips (number of trips)	187,887	147,358	-40,529	-21.6	166,513	-21,374	-11.4	166,516	-21,371	-11.4	181,061	-6,826	-3.6
U.S. Dollar Expenditures ($)	14,734,106	1,555,819	-3,178,287	-21.6	13,057,942	-1,676,164	-11.4	13,058,195	-1,675,911	-11.4	14,198,826	-535,280	-3.6
ALL COLUMBIA RIVER BASIN													
CATCH (NUMBER OF FISH)	**183,660**	**108,557**	**-75,103**	**-40.9**	**148,489**	**-35,171**	**-19.2**	**161,461**	**-22,199**	**-12.1**	**157,479**	**-26,181**	**-14.3**
TRIPS (NUMBER OF TRIPS)	**605,410**	**356,323**	**-249,087**	**-41.1**	**487,839**	**-117,572**	**-19.4**	**531,393**	**-74,017**	**-12.2**	**517,035**	**-88,376**	**-14.6**
U.S. DOLLAR EXPENDITURES ($)	**47,476,271**	**27,942,878**	**-19,533,393**	**-41.1**	**38,256,303**	**-9,219,968**	**-19.4**	**41,671,856**	**-5,804,415**	**-12.2**	**40,545,853**	**-6,930,418**	**-14.6**

Source: Catch (number of fish harvested) values are modeled estimates provided by the Mitchell Act Fishery Modeling Team. Number of trips and expenditures were derived based on the modeled catch estimates shown in the table (Appendix J).

[1] All values for Alternative 1 are based on modeled harvest (number of fish) values; consequently, these values do not match the average annual (2002 through 2006) values presented in Section 3.3, Socioeconomics.

[2] All dollar values are expressed in 2007 dollars.

ABLE 4-92. CHANGE IN NET ECONOMIC VALUE OF RECREATIONAL FISHERIES IN WHICH COLUMBIA RIVER STOCKS CONTRIBUTE BY ALTERNATIVE.

			CHANGE COMPARED TO ALTERNATIVE 1							
	ALTERNATIVE 1 (NO ACTION)		ALTERNATIVE 2		ALTERNATIVE 3		ALTERNATIVE 4		ALTERNATIVE 5	
ECONOMIC IMPACT REGION/SPECIES	NUMBER OF FISH	NET ECONOMIC VALUE IN U. S. DOLLARS ($)[1,2]	NUMBER OF FISH	NET ECONOMIC VALUE IN U. S. DOLLARS ($)	NUMBER OF FISH	NET ECONOMIC VALUE IN U. S. DOLLARS ($)	NUMBER OF FISH	NET ECONOMIC VALUE IN U. S. DOLLARS ($)	NUMBER OF FISH	NET ECONOMIC VALUE IN U. S. DOLLARS ($)
COLUMBIA RIVER BASIN										
Chinook Salmon	45,943	9,172,182	-12,917	-2,599,024	-4,564	-943,237	-3,644	-755,118	-2,280	-496,069
Coho Salmon	35,154	7,059,914	-28,357	-5,675,474	-17,440	-3,496,524	-10,783	-2,138,572	-17,440	-3,496,524
Sockeye Salmon	0	0	0	0	0	0	0	0	0	0
Steelhead	102,563	19,559,757	-33,829	-6,451,518	-13,167	-2,511,074	-7,772	-1,482,196	-6,461	-1,232,175
TOTAL	**183,660**	**35,791,853**	**-75,103**	**-14,726,016**	**-35,171**	**-6,950,835**	**-22,199**	**-4,375,886**	**-26,181**	**-5,224,768**
PACIFIC OCEAN AND PUGET SOUND										
California Coast										
Chinook Salmon	0	0	0	0	0	0	0	0	0	0
Coho Salmon	540	22,642	-199	-8,344	-94	-3,941	-50	-2,096	-94	-3,941
Steelhead	0	0	0	0	0	0	0	0	0	0
TOTAL	**540**	**22,642**	**-199**	**-8,344**	**-94**	**-3,941**	**-50**	**-2,096**	**-94**	**-3,941**
Oregon Coast										
Chinook Salmon	1,734	146,449	-566	-47,803	-199	-16,807	-156	-13,175	-200	-16,891
Coho Salmon	37,057	3,129,728	-14,022	-1,184,258	-7,415	-626,250	-4,423	-373,554	-7,415	-626,250
Steelhead	0	0	0	0	0	0	0	0	0	0
TOTAL	**38,791**	**3,276,177**	**-14,588**	**-1,232,061**	**-7,614**	**-643,057**	**-4,579**	**-386,729**	**-7,615**	**-643,141**
Washington Coast										
Chinook Salmon	22,600	1,172,028	-7,387	-383,087	-2,599	-134,783	-2,042	-105,897	-2,615	-135,613
Coho Salmon	63,925	3,315,128	-25,337	-1,313,968	-15,716	-815,026	-20,846	-1,081,066	-15,716	-815,026
Steelhead	0	0	0	0	0	0	0	0	0	0
TOTAL	**86,525**	**4,487,156**	**-32,724**	**-1,697,055**	**-18,315**	**-949,809**	**-22,888**	**-1,186,963**	**-18,331**	**-950,639**
Puget Sound/Strait of Juan de Fuca										
Chinook Salmon	27,813	1,442,372	-1,135	-58,882	-95	-4,921	-16	-822	-97	-5,016
Coho Salmon	68,860	3,571,055	-224	-11,603	-154	-7,963	-114	-5,890	-154	-7,963
Steelhead	0	0	0	0	0	0	0	0	0	0
TOTAL	**96,673**	**5,013,427**	**-1,359**	**-70,485**	**-248**	**-12,884**	**-129**	**-6,713**	**-250**	**-12,979**
Southeast Alaska/British Columbia										
Chinook Salmon	178,367	8,073,260	-8,055	-396,769	-637	-42,030	1,170	40,490	-277	-25,792
Coho Salmon	29,083	1,508,234	-12	-622	-7	-363	-4	-207	-7	-363
Steelhead	0	0	0	0	0	0	0	0	0	0
TOTAL	**207,450**	**9,581,494**	**-8,067**	**-397,391**	**-644**	**-42,393**	**1,166**	**40,283**	**-284**	**-26,155**
ALL PACIFIC OCEAN AND PUGET SOUND										
CHINOOK SALMON	**230,514**	**10,834,108**	**-17,144**	**-886,541**	**-3,530**	**-198,542**	**-1,044**	**-79,405**	**-3,189**	**-183,312**
COHO SALMON	**199,465**	**11,546,788**	**-39,794**	**-2,518,795**	**-23,386**	**-1,453,543**	**-25,437**	**-1,462,814**	**-23,386**	**-1,453,543**
STEELHEAD	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
TOTAL	**429,979**	**22,380,896**	**-56,938**	**-3,405,336**	**-26,915**	**-1,652,085**	**-26,480**	**-1,542,219**	**-26,574**	**-1,636,855**

Source: Catch (number of fish harvested) values are modeled estimates provided by the Mitchell Act Fishery Modeling Team (Appendix K). Application of net income (net economic value) factors for recreational fishing are identified in Appendix J.

[1] All dollar values are expressed in 2007 dollars.

[2] Values in this table for the Columbia River basin and for the California, Oregon, and Washington coasts for Alternative 1 do not match those in Section 3.3, Socioeconomics, because these values are based on modeled estimates of harvest provided by the Mitchell Act Fishery Modeling Team.

TABLE 4-93. EFFECTS ON RECREATIONAL CATCH, RECREATIONAL FISHING TRIPS, AND EXPENDITURES IN THE PACIFIC OCEAN AND PUGET SOUND BY ALTERNATIVE.

	ALTERNATIVE 1 (NO ACTION)[1]	ALTERNATIVE 2			ALTERNATIVE 3			ALTERNATIVE 4			ALTERNATIVE 5		
			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1	
ECONOMIC IMPACT REGION	NUMBER	NUMBER	NUMBER	PERCENT (%)	NUMBER	NUMBER	PERCENT (%)	NUMBER	NUMBER	PERCENT (%)	NUMBER	NUMBER	PERCENT (%)
California Coast													
Catch (number of fish)	540	341	-199	-36.9	446	-94	-17.4	490	-50	-9.3	446	-94	-17.4
Trips (number of trips)	383	242	-141	-36.9	316	-67	-17.4	348	-35	-9.3	316	-67	-17.4
U.S. Dollar Expenditures ($)[2]	41,411	26,151	-15,261	-36.9	34,203	-7,209	-17.4	37,577	-3,834	-9.3	34,203	-7,209	-17.4
Oregon Coast													
Catch (number of fish)	38,791	24,203	-14,588	-37.6	31,177	-7,614	-19.6	34,212	-4,579	-11.8	31,176	-7,615	-19.6
Trips (number of trips)	55,416	34,576	-20,840	-37.6	44,539	-10,877	-19.6	48,874	-6,541	-11.8	44,537	-10,879	-19.6
U.S. Dollar Expenditures ($)	4,345,700	2,711,428	-1,634,273	-37.6	3,492,715	-852,986	-19.6	3,832,721	-512,979	-11.8	3,492,603	-853,098	-19.6
Washington Coast													
Catch (number of fish)	86,525	53,801	-32,724	-37.8	68,210	-18,315	-21.2	63,637	-22,888	-26.5	68,194	-18,331	-21.2
Trips (number of trips)	75,899	47,194	-28,705	-37.8	59,833	-16,066	-21.2	55,822	-20,077	-26.5	59,819	-16,080	-21.2
U.S. Dollar Expenditures ($)	5,345,575	3,323,864	-2,021,712	-37.8	4,214,062	-1,131,514	-21.2	3,931,539	-1,414,037	-26.5	4,213,073	-1,132,502	-21.2
Puget Sound/Strait of Juan de Fuca													
Catch (number of fish)	96,673	95,314	-1,359	-1.4	96,425	-248	-0.3	96,544	-129	-0.1	96,423	-250	-0.3
Trips (number of trips)	84,801	83,609	-1,192	-1.4	84,583	-218	-0.3	84,687	-114	-0.1	84,581	-220	-0.3
U.S. Dollar Expenditures ($)	5,972,526	5,888,556	-83,970	-1.4	5,957,177	-15,349	-0.3	5,964,529	-7,997	-0.1	5,957,065	-15,461	-0.3
British Columbia													
Catch (number of fish)	138,334	131,499	-6,835	-4.9	137,161	-1,173	-0.8	138,314	-20	0.0	137,379	-955	-0.7
Trips (number of trips)	121,346	115,350	-5,996	-4.9	120,317	-1,029	-0.8	121,328	-18	0.0	120,508	-838	-0.7
U.S. Dollar Expenditures ($)	27,214,181	25,869,546	-1,344,634	-4.9	26,983,435	-230,746	-0.8	27,210,201	-3,980	0.0	27,026,223	-187,958	-0.7
Southeast Alaska													
Catch (number of fish)	69,116	67,884	-1,232	-1.8	69,645	529	0.8	70,303	1,187	1.7	69,788	672	1.0
Trips (number of trips)	60,628	59,547	-1,081	-1.8	61,092	464	0.8	61,669	1,041	1.7	61,217	589	1.0
U.S. Dollar Expenditures ($)	13,597,057	13,354,598	-242,459	-1.8	13,701,166	104,108	0.8	13,830,487	233,430	1.7	13,729,176	132,119	1.0
ALL PACIFIC OCEAN AND PUGET SOUND													
CATCH (NUMBER OF FISH)	**429,979**	**373,041**	**-56,938**	**-13.2**	**403,064**	**-26,915**	**-6.3**	**403,499**	**-26,480**	**-6.2**	**403,405**	**-26,574**	**-6.2**
TRIPS (NUMBER OF TRIPS)	**398,473**	**340,517**	**-57,955**	**-14.5**	**370,680**	**-27,792**	**-7.0**	**372,728**	**-25,745**	**-6.5**	**370,978**	**-27,494**	**-6.9**
U.S. DOLLAR EXPENDITURES ($)	**56,516,450**	**51,174,142**	**-5,342,309**	**-9.5**	**54,382,756**	**-2,133,694**	**-3.8**	**54,807,054**	**-1,709,397**	**-3.0**	**54,452,342**	**-2,064,109**	**-3.7**

Source: Catch (number of fish harvested), trips and expenditure values for Alternative 1 for the Puget Sound, British Columbia, and Southeast Alaska are based on average annual values. All other values are based on modeled estimates of harvest provided by the Mitchell Act Fishery Modeling Team and shown in the table. The number of trips and expenditures for all alternatives were derived based on the catch estimates shown in the table (Appendix J).

[1] Alternative 1 values for the California coast, Oregon coast, and Washington coast are based on modeled harvest (number of fish) values; consequently, these values do not match the average annual (2002 through 2006) values presented in Section 3.3, Socioeconomics. Alternative 1 values for Puget Sound, British Columbia, and Southeast Alaska are based on average annual (2002 though 2006) values and therefore match the values presented in Section 3.3, Socioeconomics.

[2] All dollar values are expressed in 2007 dollars.

TABLE 4-94. TOTAL (DIRECT AND SECONDARY) ECONOMIC IMPACTS ON INCOME IN THE COLUMBIA RIVER BASIN BY ALTERNATIVE.

		Alternative 2			Alternative 3			Alternative 4			Alternative 5		
	Alternative 1 (No Action)		Change from Alternative 1			Change from Alternative 1			Change from Alternative 1			Change from Alternative 1	
Economic Impact Region	U.S. Dollars ($)[1]	U.S. Dollars ($)	U.S. Dollars ($)	Percent (%)	U.S. Dollars ($)	U.S. Dollars ($)	Percent (%)	U.S. Dollars ($)	U.S. Dollars ($)	Percent (%)	U.S. Dollars ($)	U.S. Dollars ($)	Percent (%)
Lower Columbia River													
Commercial	2,336,871	994,224	-1,342,646	-57.5	1,740,050	-596,820	-25.5	2,359,383	22,512	1.0	1,754,242	-582,629	-24.9
Recreational	19,884,560	10,470,208	-9,414,352	-47.3	15,402,056	-4,482,504	-22.5	17,993,666	-1,890,894	-9.5	15,836,906	-4,047,654	-20.4
Hatchery Facility Operations	21,452,745	10,118,029	-11,334,716	-52.8	16,387,668	-5,065,077	-23.6	21,422,349	-30,396	-0.1	19,448,213	-2,004,533	-9.3
TOTAL	**43,674,176**	**21,582.461**	**-22,091,715**	**-50.6**	**33,529,775**	**-10,144,401**	**-23.2**	**41,775,398**	**-1,898,778**	**-4.3**	**37,039,361**	**-6,634,815**	**-15.2**
Mid Columbia River													
Commercial	4,419,786	2,308,448	-2,111,338	-47.8	3,891,504	-528,282	-12.0	3,897,901	-521,885	-11.8	4,582,321	162,535	3.7
Recreational	3,752,036	1,228,207	-2,523,829	-67.3	2,839,945	-912,091	-24.3	2,856,374	-895,662	-23.9	3,047,290	-704,746	-18.8
Hatchery Facility Operations	10,247,039	3,654,571	-6,592,468	-64.3	9,981,230	-265,809	-2.6	10,028,138	-218,901	-2.1	10,365,152	118,113	1.2
TOTAL	**18,418,862**	**7,191,226**	**-11,227,636**	**-61.0**	**16,712,679**	**1,706,183**	**-9.3**	**16,782,414**	**-1,636,448**	**-8.9**	**17,994,764**	**-424,098**	**-2.3**
Upper Columbia River													
Commercial	85,892	64,955	-20,937	-24.4	70,823	-15,070	-17.5	50,027	-35,865	-41.8	67,984	-17,909	-20.9
Recreational	805,208	534,414	-270,795	-33.6	568,405	-236,804	-29.4	509,865	-295,344	-36.7	783,681	-21,528	-2.7
Hatchery Facility Operations	6,963,591	6,900,758	-62,834	-0.9	7,082,297	118,706	1.7	7,093,385	129,794	1.9	7,993,778	1,030,187	14.8
TOTAL	**7,854,692**	**7,500,127**	**-354,566**	**-4.5**	**7,721,524**	**-133,168**	**-1.7**	**7,653,277**	**-201,415**	**-2.6**	**8,845,442**	**990,751**	**12.6**
Lower Snake River													
Commercial	452,005	394,766	-57,239	-12.7	402,745	-49,259	-10.9	402,745	-49,259	-10.9	478,936	26,932	6.0
Recreational	10,998,911	8,626,341	-2,372,570	-21.6	9,747,665	-1,251,245	-11.4	9,747,854	-1,251,056	-11.4	10,599,328	-399,583	-3.6
Hatchery Facility Operations	22,589,900	19,301,015	-3,288,885	-14.6	22,685,675	95,775	0.4	22,690,385	100,486	0.4	24,981,182	2,391,283	10.6
TOTAL	**34,040,815**	**28,322,121**	**-5,718,693**	**-16.8**	**32,836,085**	**-1,204,730**	**-3.5**	**32,840,985**	**-1,199,830**	**-3.5**	**36,059,446**	**2,018,632**	**5.9**
ALL COLUMBIA RIVER BASIN													
COMMERCIAL	**7,294,554**	**3,762,393**	**-3,532,160**	**-48.4**	**6,105,122**	**-1,189,431**	**-16.3**	**6,710,056**	**-584,497**	**-8.0**	**6,883,483**	**-411,071**	**-5.6**
RECREATIONAL	**35,440,715**	**20,859,170**	**-14,581,546**	**-41.1**	**28,558,071**	**-6,882,644**	**-19.4**	**31,107,759**	**-4,332,956**	**-12.2**	**30,267,205**	**-5,173,511**	**-14.6**
HATCHERY FACILITY OPERATIONS	**61,253,275**	**39,974,372**	**-21,278,903**	**-34.7**	**56,136,869**	**-5,116,406**	**-8.4**	**61,234,258**	**-19,017**	**0.0**	**62,788,326**	**1,535,050**	**2.5**
TOTAL	**103,988,544**	**64,595,934**	**-39,392,610**	**-37.9**	**90,800,063**	**-13,188,481**	**-12.7**	**99,052,073**	**-4,936,470**	**-4.7**	**99,939,014**	**-4,049,530**	**-3.9**

Source: Based on modeled estimates of harvest provided by the Mitchell Act Fishery Modeling Team (Appendix K) and application of personal income factors identified in Appendix J.

[1] All dollar values are expressed in 2007 dollars.

TABLE 4-95. TOTAL (DIRECT AND SECONDARY) ECONOMIC IMPACTS ON JOBS IN THE COLUMBIA RIVER BASIN BY ALTERNATIVE.

ECONOMIC IMPACT REGION	ALTERNATIVE 1 (NO ACTION)	ALTERNATIVE 2			ALTERNATIVE 3			ALTERNATIVE 4			ALTERNATIVE 5		
			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1	
	NUMBER OF JOBS[1]	NUMBER OF JOBS	NUMBER OF JOBS	PERCENT (%)	NUMBER OF JOBS	NUMBER OF JOBS	PERCENT (%)	NUMBER OF JOBS	NUMBER OF JOBS	PERCENT (%)	NUMBER OF JOBS	NUMBER OF JOBS	PERCENT (%)
Lower Columbia River													
Commercial	61.2	26.0	-35.1	-57.5	45.6	-15.6	-25.5	61.8	0.6	1.0	45.9	-15.3	-24.9
Recreational	520.5	274.1	-246.4	-47.3	403.2	-117.3	-22.5	471.0	-49.5	-9.5	414.6	-106.0	-20.4
Hatchery Facility Operations	429.1	202.4	-226.7	-52.8	327.8	-101.3	-23.6	428.4	-0.6	-0.1	389.0	-40.1	-9.3
TOTAL	**1,010.8**	**502.5**	**-508.3**	**-50.3**	**776.5**	**-234.3**	**-23.2**	**961.2**	**-49.5**	**-4.9**	**849.5**	**-161.3**	**-16.0**
Mid Columbia River													
Commercial	136.4	71.2	-65.2	-47.8	120.1	-16.3	-12.0	120.3	-16.1	-11.8	141.4	5.0	3.7
Recreational	115.8	37.9	-77.9	-67.3	87.6	-28.1	-24.3	88.2	-27.6	-23.9	94.0	-21.8	-18.8
Hatchery Facility Operations	204.9	73.1	-131.8	-64.3	199.6	-5.3	-2.6	200.6	-4.4	-2.1	207.3	2.4	1.2
TOTAL	**457.1**	**182.2**	**-274.9**	**-60.1**	**407.4**	**-49.8**	**-10.9**	**409.0**	**-48.1**	**-10.5**	**442.8**	**-14.4**	**-3.1**
Upper Columbia River													
Commercial	2.9	2.2	-0.7	-24.4	2.4	-0.5	-17.5	1.7	-1.2	-41.8	2.3	-0.6	-20.9
Recreational	27.6	18.3	-9.3	-33.6	19.5	-8.1	-29.4	17.5	-10.1	-36.7	26.8	-0.7	-2.7
Hatchery Facility Operations	139.3	138.0	-1.3	-0.9	141.6	2.4	1.7	141.9	2.6	1.9	159.9	20.6	14.8
TOTAL	**169.8**	**158.5**	**-11.2**	**-6.6**	**163.5**	**-6.3**	**-3.7**	**161.0**	**-8.7**	**-5.2**	**189.0**	**19.3**	**11.3**
Lower Snake River													
Commercial	17.8	15.6	-2.3	-12.7	15.9	-1.9	-10.9	15.9	-1.9	-10.9	18.9	1.1	6.0
Recreational	433.3	339.9	-93.5	-21.6	384.0	-49.3	-11.4	384.0	-49.3	-11.4	417.6	-15.7	-3.6
Hatchery Facility Operations	451.8	386.0	-65.8	-14.6	453.7	1.9	0.4	453.8	2.0	0.4	499.6	47.8	10.6
TOTAL	**902.9**	**741.4**	**-161.5**	**-17.9**	**853.6**	**-49.3**	**-5.5**	**853.7**	**-49.2**	**-5.5**	**936.1**	**33.1**	**3.7**
ALL COLUMBIA RIVER BASIN													
COMMERCIAL	**218.3**	**115.0**	**-103.3**	**-47.3**	**184.0**	**-34.3**	**-15.7**	**199.7**	**-18.6**	**-8.5**	**208.5**	**-9.8**	**-4.5**
RECREATIONAL	**1,097.2**	**670.2**	**-427.1**	**-38.9**	**894.3**	**-202.8**	**-18.5**	**960.7**	**-136.5**	**-12.4**	**953.0**	**-144.2**	**-13.1**
HATCHERY FACILITY OPERATIONS	**1,225.1**	**799.5**	**-425.6**	**-34.7**	**1,122.7**	**-102.3**	**-8.4**	**1,224.7**	**-0.4**	**0.0**	**1,255.8**	**30.7**	**2.5**
TOTAL	**2,540.6**	**1,584.7**	**-955.9**	**-37.6**	**2,201.0**	**-339.6**	**-13.4**	**2,385.0**	**-155.6**	**-6.1**	**2,417.4**	**-123.3**	**-4.9**

Source: Derived based on application of earnings-per-job factors to total personal income generated by commercial and recreational harvest (Appendix J), and on application of jobs per million dollars of hatchery production costs from Table 4-85.

[1] Jobs are expressed in full- and part-time jobs.

TABLE 4-96. TOTAL (DIRECT AND SECONDARY) ECONOMIC IMPACTS ON INCOME IN THE PACIFIC OCEAN AND PUGET SOUND BY ALTERNATIVE.

		ALTERNATIVE 2			ALTERNATIVE 3			ALTERNATIVE 4			ALTERNATIVE 5		
	ALTERNATIVE 1 (NO ACTION)		CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1	
ECONOMIC IMPACT REGION	U.S. DOLLARS ($)[1]	U.S. DOLLARS ($)	U.S. DOLLARS ($)	PERCENT (%)	U.S. DOLLARS ($)	U.S. DOLLARS ($)	PERCENT (%)	U.S. DOLLARS ($)	U.S. DOLLARS ($)	PERCENT (%)	U.S. DOLLARS ($)	U.S. DOLLARS ($)	PERCENT (%)
California Coast													
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0
Recreational	26,291	16,612	-9,678	-36.8	21,729	-4,562	-17.4	23,878	-2,413	-9.2	21,729	-4,562	-17.4
TOTAL	**26,291**	**16,612**	**-9,678**	**-36.8**	**21,729**	**-4,562**	**-17.4**	**23,878**	**-2,413**	**-9.2**	**21,729**	**-4,562**	**-17.4**
Oregon Coast													
Commercial	722,955	479,123	-243,832	-33.7	616,289	-106,666	-14.8	645,286	-77,669	-10.7	615,923	-107,031	-14.8
Recreational	2,932,009	1,827,669	-1,104,341	-37.7	2,352,116	-579,893	-19.8	2,580,518	-351,492	-12.0	2,352,035	-579,974	-19.8
TOTAL	**3,654,964**	**2,306,792**	**-1,348,172**	**-36.9**	**2,968,405**	**-686,559**	**-18.8**	**3,225,803**	**-429,161**	**-11.7**	**2,967,958**	**-687,006**	**-18.8**
Washington Coast													
Commercial	4,864,987	3,520,167	-1,344,820	-27.6	4,361,582	-503,405	-10.3	4,476,363	-388,624	-8.0	4,358,911	-506,076	-10.4
Recreational	6,754,135	4,215,080	-2,539,055	-37.6	5,353,314	-1,400,822	-20.7	5,065,366	-1,688,770	-25.0	5,351,936	-1,402,199	-20.8
TOTAL	**11,619,122**	**7,735,247**	**-3,883,875**	**-33.4**	**9,714,895**	**-1,904,227**	**-16.4**	**9,541,729**	**-2,077,393**	**-17.9**	**9,710,847**	**-1,908,275**	**-16.4**
Puget Sound/Strait of Juan de Fuca													
Commercial	6,648,698	6,364,914	-283,784	-4.3	6,615,701	-32,997	-0.5	6,637,134	-11,564	-0.2	6,615,271	-33,427	-0.5
Recreational	7,364,956	7,261,410	-103,547	-1.4	7,346,029	-18,927	-0.3	7,355,095	-9,861	-0.1	7,345,890	-19,066	-0.3
TOTAL	**14,013,654**	**13,626,324**	**-387,331**	**-2.8**	**13,961,730**	**-51,924**	**-0.4**	**13,992,229**	**-21,425**	**-0.2**	**13,961,161**	**-52,493**	**-0.4**
British Columbia													
Commercial	17,538,656	16,416,645	-1,122,011	-6.4	17,328,493	-210,163	-1.2	17,511,010	-27,646	-0.2	17,361,889	-176,767	-1.0
Recreational	36,055,422	34,273,948	-1,781,474	-4.9	35,749,712	-305,710	-0.8	36,050,150	-5,273	0.0	35,806,401	-249,021	-0.7
TOTAL	**53,594,078**	**50,690,593**	**-2,903,485**	**-5.4**	**53,078,205**	**-515,873**	**-1.0**	**53,561,160**	**-32,918**	**-0.1**	**53,168,290**	**-425,788**	**-0.8**
Southeast Alaska													
Commercial	15,038,678	14,768,478	-270,200	-1.8	15,154,697	116,020	0.8	15,298,814	260,137	1.7	15,185,912	147,235	1.0
Recreational	18,014,418	17,693,190	-321,229	-1.8	18,152,349	137,931	0.8	18,323,684	309,265	1.7	18,189,459	175,041	1.0
TOTAL	**33,053,096**	**32,461,667**	**-591,429**	**-1.8**	**33,307,047**	**253,951**	**0.8**	**33,622,498**	**569,402**	**1.7**	**33,375,371**	**322,275**	**1.0**
ALL PACIFIC OCEAN AND PUGET SOUND													
COMMERCIAL	**44,813,974**	**41,549,327**	**-3,264,647**	**-7.3**	**44,076,762**	**-737,211**	**-1.6**	**44,568,607**	**-245,366**	**-0.5**	**44,137,906**	**-676,066**	**-1.5**
RECREATIONAL	**71,147,232**	**65,287,908**	**-5,859,324**	**-8.2**	**68,975,249**	**-2,171,983**	**-3.1**	**69,398,690**	**-1,748,544**	**-2.5**	**69,067,451**	**-2,079,781**	**-2.9**
TOTAL	**115,961,205**	**106,837,236**	**-9,123,970**	**-7.9**	**113,052,011**	**-2,909,194**	**-2.5**	**113,967,297**	**-1,993,908**	**-1.7**	**113,205,357**	**-2,755,849**	**-2.4**

Source: Derived based on harvest estimates from Table 4-89 and Table 4-93, and on application of personal income factors identified in Appendix J.

[1] All dollar values are expressed in 2007 dollars.

TABLE 4-97. TOTAL (DIRECT AND SECONDARY) ECONOMIC IMPACTS ON JOBS IN THE PACIFIC OCEAN AND PUGET SOUND BY ALTERNATIVE.

		ALTERNATIVE 2			ALTERNATIVE 3			ALTERNATIVE 4			ALTERNATIVE 5		
	ALTERNATIVE 1 (NO ACTION)		CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1			CHANGE FROM ALTERNATIVE 1	
ECONOMIC IMPACT REGION	NUMBER OF JOBS[1]	NUMBER OF JOBS	NUMBER OF JOBS	PERCENT (%)	NUMBER OF JOBS	NUMBER OF JOBS	PERCENT (%)	NUMBER OF JOBS	NUMBER OF JOBS	PERCENT (%)	NUMBER OF JOBS	NUMBER OF JOBS	PERCENT (%)
California Coast													
Commercial	0.0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0	0.0	0.0	0
Recreational	0.5	0.3	-0.2	-36.9	0.4	-0.1	-17.4	0.5	0.0	-9.2	0.4	-0.1	-17.4
TOTAL	**0.5**	**0.3**	**-0.2**	**-36.9**	**0.4**	**-0.1**	**-17.4**	**0.5**	**0.0**	**-9.2**	**0.4**	**-0.1**	**-17.4**
Oregon Coast													
Commercial	21.4	14.2	-7.2	-33.7	18.2	-3.2	-14.8	19.1	-2.3	-10.7	18.2	-3.2	-14.8
Recreational	90.7	56.6	-34.1	-37.6	72.9	-17.8	-19.7	80.0	-10.8	-11.9	72.9	-17.9	-19.7
TOTAL	**112.1**	**70.8**	**-41.3**	**-36.9**	**91.1**	**-21.0**	**-18.7**	**99.1**	**-13.1**	**-11.6**	**91.1**	**-21.0**	**-18.7**
Washington Coast													
Commercial	145.6	105.4	-40.2	-27.6	130.5	-15.1	-10.3	134.0	-11.6	-8.0	130.5	-15.1	-10.4
Recreational	206.3	128.5	-77.8	-37.7	163.1	-43.2	-20.9	151.8	-54.5	-26.4	163.1	-43.2	-21.0
TOTAL	**351.9**	**234.0**	**-117.9**	**-33.5**	**293.6**	**-58.2**	**-16.5**	**285.8**	**-66.1**	**-18.8**	**293.5**	**-58.4**	**-16.6**
Puget Sound/Strait of Juan de Fuca													
Commercial	118.9	113.8	-5.1	-4.3	118.3	-0.6	-0.5	118.7	-0.2	-0.2	118.3	-0.6	-0.5
Recreational	131.7	129.8	-1.9	-1.4	131.4	-0.3	-0.3	131.5	-0.2	-0.1	131.4	-0.3	-0.3
TOTAL	**250.6**	**243.7**	**-6.9**	**-2.8**	**249.7**	**-0.9**	**-0.4**	**250.2**	**-0.4**	**-0.2**	**249.6**	**-0.9**	**-0.4**
British Columbia													
Commercial	313.6	293.6	-20.1	-6.4	309.9	-3.8	-1.2	313.1	-0.5	-0.2	310.5	-3.2	-1.0
Recreational	644.7	612.9	-31.9	-4.9	639.3	-5.5	-0.8	644.6	-0.1	0.0	640.3	-4.5	-0.7
TOTAL	**958.4**	**906.4**	**-51.9**	**-5.4**	**949.1**	**-9.2**	**-1.0**	**957.8**	**-0.6**	**-0.1**	**950.7**	**-7.6**	**-0.8**
Southeast Alaska													
Commercial	268.9	264.1	-4.8	-1.8	271.0	2.1	0.8	273.6	4.7	1.7	271.6	2.6	1.0
Recreational	322.1	316.4	-5.7	-1.8	324.6	2.5	0.8	327.7	5.5	1.7	325.3	3.1	1.0
TOTAL	**591.0**	**580.5**	**-10.6**	**-1.8**	**595.6**	**4.5**	**0.8**	**601.2**	**10.2**	**1.7**	**596.8**	**5.8**	**1.0**
ALL PACIFIC OCEAN AND PUGET SOUND													
COMMERCIAL	**868.4**	**791.1**	**-77.4**	**-8.9**	**847.9**	**-20.6**	**-2.4**	**858.5**	**-9.9**	**-1.1**	**849.1**	**-19.5**	**-2.2**
RECREATIONAL	**1,396.1**	**1,244.6**	**-151.6**	**-10.9**	**1,331.6**	**-64.4**	**-4.6**	**1,336.1**	**-60.1**	**-4.4**	**1,333.3**	**-62.9**	**-4.5**
TOTAL	**2,264.5**	**2,035.6**	**-228.8**	**-10.1**	**2,179.6**	**-84.9**	**-3.8**	**2,194.5**	**-70.0**	**-3.1**	**2,182.3**	**-82.2**	**-3.6**

Source: Derived based on earnings-per-job factors to total personal income by commercial and recreational harvest. Refer to Appendix J for additional information.

[1] Jobs are expressed in full- and part-time jobs.

4.4 Environmental Justice

4.4.1 Introduction

This section describes how hatchery production and management changes would affect tribal harvest, revenues, and values derived from salmon and steelhead. It also analyzes the potential effects on other user groups of concern, specifically minority and low-income populations. As described in Chapter 2, Alternatives, one implementation scenario has been identified for each alternative so that the effects of each alternative can be understood and compared. Implementation measures are combined under each alternative to create an implementation scenario (Table 2-6). Table 4-98 shows the implementation measures that may affect environmental justice indicators. Four implementation measures may affect environmental justice indicators:

- Change production levels in hatchery programs.
- Establish new selective fisheries in terminal areas.
- Establish new hatchery programs.
- Terminate hatchery programs that support harvest if they fail to meet performance goals.

Because all of these implementation measures relate to harvest changes, the analysis below is based on changes in harvest across the alternatives.

As described in Section 3.4.2, Analysis Area, the analysis area for environmental justice includes the project area (Section 2.2, Description of Project Area) plus the following areas: 1) coastal areas of Washington, Oregon, and Idaho; 2) British Columbia (Canada); 3) the Puget Sound/Strait of Juan de Fuca; and 4) Southeast Alaska.

Most of the information presented in this section is at the county level. However, for consistency with the socioeconomic conditions presented in Section 3.3, Socioeconomics, its related analyses in Section 4.3, Socioeconomics, and environmental justice conditions presented in Section 3.4, Environmental Justice, information is organized according to the following economic impact regions: lower Columbia River, mid Columbia River, upper Columbia River, lower Snake River, Oregon coast, Washington coast, California coast, Puget Sound/Strait of Juan de Fuca, British Columbia, and Southeast Alaska.

TABLE 4-98. ENVIRONMENTAL JUSTICE INDICATORS THAT MAY BE AFFECTED BY IMPLEMENTATION MEASURES INCLUDED UNDER THE ALTERNATIVES' IMPLEMENTATION SCENARIOS.

IMPLEMENTATION MEASURES INCORPORATED IN ONE OR MORE OF THE ALTERNATIVES' IMPLEMENTATION SCENARIOS	ENVIRONMENTAL JUSTICE INDICATORS THAT MAY BE AFFECTED				
	FISH HARVEST AND TRIBAL VALUE	CEREMONIAL AND SUBSISTENCE HARVEST FOR TRIBES	TRIBAL SALMON FISHING AND HATCHERY PROGRAM REVENUE	NET REVENUE FOR NON-TRIBAL USER GROUPS OF CONCERN	PER CAPITA INCOME IN COMMUNITIES OF CONCERN
Change production levels in hatchery programs.	X	X	X	X	X
Change broodstock collection protocols in hatchery programs.					
Update water intake screens at hatchery facilities.					
Update hatchery facilities to allow all salmon and steelhead of all ages to bypass or pass through hatchery-related structures.					
Improve rearing and release protocols in hatchery programs.					
Correct water quality issues at hatchery facilities.					
Install new temporary weirs.					
Install new permanent weirs.					
Establish new selective fisheries in terminal areas.	X	X	X	X	X
Change hatchery program goals (i.e., harvest or conservation).					
Change hatchery program's operational strategy (i.e., segregated or integrated).					
Establish new hatchery programs.	X	X	X	X	X
Terminate hatchery programs that support harvest if they fail to meet performance goals.	X	X	X	X	X

These changes apply to hatchery programs funded through the Mitchell Act and hatchery programs receiving funding from other sources. Implementation measures that were not applied under any of the alternatives were not included in this table.

4.4.2 Methods for Analysis

The analysis of environmental justice effects is based on evaluating environmental justice communities and groups of concern in the context of the applicable environmental justice indicators described in Section 3.4, Environmental Justice. As described below, separate indicators are used for tribal interests, non-tribal user groups, and communities of concern. For each indicator, effects serve as the basis for conclusions concerning potential environmental justice effects.

As described in Section 4.3.2.1, Harvest Estimates, historical averages and modeled estimates of harvest are used to evaluate salmon and steelhead catch under Alternative 1 (No Action) and the action alternatives. These harvest numbers provide the foundation for determining values for the environmental justice indicators under the alternatives. As indicated in Section 3.4.3, Environmental Justice Methodology, the values in the tables of this section were developed for comparing relative numerical and proportional differences among alternatives, and should not be considered precise predictions of actual harvests in the future. Refer to Appendix J and Appendix K for more detailed information on the methods used to estimate harvest levels by alternative.

As described in Section 3.4, Environmental Justice, the EIS alternatives may affect eight groups of Native Americans within the Columbia River basin: Nez Perce Tribe, CTUIR, Confederated Tribes of Warm Springs Reservation, Yakama Nation, Confederated Tribes of the Colville Reservation, Cowlitz Indian Tribe, Confederated Tribes of the Grand Ronde, and Shoshone-Bannock Tribes. Although changes in Columbia River hatchery management could affect Alaska Natives and tribes in British Columbia, there is insufficient quantitative information on the location and magnitude of their fishing activities to determine how changes in Columbia River basin hatchery production could affect their harvest activities. As a result, environmental justice effects on Alaska Natives and tribes in British Columbia are not further discussed in this analysis.

4.4.3 Indicators of Environmental Justice Effects

A range of categories (or indicators) may be used to indicate the presence or absence of environmental justice effects and the extent of potential effects. Because indicators of environmental justice effects can vary across user groups, separate indicators were developed for tribes, other user groups, and communities, as described below.

4.4.3.1 Tribal Indicators of Environmental Justice Effects

Selection of indicators to represent potential effects on tribal peoples appropriately is based both on cultural and economic criteria. While economic issues are of concern to tribes based on the need for jobs and income, the tribes also place great importance on spiritual, cultural, and lifestyle values associated with fish and wildlife (Section 3.4.4.1, Native American Tribes of Concern). Consequently, this analysis uses the following indicators to predict effects on affected tribes: fish harvest and tribal values, ceremonial and subsistence harvests, and tribal fishing and hatchery revenue.

4.4.3.1.1 Fish Harvests and Tribal Values

From a tribal perspective, the value of the salmon is self-evident and extends beyond economic measures. Numbers of salmon harvested provide an indicator of the health of stocks and are an appropriate measure of relative harvest abundance and of tribal value.

4.4.3.1.2 Ceremonial and Subsistence Harvests

A portion of tribal fish harvests is used to meet ceremonial and subsistence needs, which serve as an indicator of cultural viability. As such, this indicator addresses potential effects on cultural sustainability, passing on tribal knowledge to future tribal generations, preservation of tribal identity, and tribal health.

4.4.3.1.3 Tribal Salmon Fishing and Hatchery Program Revenue

This tribal indicator directly addresses economic revenue obtained by the tribes from the sale of commercially caught salmon, steelhead, and/or salmon eggs. Tribes also receive economic revenue from processing salmon. For this analysis, a comparison of direct revenues from the sale of tribal harvests was used as an indicator of economic-based environmental justice concerns for tribes, including changes in tribal income associated with each alternative.

4.4.3.2 Non-tribal User Group Indicators of Environmental Justice Effects

For non-tribal commercial fishers, economic changes in fish harvest represent the primary factor affecting environmental justice concerns for this user group. Changes in net revenues (i.e., profits) are tied directly to fish harvest and have been estimated as part of the economic analysis (Section 4.3, Socioeconomics). In turn, net revenues earned by commercial fishers affect income levels and poverty rates, which are key environmental justice issues (Section 3.4.4.2, Non-tribal User Groups of Concern).

4.4.3.3 Community Indicators of Environmental Justice Effects

The direct economic effects of fish harvests in the Columbia River basin associated with commercial and recreational fishing also ripple through the local economies. Similarly, hatchery operations not only provide direct economic benefits in the form of employment and labor income, hatchery-related spending attributed to fish production has secondary economic benefits in the affected economy. These indirect economic benefits provide income and employment to local residents not engaged in fish harvest and/or hatchery operations. From the perspective of environmental justice, changes in these regional economic benefits can have an impact on low-income and minority populations in the affected economic impact regions. Per capita income generated from fish harvest is used as an indicator of economic benefits at a community level (i.e., county level).

4.4.4 Analysis of Environmental Justice Effects

The analysis of environmental justice effects is based on evaluating the environmental justice communities and groups of concern in the context of the applicable environmental justice indicators described in the above sections. For each indicator, a summary of effects across alternatives is presented. The summaries serve as the basis for conclusions regarding potential environmental justice effects.

4.4.4.1 Fish Harvest and Tribal Values

Table 4-99 presents a summary of estimated total fish harvests (i.e., commercial, ceremonial, and subsistence) by Native American tribes in the affected economic impact regions through model results as explained in Section 4.3.2, Methods for Analysis.

TABLE 4-99. TOTAL TRIBAL FISH HARVESTS BY NUMBER OF FISH.

ECONOMIC IMPACT REGION	ALTERNATIVE 1 (NO ACTION)	ALTERNATIVE (CHANGE IN NUMBER OF FISH FROM ALTERNATIVE 1)			
		2	3	4	5
Lower Columbia River	0	0	0	0	0
Mid Columbia River	72,190	-41,756	-14,754	-14,702	-5,793
Upper Columbia River	1,247	-307	-230	-490	-267
Lower Snake River	5,891	-746	-642	-642	351
Washington Coast	92,114	-11,052	-4,769	-3,636	-4,786
Oregon Coast	0	0	0	0	0
California Coast	0	0	0	0	0
Puget Sound/Strait of Juan de Fuca (marine)[1]	215,987	-3,692	-810	-462	-814
Total	387,429	-57,553	-21,205	-19,932	-11,309

Source: Estimates developed by the Mitchell Act Fishery Modeling Team with the exception of Puget Sound/Strait of Juan de Fuca economic impact region under Alternative 1, which represents average harvest between 2002 and 2006 (Appendix K).

[1] In the Puget Sound/Strait of Juan de Fuca and Washington coast economic impact regions, values for Alternative 1 represent total harvest by tribes in those economic impact regions, not just fish originating from the Columbia River. Southeast Alaska and British Columbia are not included in the table because there is insufficient quantitative information on the location and magnitude of their fishing activities to determine how changes in Columbia River basin hatchery production could affect their harvest activities.

4.4.4.1.1 Alternative 1 (No Action)

Under Alternative 1, Native American tribes in the affected economic impact regions would likely catch about 387,429 fish annually (Table 4-99). Tribal fish harvests would occur primarily in five economic impact regions: mid Columbia River, upper Columbia River, lower Snake River, Washington coast, and Puget Sound/Strait of Juan de Fuca (Table 4-99). However, harvest of Columbia River salmon and steelhead would occur primarily in the mid Columbia River, upper Columbia River, and lower Snake River economic impact regions since Puget Sound/Strait of Juan de Fuca and Washington coast harvests are primarily obtained from fish outside the Columbia River (Table 3-11). Thus, the largest percentage of Columbia River fish would be taken in the mid Columbia River economic impact region (Table 4-99). This is largely due to the Zone 6 tribal commercial fisheries, which occur between the Bonneville and The Dalles Dam (Zone 6 is within the mid Columbia River economic impact region). The Warm Springs, Nez Perce, Yakama, and Umatilla Tribes are the only tribes that fish in Zone 6 fisheries (Section 3.4.4.1, Native American Tribes of Concern).

In the context of environmental justice, Alternative 1 would result in current harvest opportunities without changes to various economic, material, and cultural activities and values when compared to baseline conditions.

4.4.4.1.2 Alternative 2

The implementation scenario for Alternative 2 would result in the largest annual decline in tribal fish harvests (57,553 fish) among implementation scenarios for Alternative 2 through Alternative 5 when compared to Alternative 1 (Table 4-99). In total, tribal harvests would decrease by 15 percent compared to Alternative 1 (Table 4-99). The most substantial declines would occur in the mid Columbia River economic impact region, where tribal harvests would decline by 41,756 fish (58 percent) compared to Alternative 1 for this economic impact region (72,190 fish) (Table 4-99). The tribes that would be most affected by changes in harvest in the mid Columbia River economic impact region would be the Warm Springs, Nez Perce, Yakama, and Umatilla Tribes.

Outside the Columbia River basin, declines in tribal harvests would be concentrated in the Washington coast economic impact region and would likely affect tribes that fish off the Washington Coast (e.g., Makah, Quileute, and Quinault) (Table 4-99). Although Columbia River fish do not contribute substantially to the tribal harvests in the Puget Sound/Strait of Juan de Fuca economic impact region (Table 3-11), some fish stray into the Strait of Juan de Fuca and the marine waters of Puget Sound. As a result, Puget Sound/Strait of Juan de Fuca tribes could be affected indirectly if reductions in the ocean harvest of Columbia River fish would lead to more harvest of Puget Sound/Strait of Juan de Fuca stocks. Increased harvest would limit the number of fish available for tribes that fish in the terminal areas of Puget Sound/Strait of Juan de Fuca under this alternative compared to Alternative 1 (W. Beattie, pers. comm., Conservation Planning Coordinator, Northwest Indian Fisheries Commission, May 22, 2009).

Based on the dependence of tribes on fish harvests from an economic and social perspective, estimated losses in tribal fish harvests under the implementation scenario for Alternative 2 would result in the decline of various economic, material, and cultural activities and values and may reduce the social and economic wellbeing of all tribes that fish on Columbia River basin salmon and steelhead when compared to Alternative 1.

4.4.4.1.3 Alternative 3

Under the implementation scenario for Alternative 3, annual tribal harvests would decline by approximately 21,205 fish per year, which represents a decrease of 5 percent compared to Alternative 1 (Table 4-99). Expected declines in tribal harvests follow comparable patterns across economic impact regions as described for Alternative 2, with the greatest effects occurring in the mid Columbia River economic impact region, where the Columbia River basin tribal harvest is concentrated (Table 4-99). The tribes that would be most affected by changes in harvest in the mid Columbia River economic impact region would be the Warm Springs, Nez Perce, Yakama, and Umatilla Tribes. Other economic impact regions subject to declines in fish harvest are (in descending order) Washington coast, Puget Sound/Strait of Juan de Fuca, lower Snake River, and upper Columbia River (Table 4-99).

Based on the dependence of tribes on fish harvests from an economic and social perspective, estimated losses in tribal fish harvests under the implementation scenario for Alternative 3 would result in the decline of various economic, material, and cultural activities and values. Declines may also reduce the social and economic wellbeing of all tribes that fish on Columbia River basin salmon and steelhead when compared to Alternative 1.

4.4.4.1.4 Alternative 4

Overall, annual reductions in tribal fish harvests under the implementation scenario for Alternative 4 would be slightly lower than, but similar to, those described for Alternative 3 when compared to Alternative 1, with minor variations across economic impact regions (Table 4-99). Accordingly, the implementation scenario for Alternative 4 would have the same environmental justice effect on tribes as described under the implementation scenario for Alternative 3.

4.4.4.1.5 Alternative 5

For most economic impact regions, reductions in tribal fish harvests would occur under the implementation scenario for Alternative 5 compared to Alternative 1 but these reductions would be lower than all other action alternatives. There would be an increase in tribal fish harvests (351 fish) for the lower Snake River economic impact region compared to Alternative 1 (Table 4-99). Most reduced harvest would occur in the mid Columbia River with a decrease of 5,793 fish (Table 4-99). As a result, the implementation scenario for Alternative 5 would have an environmental justice effect on tribes that depend on fish harvests in the mid Columbia River, upper Columbia River, Washington coast, and Puget Sound/Strait of Juan de Fuca economic impact regions. Compared to Alternative 1, there would be a slight beneficial environmental justice effect on tribes that harvest fish in the lower Snake River economic impact region. As a result, there would be a decline in various economic, material, and cultural activities and values, which may reduce the social and economic wellbeing of tribes that fish in the mid Columbia

River, upper Columbia River, Washington coast, and Puget Sound/Strait of Juan de Fuca economic impact regions. However, there may be an increase in various economic, material, and cultural activities and values that would improve the social and economic wellbeing of tribes that fish in the lower Snake River economic impact region under the implementation scenario for Alternative 5 when compared to Alternative 1.

4.4.4.2 Ceremonial and Subsistence Harvests

As described under Section 3.4.4.1.2, Ceremonial and Subsistence Harvests, ceremonial and subsistence harvest of salmon, primarily Chinook salmon and coho salmon, plays a key role in the cultural viability of tribes in the affected economic impact regions, particularly those economic impact regions within the Columbia River basin. Each year, 12,976 fish are likely taken for ceremonial and subsistence use, specifically in the mid Columbia River, upper Columbia River, and lower Snake River economic impact regions (Section 3.4.4.1.2, Ceremonial and Subsistence Harvests). There would also be limited ceremonial and subsistence fishing in other economic impact regions where Columbia River stocks are caught, excluding the lower Columbia River and California coast, but such harvests are believed to be negligible (L. Lastelle, pers. comm., Senior Biologist, Biostream Environmental, April 8, 2009) and were not quantified for this analysis.

Because ceremonial and subsistence fish are taken first before fish are harvested for tribal commercial harvest, changes in hatchery production would primarily affect commercial tribal fisheries. Thus, there would be a negligible impact on ceremonial and subsistence fishing for all action alternatives compared to Alternative 1. The exception to this anticipated effect would occur under the implementation scenario for Alternative 2 in the mid Columbia River economic impact region. Under this alternative, the estimated tribal harvest of coho salmon would not be sufficient to meet historical demands for ceremonial and subsistence purposes (1,700 fish), which would result in an environmental justice impact. This would likely have a negative effect on tribal cultural viability, specifically, aspects of cultural sustainability, passing on tribal knowledge to future tribal generations, preservation of tribal identity, and tribal health.

4.4.4.3 Tribal Salmon Fishing and Hatchery Program Revenue

Changes in commercial harvests by tribes have a direct effect on revenue derived from the sale of these fish. Indirectly, changes in tribal revenue affect the economic welfare of tribes. Table 4-100 presents a summary of projected tribal salmon fishing revenue across alternatives. Alternative 1 represents a continuation of current hatchery and harvest practices, and tribal fishing revenues under Alterative 1 are based on predicted harvest estimates developed by the Mitchell Act Fishery Modeling Team (with the exception of Puget Sound/Strait of Juan de Fuca as explained in Section 4.3.2, Methods for Analysis).

TABLE 4-100. TRIBAL FISHING REVENUE.

ECONOMIC IMPACT REGION	ALTERNATIVE 1 (NO ACTION) ($)[1]	ALTERNATIVE (CHANGE IN REVENUES FROM ALTERNATIVE 1) 2 ($)	3 ($)	4 ($)	5 ($)
Mid Columbia River	3,025,164	-1,062,908	-77,691	-65,150	554,624
Upper Columbia River	68,202	-16,479	-11,425	-29,959	-13,882
Lower Snake River	391,304	-49,552	-42,644	-42,644	23,315
Washington Coast	1,440,740	-297,435	-112,647	-87,511	-113,210
Puget Sound/Strait of Juan de Fuca (marine)	2,639,040	-67,927	-10,874	-5,206	-10,969
Total	7,564,450	-1,494,302	-255,281	-230,470	439,877

[1] All dollars are in 2007 U.S. dollars.

Source: Estimates of tribal salmon revenues were derived by the Mitchell Act Socioeconomics Team using modeled harvest estimates for all areas provided by the Mitchell Act Fishery Modeling Team with the exception of Alternative 1 for the Puget Sound/Strait of Juan de Fuca (marine) area, which reflects average tribal harvest in marine waters between 2002 and 2006.

4.4.4.3.1 Alternative 1 (No Action)

Under Alternative 1, commercial catch by tribes that harvest Columbia River salmon and steelhead in the affected economic impact regions would generate approximately $7,564,450 in revenues annually (Table 4-100). Tribal revenues would be largest in the mid Columbia River economic impact region ($3,025,164), which accounts for 40 percent of total salmon revenue generated in the affected economic impact regions (Table 4-100). Other economic impact regions with tribes that realize economic benefits associated with commercial harvests of Columbia River salmon and steelhead include Puget Sound/Strait of Juan de Fuca ($2,639,040), Washington coast ($1,440,740), lower Snake River ($391,304), and upper Columbia River ($68,202) (Table 4-100). Under Alternative 1, these revenues would be maintained and would continue to have a positive effect on the economic livelihood and welfare of tribal members. Native American tribes in British Columbia and Southeast Alaska also would likely harvest some Columbia River salmon and steelhead, but the extent of this harvest is unknown (Section 4.4.2, Methods for Analysis).

Under Alternative 1, annual hatchery program costs for hatchery programs operated by the Yakama Nation would be an estimated $1.5 million, an estimated $0.9 million for hatcheries operated by the Nez Perce Tribe, and $0.6 million for hatcheries operated by the CTUIR (Table 4-85). These operating costs do not include hatchery programs that the tribes jointly operate. Total annual operating expenditures at tribal hatcheries were estimated at $3.0 million. These hatchery operation expenditures would continue to support hatchery jobs and would provide an indirect source of income to communities in which the hatcheries are located.

4.4.4.3.2 Alternative 2

Under the implementation scenario for Alternative 2, tribal fishing revenues would decline in every economic impact region with tribal harvests compared to Alternative 1 (Table 4-100). In total, there would be an estimated decline of $1,494,302 in tribal fishing revenues annually compared to Alternative 1 (Table 4-100). These effects would be concentrated in the mid Columbia River economic impact region ($1,062,908) (Table 4-100). Tribes fishing in the upper Columbia River, lower Snake River, Washington coast, and Puget Sound/Strait of Juan de Fuca economic impact regions would also be affected economically (Table 4-100). Such effects would include reductions in harvest-related revenues, such as the sale of fish and fish eggs, as well as fish processing revenues.

Tribes would also be directly affected by changes in hatchery program costs for hatchery programs they operate. Under the implementation scenario for Alternative 2, operating expenditures in tribally operated hatchery programs would decrease by about 37 percent (to a total of $1.9 million) relative to Alternative 1 (Table 4-85). The greatest impact would be experienced by the Yakama Nation, where operating expenditures would likely decrease from $1.5 million to $0.7 million annually (Table 4-85).

4.4.4.3.3 Alternative 3

The total decline in tribal fishing revenue under the implementation scenario for Alternative 3 would be $255,281 annually compared to Alternative 1 (Table 4-100). All tribes participating in commercial fishing operations and that harvest Columbia River stocks would experience a decline in fishing revenues under the implementation scenario for Alternative 3 (Table 4-100). Unlike Alternative 2, the greatest effects would be expected in the Washington coast economic impact region because these tribes would experience the greatest reductions in harvest (Table 4-100). Effects would include reductions in harvest-related revenues, such as the sale of fish and fish eggs, as well as fish processing revenues.

Under the implementation scenario for Alternative 3, hatchery program costs for tribally operated hatchery programs would decline by about 10 percent (to a total of $2.7 million) compared to Alternative 1 (Table 4-85).

4.4.4.3.4 Alternative 4

Tribal fishing revenues under the implementation scenario for Alternative 4 would decline by $230,470 annually compared to Alternative 1, which would be similar to the decline described under the implementation scenario for Alternative 3 with minor variations across economic impact regions (Table 4-100). As a result, the implementation scenario for Alternative 4 would negatively affect tribes that commercially harvest Columbia River salmon and steelhead, including tribes that fish in the mid Columbia River, upper Columbia River, lower Snake River, Washington coast, and Puget Sound/Strait of Juan de Fuca economic impact regions. Effects would include reductions in harvest-related revenues, such as the sale of fish and fish eggs, as well as fish processing revenues.

Under the implementation scenario for Alternative 4, hatchery program costs for tribally operated hatchery programs would decline by 10 percent (total of $2.7 million) relative to Alternative 1 (Table 4-85), which is similar to the implementation scenario for Alternative 3.

4.4.4.3.5 Alternative 5

In contrast to the other alternatives, total tribal fishing revenues under the implementation scenario for Alternative 5 would increase by an estimated $439,877 annually compared to Alternative 1 (Table 4-100). Across economic impact regions, however, effects on tribal fishing revenue would vary. In the mid Columbia River and lower Snake River economic impact regions, revenues would increase by an estimated $554,624 and $23,315 per year, respectively (Table 4-100). Declines in fishing revenues would be anticipated in all other economic impact regions. Declines would be greatest in the Washington coast economic impact region because these tribes would experience the greatest reductions in harvest (Table 4-100). Effects would include reductions in harvest-related revenues, such as the sale of fish and fish eggs, as well as fish processing revenues, whereas tribes in the mid Columbia River and lower Snake River economic impact regions would realize increases in revenues from the sale of fish, the sale of fish eggs, and/or fish processing (Table 4-100).

Similar to the implementation scenarios for Alternative 3 and Alternative 4, hatchery program costs for tribally operated hatchery programs would decrease under the implementation scenario for Alternative 5 by approximately 10 percent (to a total of $2.7 million) compared to Alternative 1 (Table 4-85).

4.4.4.4 Non-tribal User Groups of Concern

Hatchery management would also affect non-tribal commercial salmon harvest along the Washington coast and the Oregon coast (Section 3.4.4.2, Non-tribal User Groups of Concern). Although Table 3-27 identified 11 environmental justice user groups of concern, only five of these communities have fishing net revenues available for analysis (La Push, Neah Bay, and Westport [Washington], and Astoria and Dodson [Oregon]). Changes in commercial catch translate directly to changes in net revenues (or profits) realized by commercial fishers based in these coastal ports.

Table 4-101 summarizes changes in total net revenues for commercial fishers in these five communities. Alternative 1 represents a continuation of current hatchery and harvest practices, and the net revenues of commercial fishing operations shown under Alternative 1 are based on predicted harvests provided by the Mitchell Act Fishery Modeling Team (Appendix K).

TABLE 4-101. ANNUAL NON-TRIBAL COMMERCIAL FISHING NET REVENUES FOR USER GROUPS OF CONCERN.

ECONOMIC IMPACT REGION/ PORT	ALTERNATIVE 1 (NO ACTION) ($)[1]	ALTERNATIVE (CHANGE IN REVENUES FROM ALTERNATIVE 1)			
		2 ($)	3 ($)	4 ($)	5 ($)
Washington Coast					
La Push	76,791	-25,461	-9,997	-7,543	-10,042
Neah Bay	258,612	-84,802	-30,641	-23,839	-30,821
Westport	273,837	-90,263	-33,913	-26,017	-34,093
Oregon Coast					
Astoria	253,269	-85,380	-37,243	-26,499	-37,394
Lower Columbia River					
Dodson	54,080	-26,485	-12,408	2,362	-11,954
Total	**916,589**	**-312,391**	**-124,202**	**-81,536**	**-$124,304**

[1] All dollars are in 2007 U.S. dollars.

Source**:** Estimates of non-tribal commercial fishing net revenues were derived by the Mitchell Act Socioeconomics Team using modeled harvest estimates provided by the Mitchell Act Fishery Modeling Team for all areas (Appendix K).

4.4.4.4.1 Alternative 1 (No Action)

Under Alternative 1, total net revenues associated with salmon harvests by non-tribal commercial fishers in environmental justice user groups of concern would be an estimated $916,589 annually (Table 4-101). Along the Washington coast, fishers in the port communities of Neah Bay and Westport would realize the greatest economic benefits, with approximately $258,612 and $273,837 in annual net revenues, respectively (Table 4-101). Net commercial fishing revenues generated in La Push (Washington) would be an estimated $76,791 annually (Table 4-101). Along the Oregon coast, net revenues accruing to commercial fishers in Astoria would be an estimated $253,269 annually (Table 4-101). In the lower Columbia River economic impact region, commercial fishing for salmon would generate an estimated $54,080 annually for fishers based out of Dodson, Oregon (Table 4-101). The revenues generated by commercial fishing (e.g., the sale of fish and fish eggs, as well as fish processing revenues) would provide economic benefits to these groups through employment opportunities in related commercial fishing businesses and benefits to household incomes.

4.4.4.4.2 Alternative 2

Under the implementation scenario for Alternative 2, net revenues for non-tribal commercial fishers would likely decline for five user groups of concern (La Push, Neah Bay, Westport, Astoria, and Dodson) by a total of $312,391 annually compared to Alternative 1 (Table 4-101). Reductions in net revenues would represent an economic impact on these user groups by decreasing employment opportunities and therefore related commercial fishing businesses and household incomes. These reductions could further depress the economic standing and welfare of these user groups.

4.4.4.4.3 Alternative 3

Under the implementation scenario for Alternative 3, net revenues accruing to non-tribal commercial fishers identified as environmental justice groups of concern would decline by an estimated $124,202 annually compared to Alternative 1 (Table 4-101). Similar to the implementation scenario for Alternative 2, the implementation scenario for Alternative 3 would reduce annual commercial fishing net revenue for five non-tribal user groups of concern (La Push, Neah Bay, Westport, Astoria, and Dodson). This would likely decrease employment opportunities, commercial fishing businesses, and household income. Reductions may further depress the economic standing and welfare of these user groups. However, the distribution of these effects across commercial fishers in different port communities would be lower than that under the implementation scenario for Alternative 2. Most effects would occur in the community of Astoria (decrease of $37,243 compared to Alternative 1) (Table 4-101).

4.4.4.4.4 Alternative 4

The implementation scenario for Alternative 4 would reduce annual commercial fishing net revenue by $81,536 annually compared to Alternative 1 (Table 4-101). However, effects on individual user groups vary. There would be a negative economic impact on four (La Push, Neah Bay, Westport, and Astoria) of the five user groups. This would likely result in a decrease in economic opportunities related to commercial fishing businesses and household income. The exception to the negative economic effect would be for Dodson, which would have an estimated addition of $2,362 annually in local income compared to Alternative 1 (Table 4-101).

4.4.4.4.5 Alternative 5

The implementation scenario for Alternative 5 would reduce annual commercial fishing net revenue by $124,304 annually compared to Alternative 1 (Table 4-101). Reductions in revenue would affect all five non-tribal user groups. These changes would be similar to the implementation scenario for Alternative 3 (Table 4-101). Therefore, anticipated negative economic impacts to these communities would also be similar, resulting in a decrease in employment opportunities, related commercial fishing businesses, and household income.

4.4.4.5 Communities of Concern

Changes in commercial and recreational fish harvests and hatchery operations would also affect total regional income at the community level through inter-industry links in the affected regions. Included in these community-level effects are direct income effects on fish harvesters and hatchery staff and indirect effects on fish processors, recreational support businesses, and businesses that serve hatchery operations. For this analysis, changes in per capita income levels, a key indicator of environmental justice effects, are calculated for counties that were identified as environmental justice communities of concern because of either income levels, minority percentages, or both (Table 4-102).

4.4.4.5.1 Alternative 1 (No Action)

Annual per capita income levels across environmental justice communities of concern would range from about $14,411 (Idaho County, lower Snake River economic impact region) to $34,556 (San Francisco County, California coast economic impact region) (Table 4-102). Income levels can vary substantially both within and across economic impact regions. Under Alternative 1, there would be no change in total regional income attributed to fishery harvests and hatchery operations relative to baseline conditions. Therefore, annual per capita income levels and poverty rates would not change relative to baseline conditions, and these communities would remain environmental justice communities of concern based on income.

4.4.4.5.2 Alternative 2

Under the implementation scenarios for the action alternatives, effects on total personal income differ depending on alternative and community evaluated. For counties where total income decreases in environmental justice communities of concern, there would be a resulting reduction in annual per capita income levels and potential increases in poverty rates. The magnitude of changes in per capita income depends on the change in total income within a particular county and its population. Under the implementation scenario for Alternative 2, reductions in per capita income levels would occur for 34 of 35 counties compared to Alternative 1, although all of these decreases are 5 percent or less of the county per capita income levels (Table 4-102).

Across these counties, the largest change in annual per capita income levels under the implementation scenario for Alternative 2 would likely occur in Wheeler County (mid Columbia River economic impact region), declining by 2 percent compared to Alternative 1 ($320.87) (Table 4-102). Umatilla County currently qualifies as an environmental justice community of concern based on minority thresholds, but does not meet thresholds that would qualify the county as an environmental justice community based on income. However, under the implementation scenario for Alternative 2, per capita income for the county would be reduced enough to qualify the community as an environmental justice community of concern based on income.

TABLE 4-102. PER CAPITA INCOME CHANGES FOR COUNTIES REPRESENTING COMMUNITIES OF CONCERN.

ECONOMIC IMPACT REGION/ COUNTY	ALTERNATIVE 1 (NO ACTION) ($)[1]	ALTERNATIVE (CHANGE IN PER CAPITA INCOME FROM ALTERNATIVE 1) 2 ($)	3 ($)	4 ($)	5 ($)
Lower Columbia River					
Marion	18,408	-2.93	-1.21	-0.03	-0.55
Multnomah	22,606	-2.83	-1.34	-0.28	-1.02
Washington	24,969	-1.33	-0.60	0.01	-0.24
Yamhill	18,951	-9.39	-3.89	-0.11	-1.77
Mid Columbia River					
Hood River	17,877	-21.30	-2.62	-2.59	-0.91
Jefferson[2]	15,675	-47.85	-6.55	-6.14	3.62
Morrow[2]	15,802	-34.81	-1.40	-1.16	0.62
Umatilla	16,410	-12.93	-2.29	-2.24	0.47
Wasco	17,195	-42.78	-6.51	-6.20	2.57
Wheeler[2]	15,884	-320.87	-27.32	-26.05	-4.77
Franklin[2]	15,459	-6.93	-0.08	0.03	0.56
Klickitat	16,502	-90.94	-26.75	-26.39	-15.33
Walla Walla	16,509	-8.55	-1.33	-1.34	-0.57
Grant (WA)[2]	15,037	-56.07	-2.26	-1.86	1.00
Upper Columbia River					
Chelan	19,273	-2.46	-0.71	-0.88	2.31
Douglas	17,148	-2.41	-1.32	-1.68	4.57
Kittitas	18,928	-0.33	0.47	0.44	4.38
Okanogan[2]	14,900	-2.20	-1.22	-1.53	4.18
Yakima[2]	15,606	-0.16	-0.01	-0.11	0.64
Lower Snake River					
Clearwater	15,463	-55.91	-16.08	-16.04	14.22
Idaho	14,411	-31.41	-10.08	-10.06	8.38
Latah	16,690	-5.72	0.17	0.17	4.16
Lewis	15,942	-96.14	-20.86	-20.77	38.82
Nez Perce	18,544	-8.87	-1.92	-1.92	3.58
Shoshone	15,934	-15.92	0.46	0.49	11.57
Whitman[2]	15,298	-7.78	-1.35	-1.35	3.11
Washington Coast					
Clallam	19,517	-12.84	-5.23	-3.96	-5.25
Grays Harbor	16,799	-24.88	-11.97	-8.68	-11.99
Oregon Coast					
Coos	17,547	-2.42	-1.14	-0.59	-1.14
Lincoln	18,692	-7.40	-3.50	-1.82	-3.50
California Coast					
Del Norte	14,573	-0.01	0.00	0.00	0.00
Humboldt	17,203	-0.01	-0.01	0.00	-0.01
Mendocino	19,443	-0.03	-0.01	-0.01	-0.01
Monterey	20,165	0.00	0.00	0.00	0.00
San Francisco	34,556	-0.01	0.00	0.00	0.00

[1] All dollars are in 2007 U.S. dollars.

[2] Environmental Justice communities of concern based on average per capita incomes in 2000 (Table 3-28).

Sources: Estimated by the Mitchell Act Socioeconomics Team based on average per capita income from the U.S. Census Bureau and predicted changes in personal income by economic impact region and county from predicted changes in harvest and hatchery operations.

4.4.4.5.3 Alternative 3

In the context of harvest-related effects, the magnitude of declines in per capita income levels compared to Alternative 1 would generally be lower under the implementation scenario for Alternative 3 relative to the implementation scenario for Alternative 2 (Table 4-102). Of the 35 counties, declines in annual per capita incomes would occur in 29 counties when compared to Alternative 1. However, one county in the upper Columbia River economic impact region and two counties in the lower Snake River economic impact region would experience an increase in income levels of 1 percent or less compared to Alternative 1 due to increases in hatchery production (Table 4-102). Although there would be slight increases in income levels, the communities would remain environmental justice communities of concern based on income levels under Alternative 3.

4.4.4.5.4 Alternative 4

Under the implementation scenario for Alternative 4, declines in annual per capita income levels in environmental justice communities of less than 1 percent would occur for 26 out of the 35 communities based on fishery harvest and hatchery operations effects compared to Alternative 1 (Table 4-102). These effects would occur in economic impact regions experiencing a decline in both fishery harvest and hatchery production (i.e., lower Columbia River and mid Columbia River), as well as in communities in the other two economic impact regions where increases due to hatchery operations would be more than offset by decreases in harvest. These communities would remain environmental justice communities of concern based on income levels under Alternative 4.

4.4.4.5.5 Alternative 5

Under the implementation scenario for Alternative 5, annual per capita income levels would decrease by less than 1 percent for 14 of the 35 communities compared to Alternative 1 (Table 4-102). However, per capita income levels under the implementation scenario for Alternative 5 would likely increase by 1 percent or less compared to Alternative 1 for 18 communities due to increases in commercial fishery harvests and hatchery production in the mid Columbia River, upper Columbia River, and lower Snake River economic impact regions (Table 4-102). With these slight increases in income levels, the communities would remain as environmental justice communities of concern based on income levels under Alternative 5.

4.5 Wildlife

4.5.1 Introduction

As described in Section 3.5, Wildlife, hatchery operations have the potential to affect wildlife by changing the total abundance of salmon and steelhead in aquatic and marine environments. Changes in the abundance of salmon and steelhead can affect wildlife predator/prey interactions. In addition, hatcheries could affect wildlife through transfer of toxic contaminants or pathogens from hatchery-origin fish to wildlife, operation of weirs (which could block or entrap wildlife), or predator control programs (which may harass or kill wildlife preying on juvenile salmon at hatchery facilities). This section describes the effects of implementing the proposed alternatives on 1) ESA-listed aquatic, marine, and terrestrial wildlife species, 2) non-listed birds, 3) non-listed marine mammals, and 4) other non-listed aquatic and terrestrial wildlife species, including invertebrates.

As described in Chapter 2, Alternatives, one implementation scenario has been identified for each alternative so that the effects of each alternative can be understood and compared. Implementation measures are combined under each alternative to create an implementation scenario (Table 2-6). Table 4-103 shows the implementation measures that may affect wildlife. Six implementation measures may affect wildlife species:

- Change production levels in hatchery programs.
- Correct water quality issues at hatchery facilities.
- Install new temporary weirs.
- Install new permanent weirs.
- Establish new hatchery programs.
- Terminate hatchery programs that support harvest if they fail to meet performance goals.

Three of these implementation measures (change production levels in hatchery programs, establish new hatchery programs, and terminate hatchery programs that support harvest if they fail to meet performance goals) relate to changes in production levels and could affect all wildlife species. Specifically, changes in production levels may affect predator/prey interactions, the transfer of contaminants from hatchery-origin fish to wildlife species, and the number of salmon and steelhead carcasses available to wildlife. Two implementation measures relate to weirs (install permanent and temporary weirs) and may affect river otters, mink, and bird species. One implementation measure targets water quality (correct water quality issues at hatchery facilities) and may affect any wildlife species found near the hatchery facilities.

However, as described in Section 3.6 (Water Quality and Quantity), all hatchery facilities are currently in compliance with their NPDES permits, and this would continue to occur under all of the alternatives.

The primary focus of this analysis relates to effects on wildlife predators that feed on salmon and steelhead with additional information on wildlife that have other relationships with salmon. Discussion of several topics is relevant to more than one wildlife group, including availability of salmon and steelhead to wildlife predators, transfer of contaminants from hatchery-origin to wildlife species, weirs, predator control programs, and availability of nutrients from salmon carcasses. To avoid duplicating the discussions for each wildlife group, these topics are presented in separate sections before the analyses of effects on each wildlife group.

As described in Section 3.5.2, Analysis Area, the analysis area for wildlife is the same as the project area (Section 2.2, Description of Project Area). Information is organized according to species, although some species are grouped when appropriate. Some wildlife species are found throughout the analysis area, while others are only found in part of the analysis area (Table 3-29, Table 3-30, and Table 3-31).

4.5.2 Methods for Analysis

Analyses conducted for wildlife were based on use of literature representing best available science and other studies that identified effects that occurred from similar or related projects within and near the analysis area. No modeling was conducted. No evidence was found that wildlife predators distinguish between hatchery-origin salmon and steelhead and natural-origin salmon and steelhead. Information on the proportion of hatchery-origin fish compared to natural-origin fish in the diets of predators is lacking. Therefore, the analysis on effects of the alternatives on wildlife considers changes in total salmon and steelhead production under the assumption that wildlife predators do not distinguish between hatchery-origin and natural-origin fish.

Table 4-103. Wildlife Species that May be Affected by Implementation Measures Included under the Alternatives' Implementation Scenarios.

Implementation Measures Incorporated in One or More of the Alternatives' Implementation Scenarios	Wildlife Species that May be Affected						
	Killer Whale	Seals, Sea Lions, River Otters, and Mink	Bird Species that Eat Salmon and Steelhead	Bird Species that Eat Similar Foods as Salmon and Steelhead	Salamanders and Frogs	Aquatic Insects	Marine Invertebrates
Change production levels in hatchery programs.	X	X	X	X	X	X	X
Change broodstock collection protocols in hatchery programs.							
Update water intake screens at hatchery facilities.							
Update hatchery facilities to allow all salmon and steelhead of all ages to by-pass or pass through hatchery-related structures.							
Improve rearing and release protocols in hatchery programs.							
Correct water quality issues at hatchery facilities.		X	X	X	X	X	
Install new temporary weirs.		X	X	X			
Install new permanent weirs.		X	X	X			
Establish new selective fisheries in terminal areas.							
Change hatchery program goals (i.e., harvest or conservation).							
Change hatchery program's operational strategy (i.e., segregated or integrated).							
Establish new hatchery programs.	X	X	X	X	X	X	X
Terminate hatchery programs that support harvest if they fail to meet performance goals.	X	X	X	X	X	X	X

4.5.3 Basinwide Effects under All Alternatives

4.5.3.1 Availability of Salmon and Steelhead to Wildlife Predators

Information summarized in Table 4-104 provides estimates in changes in salmon and steelhead availability for wildlife predators. Alternative 2 through Alternative 5 would reduce hatchery production of salmon and steelhead (Chinook salmon, steelhead, coho salmon, and chum salmon) relative to Alternative 1, which is predicted to increase the number of natural-origin salmon and steelhead available to predators in the analysis area. Although the abundance of natural-origin salmon and steelhead for each affected ESU is expected to increase under the alternatives, the total abundance of salmon and steelhead (natural-origin and hatchery-origin) would be substantially lower than Alternative 1. The expected decrease in total abundance would be greatest under the implementation scenario for Alternative 2 and least under the implementation scenario for Alternative 4 (Table 4-104). Also provided in Table 4-104 are changes in adult Chinook salmon abundance in the ocean because southern resident killer whales prefer to feed on Chinook salmon (Section 3.5.3.1.1, Killer Whale [Southern Resident Stock]).

TABLE 104. REDUCTIONS IN SALMON AND STEELHEAD ABUNDANCE RELATIVE TO ALTERNATIVE 1 BY ACTION ALTERNATIVE.

	ALTERNATIVE (PERCENT [%] DECREASE FROM ALTERNATIVE 1 [NO ACTION])			
AGE CLASS	**2**	**3**	**4**	**5**
Total Hatchery-origin and Natural-origin Smolts (All Species/ESUs)	52	19	12	17
Total Hatchery-origin and Natural-origin Adult Recruits (All Species/ESUs)	43	18	10	16
Total Chinook Salmon Adult recruits (Hatchery-origin and Natural-origin)	33	7	2	5

4.5.3.2 Transfer of Toxic Contaminants and Pathogens

As discussed in Section 3.5.3.2, Transfer of Toxic Contaminants and Pathogens, limited information is available on the relative contribution of contaminants from ingestion of hatchery-origin fish compared to natural-origin fish. Developing hatchery-origin and natural-origin salmon and steelheads may accumulate contaminants from a variety of sources in freshwater and marine environments (Johnson et al. 2007; PSAT 2007). For example, tissue analyzed and obtained from fish occurring within several Washington State Watershed Resource Inventory Areas (WRIAs) and river segments exceeded listed parameters for contaminants, such as polychlorinated biphenyls (PCBs) and chlorinated hydrocarbons (Section 3.6, Water Quality and Quantity). Although there is some potential for elevated contaminant loads to occur in hatchery-origin fish prior to their release due to their ingestion of fish feed, data are insufficient to determine if fish feed increases contaminant loading in hatchery-origin fish compared to natural-origin salmonids (Johnson et al. 2007). Thus, for this analysis, it is assumed that hatchery-origin fish would not contain higher contaminant loads than natural-origin fish because both types of fish rear in, and migrate through, potentially impaired waters. Therefore, the potential for transfer of toxins to wildlife from fish ingestion is expected to be proportional to the total number of salmon and steelhead (natural-origin plus hatchery-origin) available to wildlife predators. The implementation scenarios for Alternative 2 through Alternative 5 would reduce the number of salmon and steelhead (natural-origin plus hatchery-origin) available to wildlife (Table 4-99) relative to Alternative 1 and would, therefore, reduce the potential for transfer of toxic contaminants from salmon and steelhead to wildlife.

Information on the transfer of pathogens from salmon to, or through, wildlife species is lacking, as discussed in Section 3.5.3.2, Transfer of Toxic Contaminants and Pathogens. There is no information in the literature indicating that wildlife species are susceptible to fish pathogens. One exception is salmon poisoning disease, a rickettsial disease borne by salmon and steelhead that sickens dogs, wild canids, and possibly other carnivores that ingest infected fish (Ettinger and Feldman 1995). However, hatchery programs have not been found to cause or contribute to the transfer of this disease. Thus, no effects are expected under any of the alternatives.

4.5.3.3 Weirs and Predator Control Programs

A weir can alter stream channels and habitat upstream and downstream by reducing upstream water velocity and accumulating debris. Weirs can inhibit upstream and downstream passage of aquatic wildlife, such as macroinvertebrates, amphibians, bird, and mammal species that use streams as corridors (e.g., river otter, mink, and merganser species). Although weirs currently occur within the Columbia River basin, no research has been conducted to date demonstrating the effects of weirs on wildlife. The implementation scenario for Alternative 2 assumes that no new weirs would be constructed. Thus the alternative would result in no additional effects on wildlife compared to Alternative 1. The implementation scenarios for Alternative 3 through Alternative 5 would involve construction of new weirs on Columbia River tributaries. As described in Section 4.2.3.1.1, Genetic Risks, new weirs proposed under implementation scenarios for Alternative 3 through Alternative 5 could pose some risks to wildlife due to alteration of stream habitat, flow regimes, and blockage of aquatic wildlife passage. Potential effects could be higher under these three alternatives than under Alternative 1 and Alternative 2 because new weirs could be installed on streams currently lacking them. No changes in predator control programs would occur under any of the alternatives.

4.5.3.4 Availability of Nutrients/Distribution of Salmon Carcasses

Many wildlife species scavenge on salmon carcasses in spawning streams. Carcasses become available from natural-origin and hatchery-origin fish that spawn in streams and from hatchery-origin fish that return to hatchery facilities to spawn and then have their carcasses outplanted into selected streams by hatchery operators. Hatchery operators obtain permits, as required, to outplant salmon carcasses, the amount of which is based on hatchery production and other factors (T. Friesen, pers. comm., ODFW, November 10, 2008; A. Appleby, pers. comm., WDFW, February 24, 2004). Outplanted hatchery carcasses likely comprise a relatively small proportion of the total available carcasses; however, reductions in hatchery production under the implementation scenarios for Alternative 2 through Alternative 5 would probably reduce the number of carcasses that would be available for wildlife compared to Alternative 1, with Alternative 2 resulting in the greatest decrease. Similarly, nutrient availability for aquatic invertebrates that scavenge on salmon carcasses in spawning streams would be reduced under implementation scenarios for Alternative 2 through Alternative 5, with Alternative 2 resulting in the greatest decrease compared to Alternative 1. However, it is unclear whether reduced carcasses and, therefore, nutrient availability would affect the abundance, distribution, or behavior of wildlife populations.

4.5.3.5 Hatchery Facility Effects

As described in Section 3.5.6.4, Hatchery Facility Effects, and Section 3.6 .4, Water Quantity, the operation of hatchery facilities can affect water volume and flow, particularly in the bypass areas. Depending on the timing and degree of alterations, habitat availability for stream-breeding amphibians (e.g., salamanders), crustaceans (a marine invertebrate), and aquatic insects could be affected. The amount of water used may vary among alternatives. The implementation scenarios for Alternative 2 through Alternative 5 would reduce hatchery production relative to Alternative 1 (64, 26, 18, and 23 percent, respectively), and this may result in more water in the bypass areas associated with hatchery facilities relative to Alternative 1 (Section 4.6.4, Water Quantity). More water would improve habitat for stream-breeding amphibians, crustaceans, and aquatic insects relative to Alternative 1. Improvements in habitat under the implementation scenarios for Alternative 2 through Alternative 5 may expand distribution of some aquatic and terrestrial wildlife species (especially during the summer months when water levels are low) relative to Alternative 1. However, it is unclear how improved habitat would affect the diet and abundance of these species.

Hatchery facilities contain rearing ponds with asphalt or other lined walls. If amphibians entered these ponds, they may become trapped and drown. As described in Section 3.5.6.4, Hatchery Facility Effects, susceptibility of amphibians to this type of mortality depends on the occurrence of the animals in the hatchery vicinity, mobility of the species, steepness of the rearing pond walls, and elevation of the pond water relative to the height of the walls. Because none of these factors would vary among the alternatives, there would be no expected change in mortality of amphibians through drowning under the implementation scenarios for Alternative 2 through Alternative 5 compared to Alternative 1.

Additional potential sources of mortality at the hatchery facilities include entrapment in fish screens, weirs, and other exclusionary devices. Improvements in fish screens and fish passage under the implementation scenarios for Alternative 2 through Alternative 5 may reduce the quantity of aquatic and terrestrial wildlife entrapped near the hatchery facilities relative to Alternative 1. Effects of the weirs are discussed in Section 4.5.3.3, Weirs and Predator Control Programs.

4.5.4 Wildlife Species Effects

4.5.4.1 ESA-listed Species

4.5.4.1.1 Killer Whale (Southern Resident Stock)

As described in Section 3.5.3, ESA-listed Species, southern resident killer whales have been observed in nearshore waters of Washington and Oregon and close to the mouth of the Columbia River during winter and early spring months (Ford et al. 2000; Zamon et al. 2007; NMFS 2008b,c). The diet of southern resident killer whales during this period, when they range from the outer coastal waters of British Columbia to central California, is poorly known. But based on available information on prey preference and chemical analyses, however, this stock is thought to feed on salmon and steelhead year round. They appear to prefer Chinook salmon while in inland waters of Puget Sound and the Straits of Georgia and Juan de Fuca (Krahn et al. 2002, 2007; Ford and Ellis 2006; NMFS, 2008b). The preference of southern resident killer whales for Chinook salmon in inland waters (even when other species are more abundant), combined with information indicating that the whales consume salmon year-round, makes it reasonable to expect that southern resident killer whales likely prefer Chinook salmon when available in coastal waters. Coastal sightings in California and Westport, Washington, have coincided with large runs of Chinook salmon (citations in NMFS 2008b). Although greatly reduced from historical numbers, Columbia River Chinook salmon production exceeds that of other Pacific Northwest river systems, including the Fraser River and Puget Sound (NMFS 2008b). Salmon production from Columbia River hatcheries may have partially compensated for declines in many natural-origin salmon populations to the benefit of resident killer whales. In Washington, hatchery-origin fish now account for about 75 percent of all Chinook salmon and coho salmon and nearly 90 percent of all steelhead harvested (NMFS 2008b). The contribution of all salmon and steelhead from the Columbia River basin to the prey available to the whales in the ocean is substantial. Based on the southern resident killer whale's preference for Chinook salmon, the analysis of alternatives below focuses on effects on the abundance of Chinook salmon available to southern resident killer whales in the ocean. The total estimated population of southern resident killer whales is 89 individuals (L. Barre, pers. comm., NMFS, Northwest Regional Office, April 23, 2010)

Alternative 1 (No Action)

Hatchery production levels under Alternative 1 would be the same as under baseline conditions. As a result, Alternative 1 would not affect the southern resident killer whales because there would be no expected change in prey availability compared to baseline conditions.

Alternative 2

The implementation scenario for Alternative 2 would reduce the number of adult Columbia River basin Chinook salmon in the ocean by approximately 33 percent compared to Alternative 1 (Table 4-104). Columbia River basin Chinook salmon production probably accounts for most of the Chinook salmon produced from the Strait of Georgia to central California (NMFS 2008b; Krahn et al. 2002). This reduction of an important food source could result in poorer female breeding conditions, reduced viability of offspring, and reduced adult fitness and survival compared to Alternative 1. As a result, abundance of the southern resident stock of killer whale may be reduced under the implementation scenario for Alternative 2 when compared to Alternative 1.

Ford et al. (2009) found that southern resident killer whale survival rates correlated directly with Chinook salmon availability. Given the likelihood that southern resident killer whales strongly prefer Chinook salmon, many of which originate in the Columbia River basin, the implementation scenario for Alternative 2 would likely affect the prey base for southern resident killer whales. However, the extent and magnitude of the effect are difficult to quantify without more detailed information on the proportion of Columbia River basin Chinook salmon in the whales' diet and the locations and timing of consumption of Columbia River basin Chinook salmon.

Possible effects on killer whales might include feeding on a higher proportion of natural-origin Chinook salmon due to the different proportions available between natural-origin and hatchery-origin salmon under the implementation scenario for Alternative 2 compared to Alternative 1. Within the analysis area for wildlife, the effects of the implementation scenario for Alternative 2 are unknown because it is not known whether killer whales concentrate feeding at the river mouth. Moreover, it is not known whether killer whales target Columbia River basin Chinook salmon, although the whales likely feed on these salmon anywhere they occur within the whales' range. The impact of the implementation scenario for Alternative 2 may be mitigated to some extent because southern resident killer whales apparently exploit other locally available prey sources along the Pacific coast during winter months, such as Chinook salmon runs in Monterey Bay (Wiles 2004), but it is not known how frequently this occurs.

Alternative 3

The implementation scenario for Alternative 3 would reduce the number of adult Columbia River basin Chinook salmon in the ocean by approximately 7 percent (Table 4-104) compared to Alternative 1. The implementation scenario for Alternative 3 may affect the prey base of southern resident killer whales in coastal waters when the whales are present, primarily during winter to early spring months. Although the Columbia River basin is a large producer of Chinook salmon, a 7 percent reduction in Columbia River basin Chinook salmon in the ocean compared to Alternative 1 would be a relatively small reduction in the overall coastal abundance of Chinook salmon. In addition, a 7 percent change in the Columbia River basin Chinook salmon food source may be within annual natural variability.

Given the likelihood that southern resident killer whales strongly prefer Chinook salmon, many of which originate in the Columbia River basin, the implementation scenario for Alternative 3 may result in killer whales feeding on a higher proportion of natural-origin Chinook salmon compared to hatchery-origin Chinook salmon than under Alterative 1 due to the different proportion available between the two groups. The implementation scenario for Alternative 3 would not be expected to impact the population abundance of the southern resident stock of killer whales. The impact of the implementation scenario for Alternative 3 may be mitigated to some extent because southern resident killer whales apparently exploit other locally available prey sources along the Pacific coast during winter months, such as Chinook salmon runs in Monterey Bay (Wiles 2004), but it is not known how frequently this occurs.

Alternative 4

The implementation scenario for Alternative 4 would reduce the number of adult Columbia River basin Chinook salmon in the ocean by approximately 2 percent (Table 4-104) compared to Alternative 1. Although the Columbia River basin is a large producer of Chinook salmon, a 2 percent reduction in Columbia River basin Chinook salmon in the ocean would be a minor decrease in the overall coastal abundance of Chinook salmon. This reduction in the killer whale’s preferred prey base is likely within the range of natural variability (such as ocean conditions) and would be difficult to distinguish from other sources of natural-origin salmon and steelhead population variability that are unrelated to the action alternatives. The implementation scenario for Alternative 4 would not be expected to impact the population abundance of the southern resident stock of killer whales. Similar to the other alternatives, the effect of changes in Chinook salmon availability under the implementation scenario for Alternative 4 may be mitigated to some extent because southern resident killer whales apparently exploit other locally available prey sources along the Pacific coast during winter months, such as Chinook salmon runs in Monterey Bay (Wiles 2004). It is not known how frequently this exploitation of other prey sources occurs.

Alternative 5

The implementation scenario for Alternative 5 would reduce the number of adult Columbia River basin Chinook salmon in the ocean by approximately 5 percent (Table 4-104) relative to Alternative 1. The effects of this change are likely within annual natural variability, with effects on southern killer whales similar to that described under the implementation scenario for Alternative 4. The implementation scenario for Alternative 5 would not be expected to impact the population abundance of the southern resident stock of killer whales. Similar to the other alternatives, the impact of the implementation scenario for Alternative 5 may be mitigated to some extent because southern resident killer whales apparently exploit other locally available prey sources along the Pacific coast during winter months, such as Chinook salmon runs in Monterey Bay (Wiles 2004). It is not known how frequently this exploitation of other prey sources occurs.

4.5.4.1.2 Steller Sea Lion

As summarized in Section 3.5.3, Endangered Species Act (ESA)-listed Species, the eastern stock of Steller sea lions resides year-round on the coasts of Oregon and Washington, and in the lower Columbia River (NMFS 2008d,e). Studies of the western stock of Steller sea lions showed that 20 percent of their prey consists of salmon and steelhead (Sinclair and Zeppelin 2002). No comparable information (proportion of different prey in their diet) was found for the eastern stock. The extent to which eastern stock Steller sea lions depend on salmon in the lower Columbia River and nearby coastal waters is unknown, although some Steller sea lions (e.g., 10 sea lions in 2007) appear to exploit salmon at Bonneville Dam (NMFS 2008f). Salmon remains were found in 25 percent of the scat samples obtained in 2007 at Bonneville Dam.

Available information suggests that Steller sea lions in the Columbia River rely more on sturgeon than on salmon and steelhead (NMFS 2008a,f). Observed salmon predation elsewhere by Steller sea lions (e.g., south Oregon coast) appears to have increased since the 1980s, however, and Steller sea lions have been observed preying on salmon smolts and adults (NMFS 1997).

Alternative 1 (No Action)

Hatchery production levels under Alternative 1 would be the same as under baseline conditions. As a result, Alternative 1 would not affect Steller sea lions because there would be no expected change in prey availability compared to baseline conditions.

Alternative 2

The implementation scenario for Alternative 2 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River basin by 52 percent and 43 percent, respectively, compared to Alternative 1 (Table 4-104). The importance of salmon and steelhead in the diet of Steller sea lions in the Columbia River is not well known, except as documented for a few individuals at Bonneville Dam (NMFS 2008f). Steller sea lions are opportunistic foragers that do not breed in the Columbia River basin. They could potentially forage for different prey in estuarine or coastal waters. The relatively large reduction in overall production of Columbia River basin salmon and steelhead under the implementation scenario for Alternative 2 compared to Alternative 1 could lead to changes in their distribution within the Columbia River if sea lions relocate to pursue other prey resources. No change in population abundance would be expected relative to Alternative 1.

Alternative 3

The implementation scenario for Alternative 3 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River basin by approximately 19 percent and 18 percent, respectively, compared to Alternative 1. This would potentially reduce the prey base of Steller sea lions. As under the implementation scenario for Alternative 2, depending on availability of alternate prey, the sea lions would likely consume other prey species to replace salmon and steelhead or would relocate to pursue other prey resources if this reduction in available salmon and steelhead occurred. No change in population abundance would be expected relative to Alternative 1.

Alternative 4

The implementation scenario for Alternative 4 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River basin by approximately 12 percent and 10 percent, respectively, compared to Alternative 1. This would potentially reduce the prey base of Steller sea lions. As under the implementation scenario for Alternative 2, depending on availability of alternate prey, this small reduction in one potential prey resource is not likely to be discernable among other sources of variability in the Steller sea lion prey base. No change in population abundance would be expected relative to Alternative 1.

Alternative 5

The implementation scenario for Alternative 5 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River basin by approximately 17 percent and 16 percent, respectively, compared to Alternative 1 (Table 4-104). The effect of this alternative on Steller sea lions in the analysis area would be the same as under the implementation scenario for Alternative 3. No change in population abundance would be expected relative to Alternative 1.

4.5.4.1.3 Brown Pelican

As summarized in Section 3.5.3, ESA-listed Species, the California brown pelican occurs along the Pacific Northwest coast from June to October (Wahl et al. 2005) where they feed opportunistically in shallow marine waters including estuaries (Seattle Audubon Society 2005). In Washington and Oregon, their numbers are highest at the mouth of the Columbia River, and on the coastline at Grays Harbor, Ocean Shores, and Copalis, Washington (Marshall et al. 2006; Seattle Audubon Society 2005; Opperman 2003). Although there are no nesting colonies on the Columbia River, in 2002, as many as 11,000 California brown pelicans roosted on East Sand Island at the mouth of the Columbia River (USACE 2008). These birds are subadults and non-breeding adults that move far up the west coast during the summer (June to October). The brown pelican’s diet consists of schooling anchovies, smelt, herring, Pacific mackerel, minnow, and sardines (Monterey Bay Aquarium 2003; Seattle Audubon Society 2005; NatureServe 2008). Although available information does not indicate salmon and steelhead are in the diet of brown pelicans, it is possible that this opportunistic species consumes salmon and steelhead smolts. Cederholm et al. (2001) included brown pelicans among wildlife species that have been observed or are perceived to aggregate at salmon congregations in Oregon and Washington.

Alternative 1 (No Action)

Hatchery production levels under Alternative 1 would be the same as under baseline conditions. As a result, Alternative 1 would not affect brown pelicans because there would be no expected change in prey availability compared to baseline conditions.

Alternative 2

The implementation scenario for Alternative 2 would reduce the overall production of salmon and steelhead smolts in the Columbia River basin by approximately 52 percent compared to Alternative 1 (Table 4-104). The importance of salmon and steelhead in the diet of brown pelicans near the mouth of the Columbia River is not known, and many alternative prey species exist. Since brown pelicans do not appear to target salmon and steelhead (although they may feed on them opportunistically), it is unlikely that changes in the brown pelican diet, distribution, or abundance would occur compared to Alternative 1.

Alternative 3

The implementation scenario for Alternative 3 would reduce the overall production of salmon and steelhead smolts in the Columbia River basin by approximately 19 percent (Table 4-104) compared to Alternative 1. As described above, the importance of salmon and steelhead in the diet of brown pelicans near the mouth of the Columbia River is not known, and many alternative prey species exist. Since brown pelicans do not appear to target salmon and steelhead (although they may feed on them opportunistically), it is unlikely that a reduction of 19 percent would affect brown pelican diet, distribution, or abundance compared to the implementation scenario for Alternative 1.

Alternative 4

The implementation scenario for Alternative 3 would reduce the overall production of salmon and steelhead smolts in the Columbia River basin by approximately 12 percent (Table 4-104) compared to Alternative 1. As discussed above, the importance of salmon and steelhead in the diet of brown pelicans near the mouth of the Columbia River is not known, and many alternative prey species exist. Since brown pelicans do not appear to target salmon and steelhead specifically, it is unlikely that a reduction of 12 percent would affect brown pelican diet, distribution, or abundance compared to the implementation scenario for Alternative 1.

Alternative 5

The implementation scenario for Alternative 5 would reduce the overall production of salmon and steelhead smolts in the Columbia River basin by approximately 17 percent compared to Alternative 1 (Table 4-104). The effect of this alternative on brown pelican diet, distribution, and abundance would be similar to that described under the implementation scenario for Alternative 3.

4.5.4.1.4 Marbled Murrelet

As summarized in Section 3.5.3, ESA-listed Species, marbled murrelets are opportunistic feeders that consume a diverse prey base, which may include salmon smolts, in marine habitats (Burkett 1995; Ostrand et al. 2004; McShane et al. 2004). This species' density is low near the mouth of the Columbia River, and diet studies do not suggest heavy reliance on salmon and steelhead smolts (Burkett 1995). Information on prey choice of marbled murrelets (summarized in Section 3.5.3.1.4, Marbled Murrelet) is not adequate to characterize the abundance and species composition of salmon and steelhead in the marbled murrelet's diet; however, it is assumed that some juvenile salmon and steelhead may be taken by murrelets near the mouth of the Columbia River.

Alternative 1 (No Action)

Hatchery production levels under Alternative 1 would be the same as under baseline conditions. As a result, Alternative 1 would not affect marbled murrelet because there would be no expected change in prey availability compared to baseline conditions.

Alternative 2

The implementation scenario for Alternative 2 would reduce overall and steelhead smolt production in the Columbia River basin by approximately 52 percent relative to Alternative 1 (Table 4-104). Since marbled murrelets do not appear to depend on salmon and steelhead for the majority of their prey, a 52 percent reduction would likely result in this species finding alternative prey sources. This reduction would be unlikely to change the diet, distribution, or abundance of the species compared to Alternative 1.

Alternative 3

The implementation scenario for Alternative 3 would reduce overall salmon and steelhead smolt production in the Columbia River basin by approximately 19 percent relative to Alternative 1 (Table 4-104). Since marbled murrelets do not appear to depend on salmon and steelhead for the majority of their prey, a 19 percent reduction would likely result in this species finding alternative prey sources. This reduction would be unlikely to change the diet, distribution, or abundance of the species compared to Alternative 1.

Alternative 4

The implementation scenario for Alternative 4 would reduce overall salmon and steelhead smolt production in the Columbia River basin by approximately 12 percent relative to Alternative 1 (Table 4-104). Since marbled murrelets do not appear to depend on salmon and steelhead for the majority of their prey, it is expected that a reduction of 12 percent would result in this species finding alternative prey sources. This reduction would be unlikely to change the diet, distribution, or abundance of the species compared to Alternative 1.

Alternative 5

The implementation scenario for Alternative 5 would reduce overall salmon and steelhead smolt production in the Columbia River basin by approximately 17 percent relative to Alternative 1 (Table 4-104). The affect of this alternative would be similar to the implementation scenario for Alternative 3. It is not expected that a reduction of 17 percent salmon and steelhead smolt production would change the diet, distribution, or abundance of the species compared to Alternative 1.

4.5.4.2 Non-listed Birds

4.5.4.2.1 Bald Eagle

As summarized in Section 3.5.4.1.1, Bald Eagle, bald eagles that breed along the lower Columbia River are year-round residents. Bald eagles are protected under the Bald Eagle and Golden Eagle Protection Act. In eastern Washington, Oregon, and Idaho, the reservoirs and major tributaries of the Columbia and Snake Rivers are important wintering habitats (Stinson et al. 2001). The proportion of salmon and steelhead in the diet of these bald eagles is not known, but it appears that spawning salmon and their carcasses are a preferred prey resource when available (Fitzner and Hanson 1979). Live salmon do not appear to be the primary food source of bald eagles in the Columbia River basin, although Cederholm et al. (2001) considered bald eagles to have a strong relationship with salmon and steelhead in marine habitats. Salmon and steelhead smolts are consumed by nesting eagles on the lower Columbia River and estuary, but their significance in the diet of this eagle population is unknown. As discussed in Section 4.5.3.4, Availability of Nutrients/Distribution of Salmon Carcasses, the number of salmon carcasses would decrease under the implementation scenarios for Alternative 2 through Alternative 5.

Alternative 1 (No Action)

Hatchery production levels under Alternative 1 would be the same as under baseline conditions. As a result, Alternative 1 would not affect the bald eagle because there would be no expected change in prey availability compared to baseline conditions.

Alternative 2

The implementation scenario for Alternative 2 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River basin by 52 percent and 43 percent, respectively (Table 4-104), compared to Alternative 1. The large decrease in numbers of live adults, smolts, and carcasses could affect the prey base of resident bald eagles in the lower Columbia River and estuary and would reduce the availability of salmon carcasses for overwintering bald eagles in the Columbia River basin. Bald eagles consume a wide range of fish and waterfowl, but elimination of a large number of salmon and steelhead from their prey base may result in changes in bald eagle abundance, distribution, and fitness within the Columbia River basin. Possible results in the resident population of the lower Columbia River and estuary would include reduced survival of adults and immature bald eagles, poor condition and fitness of adults entering the breeding season, and poor survival of pre-fledgling chicks compared to Alternative 1.

Alternative 3

The implementation scenario for Alternative 3 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River basin by 19 percent and 18 percent, respectively (Table 4-104), compared to Alternative 1. The decrease in numbers of live adults, smolts, and carcasses would affect the prey base of resident bald eagles in the lower Columbia River and estuary and would reduce the availability of salmon carcasses for overwintering bald eagles in the Columbia River basin. Bald eagles consume a wide range of fish and waterfowl and would likely forage on non-salmon prey, but this reduction may result in changes in bald eagle diet, distribution, and abundance compared to Alternative 1.

Alternative 4

The implementation scenario for Alternative 4 would reduce overall production of hatchery-origin salmon and steelhead smolts and adults in the Columbia River basin by 12 percent and 10 percent, respectively (Table 4-104), compared to Alternative 1. The decrease in numbers of live adults, smolts, and carcasses would affect the prey base of resident bald eagles in the lower Columbia River and estuary and would reduce the availability of salmon carcasses for overwintering bald eagles in the Columbia River basin. However, the production changes under this alternative may be difficult to discern from other sources of natural variability in the prey base, such as variability in waterfowl populations in the upper Columbia River basin (including Snake River) and non-salmonid freshwater and marine fish species. Bald eagles consume a wide range of fish and waterfowl and would likely forage on other fish. As a result, the implementation scenario for Alternative 4 would not likely affect bald eagle diet, distribution, or abundance compared to Alternative 1.

Alternative 5

The implementation scenario for Alternative 5 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River basins by 17 percent and 16 percent, respectively (Table 4-104), compared to Alternative 1. The decrease in numbers of live adults, smolts, and carcasses would affect the prey base of resident bald eagles in the lower Columbia River and estuary and would reduce the availability of salmon carcasses for overwintering bald eagles in the Columbia River basin. The effect of this alternative would be similar to that described under the implementation scenario for Alternative 3.

4.5.4.2.2 Other Birds

As described in Section 3.5.4.1.2, Other Birds, avian predators on salmon and steelhead are present throughout the Columbia River basin. They concentrate in the estuary and at reservoirs and tailrace outfalls below dams. Population increases of Caspian terns and double-crested cormorants have been linked to environmental changes associated with dredge spoils management and hydroelectric projects on the Columbia River that increase prey vulnerability during the birds' nesting season (NMFS 2008c). In particular, the Caspian tern breeding colony on East Sand Island in the lower estuary has grown in recent years and currently supports the largest breeding colony of this species. Cederholm et al. (2001) considered some avian predators (such as osprey, Caspian terns, and harlequin duck) to have a strong relationship to salmon and steelhead prey, as summarized in Table 3-26. In addition, recent studies of other fish-eating, colonially nesting birds on the Columbia River (gull species, double-crested cormorants, and American white pelicans) have shown that these species consume juvenile salmon and steelhead (Collis et al. 2002; Roby and Collis 2008). However, only the Caspian tern (and, to a lesser extent, the double-crested cormorant) is considered dependent on salmon and steelhead as prey.

Alternative 1 (No Action)

Hatchery production levels under Alternative 1 would be the same as under baseline conditions. As a result, Alternative 1 would not affect other fish-eating birds because there would be no expected change in prey availability compared to baseline conditions.

Alternative 2

Compared to Alternative 1, a large reduction in salmon and steelhead smolt production in the Columbia River basin under the implementation scenario for Alternative 2 (approximately 52 percent, Table 4-104) would have an effect on most salmon-eating birds. Caspian terns would be most affected by this alternative because this species relies heavily on salmon and steelhead during the breeding season. Although Caspian terns are highly opportunistic, wide-ranging, and can change their prey, foraging areas, and nesting sites (provided undisturbed areas with the correct substrate are available), the magnitude of the change in prey base under the implementation scenario for Alternative 2 would likely negatively affect their abundance and ability to breed successfully on the Columbia River compared to Alternative 1, although the degree of this effect is unknown. Their distribution also would likely change compared to Alternative 1. Under conditions of food shortage, most birds may leave the area without nesting, and those that do attempt to breed may desert nests. Chicks and fledglings may not survive, and/or the abundance of adults may decline. Ultimately the size of the west coast Caspian tern population may be reduced compared to Alternative 1, but the amount of this decline cannot be predicted.

Other avian predators (double-crested cormorant, gull species, American white pelican, osprey, harlequin duck, mergansers) depend considerably less on salmon and steelhead than do Caspian terns, but this alternative may result in changes in the diet, distribution, and abundance of some avian predator populations compared to Alternative 1, although the degree of this effect is unknown.

Alternative 3

The implementation scenario for Alternative 3 would reduce overall salmon and steelhead smolt production in the Columbia River basin by 19 percent compared to Alternative 1 (Table 4-104). Conservatively, it is possible that other prey species populations may not be adequate to support salmon-eating bird populations, especially Caspian terns, in some years. For Caspian terns, a decrease of 19 percent may affect distribution and abundance in the Columbia River with possible area results that include reduced numbers of birds attempting to breed, nest failures, or a decrease in fitness compared to Alternative 1. Other less dependent avian predators would likely forage on non-salmon or steelhead species. However, there may be changes in the diet, distribution, and abundance of some avian populations that prey on salmon and steelhead compared to Alternative 1, although the degree of this affect is unknown.

Alternative 4

The implementation scenario for Alternative 4 would reduce overall salmon and steelhead smolt production in the Columbia River basin by approximately 12 percent relative to Alternative 1 (Table 4-104). Caspian terns and other avian predators would likely consume other prey species if this alternative were implemented, depending on their availability. The impact of the relatively small change in hatchery production under the implementation scenario for Alternative 4 would probably not be discernable relative to other natural sources of variability in the birds' prey base, which includes other fish species. As a result, there would not be any expected changes in diet, distribution, and abundance of avian predator populations compared to Alternative 1.

Alternative 5

The implementation scenario for Alternative 5 would reduce overall salmon and steelhead smolt production in the Columbia River basin by 17 percent compared to Alternative 1 (Table 4-104). The effect of this alternative would be similar to that described under the implementation scenario for Alternative 3.

4.5.4.3 Marine Mammals

Two non-ESA-listed marine mammal species (California sea lion and harbor seal) forage on salmon and steelhead in the lower Columbia River and estuary during fall and winter.

4.5.4.3.1 California Sea Lion

California sea lions are opportunistic foragers, responding to seasonal and local availability of a variety of fish species. In the Columbia River, they are present seasonally (January to late May), when they consume substantial numbers of adult Chinook salmon and steelhead, in particular at the tailrace of Bonneville Dam (River Mile [RM] 146) (Section 3.5.5.1.1, California Sea Lion).

Alternative 1 (No Action)

Hatchery production levels under Alternative 1 would be the same as under baseline conditions. As a result, Alternative 1 would not affect California sea lions because there would be no expected change in prey availability compared to baseline conditions.

Alternative 2

The implementation scenario for Alternative 2 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River basin by 52 percent and 43 percent, respectively, compared to Alternative 1 (Table 4-104). California sea lions are wide-ranging and highly opportunistic in their prey choices. They would likely increase their use of different prey species and other locations. Sea lion predation on marine forage fish, in particular, may increase. However, alternate prey species may not be adequate to support existing population numbers every year, depending on a number of natural oceanic conditions not related to any of the action alternatives. A conservative interpretation of available information would be that the large reduction in the abundance of salmon and steelhead under this alternative would substantially reduce the prey base for California sea lions spending the non-breeding season in the lower Columbia River and could affect adult fitness and survival. Numbers of sea lions at Bonneville Dam would probably decline compared to under Alternative 1, but the amount of this decline cannot be predicted. Depending on the availability of alternate prey, this alternative would likely affect the abundance and distribution of California sea lions in the Columbia River compared to Alternative 1, and these sea lions would likely move to other areas in the Pacific Northwest with concentrated readily exploited prey resources.

Alternative 3

The implementation scenario for Alternative 3 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River basin by approximately 19 percent and 18 percent, respectively, compared to Alternative 1 (Table 4-104), reducing the prey base of non-breeding California sea lions as discussed under the implementation scenario for Alternative 2. The sea lions would likely increase consumption of other prey species, especially marine forage fish depending on availability, if this alternative were implemented. The implementation scenario for Alternative 3 may affect California sea lion diet, distribution, and abundance in the Columbia River basin relative to Alternative 1, but the degree of this effect is unknown.

Alternative 4

The implementation scenario for Alternative 4 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River basin by approximately 12 percent and 10 percent, respectively, compared to Alternative 1 (Table 4-104), reducing the prey base of non-breeding California sea lions as discussed under the implementation scenario for Alternative 2. Depending on availability of alternate prey, this small reduction in one potential prey resource is not likely to be discernable among other sources of variability in the California sea lion prey base. As a result, there would not be any expected changes in the diet, distribution, or abundance of California sea lions in the Columbia River basin compared to Alternative 1.

Alternative 5

The implementation scenario for Alternative 5 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River basin by approximately 17 percent and 16 percent, respectively, compared to Alternative 1 (Table 4-104), reducing the prey base of non-breeding California sea lions as discussed under the implementation scenario for Alternative 2. The effect of this alternative would be similar to that described under the implementation scenario for Alternative 3.

4.5.4.3.2 Harbor Seal

Although resident in coastal areas and the estuary, harbor seals are wide-ranging and highly opportunistic in their foraging, responding to seasonal availability of many prey species. As described in Section 3.5.5.1.2, Harbor Seal, the importance of salmon and steelhead in the diet of harbor seals may be greatest during spring and fall months. However, the frequency of occurrence of adult (fall months) and juvenile salmon (spring months) in scat samples on the lower Columbia River was about 10 percent and 19 percent, respectively (Browne et al. 2002), suggesting that seals are not closely dependent on salmon and steelhead in the analysis area. Harbor seal numbers in the Columbia River peak from December to mid-March, when they consume substantial numbers of smelt (Jeffries 1984; Beach et al. 1985; Jeffries 1986; NMFS 1993 *in* LCFRB 2004).

Alternative 1 (No Action)

Hatchery production levels under Alternative 1 would be the same as under baseline conditions. As a result, Alternative 1 would not affect harbor seal because there would be no expected change in prey availability compared to baseline conditions.

Alternative 2

Relative to Alternative 1, overall production of salmon and steelhead smolts and adults in the Columbia River basin would decrease by 52 percent and 43 percent, respectively, under the implementation scenario for Alternative 2 (Table 4-104), resulting in a reduced prey base for harbor seals in the lower Columbia River and estuary. This mobile, opportunistic species would likely shift to other non-salmon and steelhead prey in coastal waters. However, alternate prey species may not be sufficient to support existing harbor seal populations, depending on conditions in marine waters and the estuary that are not related to the action alternatives. Thus, in some years, alternate prey may be scarce, affecting the diet, distribution, and fitness of harbor seals. Poorer breeding conditions may result in reduced fitness of offspring. Consequently, there may be an overall reduction in harbor seal abundance under the implementation scenario for Alternative 2 compared to Alternative 1, but such reduction levels cannot be predicted.

Alternative 3

The implementation scenario for Alternative 3 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River basin by approximately 19 percent and 18 percent, respectively, relative to Alternative 1, reducing the prey base of harbor seals as discussed under the implementation scenario for Alternative 2. The seals would likely increase consumption of other prey species if this alternative were implemented, depending on availability. However, there may changes in harbor seal diet, distribution, and abundance under the implementation scenario for Alternative 3 compared to Alternative 1, the degree of which cannot be predicted.

Alternative 4

The implementation scenario for Alternative 4 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River basin by approximately 12 percent and 10 percent, respectively, relative to Alternative 1, reducing the prey base of harbor seals as discussed under the implementation scenario for Alternative 2 and Alternative 3. The impact of the relatively small change in salmon and steelhead production under the implementation scenario for Alternative 4 would probably not be discernable relative to other natural sources of variability in the seals’ prey base, which includes a variety of other marine fish species. As a result, no changes in diet, distribution, or abundance would be expected under the implementation scenario for Alternative 4 relative to Alternative 1.

Alternative 5

The implementation scenario for Alternative 5 would reduce overall production of salmon and steelhead smolts and adults in the Columbia River basin by approximately 17 percent and 16 percent, respectively, relative to Alternative 1 (Table 4-104). The effect of this alternative would be similar to that described under the implementation scenario for Alternative 3.

4.5.4.4 Other Aquatic and Terrestrial Wildlife

River otter and mink are widely distributed predators in freshwater aquatic habitats in the Columbia River basin, as well as in the estuary and nearshore marine environments (Section 3.5.6.1, Distribution of Other Aquatic and Terrestrial Wildlife and their Food Resources). Otter depend more on aquatic habitats and fish species as prey than do mink (Melquist 1997). They feed on several life stages of salmon and steelhead (juveniles, spawning fish, and salmon carcasses).

Two salamander species (Pacific giant salamander and Cope's giant salamander) may prey on or compete for salmon and steelhead in streams, but their relationships with salmon and steelhead are poorly understood. If giant salamanders prey on salmon and steelhead, it would most likely be on fry of natural origin. Since hatchery-origin fish are generally released as smolts, they would likely be less vulnerable to giant salamanders because of their larger size. However, salmon and steelhead fry and smolts may compete with giant salamanders for aquatic and terrestrial insect prey.

Salmon and steelhead smolts and juveniles feed on marine invertebrates, as do many other types of predators, including forage fishes and some marine birds and marine mammals. In freshwater systems, aquatic insects are consumed by salmon and steelhead fry, spawning salmon and steelhead increase niche space for benthic aquatic invertebrates, and salmon carcasses contribute nutrients to streams, helping to support increases in aquatic invertebrate populations.

Alternative 1 (No Action)

Hatchery production levels under Alternative 1 would be the same as under baseline conditions. As a result, Alternative 1 would not affect river otter, mink, amphibians, freshwater aquatic invertebrates, or marine invertebrates because there would be no expected change in prey availability compared to baseline conditions.

Alternative 2

The substantial decrease in total salmon and steelhead smolt and adult production in the Columbia River basin under the implementation scenario for Alternative 2 (52 percent for smolts and 43 percent for adults, compared to Alternative 1 [Table 4-104]) would affect the food supply available to river otter. Because otters have a strong relationship with salmonid populations, and salmon and steelhead are likely to be among the most easily acquired prey (especially spawning fish and carcasses), changes resulting from Alternative 2 would reduce their prey base. Depending on the availability of alternate prey, food scarcity could ultimately affect river otter population size by decreasing survival or fitness of adults and juveniles and potentially reducing reproductive success. Available information on the diets of mink and their foraging behavior (Cederholm et al. 2001; Melquist 1997) suggests that the impact of Alternative 2 on this species would be minor compared to Alternative 1 because they are not closely linked to salmon and steelhead and have many other prey sources.

The implementation scenario for Alternative 2 is unlikely to change the prey base for giant salamander species compared to Alternative 1. The expected increase in the abundance of natural-origin salmon and steelhead fry may benefit salamanders. Larger juvenile salmon and steelhead rearing in streams with giant salamanders may also compete for aquatic macroinvertebrates and insects. Thus, the alternative may reduce competition compared to Alternative 1. An analysis of the effects of this alternative would require information that is not currently available about interactions among amphibians and salmon and steelhead

The implementation scenario for Alternative 2 would reduce predation pressure on marine invertebrates and aquatic insect populations because numbers of juvenile salmon and steelhead would be lower. In freshwater systems, nutrient import from marine waters would be reduced because fewer adult carcasses would be deposited in spawning streams. However, an analysis of the effects of this alternative on marine invertebrate and aquatic insect populations would require information that is not currently available about interactions among competing predators and other aquatic ecosystem effects.

Alternative 3

The implementation scenario for Alternative 3 would reduce salmon and steelhead smolt and adult production in the Columbia River basin by 19 percent and 18 percent, respectively, compared to Alternative 1 (Table 4-104). Depending on the availability of alternate prey, food scarcity could affect river otter population size compared to Alternative 1 by decreasing survival or fitness of adults and juveniles and potentially reducing reproductive success in some years. As described under the implementation scenario for Alternative 2, effects on mink would be minor or negligible due to their diversity of prey consumption.

As discussed under the implementation scenario for Alternative 2, the effects of the implementation scenario for Alternative 3 on giant salamanders would depend on the extent to which hatchery-origin salmon and steelhead are present in streams that these salamanders occupy. Iinformation about interactions among salamanders and salmon and steelhead is not currently available.

As discussed under the implementation scenario for Alternative 2, there would be a reduction in predation pressure on marine invertebrates and aquatic insect populations under the implementation scenario for Alternative 3 when compared to Alternative 1. There would also be a reduction in nutrient import into freshwater systems compared to Alternative 1. However, an analysis of the effects of this alternative on overall marine invertebrate and aquatic insect populations would require information that is not currently available about interactions among competing predators and other aquatic ecosystem effects.

Alternative 4

The implementation scenario for Alternative 4 would reduce salmon and steelhead smolt and adult production in the Columbia River basin by 12 percent and 10 percent, respectively, compared to Alternative 1 (Table 4-104). River otters and mink would likely shift to alternate prey if they were available. The effect of this alternative on the prey base would probably not be discernable compared to other natural and unrelated sources of variability in prey population sizes.

As discussed under the implementation scenario for Alternative 2, the effects of the implementation scenario for Alternative 4 on giant salamanders would depend on the extent to which hatchery-origin salmon and steelhead are present in streams these salamanders occupy. Information is not currently available about interactions among salamanders and salmon and steelhead.

There would be a reduction in predation pressure on marine invertebrates and invertebrate populations under the implementation scenario for Alternative 4 compared to under Alternative 1. Considering natural variability of salmon and steelhead, marine invertebrates, and insect populations, it is unlikely that this decrease would affect distribution or abundance of either marine invertebrates or aquatic insects.

Alternative 5

The implementation scenario for Alternative 5 would reduce salmon and steelhead smolt and adult production in the Columbia River basin by 17 percent and 16 percent, respectively, compared to Alternative 1 (Table 4-104), with possible consequences to river otter and mink similar to those described for Alternative 3.

4.6 Water Quality and Quantity

4.6.1 Introduction

Successful operation of Federal, state, and tribal hatcheries depends on a constant supply of high-quality surface, spring, or groundwater that, after use in the hatchery facility, is discharged to adjacent receiving environments. Various components of water quality and quantity that could be affected by hatchery operations are discussed in Section 3.6, Water Quality and Quantity. This section describes the effects of implementing the alternatives on water quality and quantity. As described in Chapter 2, Alternatives, one implementation scenario has been identified for each alternative so that the effects of each alternative can be understood and compared. Implementation measures are combined under each alternative to create an implementation scenario (Table 2-6). Table 4-105 shows the implementation measures that may affect water quality and quantity indicators. Six implementation measures may affect water quality and quantity indicators:

- Change production levels in hatchery programs.
- Correct water quality issues at hatchery facilities.
- Install new temporary weirs.
- Install new permanent weirs.
- Establish new hatchery programs.
- Terminate hatchery programs that support harvest if they fail to meet performance goals.

All of these implementation measures are related to changes in production levels (including those associated with new and terminated hatchery programs), installation of weirs, and improvements to the water quality of the hatchery effluent (Table 4-105). The analysis is primarily based on the above issues because the number of hatchery-origin fish produced determines the quantity of water needed for operations, the amount of chemicals and solids in the effluent discharged, and the number of returning hatchery-origin fish that ends up as carcasses in local steams. Effects of installing new weirs and correcting water quality issues at hatchery facilities are discussed, but in less detail as effects may be negligible. As described in Section 3.6.2 (Analysis Area), the analysis area for water quality and quantity is the same as the project area (Section 2.2, Description of Project Area).

TABLE 4-105. WATER QUALITY AND QUANTITY INDICATORS THAT MAY BE AFFECTED BY IMPLEMENTATION MEASURES INCLUDED UNDER THE ALTERNATIVES' IMPLEMENTATION SCENARIOS.

IMPLEMENTATION MEASURES INCORPORATED IN ONE OR MORE OF THE ALTERNATIVES' IMPLEMENTATION SCENARIOS	WATER QUALITY AND QUANTITY INDICATORS THAT MAY BE AFFECTED			
	WATER QUALITY PARAMETERS[1]	COMPLIANCE WITH APPLICABLE HATCHERY REGULATIONS	SURFACE WATER DIVERSIONS AND CONSUMPTION	GROUNDWATER DIVERSIONS AND CONSUMPTION
Change production levels in hatchery programs.	X	X	X	X
Change broodstock collection protocols in hatchery programs.				
Update water intake screens at hatchery facilities.				
Update hatchery facilities to allow all salmon and steelhead of all ages to by-pass or pass through hatchery-related structures.				
Improve rearing and release protocols in hatchery programs.				
Correct water quality issues at hatchery facilities.	X			
Install new temporary weirs.			X	
Install new permanent weirs			X	
Establish new selective fisheries in terminal areas.				
Change hatchery program goals (i.e., harvest or conservation).				
Change hatchery program's operational strategy (i.e., segregated or integrated).				
Establish new hatchery programs.	X	X	X	X
Terminate hatchery programs that support harvest if they fail to meet performance goals.	X	X	X	X

These changes apply to hatchery programs funded through the Mitchell Act and hatchery programs receiving funding from other sources. Implementation measures that were not applied under any of the alternatives were not included in this table.

[1] Water quality parameters include temperature, nutrients, dissolved oxygen, pH, sediment, polychlorinated biphenyls (PCBs) and dichlorophenyltrichloroethane (DDT), pathogens, steroid hormones, and hatchery treatment chemicals.

4.6.2 Methods for Analysis

The qualitative analysis conducted for water quality and quantity for this section was based on use of literature representing best available science, consistency with regulatory requirements, and use of other studies that identified effects that resulted from similar or related projects within and near the analysis area. No modeling was conducted.

4.6.3 Water Quality

Changes in salmon production levels (including those associated with new and terminated hatchery programs) have the potential to affect water quality in downstream receiving environments of each hatchery program (Section 3.6.3, Water Quality). Increases in production could reduce the quality of the water being discharged from hatchery facilities to downstream receiving environments, while decreasing production would concurrently increase the quality of the water being discharged from the hatchery facilities to downstream receiving environments through reductions in temperature, ammonia, nutrients (e.g., nitrogen), biochemical oxygen demand (BOD), pH, sediment levels, therapeutics (e.g., antibiotics), fungicides, disinfectants, steroid hormones, anesthetics, pesticides, herbicides, and pathogens (Section 3.6.3.1, Water Quality Parameters). It is unclear whether the amount of PCBs and dichlorodiphenyltrichloroethane (DDT) would be affected by changes in production levels since it is unclear how these changes in production levels would affect the distribution of hatchery-origin salmon carcasses, which could release PCBs and DDTs into the freshwater aquatic system. As a result, changes in PCBs and DDTs will not be compared across alternatives.

Operation of hatchery facilities requires compliance with Federal and state water quality and quantity regulations (Section 3.6.3.2, Applicable Hatchery Regulations and Compliance). Currently, all hatchery programs in the analysis area are in compliance with their NPDES discharge permits (Table 4-7). However, hatchery programs are a possible source of several parameters that have been identified as impairing segments of the Columbia and Snake Rivers: algae, ammonia, dissolved oxygen, nutrients, pathogens, pH, sediment, sedimentation, temperature, and total phosphorus (Table 3-33). Although hatcheries have not been identified as a source of impairment to these streams, and all hatcheries are in compliance with their NPDES discharge permits, the hatchery effluent released from these hatcheries could contribute to the impairment of these waters. Thus, any decrease in hatchery production may decrease the contribution of hatchery facilities to the impairment of these waters. Any hatchery facility that would increase production under any of the alternatives would have to do so in compliance with an NPDES permit. As a result, compliance with applicable hatchery regulations across alternatives will not be further analyzed.

4.6.3.1.1 Alternative 1 (No Action)

Alternative 1 would not result in changes to water quality parameters since there would be no expected changes in species production levels (Table 2-7) relative to baseline conditions (Section 3.6.3, Water Quality).

4.6.3.1.2 Alternative 2

Under the implementation scenario for Alternative 2, hatchery production would decrease by 64 percent overall compared to Alternative 1 (Table 2-7), which would increase water quality through reductions in temperature, ammonia, nutrients (e.g., nitrogen), BOD, pH, sediment levels, antibiotics, fungicides, disinfectants, steroid hormones, and pathogens (Section 3.6.3.1, Water Quality Parameters). These reductions would decrease the contribution of hatchery facilities to the impairment of 303(d) waters relative to Alternative 1 (Section 3.6.3.2, Applicable Hatchery Regulations and Compliance).

4.6.3.1.3 Alternative 3

Similar to the implementation scenario for Alternative 2, the implementation scenario for Alternative 3 would result in a 26 percent decrease in hatchery production compared to Alternative 1 (Table 2-7), which would increase water quality relative to Alternative 1 through reductions in temperature, ammonia, nutrients (e.g., nitrogen), BOD, pH, sediment levels, antibiotics, fungicides, disinfectants, steroid hormones, and pathogens (Section 3.6.3.1, Water Quality Parameters). These reductions would decrease the contribution of hatchery facilities to the impairment of 303(d) waters relative to Alternative 1 (Section 3.6.3.2, Applicable Hatchery Regulations and Compliance), but not to the same level as Alternative 2, which would experience a 64 percent decrease in hatchery production levels.

4.6.3.1.4 Alternative 4

The implementation scenario for Alternative 4 results in an 18 percent decrease in hatchery production relative to Alternative 1 (Table 2-7), which would increase water quality relative to Alternative 1 through reductions in temperature, ammonia, nutrients (e.g., nitrogen), BOD, pH, sediment levels, antibiotics, fungicides, disinfectants, steroid hormones, and pathogens (Section 3.6.3.1, Water Quality Parameters). These reductions would decrease the contribution of hatchery facilities to the impairment of 303(d) waters relative to Alternative 1 (Section 3.6.3.2, Applicable Hatchery Regulations and Compliance), but not to the same level as Alternative 2 and Alternative 3, which would have a 63 percent and 26 percent reduction, respectively.

4.6.3.1.5 Alternative 5

The implementation scenario for Alternative 5 results in a 23 percent reduction in hatchery production relative to Alternative 1 (Table 2-7), which would increase water quality relative to Alternative 1 through reductions in temperature, ammonia, nutrients (e.g., nitrogen), BOD, pH, sediment levels, antibiotics, fungicides, disinfectants, steroid hormones, and pathogens (Section 3.6.3.1, Water Quality Parameters). These reductions would decrease the contribution of hatchery facilities to the impairment of 303(d) waters relative to Alternative 1 (Section 3.6.3.2, Applicable Hatchery Regulations and Compliance) similar to the implementation scenario for Alternative 3, which would have a 26 percent reduction in production levels relative to Alternative 1.

4.6.4 Water Quantity

Changes in production levels have the potential to affect water quantity by changing the amount of water withdrawn from a surface water body or groundwater for hatchery operations (Section 3.6.4, Water Quantity). Additionally, some hatchery facilities do not return diverted waters to the intake point (meaning that diverted waters are taken from one part of the river or stream and discharged to a different location downstream of the intake point) (Section 3.6.4.1, Surface Water Diversion and Consumption). Discharges to waters not at the intake point are considered consumptive water uses. Groundwater withdrawals have the potential to modify groundwater levels and inflow into surface water bodies (Section 3.6.4.2, Groundwater Diversion and Consumption).

Installation of weirs also has the potential to alter surface water flow at and around the locations of the weirs (Section 3.6.4.1, Surface Water Diversion and Consumption). This potential effect would be present year-around where permanent weirs are installed. The potential effect from a temporary weir would be present only while the weir is installed.

4.6.4.1.1 Alternative 1 (No Action)

Alternative 1 would not result in changes to water quantity since there would be no expected changes in species production levels relative to baseline conditions (Section 3.6.4, Water Quantity). No new weirs would be installed under Alternative 1 relative to baseline conditions (Table 2-9), so no changes in water flow would be expected relative to baseline conditions.

4.6.4.1.2 Alternative 2

Under the implementation scenario for Alternative 2, hatchery production would decrease by 64 percent overall compared to Alternative 1 (Table 2-7). This change in production might increase surface and groundwater flows within the existing water source. Similarly, it is possible that those hatchery programs discharging to locations other than their intake locations would decrease the amount of consumptive water use compared to Alternative 1. This decrease would contribute to increased surface and groundwater flows within the existing adjacent river, stream, and/or groundwater source. No new weirs would be installed under this alternative (Table 2-9); therefore, no changes would be expected in water flow relative to Alternative 1.

4.6.4.1.3 Alternative 3

Under the implementation scenario for Alternative 3, hatchery production would decrease by 26 percent compared to Alternative 1 (Table 2-7). This change in production might increase surface and groundwater flows within the existing water source. Similarly, it is possible that those hatchery programs discharging to locations other than their intake locations would decrease the amount of consumptive water use compared to Alternative 1. This decrease would contribute to increased surface and groundwater flows within the existing adjacent river, stream, and/or groundwater source. Compared to Alternative 1, 13 new temporary weirs would be installed, potentially increasing negative effects on stream flow (Table 2-9), but such effects would be temporary.

4.6.4.1.4 Alternative 4

Under the implementation scenario for Alternative 4, hatchery production would decrease by 18 percent compared to Alternative 1 (Table 2-7). It is possible that this change in production would increase surface and groundwater flows within the existing water source. Similarly, it is possible that those hatchery programs discharging to locations other than their intake locations would decrease the amount of consumptive water use compared to Alternative 1. This decrease would contribute to increased surface and groundwater flows within the existing adjacent river, stream, and/or groundwater source. Compared to Alternative 1, 16 new permanent weirs would be installed, potentially negatively impacting stream flow (Table 2-9). Effects from weirs under the implementation scenario for Alternative 4 would be greater than under the implementation scenarios for Alternative 1 through Alternative 3 because of the number of permanent weirs to be installed.

4.6.4.1.5 Alternative 5

Under the implementation scenario for Alternative 4, hatchery production would decrease by 23 percent compared to Alternative 1 (Table 2-7). It is possible that this change in production would increase surface and groundwater flows within the existing water source. Similarly, it is possible that those hatchery programs discharging to locations other than their intake locations would decrease the amount of consumptive water use compared to Alternative 1. This would contribute to increased surface and groundwater flows within the existing adjacent river, stream, and/or groundwater source. Compared to Alternative 1, 17 new permanent weirs would be installed, potentially negatively impacting stream flow

(Table 2-9). Effects from permanent weirs under the implementation scenario for Alternative 4 would be greater than under the implementation scenarios for Alternative 1 through Alternative 3 and would be similar to the implementation scenario for Alternative 4.

4.7 Human Health

4.7.1 Introduction

Hatchery facilities routinely use chemicals in the management of their facilities. These chemicals include therapeutics (e.g., antibiotics), fungicides, disinfectants, anesthetics, pesticides, and herbicides (Section 3.6.3.1, Water Quality Parameters). These chemicals are not considered hazardous to human health when safety precautions and regulations are followed (Section 3.7.3, Safe Handling of Hatchery Chemicals). However, some chemicals (e.g., antibiotics) do not have established water quality criteria and, therefore, may be discharged to surface waters near hatchery facilities and may pose a threat to human health (Section 3.7.4.2, Therapeutics).

Hatchery workers may also be exposed to diseases while handling fish. There are a number of parasites, viruses, and bacteria that are potentially harmful to human health and may be transmitted from fish species (Section 3.7.6, Relevant Disease Vectors and Transmission). Many of these are transmitted primarily through seafood consumption (i.e., improperly or under-cooked fish). However, exposure to these pathogens may also occur through skin contact with fish or accidental needle-stick injuries during vaccination of fish (Section 3.7.6, Relevant Disease Vectors and Transmission). Concerns have also been raised that farm- or hatchery-raised fish may contain toxic contaminants that pose a health risk to consumers (Section 3.7.5, Toxic Contaminants in Hatchery-origin Fish).

As described in Chapter 2, Alternatives, one implementation scenario has been identified for each alternative so that the effects of each alternative can be understood and compared. Implementation measures are combined under each alternative to create an implementation scenario (Table 2-6). Table 4-106 shows the implementation measures that may affect human health. Three implementation measures may affect water quality and quantity indicators:

- Change production levels in hatchery programs.
- Establish new hatchery programs.
- Terminate hatchery programs that support harvest if they fail to meet performance goals.

Because all of these implementation measures are related to changes in production levels (including those associated with new and terminated hatchery programs), the analysis below analyzes how production levels affect 1) the use, handling, and safety of chemicals in hatcheries (Section 3.7.3, Safe Handling of Hatchery Chemicals, and Section 3.7.4, Chemicals Used in Hatchery Programs); 2) the transfer of toxic contaminants from fish to humans (Section 3.7.5, Toxic Contaminants in Hatchery-origin Fish); and 3) the potential for transfer of disease from fish to humans (Section 3.7.6, Relevant Disease Vectors and

Transmission). As described in Section 3.7.2 (Analysis Area), the analysis area for human health is the same as the project area (Section 2.2, Description of Project Area).

TABLE 4-106. HUMAN HEALTH INDICATORS THAT MAY BE AFFECTED BY IMPLEMENTATION MEASURES INCLUDED UNDER THE ALTERNATIVES' IMPLEMENTATION SCENARIOS.

IMPLEMENTATION MEASURES INCORPORATED IN ONE OR MORE OF THE ALTERNATIVES' IMPLEMENTATION SCENARIOS	HUMAN HEALTH INDICATORS THAT MAY BE AFFECTED		
	HATCHERY CHEMICAL USE, HANDLING, AND SAFETY	TRANSFER OF TOXIC CONTAMINANTS FROM FISH TO HUMANS	RELEVANT DISEASE VECTORS AND TRANSMISSION FROM FISH TO HUMANS
Change production levels in hatchery programs.	X	X	X
Change broodstock collection protocols in hatchery programs.			
Update water intake screens at hatchery facilities.			
Update hatchery facilities to allow all salmon and steelhead of all ages to by-pass or pass through hatchery-related structures.			
Improve rearing and release protocols in hatchery programs.			
Correct water quality issues at hatchery facilities.			
Install new temporary weirs.			
Install new permanent weirs.			
Establish new selective fisheries in terminal areas.			
Change hatchery program goals (i.e., harvest or conservation).			
Change hatchery program's operational strategy (i.e., segregated or integrated).			
Establish new hatchery programs.	X	X	X
Terminate hatchery programs that support harvest if they fail to meet performance goals.	X	X	X

These changes apply to hatchery programs funded through the Mitchell Act and hatchery programs receiving funding from other sources. Implementation measures that were not applied under any of the alternatives were not included in this table.

Water quality parameters include temperature, nutrients, dissolved oxygen, pH, sediment, PCBs and DDTs, pathogens, steroid hormones, and hatchery treatment chemicals.

4.7.2 Methods for Analysis

The qualitative analysis conducted for human health for this section was based on use of literature representing best available science and other studies that identified effects that resulted from similar or related projects within and near the analysis area. No modeling was conducted.

4.7.3 Hatchery Chemical Use, Handling, and Safety

Hatchery facilities use a variety of chemicals to maintain a clean environment for the production of disease-free fish (Section 3.7.4, Chemicals Used in Hatchery Programs). Common chemical classes include disinfectants, therapeutics, anesthetics, pesticides/herbicides, and feed additives. As described in Section 3.7.3 (Safe Handling of Chemicals), these chemicals are not considered hazardous to human health when safety precautions and regulations are followed.

4.7.3.1 Alternative 1 (No Action)

Under Alternative 1, hatchery production levels would not change relative to baseline conditions, so there would be no expected change in the amount of chemicals used within the hatcheries relative to baseline conditions. There also would be no expected change in the amount of chemicals (e.g., antibiotics) being discharged to surface waters near hatchery facilities (Section 3.7.4.2, Therapeutics) compared to baseline conditions. All safety precautions and regulations would continue to be followed. As a result, there would be no expected changes in risk to human health under Alternative 1 when compared to baseline conditions.

4.7.3.2 Alternative 2

Under the implementation scenarios for Alternative 2, hatchery production levels would be reduced 64 percent relative to Alternative 1 (Table 2-7), so there would be a reduction in the amount chemicals used within the hatcheries relative to Alternative 1. There also would be a reduction in the amount of chemicals (e.g., antibiotics) being discharged to surface waters near hatchery facilities (Section 3.7.4.2, Therapeutics) compared Alternative 1. However, because all safety precautions and regulations would continue to be followed, there would be no expected changes in risk to hatchery workers, but there may be a reduced risk to human health compared to Alternative 1 since fewer chemicals would be released into the surface waters near hatchery facilities (Section 4.6.3, Water Quality).

4.7.3.3 Alternative 3

Under the implementation scenarios for Alternative 3, hatchery production levels would be reduced 26 percent relative to Alternative 1 (Table 2-7), so there would be a reduction in the amount of chemicals used within the hatcheries relative to Alternative 1. There also would be a reduction in the amount of chemicals (e.g., antibiotics) being discharged to surface waters near hatchery facilities (Section 3.7.4.2, Therapeutics) compared Alternative 1. Because all safety precautions and regulations would continue to be followed, there would be no expected changes in risk to hatchery workers, but there may be a reduced risk to human health compared to Alternative 1 since fewer chemicals would be released into the surface waters near hatchery facilities (Section 4.6.3, Water Quality). However, risk to human health would not be reduced to the same level as under the implementation scenario for Alternative 2, which would reduce hatchery production levels by 64 percent relative to Alternative 1 (Table 2-7).

4.7.3.4 Alternative 4

Under the implementation scenario for Alternative 4, hatchery production levels would be reduced 18 percent relative to Alternative 1, so there would be a reduction in the amount chemicals used within the hatcheries relative to Alternative 1 (Table 2-7). There also would be a reduction in the amount of chemicals (e.g., antibiotics) being discharged to surface waters near hatchery facilities (Section 3.7.4.2, Therapeutics) compared to Alternative 1. Because all safety precautions and regulations would continue to be followed, there would be no expected changes in risk to hatchery workers, but there may be a reduced risk to human health compared to Alternative 1 since fewer chemicals would be released into the surface waters near hatchery facilities (Section 4.6.3, Water Quality).

4.7.3.5 Alternative 5

Under the implementation scenario for Alternative 5, hatchery production levels would be reduced 23 percent relative to Alternative 1, so there would be a reduction in the amount chemicals used within the hatcheries relative to Alternative 1 (Table 2-7). There also would be a reduction in the amount of chemicals (e.g., antibiotics) being discharged to surface waters near hatchery facilities (Section 3.7.4.2, Therapeutics) compared to Alternative 1 Table 2-7. Because all safety precautions and regulations would continue to be followed, there would be no expected changes in risk to hatchery workers, but there may be a reduced risk to human health compared to Alternative 1 since fewer chemicals would be released into the surface waters near hatchery facilities compared to Alternative 1 (Section 4.6.3, Water Quality). The risk to human health under the implementation scenario for Alternative 5 would be most similar to conditions under the implementation scenario for Alternative 3, which would have a 26 percent reduction in production levels relative to Alternative 1 (Table 2-7).

4.7.4 Toxic Contaminants in Hatchery-origin Fish

As described in Section 3.7.5 (Toxic Contaminants in Hatchery-origin Fish), hatchery-origin fish have the potential to accumulate chemicals used during their production. Hatchery-origin fish may contain residues of antibiotics, metals, or other organic pollutants, which may be consumed by people fishing from the waterways to which the fish are released. The source of metals or other organic pollutants may be from the feed supplied to the fish, products used to maintain the hatchery facilities (i.e., cleaning products or lead-based paints used on the interior of holding tanks), or pollutants that occur in rivers, estuaries, and oceans where the fish migrate or reside following their departure from hatchery facilities. Accumulation of chemicals in fish tissues depends on many factors (e.g., chemistry of the compound, dose, and frequency). The potential for human exposure depends on the concentration of the chemicals in tissue residues and the frequency of consumption. The effects of the proposed alternatives on this issue are described below.

4.7.4.1 Alternative 1 (No Action)

Fish production under Alternative 1 would be the same as under baseline conditions. As a result, there would be no change in the transfer of toxic contaminants from hatchery-origin fish to humans under Alternative 1 when compared to baseline conditions.

4.7.4.2 Alternative 2

Under the implementation scenario for Alternative 2, there would be no expected change in the level of toxic contaminants in hatchery-origin fish relative to Alternative 1 because there would be no change in their exposure to chemicals, feeds, or contamination in the environment where they are reared and released. However, production levels under the implementation scenario for Alternative 2 would be reduced 64 percent relative to Alternative 1 (Table 2-7). Reduced production levels would decrease the number of hatchery-origin salmon and steelhead that would be eaten by humans relative to Alternative 1, thus reducing the transfer of contaminants from hatchery-origin salmon and steelhead to humans. It is unclear whether consumption patterns would change due to reduced availability of hatchery-origin salmon and steelhead.

4.7.4.3 Alternative 3

Under the implementation scenario for Alternative 3, there would be no expected change in the level of toxic contaminants in hatchery-origin fish relative to Alternative 1 because there would be no change in their exposure to chemicals, feeds, or contamination in the environment where they are reared and released. However, production levels under the implementation scenario for Alternative 3 would be reduced 26 percent relative to Alternative 1 (Table 2-7). Reduced production levels would decrease the number of hatchery-origin salmon and steelhead that would be eaten by humans relative to Alternative 1, thus reducing the transfer of contaminants from hatchery-origin salmon and steelhead to humans. It is unclear whether consumption patterns would change due to reduced availability of hatchery-origin salmon and steelhead.

4.7.4.4 Alternative 4

Under the implementation scenario for Alternative 4, there would be no expected change in the level of toxic contaminants in hatchery-origin fish relative to Alternative 1 because there would be no change in their exposure to chemicals, feeds, or contamination in the environment where they are reared and released. However, production levels under the implementation scenario for Alternative 4 would be reduced 18 percent relative to Alternative 1 (Table 2-7). Reduced production levels would decrease the number of hatchery-origin salmon and steelhead that would be eaten by humans relative to Alternative 1, thus reducing the transfer of contaminants from hatchery-origin salmon and steelhead to humans. It is unclear whether consumption patterns would change due to reduced availability of hatchery-origin salmon and steelhead.

4.7.4.5 Alternative 5

Under the implementation scenario for Alternative 4, there would be no expected change in the level of toxic contaminants in hatchery-origin fish relative to Alternative 1 because there would be no change in their exposure to chemicals, feeds, or contamination in the environment where they are reared and released. However, production levels under the implementation scenario for Alternative 4 would be reduced 23 percent relative to Alternative 1 (Table 2-7). As under Alternative 2 through Alternative 4, reduced production levels would decrease the number of hatchery-origin salmon and steelhead that would be eaten by humans relative to Alternative 1, thus reducing the transfer of contaminants from hatchery-origin salmon and steelhead to humans. Again, it is unclear whether consumption patterns would change due to reduced availability of hatchery-origin salmon and steelhead.

4.7.5 Relevant Disease Vectors and Transmission

As described in Section 3.7.6 (Relevant Disease Vectors and Transmission), a number of parasites, viruses, and bacteria are potentially harmful to human health and may be transmitted from fish species primarily through seafood consumption (i.e., improperly or under-cooked fish) or handling of infected fish or fish carcasses. The transmission of fish-borne pathogens to humans is rare and can be controlled with the proper safety measures. All existing hatchery programs implement practices to minimize the potential of pathogens occurring in fish. This would continue to occur under all of the alternatives. Reduced production levels under the implementation scenarios for Alternative 2 through Alternative 5 may reduce the potential for the transmission of pathogens from hatchery-origin fish to humans through consumption or handling relative to Alternative 1 since there would be fewer hatchery-origin fish to handle and consume, but risks would be negligible under all alternatives.

4.8 Summary of Resource Effects

Table 4-107 summarizes predicted effects from implementation of the No-action Alternative (Alternative 1) and action alternatives (Alternative 2 through Alternative 5). The summary reflects the detailed resource discussions in EIS Section 4.2, Fish, through Section 4.7, Human Health. Refer to these sections to understand why conclusions as stated in Table 4-107 were drawn. No preferred alternative has been selected for the draft EIS.

TABLE 4-107. SUMMARY OF ENVIRONMENTAL CONSEQUENCES FOR EIS ALTERNATIVES BY RESOURCE.

RESOURCE	INDICATOR	ALTERNATIVE 1 (NO ACTION)	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5
Fish	Number of salmon and steelhead hatchery programs	178	106	161	174	171
	Number of hatchery-origin salmon and steelhead produced annually	143,577,000	51,896,000	106,928,000	118,362,000	110,630,000
	Percent (%) of primary and contributing salmon and steelhead populations that meet stronger metrics	50	71	63	66	71
	Percent (%) of primary and contributing salmon and steelhead populations that meet intermediate metrics or stronger metrics	58	91	89	84	88
	Number of weirs installed to control pHOS	0	0	13	16	17
Socioeconomics	Annual cost of Columbia River basin hatchery production (millions of 2007 U.S. dollars [$])	79.5	51.9	76.9	79.4	81.5
	Number of Columbia River basin salmon and steelhead harvested in all fisheries	602,368	309,465	482,509	535,529	497,085
	Net economic value (2007 U.S. dollars [$]) of commercial fisheries (tribal and non-tribal) in the Columbia River basin	2,115,979	1,145,205	1,793,706	2,016,671	2,025,634
	Net economic value (2007 U.S. dollars [$]) of commercial fisheries (tribal and non-tribal) in the Pacific Ocean and Puget Sound to which Columbia River basin fish contribute	13,474,389	12,537,078	13,262,657	13,408,620	13,280,994

TABLE 4-107.SUMMARY OF ENVIRONMENTAL CONSEQUENCES FOR EIS ALTERNATIVES BY RESOURCE (CONTINUED).

RESOURCE	INDICATOR	ALTERNATIVE 1 (NO ACTION)	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5
Socioeconomics (continued)	Commercial ex-vessel value (2007 U.S. dollars [$]) in the Columbia River basin	6,188,673	3,735,500	5,436,555	6,169,064	6,155,051
	Commercial ex-vessel value (2007 U.S. dollars [$]) in the Pacific Ocean and Puget Sound	36,594,962	34,379,075	36,169,953	36,561,643	36,228,773
	Net economic value (2007 U.S. dollars [$]) of recreational fisheries in the Columbia River basin	35,791,853	21,065,837	28,841,018	31,415,967	30,567,085
	Net economic value (2007 U.S. dollars [$]) of recreational fisheries in the Pacific Ocean and Puget Sound to which Columbia River basin fish contribute	22,380,896	18,975,560	20,728,811	20,838,677	20,744,041
	Total (direct and indirect) economic impacts on income (2007 U.S. dollars [$]) in the Columbia River basin	103,988,544	64,595,934	90,800,063	99,052,073	99,939,014
	Total (direct and indirect) economic impacts on income (2007 U.S. dollars [$]) in the Pacific Ocean and Puget Sound	115,961,205	106,837,236	113,052,011	113,967,297	113,205,357
	Total (direct and indirect) economic impacts on jobs in the Columbia River basin	2,540.6	1,584.7	2,201.0	2,385.0	2,417.4
	Total (direct and indirect) economic impacts on jobs in the Pacific Ocean and Puget Sound	2,264.5	2,035.6	2,179.6	2,194.5	2,182.3
	Recreational expenditures (2007 U.S. dollars [$]) in the Columbia River basin	47,476,271	27,942,878	38,256,303	41,671,856	40,545,853

TABLE 4-107.SUMMARY OF ENVIRONMENTAL CONSEQUENCES FOR EIS ALTERNATIVES BY RESOURCE (CONTINUED).

RESOURCE	INDICATOR	ALTERNATIVE 1 (NO ACTION)	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5
Socioeconomics (continued)	Recreational expenditures (2007 U.S. dollars [$]) in the Pacific Ocean and Puget Sound	56,516,450	51,174,142	54,382,756	54,807,054	54,452,342
Environmental Justice	Total tribal fish harvests (commercial, ceremonial, and subsistence) by number of fish in the Columbia River basin	79,328	36,519	63,702	63,494	73,619
	Tribal fishing revenue in the Columbia River basin (2007 U.S. dollars [$])	3,484,670	2,355,731	3,352,910	3,346,917	4,048,727
Wildlife	Caspian terns and bald eagles	Populations increasing	Potential reductions in abundance, distribution, and fitness relative to Alternative 1	Same as Alternative 2	Same as Alternative 1	Same as Alternative 2
	Southern resident killer whale (listed)	89 individuals are currently in Southern Resident stock; populations fluctuate from decreasing to increasing	Potential reductions in abundance relative to Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
	California sea lions	Populations increasing	Abundance in Columbia River would probably decline relative to Alternative 1	Abundance may be affected relative to Alternative 1	Same as Alternative 1	Same as Alternative 3
	Stellar sea lions (listed)	Populations increasing	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Human Health	N/A	Chemicals and antibiotics would be used consistent with Federal and state guidelines; potential pathogen exposure.	Potential decrease in use of chemicals and antibiotics; no change in exposure to pathogens	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

TABLE 4-107.SUMMARY OF ENVIRONMENTAL CONSEQUENCES FOR EIS ALTERNATIVES BY RESOURCE (CONTINUED).

RESOURCE	INDICATOR	ALTERNATIVE 1 (NO ACTION)	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5
Water Quality and Quantity	N/A	NPDES permits current	Potential improvements in water quality and reduction in water use	Same as Alternative 2	Same as Alternative 2	Same as Alternative 2

N/A = not applicable

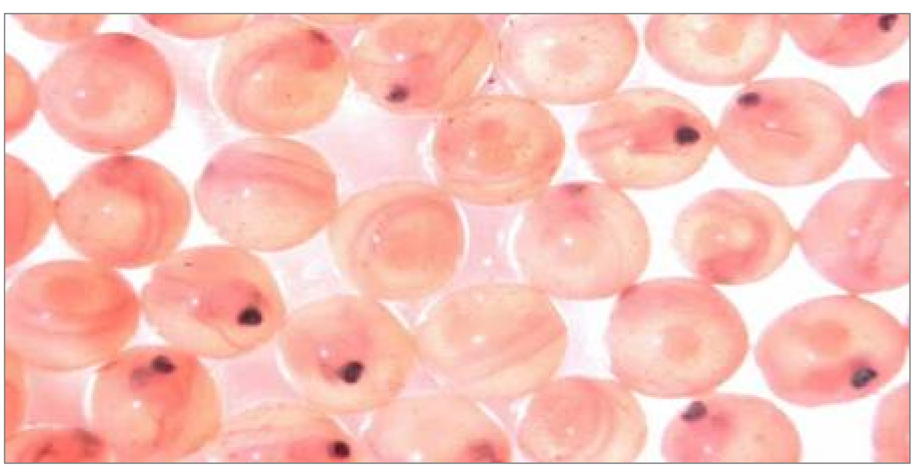
Primary and contributing populations are terms that were used by the Lower Columbia Fish Recovery Board (LCFRB) in the development of the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (LCFRB 2004), adapted throughout the basin by the HSRG after discussions with the Columbia River fish managers, and they are applied in this draft EIS (Section 2.4, Alternative Development).

Socioeconomic values for the Pacific Ocean and Puget Sound are based on the total number of salmon and steelhead harvested in those areas, not just those from the Columbia River basin.

Science, Service, Stewardship

Chapter 5

Cumulative Effects



5.0 CUMULATIVE EFFECTS

5.1 Introduction

The National Environmental Policy Act defines cumulative effects as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR 1508.7). Chapter 3, Affected Environment describes the baseline conditions for each resource and reflects the effects of past and existing actions (including hydropower, habitat loss, harvest, and hatchery production). Chapter 4, Environmental Consequences, evaluates the direct and indirect effects of the alternatives on each resource's baseline conditions. Chapter 5, Cumulative Effects, now considers the cumulative effects of each alternative in the context of past actions, existing conditions, and reasonably foreseeable future actions and conditions.

The cumulative effects analysis is important for review of this proposed action because it is pertinent to development of a policy direction that will inform the operation of hatchery programs in the Columbia River basin and the funding of Mitchell Act hatchery programs. As climate change and development continue to affect the Columbia River basin, decisions on Mitchell Act funding and Columbia River basin hatchery operations will have to be responsive to such changes. It is also a valuable tool to provide anticipated impact trends within the Columbia River basin, which will be useful during future Endangered Species Act (ESA) analyses.

The cumulative effects analysis area includes the project area (Section 2.2, Description of Project Area) plus the following areas: 1) coastal areas of Washington, Oregon, and California; 2) British Columbia (Canada); 3) Puget Sound/Strait of Juan de Fuca; and 4) Southeast Alaska (Figure 3-1).

Provided below are known future actions reasonably likely to occur within the analysis area. Expected future actions include climate change, proposed developments, and planned habitat restoration activities. Additional future actions of which the National Marine Fisheries Service (NMFS) is not aware may occur within the analysis area, so reviewers are encouraged to comment on additional actions that should be considered.

Many plans, regulations, and laws are in place to minimize the effects of development and to restore habitat function (Section 1.7, Relationship to Other Plans, Regulations, Agreements, Laws, and Secretarial Orders). However, it is unclear if these plans, regulations, and laws will be successful in meeting their environmental goals and objectives. In addition, it is impossible to predict the magnitude of effects from future development and habitat restoration for several reasons: 1) the activities have not yet been proposed, 2) mitigation measures have not been identified for many proposed projects, or 3) there is uncertainty whether mitigation measures will be fully implemented. However, when combined with climate change, a general trend in expected cumulative impacts can be estimated.

Section 5.2, Future Actions, discusses all expected future actions within the action area; the cumulative effects analysis in Section 5.3, Resource Effects from Climate Change and Future Actions, focuses on the effects of each alternative in the context of future climate change when combined with future actions.

The timeframe for the cumulative effects analyses is approximately 10 years, which is the expected term in which NMFS would implement the proposed action/policy direction (Section 1.1, Introduction). A 10-year timeframe may not be substantial in terms of climate change impacts on the environment; as such, the analyses of resource effects could most appropriately be considered as short-term effects in relation to the scale of climate change. Such short-term effects are difficult to estimate given this timeframe in relation to the scale of climate changes. In contrast, localized future actions (e.g., development) would have a greater potential to impose immediate, measureable cumulative effects on resources when combined with the direct and indirect effects analyzed in Chapter 4, Environmental Consequences, for this 10-year period. Because of the limited 10-year timeframe, this cumulative effects analysis provides expected trends under each alternative, but recognizes that sufficient data are lacking to make definitive impact determinations.

5.2 Future Actions

5.2.1 Climate Change

Climate change could affect all of the alternatives equally; in other words, trends in environmental changes would likely take place basinwide, so no single implementation scenario would be affected more than another. Long-term climate changes that have taken place and are expected to continue in the Columbia River basin include the following (as summarized in Joint Institute for the Study of Atmosphere and Ocean Climate Impacts Group 1999; Climate Impacts Group 2004; West Coast Governor's Global Warming Initiative 2004; Kay et al. 2005; Independent Science Advisory Board [ISAB] 2007a; Mote and Salathe 2009): 1) increased precipitation during winter months with less precipitation during summer months, and 2) mean annual air warming trend of at least 0.2°F per decade. These changes could result in the following climatic trends:

- Warmer air temperatures will result in more precipitation falling as rain rather than snow.
- Snow pack will diminish, and stream flow timing will be altered.
- Peak river flows will likely increase.
- Water temperatures will continue to rise.
- The ocean will continue to rise, resulting in coastal erosion and an increased proportion of salinity in estuaries.
- There will be increased water stratification in lakes, marine estuaries, and the ocean.
- The likelihood of extreme events (floods, droughts, fires, and insect outbreaks) is expected to increase.

In general, the long-term effects of climate change would likely be similar in nature, but greater in magnitude, to some of the effects of short-term climate variability observed on an annual basis. This would be a result of similarities between the regional climate shifts projected for anthropogenic climate change (warmer wetter winters, resulting in increased winter stream flow; warmer summers; and increased sea level) and some of those experienced during La Niña winters (increased precipitation and winter streamflow) and El Niño years (warmer winters, resulting in decreased spring and summer streamflow and increased sea level). Some short-term climate variation is normal, but longer-term trends now indicate a changing climate (Climate Impacts Group 2010).

5.2.2 Development

Development that has occurred over the past decade within the Columbia River basin has affected the abundance, distribution, and health of hatchery-origin and natural-origin salmon and steelhead, other fish, socioeconomics, wildlife populations, and water quantity and quality. Provided below is a bulleted list of these development trends taken from ISAB (2007a, b) and the Lower Columbia River Estuary Partnership (2005), followed by some of the larger planned projects within the Columbia River basin. These trends cannot be quantified in full detail because some of the development projects are in the early stages of permitting and planning, while others are closer to implementation decisions demonstrated by completion of records of decision (RODs) or draft environmental impact statements (EISs). However, this analysis assumes that all of the projects described in this chapter would be implemented during the 10-year period of the proposed action to provide a review of the highest-impact potential scenario.

- Human populations are increasing primarily in urban metropolitan areas, with smaller increases in rural areas; this increase is expected to continue until at least 2030.
- Freshwater withdrawals for domestic, industrial, commercial, and public uses are increasing, whereas withdrawals for irrigation purposes are decreasing due to the conversion of agricultural lands to residential areas.
- Forests are also being converted for development, which is resulting in forest fragmentation.
- Mining in the Columbia River basin is focused on sand and gravel with the removal occurring along or within rivers.
- Electrical demand continues to increase approximately 1 percent per year.
- Globalization of trade has contributed to the loss of trade in some areas (e.g., the Mexico strawberry market) and to the increase in trade in other areas (e.g., increased Columbia River basin wine production due to Australia droughts).
- An increase in ship traffic is likely to occur because of Columbia River channel deepening projects.
- New port infrastructure projects continue to result in loss of aquatic habitat.
- Hazardous materials transport and airborne pollution has been increasing in the Columbia River basin.

United States Army Corps of Engineers (USACE) – Jetty Rehabilitation at the Mouth of the Columbia River. This project (located in Clatsop County, Oregon) has been ongoing since 2005 when U.S. District Court Judge Ricardo Martinez ruled in favor of the Columbia River Channel Improvement Project (*Northwest Environmental Advocates v. NMFS, United States Army Corps Of Engineers and Ports Of Vancouver, Woodland, Kalama, Longview, Portland, And St. Helens*), confirming that the USACE and NMFS had properly analyzed the project's impacts under federal law. The project involves repair of damaged portions of the jetty, along with rebuilding existing haul roads at the jetty and is near completion. The effort involves placing approximately 70,000 tons of stone on the north and south sides of the jetty, as well as using 50,000 tons of small rock material for the access road areas. Noise is generated by construction activities. These actions are expected to preserve the jetty for the next 10 to 15 years when a more durable long-term rehabilitation would be implemented. On January 13, 2010, The USACE issued a public notice and environmental assessment to further evaluate environmental effects for rehabilitation of the North and South jetties, Jetty A, and other jetty associated projects at the mouth of the Columbia River. Based on public comments, the agency will determine if further environmental analysis is required. More information can be found at the following websites: http://www.channeldeepening.com/index.asp and http://www.nwp.usace.army.mil/pm/e/en_plan_assess.asp.

Leucadia National – Liquefied Natural Gas (LNG) Terminal, Warrenton, Oregon. For this project, the applicant proposes to site, construct, and operate an LNG import terminal on the northern portion of the East Skipanon Peninsula near the confluence of the Skipanon and Columbia Rivers in Warrenton, Clatsop County, Oregon. The proposed Oregon LNG Terminal would be located at river mile (RM) 11.5 of the Columbia River within an approximate 96-acre parcel of land that is owned by the State of Oregon and leased to the Port of Astoria by the Oregon Department of State Lands. Oregon LNG holds a long-term sublease with the Port of Astoria for the entire land parcel. The project received land use approval from the City of Warrenton, and the Port of Astoria approved a lease for the project. The applicant submitted its application to the Federal Energy Regulatory Commission (FERC), and an EIS for the project has not yet been completed. The project will also require water and air pollution permits from Oregon State and a determination as to whether the project complies with the Coastal Zone Management Act. More information can be found at the following website: http://www.leucadia.com.

USACE – Columbia River Channel Deepening, Columbia River. This project, extending from the mouth of the Columbia River to RM 103.5 (near the I-5 Bridge between Vancouver, Washington, and Portland, Oregon), has been ongoing since 2006. It involves navigation improvements and expanded restoration components. The ROD was signed in January 2004. The river is being dredged from a depth of 40 feet to a depth of 43 feet, thereby enabling use of larger, more efficient vessels to transport commodities. Most of the dredged material is disposed at upland sites for beneficial uses. The project includes effects on 15 acres of wetlands, 50 acres of riparian habitat, and 171 acres of agricultural lands. The effects are being offset by 736 acres of wetland and riparian mitigation. Following construction, maintenance of the channel would require removal of approximately 8 million cubic yards per year initially, declining to 3 million cubic yards per year as the channel reaches equilibrium. More information can be found at the following website: http://www.channeldeepening.com/channel_projoverview.asp.

U.S. Department of Transportation Federal Highway Administration, Oregon Department of Transportation, Washington State Department of Transportation – Columbia River Crossing Interstate 5 (I-5) and Hayden Island Redevelopment, Clark County, Oregon and Clark County, Washington. This project is a proposed bridge, transit, and highway improvement plan focused on expanding and improving I-5 between Portland, Oregon, and Vancouver, Washington. Transportation improvements would include expanding I-5, providing increased light rail capacity, constructing an additional bridge across the Columbia River, and improving capacity for freight rail. A draft EIS for the project has been completed; the final EIS analyses are currently being conducted. Hayden Island redevelopment would include new residences, a shopping center, and transportation improvements. More information can be found at the following website: http://www.columbiarivercrossing.org/CurrentTopics/Default.aspx.

Puget Sound Energy (PSE) and Renewable Energy Systems Americas Inc. (RES Americas) – Lower Snake River Wind Energy Project, Columbia and Garfield Counties, Washington. PSE and RES Americas are proposing 1,250 megawatts of new wind energy. PSE and RES Americas filed a conditional use permit application in early 2009 to construct approximately 444 wind turbines in Garfield County (which was approved in November 2009), as well as a conditional use permit for 351 wind turbines in Columbia County in late 2009 (which was approved in May 2010). Final installed energy capacity and turbine layouts would be determined through state and county permitting processes, and an evaluation of available wind resources and environmental impacts. More information can be found at the following website: http://www.snakeriverwind.com/default.html.

5.2.3 Habitat Restoration

Throughout the Columbia River basin, habitat restoration efforts are supported by Federal, state, and local agencies; tribes; environmental organizations; and communities. Projects supported by these entities focus on improving general habitat and ecosystem function or species-specific conservation objectives that, in some cases, are identified through ESA recovery plans. The larger, more region-wide, restoration and conservation efforts, either underway or planned throughout the Columbia River basin, are presented below. While these efforts are reasonably likely to occur, funding levels may vary.

Bonneville Power Association (BPA), Bureau of Reclamation (BOR), and the USACE – Federal Columbia River Power System (FCRPS) NMFS Biological Opinion, Columbia River, Washington, Oregon, and Idaho. The FCRPS biological opinion describes how BPA, BOR, and USACE will operate the 14 Federal dams on the Columbia and Snake Rivers over the next 10 years to protect fish listed under the ESA. The biological opinion is comprehensive and includes hydro, habitat, hatchery, and harvest measures to address the biological needs of salmon and steelhead in every life stage. It includes commitments to achieve at least 96 percent dam passage survival for spring juvenile migrants and 93 percent dam passage survival for summer migrants on average, per dam. The biological opinion proposes new and expanded hatchery facilities that promote salmon and steelhead recovery and hatchery reforms that reduce impacts on listed fish. With regard to habitat, actions would be implemented to protect and improve tributary and estuary environments and reduce limiting factors based on the biological needs of listed fish. These habitat actions must achieve specific habitat quality improvement targets. Predation management actions would address juvenile and adult losses from birds, other fish, and marine mammals. Also included are established performance standards and a comprehensive research, monitoring, and evaluation program.

The BPA has negotiated memorandums of agreement (MOAs) (also referred to as the 2008 Columbia Basin Fish Accords) with four Indian tribes (Confederated Tribes of Umatilla Indian Reservation, Confederated Tribes of Warm Springs Reservation, Confederated Tribes and Bands of Yakama Nation, and Confederated Tribes of Colville Indian Reservation), two states (Idaho and Montana), and two Federal action agencies (USACE and BOR) to augment and advance these actions. The MOAs are for 10 years, and they include projects to benefit fish (such as habitat restoration, hatchery actions, and hydro actions), as described in the FCRPS biological opinion. The Fish Accords would result in $933 million funding for fish recovery from 2008 through 2017.

Additional funding by BPA would include operational changes to support fish survival. From 2008 through 2011, another $116 million would likely be available for additional mitigation measures identified in the FCRPS biological opinion. More information can be found at the following website: http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/Final-BOs.cfm.

NOAA Community-based Restoration Program (CRP). The CRP is a financial and technical assistance program authorized under the Magnuson-Stevens Reauthorization Act of 2006. The program helps communities implement habitat restoration projects. Within the Pacific Northwest and Alaska, the CRP has supported over 300 CRPs benefiting more than 1,400 acres of estuarine and riparian habitat and opening approximately 400 miles of in-stream salmon habitat. NOAA has contributed more than $8 million for restoration activities in the Pacific Northwest Region with partners providing an additional $20 million in non-Federal and in-kind matching funds. More information can be found at the following website: http://www.nmfs.noaa.gov/habitat/restoration.

NMFS - Pacific Coastal Salmon Recovery Fund (PCSRF), Columbia and Snake Rivers. Congress created the PCSRF in 2000 to address ESA-listed salmon, as well as impacts from the Pacific Salmon Treaty Agreement between the U.S. and Canada. Under the PCSRF, states and tribes of the Pacific Coast region (Washington, Oregon, California, Idaho, and Alaska) implement projects and activities to restore and protect salmon and steelhead and their habitat. The types of projects funded by the PCSRF have included protection, restoration, and creation of instream, wetland, estuarine, riparian, and upland habitats; land acquisition; fish passage; hatchery enhancements; watershed planning and assessment; and research, monitoring, and evaluation studies. For this EIS, applicable projects are located in the designated Lower Columbia Salmon Recovery, Middle Columbia Salmon Recovery, Upper Columbia River Recovery, and Snake River Recovery Regions. More information can be found at the following website: http://www.nwr.noaa.gov.

Northwest Power Planning and Conservation Council – Fish and Wildlife Program, Columbia and Snake Rivers. The Fish and Wildlife Program was developed for the 31 dams within the Columbia River basin that are operated by the USACE (21 dams) and BOR (10 dams). Due to construction and operation of these dams, the Northwest Power Act requires the Northwest Power Planning and Conservation Council to prepare a program to protect, mitigate, and enhance fish and wildlife habitat and related spawning grounds affected by hydroelectric development. This program must be reviewed at least every 5 years. The most recent review led to a revision of the fish and wildlife program in October 2000. Currently, the program is implemented through recommendations from 58 subbasin plans that were developed locally in the tributary subbasins of the Columbia River and then incorporated into the program in 2004 and 2005. The program budget averages $143 million per year for funding projects. Funding is allocated for spill and flow management to support fish survival, predator control, fish habitat improvements, funding support for the Fish Passage Center, and the designation of new protected areas. More information can be found at the following website: http://www.nwppc.org.

State of Idaho. The State of Idaho's Department of Lands is pursuing an ESA Section 6 Cooperative Agreement. This forestry program, if approved, would apply to forestry management and timber harvest on state and private lands (voluntary) in the Salmon and Clearwater basins in Idaho. The intent of the cooperative agreement is to develop forest management practices that would better protect aquatic habitat for ESA-listed fish. An EIS is currently being prepared for this program. More information can be found at the following website: http://www.idl.idaho.gov/eis.

The State of Idaho is also actively pursuing an ESA Section 6 Cooperative Agreement to enhance flows in the Lemhi River basin. This program is designed to provide certainty for irrigators and to improve flow for listed fish in the Lemhi drainage. For more background information on this project, refer to http://epw.senate.gov/public/index.cfm?FuseAction =Hearings.Testimony&Hearing_ID=e4f071be-802a-23ad-4fb5-a21b035dbda9&Witness_ID=b13 a81f6-c9aa-4419-8a90-7e0ea1d1fe9d.

State of Oregon. The Oregon Plan for Salmon and Watersheds includes voluntary restoration actions by private landowners, monitoring, and scientific oversight that is coordinated with state and Federal agencies and tribes. The Oregon Legislature allocates monies drawn from the Oregon Lottery and salmon license plant funds, which have provided $100 million and $5 million, respectively, to projects benefiting water, salmon, and other fish throughout Oregon. Projects include reducing road-related impacts to salmon and trout streams by improving water quality, fish habitat, and fish passage; providing monitoring and education support; helping local coastal watershed councils; and providing staff technical support. More information can be found at http://www.oregon-plan.org.

State of Washington. The Governor's Salmon Recovery Office was developed from Washington's Salmon Recovery Act and includes the Salmon Recovery Funding Board (SRFB). The SRFB has helped finance more than 900 salmon recovery projects focused on habitat protection and restoration projects. Approximately $270 million was allocated from 2007 to 2009, while $401 million was identified for habitat projects from 2009 to 2011. The SRFB administers two grant programs (Salmon Recovery Funding Board Grants and Family Forest Fish Passage Program Grants). Municipalities, tribal governments, state agency nonprofit organizations, regional fisheries enhancement groups, and private landowners may apply for these grants. More information can be found at http://www.governor.wa.gov/gsro.

Regional and Local Habitat Restoration and Conservation Support. Numerous environmental organizations, communities, and tribes have contributed to salmon habitat restoration and conservation efforts. These projects are often funded by in-kind matches with funding provided by NOAA CRP, PCSRF, the three states' salmon recovery funds, and other sources. The projects vary, ranging from small- to large-scale efforts that include habitat conservation, creation, enhancement, restoration, and protection. Some project examples include donating conservation easements, excavating new tidal channels, removing invasive species, stabilizing stream banks, installing or upgrading culverts, removing barriers to fish migration, planting riverbanks, conserving water, restoring wetlands, and managing grazing to protect high-quality aquatic habitat, among others.

5.3 Resource Effects from Climate Change and Future Actions

5.3.1 Fish

Section 3.2, Fish, describes how past and present conditions have influenced fish populations in the analysis area (Section 3.2.2, Analysis Area). These conditions represent effects from many years of development, as well as habitat restoration in the basin, and, most likely, climate changes. The expected direct and indirect effects of the alternatives on fish populations are described in Section 4.2, Fish. Future actions are described in Section 5.2. This section considers impacts that may occur as a result of implementing any one the alternatives being implemented at the same time as other anticipated actions (e.g., development) and in the context of climate change.

5.3.1.1 Salmon and Steelhead

According to the ISAB (2007a), the effects of climate change on salmon and steelhead would vary among species and with life history stages, but they potentially may affect virtually every species and life history type of salmon and steelhead in the Columbia River basin. The cumulative effects on salmon and steelhead may be greater than those described in Section 4.2.3, Effects on Salmon and Steelhead, for all alternatives because this is a newly emerging area of scientific study. The following sections analyze cumulative effects on the five categories of effects that are described in Section 3.2.3.1, General Risks and Benefits of Hatchery Programs to Salmon and Steelhead Species, and analyzed in Section 4.2.3, Effects on Salmon and Steelhead.

5.3.1.1.1 Genetic Risks

Climate change is expected to result in changing environmental conditions for salmon and steelhead (Section 5.2.1, Climate Change). As described in Section 3.2.3.1.1, Genetic Risks, unique patterns of genetic diversity can be lost in natural-origin populations when they interbreed with hatchery-origin fish. Although Alternative 2 through Alternative 5 would generally reduce direct and indirect genetic risks of hatchery-origin fish on natural-origin salmon and steelhead population compared to Alternative 1 (Section 4.2.3, Effects on Salmon and Steelhead), genetic risks would still exist, and may exacerbate the effects of climate change on natural-origin salmon and steelhead populations. For example, if hatchery production disrupts unique patterns of genetic diversity in a natural-origin salmon or steelhead population, that population may be less able to adapt to the changing environmental conditions anticipated as a result of future climate change (Section 5.2.1, Climate Change).

Changing environmental conditions are also likely to occur as a result of development in the basin. While habitat restoration programs are in place, it is unclear whether they will fully mitigate for the effects of ongoing and planned development projects. As a result, cumulative genetic risks of hatchery-origin salmon and steelhead on natural-origin salmon and steelhead would be greater under all alternatives than those considered in Section 4.2.3, Effects on Salmon and Steelhead.

5.3.1.1.2 Hatchery Facility Risks

If the combined effect of climate change and development actions is an increase in basin water temperatures, there may be increased cumulative mortality of salmon and steelhead at weirs and other collection facilities beyond what is considered in the direct and indirect impact analyses (Section 4.2.3, Effects on Salmon and Steelhead) for all alternatives. This is because increased temperatures resulting from climate change and development actions may increase the stress level of fish, which may increase mortality rates (Section 5.2.1, Climate Change). Though habitat restoration programs are in place, it is unclear if they will fully mitigate for the effects of ongoing and planned development projects on water temperature.

5.3.1.1.3 Risks from Competition with and Predation from Hatchery-origin Fish

Due to climate change and development in the Columbia River basin, cumulative competition and predation impacts on natural-origin fish may be greater under all alternatives than effects considered in the direct and indirect impact analyses (Section 4.2.3, Effects on Salmon and Steelhead). Specific climate change effects would likely include the following:

- Predation risk would increase if temperatures exceed optimal levels (Table 5-1).
- Warmer winters may increase predator activity/hunger, which can also contribute to lower winter survival (Table 5-1).
- Food may be less available while metabolic rates are higher (Table 5-1).
- There would be greater metabolic demands, which would increase competition for food (Table 5-1).

TABLE 5-1. POTENTIAL IMPACTS OF CLIMATE CHANGE ON SALMON LIFE CYCLE STAGES.

LIFE STAGE	HIGH TEMPERATURE EFFECTS
Egg	1) Increased maintenance metabolism would lead to smaller fry. 2) Lower disease resistance may lead to lower survival. 3) Changed thermal regime during incubation may lead to lower survival. 4) Faster embryonic development would lead to earlier hatching. 5) Increased mortality due to more frequent flood flows as snow level rises.
Spring, Summer Rearing	1) Faster yolk utilization may lead to early emergence. 2) Smaller fry are expected to have lower survival rates. 3) Higher maintenance metabolism would lead to greater food demand. 4) Growth rates would be slower if food is limited or if temperature increases exceed optimal levels; growth could be enhanced food is available, and temperatures do not reach stressful levels. 5) Predation risk would increase if temperatures exceed optimal levels.
Overwinter Rearing	1) Smaller size at start of winter is expected to result in lower winter survival. 2) Mortality would increase due to more frequent flood flows as snow level rises. 3) Warmer winter would lead to higher metabolic demands, which may also contribute to lower winter survival if food is limited, or higher winter survival if growth and size are enhanced. 4) Warmer winters may increase predator activity/hunger, which can also contribute to lower winter survival.

Source: ISAB 2007a

Again, while habitat restoration programs are in place in the basin, it is unclear whether they will fully mitigate for the effects of ongoing and planned development projects. Therefore, the positive effects of restoration activities on competition and predation are uncertain, particularly when combined with climate change impacts.

5.3.1.1.4 Risks Associated with Masking

No cumulative effects would be expected beyond those already considered in the direct and indirect impact analyses (Section 4.2.3, Effects on Salmon and Steelhead) for all alternatives as a result of climate change, development, or habitat restoration. This is because these cumulative effect factors would not affect a hatchery program manager's ability to determine the abundance and productivity of natural-origin salmon and steelhead populations during any period within the 10-year timeframe.

5.3.1.1.5 Risks Associated with Fisheries that Target Hatchery-origin Fish

No cumulative effects would be expected beyond those already considered in the direct and indirect analyses (Section 4.2.3, Effects on Salmon and Steelhead) for all alternatives as a result of climate change, development, or habitat restoration. If the abundance and productivity of natural-origin salmon and steelhead are reduced as a result of cumulative effects, including climate change, then fishing rates would be reduced to keep impacts on natural-origin populations to an acceptable management level. Conversely, if abundance and productivity are increased as a result of habitat restoration actions, fishing rates may be correspondingly increased, but would remain within acceptable management levels.

5.3.1.1.6 Benefits of Nutrient Cycling

If there is decreased survival of natural-origin salmon and steelhead as a result of future climate change (Table 5-1) or development, the importance of hatchery-origin fish for nutrient cycling may be greater than what is considered in the direct and indirect analyses (Section 4.2.3, Effects on Salmon and Steelhead) for all alternatives. Cumulative effects would likely reduce the available nutrient-cycling source, which could be detrimental to fish life cycles in the long term. Habitat restoration actions may mitigate for this potential cumulative effect, but it is uncertain whether these initiatives could fully mitigate for the combined negative effects of climate change and development in the basin.

5.3.1.1.7 Risks Associated with Disease Transfer

Climate change and development may reduce disease resistance (Table 5-1) compared to conditions considered in the direct and indirect analyses (Section 4.2.3, Effects on Salmon and Steelhead) because increased temperatures would likely stress salmon and steelhead, making them more vulnerable to disease. Therefore, cumulatively, the effects of climate change, along with other future and ongoing development actions, may increase the risk of hatchery-origin fish transmitting disease to natural-origin fish beyond what is considered in Section 4.2.3.1.6, Risks Associated with Disease Transfer, under all alternatives. It is unclear whether habitat restoration actions in the basin would fully mitigate for the combined negative effects of climate change and development on reduced disease resistance.

5.3.1.1.8 Effects on the Viable Salmonid Population Concept

McElhany et al. (2000) developed the Viable Salmonid Population (VSP) concept as a means to evaluate the conservation status of Pacific salmon and steelhead. These VSP indicators of population status are abundance (the number of natural-origin spawners), productivity (the ratio of natural-origin offspring produced per parent), diversity (the genetic variety among population members), and spatial structure (the distribution of population members across a subbasin or subbasins) (Section 3.2.3.1, General Risks and Benefits of Hatchery Programs to Salmon and Steelhead Species). Climate change in the Columbia River basin may reduce the abundance and productivity of salmon and steelhead populations compared to anticipated direct and indirect conditions considered in Section 4.2.3, Effects on Salmon and Steelhead, for all alternatives through the following mechanisms:

- Increased mortality would occur due to more frequent flood flows, changed thermal regime during incubation, and lower disease resistance (Table 5-1).
- Warmer winter would lead to higher metabolic demands, which may also contribute to lower winter survival if food is limiting (Table 5-1).
- Warmer winters may increase predator activity/hunger, which can also contribute to lower winter survival (Table 5-1).

It is unclear how climate change would affect the spatial structure and diversity of salmon and steelhead populations, but it is expected that some level of negative effect on these VSP indicators of population status would occur.

When combined with the negative effects of development, it is anticipated that negative trends in spatial structure and diversity of salmon and steelhead populations would occur over the 10-year timeframe of the proposed action. It is possible that habitat restoration actions may improve spatial structural conditions within the basin, but the degree to which that would occur is uncertain in light of concurrent negative climate change and development impacts on these VSP indicators.

5.3.1.2 Other Fish Species with a Relationship to Salmon and/or Steelhead

Other cold-water fish may also be affected by climate change (O'Neal 2002). In many cases, climate change effects on fish at one life history stage may contribute to increased mortality at later stages (ISAB 2007a). For example, if climate change leads to increases in water temperature, food may be less available while metabolic rates are higher. This may result in smaller fish with a reduced ability to survive at later life stages. As a result, climate change may reduce the abundance of other fish species that have a relationship with salmon and/or steelhead compared to direct and indirect conditions considered in Section 4.2.4, Effects on Other Fish Species with a Relationship to Salmon and Steelhead, for all alternatives.

Fish habitat may also be affected by changes in water temperatures, precipitation, and extreme events that may result in an increased likelihood of floods and droughts, as well as degraded or lost fish habitat, which can occur from development and climate changes. Changes in habitat quality and quantity will influence the abundance of warmwater fish. In response to sea-level rise and increasing salinity levels in rivers and estuaries, warmwater fish could shift habitat use to upstream habitats. Fish that are more adaptable to warmer aquatic conditions could ultimately replace coldwater fish as the dominant species.

The combined effects of development and climate changes within the Columbia River basin would likely be negative for these other fish species, as well as salmon and steelhead. As discussed, the mitigated benefits from habitat restoration actions in the basin are difficult to predict in light of negative effects from concurrent development and climate changes. It is possible that habitat restoration actions could have localized, microclimate benefits for some cold-water species other than salmon and steelhead, but this benefit cannot be quantified.

5.3.2 Socioeconomics

Section 3.3, Socioeconomics, describes how past and existing conditions have influenced socioeconomics in the analysis area (Section 3.3.2, Analysis Area). These conditions represent effects from many years of development, as well as habitat restoration in the basin, and, most likely, indirect effects from climate changes. The expected effects of the alternatives on socioeconomics are described in Section 4.3, Socioeconomics. Future actions are described in Section 5.2. This section considers potential effects that may occur as a result of implementing any one of the alternatives at the same time as other anticipated actions. This section only discusses impacts that have not already been described and evaluated in Section 4.3, Socioeconomics.

5.3.2.1 Hatchery Facility Costs

Hatchery facility costs include those associated with smolt production and release, implementation of best management practices, and construction of weirs. Climate change, basinwide development, and/or restoration actions are not expected to affect hatchery facility costs, so there would be no cumulative effects beyond those considered in Section 4.3, Socioeconomics, for all alternatives.

5.3.2.2 Gross and Net and Economic Values

Commercial and recreational fishers are consumptive users of fishery resources, and they place monetary value on their fishing activities. For commercial fishers (including both tribal and non-tribal), the ex-vessel value (i.e., the price received for the product at the dock) of salmon and steelhead provides a measure of its gross economic value. If the cost of fishing (e.g., equipment, fuel, boats, insurance, etc.) is calculated, the resulting net income (ex-vessel value minus costs) provides a measure of net economic value.

Recreational anglers' total willingness to pay for their recreational fishing experience represents a measure of gross economic value associated with fishing for salmon or steelhead. Because recreational anglers also incur costs to fish (e.g., bait, tackle, lodging, guide fees, boat-related expenses, travel expenses, etc.), subtracting these costs provides a measure of the net economic value (i.e., net willingness to pay) for fishing opportunities.

Although unquantifiable, climate change and development actions may reduce the number of salmon and steelhead available for harvest over the 10-year timeframe. This, in turn, would reduce the total ex-vessel value obtained by commercial fishers relative to conditions considered in Section 4.3, Socioeconomics, for all alternatives. As a result, the cumulative effects on gross and net economic values for commercial fishers may differ from that considered in Section 4.3, Socioeconomics, for all alternatives. If abundance of salmon and steelhead decreases as a result of future climate change, combined with development in the Columbia River basin, cumulative gross and net economic values for commercial fisheries may be lower than what is considered in

Section 4.3, Socioeconomics, for all alternatives unless prices increase as a result of reduced supply[1].

Climate change combined with development in the basin may affect the cost recreational anglers incur or their total willingness to pay. If fewer fish are available for harvest, and more restrictions are in place (e.g., reduced bag limits and fishing seasons), fewer recreational fishers may be willing to pay for the opportunity to fish. As a result, cumulative effects on gross and net economic values for recreational fishers may lead to values lower than those considered in Section 4.3, Socioeconomics, for all alternatives.

The potential benefits of restoration actions within the basin are difficult to quantify. It is unknown whether these actions would fully, or even partially, mitigate for the impacts of climate change or development on available fish for commercial or recreational harvest.

5.3.2.3 Regional and Local Economic Impacts

The assessment of regional and local economic effects of the alternatives incorporates changes in personal income and jobs as key indicators of the direction and magnitude of economic effects (note that personal income differs from net economic value). Commercial and recreational fisheries generate personal income and jobs in regional economies through the export of products and services to outside economies. Commercial catch is frequently sold directly, or after processing, to individuals or businesses located outside the regional economy. Similarly, non-local recreational anglers (i.e., anglers who do not live in a local area) spend money on guide services, lodging, and other goods and services that generate household income and employment in many sectors of the regional economy. This regional transfer of money supports payments to labor, and those payments are then re-spent regionally, resulting in a multiplier effect. Additionally, hatchery facility operations, including employment of hatchery workers and procurement of goods and services, directly and indirectly generate economic impacts.

Climate change and development-related impacts may reduce the number of salmon and steelhead available for harvest, which would reduce the total number of salmon and steelhead exported to outside economies relative to conditions considered in Section 4.3, Socioeconomics, for all alternatives. As a result, the cumulative effects creating regional and local economic impacts may differ from those considered in Section 4.3, Socioeconomics, for all alternatives. If abundance of salmon and steelhead decreases a result of future climate change and development,

[1] Because of the wide availability of farmed fish, the market may not support increased prices for natural-origin salmon (Appendix I).

the cumulative regional and local effects of commercial fisheries may be lower than those considered in Section 4.3, Socioeconomics, for all alternatives.

Climate change and development-related impacts on fish abundance may affect the export of services to economies outside the northwest. Recreational anglers may decide not to travel to the Columbia River basin from outside areas if fewer fish are available for harvest and more fishing restrictions are in place. As a result, the cumulative effects on regional and local economic conditions may lead to worse regional and economic conditions than are considered in Section 4.3, Socioeconomics.

The potential benefits of restoration actions within the basin are difficult to quantify. It is unknown whether these actions would fully, or even partially, mitigate for the impacts of climate change or development on available fish for commercial or recreational harvest, and therefore, on regional and local economies. Such benefits may be more readily quantifiable at the local habitat or microclimate level over the 10-year timeframe, which may or may not represent conditions at the broader regional or local economic environment level.

5.3.3 Environmental Justice

Section 3.4, Environmental Justice, describes how past and present conditions have influenced environmental justice in the analysis area (Section 3.4.2, Analysis Area). Section 3.4, Environmental Justice, also describes the methods for identifying environmental justice user groups and communities of concern. Environmental user groups and communities of concern include Native American tribes that fish for Columbia River basin salmon and steelhead, low-income or minority communities, and low-income or minority fishing groups. The expected effects of the alternatives on environmental justice are described in Section 4.4, Environmental Justice. Future actions are described in Section 5.2. This section considers potential effects that may occur as a result of implementing any one of the alternatives at the same time as other anticipated actions. This section only discusses impacts that have not already been described and evaluated in Section 4.4, Environmental Justice.

5.3.3.1 Fish Harvest and Tribal Value

From a tribal perspective, the value of the salmon is self-evident and extends beyond economic measures. Numbers of salmon harvested provide an indicator of stock health and represent an appropriate measure of relative harvest abundance and tribal value.

As described in Section 5.3.2, Socioeconomics, climate change and ongoing or planned development in the basin may reduce the number of salmon and steelhead available for harvest.

As a result, cumulative effects on fish harvest and tribal value may be lower than those considered in Section 4.4, Environmental Justice, for all alternatives.

The potential benefits of restoration actions within the basin are difficult to quantify, including actions planned or currently managed by tribes in the action area. It is unknown whether these actions would fully, or even partially, mitigate for the impacts of climate change and development on available fish for future tribal uses, but there would likely be some localized tribal benefit over the 10-year timeframe.

5.3.3.2 Ceremonial and Subsistence Harvest for Tribes

A portion of tribal fish harvests is used to meet ceremonial and subsistence needs, which serve as an indicator of cultural viability. As such, this indicator focuses on the potential effects on cultural sustainability, passing on tribal knowledge to future tribal generations, the preservation of tribal identity, and tribal health.

As described in Section 5.3.2, Socioeconomics, climate change and/or development may reduce the number of salmon and steelhead available for harvest. As a result, cumulative effects may lead to less ceremonial and subsistence harvest than is considered in Section 4.4, Environmental Justice, for all alternatives.

The potential benefits of restoration actions within the basin are difficult to quantify, including actions planned or currently managed by tribes in the action area. It is unknown whether these actions would fully, or even partially, mitigate for the impacts of climate change and development on available fish for future tribal ceremonial and subsistence uses, but it is likely that there would be some localized tribal benefit over the 10-year timeframe.

5.3.3.3 Tribal Fishing and Hatchery Revenue

This tribal indicator directly addresses economic revenue obtained by the tribes from the sale of commercially caught salmon, steelhead, and/or salmon eggs. Tribes also receive economic revenue from processing salmon.

As described in Section 5.3.2, Socioeconomics, climate change and development may reduce the number of salmon and steelhead available for harvest. As a result, cumulative effects may lead to less tribal economic revenue from the sale of commercially caught salmon than what is considered in Section 4.4, Environmental Justice, for all alternatives.

The potential benefits of restoration actions within the basin are difficult to quantify, including actions planned or currently managed by tribes in the action area. It is unknown whether these actions would fully, or even partially, mitigate for the impacts of climate change and development on available fish for future revenues, but there would likely be some localized tribal benefit over the 10-year timeframe.

5.3.3.4 Net Revenue for Non-Tribal User Groups of Concern

Hatchery management would also affect non-tribal commercial salmon harvest along the Washington coast and as far south as Cape Falcon (just south of Astoria) along the Oregon coast. Based on the socio-demographic data for these port communities, commercial fishers in select port communities have been identified as environmental justice groups of concern. These include commercial fishers in La Push, Neah Bay, and Westport, Washington, and in Astoria and Dodson, Oregon.

As described in Section 5.3.2, Socioeconomics, climate change and planned and ongoing development in the basin may reduce the number of salmon and steelhead available for harvest. As a result, cumulative effects may lead to less net revenue for non-tribal user groups of concern than what is considered in Section 4.4, Environmental Justice, for all alternatives.

The potential benefits of restoration actions within the basin are difficult to quantify, including actions planned or currently managed by non-tribal user groups in the action area. It is unknown whether these actions would fully, or even partially, mitigate for the impacts of climate change and development on available fish for future revenues.

5.3.3.5 Per Capita Income in Communities of Concern

Changes in commercial and recreational fish harvests and hatchery operations would also affect total regional income at the community level through inter-industry links in the affected regions. Community-level effects include the following:

- Direct income effects on fish harvesters and hatchery staff
- Indirect effects on fish processors, recreational support businesses, and businesses that serve hatchery operations

As described in Section 5.3.2, Socioeconomics, climate change and development in the basin may reduce the number of salmon and steelhead available for harvest. As a result, cumulative effects may lead to less per capita income in communities of concern than what is considered in Section 4.4, Environmental Justice, for all alternatives.

The potential benefits of restoration actions within the basin are difficult to quantify. It is unknown whether these actions would fully, or even partially, mitigate for the effects of climate change and development on available fish for future revenues and per capita incomes in communities of concern.

5.3.4 Wildlife

Section 3.5, Wildlife, describes how past and present conditions have influenced wildlife populations in the Columbia River basin. These conditions represent effects from many years of basin-wide development, as well as habitat restoration, and, most likely, climate changes. The effects of the alternatives on wildlife populations are described in Section 4.5, Wildlife. Future actions are described in Section 5.2. This section considers potential effects that may occur as a result of implementing any one of the alternatives at the same time as other anticipated actions. This section only discusses effects that have not already been described and evaluated in Section 4.5, Wildlife.

As described in Section 5.3.1, Fish, climate change and development in the Columbia River basin may reduce the abundance and productivity of natural-origin salmon and steelhead populations. Hatchery-origin salmon and steelhead would be similarly affected, but to a lesser degree since they would have more favorable conditions in their early life stages (while in the hatchery facility) since water temperature and food availability would be controlled. Consequently, the total number of salmon and steelhead available as prey to wildlife may be lower than that considered in Section 4.5, Wildlife, for all alternatives. Reduced abundance of salmon and steelhead would also decrease the number of salmon and steelhead carcasses available to wildlife for scavenging and for nutrient contribution to the freshwater system.

The potential benefits of restoration actions within the basin are difficult to quantify. It is unknown whether these actions would fully, or even partially, mitigate for the impacts of climate change and development on salmon and steelhead abundances. Therefore, it is difficult to estimate trends in available prey bases for wildlife and available nutrient contributions to the freshwater system. Again, however, localized microclimate fish habitat improvements may be realized from these restoration actions. This potential benefit would be experienced by wildlife that inhabits the same localized ecosystem.

5.3.5 Water Quality and Quantity

Section 3.6, Water Quality and Quantity, describes how past and present conditions have influenced water quality and quantity in the Columbia River basin, including conditions resulting from past development and ongoing restoration actions. Climate change effects on present water quality and quantity are likely represented in these current conditions as well. The effects of the alternatives on water quality and quantity are described in Section 4.6, Water Quality and Quantity. Future actions are described in Section 5.2. This section considers effects that may occur as a result of the alternatives being implemented at the same time as other anticipated future actions. This section only discusses impacts that have not already been described and evaluated in Section 4.6, Water Quality and Quantity.

Successful operation of Federal, state, and tribal hatcheries depends on a constant supply of high-quality surface, spring, or groundwater that, after use in the hatchery facility, is discharged to adjacent receiving environments (Section 3.6, Water Quality and Quantity). Climate change is expected to affect water quality by increasing water temperatures and changing seasonal river flows. As a result, cumulative effects may lead to impaired quality and less quantity than is considered in Section 4.6, Water Quality and Quantity.

The potential benefits of restoration actions within the basin are difficult to quantify. It is unknown whether these actions would fully, or even partially, mitigate for the impacts of climate change and development on water quality and quantity, but this is the goal of many of the restoration programs. It is unlikely that substantial water quality and quantity benefits would be realized in the action area over the 10-year timeframe, but they could be realized beyond this period.

5.3.6 Human Health

Section 3.7, Human Health, describes how past and present conditions have influenced human health in the analysis area (Section 3.7.2, Analysis Area), including conditions resulting from past development and ongoing restoration actions. The expected effects of the alternatives on human health are described in Section 4.7, Human Health. Future actions are described in Section 5.2. This section considers potential impacts that may occur as a result of implementing any one of the alternatives at the same time as other anticipated actions. This section only discusses impacts that have not already been described and evaluated in Section 4.7, Human Health.

5.3.6.1 Hatchery Chemical Use, Handling, and Safety

Hatchery facilities use a variety of chemicals to maintain a clean environment for the production of disease-free fish (Section 3.7.4, Chemicals Used in Hatchery Facilities). Common chemical classes include disinfectants, therapeutics, anesthetics, pesticides/herbicides, and feed additives. Climate change, development, and habitat restoration actions in the basin are not expected to affect the use, handling, or safety of chemicals used in hatchery facilities because all chemicals would continue to be used according to their labels. As a result, no cumulative effects would be expected beyond those already discussed in Section 4.7, Human Health.

5.3.6.2 Transfer of Toxic Contaminants from Fish to Humans

As described in Section 3.7.5, Toxic Contaminants in Hatchery-origin Fish, hatchery-origin fish have the potential to accumulate chemicals used during their production prior to release. Hatchery-origin fish may contain residues of antibiotics, metals, or other organic pollutants that may be consumed by people fishing from the waterways into which the fish are released. Climate change, development, and habitat restoration actions in the basin are not expected to affect the transfer of toxic contaminants from fish to humans. As a result, no cumulative effects would be expected beyond those already discussed in Section 4.7, Human Health.

5.3.6.3 Relevant Disease Vectors and Transmission from Fish to Humans

As described in Section 3.7.6, Relevant Disease Vectors and Transmission, a number of parasites, viruses, and bacteria are potentially harmful to human health and may be transmitted from fish species, primarily through seafood consumption (e.g., improperly or undercooked fish) or handling of infected fish or fish carcasses. The transmission of fish-borne pathogens to humans is rare and can be controlled with the proper safety measures. All existing hatchery programs implement practices to minimize the potential of pathogens occurring in fish, and this would continue under all of the alternatives (Section 4.7, Human Health). Climate change, development, and habitat restoration actions in the basin are not expected to affect the transmission of disease from fish to humans, so no cumulative effects would be expected beyond those already discussed in Section 4.7, Human Health.

Science, Service, Stewardship

Chapter 6

References

References

Chapter 1

Lower Columbia Fish Recovery Board (LCFRB). 2004. Lower Columbia salmon recovery and fish & wildlife subbasin plan, volume 1 & II. LCFRB, Longview, Washington.

McElhany, P., C. Busack, M. Chilcote, S. Kolmes, B. McIntosh, J. Myers, D. Rawding, A. Steel, C. Steward, D. Ward, T. Whitesel, and C. Willis (Willamette/Lower Columbia Technical Recovery Team and Oregon Department of Fish and Wildlife). 2006. Revised viability criteria for salmon and steelhead in the Willamette and Lower Columbia basins.

National Marine Fisheries Service (NMFS).1981. Columbia River fisheries development program. Portland, OR.

NMFS. 2003. A handbook for National Environmental Policy Act compliance; a planning tool for effective project management. Presented in NEPA training session. August, 2003, Seattle, WA.

Pacific Salmon Commission (PSC). 1985. Treaty between government of Canada and the United States of America concerning pacific salmon. Available at http://www.psc.org.

Washington Department of Fish and Wildlife (WDFW) and Western Washington Treaty Tribes. 1997. Wild salmonid policy. Adopted by Washington Fish and Wildlife Commission, Olympia, WA.

Chapter 2

Hatchery Scientific Review Group (HSRG). 2009. Columbia River hatchery reform system-wide report.

Johnson, D.H., B.M. Shrier, J.S. O'Neal, J.A. Knutzen, X. Augerot, T.A. ONeil, and .N. Pearsons, plus 37 contributing authors, 2007. Salmonid field protocols handbook: techniques for assessing status and trends in salmon and trout populations. American Fisheries Society.

Lower Columbia Fish Recovery Board (LCFRB). 2004. Lower Columbia salmon recovery and fish & wildlife subbasin plan, volume 1 & II. LCFRB, Longview, Washington.

McLean, M., R. Seeger, and L. Hewitt. Grande Ronde endemic spring Chinook salmon supplementation program: facility operations and maintenance. 2004 Annual Report, Project No. 199800703. BPA Report DOE/BP-00006509-7. 54 electronic pages.

Recovery Implementation Science Team (RIST). 2009. A review of some applications of science to hatchery reform issues. April 9, 2009.

Washington Department of Fish and Wildlife (WDFW) and the Point No Point Treaty Tribes (PNPTT). 2005. 2004 progress report on Hood Canal summer chum salmon. Memorandum to NOAA Fisheries Service and the Puget Sound Technical Review Team. February 10, 2005. Fish Program. Washington Department of Fish and Wildlife. Olympia, Washington. 15 pages.

Willamette/Lower Columbia Technical Recovery Team and Oregon Department of Fish and Wildlife (ODFW). 2006. Revised viability criteria for salmon and steelhead in the Willamette and lower Columbia basins.

Chapter 3 and Chapter 4

Salmon and Steelhead

Araki, H., B. Cooper, and M.S. Blouin. 2007. Genetic effects of captive breeding cause a rapid, cumulative fitness decline in the wild. Science (Washington, D.C.). Volume 318, pages 100 to 103. doi:10.1126/science.1145621. PMID:17916734.

Beaty, R.E. 1996. Evaluation of Deschutes River fall Chinook salmon. Columbia River Inter-tribal Fish Commission Technical Report 96-6. 204 pages.

Beauchamp, D.A. 1990. Seasonal and diet food habits of rainbow trout stocked as juveniles in Lake Washington. Trans. of the American Fish Society. Volume 119, pages 475 to 485.

Berejikian, B.A. and M.J. Ford. 2004. Review of relative fitness of hatchery and natural salmon. NOAA Technical Memorandum NMFS-NWFSC-61. 28 pages.

Berejikian, B.A., E.P. Tezek, S.L. Schroder, C.M. Knudson, and J.J. Hard. 1997. Reproductive behavioral interactions between spawning and wild and captivity reared coho salmon (Oncorhynchus kisutch). ICES Journal of Marine Science. Volume 54, pages 1040 to 1049.

Berejikian, B.A., D.M. Van Doornik, J.A. Scheurer, and R. Bush. 2009. Reproductive behavior and relative reproductive success of natural- and hatchery-origin Hood Canal summer chum salmon (Oncorhynchus keta). Canadian Journal of Fisheries and Aquatic Sciences. Volume 66, pages 781 to 789.

Beverton, R.J. and S.J. Holt. 1957. On the dynamics of exploited fish populations. Fishery Investigations Series II Volume XIX, Ministry of Agriculture, Fisheries and Food.

Bilby, R.E., B.R. Fransen, P.A. Bission, and J.K. Walter. 1998. Response of juvenile coho salmon (Oncorhynchus kisutch) and steelhead (Onchorhynchus mykiss) to the addition of salmon carcasses to two streams in southwestern Washington, U.S.A. Can. J. Fish. Aquat. Sci. Volume 55, pages 1909 to 1918

Bottom, D.L., C.A. Simenstad, J. Burke, A.M. Bapista, D.A. Jay, K.K. Jones, E. Casillas, and M.H. Schiewe. 2005. Salmon at river's end: the role of the estuary in the decline and recovery of Columbia River salmon. U.S. Dept. Commer., NOAA Technical Memorandum. NMFS-NWFSC-68. 246 pages.

Buhle, E.R., K.K. Holsman, M.D. Scheuerell, and A. Albaugh. 2009. Using an unplanned experiment to evaluate the effects of hatcheries and environmental variation on threatened populations of wild salmon. Biological Conservation. Volume 142, pages 2449 to 2455.

Cannamela, D.A. 1993. Hatchery steelhead smolt predation of wild and natural juvenile Chinook salmon fry in the upper Salmon River, Idaho R93D, Idaho Department of Fish and Game, Fisheries Reasearch.

Chilcote, M.W. 2003. Relationship between natural productivity and the frequency of wild fish in mixed spawning populations of wild and hatchery steelhead (Oncorhynchus mykiss). Canadian Journal of Fisheries and Aquatic Sciences. Volume 60, pages 1057 to 1067.

Columbia Basin Fish and Wildlife Authority (CBFWA) 1996. Draft programmatic environmental impact statement – impacts of artificial salmon and steelhead production strategies in the Columbia River basin. USFWS, NMFS, and BPA. Portland, OR. December 10, 1996, draft.

Fish Passage Center (FPC). 2007. Annual report. 688 pages.

Flagg, T.A., F.W. Waknitz, D.J. Maynard, G.B. Milner, and C.V. Mahnken. 1995. The effect of hatcheries on native coho salmon populations in the lower Columbia River. In Schramm, H.I. and R.G. Piper, editors. Uses and effects of cultured fishes in aquatic ecosystems. American Fisheries Society Symposium 15. Bethesda, Maryland.

Fleming, I.A. and M.R. Gross. 1993. Breeding success of hatchery and wild coho salmon (Oncorhynchus kisutch) in competition. Ecological Applications. Volume 3(2), pages 230 to 245.

Fleming, I.A. and S. Einum. 1997. Experimental tests of genetic divergence of farmed from wild Atlantic salmon due to domestication. ICES Journal of Marine Science. Volume 54, pages 1051 to 1063.

Grant, S.W., editor. 1997. Genetic effects of straying of non-native hatchery fish into natural populations: proceedings of the workshop. U.S. Dept. Commerce, NOAA Technical Memorandum. NMFS-NWFSC-30. 130 pages.

Hastein, T. and T. Lindstad. 1991. Diseases in wild and cultured salmon: possible interaction. Aquaculture. Volume 98, pages 277 to 288.

Hatchery Scientific Review Group (HSRG) 2009. Columbia River hatchery reform system wide report. Available from http://www.hatcheryreform.us/hrp/reports/system/welcome_show.action.

Hillman, T.W. and J.W. Mullan. 1989. Effect of hatchery releases on the abundance of wild juvenile salmonids in Summer and winter ecology of juvenile Chinook salmon and steelhead trout in the Wenatchee River, Washington. Report to Chelan County PUD by D.W. Chapman Consultants, Inc. Boise, Idaho.

Hoekstra, J.M., K.K. Bartz, M.H. Ruckelshaus, J.M. Moslemi, and T.K. Harms. 2007. Quantitative threat analysis for management of an imperiled species: Chinook salmon (Oncorhynchus tshawytscha). Ecological Applications. Volume 17(7), pages 2061 to 2073.

Horner, N.J. 1978. Survival, densities and behavior of salmonid fry in stream in relation to fish predation. M.S. Thesis, University of Idaho, Moscow, Idaho. 115 pages.

Integrated Hatchery Operations Team (IHOT) 1995. Policies and Procedures for Columbia Basin Anadromous Salmonid Hatcheries. Annual Report. DOE/BP-60629. 119 pages.

Interior Columbia Technical Recovery Team (ICTRT). 2007. Viability criteria for application to interior Columbia basin Salmonid ESUs, review draft. U.S. Dept. Commer., NOAA, National Marine Fisheries Service, Northwest Region, Portland, Oregon.

Kendra, W. 1991. Quality of salmonid hatchery effluents during a summer low-flow season. Transactions of the American Fisheries Society. Volume 120, pages 43 to 51.

Lower Columbia River Fish Recovery Board (LCFRB). 2004. Lower Columbia salmon recovery and fish & wildlife subbasin plan, volume 1 & II. LCFRB, Longview, Washington.

McElhaney, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Dept. Commer., NOAA Technical Memorandum. NMFS-NWFSC-42. 156 pages.

McElhany, P., T. Backman, C. Busack, S. Heppell, S. Kolmes, A. Maule, J. Myers, D. Rawding, D. Shively, A. Steel, C. Steward, and T. Whitesel. 2003. Interim report on viability criteria for Willamette and Lower Columbia basin Pacific salmonids. NOAA Fisheries, Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-NWFSC-35. 443 pages.

Nickelson, T.E. 2003. The influence of hatchery coho salmon (Oncorhynchus kisutch) on the productivity of wild coho salmon populations in Oregon coastal basins. Canadian Journal of Fisheries and Aquatic Sciences. Volume 60, pages 1050 to 1056.

National Marine Fisheries Service (NMFS). 1994. Listing endangered and threatened species and designating critical habitat: initiation of status reviews for pink salmon, chum salmon, Chinook salmon, and sea-run cutthroat trout populations in Washington, Oregon, Idaho, and California. Federal Register [Docket 081694D, 12 September 1994]. Volume 59(175), pages 46808 to 46810.

NMFS. 1995. Juvenile fish screen criteria. Available at http://www.nwr.noaa.gov/Salmon-Hydropower/FERC/upload/juv-screen-crit.pdf. Web site accessed May 31, 2006.

NMFS. 1996. Endangered and threatened species: proposed endangered status for five ESUs of steelhead and proposed threatened status for five ESUs of steelhead in Washington, Oregon, Idaho, and California. Federal Register [Docket No. 960730210-6210-01, 9 August 1996]. Volume 61(155), page 41558.

NMFS. 2004. Salmonid hatchery inventory and effects evaluation report. An evaluation of the effects of artificial propagation on the status and likelihood of extinction of west coast salmon and steelhead under the Federal Endangered Species Act. Technical Memorandum NMFS-NWR/SWR. May 28, 2004.

NMFS. 2008. Supplemental comprehensive analysis of the Federal Columbia River Power System and mainstem effects of USBR Upper Snake and other tributary actions. NMFS, Portland, OR.

National Research Council (NRC). 1996. Upstream: salmon and society in the Pacific Northwest. National Academy Press. Washington, D.C. 452 pages.

Oregon Department of Fish and Wildlife (ODFW) 2005. 2005 Oregon native fish status report. Oregon Department of Fish & Wildlife, Fish Division. Salem, Oregon.

ODFW and Washington Department of Fish and Wildlife (WDFW). 2009. 2009 Joint staff report: stock status and fisheries for fall Chinook salmon, coho salmon, chum salmon, summer steelhead and white sturgeon. Joint Columbia River Management Staff.

Pacific Northwest Fish Health Protection Committee 1989. Model comprehensive fish health protection program. 19 pages.

Pacific Salmon Commission (PSC) 1996. Review of the 1995 ocean salmon fisheries. Pacific Fishery Management Council. Portand, Oregon. 115 pages + appendices.

Pearcy, W.G. 1992. Ocean ecology of north Pacific salmonids. Washington Sea Grant Program. University of Washington Press. Seattle, Washington. 179 pages.

Pearsons, T.N. and A.L. Fritts. 1999. Maximum size of Chinook salmon consumed by juvenile coho salmon. North American Journal of Fisheries Management. Volume 19(1), pages 165 to 170.

Polis, G.A. and S.D. Hurd. 1996. Linking marine and terrestrial food webs: allochthonous input from the ocean supports high productivity in small island and coastal land communities. American Naturalist. Volume 173(3), pages 396 to 423.

Quinn, T.P. 2005. The behavior and ecology of Pacific salmon and trout. University of Washington Press. 363 pages.

Recovery Implementation Science Team (RIST) 2009. Hatchery reform science: a review of some applications of science to hatchery reform issues. April 9, 2009. 93 pages.

Species Interaction Work Group (SIWG). 1984. Evaluation of potential interaction effects in the planning and selection of salmonid enhancement projects. J. Rensel, chairman and K. Fresh editor. Report prepared for the Enhancement Planning Team for implementation of the Salmon and Steelhead Conservation and Enhancement Act of 1980. WDFW. Olympia, Washington. 80 pages.

Steward, C.R. and T.C. Bjornn. 1990. Supplementation of salmon and steelhead stocks with hatchery fish: a synthesis of published literature. In Miller, W.H., editor. Analysis of salmon and steelhead supplementation. Report to Bonneville Power Administration (BPA), Portland, Oregon. Project No. 88-100. 126 pages.

Taylor, E.B. 1991. Behavioral interaction and habitat use in juvenile Chinook, Oncorhynchus tshawytscha, and coho O. kisutch, salmon. Anim. Behav. Volume 42, pages 729 to 744.

Thorpe, J.E. 1994. Salmonid fishes and the estuarine environment. Estuaries. Volume 17, pages 76 to 93.

U.S. Environmental Protection Agency (EPA). 1999. National Pollutant Discharge Elimination System (NPDES) Permit Program. Available at http://www.epa.gov/owm/gen2.htm.

U.S. Fish and Wildlife Service (USFWS). 1994. Biological assessment for operation of USFWS operated or funded hatcheries in the Columbia River basin in 1995-1998. Submitted to NMFS under cover letter dated August 2, 1994, from William F. Shake, Acting Regional Director to Brian Brown, NMFS.

Waknitz, F.W., G.M. Matthews, T. Wainwright, and G. Winans. 1995. Status review for mid-Columbia River summer Chinook salmon. NOAA Technical memo. NMFS-NWFSC- 22.

West Coast Chinook Salmon Biological Review Team. 1999. Status review update for the deferred ESUs of West Coast Chinook salmon (Oncorhynchus tshawytscha) from Washington, Oregon, California, and Idaho. July 1999. Available at http://www.nwr.noaa.gov/Publications/Biological-Status-Reviews/loader.cfm?csModule=security/getfile&pageid=21676.

Williams, I.V. and D.F. Amend. 1976. A natural epizootic of Infectious Hematopoietic Necrosis in fry of sockeye salmon (Oncorhynchus nerka) at Chilko Lake, British Columbia. J. Fish. Res. Board Can. Volume 33, pages 1564 to 1567.

Other Fish Species

Belica, L.T. and N. P. Nibbelink. 2006. Mountain sucker (Catostomus platyrhynchus): a technical conservation assessment. USDA Forest Service, Rocky Mountain Region, Species Conservation Project. Available at http://www.fs.fed.us/r2/projects/scp/assessments/mountainsucker.pdf. Web site accessed March 1, 2010.

Butte County Association of Governments. 2007. Species account – river lamprey. In Butte Regional Habitat Conservation Plan and Natural Community Conservation Plan. Available at http://www.buttehcp.com/. Web site accessed November 10, 2009.

Columbia River Basin Lamprey Technical Workgroup. 2010. Translocating adult Pacific lamprey within the Columbia River basin: state of the science. Draft, January 2010. Available at http://www.cbfwa.org/committee_LTW.cfm. Web site accessed March 23, 2010.

Confederated Tribes of the Umatilla Indian Reservation. 2004. Species of interest: Pacific and western brook lamprey and freshwater mussels. Detailed life history, distribution, abundance, and other information. Available at http://www.nwcouncil.org/fw/subbasinplanning/wallawalla/plan/AppE_SpeciesofInterest.pdf. Web site accessed November 10, 2009.

Essington, T.E., T.P. Quin, and V.E. Ewert 2000. Intra- and inter-specific competition and the reproductive success of sympatric Pacific salmon. Can. J. Fish. Aquat. Sci. Volume 57(1), pages 205 to 213.

FishBase. 2010. Leopard dace fact sheet, at http://www.fishbase.org/ComNames/CommonNameSummary.php?autoctr=100684. Web site accessed March 1, 2010.

Gawrylewski, A. 2004. Rainbow trout introduced species summary project. Invasion Biology Introduced Species Summary Project – Columbia University. Available at http://www.columbia.edu/itc/cerc/danoff-burg/invasion_bio/inv_spp_summ/oncorhynchus mykiss. Web site accessed November 13, 2009.

Hearn, W.E. 1987. Interspecific competition and habitat segregation among stream-dwelling trout and salmon: a review. American Fisheries Society. Volume 12(5), pages 24 to 31.

Idaho Department of Fish and Game (IDFG). 2010a. Leopard dace fact sheet, at http://fishandgame.idaho.gov/cms/tech/CDC/cwcs_appf/Leopard%20Dace.pdf. Web site accessed March 1, 2010.

IDFG. 2010b. Umatilla dace fact sheet, at http://www.fishandgame.idaho.gov/cms/tech/CDC/cwcs_appf/Umatilla%20Dace.pdf. Web site accessed March 1, 2010.

IDFG. 2010c. Westslope cutthroat trout fact sheet, at http://fishandgame.idaho.gov/cms/tech/CDC/cwcs_appf/Westslope%20Cutthroat%20Trout.pdf. Web site accessed March 1, 2010.

Idaho Fisheries Society. 2010. Leopard dace fact sheet, at http://www.idahoafs.org/fishes.php?id+26. Web site accessed March 1, 2010.

Kostow, K. 2002. Oregon lampreys: natural history status and problem analysis. Report prepared for Oregon Department of Fish and Wildlife, Portland, Oregon. January 24, 2002.

Kozfkay, C.C., M.R. Campbell, S.P. Yundt, M.P. Peterson, and M.S Powell. 2007. Incidence of hybridization between naturally sympatric westslope cutthroat trout and rainbow trout in the Middle Fork Salmon River drainage, Idaho. Transactions of the American Fisheries Society. Volume 2007(136), pages 624 to 638.

Lonzarich, M.E. 1996. Analysis of selected taxonomic characters of Cottus marginatus, the margined sculpin (Pisces: Cottidae). Copeia. Volume 4, pages 1012 to 1016.

Lower Columbia Fish Recovery Board (LCFRB). 2004. Northern pikeminnow. In Lower Columbia salmon and steelhead recovery and subbasin plan, Technical foundation Volume III, other species. Northwest Power and Conservation Council. Available at http://www.nwcouncil.org/fw/subbasinplanning/lowerColumbia/plan/2004_05/TechnicalFoundation/VolumeIII/Vol.%20III%20Ch.%205--Pikeminnow.pdf. Web site accessed November 10, 2009.

McIntyre, J.S. and B.E. Rieman. 1995.Chapter 1.Westslope cutthroat trout. In Young, Michael K., technical editor. Conservation assessment for inland cutthroat trout. General Technical Report RM-256. Fort Collins, CO. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, pages 1 to 15. USDA Forest Service – Research and Development.

Moser, M.L. and D.A. Close. 2003. Assessing Pacific lamprey status in the Columbia River basin. Northwest Science. Volume 77(2), pages 116 to 125.

Nakamoto, R.J. and T.T. Kisanuki. 1995. Age and growth of Klamath River green sturgeon (Acipenser medirostris). U.S. Fish and Wildife Service, Klamath River Fishery Resource Office, Yreka, California. Project #93-FP-13.

National Marine Fisheries Service (NMFS). 1999. Status review of coastal cutthroat trout from Washington, Oregon, and California. NMFS Conservation Biology Division, Seattle, WA, NOAA Technical Memorandum NMFS-NWFSC-37. 292 pages.

NMFS. 2005. Green sturgeon (Acipenser medirostris) status review update. NOAA Fisheries Biological Review Team, Santa Cruz Laboratory, Southwest Fisheries Science Center. February 2005.

NMFS. 2008. Questions and answers on the NOAA Fisheries Service decision to conduct an Endangered Species Act status review for the West Coast eulachon (smelt). March 2008. Available at http://www.nwr.noaa.gov/Other-Marine-Species/eulachon.cfm. Web site accessed March 16, 2010.

NMFS. 2009. Designation of critical habitat for the threatened southern distinct population segment of North American green sturgeon. Final biological report. NMFS, Southwest Region, Protected Resources Division, Long Beach, CA.

NMFS. 2010. Status review update for eulachon in Washington, Oregon, and California. Prepared by the Eulachon Biological Review Team, NMFS, January 20, 2010. Available at http://www.nwr.noaa.gov/Other-Marine-Species/eulachon.cfm. Web site accessed March 16, 2010.

Natural Resources Conservation Service (NRCS). 2000. Rainbow trout (Oncorhynchus mykiss). Fish and wildlife habitat management leaflet, at ftp://ftp-fc.sc.egov.usda.gov/WHMI/WEB/pdf/RAINBOW1.pdf. Web site accessed November 10, 2009.

NRCS. 2006. Bull Trout (Salvelinus confluentus). Wildlife Habitat Council. Fish and Wildlife Habitat Management Leaflet No. 36. January 2006.

NRCS. 2007. Cutthroat trout (Oncorhynchus clarki) Wildlife Habitat Council, fish and wildlife habitat management leaflet number 47. January 2007. WDFW. 1992. Cutthroat trout fact sheet. Available at http://wdfw.wa.gov/archives/pdf/94021371.pdf. Web site accessed March 1, 2010.

NatureServe Explorer. 2010a. Leopard dace fact sheet, at http://www.natureserve.org/explorer/servlet/NatureServe?sourceTemplace+tabular_report.wmt&loadTemplate=species_RptComprehensive.wmt&selectedReport=RptComprehensive.wmt&summaryView=tabular_report.wmt&elKey=106396&paging=home&save=true&startIndex=1&nextStartIndex=1&reset=false&offPageSelectedElKey=106396&offPageSelectedElType=species&offPageYesNo=true&post_processes=&radiobutton=radiobutton&selectedIndexes=106396. Web site accessed March 2, 2010.

NatureServe Explorer. 2010b. Umatilla dace fact sheet, at http://www.natureserve.org/explorer/servlet/NatureServe?sourceTemplate=tabular_report.wmt&loadTemplate=species_RptComprehensive.wmt&selectedReport=RptComprehensive.wmt&summaryView=tabular_report.wmt&elKey=100872&paging=home&save=true&startIndex=1&nextStartIndex=1&reset=false&offPageSelectedElKey=100872&offPageSelectedElType=species&offPageYesNo=true&post_processes=&radiobutton=radiobutton&selectedIndexes=100872. Web site accessed March 1, 2010.

Oregon Department of Fish and Wildlife (ODFW). 1997. Oregon’s coastal cutthroat trout. Backgrounder. ODFW. February 2, 1997.

ODFW. 2005a. Cutthroat trout. Oregon native fish status report. Volume II, Assessment methods and population results. Assessed at http://www.dfw.state.or.us/fish/ONFSR/index.asp. Web site accessed November 10, 2009.

ODFW. 2005b. Western brook lamprey. Oregon native fish status report. Volume II, Assessment methods and population results. Available at http://www.dfw.state.or.us/fish/ONFSR/index.asp. Web site accessed November 10, 2009.

Ostberg, C.O., S.L. Slatton, and R.J. Rodriquez,. 2004. Spatial partitioning and asymmetric hybridization among sympatric coastal steelhead trout (Oncorhynchus mykiss irideus), coastal cutthroat trout (O. clarki clarki) and interspecific hybrids. Mol. Ecol. Volume 13(9), pages 2773 to 2788.

Pearcy, W.G., R.D. Brodeur, and J.P. Fisher. 1990. Distribution and biology of juvenile cutthroat trout Oncorhynchus clarki clarki and steelhead O. mykiss in coastal waters off Oregon and Washington. Fishery Bulletin. Volume 88(4), pages 697 to 711.

Roberge, M., J.M.B. Hume, C.K. Minns, and T. Slaney. 2002. Life history characteristics of freshwater fishes occurring in the British Columbia and the Yukon, with major emphasis on stream habitat characteristics. Can. Manuscr. Rep. Fish. Aquat. Sci. 2611. 248 +xiv pages.

Romero, N. 2004. Seasonal influences on food availability and diet of coastal cutthroat trout in relation to riparian vegetation. M.S. Thesis, Oregon State University, Corvallis, Oregon.

Scheerer, P.D. 2002. Implications of floodplain isolation and connectivity on the conservation of an endangered minnow, Oregon chub, in the Willamette River, Oregon. American Fisheries Society. Volume 131, pages 1070 to 1080.

Shepard, B.B., B.E. May, and W. Urie. 2003. Status of westslope cutthroat trout (Oncorhynchus clarki lewisi) in the United States: 2002. Available at http://www.fwpiis.mt.gov/content/getItem.aspx?id=7538 -. Web site accessed March 1, 2010.

Stasiak. R.H. 2006. Lake Chub (Couesius plumbeus): a technical conservation assessment. USDA Forest Service, Rocky Mountain Region, Species Conservation Project. Available at http://www.fs.fed.us/r2/projects/scp/assessments/lakechub.pdf. Web site accessed March 1, 2010.

Thurow, R.F., B.E. Rieman, D.C. Lee, P.J. Howell, and R.D. Perkinson. 2007. Distribution and status of redband trout in the interior Columbia River basin and portions of the Klamath River and great basins. In Redband trout: resilience and challenge in a changing landscape. American Fisheries Society, Oregon Chapter. Available at http://www.treesearch.fs.fed.us/pubs/29180. Web site accessed November 13, 2009.

U.S. Fish and Wildlife Service (USFWS). 1998a. Oregon chub (Oregonichtys crameri) recovery plan. USFWS, Portland, Oregon. 69 pages.

USFWS. 1998b. Bull Trout Facts. Public Affairs Office, USFWS, Portland Oregon. May 1998.

USFWS. 2003. USFWS determines that westslope cutthroat should not be listed as a threatened species under the Endangered Species Act. Available at http://fws.gov/mountain-prairie/PRESSREL/03-67. Web site accessed March 1, 2010.

USFWS. 2004. Lamprey species and the Columbia River basin lamprey technical workgroup. PowerPoint presentation by Jen Stone (USFWS) at the Columbia River Basin Pacific Lamprey Summit. October 22, 2004. Portland State University.

USFWS. 2008a. Oregon chub (Oregonichthys crameri) 5-year review summary and evaluation. U.S. Fish and Wildlife Service, Oregon Fish and Wildlife Office, Portland, Oregon, February 8, 2008.

USFWS. 2008b. Bull Trout (Salvelinus confluentus) 5-Year review: summary and evaluation. USFWS, Portland, Oregon.

USFWS. 2008c. Fact sheet Pacific lamprey, at http://www.fws.gov/oregonfwo/Species/Data/PacificLamprey/Documents/012808PL-FactSheet.pdf. Web site accessed November 10, 2009.

USFWS. 2009a. Species fact sheet coastal cutthroat trout. USFWS, Pacific Region. Available at http://www.fws.gov/oregonfwo/Species/Data/CoastalCutthroatTrout. Web site accessed November 2009.

USFWS. 2009b. Pacific lamprey species fact sheet, at http://www.fws.gov/oregonfwo/Species/Data/PacificLamprey/. Web site accessed November 10, 2009.

USFWS. 2010a. Oregon chub fact sheet, at http://www.fws.gov/oregonfwo/Species/Data/OregonChub/. Web site accessed March 1, 2010.

USFWS. 2010b. Bull trout background information (biology, species description, proposed critical habitat description, species profile), at http://www.fws.gov/pacific/bulltrout/. Web site accessed March 31, 2010.

USFWS. 2010c. News release, February 25, 2010. Fish and Wildlife Service withdraws proposal to list the southwest Washington/Columbia River distinct population segment of coastal cutthroat trout. Available at http://www.fws.gov/news/newsreleases/showNews.cfm?newsId=060A4CF8-E514-2572-6DB3D668E664D88A. Website accessed March 17, 2009.

U.S. Geological Survey (USGS). 2009. System-wide significance of predation on juvenile salmonids in Columbia and Snake River reservoirs and evaluation of predation control measures. Available at http://wfrc.usgs.gov/research/aquatic%20ecology/STPeterson 10.htm. Web site accessed November 10, 2009.

Ward, D.L. and M.P. Zimmerman. 1999. Response of smallmouth bass to sustained removals of northern pikeminnow in the lower Columbia and Snake Rivers. Transactions of the American Fisheries Society. Volume 128, pages 1020 to 1035.

Washington Department of Fish and Wildlife (WDFW). 1992. Cutthroat trout fact sheet, at http://wdfw.wa.gov/archives/pdf/94021371.pdf. Web site accessed March 1, 2010. WCT

Washington Department of Fish and Wildlife (WDFW). 1998a. Washington State status report for the margined sculpin. WDFW, Olympia, Washington. 15 pages.

Washington Department of Fish and Wildlife (WDFW). 1998b. Washington State status report for the pygmy whitefish. WDFW, Olympia, Washington. 15 pages.

Zimmerman, M.P. 1999. Food habits of smallmouth bass, walleyes, and northern pikeminnow in the lower Columbia River basin during outmigration of juvenile anadromous salmonids. Transactions of the American Fisheries Society. Volume 128, pages 1036 to 1054.

Socioeconomics

Mann, R. 2004. The Yakima basin regional economy and the contribution of fish and wildlife. Yakima County Public Services. November, 2004.

National Marine Fisheries Service (NMFS). 2003. Final programmatic environmental impact statement for Pacific salmon fisheries management off the coasts of Southeast Alaska, Washington, Oregon, and California, and in the Columbia River basin. National Marine Fisheries Service, Northwest Region. Seattle, Washington.

National Research Council (NRC). 1999. Sharing the fish: toward a national policy on individual fishery quotas. Washington D.C. National Academy Press.

The Research Group. 2009. Preliminary 2.1 economic and social analysis sections prepared for the Mitchell Act EIS. Prepared for NOAA Fisheries, Northwest Regional Office Salmon Recovery Division. Corvallis, Oregon.

Joint Columbia River Management Staff. 2008a. 2008 joint staff report: stock status and fisheries for spring Chinook, summer Chinook, sockeye, steelhead, and other species, and miscellaneous regulations. Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife. January 31, 2008. Available at http://wdfw.wa.gov/fish/crc/crcindex.htm.

Joint Columbia River Management Staff. 2008b. 2008 joint staff report: stock status and fisheries for fall Chinook salmon, coho salmon, chum salmon, summer steelhead, and white sturgeon. Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife. July 14, 2008. Available at http://wdfw.wa.gov/fish/crc/crcindex.htm.

Joint Columbia River Management Staff. 2009a. 2009 joint staff report: stock status and fisheries for spring Chinook, summer Chinook, sockeye, steelhead, and other species, and miscellaneous regulations. Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife. January 26, 2009. Available at http://wdfw.wa.gov/fish/crc/crcindex.htm

Joint Columbia River Management Staff. 2009b. 2009 joint staff report: stock status and fisheries for fall Chinook salmon, coho salmon, chum salmon, summer steelhead, and white sturgeon. Oregon Department of Fish and Wildlife, Washington Department of Fish and Wildlife. July 16, 2009. Available at http://wdfw.wa.gov/fish/crc/crcindex.htm

Pacific Fishery Management Council (PFMC). 2003. Stock assessment and fishery evauation (SAFE) documents: review of 2002 ocean salmon fisheries. Available at http://www.pcouncil.org/salmon/stock-assessment-and-fishery-evaluation-safe-documents/review-of-2002-ocean-salmon-fisheries/.

PFMC. 2004. Stock assessment and fishery evauation (SAFE) documents: review of 2003 ocean salmon fisheries. Available at http://www.pcouncil.org/salmon/stock-assessment-and-fishery-evaluation-safe-documents/review-of-2002-ocean-salmon-fisheries/.

PFMC. 2005. Stock assessment and fishery evauation (SAFE) documents: review of 2004 ocean salmon fisheries. Available at http://www.pcouncil.org/salmon/stock-assessment-and-fishery-evaluation-safe-documents/review-of-2002-ocean-salmon-fisheries/.

PFMC. 2006. Stock assessment and fishery evauation (SAFE) documents: review of 2005 ocean salmon fisheries. Available at http://www.pcouncil.org/salmon/stock-assessment-and-fishery-evaluation-safe-documents/review-of-2002-ocean-salmon-fisheries/.

PFMC. 2007. Stock assessment and fishery evauation (SAFE) documents: review of 2006 ocean salmon fisheries. Available at http://www.pcouncil.org/salmon/stock-assessment-and-fishery-evaluation-safe-documents/review-of-2002-ocean-salmon-fisheries/.

Pacific Salmon Commission (PSC). 2003. 2001/2002 seventeenth annual report. Available at http://www.psc.org/publications_annual_pscreport.htm.

PSC. 2004. 2002/2003 Eighteenth annual report. Available at http://www.psc.org/publications_annual_pscreport.htm.

PSC. 2005. 2003/2004 Nineteenth annual report. Available at http://www.psc.org/publications_annual_pscreport.htm.

PSC. 2006. 2004/2005 Twentieth annual report. Available at http://www.psc.org/publications_annual_pscreport.htm.

PSC. 2007. 2005/2006 Twenty First annual report. Available at http://www.psc.org/publications_annual_pscreport.htm.

Pacific States Marine Fisheries Commission. 2008. Pacific Fisheries Information Network (PacFIN) Washington, Oregon, and California all species catch reports. Available at http://pacfin.psmfc.org/pacfin_pub/woc.php.

Washington Department of Fish and Wildlife (WDFW). 2008. Washington State sport catch report 2002. Available at http://wdfw.wa.gov/fish/harvest/.

Environmental Justice

Council on Environmental Quality. 1997. Environmental justice guidance under the National Environmental Policy Act.

Executive Order 12898. Federal actions to address environmental justice in minority populations and low-income populations. Federal Register, Vol. 59, No. 32, February 11, 1994.

National Marine Fisheries Service (NMFS). 2003. Final programmatic environmental impact statement for Pacific salmon fisheries management off the coasts of Southeast Alaska, Washington, Oregon, and California and in the Columbia River basin.

NMFS. 2004. Final Puget Sound salmon harvest environmental impact statement.

U.S. Environmental Protection Agencye (EPA). 1998. Reviewing for environmental justice: EIS and permitting resource guide. EPA Review. Region 10 – Environmental Justice Office.

EPA. 2009. Environmental Justice, at http://www.epa.gov/compliance/environmentaljustice/index.html.

U.S. Fish and Wildlife Service (USFWS). 2006. 2006 national survey of fishing, hunting, and wildlife-associated recreation.

Wildlife

Anthony, R.G., M.G. Garrett, and C.A. Schuler. 1993. Environmental contaminants in bald eagles in the Columbia River estuary. Journal of Wildlife Management. Volume 57, pages 10 to 19.

Beach, R.J., A.C. Geiger, S.J. Jeffries, S.D. Tracy, and B.L. Troutman. 1985. Marine mammals and their interactions with fisheries of the Columbia River and adjacent waters, 1980-1982. NMFS-AFSC Processed Rep. 8504. Alaska Fisheries Science Center, Natl. Mar. Fish. Serv., NOAA, Seattle, Washington. 316 pages.

Bottom, D.L., C.A. Simenstad, J. Burke, A.M. Baptista, D.A. Jay, K.K. Jones, E. Casillas, and M.H. Schiewe. 2005. Salmon at river’s end: the role of the estuary in the decline and recovery of Columbia River salmon. NOAA Technical Memorandum. NMFS-NWFSW-68.

Browne, P., J.L. Laake, and R.L. DeLong. 2002. Improving pinniped diet analysis through identification of multiple skeletal structures in fecal samples. Fishery Bulletin. Volume 100, pages 423 to 433.

Buck, J.A., R.G. Anthony, C.A. Schuler, F.B. Isaacs, and D.E. Tillitt. 2005. Changes in productivity and contaminants in bald eagles nesting along the lower Columbia River, USA. Environmental Toxicology and Chemistry. Volume 24(7), pages 1779 to 1792.

Burkett, E.E. 1995. Marbled murrelet food habits and prey ecology. In Ralph, C.J., G.L. Hunt Jr., M.G. Raphael, J.F. Piatt, editors. Ecology and conservation of the marbled murrelet. Gen. Tech. Rep. PSW-152. Albany.

Carretta, J.V., K.A. Forney, M.S. Lowry, J. Barlow, J. Baker, B. Hanson, and M.M. Muto. 2007. U.S. Pacific marine mammal stock assessments: 2007. National Marine Fisheries Service. NOAA-TM_NMFS-SWFSC-414.

Cederholm, C.J., D.H. Johnson, R.E. Bilby, L.G. Dominguez, A.M. Garrett, W.H. Graeber, E.L. Greda, M.D. Kunze, B.G. Marcot, J.F. Palmisano, R.W. Plotnikoff, W.G. Pearcy, C.A. Simenstad, and P.C. Trotter. 2001. Pacific salmon and wildlife – ecological contexts, relationships, and implications for management. In Johnson, D.H. and T.A. O'Neil, Wildlife-Habitat Relationships in Oregon and Washington. Washington Department of Fish and Wildlife, Olympia, Washington.

Christmas Bird Count. 2004. Columbia estuary, 1988-1996, at http://www.pacifier.com/~mpatters/cb/ce_sum2.txt. Web site accessed August 8, 2008.

Collis, K., D.D. Roby, D.P. Craig, S. Adamany, J. Adkins, and D.E. Lyons. 2002. Colony size and diet composition of piscivorous waterbirds on the lower Columbia River: implications for loses of juvenile salmonids to avian predation. Transactions of the American Fisheries Society. Volume 131, pages 537 to 530.

Collis, K., D.D. Roby, D.P. Craig, B.A. Ryan, and R.D. Ledgerwood. 2001. Colonial waterbird predation on juvenile salmonids tagged with passive integrated transponders in the Columbia River estuary: vulnerability of different salmonid species, stocks, and rearing types. Transactions of the American Fisheries Society. Volume 130, pages 385 to 396.

Ettinger, S.J. and E.C. Feldman. 1995. Textbook of veterinary internal medicine. W.B. Saunders Co.

Fielder, P.C. 1982. Food habits of bald eagles along the mid-Columbia River, Washington. Murrelet. Volume 63(2), pages 46 to 50.

Fitzner, R.E and W.C. Hanson. 1979. A congregation of wintering bald eagles. Condor. Volume 81, pages 311 to 313.

Fitzner, R.E., D.G. Watson, and W. Rickard. 1980. Bald eagles of the Hanford National Environmental Research Park. Pages 207 to 218 in R.L. Knight, G.T. Allen, M.V. Stalmaster, and C.W. Servheen, editors. Proceedings of the Washington Bald Eagle Symposium, Seattle, Washington.

Ford, J.K.B., G.M. Ellis, and K.C. Balcomb. 2000. Killer whales: the natural history and genealogy of Orcinus orca in British Columbia and Washington State. 2nd ed. UBC Press, Vancouver, British Columbia.

Ford, J.K.B. and G.M. Ellis. 2006. Selective foraging by fish-eating killer whales Orcinus orca in British Columbia. Marine Ecology Progress Series. Volume 316, pages 185 to 199.

Ford, J.K., G.M. Ellis., P. F. Olesiuk, and K.C. Balcomb III. 2009. Linking killer whale survival and prey abundance: food limitation in the oceans' apex predator? Biology Letters doi:10.1098/rsbl.2009.0468.

Fresh, K.L., D. Casillas, L. Johnson, and D.L. Bottom. 2005. Role of the estuary in the recovery of Columbia River basin salmon and steelhead: an evaluation of limiting factors. NOAA Technical Memorandum. NMFS-NWFSC-69. Northwest Fisheries Science Center, National Marine Fisheries Service, Seattle, Washington.

Gilligan, J., D. Rogers, M. Smith, and A. Contreras, editors. 1994. Birds of Oregon: status and distribution. Cinclus Publications, McMinnville, Oregon.

Hanson, M.B., R.W. Baird, C. Emmons, J. Hempelmann, G.S. Schorr, J. Sneva, and D.Van Doornik. 2007. Summer diet and prey stock identification of the fisheating "southern resident" killer whales: addressing a key recovery need using fish scales, fecal samples, and genetic techniques. Abstract from the 17th Biennial Conference on the Biology of Marine Mammals, Capetown, South Africa.

Hanson, M.B., R.W. Baird, J.K.B. Ford, J. Hempelmann-Halos, D.M. Van Doornik, J.R. Candy, C. K. Emmons, G.S. Schorr, B. Gisborne, K.L. Ayres, S.K. Wasser, K.C. Balcomb, K. Balcomb-Bartok, J.G. Sneva, and M.J. Ford. 2010. Species and stock identification of prey consumed by endangered southern resident killer whales in their summer range. Endangered Species Research. Volume 11, pages 69 to 82.

Henny, C.J., J.L. Kaiser, R.A. Gove, V.R. Bentley, and J.E. Elliott. 2003. Biomagnification factors (fish to osprey eggs from Willamette River, Oregon, USA) for PCDDs, PCDFs, PCBs and OC pesticides. Environmental Monitoring and Assessment. Volume 84(3), pages 275 to 315.

Jeffries, S.J. 1984. Marine mammals of the Columbia River estuary. Final report on the marine mammals work unit of the Columbia River estuary data development program. Washington Department of Game. Olympia, WA.

Jeffries, S.J. 1986. Seasonal movements and population trends of harbor seals (Phoca vitulina richardsi) in the Columbia River and adjacent waters of Washington and Oregon. Pages 1976 to 1982. Final Report to the Marine Mammal Commission, Washington, DC.

Jeffries, S.J., P.J. Gearin, H.R. Huber, D.L. Saul, and D.A. Pruett. 2000. Atlas of seal and sea lion haulout sites in Washington. Washington Department of Fish and Wildlife, Olympia, Washington.

Jeffries, S., H. Huber, J. Calambokidis, and J. Laake. 2003. Trends and status of harbor seals in Washington state: 1978-1999. Journal of Wildlife Management. Volume 67(1), pages 208 to 219.

Johnson, L.L., G.M. Ylitalo, C.A. Sloan, B.F. Anunacion, A.N. Kagley, M.R. Arkoosh, R.A. Lundrigan, K. Larson, M. Siipola, and T.K. Collier. 2007. Persistent organic pollutants in outmigrant juvenile Chinook salmon from the lower Columbia Estuary, USA. Science of the Total Environment. Volume 374(2007), pages 342 to 366.

Kline, T.C., J.J. Goering, O.A. Mathison, P. Poe, P.L. Parker, and R.S. Scalan. 1993. Recycling of elements transported upstream by runs of Pacific salmon: II - N and C evidence in Sashin Creek, Southeastern Alaska. Canadian Journal of Fisheries and Aquatic Sciences. Volume 47, pages 136 to 144.

Knight, R.L., J.B. Athearn, J.J. Brueggeman, and A.W. Erickson. 1979. Observations on wintering bald and golden eagles on the Columbia River, Washington. The Murrelet. Volume 60(3), pages 99 to 105.

Krahn, M.M., et al. 2002. Status review of southern resident killer whales (Orcinus orca) under the Endangered Species Act. NOAA Technical Memorandum. NMFS-NWFSC-54.

Krahn, M.M., J.J. Ford, W.F. Perrin, P.R. Wade, R.P. Angliss, M.B. Hanson, B.L. Taylor, G.M. Ylitalo, M.E. Dahlheim, J.E. Stein, and R.S. Waples. 2004. 2004 Status review of southern resident killer whales (Orcinus orca) under the Endangered Species Act. NOAA Technical Memorandum NMFS-NWF-SC-62, National Marine Fisheries Service, Northwest Region, Seattle, Washington.

Krahn, M.M., M.B. Hanson, R.W. Baird, R.H. Boyer, D.G. Burrows, C.E. Emmons, J.K.B. Ford, L.L. Jones, D.P. Noren, P.S. Ross, G.S. Schorr, and T.K. Collier. 2007. Persistent organic pollutants and stable isotopes in biopsy samples (2005/2006) from Southern resident killer whales. Marine Pollution Bulletin. Volume 54, pages 1903 to 1911.

Lower Columbia River Fish Recovery Board (LCFRB). 2004. Lower Columbia salmon recovery and fish & wildlife subbasin plan, volume 1 & II. LCFRB, Longview, Washington.

Lower Columbia River Estuary Partnership (LCREP). 2005. Lower Columbia River Ecosystem Partnership Monitoring Report. Portland, Oregon.

Lowry, M.S. and K.A. Forney. 2005. Abundance and distribution of California sea lions (Zalophus californianus) in central and northern California during 1998 and summer 1999. Fish. Bull. Volume 103, pages 331 to 343.

Marshall, D.B., M.G. Hunter, and A.L. Contreras. 2006. Birds of Oregon. Oregon State University Press. Corvallis, Oregon.

Maser, C. 1998. Mammals of the Pacific Northwest. Oregon State University Press. Corvallis, Oregon.

McShane, C., T. Hamer, H. Carter, G. Swartzman, V. Friesen, D. Ainley, R. Tressler, K. Nelson, A. Burger, L. Spear, T. Mohagen, R. Martin, L. Henkel, K. Prindle, C. Strong, and J. Keany. 2004. Evaluation report for the 5-year status review of the marbled murrelet in Washington, Oregon, and California. Unpublished report. EDAW, Inc. Seattle, Washington. Prepared for the U.S. Fish and Wildlife Service, Region 1. Portland, Oregon

McVicar, A.H., G. Olivier, G.S. Traxler, S. Jones, D. Kieser, and A-M. MacKinnon. 2008. A scientific review of the potential environmental effects of aquaculture in aquatic ecosystems-Volume 4. Fisheries and Oceans Canada. Available at http://www.dfo-mpo.gc.ca/Science/enviro/aquaculture/sok-edc/volume4.pdf. Web site accessed February 17, 2009.

Melquist, W. 1997. Aquatic mustelids. In Harris, J.E. and C.V. Ogan, editors. Mesocarnivores of northern California: biology, management and survey techniques. Workshop manual. August 12-15, 1997. Humboldt State University, Arcata, California. The Wildlife Society, California North Coast Chapter, Arcata, California.

Monterey Bay Aquarium. 2003. Brown Pelican, at http://www.mbayaq.org/efc/living_species/print.asp?inhab=508. Web site accessed August 2, 2008.

National Marine Fisheries Service (NMFS). 1993. Contaminant exposure and associated biological effects in juvenile Chinook salmon (Oncorhynchus tshawytscha) form urban and nonurban estuaries of Puget Sound. NOAA Technical Memorandum NMFS-NWFSC-8. Northwest Fisheries Science Center, Seattle, WA.

NMFS. 1997. Investigation of scientific information on the impacts of California sea lions and Pacific harbor seals on salmonids and on the coastal ecosystems of Washington, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-28.

NMFS. 2008a. Biological opinion. Endangered Species Act (ESA) section 7 consultation number F/NRW/2008/00486. Assessment of impacts from sea lion removal program. National Marine Fisheries Service, Northwest Region. Protected Resources Division, Portland, Oregon.

NMFS. 2008b. Recovery plan for southern resident killer whales (Orcinus orca). National Marine Fisheries Service, Northwest Region, Seattle, Washington.

NMFS. 2008c. Supplemental comprehensive analysis. FCRPS biological opinion. NOAA Fisheries Log # F/NWR/2005/05883. National Marine Fisheries Service, Northwest Region, Seattle, Washington.

NMFS. 2008d. Recovery plan for the Steller sea lion: eastern and western distinct population segments (Eumetopias jubatus). National Marine Fisheries Service, Northwest Region, Seattle, Washington.

NMFS. 2008e. Seal and sea lion facts of the Columbia River and adjacent nearshore marine areas, at http://www.nwr.noaa.gov/Marine-Mammals/Seals-and-Sea-Lions/upload/CR-Pinniped-FS.pdf. Web site accessed August 8, 2008.

NMFS. 2008f. Final environmental assessment. Reducing the impact on at-risk salmon and steelhead by California sea lions in the area downstream of Bonneville Dam on the Columbia River, Oregon and Washington. National Marine Fisheries Service, Northwest Region.

NatureServe. 2008. http://www.natureserve.org. Information obtained from the website in 2008.

North Cascades Grizzly Bear Outreach Project. 2010. Website devoted to exchange of information on grizzly bears in the North Cascades, at http://bearinfo.org/grizzlies/issues-history/. Web site accessed June 21, 2010.

NW Fishletter. 2009. NW Fishletter #256, January 8, 2009. Available at http://www.newsdata.com/fishletter/256/3story.htm. Web site accessed January 12, 2009.

Opperman, H. 2003. A birder's guide to Washington. American Birding Association, Inc. Colorado Springs, Colorado.

Oregon Department of Fish and Wildlife (ODFW). 2007. Fish carcass distribution guidelines. Salmon and Trout Enhancement Program. November 2007.

Ostrand, W.D., S. Howlin, and T.A. Gotthardt. 2004. Fish school selection by marbled murrelets in Prince William Sound, Alaska: responses to changes in availability. Marine Ornithology. Volume 32, pages 69 to 76.

Pacific Biodiversity Institute. 2008. Bald eagle, at http://www.pacificbio.org/ESIN/Birds/BaldEagle/baldeaglepg.html. Web site accessed August 8, 2008.

Park., D.L. 1993. Effects of marine mammals on Columbia River salmon listed under the Endangered Species Act: recovery issues for threatened and endangered Snake River salmon. Technical Report 3 of 11. Prepared by D.L. Park under subcontract to S.P. Cramer & Associates, Inc., Gresham, OR. Prepared for U.S. Department of Energy. Bonneville Power Administration. Portland, OR 97208.

Pearcy, W. 1992. Ocean ecology of North Pacific salmonids. Washington Sea Grant Program. University of Washington Press, Seattle, Washington.

Phinney, D.D., S.B. Mathews, and T.N. Pearsons. 1998. Development of a bird predation index, annual report 1998. Submitted to Bonneville Power Administration, Contract No. 1998AT02689, Project No. 199506408. BPA Report DOE/BP-64873-3.

Portland Audubon Society. 2008. Oregon's important bird areas: East Sand Island, at http://www.audubonportland.org/issues/statewide/iba/iba-map/eastsand/?searchterm=Sand%20Island. Web site accessed on October 8, 2008.

Puget Sound Action Team. (PSAT). 2007. 2007 Puget Sound update: ninth report of the Puget Sound ambient monitoring program. Puget Sound Action Team. Olympia, Washington. Pages 129, 140, and 153 to 156.

Quamme, D. and P.A. Slaney. 2002. The relationship between nutrient concentration and stream insect abundance. In Nutrients in salmonid ecosystems: sustaining production and biodiversity. American Fisheries Society Symposium. Volume 34,163-175.

Reimer, S.D and R.F. Brown. 1997. Prey of pinnipeds at selected sites in Oregon identified by scat (fecal) analysis, 1983-1996. Oregon Dept. of Fish and Wildlife, Tech. Report 97-6-02.

Richardson, S., D. Hays, R. Spencer, and J. Stofel. 2000. Washington state status report for the common loon. Washington Department of Fish and Wildlife, Olympia, Washington.

River Otter Journal. 2003. Food habits of the North American river otter (Lutra canadensis). River Otter Journal. Volume 12(2), pages 1 to 2.

Robertson, G.J. and R. Goudie. 1999. Harlequin duck (Histrionicus histrionicus). In The birds of North America.

Roby, D.D and Collis, K. 2008. Research, monitoring, and evaluation of avian predation on salmonid smolts in the lower and middle Columbia River: draft 2007 season summary. Report prepared for Bonneville Power Administration and U.S. Army Corps of Engineers. June 2008.

Roni, P. 2002. Habitat use by fishes and Pacific giant salamanders in small western Oregon and Washington streams. Transactions American Fisheries Society. Volume 131, pages 743 to 761.

Ross, P.S., G.M. Ellis, M.G. Ikonomou, L.G. Barrett-Lennard, and R.F. Addison. 2000. High PCB concentrations in free-ranging Pacific killer whales, Orcinus orca: effects of age, sex, and dietary preference. Marine Pollution Bulletin. Volume 40(6), pages 504 to 515.

Ryan, B.A., S.G. Smith, J.M. Butzerin, and J.W. Ferguson. 2003. Relative vulnerability to avian predation of juvenile salmonids tagged with passive integrated transponders in the Columbia River estuary, 1998-2000. Transactions American Fisheries Society. Volume 132, pages 275 to 288.

Sauer, J.R., J.E. Nines, and J. Fallon. 2008. The North American Breeding Bird Survey, Results and Analysis, 1966-2007. Version 5.1.5.2008. USGS Patuxent Wildlife Research Center, Laurel, Maryland. Available at http://www.mbr-pwrc.usgs.gov/bbs/bbs.html. Web site accessed August 8, 2008.

Seattle Audubon Society. 2005. Brown pelican. BirdWeb: Seattle Audubon's online guide to the birds of Washington State, at http://www.birdweb.org/birdweb/bird_details.aspx?value=search&id=34. Web site accessed August 4, 2008.

Shuford, W.D. and D.P. Craig. 2002. Status assessment and conservation recommendations for the Caspian tern (Sterna caspia) in North America. U.S. Fish and Wildlife Service, Portland, Oregon.

Sinclair, E.H. and T.K. Zeppelin. 2002. Seasonal and spatial differences in diet in the western stock of Steller sea lions (Eumetopias jubatus). Journal of Mammalogy. Volume 83, pages 973 to 990.

Smith, M.R., P.W. Mattocks, Jr., and K.M. Cassidy. 1997. Breeding birds of Washington state: location data and predicted distributions. Volume 4 in K.M. Cassidy, C.E. Grue, M.R. Smith, and K.M Dvornich, editors. Washington State Gap Analysis Final Report. Washington Cooperative Fish and Wildlife Research Unit, University of Washington, Seattle, Washington.

Stinson, D.W., J.W. Watson, and K.R. McAllister. 2001. Washington State status report for the bald eagle. Washington Department of Fish and Wildlife, Olympia. 92 + ix pages.

Stinson, D.W., J.W. Watson and K.R. McAllister. 2007. Washington State status report for the bald eagle. Washington Department of Fish and Wildlife, Olympia. 86 + viii pages.

Thompson, C.W. 1999. Distribution and abundance of marbled murrelets and common murres on the outer coast of Washington – summer 1997 through winter 1998-1999. Prepared for Washington Department of Fish and Wildlife.

U.S. Army Corps of Engineers (USACE). 2008. News Release 08-086. Dated May 28, 2008.

U.S. Department of the Interior (USDI) and Bureau of Land Management (BLM). 2007. Migratory bird conservation program. Idaho, Burley District Bird Guide. Northern Prairie Wildlife Research Center Online. Available at http://www.npwrc.usgs.gov/resource/birds/chekbird/r1/burl.htm. Web site accessed August 8, 2008.

U.S. Forest Service (USFS). 2008. Marbled murrelet effectiveness monitoring module. 2008. NorthwestForest Plan Interagency Regional Monitoring Program, Portland, Oregon.

U.S. Fish and Wildlife Service (USFWS). 1997. Recovery plan for the marbled murrelet (Washington, Oregon, and California populations). Region 1, USFWS, Portland, Oregon.

USFWS. 2007a. Grizzly bear recovery, at http://www.fws.gov/mountain-prairie/species/mammals/grizzly/index.htm. Web site accessed August 8, 2008.

USFWS. 2007b. Deer Flat National Wildlife Refuge, at http://www.fws.gov/deerflat/birdlist1text.htm. Web site accessed August 8, 2008.

USFWS. 2009. Final 5-year review for the marbled murrelet. USFWS. Washington Fish and Wildlife Office. Lacey, WA.

Varoujean, D.H. and W. A. Williams. 1995. Abundance and distribution of marbled murrelets in Oregon and Washington based on aerial surveys. In USFS General Technical Report PSW-152, Ecology and Conservation of the Marbled Murrelet, Chapter 31.

Wahl, T.R., B. Tweit, and S.G. Mlodinow. 2005. Birds of Washington. Oregon State University Press. Corvallis, OR.

Washington Department of Fish and Wildlife (WDFW). 2008. Nutrient enhancement. Washington Department of Fish and Wildlife Hatcheries program, at http://wdfw.wa.gov/hat/overview.htm. Web site accessed August 28, 2008.

Watson, J.W., M.G. Garrett, and R.G. Anthony. 1991. Foraging ecology of bald eagles in the Columbia River estuary.

Watson, J.W., D. Stinson, K.R. McAllister, and T.E. Owens. 2002. Population status of bald eagles breeding in Washington at the end of the 20th century. Journal of Raptor Research. Volume 36, pages 161 to 169.

Wiles, G.J. 2004. Washington state status report for the killer whale. Washington Department of Fish and Wildlife. March 2004.

Ylitalo, G.M., C.O. Matikin, J. Buzitis, M.M. Krahn, L.J. Jones, T. Rowles, and J.E. Stein. 2001. Influence of life-history parameters on organochlorine concentrations in free-ranging killer whales (Orcinus orca) from Prince William Sound, AK. The Science of the Total Environmental. Volume 281, pages 183 to 203.

Zamon, J.E., T.J. Guy, K. Balcomb, and D. Ellifrit. 2007. Winter observations of southern resident killer whales (Orcinus orca) near the Columbia River plume during the 2005 spring Chinook salmon (Oncorhynchus tshawytscha) spawning migration. Northwestern Naturalist. Volume 88, pages 193 to 198.

Water Quality and Quantity

Bergheim, A. and T. Åsgård. 1996. Chapter 3. Waste Production from Aquaculture. In , Baird, D.J., et al., editors. Aquaculture and Water Resource Management. Blackwell Science, Ltd. Oxford, England. Pages 50 to 80.

Bonneville Power Administration (BPA) and Confederated Tribes of the Colville Reservation (CTCR). 2007. Chief Joseph Hatchery Program Draft Environmental Impact Statement. DOE/EIS-0384. May 2007. Available at http://www.efw.bpa.gov/environmental_services/Document_Library/Chief_Joseph/Chief_Joseph_Draft_EIS.pdf. Web site accessed July 24, 2009.

Boxall A.B., L.A. Fogg, P.A. Blackwell, P. Kay, E.J. Pemberton, and A. Croxford. 2004. Veterinary medicines in the environment. Rev Environ Contam Toxicol. Volume 2004, pages 1 to 91.

Camargo, Julio A. 1992. Structural and trophic alterations in macrobenthic communities downstream from a fish farm outlet. Hydrobiologia. Volume 242, pages 41 to 49.

Cederholm, C.J., D.H. Johnson, R.E. Bilby, L.G. Dominguez, A.M. Garrett, W.H. Graeber, E.L. Greda, M.D. Kunze, B.G. Marcot, J.F. Palmisano, R.W. Plotnikoff, W.G. Pearcy, C.A. Simenstad, and P.C. Trotter. 2001. Pacific salmon and wildlife – ecological contexts, relationships, and implications for management. In Johnson, D.H. and T.A. O'Neil, Wildlife-Habitat Relationships in Oregon and Washington. Washington Department of Fish and Wildlife, Olympia, Washington.

Colman, J.R., D. Baldwin, L.L. Johnson, and N. L. Scholz. 2009. Effects of the synthetic estrogen, 17alpha-ethinylestradiol, on aggression and courtship behavior in male zebrafish (Danio rerio) Aquatic Toxicology. Volume 91, pages 346 to 354.

Confederated Tribes of the Umatilla Indian Reservation. 2001. Confederated Tribes of the Umatilla Indian Reservation of Oregon Water Quality Standards. Available at http://www.epa.gov/waterscience/standards/wqslibrary/tribes/umatilla.pdf. Web site accessed July 14, 2009.

Confederated Tribes of the Colville Reservation. 2005. Federal Water Quality Standards Regulations for the Confederated Tribes of the Colville Reservation (40 CFR 131.35). Available at http://www.epa.gov/waterscience/standards/wqslibrary/tribes.html. Web site accessed July 14, 2009.

Cripps, Simon J. 1995. Serial particle size fractionation and characterization of an aquacultural effluent. Aquaculture. Volume 133, pages 323 to 339.

Hatchery Scientific Review Group (HRSG). 2005. Hatchery reform in Washington State: principles and emerging issues. Fisheries. Volume 30(6), pages 1 to 23.

HSRG 2009. Columbia River hatchery reform system wide report. Available at http://www.hatcheryreform.us/hrp/reports/system/welcome_show.action. Web site accessed July 14, 2009.

Idaho Department of Environmental Quality (IDEQ). 2002 Idaho Waste Management Guidelines for Aquaculture Operations. Available at http://www.deq.idaho.gov/water/prog_issues/waste_water/pollutant_trading/aquaculture_guidelines.pdf. Accessed July 14, 2009.

IDEQ. 2008. Aquaculture in Idaho, at http://www.deq.state.id.us/water/prog_issues/agriculture/aquaculture.cfm. Accessed May 19, 2008.

IDEQ. 2009. Surface Water: Department of Environmental Quality working principles and policies for the 2008 integrated (303[d]/305[b]) report. State of Idaho Department of Environmental Quality, Boise, Idaho. May 22, 2009. Available at http://www.deq.state.id.us/water/data_reports/surface_water/monitoring/integrated_report.cfm. Web site accessed September 10, 2009.

Idaho Department of Fish and Game (IDFG). 2005. The compass 2005: Idaho Department of Fish and Game strategic plan. Idaho Department of Fish and Game, Boise, Idaho. 24 pages. Available at http://fishandgame.idaho.gov/cms/about/compass/compass.pdf. Web site accessed July 14, 2009.

IDFG. 2006. Fisheries management plan 2007-2012. Available at http://fishandgame.idaho.gov/fish/programs/fish-plan.pdf. Web site accessed July 14, 2009.

IDFG. 2008. Direction 2008. Issues, accomplishments, and priorities. Available at http://fishandgame.idaho.gov/cms/about/compass/direction08.pdf. Web site accessed August 29, 2008.

Kendra, Will. 1991. Quality of salmonid hatchery effluents during a summer low-flow season. Transactions of the American Fisheries Society. Volume 120, pages 43 to 51.

Kolodziej E.P., T. Harter, and D.L. Sedlak . 2004. Dairy wastewater, aquaculture, and spawning fish as sources of steroid hormones in the aquatic environment. Environ. Sci. Technol. Volume 38, pages 6377 to 6384.

LaPatra, S.E. 2003. The lack of scientific evidence to support the development of effluent limitations guidelines for aquatic animal pathogens. Aquaculture. Volume 226(14), pages 191 to 199.

Martínez-Bueno M.J., M.D. Hernando, A. Agüera, and A.R. Fernández-Alba. 2009. Application of passive sampling devices for screening of micro-pollutants in marine aquaculture using LC-MS/MS. Talanta. Volume 77, pages 1518 to 1527.

Maule, A.G., A.L. Gannam, and J. W. Davis. 2007. Chemical contaminants in fish feeds used in federal salmonid hatcheries in the USA. Chemosphere. Volume 67(7), pages 1308 to 1315

Maule, A. 2009. Chemical contamination of hatchery fish feed. Available at http://wfrc.usgs.gov/research/contaminants/STSeelye4.htm. Web site accessed July 31, 2009.

McLaughlin, T.W. 1981. Hatchery effluent treatment. U.S. Fish and Wildlife Service. Bio-Engineering Symposium for Fish Culture (FCS Publ. 1), pages 167 to 173.

Michael, Jr, J.H. 2003. Nutrients in salmon hatchery wastewater and its removal through the use of wetland constructed to treat off-line settling pond effluent. Aquaculture. Volume 226, pages 213 to 225.

Missildine, B.R., R.J. Peters, G. Chin-Leo, and D. Houck. 2005. Polychlorinated biphenyl concentrations in adult Chinook salmon (Oncorhynchus tshawytscha) returning to coastal and Puget Sound hatcheries of Washington State. Environmental Science and Technology. Volume 39, pages 6944 to 6951.

National Marine Fisheries Service (NMFS). 2001.Toxic contaminants, ESA listed salmon, and channel deepening in the lower Columbia River. SEI Science Panel workshop: sediments and sediment quality, June 7-8, 2001, Vancouver, WA. Environmental Conservation Division, Northwest Fisheries Science Center, Seattle, Washington. Available at http://www.sei.org/columbia/downloads/tracyjune.PDF. Web site accessed August 3, 2009.

Naylor, R., K. Hindar, I.A. Fleming, R. Goldburg, S. Williams, J. Volpe, F. Whoriskey, J. Eagle, D. Kelso, and M. Mangel. 2005. Fugitive salmon: assessing the risks of escaped fish from net-pen aquaculture. BioScience. Volume 55(5), pages 427 to 437.

Northwest Indian Fisheries Commission (NWIFC). 2006. Tribal Fish Health Manual. Available at http://access.nwifc.org/enhance/documents/TribalFishHealthManual5-01-07.pdf. Web site accessed July 14, 2009.

NWIFC, Washington Department of Fish and Wildlife (WDFW), U.S. Fish and Wildlife Service (USFWS). 2006. The salmonid disease control policy of the fisheries co-managers of Washington State (Revised July 2006). Available at http://access.nwifc.org/enhance/documents/FinalDiseasePolicy-July2006_Ver3.pdf. Web site accessed July 14, 2006.

Oregon Department of Environmental Quality (ODEQ) 2009a. Water quality assessment - Oregon's 2004/2006 integrated report database. Available at http://www.deq.state.or.us/wq/assessment/rpt0406/search.asp.

ODEQ. 2009b. Oregon’s groundwater protection program, at http://www.deq.state.or.us/wq/groundwater/agencies.htm. Web site acessed July 31, 2009.

Oregon Department of Fish and Wildlife (ODFW). 2003. Fish health management policy. Available at http://www.dfw.state.or.us/fish/hatchery/fish_mgmt_policy.pdf. Web site accessed on July 14, 2009.

Oregon Plan. 1999. Oregon aquatic habitat restoration and enhancement guide. The Oregon Plan for salmon and watersheds. May 1999. Available at http://www.oregon.gov/OWEB/docs/pubs/habguide99-complete.pdf. Web site accessed August 29, 2008.

Pearsons T., C. Johnson, M. Schmuck, T. Webster, D. Roley, and R. Bilby. 2003. Influences of stocking salmon carcass analogs on salmonids in Yakima River tributaries: progress report – May 2001 – December 2002. Prepared for the Washington Department of Fish and Wildlife, Olympia, WA. Available at http://pisces.bpa.gov/release/documents/documentviewer.aspx?pub=P00005636-1.pdf. Web site accessed July 14, 2009.

Piedrahita, R., K. Fitzsimmons, W. Zachritz II, and C. Brockway. 1996. Evaluation and improvements of solids removal systems for aquaculture. In Proceedings of the First International Conference on Recirculating Aquaculture. Available at http://nsgl.gso.uri.edu/vsgcp/vsgcpc00001/1996/TS1-open_papers.pdf. Web site accessed July 15, 2009.

Pouliquen H., C. Thorin, J. Haury, M. Larhantec-Verdier, M.L. Morvan, R. Delépée, and H. Le Bris. 2008. Comparison of water, sediment and plants for the monitoring of antibiotics: a case study on a river dedicated to fish farming. Environ Toxicol Chem.Volume 2008(Nov. 3), page 1.

Selong, J.H. and L.A. Helfrich. 1998. Impacts of trout culture effluent on water quality and biotic communities in Virginia headwater streams. The Progressive Fish-Culturist. Volume 60, pages 47 to 262.

Sparrow, R.A.H. 1981. Hatchery effluent water quality in British Columbia. Bio-Engineering Symposium for Fish Culture (FCS Publ. 1), pages 162 to 166.

U.S. Environmental Protection Agency (EPA). 2004. Technical development document for the final effluent limitations guidelines and new source performance standards for the concentrated aquatic animal production point source category (revised August 2004). Engineering and Analysis Division, Office of Science and Technology, U.S. Environmental Protection Agency, Washington, DC 20460. EPA-821-R-04-12. August 2004.

EPA. 2007a. Authorization to discharge under the National Pollutant Discharge Elimination System. Cold water aquaculture facilities in Idaho (not subject to wasteload allocations). Region 10, 1200 Sixth Avenue, Seattle, Washington 98101. Permit No. IDG-131000. October 25, 2007.

EPA. 2007b. Authorization to discharge under the National Pollutant Discharge Elimination System. Aquaculture facilities in Idaho, subject to wasteload allocations under selected total maximum daily loads. Region 10, 1200 Sixth Avenue, Seattle, Washington 98101. Permit No. IDG-130000. October 25, 2007.

U.S. Fish and Wildlife Service (USFWS). 1999. Hatchery facts. Frequently asked questions, at http://library.fws.gov/Pubs1/hatcheryfacts99.pdf. Web site accessed July 31, 2009.

Washington Department of Ecology (Ecology). 1989. Quality and fate of fish hatchery effluents during the summer low flow season. Publication No. 89-17. Prepared by Will Kendra, Washington Department of Ecology, Environmental Investigations and Laboratory Services Program, Surface Water Investigations Section, Mail Stop PV-11, Olympia, Washington 98504. May 1989. Available at http://www.ecy.wa.gov/pubs/9817.pdf. Web site accessed July 15, 2009.

Ecology. 2004. Washington State's water quality assessment [303(d)]. 2002/2004 303(d) list simple query tool, at http://www.ecy.wa.gov/programs/wq/303d/index.html. Web site accessed January 16, 2004.

Ecology. 2005a. Upland fin-fish hatching and rearing National Pollutant Discharges Elimination System waste discharge general permit. State of Washington, Department of Ecology, Olympia, Washington 98504-7600. Available at http://www.ecy.wa.gov/programs/wq/permits/permit_pdfs/upland_fin_fish/FinFishHatchery_Permit.pdf. Web site accessed July 23, 2009.

Ecology. 2005b. Upland fin-fish hatching and rearing general permit fact sheet. State of Washington, Department of Ecology. Available at http://www.ecy.wa.gov/programs/wq/permits/permit_pdfs/upland_fin_fish/FinFishHatchery_FactSheet.pdf. Web site accessed July 15 2009.

Washington Department of Fish and Wildlife (WDFW). 2004. Protocols and Guidelines for Distributing Salmonid Carcasses, Salmon Carcass Analogs, and Delayed Release Fertilizers to Enhance Stream Productivity in Washington State. http://wdfw.wa.gov/hab/ahg/shrg/12-shrg_nutrient_supplementation.pdf. Accessed August 29, 2008.

Williams, R., J. Lichatowich, P. Mundy, and M. Powell. 2003. A blueprint for hatchery reform in the 21st century. A landscape approach. A Trout Unlimited special report. Available at http://www.tu.org/atf/cf/%7BED0023C4-EA23-4396-9371-8509DC5B4953%7D/landscapemedia.pdf. Web site accessed July 29, 2009.

Human Health

Burka, J.F., K.L. Hammell, T.E. Horsberg, G.R. Johnson, D.J.Rainnie, and D.J. Speare. 1997. Drugs in salmonid aquaculture – a review. J. Vet. Pharmacol. Therap. Volume 20, pages 333 to 349.

Boxall A.B., L.A. Fogg, P.A. Blackwell, P. Kay, E.J. Pemberton, and A. Croxford. 2004. Veterinary medicines in the environment. Rev. Environ. Contam. Toxicol. Volume 2004(180), pages 1 to 91.

Cabello F.S. 2006. Heavy use of prophylactic antibiotics in aquaculture: a growing problem for human and animal health and for the environment. Environmental Microbiology. Volume 8(7), pages 1137 to 1144.

Carlson, D.L. and R.A. Hites. 2005. Polychlorinated biphenyls in salmon and salmon feed: global differences and bioaccumulation. Environmental Science and Technology. Volume 39, pages 7389 to 7395.

Cullon DL, M.B. Yunker, C. Alleyne, N.J. Dangerfield, S. O'Neill, M.J. Whiticar, and P.S. Ross. 2009. Persistent organic pollutants in Chinook salmon (Oncorhynchus tshawytscha): implications for resident killer whales of British Columbia and adjacent waters. Environ. Toxicol. Chem. Volume 28, pages 148 to 161.

Cornwall, W. 2005. Hatcheries may be releasing pollutants along with fish. Seattle Times (http://seattletimes.nwsource.com/html/localnews/2002269291_hatchery10m.html). May 10, 2005.

Douglas, J.D.M. 1995. Salmon farming: occupational health in a new rural industry. Occupational Medicine.Volume 45(2), pages 89 to 92.

Durborow, R.M. 1999. Health and safety concerns in fisheries and aquaculture. Occupational Medicine. Volume 14(2), pages 373 to 406.

Easton, M.D.L., D. Luszniak, and E. Von der Geest. 2002. Preliminary examination of contaminant loadings in farmed salmon, wild salmon and commercial salmon feed. Chemosphere. Volume 46, pages 1053 to 1074.

Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP). 1997. Towards safe and effective use of chemicals in coastal aquaculture. GESAMP. Food and Agriculture Organization of the United Nations. GESAMP Reports and Studies No. 65. Rome, FAO. 1997. 40 pages.

Hamilton, M.C., R.A. Hites, S.J. Schwager, J.A. Foran, B.A. Knuth, and D.O. Carpenter. 2005. Lipid composition and contaminants in farmed and wild salmon. Environmental Science and Technology. Volume 39, pages 8622 to 8629.

Hites, R.A., J.A. Foran, D.O. Carpenter, M.C. Hamilton, B.A. Knuth, and S.J. Schwager. 2004. Global assessment of organic contaminants in farmed salmon. Science. Volume 303, pages 226 to 229.

Hazardous Substance DataBank (HSDB). 2007. Hazardous Substances DataBank. Online database maintained by the National Library of Medicine (http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB).

Jacobs, M.N., A. Covaci, and P. Schepens. 2002a. Investigation of selected persistent organic pollutants in farmed Atlantic salmon (Salmo salar), salmon aquaculture feed, and fish oil components of the feed. Environmental Science and Tehcnology. Volume 36, pages 2797 to 2805.

Jacobs, M., J. Ferrario, and C. Byrne. 2002b. Investigation of polychlorintated dibenzo-p-dioxins, dibenzo-p-furans and selected coplanar biphenyls in Scottish farmed Atlantic salmon (Salmo salar). Chemosphere. Volume 47(2), pages 183 to 191.

Johnson, L.L., G.M. Ylitalo, M.R. Arkoosh, A.N. Kagley, C. Stafford, J.L. Bolton, J. Buzitis, B.F. Anulacion, and T.K. Collier. 2007a. Contaminant exposure in outmigrant juvenile salmon from Pacific Northwest estuaries of the United States. Environ. Monit. Assess. Volume 124(1-3), pages 167 to 94.

Johnson, L.L., G.M. Ylitalo, C.A. Sloan, B.F. Anulacion, A.N. Kagley, M.R. Arkoosh, T.A. Lundrigan, K. Larson, M. Siipola, and T.K. Collier. 2007b. Persistent organic pollutants in outmigrant juvenile Chinook salmon from the lower Columbia estuary, USA. Sci. Total Environ. Volume 374(2-3), pages 342 to 366.

Johnson, L.L., M.L. Willis, O.P. Olson, R.W. Peace, C.A. Sloan, and G.M. Ylitalo. 2009. Contaminant concentrations in juvenile fall Chinook salmon (Oncorhynchus tschawytscha) from Columbia River hatcheries. North American Journal of Aquaculture (in press).

Kelly, B.C., S.L. Gray, M.G. Ikonomou, J.S. Macdonald, S.M. Bandiera, and E.G. Hrycay. 2007. Lipid reserve dynamics and magnification of persistent organic pollutants in spawning sockeye salmon (Oncorhynchus nerka) from the Fraser River, British Columbia. Environ. Sci. Technol. Volume 41, pages 3083 to 3089.

Kelly, B.C., M.P. Fernandez, M.G. Ikonomou, and W. Knapp. 2008. Persistent organic pollutants in aquafeed and Pacific salmon smolts from fish hatcheries in British Columbia, Canada. Aquaculture. Volume 285, pages 224 to 233.

Lehane, L. and G.T. Rawlin. 2000. Topically acquired bacterial zoonoses from fish: a review. MJA. Volume 173, pages 256 to 259.

Leira, H.L. and K.J. Baalsrud. 1997. Operator safety during injection vaccination of fish. Dev. Biol. Stand. Basel. Volume 90, pages 383 to 387.

Macmillan, J.R., R.A. Schnick, and G. Fornshell. 2006. Stakeholder position paper: aquaculture producer. Preventive Veterinary Medicine. Volume 73, pages 197 to 202.

Martínez-Bueno M.J., M.D. Hernando, A. Agüera, A.R. Fernández-Alba. 2009. Application of passive sampling devices for screening of micro-pollutants in marine aquaculture using LC-MS/MS. Talanta. Volume 77, pages 1518 to 1527.

Maule A.G, A.L. Gannam, and J.W. Davis. 2007. Chemical contaminants in fish feeds used in Federal salmonid hatcheries in the USA. Chemosphere. Volume 67, pages 1308 to 1315.

Mayo Clinic. 2010. Omega-3 fatty acids, fish oil, alpha-linolenic acid background information, at http://www.mayoclinic.com/health/fish-oil/ns_patient-fishoil. Web site accessed April 23, 2010.

Milewski, I. 2001. Impacts of salmon aquaculture on the coastal environment: a review. In Tlusty, M.F., D.A. Bengston, H.O. Halvorson, S.D. Oktay, J.B. Pearce, and R.B. Rheault, Jr., editors. Marine aquaculture and the environment. A meeting for Stakeholders in the Northeast. Cape Cod Press, Falmouth, Massachusetts.

Missildine, B.R., R.J. Peters, G. Chin-Leo, and D. Houck. 2005. Polychlorinated biphenyl concentrations in adult Chinook salmon (Oncorhynchus tshawytscha) returning to coastal and Puget Sound hatcheries of Washington State. Environmental Science and Technology. Volume 39, pages 6944 to 6951.

Neergaard, L. 2004. Farm-raised salmon carry more pollutants than wild salmon. Seattle Times. January 9, 2004.

O'Neill, S. M. and J.E. West. 2009. Marine distribution, life history traits and the accumulation of polychlorinated biphenyls (PCBs) in Chinook salmon from Puget Sound, Washington. Transactions of the American Fisheries Society (in press).

Pouliquen H., C. Thorin, J. Haury, M. Larhantec-Verdier, M.L. Morvan, R. Delépée, and H. Le Bris. 2008. Comparison of water, sediment and plants for the monitoring of antibiotics: a case study on a river dedicated to fish farming. Environ Toxicol Chem. Volume 2008(Nov. 3), page 1.

Texas Agricultural Extension Service. 1994. Guide to drug, vaccine, and pesticide use in aquaculture. Prepared by the Federal Joint Subcommittee on Aquaculture. Working Group on Quality Assurance in Aquaculture Production, in cooperation with the Extension Service, U.S. Department of Agriculture. The Texas A&M University System. Publication No. B-5085.

U.S. Environmental Protection Agency (EPA). 1999. Exposure factors handbook (EFH). Office of Research and Development, Washington, D.C. EPA/600/C-99/001. February 1999.

EPA. 2007. Integrated Risk Information System (IRIS), and internet-accessible database for carcinogenecity information of chemicals (http://www.epa.gov/iriswebp/iris/index.html).

World Health Organization (WHO). 1999. Food safety issues associated with products from aquaculture. Report of a Joint FAO/NACA/WHO Study Group. World Health Organization (WHO) Technical Report Series 883. 55 pages.

Chapter 5

Climate Impacts Group. 2004. Overview of the climate change impacts in the Pacific Northwest. Prepared by the Climate Impacts Group, University of Washington, Seattle, Washington. 13 pages.

Climate Impacts Group. 2010. Climate impacts on Pacific Northwest coasts. About Pacific Northwest climate, climate impacts in brief. Prepared by the Climate Impacts Group, University of Washington, Seattle, Washington. Accessible through the Internet at http://cses.washington.edu/cig/pnwc/pnwcoasts.shtml. Website accessed May 17, 2010.

Independent Science Advisory Board (ISAB). 2007a. Climate change impacts on Columbia fish and wildlife. ISAB Climate Change Report. ISAB 2007-2. ISAB, Northwest Power and Conservation Council, Portland, Oregon. May 11, 2007. 136 pages.

ISAB. 2007b. Human population impacts on Columbia River basin fish and wildlife. ISAB climate change report. ISAB 2007-3. ISAB, Northwest Power and Conservation Council, Portland, Oregon. June 8, 2007. 30 pages.

Joint Institute for the Study of Atmosphere and Ocean Climate Impacts Group. 1999. Impacts of climate variability and change in the Pacific Northwest. The JISAO Climate Impacts Group, Office of Global Programs at the NOAA. Seattle, Washington. 109 pages.

Kay, J., J. Casola, A. Snover, and the Climate Impacts Group. 2005. Regional climate change primer: observed changes in Pacific Northwest climate. Prepared for University of Washington King County. October 27, 2005 Climate Change Conference, Seattle, Washington. 1 page.

Lower Columbia River Estuary Partnership (LCREP). 2005. 2005 Report on the estuary. Lower Columbia River Estuary Partnership, Portland, Oregon. 20 pages.

McElhaney, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Department of Commerce, NOAA Tech. Memo. NMFS –NWFSC-42. 156 pages.

Mote, P.W. and E.P. Salathe, Jr. 2009. Future climate in the Pacific Northwest. JISAO Climate Impacts Group, University of Washington, Seattle, Washington. 44 pages.

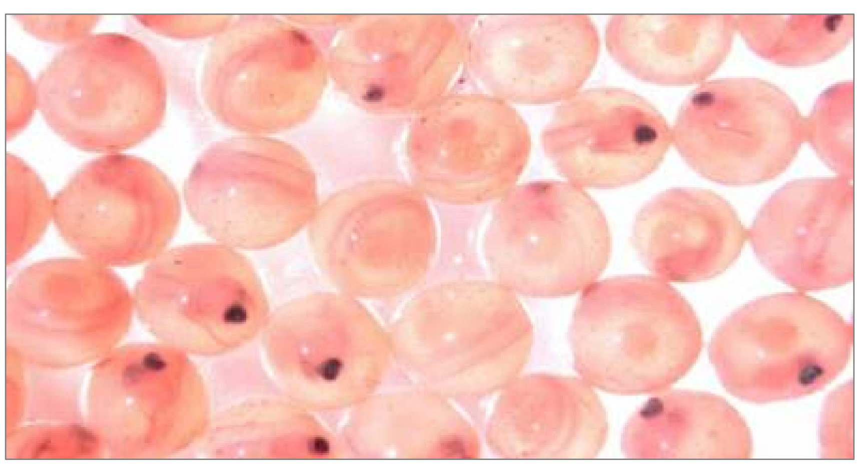
O’Neal, K. 2002. Effects of global warming on trout and salmon in U.S. streams. Defenders of Wildlife, Washington, D.C. 46 pages.

West Coast Governor’s Global Warming Initiative. 2004. Staff recommendations. Report prepared by the Executive Committee of the West Coast Governors’ Global Warming Initiative. (http://www.ef.org/westcoastclimate/). Website accessed on August 11, 2009. 16 pages.

Science, Service, Stewardship

Chapter 7

Distribution List



DISTRIBUTION LIST

Federal and State Agencies

Alaska Department of Fish and Game, Juneau Office
Bonneville Power Administration
Council of Environmental Quality
Department of Fisheries and Oceans, Government of Canada
Idaho Department of Fish and Game
NMFS Northwest Fisheries Science Center
Oregon Department of Fish and Wildlife, Salem Office
U.S. Army Corps of Engineers, Portland District
U.S. Department of the Interior, Bureau of Indian Affairs
U.S. Fish & Wildlife Service, Western Washington Office
U.S. Fish & Wildlife Service, Portland Oregon Office
U.S. Environmental Protection Agency, Region 10
Washington Department of Fish and Wildlife, Olympia Office

Elected Officials

Governor's Offices in California, Idaho, Oregon, and Washington
United States Representatives in California, Idaho, Oregon, and Washington
United States Senators in California, Idaho, Oregon, and Washington

---

Utilities

Chelan PUD
Douglas PUD
Grant PUD
Portland General Electric

Western Oregon Native American Tribes

Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians
Confederated Tribes of the Grand Ronde Community of Oregon
Coquille Indian Tribe
Cow Creek Band of Umpqua Tribe of Indians
Klamath Tribe
Siletz Tribe

Columbia River Basin Native American Tribes

Burns Paiute Tribe
Coeur d'Alene Tribe
Confederated Tribes of the Colville Reservation
Confederated Salish and Kootenai Tribes
Confederated Tribes of the Umatilla Reservation
Confederated Tribes of the Warm Springs Reservation of Oregon
Confederated Tribes and Bands of the Yakama Nation
Cowlitz Indian Tribe
Kalispel Tribe
Kootenai Tribe of Idaho
Nez Perce Tribe
Shoshone-Bannock Tribes
Shoshone-Paiute Tribe
Spokane Tribe of Indians
Upper Columbia United Tribes

Puget Sound and Olympic Peninsula Native American Tribes

Chehalis Tribe
Hoh Tribe
Jamestown S'Klallam Tribe
Lower Elwha Klallam Tribe
Lummi Indian Nation
Makah Indian Tribe
Muckleshoot Indian Tribe
Nisqually Indian Tribe
Nooksack Indian Tribe
Port Gamble S'Klallam Tribe
Puyallup Tribe
Quileute Tribe
Quinault Indian Nation
Sauk-Suiattle Indian Tribe
Shoalwater Bay Indian Tribe
Skokomish Tribe
Skagit System Cooperative
Snoqualmie Tribe
Squaxin Island Tribe
Stillaguamish Tribe
Suquamish Tribe
Swinomish Indian Tribal Community
Tulalip Tribes
Upper Skagit Tribe

Councils and Commissions

Columbia River Inter-tribal Fish Commission
Northwest Indian Fisheries Commission
Northwest Power and Conservation Council
Pacific Fishery Management Council
Pacific Salmon Commission
Pacific States Marine Fisheries Commission
Point No Point Treaty Council

Organizations and Associations

Clatsop County Economic Development
Columbia River Gillnetters Association
Native Fish Society
Northwest Marine Trade
Northwest Sportfishing Industry Association
Oregon Trout
Save our Wild Salmon
Trout Unlimited
Washington Trollers Association
Westport Charterboat Association
Wild Fish Conservancy
Wild Salmon Center

Libraries

- Aberdeen Public Library
- Astoria Public Library
- Boardman Library
- Boise Public Library, Main Library
- Buena Vista Public Library
- Burbank Library
- Carpenter Memorial Library
- City of Salem Central Library
- Clallam Bay Library
- Colfax Library
- Coos Bay Public Library
- Coos Bay Public Library
- County of Tillamook Library
- Del Norte County Library
- Del Norte Library
- East Wenatchee Public Library
- Eugene City Library
- Eugene Public Library
- Eureka Library
- Forks Memorial Library
- Fossil Public Library
- Grangeville Centennial Library
- Hillsboro Main Public Library
- Hood River County Library
- Humboldt County Library
- Jefferson County Library District
- Kamiah Community Library
- Kellogg Public Library
- Lewiston City Library
- McMinnville Public Library
- Mendocino County Library
- Moscow Public Library
- Moses Lake Library
- Multnomah County Library – Central Library
- Newport Public Library
- Okanogan Library
- Olympia Timberland Library
- Pierce Free Public Library
- Prairie River Library
- San Francisco Public Library – Main Branch
- Stevenson Community Library
- The Dalles – Wasco County Library
- The Seattle Public Library, Main Library
- Ukiah Library
- Umatilla Public Library
- Vancouver Community Library
- Vancouver Island Regional Library
- Wenatchee Public Library
- Westport Timberland Library
- Yakima Valley Regional Library

*Individuals**

- Paul Friesema
- David Lindbloom
- Alice Perry Linker
- Robert Ruedink
- Sally A. Streeter

* Additional individuals were contacted via email and sent an electronic link to the draft EIS.

Science, Service, Stewardship

Chapter 8 List of Preparers

List of Preparers and Agencies Consulted

NAME/POSITION	AFFILIATION	EDUCATION
Bob Turner, NMFS Policy Lead	NMFS	BA Economics and Finance, JD
Allyson Purcell, NMFS Project Manager	NMFS	BS Biology, MS Fisheries and Allied Aquaculture
Pamela Gunther, Contractor Project Manager, Other Fish Species	Golder Associates, Inc.	BS Wildlife Science, MA Biology
Brian Allee, Fish Support	NMFS	BA Zoology, PhD Fisheries Science
Greg Blair, Salmon and Steelhead	ICF International	BS Fisheries Science, MS Fisheries Science
Craig Busack, Fish Support	NMFS	BS Genetics, MS Genetics, PhD Genetics
Karen Cantillon, Grammatical Editing	Parametrix	BA English Literature
Mark Chilcote, Fish Support	NMFS	BS Fisheries, MS Fisheries and Genetics
Patty Dornbusch, Project Management Support	NMFS	BA English, MA Regional and City Planning
Larry Lastelle, Salmon and Steelhead Harvest	Biostream Environmental	BS Fisheries Science, MS Fisheries Science
David Mayfield, Human Health	Parametrix	BS Biology, MS Environmental Health
Lars Mobrand, Salmon and Steelhead	ICF International	BS Chemistry, PhD Biomathematics
Gary Morishima, Salmon and Steelhead Harvest	MORI-ko LLC	BS Mathematics, PhD Quantitative Science and Environmental Management
Ryan Scally, Word Processing	Parametrix	Associates Degree in Arts
Alix Smith, Graphics	NMFS	BA Communications, MS Communications
Margaret Spence, Contractor Project Manager, GIS, Water Quality and Quantity Support	Parametrix	BS Mathematical Sciences, MS Applied Statistics-Biometry
Robert Sullivan, Fish Support	Parametrix	BS Fisheries Biology
Bernice Tannenbaum, Wildlife	SAIC	BS Zoology, PhD Ecology and Animal Behavior
Roger Trott, Socioeconomics and Environmental Justice	TCW Economics	BA Economics, MS Agricultural Economics
Dan Warren, Contractor Project Manager	D.J. Warren and Associates, Inc.	BS Fisheries Science, MBA

NAME/POSITION	AFFILIATION	EDUCATION
Bruce Watson, Salmon and Steelhead	ICF International	BS Psychology, BS Zoology
Thomas Wegge, Socioeconomics and Environmental Justice	TCW Economics	BA Urban Studies, MS Environmental Economics
Charles Wisdom, Water Quality and Quantity	Parametrix	BA Biology, PhD Chemical Ecology

During draft EIS development, NMFS also consulted with the following agencies, organizations, and individuals:

- NMFS Protected Resources (Lynne Barre on killer whales, Donna Darm on cumulative effects, Gary Sims on tribal resources, and Mark Romano on Eulachon)
- NMFS Northwest Fisheries Science Center (Tom Cooney on salmon and steelhead, Mark Plummer on socioeconomics and environmental justice, Lyndal Johnson on human health, and Edmundo Casillas and Lyndal Johnson on water quality and quantity)
- NMFS Salmon Recovery Division (Lance Kruzic, Rich Turner, Brett Farman, Kris Petersen, and Rob Jones on hatchery production)
- USFWS (Jeffrey Chan on bull trout)
- NWIFC (Will Beattie on fisheries effects)
- Shoshone-Bannock Tribes (Claudio Broncho and Lytle Denny on tribal resources)
- Confederated Tribes of the Colville Reservation (Joe Peone on tribal resources)
- WDFW (Andy Appleby and John Kerwin on hatchery production; Catie Mains on water quality)
- ODFW (John Thorpe and Tom Friesen on hatchery production; Bruce McIntosh on recovery planning)
- Cowlitz Indian Tribe (Taylor Aalvik on tribal resources)
- Upper Columbia United Tribes (Keith Kutchins and D.R. Michel on tribal resources)
- Confederated Tribes of the Grand Ronde (Kelly Dirksen on tribal resources)

List of Appendices

(CDROM only)

Appendix A

Columbia River Hatchery Programs and Facility Information

Appendix A. Columbia River Hatchery Programs and Facility Information

Agency abbreviations: CTC – Confederated Tribes Colville; CTUIR – Confederated Tribes Umatilla Indian Reservation; CTWS – Confederated Tribes of Warm Springs; IDFG – Idaho Fish and Game; NOAA – National Oceans and Atmospheric Administration; NPT – Nez Perce Tribe; ODFW – Oregon Department Fish and Wildlife; USFWS – U.S. Fish and Wildlife Service; WDFW – Washington Department Fish and Wildlife; YN – Yakama Nation

Population ID	Province	Subbasin	Population/Program Name	Species	Species/Race	Hatchery Program Type	Hatchery Program Purpose	Hatchery Operating Agency	Funding Source	Number fish release	Primary Facility	Supporting Facilities		Release Location
296	Blue Mountain	Tucannon	Tucannon Spring Chinook	Chinook	Spring Chinook	Int	Cons	WDFW	Other	132,600	WDFW Lyons Ferry	WDFW Tucannon Hatchery	WDFW Curl Lake Acclimation Pond (Tucannon Hatchery Satellite)	Fish released from Curl Lake Acclimation Pond into the Tucannon River @ RKm 66.
455	Mountain Snake	Salmon	Little Salmon Spring Chinook (Rapid River-Hatchery)	Chinook	Spring Chinook	Seg	Harv	IDFG	Other	2,736,600	IDFG Rapid River Hatchery			Spring chinook yearling smolts are: (1) released from the Rapid River Hatchery into Little Salmon River (Hazard Creek) @ RKm 4; and (2) transported from the Rapid River Hatchery and released downstream of Hells Canyon Dam @ RKm 397.
523	Mountain Snake	Salmon	SF Salmon Summer Chinook (McCall-Hatchery)	Chinook	Spring Chinook	Seg	Harv	IDFG	Other	1,060,900	IDFG McCall Fish Hatchery			Fish are transported from the McCall Fish Hatchery to the Stolle Meadows Pond Acclimation site for release into the South Fork Salmon River.
458	Mountain Snake	Salmon	EF-SF Johnson Creek Summer Chinook	Chinook	Spring Chinook	Int	Both	NPT/IDFG	Other	101,800	IDFG McCall Hatchery			Yearling summer chinook smolts are transported from the McCall Fish Hatchery and released into Johnson Creek (@ RKm 11.5), tributary of the South Fork Salmon River.
508	Mountain Snake	Clearwater	Lochsa Spring Chinook (Hatchery)	Chinook	Spring Chinook	Seg	Harv	IDFG	Other	700,800	IDFG Clearwater Fish Hatchery	IDFG Powell Satellite Facility		Spring chinook are transported from the Clearwater Fish Hatchery to the Powell Satellite Facility for short acclimation and release
785	Mountain Snake	Clearwater	Lower Selway Spring Chinook	Chinook	Spring Chinook	Int	Both	NPT	Other	429,800	IDFG Clearwater Fish Hatchery	Nez Perce Tribal Fish Hatchery		Fish released into lower Selway near Meadow creek and into Meadow Creek.
535	Mountain Snake	Salmon	Pahsimeroi Summer Chinook (Pahsimeroi Hatchery)	Chinook	Spring Chinook	Seg	Harv	IDFG	Other	999,400	IDFG Pahsimeroi hatchery			Fish released into Pahsimeroi River from upper facility ponds.
518	Mountain Snake	Clearwater	Lower Selway Spring Chinook (Hatchery)	Chinook	Spring Chinook	Seg	Harv	NPT	Other	300,300	IDFG Clearwater Fish Hatchery			Spring chinook yearling smolts are transported from the Clearwater Fish Hatchery and released into Meadow Creek, tributary to the Selway River.
788	Mountain Snake	Salmon	Upper Salmon Mainstem Spring Chinook (Sawtooth Hatchery)	Chinook	Spring Chinook	Seg	Harv	IDFG	Other	1,034,900	IDFG Sawtooth Hatchery			Fish released from the Sawtooth Hatchery.
786	Mountain Snake	Clearwater	Upper Selway Spring Chinook (Hatchery)	Chinook	Spring Chinook	Seg	Harv	NPT	Other	300,300	IDFG Clearwater Fish Hatchery			Fry release into Selway River at McGruder Corridor.
828	Mountain Snake	Clearwater	South Fork Clearwater_Newsome Creek Spring Chinook	Chinook	Spring Chinook	Int	Both	IDFG	Other	75,400	IDFG Clearwater Fish Hatchery	Nez Perce Tribal Fish Hatchery		Fish released into Newsome Creek at acclimation facility
519	Mountain Snake	Clearwater	South Fork Clearwater Spring Chinook (Hatchery)	Chinook	Spring Chinook	Seg	Harv	IDFG	Other	1,100,000	IDFG Clearwater Fish Hatchery	IDFG Crooked River Satellite Facility,	IDFG Red River Satellite Facility	Spring chinook are transported from the Clearwater Fish Hatchery to the Crooked River and Red River Acclimation Satellite Facilities in the S.F. Clearwater River.
439	Mountain Snake	Clearwater	Lolo Creek Spring Chinook	Chinook	Spring Chinook	Int	Both	NPT	Other	148,800	IDFG Clearwater Fish Hatchery			Spring chinook yearling smolts are transported from the Clearwater Fish Hatchery and directly released into Lolo Creek, tributary to the Clearwater River.
444	Mountain Snake	Clearwater	Middle Fork Clearwater Spring Chinook (Kooskia-Hatchery)	Chinook	Spring Chinook	Seg	Harv	USFWS	Other	600,700	USFWS Kooskia National Fish Hatchery			Spring chinook smolts are released into Clear Creek, tributary to the Middle Fork Clearwater River.
443	Mountain Snake	Clearwater	NF Clearwater Spring Chinook (Dworshak-Hatchery)	Chinook	Spring Chinook	Seg	Harv	USFWS	Other	1,051,100	USFWS Dworshak National Fish Hatchery			Spring chinook yearling smolts are released during mid April-mid May period from the Dworshak NFH into the Clearwater River (RKm 64).
820	Mountain Snake	Clearwater	Lower Mainstem_Spring Chinook (NPTH-Hatchery)	Chinook	Spring Chinook	Seg	Harv	NPT	Other	124,600	Nez Perce Tribal Fish Hatchery			Smolt are released into Clearwater mainstem at Nez Perce Tribal Hatchery
215	Blue Mountain	Grande Ron	Lostine Spring Chinook	Chinook	Spring Chinook	Int	Cons	ODFW/NPT	Other	249,500	ODFW Lookingglass Hatchery	Nez Perce Tribal Lostine River Acclimation Pond		Spring chinook yearling smolts are acclimated and released from the Nez Perce Tribal Lostine River Acclimation Facility into Lostine River (tributary of the Grande Ronde River) @ RM 11.5.
222	Blue Mountain	Imnaha	Imnaha Spring-Summer Chinook	Chinook	Spring Chinook	Int	Both	ODFW	Other	359,200	ODFW Lookingglass Hatchery	IDFG Imnaha Smolt Acclimation Facility		Summer/Spring chinook smolts are directly released from the Imnaha Smolt Acclimation Facility into the Imnaha River @ RM 45.5.
322	Columbia Estuary	Big Creek	Big Creek Fall Chinook (Tules-Hatchery)	Chinook	Fall Chinook	Seg	Harv	ODFW	Mitchell Act	5,826,600	ODFW Big Creek Hatchery			Chinook are released from the Big Creek Hatchery in Big Creek (RM 3.3), a tributary entering the Lower Columbia River @ ~RM 27.
323	Columbia Estuary	Columbia Es	Deep River Spring Chinook (Cowlitz-Merwin-Grays-Hatchery)	Chinook	Spring Chinook	Seg	Harv	WDFW	Other	362,300	WDFW Grays River Hatchery			Spring chinook smolts are released from netpens into the Deep River (RKm 6.4).
320	Columbia Estuary	Youngs Bay	Youngs Bay Fall Chinook (Rogue Brights-CEDC SAFE-Hatchery)	Chinook	Fall Chinook	Seg	Harv	ODFW	Other	1,174,100	ODFW Klaskanine Hatchery (North Fork)	ODFW South Fork Klaskanine Hatchery	ODFW Big Creek Hatchery	Subyearling Chinook salmon smolts are directly released from the Klaskanine Hatchery into the North Fork Klaskanine River @ RM 3.0, from the South Fork Klaskanine Hatchery and from net pens in Youngs Bay.
566	Columbia Estuary	Youngs Bay	Youngs Bay Spring Chinook (CEDC SAFE-Willamette-Hatchery)	Chinook	Spring Chinook	Seg	Harv	ODFW	Other	850,100	ODFW Willamette Hatchery	ODFW Gnat Creek Hatchery		Yearling spring chinook salmon smolts are directly released from the Youngs Bay Net Pens (RM 1.5-1.7) into Youngs Bay (Columbia River Mainstem RM 11).
257	Columbia Gorge	Columbia G	Spring Creek Fall Chinook (Tules-Hatchery)	Chinook	Fall Chinook	Seg	Harv	USFWS	Mitchell Act	15,044,900	USFWS Spring Creek National Fish Hatchery			Chinook are released from the Spring Creek NFH facilities into the Columbia River @ RKm 269.
692	Columbia Plateau	Mid-Columb	Columbia Lower Middle Columbia Fall Chinook (URB-Ringold-Hatchery)	Chinook	Fall Chinook	Seg	Harv	WDFW	Mitchell Act	3,499,500	WDFW Ringold Springs Hatchery	ODFW Bonneville Hatchery		Fall chinook fingerlings are released from a 9-acre pond to an outlet that enters Spring Creek, which flows into the Columbia River (RKm 567).
286	Columbia Plateau	Mid-Columb	Columbia Lower Middle Hanford Fall Chinook (Priest Rapids Upriver Brights)	Chinook	Fall Chinook	Int	Harv	WDFW	Other	6,691,200	WDFW Priest Rapids Hatchery Complex			Fall chinook fingerling smolts are released from the Priest Rapids Hatchery Complex facility into the Columbia River (RKm 662).
693	Columbia Plateau	Mid-Columb	Mainstem Columbia Spring Chinook (Ringold Via LWS-Hatchery)	Chinook	Spring Chinook	Seg	Harv	WDFW	Other	487,100	WDFW Ringold Springs Hatchery	USFWS Little White/Willard Salmon National Fish Hatchery		Spring chinook yearling smolts are released from a 9-acre pond to an outlet that enters Spring Creek, which flows into the Columbia River (RKm 567).
354	Lower Columbia	Cowlitz	Lower Cowlitz Fall Chinook	Chinook	Fall Chinook	Int	Harv	WDFW	Other	4,807,400	Cowlitz Salmon Hatchery			Fingerling fall chinook are released from the Cowlitz Salmon Hatchery into the Cowlitz River (RKm 78.8)
722	Lower Columbia	Cowlitz	Toutle Fall Chinook (Hatchery)	Chinook	Fall Chinook	Seg	Harv	WDFW	Mitchell Act	2,500,400	WDFW North Toutle River Hatchery			Release from North Toutle Hatchery into Green River (RKm 0.8), tributary to the North Fork Toutle River.
609	Lower Columbia	Cowlitz	Upper Cowlitz Spring Chinook	Chinook	Spring Chinook	Int	Harv	WDFW	Other	1,263,600	WDFW Cowlitz Salmon Hatchery			Upper Cowlitz River (Above Mossyrock Dam)- Direct river release at variable locations.
290	Columbia Plateau	Deschutes	Deschutes Spring Chinook	Chinook	Spring Chinook	Int	Harv	USFWS/CTWS	Other	746,900	USFWS Warm Springs National Fish Hatchery			Fingerling spring chinook (Age 0+) are released from the Warms Springs NFH during the fall, and yearling spring chinook smolts (Age 1+) are released during the spring from the Warm Springs NFH) into the Warm Springs River @ RKm 16.0.
289	Columbia Plateau	Deschutes	Deschutes Spring Chinook (Round Butte-Hatchery)	Chinook	Spring Chinook	Seg	Harv	ODFW	Other	320,600	ODFW Round Butte Hatchery			Spring chinook smolts are released from the Pelton Fish Ladder Acclimation facility into the Deschutes River @ RM 100.1.
339	Columbia Estuary	Elochoman	Elochoman Fall Chinook	Chinook	Fall Chinook	Int	Harv	WDFW	Mitchell Act	2,072,100	WDFW Elochoman Hatchery			Chinook smolts are released from the Elochoman Hatchery rearing/acclimation facilities @ RKm 11.3
214	Blue Mountain	Grande Ron	Catherine Creek Spring Chinook	Chinook	Spring Chinook	Int	Cons	ODFW	Other	130,000	ODFW Lookingglass Hatchery	CTUIR Catherine Creek Acclimation Pond		Spring chinook yearling smolts are acclimated and released from the CTUIR Catherine Creek Acclimation Facility into Catherine Creek (tributary of the Grande Ronde River) @ RM 21.5
213	Blue Mountain	Grande Ron	Lookingglass Creek Spring Chinook	Chinook	Spring Chinook	Int	Both	ODFW	Other	249,500	ODFW Lookingglass Hatchery			Fish are released from Lookinglass Hatchery in Lookingglass Creek a tributary to the Grande Ronde River.
216	Blue Mountain	Grande Ron	Upper Grande Ronde Spring Chinook	Chinook	Spring Chinook	Int	Cons	ODFW/CTUIR	Other	251,000	ODFW Lookingglass Hatchery	CTUIR Upper Grande Ronde Acclimation Pond		Spring chinook yearling smolts are acclimated and released from the CTUIR Upper Grande Ronde Acclimation Facility into Upper Grande Ronde River @ RM 145.5.
261	Columbia Gorge	Hood	Hood Spring Chinook	Chinook	Spring Chinook	Int	Cons	ODFW	Other	125,900	ODFW Round Butte Hatchery			Spring chinook yearling smolts are released at two sites on the West Fork Hood River site and one site on the Middle Fork Hood River.
578	Lower Columbia	Kalama	Kalama Fall Chinook (Hatchery)	Chinook	Fall Chinook	Seg	Harv	WDFW	Mitchell Act	5,040,000	WDFW Kalama Falls Hatchery			Fish are released from the Kalama Falls Hatchery @ RKm 16.1
367	Lower Columbia	Kalama	Kalama Spring Chinook	Chinook	Spring Chinook	Int	Harv	WDFW	Mitchell Act	501,300	WDFW Kalama Falls Hatchery			Fish are released from Gobar Pond (tributary to the Kalama River at RKm 32.2); and from Fallert Creek Hatchery (RKm 8.2).

Appendix A. Columbia River Hatchery Programs and Facility Information

Agency abbreviations: CTC – Confederated Tribes Colville; CTUIR – Confederated Tribes Umatilla Indian Reservation; CTWS – Confederated Tribes of Warm Springs; IDFG – Idaho Fish and Game; NOAA – National Oceans and Atmospheric Administration; NPT – Nez Perce Tribe; ODFW – Oregon Department Fish and Wildlife; USFWS – U.S. Fish and Wildlife Service; WDFW – Washington Department Fish and Wildlife; YN – Yakama Nation

Population ID	Province	Subbasin	Population/Program Name	Species	Species/Race	Hatchery Program Type	Hatchery Program Purpose	Hatchery Operating Agency	Funding Source	Number fish release	Primary Facility	Supporting Facilities		Release Location
270	Columbia Gorge	Klickitat	Klickitat Fall Chinook (URB-Hatchery)	Chinook	Fall Chinook	Seg	Harv	YN	Mitchell Act	3,867,200	WDFW Klickitat Hatchery			Fall chinook are released from the Klickitat Hatchery facility into the Klickitat River (RKm 70.0).
271	Columbia Gorge	Klickitat	Klickitat Spring Chinook	Chinook	Spring Chinook	Int	Both	YN	Mitchell Act	831,200	WDFW Klickitat Hatchery			Spring chinook are released into the Klickitat River (RKm 68.0) from a pond adjacent to the hatchery.
724	Lower Columbia	Lewis	NF Lewis Spring Chinook (Hatchery)	Chinook	Spring Chinook	Seg	Harv	WDFW	Other	1,351,400	WDFW Lewis River Hatchery			North Fork Lewis (from Lewis River Hatchery) @ RKm 20.9.
277	Columbia Gorge	Little White	Little White Salmon Fall Chinook (URB-Hatchery)	Chinook	Fall Chinook	Seg	Harv	USFWS	Mitchell Act	2,007,200	USFWS Little White/Willard National Fish Hatchery Complex			Chinook are released from the Little White Salmon NFH (RKm 2.0 of the Little White Salmon) into Drano Lake/Columbia River (RKm 261).
278	Columbia Gorge	Little White	Little White Salmon Spring Chinook (Hatchery)	Chinook	Spring Chinook	Seg	Harv	USFWS	Mitchell Act	1,005,200	USFWS Little White/Willard National Fish Hatchery Complex			Chinook are volitionally released from the Little White Salmon facilities into the Little White Salmon River (RKm 2.0).
390	Lower Columbia	Lower Colur	Bonneville Fall Chinook (Hatchery)	Chinook	Fall Chinook	Seg	Harv	ODFW	Mitchell Act	4,493,100	ODFW Bonneville Hatchery			Fall chinook are released into Tanner Creek, a direct tributary to the Columbia River (RM 140.9).
234	Columbia Cascade	Methow	Methow (Methow-Chewuch) Spring Chinook	Chinook	Spring Chinook	Int	Cons	WDFW	Other	359,100	WDFW Methow Hatchery			Fish are released on station from the Methow Hatchery to the Methow River at RKm 72.5, from an acclimation pond on the Chewuck River at RKm 83.2 and into Lake Creek, a tributary of the Chewuck River ar ~ RKm 104.
821	Columbia Cascade	Methow	Methow (Twisp) Spring Chinook	Chinook	Spring Chinook	Int	Cons	WDFW	Other	183,000	WDFW Methow Hatchery			Fish are released from an acclimation pond on the Twisp River at RKm 8.6.
235	Columbia Cascade	Methow	Methow Spring Chinook (Winthrop Hatchery)	Chinook	Spring Chinook	Seg	Both	USFWS	Other	601,500	USFWS Winthrop Hatchery			Fish are released into the Methow River at Foster-Lucas Ponds.
826	Columbia Cascade	Methow	Methow Summer Chinook (Wells Hatchery)	Chinook	Summer Chinook	Seg	Both	WDFW	Other	340,800	WDFW Wells Hatchery			400K smolt into Methow river from Carlton Pond.
240	Columbia Cascade	Okanogan	Okanogan-Similkimeen Summer Chinook	Chinook	Summer Chinook	Int	Both	WDFW	Other	574,100	WDFW Eastbank Hatchery Complex			Summer Chinook yearling smolts are released from Similkameen Pond into the Similkameen River (RKm 5)
402	Lower Columbia	Sandy	Sandy Spring Chinook	Chinook	Spring Chinook	Int	Harv	ODFW	Mitchell Act	300,500	ODFW Sandy Hatchery	ODFW Clackamas Hatchery	ODFW Willamette Hatchery	Spring chinook are released from the Sandy Hatchery into Cedar Creek (RM 0.25), tributary to the Sandy River.
224	Blue Mountain	Snake Hells	Snake Hells Canyon Fall Chinook	Chinook	Fall Chinook	Int	Both	WDFW/NPT	Other	5,802,700	WDFW Lyons Ferry Hatchery	Nez Perce Tribal Hatchery	Multiple release sites above Lower Granite Dam	Subyearling fall chinook smolts are transported from the hatcheries and released at multiple sites in the Snake River downstream of the Hells Canyon Dam and in the Clearwater River.
228	Blue Mountain	Snake Hells	Snake Hells Canyon Spring Chinook (Oxbow Hatchery)	Chinook	Spring Chinook	Seg	Harv	ODFW/IDFG	Other	299,500	IDFG Oxbow Hatchery (adult collection-holding and early incub)	IDFG Rapid River Hatchery (incub. and rearing)		Spring chinook yearling smolts are transported from the Rapid River Hatchery and released into the Snake River (@ RKm 397) downstream of Hells Canyon Dam.
300	Columbia Plateau	Umatilla	Umatilla Fall Chinook	Chinook	Fall Chinook	Int	Both	CTUIR/ODFW	Other	399,200	CTUIR Three Mile Dam Facility (local brood)	CTUIR Umatilla Hatchery (incub/rear)	Thornhollow Acclimation Facility	Thornhollow Acclimation Facility into the Umatilla River (RM 73.5) and into Umatilla River near the confluence with McKay Creek at Reith Bridge (RM 45.0).
809	Columbia Plateau	Umatilla	Umatilla Fall Chinook (Hatchery)	Chinook	Fall Chinook	Harv	Seg	CTUIR/ODFW	Other	648,000	ODFW Bonneville Hatchery (broodstock/incub/rear.)		Thornhollow Acclimation Facility	Thornhollow Acclimation Facility into the Umatilla River (RM 73.5) and into Umatilla River near the confluence with McKay Creek at Reith Bridge (RM 45.0).
301	Columbia Plateau	Umatilla	Umatilla Spring Chinook	Chinook	Spring Chinook	Int	Both	CTUIR	Other	925,300	USFWS Little White Salmon/Willard National Fish Hatchery Complex			Spring chinook smolts are released from the Imeques C-mem-ini-kem acclimation facility (CTUIR) into the Umatilla River @ RM 79.5
694	Columbia Cascade	Upper Colur	Upper Middle Columbia Summer Chinook (Wells Hatchery)	Chinook	Summer Chinook	Seg	Harv	WDFW	Other	803,000	WDFW Wells Hatchery			Yearling and fingerling summer chinook are released from the Wells Hatchery facilities into the Columbia River (RKm 829.0).
245	Columbia Cascade	Upper Colur	Mainstem Summer Chinook (Turtle Rock-Hatchery)	Chinook	Summer Chinook	Seg	Harv	WDFW	Other	1,277,900	WDFW Wells/Eastbank Hatcheries	Chelan Falls Acclimation Facility		Summer chinook yearlings are released from Turtle Rock Hatchery on the Columbia River and the Chelan Falls Rearing/Acclimation Facility into the Chelan Falls tailrace.
304	Columbia Plateau	Walla Walla	Walla Walla Spring Chinook	Chinook	Spring Chinook	Int	Cons	CTUIR/USFWS	Other	249,500	USFWS Carson National Fish Hatchery			Spring chinook yearling smolts are released into the South Fork Walla Walla River (RKm 7.8).
581	Lower Columbia	Washougal	Washougal Fall Chinook (Hatchery)	Chinook	Fall Chinook	Seg	Harv	WDFW	Mitchell Act	4,002,600	WDFW Washougal Hatchery			Subyearling fall chinook are released into Washougal River @ RKm 27.
247	Columbia Cascade	Wenatchee	Wenatchee (Chiwawa) Spring Chinook	Chinook	Spring Chinook	Int	Cons	WDFW	Other	351,500	WDFW Eastbank Hatchery,			Spring chinook are released from the Chiwawa Acclimation Facility into the Chiwawa River, tributary to the Wenatchee River.
823	Columbia Cascade	Wenatchee	Wenatchee (White) Spring Chinook	Chinook	Spring Chinook	Int	Cons	WDFW	Other	65,900	USFWS Little White Salmon/Willard National Fish Hatchery Complex			Spring chinook are released from the Tall Timbers Rearing Facility (interim/temporary facility) into the White River (RKm 18.5), tributary to the Wenatchee River.
248	Columbia Cascade	Wenatchee	Wenatchee Spring Chinook (Leavenworth NFH)-Hatchery	Chinook	Spring Chinook	Seg	Harv	USFWS	Other	1,650,200	USFWS Leavenworth National Fish Hatchery			Spring chinook are released from the Leavenworth NFH facility into Icicle Creek (RKm 2.7), a tributary to the Wenatchee River.
249	Columbia Cascade	Wenatchee	Wenatchee Summer Chinook	Chinook	Summer Chinook	Int	Both	WDFW	Other	737,100	WDFW Eastbank Hatchery			Wenatchee River summer chinook are released as from Dryden Pond (RKm 25.8) on the Wenatchee River
415	Lower Columbia	Willamette	Clackamas Spring Chinook(Hatchery)	Chinook	Spring Chinook	Seg	Harv	ODFW	Mitchell Act	1,077,800	ODFW Clackamas Hatchery	Multiple release sites in Clackamas River		Multiple release sites in the lower Clackamas River
417	Lower Columbia	Willamette	MF Willamette Spring Chinook	Chinook	Spring Chinook	Int	Both	ODFW	Other	1,256,600	ODFW Willamette Hatchery and Dexter Ponds			A fall release group of spring chinook (300,000 fish) @ ~8.0 fpp is released from the Dexter Pond satellite during November into the Middle Fork Willamette River (RKm 28) and in the spring a second group is released from the Dexter Pond satellite (RKm 28); during February into the Middle Fork Willamette River;
416	Lower Columbia	Willamette	McKenzie Spring Chinook	Chinook	Spring Chinook	Int	Both	ODFW	Other	1,265,600	ODFW McKenzie Hatchery			Yearling spring chinook smolts are released from the McKenzie Hatchery into the McKenzie River (RM 37).
418	Lower Columbia	Willamette	Molalla Spring Chinook	Chinook	Spring Chinook	Int	Both	ODFW	Other	99,100	ODFW South Santiam Hatchery	ODFW Willamette Hatchery		A fall release of spring chinook pre-smolts during early November into the Molalla River and a late-winter group of yearling spring chinook smolts is released in February/March into the Molalla River.
419	Lower Columbia	Willamette	North Santiam Spring Chinook	Chinook	Spring Chinook	Int	Both	ODFW	Other	752,200	ODFW Marion Forks Hatchery	ODFW Minto Pond Acclimation Site		In the spring chinook smolts are released from Minto Ponds into the North Santiam River (RM 42) at the base of Minto Dam. Also, fingerling spring chinook are released into Detroit Reservoir (lake behind Minto Dam) @ RM 49-58.
420	Lower Columbia	Willamette	South Santiam Spring Chinook	Chinook	Spring Chinook	Int	Harv	ODFW	Other	1,123,200	ODFW South Santiam Hatchery	ODFW Willamette Hatchery		A fall release group of yearling spring chinook is released during early November into the South Santiam River and a late-winter group of yearling spring chinook is released in two sub-groups, one during February and the other in March into the South Santiam River.
283	Columbia Gorge	Wind	Wind Spring Chinook (Hatchery)	Chinook	Spring Chinook	Seg	Harv	USFWS	Mitchell Act	1,145,000	USFWS Carson National Fish Hatchery			Chinook salmon smolts are released from the Carson National Fish Hatchery facilities into the Wind River.
313	Columbia Plateau	Yakima	Yakima Fall Chinook	Chinook	Fall Chinook	Int	Harv	YN	Mitchell Act	346,600	USFWS Little White Salmon/Willard National Fish Hatchery Complex	YN Prosser Hatchery		Fall Chinook are released from the Prosser Hatchery facility (RM 46.8) on the Yakima River.
794	Columbia Plateau	Yakima	Yakima Fall Chinook (Little White Salmon-Hatchery)	Chinook	Fall Chinook	Seg	Harv	USFWS	Mitchell Act	1,701,000	YN Prosser Hatchery			Fall chinook fry are transferred from the Little White Salmon/Willard NFH Complex to Yakima Nation Prosser Hatchery for rearing and later release from the Prosser Hatchery facility.
311	Columbia Plateau	Yakima	Marion Drain Fall Chinook	Chinook	Fall Chinook	Int	Cons	YN	Other	20,500	YN Marion Drain Hatchery			Fall Chinook fry are released from the Marion Drain Facility into Marion Drain/Yakima River (~RKm 132.9).
312	Columbia Plateau	Yakima	Upper Yakima Spring Chinook	Chinook	Spring Chinook	Int	Both	YN	Other	810,700	YN Cle Elum Hatchery Facility			Spring chinook are released from (1) Easton Pond (Near Easton, WA) and Clark Flat (near Ellensburg, WA) Acclimation Facilities into the Yakima River, and (2) Jack Creek Acclimation Facility (north of Cle Elum, WA) into the upper Teanaway R
348	Columbia Estuary	Grays	Grays-Chinook River Chum	Chum	Chum	Int	Cons	WDFW	Other	200,100	WDFW Grays River Hatchery			Chum salmon fed fry are released from the Grays River Hatchery into the West Fork (RKm 3.2) of the Grays River.

Appendix A. Columbia River Hatchery Programs and Facility Information

Agency abbreviations: CTC – Confederated Tribes Colville; CTUIR – Confederated Tribes Umatilla Indian Reservation; CTWS – Confederated Tribes of Warm Springs; IDFG – Idaho Fish and Game; NOAA – National Oceans and Atmospheric Administration; NPT – Nez Perce Tribe; ODFW – Oregon Department Fish and Wildlife; USFWS – U.S. Fish and Wildlife Service; WDFW – Washington Department Fish and Wildlife; YN – Yakama Nation

Population ID	Province	Subbasin	Population/Program Name	Species	Species/Race	Hatchery Program Type	Hatchery Program Purpose	Hatchery Operating Agency	Funding Source	Number fish release	Primary Facility	Supporting Facilities		Release Location
392	Lower Columbia	Washougal	Duncan Creek Chum	Chum	Chum	Int	Cons	WDFW	Other	99,900	WDFW Washougal Hatchery			Duncan Creek, Hardy Creek, Hamilton Creek, and Mainstem Columbia near Ives Island.
446	Mountain Snake	Clearwater	Clearwater Coho	Coho	Coho	Int	Cons	USFWS/NPT	Mitchell Act	833,900	USFWS Eagle Creek National Fish Hatchery			Coho yearling smolts are transported from the Eagle Creek HFH to the Clearwater Subbasin for release in selected tributaries.
335	Columbia Estuary	Columbia Es	Bernie Creek Coho (Late-Type N-FFA)	Coho	Coho	Seg	Harv	WDFW	Mitchell Act	16,500	WDFW Elochoman River Hatchery	FFA Bernie Creek Rearing and Acclimation Pond		Coho smolts are released from the FFA Rearing and Acclimation Pond into Bernie Creek (RMk 0.1)
329	Columbia Estuary	Columbia Es	Big Creek Coho (Hatchery)	Coho	Coho	Seg	Harv	ODFW	Mitchell Act	582,100	ODFW Big Creek Hatchery			Coho smolts are released from the Big Creek Hatchery into Big Creek (RM 3.3), a tributary entering the lower Columbia River @ ~RM 27.
334	Columbia Estuary	Columbia Es	Deep River Coho (Early-Type S-Grays-Hatchery)	Coho	Coho	Seg	Harv	WDFW	Other	401,300	WDFW Grays River Hatchery			Coho smolts are released from netpens located on the Deep River at RKm 6.4 and 8.1.
331	Columbia Estuary	Columbia Es	Youngs Bay Coho (Bonneville-Sandy-Hatchery)	Coho	Coho	Seg	Harv	ODFW	Mitchell Act	1,726,200	ODFW Bonneville Hatchery	Youngs Bay Net Pen Facilities		Yearling coho salmon smolts (Bonneville Stock 14) are directly released from the Youngs Bay Net Pens (RM 1.5-1.7) into Youngs Bay (Columbia River Mainstem RM 11).
612	Lower Columbia	Cowlitz	Cowlitz Upper Cowlitz Coho	Coho	Coho	Int	Harv	WDFW	Other	238,800	WDFW Cowlitz Hatchery			Direct release into Upper Cowlitz
795	Lower Columbia	Cowlitz	Lower Cowlitz Coho (Type N Hatchery)	Coho	Coho	Seg	Harv	WDFW	Other	3,223,400	WDFW Cowlitz Hatchery			Smolt release into Cowlitz River at Rkm 78.9 (Cowlitz Salmon Hatchery)
796	Lower Columbia	Cowlitz	Toutle Coho (Early-Type S Hatchery)	Coho	Coho	Seg	Harv	WDFW	Mitchell Act	801,300	WDFW Green River Hatchery (N.F. Toutle River)			Green River Fish Hatchery located approximately 0.81 Rkm above the confluence of the Green and North Fork Toutle.
341	Columbia Estuary	Elochoman	Elochoman Coho (Early- Type S Hatchery)	Coho	Coho	Seg	Harv	WDFW	Mitchell Act	415,000	WDFW Elochoman Hatchery			Coho smolts are released from the Elochoman Hatchery Pond 23 (RKm 11.3).
342	Columbia Estuary	Elochoman	Elochoman Coho (Late- Type N)	Coho	Coho	Int	Both	WDFW	Mitchell Act	496,100	WDFW Elochoman Hatchery			Coho smolts are released from the Elochoman Hatchery Pond 23 (RKm 11.3).
685	Columbia Estuary	Grays	Grays Coho (Early-Type S-Hatchery)	Coho	Coho	Seg	Harv	WDFW	Other	150,400	WDFW Grays River Hatchery			Coho smolts are released from rearing ponds of the Grays River Hatchery into the West Fork of the Grays River (RKm 3.2).
371	Lower Columbia	Kalama	Kalama Coho (Early- Type S)	Coho	Coho	Seg	Harv	WDFW	Mitchell Act	353,100	WDFW Fallert Creek Hatchery			Fallert Creek Hatchery @ RKm 8.2 (of the Kalama River).
370	Lower Columbia	Kalama	Kalama Coho (Late- Type N)	Coho	Coho	Seg	Harv	WDFW	Mitchell Act	350,800	WDFW Kalama Falls Hatchery			Kalama Falls Hatchery @ RKm 16.1.
272	Columbia Gorge	Klickitat	Klickitat Coho (Lewis-Hatchery)	Coho	Coho	Seg	Harv	WDFW	Mitchell Act	1,238,600	WDFW Klickitat Hatchery			Coho are released from the Klickitat Hatchery into the Klickitat River (RKm 70.0).
273	Columbia Gorge	Klickitat	Klickitat Coho (Washougal-Hatchery)	Coho	Coho	Seg	Harv	WDFW	Mitchell Act	2,461,900	WDFW Washougal Hatchery			Yearling coho smolts are transported from the Washougal Hatchery and directly released at RKm 12.0 site and RKm 29.0 site in the Klickitat River.
781	Lower Columbia	Lewis	NF Lewis Coho (Early-Type S Hatchery)	Coho	Coho	Seg	Both	WDFW	Other	880,000	WDFW Lewis River Hatchery	WDFW Merwin Hatchery		Lewis River Hatchery Trap (North Fork Lewis River) @ RKm 20.9.
777	Lower Columbia	Lewis	NF Lewis Coho (Late-Type N Hatchery)	Coho	Coho	Seg	Harv	WDFW	Other	815,100	WDFW Lewis River Hatchery	WDFW Merwin Hatchery		NF Lewis at Rkm 6.5
381	Lower Columbia	Lewis	NF Lewis Coho (Late-Type N)	Coho	Coho	Int	Harv	WDFW	Other	40,000	WDFW Lewis River Hatchery			Lewis River Hatchery Trap (North Fork Lewis River) @ RKm 20.9.
396	Lower Columbia	Lower Colur	Bonneville Coho (Hatchery)	Coho	Coho	Seg	Harv	ODFW	Mitchell Act	1,247,700	ODFW Bonneville Hatchery	ODFW Oxbow Hatchery	ODFW Oxbow Hatchery	Coho smolts are released into Tanner Creek, a direct tributary to the Columbia River 140.9 miles from the mouth of the Columbia River.
237	Columbia Cascade	Methow	Methow Coho	Coho	Coho	Int	Cons	YN	Other	495,400	USFWS Winthrop National Fish Hatchery			Coho are released from the Winthrop NFH facilities into the Methow River @ RM 50.4.
404	Lower Columbia	Sandy	Sandy Coho (Hatchery)	Coho	Coho	Seg	Harv	ODFW	Mitchell Act	700,100	ODFW Sandy Hatchery			Coho smolts are released from the Sandy Hatchery into Cedar Creek (RM 0.25), tributary to the Sandy River.
686	Columbia Plateau	Umatilla	Umatilla Coho (Bonneville-Cascade-Oxbow-Hatchery)	Coho	Coho	Seg	Harv	ODFW/CTUIR	Mitchell Act	1,530,000	ODFW Bonneville/Oxbow/Cascade Hatcheries	CTUIR Pendleton Acclimation Facility		Coho yearling smolts are released from the CTUIR Pendleton Acclimation Facility into the Umatilla River @ RM 56.
409	Lower Columbia	Washougal	Washougal Coho	Coho	Coho	Int	Harv	WDFW	Mitchell Act	497,900	WDFW Washougal Hatchery			Washougal Hatchery into Washougal River @ RKm 32.3.
250	Columbia Cascade	Wenatchee	Wenatchee Coho	Coho	Coho	Int	Cons	YN	Other	1,048,000	USFWS Little White Salmon/Willard National Fish Hatchery Complex			Coho are released from unspecified locations in the Wenatchee Subbasin.
423	Lower Columbia	Willamette	Clackamas-Eagle Creek Coho (Hatchery)	Coho	Coho	Seg	Harv	USFWS	Mitchell Act	349,100	USFWS Eagle Creek National Fish Hatchery			Yearling smolts are released from the Eagle Creek NFH into the Clackmas River (RKm 16);
314	Columbia Plateau	Yakima	Yakima Coho (Hatchery)	Coho	Coho	Seg	Both	YN	Mitchell Act	427,900	YN Prosser Hatchery			Coho are transferred in to two sites (Lost Creek Ponds @ RM 39 and Stiles Ponds @ RM 9.0) of the Naches River and two sites in the Upper Yakima River (RM 160 and RM 180) for acclimation and release.
315	Columbia Plateau	Yakima	Upper Yakima-Naches Coho	Coho	Coho	Int	Both	YN	Mitchell Act	452,100	USFWS Little White Salmon/Willard National Fish Hatchery Complex	USFWS Eagle Creek National Fish Hatchery		Coho are transferred in Mid-March to two sites (Lost Creek Ponds @ RM 39 and Stiles Ponds @ RM 9.0) of the Naches River and two sites in the Upper Yakima River (Rm 160 and Rm 180).
461	Mountain Snake	Salmon	Redfish Lake Sockeye	Sockeye	Sockeye	Int	Cons	IDFG/NOAA	Mitchell Act	151,700	IDFG Sawtooth Hatchery (adult hold, incub, rear)	IDFG Eagle Creek Hatcheries (adult hold, spawn, incub, rear)		Production of this program is distributed as egg outplants, fingerlings, yearling smolts, and adults into Pettit, Alturas and Redfish Lakes in the Stanley Basin.
251	Columbia Cascade	Wenatchee	Wenatchee Sockeye	Sockeye	Sockeye	Int	Cons	WDFW	Other	211,700	WDFW Eastbank Hatchery			Sockeye fingerlings are released into the west end of Lake Wenatchee near the confluence of the lake with the Little Wenatchee and White rivers (approximately Rkm 90.0 of the Wenatchee River).
299	Blue Mountain	Tucannon	Tucannon Summer Steelhead	Steelhead	Summer Steelhead	Int	Cons	WDFW	Other	50,900	WDFW Lyons Ferry Hatchery	WDFW Tucannon Hatchery,	Curl Lake Acclimation Pond (Tucannon Hatchery Satellite)	Summer steelhead smolts are directly released from Curl Lake Intake (Tucannon Hatchery) into the Tucannon River @ ~RKm 66.
512	Blue Mountain	Grande Ron	Wallowa Summer Steelhead (Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	ODFW	Other	799,300	ODFW Wallowa Hatchery	Big Canyon Acclimation Facility		Steelhead are released from the Spring Creek Acclimation Ponds (Wallowa Hatchery) into Spring Creek (tributary to the Wallowa River) @ RKm 1; and the Big Canyon Acclimation Ponds into Deer Creek (tributary to the Wallowa River) @ RKm 0.1.
550	Mountain Snake	Salmon	Little Salmon Summer Steelhead (A-Run-Pahsimeroi-Oxbow-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	IDFG	Other	645,000	IDFG Sawtooth Hatchery (broodstock, early incub.)	IDFG Magic Vally Hatchery (incub., late rear.)	Hagerman NFH (incub., early rear.)	Summer steelhead yearling smolts are transported from the Hagerman NFH and directly released into Little Salmon River at Stinky Springs site and Hazard Creek site.
791	Mountain Snake	Salmon	Little Salmon Summer Steelhead (B-Run-Dworshak-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	IDFG/USFWS	Other	316,300	USFWS Dworshak Hatchery			Steelhead are released into the Little Salmon River and Stinky Springs.
298	Blue Mountain	Tucannon	Tucannon Summer Steelhead (Lyons Ferry-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	WDFW	Other	100,700	WDFW Lyons Ferry Hatchery			Yearling summer steelhead smolts are transported from the Lyons Ferry Hatchery to the Tucannon River for a direct release @ RM 11 (Westergreen Bridge).
790	Mountain Snake	Salmon	Lemhi Summer Steelhead (A-Run-Pahsimeroi Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	IDFG	Other	119,700	IDFG Pahsimeroi Hatchery			Steelhead are transported from Magic Valley hatcheries and released directly into the Salmon River near Red Rock.
539	Mountain Snake	Salmon	Pahsimeroi Summer Steelhead (A-Run-Pahsimeroi Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	IDFG	Other	1,086,800	IDFG Sawtooth Hatchery (broodstock, early incub.)	IDFG Magic Vally Hatchery (incub., late rear.)	Hagerman NFH (incub., early rear.)	Summer steelhead yearling smolts are transported from the Magic Valley Hatchery and directly released into Pahsimeroi River downstream of the Pahsimeroi Hatchery Trap.
467	Mountain Snake	Salmon	East Fork Salmon Summer Steelhead	Steelhead	Summer Steelhead	Int	Cons	IDFG	Other	49,500	IDFG Sawtooth Hatchery (early incub.)	IDFG Magic Valley Hatchery (late incub., rearing)	IDFG East Fork Salmon Satellite (broodstock spawn, release)	Summer steelhead smolts are transported from the Magic Valley Hatchery and released into the East Fork Salmon River at the East Fork Salmon River Satellite Facility (~RM 20).
792	Mountain Snake	Salmon	East Fork Salmon Summer Steelhead (B-Run Dworshak-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	IDFG/USFWS	Other	324,800	USFWS Dworshak Hatchery	IDFG Magic Valley Hatchery (late incub., rearing)	Hagerman NFH (incub., early rear.)	Summer steelhead are transported from Magic Valley hatcheries and directly released into lower East Fork Salmon River near East Fork mouth.

Appendix A. Columbia River Hatchery Programs and Facility Information

Agency abbreviations: CTC – Confederated Tribes Colville; CTUIR – Confederated Tribes Umatilla Indian Reservation; CTWS – Confederated Tribes of Warm Springs; IDFG – Idaho Fish and Game; NOAA – National Oceans and Atmospheric Administration; NPT – Nez Perce Tribe; ODFW – Oregon Department Fish and Wildlife; USFWS – U.S. Fish and Wildlife Service; WDFW – Washington Department Fish and Wildlife; YN – Yakama Nation

Population ID	Province	Subbasin	Population/Program Name	Species	Species/Race	Hatchery Program Type	Hatchery Program Purpose	Hatchery Operating Agency	Funding Source	Number fish release	Primary Facility	Supporting Facilities		Release Location
814	Mountain Snake	Salmon	East Fork Salmon Summer Steelhead (A-Run Pahasimeroi-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	IDFG	Other	180,500	IDFG Pahsimeroi Hatchery	IDFG Magic Valley Hatchery (late incub., rearing)		Summer steelhead are transferred from Magic Valley Hatchery and released into maintem Salmon River at Tunnel Rock and McNabb Point near the mouth of the East Fork Salmon River.
465	Mountain Snake	Salmon	Upper Salmon Summer Steelhead (A-Run Sawtooth-Pahsimeroi-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	IDFG	Other	1,284,600	IDFG Sawtooth Hatchery (broodstock, early incub.)	IDFG Magic Vally Hatchery (incub., late rear.)	Hagerman NFH (incub., early rear.)	Summer steelhead yearling are transported from the Hagerman NFH to the Sawtooth Hatchery for direct release as into the Upper Salmon River (below the Sawtooth Hatchery weir), Slate Creek, Yankee Fork River and Valley Creek.
466	Mountain Snake	Salmon	Upper Salmon Summer Steelhead (B-Run Dworshak-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	IDFG/USFWS	Other	250,300	IDFG Magic Valley Hatchery	IDFG Clearwater Fish Hatchery	USFWS Dworshak NFH	Summer steelhead pre-smolts are transported from the Magic Valley Hatchery to the Squaw Creek Pond Acclimation Facility for acclimation and release and are directly released into Squaw Creek (no acclimation).
793	Mountain Snake	Salmon	Upper Salmon Summer Steelhead (Upper Salmon B-Run-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	IDFG	Other	59,200	USFWS Dworshak Hatchery			Summer steelhead are released into the Squaw Creek Acclimation facility prior to release.
981	Blue Mountain	Imnaha	Little Sheep Summer Steelhead	Steelhead	Summer Steelhead	Int	Both	ODFW	Other	212,300	ODFW Irrigon Hatchery	ODFW Little Sheep Adult collection/acclimation Facility		Summer steelhead are released from the Little Sheep Creek acclimation facility.
230	Blue Mountain	Snake Hells	Snake Hells Canyon Summer Steelhead (Oxbow-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	ODFW/IDFG	Other	525,400	IDFW Oxbow Hatchery (adult collect-spawn, incubation)	IDFG Niagra Springs Fish Hatchery		Summer steelhead are released into Snake River below Hells Canyon Dam.
449	Mountain Snake	Clearwater	SF Clearwater Summer Steelhead (B-Run)	Steelhead	Summer Steelhead	Int	Harv	USFWS	Other	399,800	IDFG Clearwater Fish Hatchery			Summer steelhead are released into Newsome Creek, American River, Meadow Creek, Red River, and Mill Creek
827	Mountain Snake	Clearwater	SF Clearwater_Crooked River Summer Steelhead (B-Run)	Steelhead	Summer Steelhead	Int	Harv	USFWS	Other	84,200	IDFG Clearwater Hatchery			Crooked River a tributary to the S.F. Clearwater River
789	Mountain Snake	Clearwater	SF Clearwater Summer Steelhead (B-Run Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	IDFG	Other	911,300	USFWS Dworshak Hatchery	IDFG Clearwater Fish Hatchery		Summer steelhead are transported from the Clearwater Hatchery and directly released into the S.F. Clearwater at Redhouse Hole.
744	Mountain Snake	Clearwater	Lolo Summer Steelhead (A+B-Run)	Steelhead	Summer Steelhead	Int	Cons	IDFG	Other	49,700	IDFG Clearwater Hatchery			Direct release into Lolo Creek.
450	Mountain Snake	Clearwater	NF Clearwater Summer Steelhead (B-Run-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	IDFG	Other	1,199,300	USFWS Dworshak Hatchery			NF Clearwater at Dworshak Hatchery.
738	Mountain Snake	Clearwater	Lower Clearwater Summer Steelhead (B-Run-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	IDFG	Other	298,000	IDFG Clearwater Fish Hatchery	USFWS Hagerman NFH	IDFG Red River Acclimation Facility, and Crooked River Acclimation Facility	Summer steelhead smolts are transported to the Kooskia NFH for release into Clear Creek (tributary to the Middle Fork Clearwater River).
218	Blue Mountain	Grande Ron	Cottonwood Creek Summer Steelhead (Wallowa-Lyons Ferry-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	WDFW	Other	160,100	WDFW Lyons Ferry Hatchery	WDFW Cottonwood Creek Satellite Facility (Adult Collection and smolt Accl.)		Summer steelhead smolts are acclimated and released from the Cottonwood Creek Acclimation Facility into Cottonwood Creek (RM 0.25), tributary to the Lower Grande Ronde River.
590	Columbia Estuary	Big Creek	Big Creek Winter Steelhead (Hatchery)	Steelhead	Winter Steelhead	Seg	Harv	ODFW	Mitchell Act	60,000	ODFW Big Creek Hatchery			Steelhead smolts are released from the Big Creek Hatchery into Big Creek (RM 3).
598	Columbia Estuary	Gnat Creek	Gnat Creek Winter Steelhead (Hatchery)	Steelhead	Winter Steelhead	Seg	Harv	ODFW	Mitchell Act	40,000	ODFW Big Creek Hatchery	ODFW Gnat Creek (Acclimation/Release) Hatchery		Steelhead smolts are released from the Gnat Creek Hatchery into Gnat Creek (RM 2.25).
684	Columbia Estuary	Young Bay	Youngs Bay Tribs Winter Steelhead (Hatchery)	Steelhead	Winter Steelhead	Seg	Harv	ODFW	Mitchell Act	60,000	ODFW Big Creek Hatchery	ODFW Klaskanine Hatchery (Acclimation and Release)		Steelhead smolts are released from the Klaskanine Hatchery into NF Klaskanine River (RM 2).
287	Columbia Plateau	Mid-Columb	Middle Columbia Mainstem_Ringold Summer Steelhead (Wells Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	WDFW	Mitchell Act	171,100	WDFW Ringold Springs	WDFW Wells Hatcheries		Summer steelhead yearling smolts are released from a 5.0-acre rearing pond to an outlet that enters Spring Creek, which flows into the Columbia River (RKm 567).
362	Lower Columbia	Coweeman	Coweeman Winter Steelhead (Early Elochoman-Hatchery)	Steelhead	Winter Steelhead	Seg	Harv	WDFW	Mitchell Act	20,200	WDFW Elochoman River Hatchery			Yearling steelhead are transfer from the Elochoman River Hatchery to the Lower Columbia River Fly Fishers Acclimation Pond, an off-stream site to the Coweeman River @ RKm 16.1.
365	Lower Columbia	Cowlitz	Lower Cowlitz Summer Steelhead (Skamania-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	WDFW	Other	549,200	WDFW Cowlitz Trout Hatchery			Yearling summer steelhead smolts are released into the Cowlitz River below the Barrier Dam (RKm 78.9 and from the Trout Hatchery (RKm 66.0). One group of yearling smolts are released from the Trout Hatchery into Blue Creek (RKm 0.8).
361	Lower Columbia	Cowlitz	Lower Cowlitz Winter Steelhead (Early-Hatchery)	Steelhead	Winter Steelhead	Seg	Harv	WDFW	Other	302,400	WDFW Cowlitz Trout Hatchery			Yearling early winter steelhead smolts are released from the Cowlitz Trout Hatchery into the Cowlitz River (RKm 66.0)and into Blue Creek (RKm 0.8)
363	Lower Columbia	Cowlitz	Lower Cowlitz Winter Steelhead (Late)	Steelhead	Winter Steelhead	Int	Both	WDFW	Other	288,700	WDFW Cowlitz Trout Hatchery			Fingerling releases in Upper Cowlitz River above RKm 140.
620	Lower Columbia	Toutle	NF Toutle Summer Steelhead (Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	WDFW	Mitchell Act	24,700	WDFW Skamania Hatchery			Off-stream release from WDFW Toutle Hatchery into the Green River (Tributary to N.F. Toutle River/Cowlitz subbasin) @ RKm 0.81.
364	Lower Columbia	Toutle	SF Toutle Summer Steelhead (Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	WDFW	Mitchell Act	24,700	WDFW Skamania Hatchery			Yearling fish are transfer from the Toutle Hatchery (located on the Green River, tributary to N.F. Toutle) to the Cowlitz Game & Anglers Acclimation Satellite Pond , located on the S.F. Toutle River @ RKm 16.1.
606	Lower Columbia	Cowlitz	Upper Cowlitz Winter Steelhead (Late)	Steelhead	Winter Steelhead	Int	Both	WDFW	Other	199,100	WDFW Cowlitz Trout Hatchery			Releases in Upper Cowlitz River above RKm 140.
559	Columbia Plateau	Deschutes	Deschutes Summer Steelhead (RoundButte-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	ODFW	Other	162,100	ODFW Round Butte Hatchery			Steelhead smolts are released from the Pendleton Regulation Dam site (RM 100.1).
345	Columbia Estuary	Elochoman	Elochoman Summer Steelhead (Merwin-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	WDFW	Mitchell Act	30,900	WDFW Elochoman Hatchery			Steelhead smolts are released from Pond 23 of the Elochoman Hatchery facility into the Elochoman River (RKm 11.3).
343	Columbia Estuary	Elochoman	Elochoman Winter Steelhead (Early-Hatchery)	Steelhead	Winter Steelhead	Seg	Harv	WDFW	Mitchell Act	90,700	WDFW Elochoman Hatchery			Steelhead smolts are released from the Elochoman Hatchery (RKm 11.3).
352	Columbia Estuary	Grays	Grays Winter Steelhead (Early-Elochoman-Hatchery)	Steelhead	Winter Steelhead	Seg	Harv	WDFW	Mitchell Act	40,000	WDFW Grays River Hatchery			Steelhead smolts are released from three raceways of the Grays River Hatchery into the West Fork of the Grays River (RKm 3.2).
265	Columbia Gorge	Hood	Hood Summer Steelhead	Steelhead	Summer Steelhead	Int	Cons	ODFW	Other	31,400	ODFW Oak Springs Hatchery (Deschutes Subbasin)			Summer steelhead are acclimated and released from two sites in the West Fork Hood River, the Blackberry Creek (Dry Run Bridge) site @ at RM 8.5. and the Jones Creek @ RM 14.5.
775	Columbia Gorge	Hood	Hood Summer Steelhead (Santiam-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	ODFW	Other	31,500	ODFW Oak Springs Hatchery (Deschutes Subbasin)			Steelhead are released directly into the Hood River below Powerdale Dam.
267	Columbia Gorge	Hood	Hood Winter Steelhead	Steelhead	Winter Steelhead	Int	Cons	ODFW	Other	49,200	ODFW Oak Springs Hatchery (Deschutes Subbasin)			Winter steelhead are released into the East Fork Hood River using temporary acclimation tanks and the Middle Fork Hood River at the Parkdale facility.
372	Lower Columbia	Kalama	Kalama Summer Steelhead	Steelhead	Summer Steelhead	Int	Cons	WDFW	Mitchell Act	30,500	WDFW Fallert Creek Hatcheries			Gobar Pond (Gobar Creek) @ RKm 4.8 (of Kalama River)
373	Lower Columbia	Kalama	Kalama Summer Steelhead (Skamania-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	WDFW	Mitchell Act	30,700	WDFW Fallert Creek Hatcheries			Fallert Creek Hatchery @ RKm 8.2 (of Kalama River).
374	Lower Columbia	Kalama	Kalama Winter Steelhead (Early-Hatchery)	Steelhead	Winter Steelhead	Seg	Harv	WDFW	Mitchell Act	45,800	WDFW Fallert Creek Hatcheries			Gobar Pond (Gobar Creek) @ 4.8 RKm (of the Kalama River).
375	Lower Columbia	Kalama	Kalama Winter Steelhead (Late)	Steelhead	Winter Steelhead	Int	Harv	WDFW	Mitchell Act	45,200	WDFW Fallert Creek Hatcheries			Gobar Pond (Gobar Creek) @ RKm 4.8 (of the Kalama River)
276	Columbia Gorge	Klickitat	Klickitat Summer Steelhead (Skamania-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	WDFW	Mitchell Act	100,500	WDFW Skamania Hatchery			Yearling steelhead smolts are transfer from the Skamania Hatchery and directly released into the Klickitat River at multiple locations.
385	Lower Columbia	Lewis	EF Lewis Summer Steelhead (Skamania-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	WDFW	Mitchell Act	24,700	WDFW Skamania Hatchery			Direct release into the East Fork Lewis River @ RKm 10.2 and RKm 14.4.

Appendix A. Columbia River Hatchery Programs and Facility Information

Agency abbreviations: CTC – Confederated Tribes Colville; CTUIR – Confederated Tribes Umatilla Indian Reservation; CTWS – Confederated Tribes of Warm Springs; IDFG – Idaho Fish and Game; NOAA – National Oceans and Atmospheric Administration; NPT – Nez Perce Tribe; ODFW – Oregon Department Fish and Wildlife; USFWS – U.S. Fish and Wildlife Service; WDFW – Washington Department Fish and Wildlife; YN – Yakama Nation

Population ID	Province	Subbasin	Population/Program Name	Species	Species/Race	Hatchery Program Type	Hatchery Program Purpose	Hatchery Operating Agency	Funding Source	Number fish release	Primary Facility	Supporting Facilities		Release Location
387	Lower Columbia	Lewis	EF Lewis Winter Steelhead (Skamania-Hatchery)	Steelhead	Winter Steelhead	Seg	Harv	WDFW	Mitchell Act	90,700	WDFW Skamania Hatchery			Direct releases into the East Fork Lewis River @ RKm 10.2 and RKm 14.4.
388	Lower Columbia	Lewis	NF Lewis Summer Steelhead (Merwin-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	WDFW	Other	284,800	WDFW Merwin Hatchery			North Fork Lewis River @ RKm 8.1
384	Lower Columbia	Lewis	NF Lewis Winter Steelhead (Merwin-Hatchery)	Steelhead	Winter Steelhead	Seg	Harv	WDFW	Other	100,200	WDFW Merwin Hatchery			North Fork Lewis River @ RKm 8.1
572	Lower Columbia	Washougal	Salmon Creek Winter Steelhead (Skamania-Hatchery)	Steelhead	Winter Steelhead	Seg	Harv	WDFW	Mitchell Act	24,700	WDFW Skamania Hatchery	WDFW Klineline Rearing Pond Netpens		Steelhead smolts are released from Klineline Pond into Salmon Creek (RKm 8.1).
238	Columbia Cascade	Methow	Methow Summer Steelhead	Steelhead	Summer Steelhead	Int	Both	USFW	Other	420,100	USFWS Winthrop National Fish Hatchery			Steelhead smolts are released from the Winthrop NFH rearing/acclimation facilities into the Methow River (RKm 81.0).
593	Columbia Cascade	Okanogan	Okanogan Summer Steelhead	Steelhead	Summer Steelhead	Int	Cons	CCT/WDFW	Other	20,000	Colville Tribes Cassimer Bar			Summer steelhead are released into Omak Creek.
813	Columbia Cascade	Okanogan	Okanogan Summer Steelhead (Wells-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	WDFW	Other	138,900	WDFW Wells Hatchery			Steelhead smolts are released into three sites in the Okanogan: 1) Okanogan River mainstem, 2) Simikameen River, and 3) Omak Creek.
405	Lower Columbia	Sandy	Sandy Summer Steelhead (South Santiam-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	ODFW	Mitchell Act	75,000	ODFW South Santiam H. (broodstock, spawning, eyed egg), Oak Springs H. (incub and rear), Bonneville H. (incub and rear), Sandy H. (acclim and release)	ODFW Sandy Hatchery (acclim and release)		Yearling steelhead smolts are released from the Sandy Hatchery into Cedar Creek (RM 0.25), tributary to the Sandy River.
406	Lower Columbia	Sandy	Sandy Winter Steelhead (Late)	Steelhead	Winter Steelhead	Int	Harv	ODFW	Mitchell Act	159,900	ODFW Sandy Hatchery			Yearling winter steelhead smolts are released from the Sandy River into Cedar Creek (RM 0.25), tributary to the Sandy River.
295	Blue Mountain	Lower Snak	Snake Lower Summer Steelhead (Lyons Ferry-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	WDFW	Other	60,600	WDFW Lyons Ferry Hatchery			Steelhead yearling smolts are released directly from the Lyons Ferry Hatchery into the Snake River @ RM 58.
303	Columbia Plateau	Umatilla	Umatilla Summer Steelhead	Steelhead	Summer Steelhead	Int	Both	CTUIR/ODFW	Other	149,900	ODFW/CTUIR Umatilla Hatchery	CTUIR Three Mile Dam and Minthorn Springs Facilities		Steelhead yearling smolts are released: (1) from Minthorn Springs Acclimation Facility into the Umatilla River @ RM 63.8; (2) from Pendleton Acclimation Facility into the Umatilla River @ RM 56.0: and (3) into Meacham Creek (Bonnifer Springs) @ RM 2.0, a tributary of the Umatilla River.
306	Columbia Plateau	Walla Walla	Walla Walla Summer Steelhead (Lyons Ferry-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	WDFW	Other	100,200	WDFW Lyons Ferry Hatchery			Steelhead yearling smolts are directly released into the Walla River @ RM 35.
806	Columbia Plateau	Walla Walla	Touchet Summer Steelhead (Lyons Ferry-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	WDFW	Other	84,400	WDFW Lyons Ferry Hatchery			Steelhead smolts are released into the Dayton Acclimation Pond on the Touchet River at RM 54 near Patit Creek Confluence.
307	Columbia Plateau	Walla Walla	Touchet Summer Steelhead	Steelhead	Summer Steelhead	Int	Cons	WDFW	Other	49,200	WDFW Lyons Ferry Hatchery			Steelhead are directly released in the Touchet River upstream of the Drayton Trap at RM 57.2.
412	Lower Columbia	Washougal	Washougal Summer Steelhead (Skamania-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	WDFW	Mitchell Act	60,300	WDFW Skamania Hatchery			Steelhead smolts are released into the N.F. Washougal River (On-Station Release) @ RKm 2.4) and into the mainstem Washougal River (transported release) @ RKm 12.9.
411	Lower Columbia	Washougal	Washougal Winter Steelhead (Early-Skamania-Hatchery)	Steelhead	Winter Steelhead	Seg	Harv	WDFW	Mitchell Act	59,400	WDFW Skamania Hatchery			Steelhead are released from the Skamania Hatchery into the N.F. Washougal River (RKm 2.4) and trucked and direct release into the main Washougal River RKm 3.2).
252	Columbia Cascade	Wenatchee	Wenatchee Summer Steelhead	Steelhead	Summer Steelhead	Int	Both	WDFW	Other	401,000	WDFW Eastbank Hatchery	WDFW Wells Hatchery		Steelhead yearling smolts are released into the Upper Wenatchee River, Chiwawa River (tributary to the Wenatchee River), and Nason Creek (tributary to the Wenatchee River).
254	Columbia Gorge	White Salmo	White Salmon Summer Steelhead (Skamania-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	WDFW	Mitchell Act	20,100	WDFW Skamania Hatchery			Yearling steelhead smolts are transfer from the Skamania Hatchery and directly released into the White SalmonRiver @ RKm 2.4.
256	Columbia Gorge	White Salmo	White Salmon Winter Steelhead (Skamania-Hatchery)	Steelhead	Winter Steelhead	Seg	Harv	WDFW	Mitchell Act	19,800	WDFW Skamania Hatchery			Yearling steelhead smolts are transfer from the Skamania Hatchery and directly released into the White Salmon River.
434	Lower Columbia	Willamette	Clackamas Summer Steelhead (Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	ODFW	Other	174,800	ODFW Clackamas Hatchery			Yearling summer steelhead smolts are released from the Clackamas Hatchery into the Clackamas River (RKm 22.6).
432	Lower Columbia	Willamette	Clackamas-Eagle Creek Winter Steelhead (Early-Hatchery)	Steelhead	Winter Steelhead	Seg	Harv	USFWS	Mitchell Act	151,000	USFWS Eagle Creek National Fish Hatchery			Yearling steelhead smolts are released from the Eagle Creek NFH into the Clackamas River (RKm 16).
734	Lower Columbia	Willamette	Lower Clackamas Winter Steelhead (Late)	Steelhead	Winter Steelhead	Int	Harv	ODFW	Other	164,900	ODFW Clackamas Hatchery			Winter steelhead smolts are released from the Clackamas Hatchery into the Clackamas River (RM 23) and transported from the Clackamas Hatchery to Cassidy Pond (RM 8) for acclimation and released into the Clackamas River.
688	Lower Columbia	Willamette	MF Willamette Summer Steelhead (S.Santiam-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	ODFW	Other	114,500	ODFW South Santiam Hatchery (broodstock, incubation & rearing)			Summer steelhead smolts are directly released into the Middle Fork Willamette River (~RM 20.0), approximately 8.0 miles downstream Dexter Pond Acclimation Facility.
435	Lower Columbia	Willamette	Mainstem Willamette Summer Steelhead (S.Santiam-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	ODFW	Other	51,200	ODFW South Santiam Hatchery (broodstock, incubation & rearing)			Summer steelhead smolts are directly released into the mainstem Willamette River near Eugene (Oregon).
687	Lower Columbia	Willamette	McKenzie Summer Steelhead (S.Santiam-Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	ODFW	Other	123,500	ODFW South Santiam Hatchery (broodstock, incubation & rearing)			Summer steelhead smolts are directly released into the McKenzie River (~RM 25.0), approximately 14 miles downstream of the Leaburg Hatchery.
689	Lower Columbia	Willamette	North Santiam Summer Steelhead (S. Santiam Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	ODFW	Other	161,100	ODFW South Santiam Hatchery (broodstock, incubation & rearing)	ODFW Minto Pond (acclimation and release)		Summer steelhead smolts are released from Minto Pond Acclimation Facility into the North Santiam River (RM 42.0).
690	Lower Columbia	Willamette	South Santiam Summer Steelhead (Hatchery)	Steelhead	Summer Steelhead	Seg	Harv	ODFW	Other	144,100	ODFW South Santiam Hatchery			Summer steelhead smolts are released from Foster Acclimation facility (Santiam Hatchery) into the mainstem Santiam River (RM 37) downstream of Foster Dam.

Appendix B

2008-2017

United States v. Oregon

Management Agreement

May 2008

2008-2017 United States v. Oregon

MANAGEMENT AGREEMENT

TABLE OF CONTENTS

2008-2017 *United States v. Oregon*
MANAGEMENT AGREEMENT

PREAMBLE

The purpose of this Management Agreement is to provide a framework within which the Parties may exercise their sovereign powers in a coordinated and systematic manner in order to protect, rebuild, and enhance upper Columbia River fish runs while providing harvests for both treaty Indian and non-treaty fisheries.

The primary goals of the Parties are to rebuild weak runs to full productivity and fairly share the harvest of upper river runs between treaty Indian and non-treaty fisheries in the ocean and Columbia River Basin.

As a means to accomplish this purpose, the Parties intend to use (as herein specified) habitat protection authorities, enhancement efforts, and artificial production techniques as well as harvest management to ensure that Columbia River fish runs continue to provide a broad range of benefits in perpetuity.

By this Agreement, the Parties have established procedures to facilitate communication and to resolve disputes fairly. It is the intent of the Parties that these procedures will permit the Parties to resolve disputes outside of court and that litigation will be used only after good faith efforts to settle disagreements through negotiation are unsuccessful.

I. INTRODUCTION

A. PARTICIPANTS

In their status as Parties to *United States v. Oregon*, Civil No. 68-513-KI (D. Or.), the State of Washington, the State of Oregon, the State of Idaho, the United States, the Shoshone Bannock Tribes, the Confederated Tribes of the Warm Springs Reservation of Oregon, the Confederated Tribes of the Umatilla Indian Reservation, the Nez Perce Tribe, and the Confederated Tribes and Bands of the Yakama Nation, the latter four, hereinafter referred to as "the Columbia River Treaty Tribes," (collectively, the Parties) enter into this Agreement, the 2008-2017 *United States v. Oregon* Management Agreement. The state of Idaho joins only in Parts I and III of this Agreement. The Shoshone-Bannock Tribes joins only in Part I of this Agreement. The Shoshone-Bannock Tribes have filed a complaint in intervention in *United States v. Oregon* but have not taken any action on this complaint. The Parties agree that the Shoshone-Bannock Tribes' participation in any of the forums set forth in this Agreement in no way represents an admission, determination, settlement, or adjudication of any legal or factual issues related to the nature and scope of the Shoshone-Bannock Tribes' off-reservation fishing rights under the Fort Bridger Treaty of July 3, 1868. 15 Stat. 673. In the event the Shoshone-Bannock Tribes pursue litigation on their complaint in intervention or any other claims they may have concerning the Shoshone-Bannock Tribes' Fort Bridger Treaty of July 3, 1868, the Parties reserve the right to assert any and all defenses they may have to the claims of the Shoshone-Bannock Tribes in Civil No. 68-513, and the Shoshone-Bannock Tribes' participation in any of the forums set forth in this Agreement shall not be construed as a waiver or abandonment of any Party's claims or defenses.

B. SCOPE OF AGREEMENT

1. Nature of Agreement

This Agreement will be submitted as a stipulated order in *United States v. Oregon*, Civil No. 68-513-KI (D. Or.). If approved by the Court, this Agreement shall be binding on the Parties as a decree of the Court. The fishing regimes and production actions described in this Agreement neither set precedent nor prejudice any future allocation arrangements or production actions. Nothing in this Agreement limits the positions the Parties may take in any forum regarding harvest actions or production actions other than those expressly agreed to herein.

2. ESA Section 7 Process

The Parties recognize that the United States has obligations under the Endangered Species Act (ESA) that will require the National Marine Fisheries Service (NOAA Fisheries), United States Fish and Wildlife Service (USFWS), and Bureau of Indian Affairs (BIA) to consult on some of the actions set out in this Agreement. NOAA Fisheries is expected to complete a biological opinion on the joint fishery proposal contained in the Agreement and further described in a biological assessment to be prepared by the Technical Advisory Committee.

In Part III and Tables B1-B7 of this Agreement, the Parties have identified certain production programs which will be used to support the joint fishery proposal and support the intent of the Parties to not impede and in some cases contribute to ESA recovery. NOAA Fisheries, USFWS and the BIA will continue to review the production programs contained in this Agreement and undertake ESA consultations as appropriate. The Parties may request modifications to the schedule to give priority to those consultations that the Parties deem to be of greatest urgency. NOAA Fisheries, USFWS and the BIA agree to use their best efforts to accommodate such requests.

The Parties recognize that NOAA may recommend modifications to the production actions in this Agreement based on the results of these consultations. In the event that any of the production programs set forth in this Agreement are affected by NOAA's recommendations in a manner that would affect the joint fishery proposal, the Parties agree to meet and discuss the resulting impacts on the valuable exchange of consideration reflected in this Agreement. The Parties agree to make a good faith effort to work collaboratively on any necessary modification to this Agreement. In so doing, the concerns and needs of all Parties will be accounted for to the extent possible. Should the Parties agree to modify any of the production programs in this Agreement, the Parties will monitor and evaluate the effects of such modifications on adult returns and fishery opportunities.

Notwithstanding the good faith efforts discussed above, the Parties recognize that NOAA Fisheries may issue a Biological Opinion or Opinions that necessitate changes to the production programs of this Agreement and that such Biological Opinions or changes are not subject to the provisions of Parts I.B.8 and I.C.6. The Tribes reserve their rights to seek judicial relief in *United States v. Oregon* with respect to any federal action concerning production programs that may affect the number of fish returning to tribal usual and accustomed fishing places, or that otherwise impact their Treaty-reserved fishing rights. All Parties reserve any and all rights and defenses that they may have.

The Parties will work, to the extent they deem appropriate, with the U.S. Army Corps of Engineers, the Bonneville Power Administration, the U.S. Bureau of Reclamation, the U.S. Fish and Wildlife Service and NOAA Fisheries as necessary to facilitate the implementation of the hatchery provisions set forth in this Agreement.

3. Party Positions

The Tribes maintain that tribal fisheries are subject to limitations only under the conservation necessity standards in federal case law, including case law governing the *United States v. Oregon* litigation. Other Parties, including the States, disagree.

4. Court Technical Advisor

The Court has appointed a court technical advisor to assist in technical matters related to this case (Docket Nos. 1072, 1719). Parts I.C.1.c and I.C.2.c of this Agreement provide that the court technical advisor may participate in certain meetings of the Technical Advisory Committee and the Production Advisory Committee to facilitate resolution of technical issues, at the Parties' request. When the Parties ask the court technical advisor to act as a facilitator at a meeting, USFWS, NOAA Fisheries, and the states of Idaho, Oregon and Washington will share the costs of such facilitation. USFWS and NOAA Fisheries will jointly be responsible for one-half of the cost. The states of Idaho, Oregon, and Washington will jointly be responsible for one-half of the cost.

5. Availability of Funds

This Agreement shall not be interpreted as binding federal agency or state parties to expend in any one fiscal year any sum in excess of appropriations made by Congress or a state party's legislature, and available for purposes of this Agreement for that fiscal year, or as involving the United States or a state party in any contract or other obligation for the further expenditure of money in excess of such appropriations.

6. Management Precision

Careful monitoring and a conservative in-season management philosophy will be employed to minimize the risk that harvest management objectives are not met due to inadvertent management error. The Parties recognize that even using the best available data in-season the actual harvest rates may differ due to management imprecision. Adult trapping will be conducted at Bonneville Dam, Priest

Rapids Dam and Lower Granite Dam to facilitate in-season management, run reconstruction, and/or broodstock collection.

7. Duration of Agreement

This Agreement becomes effective upon the issuance of the biological opinion on the joint fishery proposal referred to in Part I.B.2 above, or upon the signature of the Regional Administrator of NOAA Fisheries, whichever occurs later. This Agreement covers the winter, spring, summer, and fall season Columbia River fisheries and includes agreed-to production measures. The harvest provisions in Part II of this Agreement shall terminate on December 31, 2017. The production provisions for spring, summer and fall Chinook, sockeye and coho in Part III of this Agreement shall terminate with the release of the 2017 brood year production identified herein and for steelhead with the release of the 2018 brood year production.

8. Modification and Withdrawal

a. Modification. Any Party may at any time seek a modification of any provision of this Agreement. Where consideration and approval of such modification is otherwise subject to a specific process under this Agreement, the process specified in the applicable provision shall be followed. In all other instances, the Party shall provide written notice to the other Parties of the modification being sought and any changed conditions necessitating such modification, and if an agreement on modification cannot be reached, the Party seeking modification may invoke dispute resolution as provided in Part I.C.6 in order to achieve consensus. This Agreement, if adopted by the Court, shall be modified only by written agreement of all Parties.

b. Withdrawal. Any Party may withdraw from this Agreement at any time by serving written notice to the Court and the other Parties. The notification shall include a description of any changed conditions necessitating withdrawal. At the request of any Party, the Parties shall meet to discuss the withdrawal. Upon withdrawal of any Party, any remaining Party may withdraw upon notice to the Court and other Parties. Withdrawal of one or more Parties shall not preclude the remaining Parties from continuing the Agreement.

9. Communication

The Parties agree to continue to communicate in good faith, consistent with the Court's Stipulated Order, dated April 16, 1998 (Docket No. 2153).

C. *United States v. Oregon* FRAMEWORK

For purposes of implementing this Agreement, the Parties will continue to utilize the Technical Advisory Committee (TAC), the Production Advisory Committee (PAC), the Policy Committee, and Dispute Resolution as described below. TAC and PAC will provide the technical information outlined in Schedule A: *Annual Schedule for Committee Activities*. In addition, the Parties establish two workgroups, the Strategic Work Group and the Regulatory Coordination Work Group as described below.

1. Technical Advisory Committee

A Technical Advisory Committee (TAC) is hereby established to develop, analyze, and review data pertinent to this Agreement and to make reports and technical recommendations regarding harvest management. Members shall be qualified fisheries scientists familiar with harvest management of Columbia River fish runs. TAC shall be composed of designated technical representatives of each of the following entities: Washington, Oregon, Idaho, USFWS, NOAA Fisheries, the BIA, the Warm Springs Tribe, the Umatilla Tribes, the Nez Perce Tribe, the Yakama Nation, and the Shoshone-Bannock Tribes. The Parties agree to seek funding sources to assist TAC and its representatives in the performance of their functions.

a. TAC shall choose from among its members a Chair. Unless otherwise agreed, the entity represented by the Chair shall be responsible for providing administrative and logistical support to the TAC. TAC shall meet and provide technical information in accordance with Schedule A, or any then-applicable replacement schedule, or as otherwise needed.

b. Prior to the earliest contemplated or requested opening of any fishery that is subject to the requirements of this Agreement, and continuously thereafter until the close of such fishery and the final compilation of catch and escapement data for runs affected by such fishery, each Party shall promptly and continuously make available to each other Party copies of data, information, forecasts, estimates, forecasting procedures, methods, models, and other information available to or used by such Party in determining management policies and the timing, location, scope or conditions of any contemplated or requested fishery that would be subject to the provisions of this Agreement. Included in the foregoing shall be any materials pertaining to Columbia River stocks of fish furnished by such Party to the United States Section of the Pacific Salmon Commission, the Pacific or North Pacific Fishery

Management Councils or the Department of Commerce. The materials shall be exchanged through TAC or through such representative as a Party has specified in writing as its agent for this purpose when the circumstances do not allow for timely communication through TAC. Prior to any Party's distribution to any management entity of a report concerning potential fishing regulations on any fishery subject to this Agreement, TAC shall, to the extent that time permits, exchange all relevant data and review the management entities' respective recommendations for fisheries.

c. The TAC shall endeavor to reach consensus on its reports and technical recommendations. If TAC is unable to achieve consensus upon a technical issue, the TAC Chair shall advise the TAC that the court technical advisor will be asked to attend the next TAC meeting to review the various technical conclusions.

(i) The role of the court technical advisor shall be that of a facilitator, not an arbitrator. The technical advisor shall preside over the discussion and endeavor to facilitate resolution of the unresolved issue.

(ii) When the TAC is unable to achieve consensus on a report or recommendation, the TAC Chair shall cause a written report to be made and provide it to the Policy Committee. The report shall include a consensus summary of both the resolved and unresolved technical issues. The report shall also include the TAC minutes, if any; documents or other materials submitted to or considered by TAC; for unresolved technical issues, a description of the Parties' respective positions along with data and information offered in support of the Parties' positions; and any independent views or recommendations by the court technical advisor not contained in TAC report.

d. Distribution of Reports. The reports required by the attached Schedule A and this section shall be submitted by the TAC Chair to the Parties through their Policy Committee representatives. If there are issues where TAC did not reach a consensus the report shall conform with Part I.C.1.c.(ii) above with respect to those non-consensus issues. TAC shall make good faith efforts to ensure timely compilation and distribution of reports to the Parties. Except in cases of emergencies which preclude such advance distribution, all reports and recommendations shall be distributed to all Policy Committee representatives at least ten days prior to the Policy Committee meeting at which a report or recommendations are to be considered.

2. Production Advisory Committee

Coordination of production and harvest management is essential to the successful implementation of this Agreement. Accordingly, a Production Advisory Committee (PAC) is hereby established to coordinate information, review and analyze existing and future natural and artificial production programs pertinent to this Agreement and to submit recommendations to the management entities. Members shall be qualified fisheries scientists familiar with Columbia River artificial and/or natural fish production. PAC shall be composed of designated technical representatives of each of the following entities: Washington, Oregon, Idaho, USFWS, NOAA Fisheries, the BIA, the Warm Springs Tribe, the Umatilla Tribes, the Nez Perce Tribe, the Yakama Nation, and the Shoshone-Bannock Tribes. The Parties agree to seek funding sources to assist PAC and its members in the performance of its functions.

a. PAC shall select from among its members a Chair, however the PAC Chair shall not represent the same entity as the TAC Chair. Unless otherwise agreed, the entity represented by the Chair shall be responsible for providing administrative and logistical support to PAC. PAC shall meet and provide technical information in accordance with Schedule A, or any then-applicable replacement schedule, or as otherwise needed.

b. The reports and recommendations of PAC shall be summarized in writing, and shall express the consensus views and recommendations of its members whenever possible.

c. If PAC is unable to achieve consensus upon a technical issue, the PAC Chair shall advise the PAC that the court technical advisor will be asked to attend the next PAC meeting to review the various technical conclusions.

(i) The role of the court technical advisor shall be that of a facilitator, not an arbitrator. The technical advisor shall preside over the discussion and endeavor to facilitate resolution of the unresolved issue.

(ii) When the PAC is unable to achieve consensus on a report or recommendation, the PAC Chair shall cause a written report to be made and provide it to the Policy Committee. The report shall include a consensus summary of both the resolved and unresolved technical issues. The report shall also include the PAC minutes, if any; documents or other materials submitted to or considered by PAC; for unresolved technical issues, a description of the Parties’ respective positions along with date and information offered in support of the Parties’ positions; and any independent views or recommendations by the court technical advisor not contained in PAC report.

d. Distribution of Reports. The reports required by the attached Schedule A and this section shall be submitted to the Parties through their Policy Committee representatives. If there are issues where PAC did not reach a consensus, the report shall conform with Part I.C.2.c.(ii) above with respect to those non-consensus issues. PAC shall make good faith efforts to ensure timely compilation and distribution of reports to the Parties and relevant management entities. Except in cases of emergencies which preclude such advance distribution, all reports and recommendations shall be distributed to all Policy Committee representatives at least ten days prior to the meeting at which recommendations are to be considered.

3. <u>Strategic Work Group</u>

The Strategic Work Group (SWG) is created to assist the Policy Committee by reviewing technical information, evaluating potential solutions to particular problems arising over the implementation of this Agreement from a biological and policy perspective, and proposing alternative courses of action to the Policy Committee. The SWG will address those issues assigned from time to time by the Policy Committee. The SWG shall be composed of persons designated to represent the Parties' varied interests in the particular issue assigned to the group, and may vary from issue to issue. Persons assigned to the group should possess either technical or policy expertise, or both, as necessary to evaluate potential solutions from different perspectives with the aim of finding a common approach to resolving the practical difficulties of implementing this agreement.

4. Regulatory Coordination Committee

The Regulatory Coordination Committee will be composed of one person designated by each Party who shall serve as that Party's point of contact for providing regulations adopted by the Party with respect to the Agreement to the other Parties and for receiving such regulations when adopted by another Party. The Regulatory Coordination Committee will convene as necessary to review the regulations with the goal of identifying inconsistencies or inaccuracies, and will notify the Parties of potentially conflicting regulations to assure consistency with the Agreement and each other. In addition, the Regulatory

Coordination Committee shall set guidelines, provide suggestions and distribution for the prosecution referral agreements described below in Part I.E.

5. Policy Committee

A Policy Committee, composed of a policy and a legal representative appointed by each Party signatory to this Agreement, is hereby established. The purpose of the Policy Committee is to facilitate cooperative action by the Parties with regard to fishing regulations, policy issues or disputes, and the coordination of the management of fisheries on Columbia River runs and production and harvest measures. The Policy Committee may make assignments to the technical committees described in this Agreement to assist it.

The Policy Committee shall designate a Chairman and meet in accordance with Schedule A or at such times as are appropriate to conduct the business described in this Agreement. The Chairman shall provide all Parties with notice of meetings. The Committee may adopt appropriate rules to govern its proceedings.

6. Dispute Resolution Procedure

a. A Party must raise a formal “point of disagreement” to initiate the dispute resolution processes of this Agreement. A Party raising a formal point of disagreement shall provide all other Parties written notice that it is raising a formal point of disagreement. That written notice shall include a summary of the disagreement, the Party's position on the appropriate resolution(s) of the disagreement, and any documents or supporting materials that assist in describing the disagreement and/or supporting the Party's position on an appropriate resolution. If the Party raising the point of disagreement believes that emergency circumstances make it impossible to employ the full dispute resolution process, a complete explanation of the emergency shall be included. All Parties shall strive to provide notice of a point of disagreement at the earliest possible time. Points of disagreement shall be referred for dispute resolution as herein prescribed unless the Parties agree on other means for resolving them.

b. Technical Disputes –

(i) In the course of developing reports identified in Schedule A and in completing any other tasks assigned by the Policy Committee, the TAC and PAC shall employ the procedures prescribed in Part I.C.1. and Part I.C.2. above to attempt to resolve technical disputes prior to referring a non-consensus report or recommendation to the Policy Committee. If TAC or PAC is unable to achieve consensus, the TAC or PAC report conforming with the requirements of Part I.C.1. or C.2. will be provided to the Policy Committee for its review and consideration.

(ii) Non-consensus among TAC and PAC does not ripen into a formal point of disagreement unless and until a Policy Committee representative notifies all other Parties through their Policy Committee representatives that it is raising a formal point of disagreement as provided in Part I.C.6.a. above.

(iii) When a point of disagreement arising out of technical non-consensus is raised by a Party for Policy Committee consideration, the Policy Committee shall review the reports and materials submitted by TAC or PAC. In the course of considering a point of disagreement, the Policy Committee may identify additional technical issues and data needs related to the specific point of disagreement as to which further documentation is deemed necessary and ask the PAC or TAC to do additional analysis.

c. Policy Disputes

(i) Policy points of disagreement must be raised by a Party’s Policy Committee representative. If a TAC or PAC representative believes that a policy dispute is preventing a consensus on a technical TAC or PAC report or recommendation, that person should review the matter with its Policy Committee representative to determine if that Policy Committee representative should raise a policy-based point of disagreement.

(ii) Upon notice of a point of disagreement, the Policy Committee Chairman shall establish a date and place for the Policy Committee to consider the dispute, taking into consideration any emergency circumstances. The Chairman’s notice setting a date and place for consideration of the point of disagreement shall include an invitation for any Party to submit documents or supporting materials relevant to the point of disagreement that they believe should also be considered by the Policy Committee.

(iii) The Policy Committee shall discuss and attempt to resolve the point of disagreement. Unless the Committee unanimously agrees otherwise, its deliberations and discussions shall remain confidential except for the documents or other materials submitted to or considered by it. The Policy Committee Chairman shall compile a complete record of written materials considered by the Policy Committee in its deliberations on a point of disagreement. On points of disagreement over which the Policy Committee is unable to reach a consensus decision, any Party may provide to a non-Party management entity or other person a statement in support of its position on the disputed issue. The statement shall identify the data and other information that supports the Party's position but may be abbreviated as required to permit timely action by the entity or person. Any such statement shall be submitted to the Policy Committee for inclusion in its record related to the dispute.

d. The Parties recognize that the entities charged with making decisions and resolving disputes must be given the opportunity to examine competing positions of the Parties and the factual basis for their positions prior to rendering such decisions. They therefore will use their best efforts to share fully all relevant data and information and to present their positions and the factual basis therefor prior to seeking judicial review.

7. Emergency matters

Emergency matters may require immediate judicial action without compliance with this Section, and nothing in Part I.C.6.a-d. shall be construed as limiting a Party's right to seek such relief when those emergency matters arise.

However, the Parties shall make every reasonable effort to use the foregoing dispute resolution procedures prior to initiating judicial action, and the Party seeking immediate judicial relief shall have the burden of establishing the existence of an emergency.

D. JUDICIAL REVIEW OF DISPUTES

1. In the event that a dispute arises concerning this Agreement and after compliance with the foregoing Part I.C.6, to the extent required thereunder, a Party may petition the Court in Case No. 68-513 for a determination of the dispute. Unresolved disputes over matters that are not within the retained jurisdiction in Case No. 68-513, may be submitted to any court having subject matter and personal jurisdiction.

2. The Parties expect and intend that review by the Court in Case No. 68-513 of any dispute that has been subject to a Policy Committee proceeding under the foregoing Part I.C.6. will be limited to documents or other written materials submitted to or considered by the Policy Committee. The Parties understand that the Court may consider other documents or materials where good cause is shown why such documents or materials were not submitted to the Policy Committee during its deliberations. A Party may present oral testimony, declarations or affidavits concerning any documents and materials before the Court.

E. PROSECUTION REFERRAL AGREEMENTS

1. The Columbia River Treaty Tribes, Oregon and Washington agree that the Tribes should bear primary responsibility for enforcing agreed-upon regulations applicable to mainstem Treaty Indian fisheries.

2. To carry out this responsibility, the Columbia River Treaty Tribes agree to commit, to the maximum extent possible, the police, prosecutorial, and judicial resources necessary to ensure compliance with Tribal regulations governing mainstem fisheries.

3. To assist the Columbia River Treaty Tribes in carrying out this responsibility, Oregon and Washington may negotiate with each tribe for agreements to refer to the tribes for prosecution under tribal law those tribal fishermen cited by state enforcement officers for violating agreed upon mainstem fishing regulations and to cooperate with tribal authorities in making evidence and testimony available in tribal court proceedings. As part of each referral agreement, the tribe shall report the disposition of the tribal prosecution to the state law enforcement agency making the referral. The enforcement referral agreements filed with the Court on May 8, 1992 (Docket No. 1964) may provide models for implementation of this paragraph.

4. Unless specified otherwise in the referral

agreements entered into under this Part I.E., the states of Oregon and Washington shall retain authority to prosecute violations of applicable laws or regulations in state court.

5. If Oregon or Washington believes that a tribe or tribes is not carrying out its responsibilities under this section to enact and enforce agreed-upon mainstem fisheries regulations, it may refer the matter to the Policy Committee for dispute resolution as provided in Part I.C.6.c.

F. PERFORMANCE MEASURES, COMMITMENTS AND ASSURANCES

1. General

The Parties enter this Agreement based, in part, on their expectation that the measures in Parts II and III will help upriver stocks rebuild over time. The Parties also recognize that other laws and processes outside the scope of the Agreement, as well as the actions of public and private entities not signatory to this Agreement, may affect their ability to fulfill rebuilding and harvest sharing objectives. The Parties anticipate that their efforts will focus primarily on implementation of the specific measures in Parts II and III. This section establishes procedures to monitor progress toward rebuilding and to seek consensus on actions to address the circumstances where activities that are beyond the scope of the Agreement may affect the achievement of rebuilding and sharing goals.

2. Performance Evaluation

The Parties agree to establish performance measures that will be used to monitor progress toward rebuilding the upriver stocks of salmon and steelhead that presently constrain fisheries. Should rebuilding not progress as expected, the Parties further commit to a process to identify why stocks are not rebuilding and to take actions available within the scope of the Parties' joint and separate authorities to address the underlying problem and reestablish a positive rebuilding trend for those stocks.

a. Performance Measures. The Parties will monitor progress toward rebuilding by tracking trends in the status of the indicator stocks listed below. The Parties have selected these indicator stocks because of their geographic distribution, and because of the current availability of data sets that the Parties can use to establish a base against which to compare the future status of these stocks.

The Parties have identified two types of indicator stocks. Harvest indicator stocks are those used directly for managing the fisheries. Abundance indicator stocks provide more detailed information about natural-origin stocks or populations that currently limit fisheries. Neither the indicator stocks nor the performance measures listed below shall preclude the Parties from considering other indicators or performance measures that may be developed in the future, or that may be necessary to determine the status of a particular stock of concern.

The Parties will compare the status of indicator stocks to the 1988-2007 “base period,” which represents the status of stocks before completion of this Agreement. The Parties will use the performance measures and base period data as reference points for gauging progress.

TAC will update the indicator stock summaries annually and provide a report to the Policy Committee annually.

Harvest Indicator Stocks	
Stock	**Performance Measure**
Upriver spring/summer Chinook	
Upriver spring and Snake River spring/summer Chinook	Number of returning adults at Columbia River mouth
Natural-origin Snake River spring/summer Chinook	Number of returning adults at Columbia River mouth
Natural-origin Upper Columbia spring Chinook	Number of returning adults at Columbia River mouth
Upper Columbia Summer Chinook	
Upper Columbia Summer Chinook	Number of returning adults at Columbia River mouth
Sockeye	
Combined Upper Columbia River and Snake River sockeye	Number of returning adults at Columbia River mouth
Summer Steelhead	
Skamania natural-origin A-run steelhead	Number of returning adults at Bonneville Dam
Natural-origin A-Index steelhead	Number of returning adults at Bonneville Dam
Natural and Hatchery-origin B-Index steelhead	Number of returning adults at Bonneville Dam
Fall Chinook	
Upriver Bright fall Chinook	Number of returning adults at Columbia River mouth
Snake River natural-origin fall Chinook	Number of returning adults at Columbia River mouth

Abundance Indicator Stocks	
Stock	**Performance Measure**
Upriver spring/summer Chinook	
Snake River natural-origin spring/ summer Chinook	Number of returning adults at Lower Granite Dam
Upper Columbia River natural-origin spring Chinook	Number of returning adults at Priest Rapids Dam
Upriver Columbia River natural-origin spring Chinook stocks (Wenatchee, Entiat, Methow)	Sub-basin run size
Snake River spring/summer Chinook index stocks (Bear Valley, Marsh, Sulphur, Minam, Catherine Cr., Imnaha, Poverty Flats, Johnson)	Redd counts
John Day natural-origin spring Chinook	Redd counts
Warm Springs natural-origin spring Chinook	Number of returning adults at Warm Springs NFH weir
Upper Columbia Summer Chinook	
Upper Columbia River summer Chinook	Priest Rapids Dam counts
Sockeye	
Snake River	Number of returning adults at Lower Granite Dam
Lake Wenatchee natural-origin	Number of returning adults at Tumwater Dam
Okanogan natural-origin	Number of returning adults at Wells Dam
Snake River	Number of adults returning to Stanley Basin
Summer Steelhead	
Methow River natural-origin steelhead	Redd counts
Wenatchee River natural-origin steelhead	Redd counts
Select populations/groups of Snake River natural-origin A-run steelhead	Juvenile and adult abundance indices for groups that are monitored regularly
Select populations/groups of Snake River natural-origin B-run steelhead	Juvenile and adult abundance indices for groups that are monitored regularly

Abundance Indicator Stocks	
Stock	**Performance Measure**
Natural-origin Snake River A-Run Steelhead	Adults returning to Lower Granite Dam
Natural-Origin Snake River B-Run Steelhead	Adults returning to Lower Granite Dam
Joseph Cr A-run steelhead	Redd counts
John Day natural-origin steelhead	Redd counts
Umatilla natural-origin steelhead	Threemile Dam counts
Klickitat River natural-origin steelhead	Data developed in accordance with the recommendations in **Rawding, D.** 2007
Warm Springs natural-origin steelhead	Number of returning adults at Warm Springs NFH weir
Fall Chinook	
Hanford natural-origin adult fall Chinook	Population estimates
Snake River adult fall Chinook	Number of hatchery and natural adults at Lower Granite Dam
Snake River adult fall Chinook	Redd counts between Lower Granite Dam and Hells Canyon Dam and in Clearwater River
Deschutes River natural-origin adult fall Chinook	Population estimates
Additional Stocks and Performance Measures	
TAC will add additional abundance indicator stocks and performance measures to this table as directed by the Parties and as data become available. It is the intent of the Parties to update, add to, and revise the abundance indicator groups as needed to assess progress toward salmon and steelhead recovery.	

(b) Analysis of Decline. If the performance measure of any indicator stock declines for three consecutive years relative to the base period, any Party to this Agreement may request the Policy Committee to direct TAC to TAC to complete an Analysis of Decline. TAC shall complete the Analysis of Decline within one year of receiving Policy Committee direction. The Parties will exercise their best efforts to provide the resources necessary for a timely and thorough analysis.

The Analysis of Decline shall identify factors leading to the decline in the stock's performance, and shall assess the overall significance of the decline with respect to the achievement of rebuilding for the stock. The Analysis of Decline shall identify which factors are within the Parties' control, such as the activities described in Parts II and III of this Agreement, and which are not, such as ocean conditions. As part of its analysis, TAC may rely on any Assessment or review conducted by the Salmon Technical Team or Habitat Committee of the Pacific Fishery Management Council under Section 3.2.3.2 of the Pacific Coast Salmon Plan (revised May 2000).

Based on its findings, TAC shall recommend any modifications to Parts II and III of this Agreement that in TAC's judgment are needed to promote achievement of rebuilding, or may recommend adjustments to the rebuilding or performance measures. The TAC recommendations may also include suggestions for habitat restoration or enhancement measures. TAC may identify whether special programs, research, or analyses by experts who are not TAC members are needed to promote the long-term rebuilding of the stock in question.

TAC shall submit the Analysis of Decline to the Policy Committee for consideration.

3. Policy Committee Consideration

After receiving the Analysis of Decline, the Policy Committee shall convene. After review of the Analysis of Decline Report, the Policy Committee may make recommendations for modification of the Agreement. The Parties may thereafter modify Parts II and III of this Agreement, or the performance measures, consistent with the Policy Committee's recommendations. Provided, however, that only the Agreement as modified by such amendments will create additional legal obligations on Parties to the Agreement.

If the Policy Committee determines that no modifications to Parts II and III of this Agreement, or to the performance measures, can reasonably be expected to provide benefits to the stock in question, the Policy Committee may identify actions of other entities that may be needed to promote rebuilding of the stock. Examples might include habitat restoration and enhancement measures, or adjustments in fisheries outside the Columbia River Basin. The Policy Committee shall make and communicate recommendations to those other entities concerning such actions. Examples could be recommendations about fish habitat or access to habitat, fisheries regimes, data collection, or research.

4. Public Notice/Education about Terms of Agreement

The Parties will use their best efforts to make all members of their respective governments aware of the commitments in this Agreement.

G. DEFINITIONS

Terms defined in the Glossary shall have the meaning given therein wherever they are used in this Agreement.

II. HARVEST

The Parties, through this Agreement, in recognition of the Columbia River Treaty Tribes' federally secured rights, the conservation requirements, and the rights of other fishermen to fishery resources under applicable federal law, have proposed fisheries as set out below.

Tribal harvest in mainstem treaty fisheries with subsistence gear shall be consistent with any harvest guidelines identified herein. Mainstem treaty subsistence fisheries shall be open on a year round basis and shall not be restricted by the States or the United States, except for conservation purposes. The Columbia River Treaty Tribes shall manage mainstem treaty subsistence fisheries in good faith to remain within harvest guidelines, in coordination with other Parties.

This Agreement describes specific provisions for managing mainstem fisheries and certain tributary fisheries. Harvest plans for the Parties' other tributary fisheries will be developed cooperatively by the management entities with primary management responsibility in the respective sub-basin (as specified in Table 1: Lead Management Entities for each Sub-Basin). Other Parties may be affected by, and therefore may have an interest in, tributary harvest plans, and therefore shall be provided an opportunity to review and comment on the development of such plans.

The Parties have previously directed TAC to establish a schedule for investigating all upriver escapement goals, management goals and rebuilding objectives. Some progress has been made on this effort. The Parties recognize the importance of this information. Accordingly, the Parties will work with TAC to identify and prioritize their work, including development of upriver escapement goals, management goals and rebuilding objectives.

A. UPRIVER SPRING AND SNAKE RIVER SUMMER CHINOOK

Mainstem Columbia River salmon fisheries occurring from January 1 through June 15 will be managed depending on the abundance of upriver spring Chinook and Snake River summer Chinook. Upriver spring Chinook include all natural and hatchery spring Chinook stocks originating from the Columbia River and its tributaries upstream of Bonneville Dam. Snake River summer Chinook include all natural and hatchery summer Chinook stocks originating from the Snake River watershed.

1. Catch Expectations of the Parties

The Parties recognize that Table A1, Harvest Rate Schedule for Chinook in Spring Management Period sets limits on the percentage of natural origin upriver spring Chinook and SR summer Chinook that can be taken in mainstem fisheries. The Parties recognize that non-treaty fisheries may use mark-selective fishing techniques that allow for a higher harvest rate on marked hatchery fish compared to unmarked fish. Mark rates for hatchery fish subject to those fisheries will be determined in accordance with Part III.A.3. The Parties agree that the fish to be allocated among treaty and non-treaty fisheries are all upriver spring Chinook and Snake River summer Chinook. In agreeing to Table A1, the Parties expect that mainstem fisheries on upriver spring Chinook and Snake River summer Chinook will achieve catches roughly matching those shown in the *U.S. v. Oregon* Upriver Spring Chinook Catch Balance Model (Attachment B). The Parties will monitor whether those expectations are being met, as follows:

a. Each year, the States of Oregon and Washington and the Columbia River Treaty Tribes will monitor mainstem fisheries from January 1 through June 15, and will compare how actual performance compares with predicted performance as shown in Attachment B as part of the annual run reconstruction process;

b. As part of the annual run reconstruction process, the States of Oregon and Washington will monitor and report to the Parties the mark rate in the fishery; the number of fish retained or landed; the number of unmarked fish released; the number of marked fish released; the stock composition of the mortalities; and other information as agreed upon.

c. If the annual run reconstruction reveals that the Parties' catch balance expectations are widely divergent from the results, the Parties agree to meet and discuss whether modifications to the *U.S. v. Oregon* Upriver Spring Chinook Catch Balance Model should be made.

d. In addition, in 2012, TAC will conduct a comprehensive review of the prosecution of upriver spring Chinook and Snake River summer Chinook fisheries governed by this Agreement, and report to the Policy Committee. The Policy Committee will consider the TAC report to evaluate whether the catch expectations shown in Attachment B are being met. If they are not, the Parties will discuss whether to modify this Agreement so as better to meet those catch expectations.

2. Minimum Columbia River Treaty Indian Ceremonial and Subsistence Entitlement

There is a minimum mainstem treaty Indian ceremonial and subsistence entitlement to the Columbia River Treaty Tribes of 10,000 spring and summer Chinook. It is anticipated that the majority of this entitlement will be taken during the January 1 through June 15 management period. Tributary harvest of spring and summer Chinook is not included in this entitlement. It is understood that if the total mainstem Columbia River treaty Indian harvest of spring and summer Chinook is greater than or equal to 10,000 spring and summer Chinook, then this entitlement has been met. If the total mainstem Columbia River treaty Indian harvest of spring and summer Chinook is less than 10,000, then the difference will be distributed to the tribes from spring Chinook hatcheries below Bonneville Dam as first priority. If spring Chinook are not available from hatcheries below Bonneville Dam, or by agreement of the Parties, the entitlement may be filled from other hatchery sources of equivalent quantity and quality.

3. Ocean Fisheries

The Parties assume based on available information that ocean harvest of upriver spring and Snake River summer Chinook in the Pacific Ocean south of the southwesterly projection of the United States-Canada boundary between British Columbia and Washington is, and will continue to be minimal. If new information becomes available related to this assumption, the Parties agree to further discussion and consideration of management adjustments. If non-treaty ocean fisheries are proposed that would increase fishery related mortalities on upriver spring and Snake River summer Chinook above minimal levels assumed herein, the estimated ocean harvest of upriver spring and Snake River summer Chinook shall be reviewed by TAC and shall count toward the total allowable harvest for non-treaty fisheries (Table A1).

4. Non-Treaty Mainstem Columbia River Fisheries

Impacts to natural-origin upriver spring and Snake River summer Chinook in non-treaty commercial and recreational fisheries will be managed according to Table A1 of this Agreement.

5. Treaty Indian Mainstem Columbia River Fisheries

Fisheries conducted by the Columbia River Treaty Tribes will be managed according to Table A1 of this Agreement.

6. Review if Escapement Goals Established

If during the term of this Agreement TAC recommends specific escapement goals to the Policy Committee and the Policy Committee adopts those escapement goals, and if it appears that either the treaty or the non-treaty fisheries governed by this Agreement are not being accorded an opportunity to attempt to take a fair and equitable share of upriver spring Chinook and Snake River summer Chinook, the Parties will review the Harvest Rate Schedule for Chinook in Spring Management Period (Table A1) and discuss whether to modify it so as to achieve fair sharing.

B. UPPER COLUMBIA RIVER SUMMER CHINOOK

Mainstem Columbia River Chinook fisheries occurring from June 16 through July 31 will be managed based on the abundance of upper Columbia River summer Chinook as provided in Table A2. The Parties agree to manage upper Columbia River summer Chinook based on an interim management goal of 29,000 hatchery and natural origin adults as measured at the Columbia River mouth. The management goal is based on an interim combined spawning escapement goal of 20,000 hatchery and natural adults. The following table lists the component of the interim escapement goal. Mainstem fisheries will not be managed for these individual components. The Parties agree to consider new information related to the escapement goals as it becomes available.

Upper Columbia Summer Chinook Interim Goals

Stock Group	Spawning Objective Components
Wenatchee/Entiat/Chelan Natural	13,500
Methow/Okanogan Natural	3,500
Hatchery	3,000

The Northwest Power and Conservation Council has recommended that the Bonneville Power Administration (BPA) fund the construction, operation, and maintenance of a hatchery near the base of Chief Joseph Dam, along with associated facilities, that would produce summer Chinook and other fish. The Parties recognize that, should Chief Joseph Hatchery be constructed, the Chief Joseph Hatchery Program may be approved and implemented during the term of this Agreement. Following any such Program approval, the Parties will instruct TAC to calculate appropriate adjustments to the upper Columbia River summer Chinook interim escapement goals to address the aggregate broodstock and escapement needs of the upper Columbia summer Chinook programs. TAC will present its recommended adjustments to the Policy Committee.

Concerns have been identified by the federal Parties regarding the development of a better data set to monitor and evaluate natural origin and hatchery stock status of upper Columbia summer Chinook as part of the integrated management approach. The Parties direct TAC to review options regarding upper Columbia summer Chinook natural origin and hatchery stock status monitoring and to make recommendations for future consideration by the Parties.

1. Upper Columbia Summer Chinook Fishery Framework

The following table describes the framework for managing fisheries targeting upper Columbia summer Chinook. Table A2 provides the harvest rate schedule for these fisheries.

Upper Columbia Chinook Fishery Framework

Run Size at River Mouth	Allowed Treaty Harvest	Allowed Non-Treaty Harvest
<5,000	5%	<100 Chinook
5,000-<16,000	5%	<200 Chinook
16,000-<29,000	10%	5%
29,000-<32,000	10%	5-6%
32,000- <36,250 (125% of 29,000 goal)	10%	7%
36,250-50,000	50% of total harvestable[1]	50% of total harvestable[1]
>50,000	50% of 75% of margin above 50,000 plus 10,500[2]	50% of 75% of margin above 50,000 plus 10,500[2]

[1]The total number of harvestable fish is defined as the run size minus 29,000 for run sizes of 36,250 to 50,000.
[2]For the purposes of this Agreement, the total number of harvestable fish at run sizes greater than 50,000 is to be determined by the following formula: (0.75 * (runsize-50,000)) + 21,000.

2. Ocean Fisheries

The ocean harvest of Upper Columbia summer Chinook is tracked and assessed annually through the Pacific Salmon Treaty process. If ocean harvest of summer Chinook raises a concern related to achievement of the rebuilding and enhancement goals of this Agreement or catch sharing, the Parties shall review all harvest data, including ocean fishery interceptions. This review shall be completed in sufficient time prior to the opening of the ocean fisheries to allow for any necessary modifications of regulations and production or other enhancement and rebuilding agreements and activities for that year. As a result of this review, the Parties may negotiate a modification to this Agreement as appropriate. For allocation purposes, harvest in the Pacific Ocean south of the southwesterly projection of the United States-Canada boundary between British Columbia and Washington will be counted towards catch sharing.

3. Non-Treaty Fisheries

Non-treaty commercial and recreational impacts in the summer management period will be managed according to the framework and harvest rate schedule in Table A2 of this Agreement. These fisheries include commercial and recreational fisheries in the ocean south of the U.S.-Canada border at run sizes greater than 29,000, commercial and recreational fisheries in the mainstem and tributaries, and ceremonial and subsistence fisheries conducted by the Wanapum Band and the Colville Tribes.

4. Treaty Indian Fisheries

Fisheries conducted by the Columbia River Treaty Tribes will be managed according to the framework and harvest rate schedule in Table A2 of this Agreement. These fisheries include mainstem and tributary fisheries.

C. SOCKEYE

1. Bonneville Dam Management Goal

The management goal for upper Columbia River sockeye is 65,000 adult sockeye as measured at Priest Rapids Dam which, under average migration conditions, requires a 75,000 run over Bonneville Dam.

2. Non-treaty Columbia River Fisheries

Non-treaty commercial and recreational impacts on listed sockeye will be minimized to the degree possible, but the total impact shall not exceed 1% of the river mouth run of listed Snake River sockeye.

3. Treaty Indian Columbia River Fisheries

Fisheries conducted by the Columbia River Treaty Tribes will be managed according to the following schedule; all fishery impacts on sockeye will be included in the specified harvest rates:

Upriver Sockeye Run Size	Harvest Rate on Upriver Sockeye
<50,000	5%
50-75,000	7%
>75,000	7% with further discussion

4. Fisheries on Sockeye Returns Greater than 75,000 Adults

If the upriver sockeye run size is projected to exceed 75,000 adults over Bonneville Dam, any party may propose harvest rates exceeding those specified in Part II.C.2. or Part II.C.3. of this Agreement. The Parties shall then prepare a revised biological assessment of proposed Columbia River fishery impacts on ESA-listed sockeye and shall submit it to NOAA Fisheries for consultation under Section 7 of the ESA.

D. FALL CHINOOK

1. <u>Snake River Fall Chinook Harvest</u>

Fall season fisheries in the Columbia River Basin below the confluence of the Snake River will be managed according to the abundance based harvest rate schedule shown in Table A3. Upriver bright stock Chinook harvest rates will be used as a surrogate for Snake River fall Chinook harvest rates unless TAC develops and the Policy Committee approves a new methodology that makes it possible to manage fisheries based on stock-specific Snake River fall Chinook harvest rates.

2. <u>Review of Adult Conversion Rate Estimates</u>

The Fall Management Period Chinook Harvest Rate Schedule, Table A3, provides that harvest rates may increase or decrease from the status quo of recent years depending on the abundance of Upriver Bright and natural origin Snake River fall Chinook. There is currently some uncertainty regarding estimates of adult conversion rate that are necessary for preseason forecasting. The Parties agree to complete a comprehensive review of all information to determine the best method for estimating the conversion rate of adult fall Chinook by no later than December 2008. In 2009 and thereafter the Parties will use the estimates of conversion rate resulting from this review for forecasting the abundance of Snake River fall Chinook. The Parties agree to continue to update estimates of conversion rate as additional information becomes available through the duration of this Agreement.

3. Harvest Management Objectives for Fall Chinook

The Parties have agreed that the following fishery regimes and management measures will be implemented for fall Chinook fisheries:

a. TAC will annually produce a fall season fishery model output that provides the information for the annual model known as Attachment A. The Parties shall implement fisheries in approximate accordance with this modeled fishery output. The model will include expected river mouth run sizes and Bonneville Dam passage along with overall harvest rates based on river mouth run sizes of fall Chinook, summer steelhead, coho and chum. For fisheries management, the Parties agree to use Attachment A as a template for fishery models.

b. This Agreement contemplates that in the implementation of the non-treaty fisheries, Oregon and Washington agree to manage their fisheries in a manner that will not exceed an URB harvest rate shown in Table A3. If mark selective fisheries are implemented that impact upriver fall Chinook, the non-treaty ocean and in-river fisheries may not harvest more than 50% of the harvestable surplus of upriver fall Chinook, consistent with the applicable federal allocation caselaw.

c. This Agreement contemplates that in the implementation of the tribal fisheries, the Columbia River Treaty Tribes agree to manage their fisheries in a manner that will not exceed an URB harvest rate shown in Table A3.

d. The Treaty Tribes and the States of Oregon and Washington may agree to a fishery for the Treaty Tribes below Bonneville Dam not to exceed the harvest rates provided for in this Agreement.

4. Escapement and Management Objectives

a. McNary Dam: The Parties agree that the minimum combined Columbia River and Snake River upriver bright management goal at McNary Dam is 60,000 adult fall Chinook, which includes both hatchery and natural production for all areas above McNary Dam. The 60,000 McNary Dam goal will be used as part of the annual calculation of harvestable surplus and allocation shares. The Parties also agree that the minimum Upriver Bright adult escapement to meet the combined Hanford Reach, lower Yakima River, and mainstem Columbia River above Priest Rapids Dam natural spawning goal, as well as the current Priest Rapids Hatchery production goal is 43,500 adult fall Chinook (this historically included a minimal run to the Snake River). In the event of anticipated low returns of upriver bright fall Chinook to the Hanford Reach, notwithstanding the provisions of Table A3, ocean and in-river fisheries will be managed at the discretion of the Parties to help achieve the escapement goal. If future hatchery production is modified as a result of mitigation agreements or new production programs, then the Parties will instruct TAC to calculate appropriate adjustments to the McNary Dam management goal to address program adjustments and natural production needs for this area. TAC will present its recommended adjustments to the Policy Committee.

b. Spring Creek National Fish Hatchery (NFH): The Spring Creek NFH escapement necessary to meet the full hatchery program requirements is 7,000 adult fall Chinook (4,000 females) which is expected to produce a 15 million smolt release. Ocean and in-river fisheries will be managed to help achieve this escapement in accordance with the fishing regimes described herein.

c. Klickitat Hatchery: The Klickitat Hatchery program production needs of 2,400 adult bright fall Chinook shall not be a management constraint. Until the Klickitat Hatchery implements a broodstock collection program, the broodstock need for Klickitat Hatchery fall Chinook shall be made up from bright fall Chinook returning to Little White Salmon NFH or other appropriate hatchery that is above base program needs. In the event base program needs cannot be met, the Parties agree to develop a program, which will address the shortfall.

d. Little White Salmon NFH: The number of bright fall Chinook adults necessary to meet the full production program, including the on-station release program of 2.0 million smolts, the 1.7 million transfer to the Yakima River, and the Klickitat

Hatchery program need, is 4,400 fish (2,200 females). The Little White Salmon NFH escapement goal shall not be a management constraint.

e. Mid-Columbia Fall Chinook: The Parties have used the interim escapement goals recommended by TAC for Mid-Columbia tributaries for the purposes of developing the annual fishery model known as Attachment A. Mid-Columbia bright fall Chinook escapement is not a management constraint for fisheries.

f. Deschutes River: The Deschutes River fall Chinook stock is of special management concern. If a Deschutes River mouth sanctuary closure to fall Chinook fishing is determined to be necessary, then the Parties commit to conducting on the water monitoring and enforcement of any steelhead subsistence or sport fishing occurring in the closed area for the purpose of determining the incidental mortality of Chinook in those fisheries.

5. <u>Ocean Fisheries</u>

The Parties recognize that the Secretary of Commerce adopts regulations recommended by the Pacific Fishery Management Council (PFMC) that annually establish a Chinook catch quota for all fisheries south of the U.S.-Canada border. The ESA ocean fishery management criteria currently requires a 30 percent reduction of the total harvest impact on Snake River fall Chinook from the 1988-93 base period for all ocean fisheries combined (including Canadian and S.E. Alaskan fisheries). The Parties acknowledge that all U.S. ocean fisheries will be managed consistent with the ESA ocean fishery management criteria and applicable case law under *United States v. Oregon*. If NOAA Fisheries modifies the ESA ocean fishery management criteria, the Parties will discuss whether it is appropriate to reconsider criteria for in-river fisheries.

6. Non-treaty Columbia River Fisheries

Fall season Non-treaty fall season fisheries will be managed in approximate accordance with modeling summary results annually described in Attachment A and Part II.D.3 of this Agreement. Non-treaty fisheries shall be managed to not exceed the over-all URB Chinook harvest impacts listed in modeling summary results annually described in Attachment A. It is the intent of the Parties that conduct of the Hanford sport fishery will not in any manner constrain the treaty Indian fishery unless the tribes have already achieved the treaty tribal fisheries' share as described in modeling summary results provided in Attachment A.

7. Treaty Indian Fisheries

The fall season treaty Indian fishery shall be managed in approximate accordance with modeling summary results annually described in Attachment A and Part II.D.3 of this Agreement. Commercial fishing in Zone 6 of the Columbia River shall remain an exclusive treaty Indian fishery. The actual fishing dates, gear restrictions, and other shaping measures with respect to this fishery shall be defined by the tribes in-season as the fishery progresses.

8. In-Season Review

The Parties shall meet in-season to review run size updates and the fisheries that have occurred up to that point. If that review suggests that the States of Oregon and Washington or the Columbia River Treaty Tribes will be unable to achieve the fisheries or harvest sharing objectives described in Part II of this Agreement by continuing to adhere to the harvest rates set forth in Part II.D.3.b. and c. or Part II.E.3 and 4, the Parties may, by agreement, adjust those harvest rates. The total URB harvest rate resulting from such an adjustment shall not exceed those shown in Table A3. The total Group B index steelhead fall season harvest rate resulting from such an adjustment shall not exceed the rates shown in the abundance based harvest rate schedule shown in Table A4.

E. STEELHEAD

1. Management Principles

The Parties have discussed the concerns identified by the tribes regarding the appropriateness of Group A and B steelhead stock separation as applied to fisheries management relative to non harvest activities. Information and harvest management criteria will be established to address steelhead management issues. The Parties direct TAC to make recommendations to the Policy Committee for further studies as needed to address steelhead management issues. For the purposes of this Agreement, Group B index steelhead are defined as any steelhead measuring at least 78cm fork length and passing Bonneville Dam between July 1 and October 31.

2. Steelhead Escapement Goals

TAC has completed a review of Snake River steelhead escapement information. The Parties will consider the information in monitoring management activities.

3. Non-treaty Columbia River Harvest

Non-treaty fisheries in the mainstem Columbia River will be managed in approximate accordance with modeling summary results annually described in Attachment A. These fisheries will result in a harvest rate that is no greater than that shown in Table A4. Non-treaty fisheries for steelhead in the mainstem Columbia River and its tributaries will be managed consistent with *United States v. Oregon* and *United States v. Washington* case law principles regarding harvest sharing. All Non-treaty fisheries outside the Snake River basin will be managed not to exceed 2% harvest impact for natural origin Group B index steelhead. Oregon and Washington will provide catch estimates annually. The harvest impacts will be estimated for Group A and Group B index steelhead.

4. Treaty Indian Zone 6 Harvest

Zone 6 Treaty Indian fall season fisheries will be managed in approximate accordance with modeling summary results annually described in Attachment A. These fisheries will result in a harvest rate that is no greater than that shown in Table A4. The tribes will employ standard management tools, at their discretion, to stay within the steelhead guideline while achieving the fall Chinook allocation.

F. COHO

1. Management Principles

An important aspect of this Agreement is to define an understanding among the Parties regarding procedures and schedules for mass marking of Columbia River hatchery coho originating from state and federal facilities, for clarifying releases above Bonneville Dam, and for subsequent fishery management. The Parties recognize that the actions defined in this Agreement reflect the Parties' best efforts at reaching a negotiated agreement to protect, rebuild, and enhance upper Columbia River coho while providing harvests for both treaty Indian and non-treaty fisheries.

2. *United States v. Oregon* Harvest Sharing Principle

The Parties agree to implement fisheries in the Pacific Fishery Management Council (PFMC) and Columbia River Compact fora that provide treaty Indian and non-treaty fisheries the opportunity to each harvest 50 percent of the upriver adult coho available for harvest south of the U.S.-Canada border. The provision for 50 percent of the defined upriver adult coho run size to non-treaty fisheries shall include any catches in sport fisheries above Bonneville Dam as well as sport and commercial fisheries below Bonneville Dam and in the ocean. The upriver coho run is comprised of both early and late stocks.

3. Responsibilities for Costs

This agreement does not commit the tribes to additional costs directly related to mass marking and a selective fisheries plan. These envisioned costs specifically include providing for equipment use and maintenance, costs for marking and tagging operations and increases in staff for coded-wire tag sampling, if any are required. The parties sponsoring and conducting mass marking will carry out this responsibility by providing equipment and technical assistance when needed.

4. Escapement Objectives

Non-treaty fisheries will be managed to achieve at least the collective brood stock escapement necessary to fulfill Columbia River hatchery production goals, including hatchery programs both above and below Bonneville Dam. TAC shall provide a recommended spawning escapement goal analysis to the Policy Committee. The Parties intend to gather information for developing a coho spawning escapement goal and/or a management goal (in Bonneville Dam equivalents). In the event of agreement on a natural spawning escapement goal for upriver coho, the 50 percent sharing agreement shall apply to that portion of the run size in excess of the agreed natural spawning escapement goal.

5. Fisheries Management

The Parties agree that all fisheries, including selective and non-selective types, affecting upper Columbia River coho, will be implemented as a result of the co-management process that includes the North of Cape Falcon Forum, the PFMC, the Columbia River Compact, and *United States v. Oregon* Columbia River tributary jurisdictions. The Parties recognize that the Secretary of Commerce will adopt regulations recommended by the PFMC that establish ocean salmon fisheries for all areas south of the U.S.-Canada border. Upriver coho impacts in ocean and Columbia River Basin fisheries shall be described annually. Catch-and-release mortalities associated with non-treaty selective fisheries will be included in calculations of the total upriver run size and the harvest sharing provisions of Part II.F.2 of this Agreement. The Parties agree that selective and non-selective fishery options will be evaluated on their merits consistent with the management objectives and fishery sharing provisions stated in this Agreement and there is no assurance that selective fisheries will occur simply because marking has occurred. The Parties acknowledge that coho fisheries will be managed consistent with the harvest sharing principles. Fisheries adjustments in-season will also be made accordingly.

G. WHITE STURGEON

1. Management Goals

The intent of the Parties is to manage sturgeon populations in the Zone 6 fishing area to provide long term sustainable harvest opportunities for Indian and non-treaty fisheries. The current status of the sturgeon population is the key factor in determining appropriate harvest levels. The Parties commit to continue ongoing studies to estimate present and optimum population levels, life history characteristics, recruitment, spawning potential and appropriate sturgeon fishing sanctuaries.

2. Management Measures

Oregon, Washington and the Columbia River Treaty Tribes have established a joint Sturgeon Management Task Force. They will continue to meet regularly in that forum to review sturgeon management issues and set harvest guidelines for the upcoming year. Information to be reviewed includes recreational, commercial and subsistence landings for each reservoir between Bonneville and McNary Dam. Estimates of encounters in non-retention recreational activities will also be provided. The Sturgeon Management Task Force shall determine the harvest guidelines for each reservoir annually. The effectiveness of harvest management shall be measured relative to a three-year rolling average of the guidelines. Annual harvest guidelines may be adjusted to account for cumulative overages/underages. The treaty catch may be taken in gillnet, setline, platform or hook-and-line fisheries.

Oregon, Washington, and the Columbia River Treaty Tribes agree to undertake a review of sturgeon management regulations. The effect of size limits, sanctuaries and other regulations on the harvest guidelines will be estimated.

The Parties commit to pursuing enhancement activities, along with the necessary funding, for sturgeon populations in the Zone 6 fishing area. Activities considered will include, but not be limited to, artificial propagation, transplantation from other areas and flow augmentation. The Parties agree that funding for ongoing studies to estimate present and optimum population levels, life history characteristics, recruitment, spawning potential and appropriate sturgeon fishing sanctuaries is essential to successfully managing these populations.

H. SHAD

Shad runs have been sufficiently large to allow for major expansion of harvest. However, markets are limited and need to be developed for this species. Development of catch methods shall be pursued to promote a sufficient catch of shad while minimizing the catch of other species. The Parties shall seek to minimize the harvest of salmon incidental to treaty Indian and non-treaty shad fisheries as set forth in Part II, Sections A.4 and 5, B.3 and 4, and C.2

and 3. The incidental shad catch during treaty Indian fisheries for anadromous fish may be sold or otherwise utilized. The tribes may also implement directed shad fisheries using traps or other appropriate gear. All incidental impacts to salmon and steelhead will be accounted for as part of applicable harvest guidelines.

I. WALLEYE AND OTHER NON-NATIVE SPECIES

The incidental catch of walleye and other fish species not native to the Columbia River during treaty Indian fisheries for anadromous fish may be sold or otherwise utilized. Non-treaty fisheries on walleye shall continue under state regulation, which prohibits the sale of walleye.

J. LAMPREY

The Parties recognize the depressed status of lamprey populations originating from upstream of Bonneville Dam. The Parties acknowledge that factors other than harvest have been the major cause of population decline. The Parties commit to jointly support efforts to identify and implement projects to restore lamprey populations above Bonneville Dam.

There shall be no commercial harvest of lamprey in the Columbia River and its tributaries. This does not prevent trade or barter among Indian Tribes, or harvest for personal use by non-Indians, if otherwise permitted. The

Parties recognize that opportunities for harvest of lamprey are extremely limited. In recent years, the primary opportunity for harvest of lamprey has been at Willamette Falls. Annual take levels will be determined through a process that includes discussions between the State of Oregon and the tribes.

K. RESEARCH AND MONITORING

The *United States v. Oregon* Parties have agreed to a series of species-specific harvest management regimes described in Part II. Implementing those management regimes requires continuation of essential monitoring activities. Additional research and monitoring is needed to improve the accuracy and precision of management. Important components of a comprehensive research and monitoring program include, but are not limited to, those described below. The Parties agree that maintaining a vigorous research and monitoring program is essential to continued implementation of the harvest regimes as envisioned in this Agreement. The Parties therefore agree to work together to maintain funding for current programs, and seek additional funding that are considered essential to increase certainty in the conservation effectiveness of the harvest strategies contained within this Agreement.

1. Current Needs

a. Fisheries sampling for stock composition including impacts to natural origin fish.

b. Fishery effort accounting.

c. Natural spawning escapement enumeration.

d. Run reconstruction and forecasting.

e. Observer programs and test fisheries.

f. Dam passage sampling.

2. Additional Needs

a. Snake River fall Chinook run reconstruction and forecasts.

b. Enhanced natural spawning escapement enumeration.

c. PIT tag sampling.

d. Increase sampling effort to maintain necessary fishery sampling rates.

e. Evaluate genetic stock identification methods to further improve stock identification.

III. PRODUCTION ACTIONS

A. MANAGEMENT PRINCIPLES

1. General Statement

The Parties have responsibilities with regard to the conservation, rebuilding, and/or enhancement of the anadromous salmonids of the upper Columbia River Basin. The

Parties also recognize the existing Northwest Power and Conservation Council’s interim rebuilding goal to increase total adult salmon and steelhead runs above Bonneville Dam by 2025 to an average of 5 million annually in a manner that supports tribal and non-tribal harvest (Council Document 2000-19, III.C.2.). The Parties intend to use artificial production techniques where appropriate, among other strategies, to assist in rebuilding weak runs and mitigating for lost production. The Parties' stated intent to implement the production actions described in this Agreement is an important consideration to the Tribes. These production actions, in conjunction with other enhancement efforts, habitat protection, hydrosystem management, and harvest management, are intended to ensure that Columbia River fish runs continue to provide a broad range of benefits in perpetuity.

2. Research, Monitoring, and Evaluation

The Parties will work in cooperation to continue developing monitoring and evaluation programs for the production actions contained in this Agreement and for any production program modifications implemented under Part I.B.2 and III.A.1. Monitoring and evaluation programs for production shall be consistent with the research and monitoring activities for harvest described in Part II.K, and may use some of the same tools. Therefore, the Parties commit to retain flexibility as they develop monitoring and evaluation programs, to use their best efforts to maintain current funding for monitoring and evaluation programs, and to secure additional funding to address information needs. The Parties will integrate information gained from monitoring and evaluation with the production strategies in this Agreement so as to increase certainty in their conservation effectiveness.

3. Marking

The Parties recognize and have discussed the concerns identified by the Parties regarding marking protocols for various production programs identified in this Agreement. Marking scenarios identified in this Agreement are expected to occur during the period of this Agreement. It should not be interpreted that each marking program has the full support of all Parties or that any Party waives any rights it may have with regard to any marking protocol. Nothing in this Agreement shall be interpreted as setting precedent for future marking programs or as preventing Parties from reaching other agreements on individual marking programs which may be implemented during or after termination of this Agreement; provided, however, that notice of such agreements shall be given to the other Parties. All

Parties commit to make a good faith effort to continue discussions and negotiations on individual marking issues during the period of this Agreement.

In regards to spring Chinook programs described as TBD in Table B1, the Parties agree to engage in a “basin by basin” approach to develop marking protocols. The Parties will evaluate releases in all tributaries within a sub-basin. The Parties will take into account the purpose of the releases and the interests of the appropriate Parties, and accommodate all Party interests to the extent possible. The Parties will place particular emphasis on evaluating the marking protocols and allowable harvest rates that affect the harvest sharing principles embodied in this Agreement.

Nothing in this Agreement shall be interpreted to prevent the federal Parties and/or states from mass marking fish required to be marked under Section 113 of the Consolidated Appropriations Act, 2008 (PL 110-161) or other Congressional acts directing the mass marking of Chinook, coho, and steelhead intended for harvest which are released from federally operated or financed hatcheries. In the event USFWS and/or states mark fish inconsistent with Tables B1-B7, nothing in this Agreement prevents any party from challenging these acts. In the event of insufficient funding to carry out such marking, the federal Parties will consult with the other Parties to review and revise the priorities in any marking plan provided for under this Agreement. The federal Parties will, to the extent required by law, consider the other Parties' recommendations and the United States' trust and treaty responsibility to the Tribes before deciding marking priorities.

4. Broodstock, Facility and Funding Needs for Production Programs

The Parties hereby commit to a good faith effort to meet the juvenile release programs identified in Tables B1, B2, B3, B4(A or B), B5, B6, and B7. However, juvenile release levels will be dependent on obtaining adequate returns of broodstock, maintaining adequate facility rearing space, and funding to accomplish the agreed-to production programs. The Parties recognize that much of the funding for the production programs central to this Agreement is the responsibility of entities that are not Parties to this Agreement (e.g., BPA, BOR, COE, PUDs and private entities) as mitigation for Columbia River Basin water development projects. All the Parties agree to work cooperatively to provide the necessary facility rearing space and to make a good faith effort to secure the necessary funding for these production programs. In the event that production program goals are not achievable, the Parties will negotiate contingencies on a case-by-case basis through the *United States v. Oregon* Policy Committee and Dispute Resolution process.

For production programs that are not included in Tables B1-B7, the Parties commit annually to provide their individual production plans for review and discussion by the PAC. As a result of this review, the PAC will determine if there are issues that should be forwarded to the Policy Committee. Any such issues will be discussed annually at the Mid-Winter Meeting or otherwise designated negotiation session.

5. Mitchell Act Funding

The Parties agree to request, and to use their best efforts to secure, sufficient funding to carry out production management measures set forth in Tables B1-B7. If appropriations through the duration of this Agreement contain sufficient funding to carry out current Mitchell Act programs, the Parties agree to implement the Mitchell Act production actions as set forth in this Agreement subject to compliance with all applicable laws. If there is insufficient funding to maintain current Mitchell Act programs, then, consistent with the Anti-Deficiency Act, the United States cannot commit to fund any particular

Mitchell Act program. In the event of such insufficiency in Mitchell Act appropriations to meet all of the Parties' desires, the United States will consult with the Tribes and the States to review and revise the Mitchell Act program in light of the actual Fiscal Year appropriations, and, the United States will give good faith consideration to all Parties' recommendations, the United States' trust responsibility to the tribes, and Mitchell Act history before deciding which Mitchell Act program actions will be funded. It is not the Parties’ intent to eliminate or substantially reduce any Mitchell Act programs, however the upriver releases identified in this Agreement have priority over lower river releases. The Parties understand that options for any program changes will be considered pursuant to Part I.C.

6. Non-Mitchell Act Funding

Implementation of other non-Mitchell Act funded production measures in this Agreement may involve new costs that are funded by government and non-government entities. For programs funded by the federal agency signatories, non-Mitchell Act production measures are subject to obtaining funding sufficient to implement the measures and are subject to compliance with all applicable laws. The Parties agree to request, and to use their best efforts to secure, sufficient funding to carry out production management measures set forth in Tables B1-B7. If there is insufficient funding to implement non-Mitchell Act programs funded by a federal agency signatory, the Parties will consult to review and revise the program measures in light of the funding for that year. The United States will give good faith consideration to all Parties' recommendations, the United States' trust responsibility, and the purpose and history of the program before deciding which programs will be funded.

B. SPRING CHINOOK PRODUCTION

The Parties agree to implement spring Chinook production programs described in Table B1: Spring Chinook Production for Brood Years 2008-2017. In developing marking protocols, the Parties agree to take a "basin by basin" approach as described in Part III.A.3.

C. SUMMER CHINOOK PRODUCTION

The Parties agree to implement summer Chinook production programs described in Table B2: Summer Chinook Production for Brood Years 2008-2017.

D. SOCKEYE PRODUCTION

The Parties agree to implement sockeye production programs described in Table B3: Sockeye Production for Brood Years 2008-2017.

E. FALL CHINOOK PRODUCTION

1. Snake River Fall Chinook Supplementation Program

a. The Parties all have an interest in the current Snake River (SR) fall Chinook production program, its effects on SR fall Chinook abundance and productivity, and the magnitude or relative impact of the current production program compared to other actions and conditions that influence SR fall Chinook abundance and productivity. With the implementation of the SR fall Chinook supplementation program, the abundance of natural origin SR fall Chinook has significantly increased thereby effectively reducing the near-term risk to the population's persistence.

The Parties agree that the effect of the current supplementation strategy on SR fall Chinook abundance, productivity, spatial structure, and diversity, and the magnitude or relative impact of the current production program to other actions that influence SR fall Chinook will continue to be evaluated over the course of this Agreement. If, during the course of this Agreement, additional data or changed circumstances arise associated with the SR fall Chinook, then the Parties agree to consider options to address the issue identified, including whether to modify the current supplementation program or consider other management responses.

In the event that NOAA seeks to revise the SR fall Chinook supplementation program utilizing its ESA authorities, or another event triggers ESA-based re-consideration of the SR fall Chinook supplementation program during the term of this Agreement, NOAA shall meet with all the Parties to analyze the SR fall Chinook supplementation program compared to other actions and conditions that influence SR fall Chinook abundance, productivity, spatial structure and diversity, as well as legal principles, including but not limited to the Tribes' treaty rights, the States' interests, the Secretarial Order on ESA and Tribal Treaty rights, the conservation necessity principles and the ESA.

b. The Parties agree to implement Snake River fall Chinook production programs described in Table B4A or B4B: Snake River Fall Chinook Production for Brood Years 2008-2017 pursuant to action defined above.

c. The Parties will meet annually prior to September 15 of each year to develop broodstock collection protocols needed to implement Table B4A or

B4B. In the case of broodstock shortages, priorities outlined in Table B4A or B4B (whichever is in effect) will be followed. Annual plans for the respective fall Chinook brood year will be provided to PAC by October 1 of each year.

d. Trapping of adult fall Chinook at Lower Granite Dam will occur at a fixed percentage rate agreed upon by the fishery managers prior to initiation of trapping at the dam. Trapping is to provide for broodstock collection (hatchery and natural origin), accurate run reconstruction, and for removal of non-Snake origin fish.

e. The Parties will work cooperatively to seek and maintain adequate funding to operate the Lower Granite Dam trap to further the goals of the Snake River production programs.

f. A monitoring and evaluation implementation plan remains in development as part of the long term production plan for SR fall Chinook to support conservation and harvest programs. In the interim, an appropriate number of fish will be coded-wire tagged for evaluation purposes as identified in Table B4A or B4B. The tagging/marking technique shall allow for the adult returns of the off-site released juvenile

Lyons Ferry Hatchery fall Chinook to pass the Lower Granite Dam trap because it is the Parties' intent that current trapping protocols at Lower Granite Dam will ensure that the majority of supplementation fish will pass upstream of Lower Granite Dam to spawn naturally. Unless the Parties agree otherwise, the adult returns from juvenile SR fall Chinook releases that are surplus to broodstock needs shall be allowed to pass Lower Granite Dam to spawn naturally.

g. The Parties shall coordinate the use of Lyons Ferry subyearling production for supplementation and research. To facilitate research review, the Parties shall consider research proposals through existing research review forums. In order to protect the integrity of the Parties' production commitments with regard to SR fall Chinook contained in this Agreement, research proposals are subject to review and agreement of the Parties. Such agreement shall not be unreasonably withheld.

h. The PAC shall provide an annual update report of SR fall Chinook adult returns and expected egg-take by November 1. The PAC shall also provide an actual egg-take and juvenile production estimate report by January 15 of each year.

2. Other Fall Chinook Production

The Parties agree to implement other fall Chinook production programs described in Table B5: Fall Chinook Production for Brood Years 2008-2017. The Parties will finalize and present to US Army Corps of Engineers their agreed-to position for appropriate John Day and The Dalles Dams Mitigation levels by December 2008. The Parties will coordinate changes associated with these production programs.

F. STEELHEAD PRODUCTION

1. Steelhead Production for Brood Years 2009-2018

Hatchery steelhead from the 2009-2018 brood (fish that return to the Columbia River in 2008-2017 and will spawn in 2009-2018) shall be implemented as described in Table B6: Steelhead Production for Brood Years 2009-2018. The Parties agree to continue a monitoring and evaluation program for the mass marking and selective fisheries program in the Columbia River Basin. A purpose of the program is to evaluate catch and release mortalities to unmarked steelhead.

2. Monitoring Adult Composition

The Parties commit to seek funding for a program to monitor the composition of adult steelhead returning above Bonneville, Lower Granite, and Priest Rapids dams. The

Parties commit to working with US Army Corps of Engineers to improve sampling at Bonneville Dam. This program is expected to include the collection of scales from adult steelhead at Bonneville, Lower Granite, and Priest Rapids dams to assist in monitoring hatchery and natural origin adult escapement to the Snake River and upper Columbia River areas.

G. COHO

1. Purpose of Program Modifications

The coho program modifications described below are a result of a negotiated agreement between the Parties to address mass marking, the selective fisheries program, and the Parties' desire to restore upriver coho runs.

2. Upriver Coho Production for 2008-2017 Brood Coho

The Parties agree to implement upriver coho production and reintroduction programs described in Table B7: Coho Production for Brood Years 2008-2017.

3. Grande Ronde Program

The Parties understand that new funding will be necessary for this program. If funding is obtained, the Parties will develop a reintroduction plan and agree to release numbers, acclimation location (Wallowa Hatchery), a marking plan, and a monitoring and evaluation plan. If the final release number in the Wallowa /Grande Ronde River is less than 500,000 smolts, the balance of the production will revert back to release in the Umatilla River.

4. Priority for Upriver Programs

Except as described in Table B7, for each respective brood year, the upriver releases identified in this Agreement have priority over lower river releases. The states of Oregon and Washington and the United States shall manage lower river hatchery programs such that upriver release levels will meet the coho release goals described in Table B7. In the event of a juvenile rearing catastrophe, the Parties agree to consider alternative release strategies, which may include but are not limited to making up the shortfall in subsequent broodyears.

5. Contingency

The Parties recognize that disease, weather disasters, or other unforeseen events might impact non-mass marked upriver coho programs and result in a situation where already mass-marked lower river coho are the only fish available to be reprogrammed for an upriver release to meet the release goals identified in this Agreement. Therefore, if a shortfall in non-mass marked coho for upriver programs occurs after mass marking is completed, the Parties will meet and agree on how best to address the shortfall.

H. PRODUCTION ISSUES REQUIRING FURTHER DEVELOPMENT

The Parties acknowledge that on-going hatchery reviews, production planning, and other factors complicate the Parties' ability to finalize some of the production programs described in tables B1-B7. The Parties commit to good faith efforts to continue the development of production plans, including descriptions of issues requiring policy guidance, analyses of technical issues, and identification of funding mechanisms, in order to reach consensus on outstanding issues that prevent the finalization of Tables B1-B7.

The following list of production issues is recognized as being of high priority for resolution by the Parties but is not intended to exclude other production issues that may arise during the term of this Agreement. The Parties commit to good faith effort to better define and/or resolve issues and engage in cooperative planning for the implementation of the following programs:

1. <u>Table B1, Spring Chinook Salmon</u>

   a. Leavenworth NFH complex spring Chinook program levels, release locations, development of locally adapted broodstocks, and marking protocols.

b. Kooskia NFH spring Chinook integrated broodstock management and smolt release guidelines to reimplement supplementation in Clear Creek.

c. Sawtooth FH spring Chinook, Pahsimeroi FH summer Chinook, and McCall FH summer Chinook integrated broodstock management guideline and release protocols to reimplement supplementation.

d. Yankee Fork spring Chinook development of locally adapted broodstock for supplementation and production planning that also considers the Sawtooth FH program.

e. Review of options for initiating a Lemhi River spring Chinook supplementation program.

2. Table B2, Summer Chinook Salmon

a. Turtle Rock, Eastbank, and Wells FH summer Chinook development of new acclimation facilities and marking protocols.

b. Yakima River summer (early fall) Chinook reintroduction.

c. Johnson Creek summer Chinook reassessment of program size.

3. Table B3, Sockeye Salmon

a. Stanley Basin sockeye program expansion.

b. Wallowa Lake sockeye reintroduction program.

c. Lake Cle Elum sockeye reintroduction program.

4. <u>Table B5, Fall Chinook Salmon</u>

a. Spring Creek NFH fall Chinook reprogramming and John Day mitigation program.

b. Klickitat fall Chinook salmon master plan and implementation.

c. Priest Rapids Hatchery fall Chinook marking protocols (Grant County PUD mitigation program).

5. <u>Table B6, Steelhead</u>

a. Wenatchee, Methow, Okanogan steelhead development of new acclimation facilities and marking protocols.

b. Methow River/Winthrop NFH and Okanogan River steelhead management plan developed by January 2009.

c. Walla Walla, Touchet, Tucannon, and lower Grande Ronde River steelhead management plan developed for broodyear 2010.

d. South Fork Clearwater River and Lolo Creek steelhead local broodstock transition and production planning for broodyear 2010.

e. Yankee Fork of the Salmon River steelhead local broodstock transition and production planning for broodyear 2010.

f. Klickitat Basin Steelhead Master Plan.

6. Table B7, Coho Salmon

a. Entiat NFH coho development of implementation guidelines for program objectives, size, release locations, and marking protocols.

b. Wallowa FH coho reintroduction.

c. Klickitat Basin Coho Master Plan.

I. PROCESSES FOR ONGOING OR FUTURE REVIEWS AFFECTING PRODUCTION PROGRAMS, AND FOR HIGH PRIORITY PRODUCTION ITEMS THAT WILL REQUIRE FURTHER DEVELOPMENT, COOPERATIVE PLANNING, AND RESOLUTION

1. Process for Ongoing or Future Reviews Affecting Production Programs

The Parties recognize that ongoing or future reviews of hatchery management programs and policies may affect the production Programs described in this Agreement. Program modifications recommended by NOAA as a result of the ESA Section 7 Process are addressed in Section I.B.2 of this Agreement. Program modifications proposed by any other Party, will be considered by the *U.S. v. Oregon* Parties on a case-by-case basis, and the following specifics shall apply consistent with the general modification provision in Section I.B.8 of this Agreement. The Parties will consider the relationship of the proposed modification to the overall Agreement and the valuable exchange of consideration the Agreement represents. After considering any modification, the Parties may agree to modify the Agreement, renegotiate the Agreement, or pursue any and all options they may have, including but not limited to dispute resolution pursuant to this Agreement, withdrawal from this Agreement, or initiating legal action. The Parties commit to monitor and evaluate the effects of program modifications on adult returns and fishery opportunity as a condition of agreement to a modification.

2. Process for High Priority Production Items That Will Require Further Development, Cooperative Planning, and Resolution

The Parties have identified a list of high priority production items set forth in Part III.H that will require further development, cooperative planning, and resolution during the course of this Agreement and could result in modification of tables B1-B7.

The Parties agree that additions, deletions, or modifications to tables B1-B7, aside from those subject to Part I.B.2, may be made by agreement of the Parties at any time during the term of this Agreement. The following specific process shall apply to the extent feasible consistent with the general modification provision of Section I.B.8.

a. The Party proposing any such modification is responsible for supplying to other Parties all relevant information and rationale supporting a proposal. All proposals must be submitted to PAC by the relevant co-managers or Parties for technical analysis and eventual recommendation to the Policy Committee.

b. Planning efforts in connection with the proposal will occur at a sub-basin level, and appropriate Parties (as identified in Table 1) for each production program proposal will make a good faith effort to participate in and contribute to the planning effort.

c. Each Party shall advise and update its PAC representative regarding progress on production program planning efforts. An annual progress report will be provided by the PAC to the Policy Committee on each production item after coming under active consideration by the Parties.

d. In the event PAC cannot reach a consensus recommendation, an issue paper will be prepared for Policy Review which describes the issue preventing consensus and contains relevant facts of the dispute. If the Policy Committee cannot reach consensus, any Party may elect to invoke the Dispute Resolution procedure in Part I.C.6.

e. If the Parties reach consensus on a proposed modification, they shall incorporate the modification into this Agreement.

Schedule A: Schedule for Committee Activities

Annual TAC Schedule

Report/Activity	**Information**	**Dates/Deadlines**
Spring/summer season management (spring, summer, sockeye)	Post-season run reconstruction Pre-season run forecasts	November – December Mid-December
Steelhead	Post-season run reconstruction Pre-season Forecasts	December-January January
Fall season management (TAC works with Joint State Staff to accomplish these tasks)	Post-season run reconstruction (all managed fall Chinook stock groups including Snake River Fall Chinook) Pre-season forecasts	November- February February
Winter Season Joint Staff Report Sturgeon/Smelt (TAC works with Joint State Staff)	Stock status/management guidelines Fishery review/recommendations TAC review of document	Final document available mid- December Early December
Winter/Spring Season Joint Staff Report and Spring Chinook / Steelhead (TAC works with Joint State Staff)	Stock status/Run forecasts, Management guidelines, Fishery review/recommendations TAC review of document	Final document available January Early January
Fall Season Joint Staff report Fall Chinook, coho, steelhead (TAC works with Joint State Staff)	Stock status/run forecasts, Management guidelines, Fishery review/recommendations TAC review of document	Final document available Mid-July Early July
Annual Summary Report (for Policy Committee)	Final Post-season impacts from all fisheries compared to targets in Management Agreement for previous year. Includes Spring Catch Balance report, Fall summary report, Indicator Stock summary Report, and ESA Impact report.	March/April
In-season spring management	Assist Joint State staff with Compact Fact Sheet development Run size updates Fishery updates	Weekly February – May
Pre-season fall management	Run forecasts Fall fishery planning/PFMC/NOF	Mid-February March – April
In-season summer management	Assist Joint State staff with Compact Fact Sheet development Run size updates Fishery updates	Weekly June-July
Post-season spring/summer season summary report for Policy Committee	Fishery Impact Summary for spring and summer season fisheries	August-October
In-season fall management	Compact Fact Sheet development Run size updates/fishery updates	Weekly August – October
Post-season fall season summary report for Policy Committee	Fishery Impact Summary for fall season fisheries	November-December

Annual PAC Schedule

Report/Activity	**Information**	**Dates/Deadlines**
Production plan modifications based on preseason forecast	Spring/summer Chinook Fall Chinook/coho/ Steelhead	Early April Early August
Preliminary tributary escapements	Spring/summer/fall Chinook Coho Steelhead	Early November Early December Mid-June
Determine Lower Granite trapping and broodstock collection protocols	Fall Chinook	August
Post-season escapement and identification of production changes	Spring/summer/fall Chinook Coho Steelhead	Early December Early December Early May

Note: Columbia Basin production activities involve a wide number of agencies and staff. Different agencies, including parties to this agreement, delegate aspects of the above responsibilities to staff who may not be members of PAC. PAC will involve itself as needed to ensure these tasks are accomplished and PAC will work with state, federal agency staff and tribal staff as needed to collect appropriate information regarding the above activities and report it to the Policy Committee. PAC will share information regarding current production programs not included in Tables B1-B7. PAC is directed by the Policy Committee to assist in resolution of any disputes regarding production programs included in this agreement and report any issues requiring policy resolution. TAC and PAC will provide additional data and analysis as requested in order to implement this Agreement.

Annual Policy Committee Schedule

Report/Activity	**Information**	**Dates/Deadlines**
<u>Mid-Winter Meeting</u> - Specified negotiation topics - Fall fisheries post-season review - Spring and summer management period fishery preview - Sturgeon Management Task Force meeting - Production review and annual decision point for (non-steelhead) production program issues	Briefing papers TAC post-season fall season fishery report TAC pre-season fishery report (Summary of Forecasts and Joint Staff Report) Staff/TAC sturgeon technical reports/abundance data Proposed production modifications	January-February
<u>Mid-Spring Meeting</u> - Specified discussion topics - Potential Non-Party Interaction - Fall management period fishery preview - Mid-spring season fishery update - Review Annual Indicator	Briefing papers Issue Papers TAC pre-season fishery report (Summary of PFMC/NOF and in-river fishery modeling) TAC spring season update TAC Annual Indicator	April-May

Report/Activity	**Information**	**Dates/Deadlines**
Summary Report	Summary Report	
<u>Mid/Late Summer Meeting</u> - Specified discussion topics - Spring/summer fisheries post-season review - Fall Season Management Issues - Production review and annual decision point for steelhead production program issues	 Briefing papers TAC post-season spring/summer season fishery report TAC report PAC report	August-September

Table 1. Lead management entities for each sub-basin.*

Sub-Basin	**Fishery Management Entities**		**Sub-Basin**	**Fishery Management Entities**
Wind River	WDFW, YIN		Little White Salmon River	WDFW, YIN
Big White Salmon River	WDFW, YIN		Klickitat River	WDFW, YIN
Yakima River	WDFW, YIN		Wenatchee River	WDFW, YIN
Entiat River	WDFW, YIN		Methow River	WDFW, YIN
Hood River	ODFW, CTWSOR		Deschutes River	ODFW, CTWSRO
John Day River	ODFW, CTWSRO, CTUIR		Umatilla River	ODFW, CTUIR
Walla Walla River	ODFW, CTUIR, WDFW		Tucannon River	WDFW, CTUIR, NPT
Grande Ronde	ODFW, WDFW, NPT, CTUIR		Imnaha River	ODFW, NPT, CTUIR
Clearwater River	IDFG, NPT		Salmon River	IDFG, NPT, SBT**
Snake River Mainstem	WDFW, ODFW, IDFG, CTUIR, NPT		Columbia River, Upper Mainstem (Confluence of Snake R. to Chief Joseph Dam)	WDFW, YIN, CTUIR

* The lead management entities will consult with USFWS and NOAA Fisheries as necessary when fish listed under the Endangered Species Act inhabit a sub-basin and/or when the USFWS funds or has a production facility in the sub-basin.

** The Shoshone-Bannock Tribes shall be deemed a management entity for purposes of those portions of the Salmon River sub-basin which concern those lands and streams outside the Nez Perce Reservation originally established by the Nez Perce Treaty of 1855 where the Shoshone-Bannock Tribes exercise treaty-secured fishing rights, and such other sub-basin areas as may subsequently be agreed upon by the affected parties hereto.

Table A1. Spring Management Period Harvest Rate Schedule

Harvest Rate Schedule for Chinook in Spring Management Period

Total Upriver Spring and Snake River Summer Chinook Run Size[6]	Snake River Natural Spring/Summer Chinook Run Size[1]	Treaty Zone 6 Total Harvest Rate [2,5]	Non-Treaty Natural Harvest Rate [3]	Total Natural Harvest Rate[4]	Non-Treaty Natural Limited Harvest Rate[4]
<27,000	<2,700	5.0%	<0.5%	<5.5%	0.5%
27,000	2,700	5.0%	0.5%	5.5%	0.5%
33,000	3,300	5.0%	1.0%	6.0%	0.5%
44,000	4,400	6.0%	1.0%	7.0%	0.5%
55,000	5,500	7.0%	1.5%	8.5%	1.0%
82,000	8,200	7.4%	1.6%	9.0%	1.5%
109,000	10,900	8.3%	1.7%	10.0%	
141,000	14,100	9.1%	1.9%	11.0%	
217,000	21,700	10.0%	2.0%	12.0%	
271,000	27,100	10.8%	2.2%	13.0%	
326,000	32,600	11.7%	2.3%	14.0%	
380,000	38,000	12.5%	2.5%	15.0%	
434,000	43,400	13.4%	2.6%	16.0%	
488,000	48,800	14.3%	2.7%	17.0%	

Footnotes for Table A1.

1. If the Snake River natural spring/summer forecast is less than 10% of the total upriver run size, the allowable mortality rate will be based on the Snake River natural spring/summer Chinook run size. In the event the total forecast is less than 27,000 or the Snake River natural spring/summer forecast is less than 2,700, Oregon and Washington would keep their mortality rate below 0.5% and attempt to keep actual mortalities as close to zero as possible while maintaining minimal fisheries targeting other harvestable runs.

2. Treaty Fisheries include: Zone 6 Ceremonial, subsistence, and commercial fisheries from January 1-June 15. Harvest impacts in the Bonneville Pool tributary fisheries may be included if TAC analysis shows the impacts have increased from the background levels.

3. Non-Treaty Fisheries include: Commercial and recreational fisheries in Zones 1-5 and mainstem recreational fisheries from Bonneville Dam upstream to the Hwy 395 Bridge in the Tri-Cities and commercial and recreation SAFE (Selective Areas Fisheries Evaluation) fisheries from January 1-June 15; Wanapum tribal fisheries, and Snake River mainstem recreational fisheries upstream to the Washington-Idaho border from April through June. Harvest impacts in the Bonneville Pool tributary fisheries may be included if TAC analysis shows the impacts have increased from the background levels.

4. If the Upper Columbia River natural spring Chinook forecast is less than 1,000, then the total allowable mortality for treaty and non-treaty fisheries combined would be restricted to 9% or less. Whenever Upper Columbia River natural fish restrict the total allowable mortality rate to 9% or less, then non-treaty fisheries would transfer 0.5% harvest rate to treaty fisheries. In no event would non-treaty fisheries go below 0.5% harvest rate.

5. The Treaty Tribes and the States of Oregon and Washington may agree to a fishery for the Treaty Tribes below Bonneville Dam not to exceed the harvest rates provided for in this Agreement.

6. If the total in river run is predicted to exceed 380,000, the Parties agree to consider increasing the total allowed harvest rate and to reinitiate consultation with NOAA Fisheries if necessary.

Table A2. Summer Management Period Chinook Harvest Rate Schedule.

River Mouth Run Size	Max Treaty Total Harvest Rate	Treaty Harvest	Max Non-Treaty Total Harvest Rate	Non-Treaty Harvest	Escapement Past Fisheries
5,000	5.0%	250	2.0%	<100	4,650
7,500	5.0%	375	2.7%	<200	6,925
10,000	5.0%	500	2.0%	<200	9,300
12,500	5.0%	625	1.6%	<200	11,675
15,000	5.0%	750	1.3%	<200	14,050
16,000	10.0%	1,600	5.0%	800	13,600
17,500	10.0%	1,750	5.0%	875	14,875
20,000	10.0%	2,000	5.0%	1,000	17,000
22,500	10.0%	2,250	5.0%	1,125	19,125
25,000	10.0%	2,500	5.0%	1,250	21,250
27,500	10.0%	2,750	5.0%	1,375	23,375
29,000	10.0%	2,900	5.0-6.0%	1,450-1,740	≥24,360
30,000	10.0%	3,000	5.0-6.0%	1,500-1,800	≥25,200
32,500	10.0%	3,250	7.0%	2,275	26,975
35,000	10.0%	3,500	7.0%	2,450	29,050
36,250	10.0%	3,625	10.0%	3,625	29,000
37,500	11.3%	4,250	11.3%	4,250	29,000
40,000	13.8%	5,500	13.8%	5,500	29,000
42,500	15.9%	6,750	15.9%	6,750	29,000
45,000	17.8%	8,000	17.8%	8,000	29,000
47,500	19.5%	9,250	19.5%	9,250	29,000
50,000	21.0%	10,500	21.0%	10,500	29,000
52,500	21.8%	11,438	21.8%	11,438	29,625
55,000	22.5%	12,375	22.5%	12,375	30,250
57,500	23.2%	13,313	23.2%	13,313	30,875
60,000	23.8%	14,250	23.8%	14,250	31,500
62,500	24.3%	15,188	24.3%	15,188	32,125
65,000	24.8%	16,125	24.8%	16,125	32,750
67,500	25.3%	17,063	25.3%	17,063	33,375
70,000	25.7%	18,000	25.7%	18,000	34,000
72,500	26.1%	18,938	26.1%	18,938	34,625
75,000	26.5%	19,875	26.5%	19,875	35,250
77,500	26.9%	20,813	26.9%	20,813	35,875
80,000	27.2%	21,750	27.2%	21,750	36,500
82,500	27.5%	22,688	27.5%	22,688	37,125
85,000	27.8%	23,625	27.8%	23,625	37,750
87,500	28.1%	24,563	28.1%	24,563	38,375
90,000	28.3%	25,500	28.3%	25,500	39,000
92,500	28.6%	26,438	28.6%	26,438	39,625
95,000	28.8%	27,375	28.8%	27,375	40,250
97,500	29.0%	28,313	29.0%	28,313	40,875
100,000	29.3%	29,250	29.3%	29,250	41,500

Footnotes for Table A2. (Upper Columbia River Summer Chinook Harvest Rate Schedule):

1. Fisheries included are all Non-treaty fisheries in the Columbia River mainstem below McNary Dam and all Treaty fisheries in Zone 6 between June 16 and July 31 along with any treaty and non-treaty fisheries impacting upper Columbia River summer Chinook in the mainstem Columbia and tributaries above McNary Dam. Wanapum and Colville fisheries are included in the non-treaty share. Non-treaty ocean fisheries south of the U.S.-Canada border are included in the non-treaty share at run sizes above 29,000. At run sizes below 29,000, the non-treaty harvest impacts shown are for in-river fisheries. The Treaty Tribes and the States of Oregon and Washington may agree to a fishery for the Treaty Tribes below Bonneville Dam not to exceed the harvest rates provided for in this Agreement.
2. The river mouth interim management goal is 29,000 fish. This equates to a 20,000 natural and hatchery escapement goal.
3. For runs less than 16,000, the treaty harvest on the total summer period Chinook river mouth run size will be no more than 5%.
4. For runs less than 5,000, the non-treaty harvest on the total summer period Chinook river mouth run size will be less than 100 Chinook.
5. For runs sizes of 5,000, but less than 16,000, the non-treaty total harvest rate on summer period Chinook will be less than 200 Chinook.
6. For run sizes of 16,000 to 36,250 (125% of the 29,000 goal), the treaty harvest rate will be limited to 10%. For run sizes of 16,000 to 28,999, the non-treaty harvest will be limited to 5%. For run sizes of 29,000-36,249, the non-treaty harvest rate will be stepped. For run sizes of 29,000 to 32,499, the non-treaty harvest rate will be limited to 5-6%. For run sizes of 32,500 to less than 36,249, the non-treaty harvest rate will be limited to 7%.
7. For run sizes of 36,250 to 50,000, the treaty and non-treaty harvest rates will each be 50% of the total harvestable number of fish calculated as the river mouth run size minus 29,000.
8. For run sizes above 50,000, higher numbers of fish will be allowed to escape fisheries. The harvestable number of fish will be adjusted to include 75% of the margin of fish above 50,000. The treaty and non-treaty harvest rates will each be 50% of the total harvestable number of fish calculated by the following formula: (0.75 *(Runsize – 50,000)) + 21,000.

Table A3. Fall Management Period Chinook Harvest Rate Schedule

	Expected URB River Mouth Run Size		Expected River Mouth Snake River Natural Origin Run Size[1]	Treaty Total Harvest Rate	Non-Treaty Harvest Rate	Total Harvest Rate	Expected Escapement of Snake R. Natural Origin Past Fisheries
<	60,000	<	1,000	20%	1.50%	21.50%	784
	60,000		1,000	23%	4%	27.00%	730
	120,000		2,000	23%	8.25%	31.25%	1,375
>	200,000		5,000	25%	8.25%	33.25%	3,338
			6,000	27%	11%	38.00%	3,720
			8,000	30%	15%	45.00%	4,400

Footnotes for Table.

1. If the Snake River natural fall Chinook forecast is less than level corresponding to an aggregate URB run size, the allowable mortality rate will be based on the Snake River natural fall Chinook run size.
2. Treaty Fisheries include: Zone 6 Ceremonial, subsistence, and commercial fisheries from August 1-December 31.
3. Non-Treaty Fisheries include: Commercial and recreational fisheries in Zones 1-5 and mainstem recreational fisheries from Bonneville Dam upstream to the confluence of the Snake River and commercial and recreation SAFE (Selective Areas Fisheries Evaluation) fisheries from August 1-December 31.
4. The Treaty Tribes and the States of Oregon and Washington may agree to a fishery for the Treaty Tribes below Bonneville Dam not to exceed the harvest rates provided for in this Agreement.
5. Fishery impacts in Hanford sport fisheries count in calculations of the percent of harvestable surplus achieved.
6. When expected river-mouth run sizes of naturally produced Snake River Fall Chinook equal or exceed 6,000, the states reserve the option to allocate some proportion of the non-treaty harvest rate to supplement fall Chinook directed fisheries in the Snake River.

Table A4. Fall Management Period Steelhead Harvest Rate Schedule.

Forecast Bonneville Total B Steelhead Run Size	River Mouth URB Run Size	Treaty Total B Harvest Rate	Non-Treaty Natural Origin B Harvest Rate	Total Harvest Rate
<20,000	Any	13%	2.0%	15.0%
20,000	Any	15%	2.0%	17.0%
35,000	>200,000	20%	2.0%	22.0%

B Run Steelhead are defined as steelhead measuring ≥78 cm

Footnotes for Table A4:
This harvest rate schedule applies to fall season fisheries only. These fisheries include all mainstem fisheries below the mouth of Snake River from August 1 through October 31 and for mainstem fisheries from The Dalles Dam to the mouth of the Snake River from November 1 through December 31. Also included are fall season treaty fisheries in Drano Lake and tributary mouth sport fisheries in Zone 6 that impact Snake River steelhead.

Columbia River Fall Chinook Fishery Model Summary

Attachment A

Ocean Option:	PFMC April Final	Date	
Columbia River Model Option:	**Model Year -Final**	Time	

Chinook

Management Guidelines	**Total**	**Goal/Guideline**
Snake River Wild HR	X%	X%
Non-Indian	X%	X%
Treaty Indian	X%	X%
% of Harvestable Surplus		
Non-Indian	X%	50%
Treaty Indian	X%	50%
McNary Escapement	0	60,000
LRH Ocean/Inriver Exp. Rate	X%	X%
LRH Inriver Exp. Rate	X%	X%

Non-Indian Catch Sharing						
	SRW		Aug Catch URB Brights - Mainstem			
	Impact	Percent	Catch	Percent	Catch	Percent
Sport	X%	X%	0	X%	0	X%
Comm	X%	X%	0	X%	0	X%
	Tules - Mainstem		Chinook - Mains		LRH - Impacts	
	Catch	Percent	Catch	Percent	Catch	Percent
Sport	0	X%	0	X%	0	X%
Comm	0	X%	0	X%	0	X%

Steelhead/Coho/Chum Guidelines	
Non-Indian Wild B Index	
Constraint	X%
Projected	X%
Treaty Indian Total B Index	
Constraint	X%
Projected	X%
Non-Indian LCR Coho (in-river)	
Constraint	X%
Projected	X%
Non-Indian Chum	
Constraint	X%
Projected	X%

			Fishery Description	Total	BPH	URB	LRH	LRW	BUB	PUB	LRB	SAB	LRH ER	SRW HR	Wild B	Total B	LCR Coho	Chum
Ocean Harvest				0	0	0	0	0	0	0	0	0						
Columbia River Run				0	0	0	0	0	0	0	0	0						
Harvest Below Bonneville																		
Early - Mid August	X	days		0	0	0	0	0	0	0	0	0	0.0%	0.0%	0		0	0
Select Areas	X%			0	0	0	0	0	0	0	0	0		0.0%	0		0	0
Buoy 10	X%			0	0	0	0	0	0	0	0	0	0.0%	0.0%	0		0	0
Mainstem Sport	X%			0	0	0	0	0	0	0	0	0	0.0%	0.0%	0		0	0
Mid - Late August	X	days		0	0	0	0	0	0	0	0	0	0.0%	0.0%	0		0	0
Z4-5 Mid - late August	X	days		0	0	0	0	0	0	0	0	0	0.0%	0.0%	0		0	0
Z4-5 Sept Chinook	X	days		0	0	0	0	0	0	0	0	0	0.0%	0.0%	0		0	0
Mid - Late Sept Coho	X	days		0	0	0	0	0	0	0	0	0	0.0%	0.0%	0		0	0
October Coho	X			0	0	0	0	0	0	0	0	0	0.0%	0.0%	0		0	0
Tributary Sport	X%			0	0	0	0	0	0	0	0	0		0.0%	0		0	0
Lower River Total				*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	0.0%	0.0%	*0*		*0*	*0*
Bonneville Dam Passage				0	0	0			0	0					0			
Harvest Above Bonneville																		
Zone 6 - Bonn to Hwy 395				0		0			0	0				0.0%	0			
Treaty Comm. and C&S				0	0	0			0	0				0.0%	0	0		
Hanford Reach Sport				0		0												
McNary Dam Passage				0		0												
Lower Granite Dam Passage																		
Escapement					0		0		0	0		0						
Hatchery					0		0		0	0		0						
Natural					0	0	0	0	0	0	0	0						
Hatchery Surplus					0		0		0	0		0						
Natural Surplus						0		0										

U.S. v. Oregon Upriver Spring Chinook Catch Balance Model

Attachment B

This model uses current sport/commercial allocation and current mark rates.

Non-Indian Impact Allocation - **Commercial**	43%
Non-Indian Impact Allocation - **Recreational**	57%
Non-Indian Selective Fishery Mortality Rate - **Commercial**	29.3%
Tangle Net Mortality Rate	18.5%
Large Mesh Mortality Rate	40.0%
Proportion of Impacts used in Tangle Net Fishery	50.0%
Non-Indian Selective Fishery Mortality Rate - **Recreational**	10.0%

A	B	C	D	E	F	G	H	I	J	K	L	M
Run Size	Treaty Impact Rate	Non Treaty Impact Rate	Non Treaty Impacts Used in Non-Selective Fisheries	Total Upriver Spring Chinook Mark Rate	Treaty Catch	Selective Fishery Non-Treaty Landed Catch	Selective Fishery Non-Treaty Total Mortality	Non-Selective Fishery Non-Treaty Landed Catch	Non-Treaty Total Landed Catch	Non-Treaty Total Mortality	Treaty Catch minus Non-Treaty Total Mortality	Non-Treaty as a % of Total
27,500	5.0%	0.5%	0.3%	70%	1,375	276	293	83	359	375	1,000	21%
33,000	5.0%	1.0%	0.3%	70%	1,650	1,159	1,229	99	1,258	1,328	322	45%
44,000	6.0%	1.0%	0.3%	70%	2,640	1,546	1,638	132	1,678	1,770	870	40%
55,000	7.0%	1.5%	0.3%	70%	3,850	3,313	3,511	165	3,478	3,676	174	49%
82,000	7.4%	1.6%	0.3%	70%	6,068	5,350	5,670	246	5,596	5,916	152	49%
109,000	8.3%	1.7%	0.3%	70%	9,047	7,659	8,117	327	7,986	8,444	603	48%
141,000	9.1%	1.9%	0.3%	70%	12,831	11,323	12,000	423	11,746	12,423	408	49%
217,000	10.0%	2.0%	0.3%	70%	21,700	18,515	19,622	651	19,166	20,273	1,427	48%
271,000	10.8%	2.2%	0.3%	70%	29,268	25,843	27,388	813	26,656	28,201	1,067	49%
326,000	11.7%	2.3%	0.3%	70%	38,142	32,724	34,680	978	33,702	35,658	2,484	48%
380,000	12.5%	2.5%	0.3%	70%	47,500	41,959	44,467	1,140	43,099	45,607	1,893	49%
434,000	13.4%	2.6%	0.3%	70%	58,156	50,100	53,095	1,302	51,402	54,397	3,759	48%
488,000	14.3%	2.7%	0.3%	70%	69,784	58,783	62,297	1,464	60,247	63,761	6,023	48%

Column Descriptions

A Run Size - Comes directly from the 2008-2017 Management Agreement spring Chinook harvest schedule.
B Treaty Impact Rate - Comes directly from the 2008-2017 Management Agreement spring Chinook harvest schedule.
C Non-Treaty Impact Rate - Comes directly from the 2008-2017 Management Agreement spring Chinook harvest schedule.
D Non-Treaty Impacts Used in Non-Selective Fisheries - Represents incidental impacts in non-selective fisheries of the lower Columbia (Youngs Bay, Blind Slough, and Deep River) and the upper Columbia (Wanapum).
E Total Upriver Spring Chinook Mark Rate - Assumed mark rate for spring chinook destined for above Bonneville Dam.
F Treaty Catch - Number of fish harvested
G Selective Fishery Non-Treaty Landed Catch - Number of fish harvested in mark selective fisheries.
H Selective Fishery Non-Treaty Total Mortality - Includes landed catch plus catch and release mortalities.
I Non-Selective Fishery Non-Treaty Landed Catch - Number of upriver fish harvested in non-selective fisheries.
J Non-Treaty Total Landed Catch - Column G plus column I.
K Non-Treaty Total Mortality - Column H plus column I.
L Treaty Catch Minus Non-Treaty Total Mortality - Column F minus column K.
M Non-Treaty as a % of Total - Column K divided by the sum of column K and column F.

Table B1. Spring Chinook Production For Brood Years 2008-2017

Basin Columbia River Above McNary

Release Site	Rearing Facility	Stock	Life stage	Target Release Number	Mark [1]	Non-Ad-Clipped [2]	Primary Program Purpose	Funding
Yakima River (Various Release Sites)	Cle Elum Hatchery	Yakima	Yearling	810,000	100% Ad-CWT	0	Supplementation	BPA
Twisp River Acc. Site [3]	Methow	Twisp	Yearling	183,000	100% CWT only [4]	183,000 [4]	Supplementation	Grant, Douglas, Chelan PUDs
Chewuch River Acc. Site [3]	Methow	Methow Composite	Yearling	184,000	100% CWT only [4]	184,000 [4]	Supplementation	Grant, Douglas, Chelan PUDs
On Station [3]	Methow	Methow Composite	Yearling	183,000	100% CWT only [4]	183,000 [4]	Supplementation	Grant, Douglas, Chelan PUDs
On Station [5]	Winthrop NFH	Methow Composite	Yearling	600,000	TBD	TBD	Fishery Supplementation	BR
Chiwawa R. Acc. Site [3]	Eastbank	Chiwawa	Yearling	672,000	TBD [4]	TBD [4]	Supplementation	Chelan PUD
Wenatchee Basin (Various Release Sites) [3]	New Grant PUD facility	Chiwawa/Nason	Yearling	250,000	TBD [4]	TBD [4]	Supplementation	Grant PUD by 2011 or earlier
White River / Lake Wenatchee [3]	Little White Salmon/Willard NFH	White River	Yearling	150,000	100% CWT and Body tags	150,000	Conservation/ Supplementation	Grant PUD
On Station [5]	Leavenworth NFH	Carson	Yearling	1,200,000	200K Ad-CWT, 100% Ad-Clip	0	Fishery	BR
Walla Walla River [6]	Carson NFH	Carson	Yearling	250,000	100% Ad-Clip, 50K Ad-CWT	0	Supplementation	Mitchell Act
Subtotal				**4,482,000**		**700,000**		

Basin Snake River

Release Site	Rearing Facility	Stock	Life stage	Target Release Number	Mark [1]	Non-Ad-Clipped [2]	Primary Program Purpose	Funding
Tucannon	Tucannon/Lyons Ferry	Tucannon	Smolt	225,000	100%CWT	225,000	Supplementation	LSRCP/BPA
Asotin	TBD	TBD	Smolt	TBD	TBD	TBD	Supplementation	LSRCP/BPA FCRPS
Meadow Creek (Selway)	NPTH	Clearwater/RR	Parr	400,000	100% CWT	400,000	Supplementation	NPTH/BPA
Lolo Creek	NPTH	Clearwater/RR	Presmolt	150,000	100% CWT	150,000	Supplementation	BPA
Newsome Creek	NPTH	Clearwater/RR	Presmolt	75,000	100% CWT	75,000	Supplementation	BPA

Table B1. Snake River Spring Chinook – Continued

Clearwater River/NPTH [7]	NPTH/Clearwater Anad. FH	Clearwater/RR	Smolt	200,000	60,000 Ad w/ some CWT	140,000	Supplementation/ Fishery	BPA FCRPS
Upper Selway-Magruder	Clearwater Anad. FH	Clearwater/RR	Parr	300,000	Oxytet	300,000	Supplementation	LSRCP
Lower Selway	Clearwater Anad. FH	Clearwater/RR	Smolt	300,000	66% Ad, 33% CWT/No Ad	100,000	Supplementation/ Fishery	LSRCP
Powell Pond (Lochsa)	Clearwater Anad. FH	Clearwater/RR	Smolt	400,000	100% Ad-Clip	0	Fishery	LSRCP
Powell Pond (Lochsa)	Clearwater Anad. FH	Clearwater/RR	Presmolt [8]	235,000	100% Ad-Clip	0	Fishery	LSRCP
Crooked R. Pond (S.F. Cl)	Clearwater Anad. FH	Clearwater/RR	Smolt	700,000	100% Ad-Clip	0	Fishery	LSRCP
Red R. Pond (S.F.Cl)	Clearwater Anad. FH	Clearwater/RR	Smolt	400,000	100% Ad-Clip	0	Fishery	LSRCP
Red R. /Crooked R. (S. FK. Cl)	Clearwater Anad. FH	Clearwater/RR	Presmolt	100,000	100% CWT	100,000	Supplementation	LSRCP
On Station [9]	Kooskia NFH	Kooskia/Clearwater /RR	Smolt	600,000	500,000 Ad-Clip, CWT	50,000 [10]	Fishery/ Supplementation	FWS
On Station	Dworshak NFH	Dworshak/ Clearwater/RR	Smolt	1,050,000	120K Ad-CWT, 100% Ad-Clip	0	Fishery	LSRCP
On Station	Rapid River	Rapid River	Smolt	2,500,000	100% Ad-Clip	0	Fishery	IPC
Little Salmon River	Rapid River	Rapid River	Smolt	See footnote [11]	100% Ad-Clip	0	Fishery	IPC
Hells Canyon –Snake R.	Rapid River	Rapid River	Smolt	See footnote [11]	100% Ad-Clip	0	Fishery	IPC
On Station Upper Salmon R.[12]	Sawtooth FH	Upper Salmon River	Smolt	1,000,000	100% Ad-Clip	See footnote [12]	Fishery/ Supplementation	LSRCP
Yankee Fork [13]	Sawtooth/TBD	Upper Salmon River/Yankee Fork	Smolt	TBD	TBD	TBD	Supplementation	BPA FCRPS
Lemhi [14]	TBD	Lemhi	Smolt	TBD	TBD	TBD	Supplementation	BPA FCRPS
Catherine Creek [15]	Lookingglass/Captive Brood	Catherine Creek	Smolt	150,000	See footnote[16]	See footnote[16]	Supplementation/ Fishery	LSRCP/BPA
Upper Grande Ronde [15]	Lookingglass/Captive Brood	U. Grande Ronde	Smolt	250,000	See footnote[16]	See footnote[16]	Supplementation/ Fishery	LSRCP/BPA
Lostine River	Lookingglass/Captive Brood	Lostine	Smolt	250,000	TBD	TBD	Supplementation/ Fishery	LSRCP/BPA
Lookingglass Creek	Lookingglass/Captive Brood	Catherine Creek	Smolts	250,000	See footnote[16]	See footnote[16]	Fishery/ Reintroduction	LSRCP/BPA
Imnaha River sub-basin	Lookingglass	Imnaha	Smolt	490,000[17]	TBD	TBD	Supplementation/ Fishery	LSRCP
Subtotal				**+10,525,000**		**+1,540,000**		

Table B1. Spring Chinook - Continued

Basin *Columbia River, Bonneville to McNary*

Release Site	Rearing Facility	Stock	Life stage	Target Release Number	Mark [1]	Non-Ad-Clipped [2]	Primary Program Purpose	Funding
Hood River [17]	Round Butte	Deschutes/Hood	Yearling	150,000	100% ADRMCWT	0	Reintroduction Fishery	BPA
On Station	Warm Springs NFH	Deschutes	Yearling	750,000	100% Ad-CWT	0	Fishery	FWS
On Station	Round Butte	Deschutes	Yearling	320,000	100% Ad-CWT	0	Fishery	PGE
Umatilla River	Umatilla	Umatilla/Carson	Yearling	810,000	690K Ad, 120K Ad-CWT+Vent	0	Supplementation/ Fishery	BPA
Klickitat [18]	Klickitat	Klickitat	Yearling	600,000	100% Ad-Clip, 200KCWT	0	Supplementation/ Fishery	MA/BPA
Klickitat (above Castile) [18]	Klickitat	Klickitat	Adult Outplants	0	Evaluation Mark		Supplementation	MA/BPA
On Station (Drano Lake)	Little White Salmon NFH	Carson	Yearling	1,000,000	75K Ad-CWT, 100% Ad-Clip	0	Fishery	MA
Captive Brood Program [3]	Little White Salmon NFH	White River	Egg to Adult	TBD		NA	Conservation	Grant PUD
On Station [6]	Carson NFH	Carson	Yearling	1,170,000	75K Ad-CWT, 100% Ad-Clip	0	Fishery	MA
Subtotal				**4,800,000**		**0**		
Grand Total Spring Chinook				**19,807,000**		**2,240,000**		

Footnotes for Table B1: Spring Chinook Salmon

1. The category 'Mark' may include fish that are adipose fin clipped (Ad-Clip), regardless of funding source. The tribes do not agree with the concept of mass marking production using an adipose fin clip for anything other than evaluation purposes. Non-treaty Parties may propose to use mark-selective fishing techniques in spring Chinook fisheries that allow for a higher harvest rate on hatchery fish marked with an adipose fin clip compared to fish not so marked. Non-tribal Parties also recognize that mass marking by adipose clipping facilitates broodstock management and hatchery/natural origin stock assessment. In agreeing to Table A1 (Spring Chinook Harvest Rate Schedule), the Parties expect that mainstem fisheries on upriver spring Chinook will achieve catches roughly matching those shown in Catch Balance Model. As described in Part II, Section A.1, the Parties will monitor whether those expectations are being met. If they are not, the Parties will discuss whether to modify this Agreement so as better to meet those catch expectations.
2. The category "Non-Ad-Clipped" may include fish marked by other means such as CWT, PIT, or VIE tags. Nothing in this Agreement shall be interpreted to prevent the federal Parties and/or states from mass marking fish required to be marked under Section 113 of the Consolidated Appropriations Act, 2008 (PL 110-161); or other Congressional acts directing the mass marking of Chinook, coho, and steelhead released from federally operated or financed hatcheries. In the event USFWS and/or states mark fish inconsistent with Tables B1-B7, nothing in this Agreement prevents any Party from challenging these acts. In the event of insufficient funding to carry out such marking, the federal Parties will consult with the other Parties to review and revise the priorities in any marking plan provided for under this Agreement. The federal Parties will, to the extent required by law, consider the other Parties' recommendations and the United States' trust and treaty responsibility to the Tribes before deciding marking priorities.
3. These production programs will be implemented and/or adjusted based on mid-Columbia HCP's and Settlement Agreement in the future. The Parties are pursuing new funding for acclimation facilities tied to these existing programs.
4. For Brood Year 2008 and beyond, Ad-clipping and tagging will be decided by Parties consistent with the HCP/Settlement Agreement processes.
5. The Leavenworth NFH complex is currently undergoing hatchery program review. It is anticipated that there may be changes to this program during the period of this Agreement including program levels, release location, development of locally adapted broodstocks, and marking protocols to meet specific objectives. The Parties will collaboratively develop implementation guidelines per Part III.H of this Agreement. The Yakima Nation agrees to the reduction in spring Chinook production from 1.625 Million (2005-2007) to 1.2 Million as an interim action to achieve the current objectives with respect to present USFWS concerns over water quality, fish health, hatchery infrastructure issues, and ESA straying risks. Restoration back to the 1.625 Million 2005-2007 Interim Agreement program level is the goal of the Parties in the future with resolution of these issues. The Parties anticipate that the proposed Chief Joseph Hatchery is likely to begin operations during the term of this agreement. The Parties Agree to develop options for providing up to 1.2 million spring Chinook salmon eggs to initiate the Chief Joseph program when it comes on line.
6. The Parties support implementation of a 250,000 Walla Walla spring Chinook smolt release program with production at Carson Hatchery in the interim and the NPCC master planning process for a new Walla Walla Hatchery program at the 500,000 fish level in the longer term. If the program is expanded under the NPCC process then the 250,000 production would shift back to Carson NFH. Confirmation is needed that straying into the Tucannon River is not occurring at levels of concern prior to expansion of the program.
7. NPTH smolt production will occur pending availability of funding and broodstock.
8. The Parties will review culture opportunities to rear the presmolts to smolts and if feasible, will implement the smolt rearing if necessary resources are available at Powell Pond (Lochsa) in the Clearwater Basin.
9. The NPT, IDFG, and USFWS have agreed to utilize ISS and other supplementation information to develop an integrated broodstock management guideline to reimplement supplementation in Clear Creek. Planning will occur in 2008 with broodstock management protocols to be implemented with BY09. Kooskia stock will be utilized for supplementation of Clear Creek. Fish production will be prioritized with the first 50,000 (non ad-clipped) allocated for supplementation of Clear Creek, the next 500,000 (ad-clipped) for fishery purpose. Production in excess of 550,000 will be discussed by the Parties to allocate to supplementation or fisheries. The Parties are working to assess options to increase smolt production from Kooskia Hatchery either through programmatic changes or facility modifications. As a result, the target release number may change during the course of this Agreement.

10. The number of non ad-clipped or ad-clipped fish at Kooskia NFH may be greater than 50,000 pending Party discussion on allocation of production greater than 550,000 smolts.
11. Production at Rapid River Hatchery above 2.5M will be split between Hells Canyon Dam and the Little Salmon River – alternating releases of 100,000 to Hells Canyon and 50,000 to Little Salmon River. For example: 1) 2,500,000 million Rapid River; 2) 100,000 Snake River/Hells Canyon Dam; 3) 50,000 Little Salmon; 4) 100,000 Snake River/Hells Canyon Dam; 5) 50,000 Little Salmon, etc. until all production is allocated. If production is less than 3 million, Parties will discuss options.
    The Parties agree that recent smolt releases do not provide adequate and consistent mitigation for adult returns at locations affected by Idaho Power Company's Hells Canyon Complex and its operations. Several Parties also are actively participating in the re-licensing of such Complex. Idaho Power Company's mitigation responsibilities, including production numbers and release locations of Rapid River spring chinook, are a subject of these discussions. The interim target production numbers and release locations of Rapid River spring chinook specified herein shall not affect any Party's right to pursue alternative production and release locations in connection with the development of a long-term agreement and/or in connection with the Hells Canyon re-licensing process.
12. The Parties have agreed to utilize ISS and other supplementation information to develop an integrated broodstock management guideline for Sawtooth Hatchery to reimplement supplementation. Planning will occur in 2008 with broodstock management protocols to be implemented with BY09. Upper Salmon River broodstock release could be up to 1.6 million depending on egg take and facility logistics. If production is above 1.0 million, the Parties will discuss disposition of these fish.
13. Parties commit to completing an HGMP for Yankee Fork prior to BY09 for program implementation which also addresses relationship to Sawtooth program.
14. Parties commit to reviewing options for the Lemhi River to initiate program and develop details for program objective, rearing strategy and facilities, release numbers, and mark plan.
15. Maintain a safety net/captive broodstock program for Catherine Creek and Upper Grande Ronde River as part of current program if new funding is provided.
16. The marking guidelines for the Upper Grande Ronde, Catherine Creek, and Lookinglass Creek are as described in the Grande Ronde Spring Chinook Marking Guidelines found in Attachment C and referenced in the CTUIR-NPT-ODFW letter agreement dated April 28, 2008.
17. Current capacity at Lookingglass Hatchery does not allow production of 490,000 yearlings. The Parties have agreed in interim to produce 360,000 yearlings. If capacity becomes available or following the construction of NEOH on the Lostine River, production would increase
18. The current Hood River production through 2010 is 125,000 produced at Round Butte Hatchery of Deschutes/Hood stock. All fish are acclimated and volitionally released in Hood River tributaries as follows: 30k in Middle Fork and 95k in West Fork with 100% Ad,RM,CWT marking. Primary purpose is for supplementation. Funding is provided by BPA. During 2010, 150k will be released from one acclimation site in the West Fork Hood River for fishery production. Pending results of post-supplementation investigations during 2014, co-managers will evaluate the need to resume supplementation with increased production from a to-be-determined facility.
19. Klickitat Basin Spring Chinook Master Plan is in development and may include changes to the current program. The master plan is expected to be submitted in 2008. The YKFP will collaborate per Part III.H of this Agreement on proposed changes to this program.

Table B2. Summer Chinook Production for Brood Years 2008-2017.

Basin Columbia River Above McNary

Release Site	Rearing Facility	Stock	Life stage	Target Release Number	Mark[1]	Non-Ad-Clipped[2]	Primary Program Purpose	Funding
On Station [3,4]	Turtle Rock	Wells	SubYearling	1,078,000 [3]	400K Ad-CWT	678,000	Fishery	Chelan PUD
On Station [4]	Turtle Rock	Wells	Yearling	200,000	200K Ad-CWT	0	Fishery	Chelan PUD
Dryden Ponds [4]	Eastbank	Wenatchee	Yearling	864,000	TBD[6]	0	Supplementation/ Fishery	Chelan PUD
Carlton Rearing Pond [4]	Eastbank	Met./Okan/Wells [5]	Yearling	200,000	TBD[6]	0	Supplementation/ Fishery	Chelan PUD
Carlton Rearing Pond [4]	Eastbank	Met./Okan/Wells [5]	Yearling	200,000	TBD[6]	0	Supplementation/ Fishery	Chelan/Douglas PUD
Okanogan/ Similkameen Rivers [4]	Eastbank	Met./Okan/Wells [5]	Yearling	576,000	TBD[6]	0	Supplementation/ Fishery	Chelan PUD
Wells or other locations [4]	Wells	Wells	Yearling	200,000	100% Ad-Clip	0	Research	Mid Col. PUDs
On Station [4]	Wells	Wells	Yearling	320,000	100% Ad-Clip	0	Fishery	Douglas PUD
On Station [4]	Wells	Wells	SubYearling	484,000	100% Ad-Clip	0	Fishery	Douglas PUD
Yakima Basin	TBD	TBD	TBD	TBD	TBD	TBD	Parties to assess Reintroduction feasibility	TBD
Subtotal				**4,122,000**		**678,000**		

Basin Snake River

Release Site	Rearing Facility	Stock	Life stage	Target Release Number	Mark[1]	Non-Ad-Clipped[2]	Primary Program Purpose	Funding
Johnson Creek [7]	McCall Hatchery	Johnson Cr.	Smolt	100,000 [7]	100% CWT-VIE	100,000	Supplementation	BPA
Knox Bridge [8]	McCall Hatchery	South Fork	Smolt	1,000,000	100% Ad-Clip	TBD	Fishery	LSRCP
Pahsimeroi Ponds [8]	Pahsimeroi	Pahsimeroi	Smolt	1,000,000	100% Ad-Clip	TBD	Fishery	IPC
Dollar Creek [9]	McCall Hatchery	South Fork	eyed egg	300,000		300,000	Supplementation	PCSRF/LSRCP
Subtotal				**2,100,000**	**smolts**	**100,000 (smolts)**		

Grand Total	**Summer Chinook**	**6,222,000**	**778,000**

Footnotes for Table B2: Summer Chinook Salmon

1. The category 'Mark' may include fish that are adipose fin clipped (Ad-Clip), regardless of funding source. The tribes do not agree with the concept of mass marking production using an adipose fin clip for anything other than evaluation purposes. Non-treaty Parties may propose to use mark-selective fishing techniques in summer Chinook fisheries that allow for a higher harvest rate on hatchery fish marked with an adipose fin clip compared to fish not so marked. Non-tribal Parties also recognize that mass marking by adipose clipping facilitates broodstock management and hatchery/natural origin stock assessment.
2. The category "Non-Ad-Clipped" may include fish marked by other means such as CWT, PIT, or VIE tags. Nothing in this Agreement shall be interpreted to prevent the federal Parties and/or states from mass marking fish required to be marked under Section 113 of the Consolidated Appropriations Act, 2008 (PL 110-161); or other Congressional acts directing the mass marking of Chinook, coho, and steelhead released from federally operated or financed hatcheries. In the event USFWS and/or states mark fish inconsistent with Tables B1-B7, nothing in this Agreement prevents any Party from challenging these acts. In the event of insufficient funding to carry out such marking, the federal Parties will consult with the other Parties to review and revise the priorities in any marking plan provided for under this Agreement. The federal Parties will, to the extent required by law, consider the other Parties' recommendations and the United States' trust and treaty responsibility to the Tribes before deciding marking priorities.
3. The Parties may agree to mark up to 1,078,000 subyearlings with an adipose fin clip to facilitate implementation of the harvest provisions of this Agreement. The Parties have agreed to convert the Turtle Rock 1,078,000 subyearling releases to 400,000 yearlings beginning in about 2010. Marking will be determined by the Parties after the production changes to a yearling program, and may include adipose fin clipping of up to 400,000 yearlings.
4. These production programs will be implemented and/or adjusted based on mid-Columbia HCP's and Settlement Agreement in the future. The Parties are pursuing new acclimation facilities tied to these existing programs.
5. If there is insufficient numbers of Methow/Okanogan broodstock available then Wells stock will be used to make up shortfall.
6. The Parties will establish a protocol to ad-clip and CWT this production for evaluation, broodstock, and other management purposes.
7. Based on existing assessment of Johnson Creek and other Snake Basin supplementation efforts, re-assess appropriate size and necessary logistics for Johnson Creek program. Smolt production necessary for rebuilding and supported by broodstock availability, assess alternative smolt rearing locations along with McCall FH for program growth will be based on this assessment.
8. The Parties have agreed to utilize ISS and other supplementation information to develop an integrated broodstock management guideline to reimplement supplementation for Pahsimeroi and McCall Hatcheries. Planning will occur in 2008 with broodstock management protocols to be implemented with BY09.
9. The Parties will discuss any additional use of adults for supplementation outplants in Dollar Creek through the Annual Operation Plan (AOP) process.

Table B3. Sockeye Production for Brood Years 2008-2017.

Basin ***Columbia River and Snake River Above McNary***

Release Site	Rearing Facility	Stock	Life stage	Target Release Number	Mark [1]	Non-Ad-Clipped [2]	Primary Program Purpose	Funding
Lake Wenatchee Net Pen [3]	Eastbank	Wenatchee	Smolt	280,000	100% Ad-Clip	0	Supplementation	Chelan PUD
Skaha Lake [3]	Shuswap River Hat.	Okanogan	Fry	1.2-2.0 M			Experimental	Chelan/Grant PUDs
Stanley Basin	See footnote 4	Snake River	Smolt	1,000,000	TBD	TBD	Supplementation	BPA FCRPS
Wallowa Lake	See footnote 5	TBD	TBD	TBD		TBD	Reintroduction	BPA FCRPS
Lake Cle Elum/Yakima Basin Lakes	See footnote 6	TBD	TBD	TBD	TBD	TBD	Reintroduction	TBD
Grand Total	**Sockeye**			**+2,480,000**		**TBD**		

Footnotes for Table B.3: Sockeye Salmon

1. The category 'Mark' may include fish that are adipose fin clipped (Ad-Clip), regardless of funding source. The tribes do not agree with the concept of mass marking production using an adipose fin clip for anything other than evaluation purposes. Non-treaty Parties may propose to use mark-selective fishing techniques that allow for a higher harvest rate on hatchery fish marked with an adipose fin clip compared to fish not so marked. Non-tribal Parties also recognize that mass marking by adipose clipping facilitates broodstock management and hatchery/natural origin stock assessment.
2. The category "Non-Ad-Clipped" may include fish marked by other means such as CWT, PIT, or VIE tags. Nothing in this Agreement shall be interpreted to prevent the federal Parties and/or states from mass marking fish required to be marked under Section 113 of the Consolidated Appropriations Act, 2008 (PL 110-161); or other Congressional acts directing the mass marking of Chinook, coho, and steelhead released from federally operated or financed hatcheries. In the event USFWS and/or states mark fish inconsistent with Tables B1-B7, nothing in this Agreement prevents any Party from challenging these acts. In the event of insufficient funding to carry out such marking, the federal Parties will consult with the other Parties to review and revise the priorities in any marking plan provided for under this Agreement. The federal Parties will, to the extent required by law, consider the other Parties' recommendations and the United States' trust and treaty responsibility to the Tribes before deciding marking priorities.
3. These production programs will be implemented and/or adjusted based on mid-Columbia HCP's and Settlement Agreement in the future.
4. Parties commit to expanding Snake River sockeye production and as part of the planning process will develop options for rearing facility space and logistics. Implementation of full production dependent on funding and broodstock availability.
5. Parties commit to developing a plan for reintroduction of sockeye in Wallowa Lake should funds become available. Rearing facilities, stock, release numbers, and marks will be determined in this planning process. Parties commit to implementation of this plan pending funding availability.
6. The Parties commit to developing a plan for reintroduction of sockeye in Lake Cle Elum (and possibly other historic sockeye nursery lakes in the Yakima Basin) should funds become available. Rearing facilities, stock, release numbers, and marks will be determined in this planning process. Parties commit to implementation of this plan pending funding availability.

Table B4A. Snake River fall Chinook salmon production priorities for the Lower Snake River Compensation Program (LSRCP) at Lyons Ferry Hatchery, the Fall Chinook Acclimation Program (FCAP), the Idaho Power Program (IPC) and the fall Chinook transportation evaluation study – for Brood Years 2008-2017.
(For Other Fall Chinook Production, see Table B5)

Priority	Production Program				
	Rearing Facility	Number	Age	Release Location(s)	Marking [a]
1	Lyons Ferry	450,000	1+	On station	225KAdCWT+VIE 225K CWT +VIE
2	Lyons Ferry	150,000	1+	Pittsburg Landing	70K AdCWT 80K CWT only
3	Lyons Ferry	150,000	1+	Big Canyon	70K AdCWT 80K CWT only
4	Lyons Ferry	150,000	1+	Captain John Rapids	70K AdCWT 80K CWT only
5	Lyons Ferry	200,000	0+	On station	200K AdCWT
6	Lyons Ferry/Irrigon/ Dworshak	328,000 [b]	0+	Transportation Study [c,d]	328K PIT tag only
7	Lyons Ferry	500,000	0+	Captain John Rapids	100K AdCWT 100K CWT only 300K Unmarked
8	Lyons Ferry	500,000	0+	Big Canyon	100K AdCWT 100K CWT only 300K Unmarked
9	Lyons Ferry	200,000	0+	Pittsburg Landing	100K AdCWT 100K CWT only
10	Oxbow	200,000	0+	Hells Canyon Dam	200K AdCWT
11	Lyons Ferry	200,000	0+	Pittsburg Landing	200K Unmarked
12	Lyons Ferry	200,000	0+	Direct stream evaluation Near Captain John Rapids	200K AdCWT
13	Lyons Ferry [e]	200,000	0+	Grande Ronde River	200K AdCWT
14	Umatilla	200,000	0+	Hells Canyon Dam	200K AdCWT
15	Lyons Ferry [e]	200,000	0+	Grande Ronde River	200K Unmarked
16	Umatilla	600,000	0+	Hells Canyon Dam	600K Ad only
TOTAL	Yearlings	900,000			
	Subyearlings	3,528,000 (of which 328,000 are for Transportation Study)			

Footnotes for Table B4A: Snake River Fall Chinook

a/ The Parties expect that fisheries conducted in accordance with the harvest provisions of this Agreement will not compromise broodstock acquisition. If broodstock acquisition is nevertheless compromised by the current mark strategy and as a result of implementation of mark selective fisheries for fall Chinook in the ocean or Columbia/Snake River mainstem, the Parties will revisit the marking strategy during the course of this Agreement.

b/ All of the U.S. v Oregon Parties, on October 19, 2007, conveyed their endorsement for the package of tasks and activities represented in the Snake River Fall Chinook Consensus Research Proposal. In 2009, or any year thereafter, if the lower river component identified in the Consensus Research Proposal, Table 1, as the Hanford Reach, Deschutes River, and Little White Salmon NFH components is not adequately represented with PIT tags, or the transportation study is completed, then the priority for allocation of available Snake River fall Chinook fish shall be adjusted as shown in table B4B.

c/ Production of transportation study surrogates is in effect for five years. After this group of fish has been provided for five brood years the transportation study group will be removed from the table and the groups of fish below will move up one step in priority. If eggs available for subyearling production are 1.2M or less, production of the transportation study surrogate group will be reduced to 250K or be deferred for that year. The PAC will review broodstock collected and projected egg take and make a recommendation to the policy group on whether to provide 250,000 fish or defer by November 1.

d/ USACOE Transportation Study natural-origin surrogate groups direct stream released into the Clearwater near Big Canyon Creek and mainstem Snake River near Couse Creek.

e/ For logistical purposes, fish may be reared at Irrigon (LSRCP).

Table B4A cont. Snake River fall Chinook salmon production priorities for Nez Perce Tribal Hatchery – for Brood Years 2008-2017.

Production Program					
Priority	Number	Age	Life History	Release Location(s)	Marking
1	500,000	0+	Standard	On station	100K AdCWT 200K CWT only 200K Unmarked
2	200,000	0+	Early-spawning	Luke's Gulch	100K AdCWT 100K CWT only
	200,000	0+	Early-spawning	Cedar Flats	100K AdCWT 100K CWT only
3	500,000	0+	Standard	North Lapwai Valley	100K AdCWT 200K CWT only 200K Unmarked
TOTAL	1,400,000	Subyearlings			

Table B4B. Snake River fall Chinook salmon production priorities for the Lower Snake River Compensation Program (LSRCP) at Lyons Ferry Hatchery, the Fall Chinook Acclimation Program (FCAP), the Idaho Power Program (IPC) and the fall Chinook transportation evaluation study – for Brood Years 2008-2017. Production priority if lower Columbia River groups of fish not PIT tagged.
(For Other Fall Chinook Production, see Table B5)

Priority	Production Program				
	Rearing Facility	Number	Age	Release Location(s)	Marking [a]
1	Lyons Ferry	450,000	1+	On station	225KAdCWT+VIE 225K CWT +VIE
2	Lyons Ferry	150,000	1+	Pittsburg Landing	70K AdCWT 80K CWT only
3	Lyons Ferry	150,000	1+	Big Canyon	70K AdCWT 80K CWT only
4	Lyons Ferry	150,000	1+	Captain John Rapids	70K AdCWT 80K CWT only
5	Lyons Ferry	200,000	0+	On station	200K AdCWT
6	Lyons Ferry	500,000	0+	Captain John Rapids	100K AdCWT 100K CWT only 300K Unmarked
7	Lyons Ferry	500,000	0+	Big Canyon	100K AdCWT 100K CWT only 300K Unmarked
8	Lyons Ferry	200,000	0+	Pittsburg Landing	100K AdCWT 100K CWT only
9	Oxbow	200,000	0+	Hells Canyon Dam	200K AdCWT
10	Lyons Ferry	200,000	0+	Pittsburg Landing	200K Unmarked
11	Lyons Ferry	200,000	0+	Direct stream evaluation Near Captain John Rapids	200K AdCWT
12	DNFH/Irrigon	250,000	0+	Transportation Study[b, c]	250K PIT tag only
13	Lyons Ferry[d]	200,000	0+	Grande Ronde River	200K AdCWT
14	DNFH/Irrigon	78,000	0+	Transportation Study[b, c]	78K PIT tag only
15	Umatilla	200,000	0+	Hells Canyon Dam	200K AdCWT
16	Lyons Ferry[d]	200,000	0+	Grande Ronde River	200K Unmarked
17	Umatilla	600,000	0+	Hells Canyon Dam	600K Ad only
TOTAL	Yearlings	900,000			
	Subyearlings	3,528,000 (of which 328,000 are for Transportation Study)			

Footnotes for Table B4B: Snake River Fall Chinook

a/ The Parties expect that fisheries conducted in accordance with the harvest provisions of this Agreement will not compromise broodstock acquisition. If broodstock acquisition is nevertheless compromised by the current mark strategy and as a result of implementation of mark selective fisheries for fall Chinook in the ocean or Columbia/Snake River mainstem, the Parties will revisit the marking strategy during the course of this Agreement.

b/ Production of transportation study surrogates is in effect for five brood years. After this group of fish has been provided for five years the transportation study group will be removed from the table and the groups of fish below will move up one step in priority. If eggs available for subyearling production are 1.2M or less, production of the transportation study surrogate group will be reduced to 250K or be deferred for that year. The PAC will review broodstock collected and projected egg take and make a recommendation to the policy group on whether to provide 250,000 fish or defer by November 1.

c/ USACOE Transportation Study natural-origin surrogate groups direct stream released into the Clearwater and mainstem Snake River.

d/ For logistical purposes, fish may be reared at Irrigon (LSRCP).

Table B4B cont. Snake River fall Chinook salmon production priorities for Nez Perce Tribal Hatchery – for Brood Years 2008-2017.

Production Program					
Priority	Number	Age	Life History	Release Location(s)	Marking
1	500,000	0+	Standard	On station	100K AdCWT 200K CWT only 200K Unmarked
2	200,000	0+	Early-spawning	Luke's Gulch	100K AdCWT 100K CWT only
	200,000	0+	Early-spawning	Cedar Flats	100K AdCWT 100K CWT only
3	500,000	0+	Standard	North Lapwai Valley	100K AdCWT 200K CWT only 200K Unmarked
TOTAL	1,400,000	Subyearlings			

Table B5. Fall Chinook Production for Brood Years 2008-2017 (Several programs may change pending the outcome of John Day Mitigation discussions. The Parties will discuss and agree to any changes prior to implementation. For Snake Basin production, see Table B4A and B4B).

Basin **Columbia River Above McNary**

Release Site	Rearing Facility	Stock	Life stage	Target Release Number	Mark [1]	Non-Ad-Clipped [2]	Primary Program Purpose	Funding
Marion Drain (Yakima) [3]	Prosser	URB-Local	Subyearling	50,000	CWT-only [3]	50,000	Supplementation	BPA
Prosser	Prosser	URB-Local	Subyearling	320,000	TBD	320,000	Supplementation	BPA
On Station Prosser [3]	Little White Salmon NFH	URB	Subyearling	1,700,000 [3]	200K Ad-CWT 100% Ad-Clip	0	Supplementation Fishery	MA/BPA
On Station Ringold	Bonneville	URB	Subyearling	3,500,000	100% Ad-Clip 430KAd-CWT	0	Fishery	COE
On Station Priest Rapids [4]	Priest Rapids Hatchery	URB	Subyearling	6,000,000	400-600K Ad-CWT	TBD	Fishery	Grant PUD
Priest Rapids Reservoir [4]	Priest Rapids Hatchery	URB	Fry	1,000,000	TBD	TBD	Fishery	Grant PUD
On Station Priest Rapids	Priest Rapids Hatchery	URB	Subyearling	1,700,000	100% Ad-Clip CWT –TBD	0	Fishery	COE
Subtotal				14,270,000		370,000		

Basin ***Columbia Bonneville to McNary***

Release Site	Rearing Facility	Stock	Life stage	Target Release Number	Mark [1]	Non-Ad-Clipped [2]	Primary Program Purpose	Funding
On Station	Little White Salmon NFH	MCB	Subyearling	2,000,000	200K Ad-CWT 200K CWT only 1.6 M Ad-Clip	200,000	Fishery	Mitchell Act
Umatilla River (½ direct, ½ Thornhollow Acclimation Site) [5]	Umatilla	MCB	Subyearling	600,000	100% Ad-CWT	0	Supplementation/ Fishery	BPA

Umatilla River (Thornhollow, Pendleton Acclimation Sites) [5]	Bonneville	MCB	Yearling	480,000	50K Ad-CWT, 430K Ad-BWT [6]	0	Supplementation/ Fishery	COE/BPA

Table B5 Continued. Fall Chinook

Release Site	Rearing Facility	Stock	Life stage	Target Release Number	Mark [1]	Non-Ad-Clipped [2]	Primary Program Purpose	Funding
Klickitat [7]	Klickitat Hatchery	MCB	Subyearling	4,000,000	650K Ad-CWT 100% Ad-Clip	~~0~~	Fishery	MA
On Station	Spring Creek NFH	Tule	Subyearling	15,000,000	450K Ad-CWT 450K CWT only 14.1M Ad-Clip only	450,000	Fishery	MA, COE
Subtotal				22,080,000		650,000		
Grand Total				**36,350,000**		**1,020,000**		

Footnotes for Table B5:

1. The category 'Mark' may include fish that are adipose fin clipped (Ad-Clip), regardless of funding source. The tribes do not agree with the concept of mass marking production using an adipose fin clip for anything other than evaluation purposes. Non-treaty Parties may use mark-selective fishing techniques that allow for a higher harvest rate on hatchery fish marked with an adipose fin clip compared to fish not so marked. Non-tribal Parties also recognize that mass marking by adipose clipping facilitates broodstock management and hatchery/natural origin stock assessment.
2. The category "Non-Ad-Clipped" may include fish marked by other means such as CWT, PIT, or VIE tags Nothing in this Agreement shall be interpreted to prevent the federal Parties and/or states from mass marking fish required to be marked under Section 113 of the Consolidated Appropriations Act, 2008 (PL 110-161); or other Congressional acts directing the mass marking of Chinook, coho, and steelhead released from federally operated or financed hatcheries. In the event USFWS and/or states mark fish inconsistent with Tables B1-B7, nothing in this Agreement prevents any Party from challenging these acts. In the event of insufficient funding to carry out such marking, the federal Parties will consult with the other Parties to review and revise the priorities in any marking plan provided for under this Agreement. The federal Parties will, to the extent required by law, consider the other Parties' recommendations and the United States' trust and treaty responsibility to the Tribes before deciding marking priorities.
3. Yakima Basin Fall Chinook Master Plan is in development and may include changes to the current program. The master plan is expected to be submitted in 2008.
4. The Parties recognize that fall Chinook from Grant PUD-funded releases may, in some years, provide the principal source of harvestable fall Chinook available to non-treaty fisheries under Part II of this Agreement. The Parties may agree to mass mark Grant PUD-funded fall Chinook releases with an adipose fin clip to facilitate implementation of the fall Chinook harvest provisions of this Agreement.

5. Future changes to these programs may be negotiated after they have gone through the current Hatchery Scientific Review Group (HSRG) review process.
6. BWT are "Agency Only" tags.
7. Klickitat Basin Fall Chinook Master Plan is in development and may include changes to the current program. The master plan is expected to be submitted in 2008. The current plan is to provide eggs from Little White NFH for this program.

Table B6. Steelhead Production for Brood Years 2009-2018 (parents returning to freshwater in 2008-2017).

Basin **Columbia River Above McNary**

Release Site	Rearing Facility	Stock	Life stage	Target Release Number	Mark [1]	Non-Ad-Clipped[2,3]	Primary Program Purpose	Funding
Wenatchee Basin, various locations [4]	Eastbank/Chiwawa	Wenatchee	Smolt	400,000	TBD	TBD	Supplementation/ Fishery	Chelan PUD
Methow River, various locations [4,5]	Wells	Wells/Methow	Smolt	350,000	TBD	TBD	Supplementation/ Fishery	Douglas-Grant PUDs
On Station-various locations [5]	Winthrop NFH	Wells/Methow	Smolt	100,000	100% Ad-Clip	0	Fishery/ Supplementation	BR
Okanogan River multiple locations [4,6]	Wells	Wells/Okanogan	Smolt	100,000	100% Ad-Clip	0	Fishery	Douglas PUD
Upper Columbia River	TBD	Upper Columbia	Recon. Kelt	300-500	PIT Tag	300-500	Supplementation	BR
Yakima River	Prosser Hatchery	Yakima	Recon. Kelt	300-500	PIT Tag	300-500	Supplementation	BPA
On Station	Ringold	Wells	Smolt	180,000	100% Ad-RVClip	0	Fishery	MA
Walla Walla River [7]	Lyons Ferry	Lyons Ferry A	Smolt	100,000	20K CWT, 100% Ad-Clip	0	Fishery	LSRCP
Touchet River [7]	Lyons Ferry	Lyons Ferry A	Smolt	85,000	20K CWT, 100% Ad-Clip	0	Fishery	LSRCP
Touchet River	Lyons Ferry	Touchet A	Smolt	50,000	100% CWT	50,000	Broodstock Evaluation/ Supplementation	LSRCP
			Smolts	**1,365,000**		**+50,000**		
Subtotal			**Kelts**	**600-1,000**				

Table B6. Continued – Steelhead

Basin *Snake River*

Release Site	Rearing Facility	Stock	Life stage	Target Release Number	Mark	Non-Ad-Clipped[1]	Primary Program Purpose	Funding
Tucannon River	Tucannon/Lyons Ferry	Tucannon A	Smolt	50,000	100% CWT	50,000	Supplementation/ Broodstock Evaluation	LSRCP
Tucannon River [7]	Lyons Ferry	Lyons Ferry A	Smolt	100,000	20K CWT, 100% Ad-Clip	0	Fishery	LSRCP
Lyons Ferry Hatchery [7]	Lyons Ferry	Lyons Ferry A	Smolt	60,000	20K CWT, 100% Ad-Clip	0	Fishery	LSRCP
Cottonwood Pond, Grande Ronde River [7]	Lyons Ferry	Wallowa A	Smolt	160,000	20K CWT, 100% Ad-Clip	0	Fishery	LSRCP
Big Sheep Creek, Imnaha	Irrigon	Little Sheep Cr. A	Smolt	50,000-100,000 [8]	100% Ad-Clip, 4,000 PIT	0	Fishery/ Supplementation	LSRCP
Little Sheep Creek, Imnaha	Irrigon	Little Sheep Cr. A	Smolt	165,000-230,000 [8]	25KCWT, 100% Ad-Clip	0	Fishery/ Supplementation	LSRCP
Dworshak NFH	Dworshak NFH	Clearwater B [9]	Smolt	1,200,000	100% Ad-Clip, TBD CWT	0	Fishery	COE
Clear Ck, Middle Fork Clearwater	Dworshak NFH	Clearwater B [9]	Smolt	300,000	100% Ad-Clip, TBD CWT	0	Fishery	COE
Lower South Fork Clearwater – Red House Hole	Dworshak NFH	Clearwater B [9]	Smolt	400,000	100% Ad-Clip, TBD CWT	0	Fishery	COE
Lower South Fork Clearwater – Red House Hole	Clearwater	Clearwater B [9]	Smolt	260,000	100% Ad-Clip, TBD CWT	0	Fishery	LSRCP
Lower SF Clearwater	Clearwater	Clearwater B [9]	Smolt	250,000	100% Ad-Clip TBD CWT	0	Fishery	LSRCP
Crooked River, SF Clwt [10]	Clearwater	Clearwater B/South Fork Cl.[9]	Smolt	83,000	TBD	83,000	Supplementation	LSRCP/BPA FCRPS
Red River, SF Clearwater [10]	Clearwater	Clearwater B/South Fork Cl[9]	Smolt	150,000	TBD	150,000	Supplementation	LSCRP/BPA FCRPS
Newsome Ck SF Clearwater [10]	Clearwater	Clearwater B/South Fork Cl. [9]	Smolt	100,000	TBD	100,000	Supplementation	LSRCP/BPA FCRPS
Lolo Creek, MF Clearwater [10]	Dworshak NFH	Clearwater B/Lolo[9]	Smolt	200,000	TBD	200,000	Supplementation	COE/BPA FCRPS

Table B6. Steelhead - Snake River Continued

Release Site	Rearing Facility	Stock	Life stage	Target Release Number	Mark	Non-Ad-Clipped[1]	Primary Program Purpose	Funding
East Fork Salmon [11]	Magic Valley	EFSR-A	Smolt	<=200,000	H and N broodstock availability will drive mark and release number	H and N broodstock availability will drive mark and release number	Supplementation/ Fishery	LSRCP
Yankee Fork [12]	Hagerman, Magic Valley, Sawtooth	Sawtooth/Yankee Fork	Smolt	440,000	220K Ad-Clip, 220K TBD no Ad	220,000	Supplementation/ Fishery	LSRCP
Little Salmon River	Niagara Springs, Magic Valley, Hagerman NFH	Oxbow A, Pah A	Smolt	<=650,000	CWT, 100% Ad-Clip	0	Fishery	IPC/LSRCP
Hells Canyon Snake River	Niagara Springs	Oxbow A	Smolt	525,000	CWT, 100% Ad-Clip	0	Fishery	IPC
Upper Salmon Tribs.[13]	Sawtooth, Pahsimeroi	Sawtooth/ Pahsimeroi	Eggs	1 million	0		Supplementation	LSRCP
Subtotal				**5,343,000**	**smolts**	**803,000**		

Basin — *Columbia Bonneville to McNary*

Release Site	Rearing Facility	Stock	Life stage	Target Release Number	Mark	Non-Ad-Clipped[1]	Primary Program Purpose	Funding
Umatilla River, Meacham Cr.	Umatilla	Umatilla Summer	Smolt	50,000	100% Ad-Clip, 20K CWT-LV	0	Supplementation/ Fishery	BPA
Umatilla River, Minthorn AP	Umatilla	Umatilla Summer	Smolt	50,000	100% Ad-Clip, 20K CWT-LV	0	Supplementation/ Fishery	BPA
Umatilla River, Pendleton AP	Umatilla	Umatilla Summer	Smolt	50,000	100% Ad-Clip, 20K CWT-LV	0	Supplementation/ Fishery	BPA
Klickitat [14]	Skamania	Skamania Summer	Smolt	90,000	100% % Ad-Clip	0	Fishery	MA
Hood River (West and Middle Forks)	Oak Springs	Hood River Summer	Smolt	30,000	100% Ad-RM/LM Clip	0	Supplementation/ Fishery	BPA
Hood River (East Fork)	Oak Springs	Hood River Winter	Smolt	50,000	100% Ad-RV/LV Clip	0	Supplementation/ Fishery	BPA
Subtotal				**320,000**		**0**		
Grand Total	**Steelhead**			**7,028,000**		**+853,000**		

Footnotes for Table B6: Steelhead

1. The category 'Mark' may include fish that are adipose fin clipped (Ad-Clip), regardless of funding source. The tribes do not agree with the concept of mass marking production using an adipose fin clip for anything other than evaluation purposes. Non-treaty Parties may propose to use mark-selective fishing techniques that allow for a higher harvest rate on hatchery fish marked with an adipose fin clip compared to fish not so marked. Non-tribal Parties also recognize that mass marking by adipose clipping facilitates broodstock management and hatchery/natural origin stock assessment.
2. The category "Non-Ad-Clipped" may include fish marked by other means such as CWT, PIT, or VIE tags Nothing in this Agreement shall be interpreted to prevent the federal Parties and/or states from mass marking fish required to be marked under Section 113 of the Consolidated Appropriations Act, 2008 (PL 110-161); or other Congressional acts directing the mass marking of Chinook, coho, and steelhead released from federally operated or financed hatcheries. In the event USFWS and/or states mark fish inconsistent with Tables B1-B7, nothing in this Agreement prevents any Party from challenging these acts. In the event of insufficient funding to carry out such marking, the federal Parties will consult with the other Parties to review and revise the priorities in any marking plan provided for under this Agreement. The federal Parties will, to the extent required by law, consider the other Parties' recommendations and the United States' trust and treaty responsibility to the Tribes before deciding marking priorities.
3. The Parties' intent is that Fishery impacts on the fish identified in the table above as Non-Ad-Clipped will be similar to those of natural-origin fish. Marking/tagging for monitoring and evaluation is expected. Fish that are hatchery reared but not adipose fin clipped may be marked for monitoring and evaluation by other methods (including natural features such as scales and fin erosion) such that they can be identified as hatchery produced at counting stations and in Fishery. Monitoring and evaluation plans will be developed by the appropriate sub-basin management entities and shall be coordinated through the U.S. v. Oregon Production Advisory Committee. Annually, the Production Advisory Committee shall provide an update of the monitoring and evaluation plans to the Parties.
4. These production programs will be implemented and/or adjusted based on mid-Columbia HCPs and Settlement Agreement in the future. The Parties are pursuing new funding for acclimation facilities tied to these existing programs.
5. Methow River/Winthrop NFH Steelhead Programs – The Methow River steelhead programs are expected to change during the period covered by this Agreement. To guide this change, the Parties commit to developing a Methow River steelhead management plan by January 2009, designed to transition to a local Methow origin broodstock. The management plan will incorporate the hatchery mitigation requirement using an integrated steelhead program, timing of the transition, fishery objectives, marking, supplementation objectives using natural origin fish, adult management, criteria for natural origin adult collection, etc. The Parties support development of steelhead acclimation facilities for these programs. Full implementation is subject to funding being provided by PUDs and BOR.
6. The Okanogan River steelhead programs are expected to change during the period covered by this Agreement. To guide this change, the Parties commit to developing a Okanogan River steelhead management plan by January 2009, designed to transition to a local Okanogan origin broodstock. The management plan will incorporate the hatchery mitigation requirement using an integrated steelhead program, timing of the transition, fishery objectives, marking, supplementation objectives using natural origin fish, adult management, criteria for natural origin adult collection, etc. Current habitat for steelhead in the basin is limited and full implementation of the plan will depend upon timing and level of improvements to habitat. Full implementation is subject to funding being provided by PUDs, BPA, and BOR.
7. The Parties agree on current production levels to achieve mitigation objectives for the Walla Walla, Touchet, Tucannon, and lower Grande Ronde (Cottonwood) programs but not necessarily the stock used (non-local) or the release location. These steelhead programs may change during the period covered by this Agreement. To guide this change, the Parties commit to developing steelhead management plans for broodyear 2010, designed to transition to endemic stocks or segregated programs. The management plans will incorporate the hatchery mitigation requirement, timing of the

transition, fishery objectives, marking, supplementation component linked to passage improvements on Mill Creek (Walla Walla basin), release locations, criteria to be met for collecting natural-origin adults from the upper Walla Walla basin, marking, etc.

8. Production from 215,000 to 330,000 smolts will be managed to meet the Little Sheep Creek share (2,000 adults) of the LSRCP mitigation goal above Lower Granite Dam. The Parties will collaborate on an annual basis to establish juvenile release targets and adult broodstock management above the Little Sheep Creek weir and in the hatchery. If adult returns decrease the Parties have the option to release unclipped groups of fish aimed at achieving natural escapement and broodstock goals.
9. Under current production levels, returns of hatchery Group B steelhead are expected to be sufficient to meet egg take needs for existing programs. In the event that hatchery Group B steelhead returns are projected to be less than 10,000 fish at Lower Granite Dam and sport fishery on Idaho-bound hatchery steelhead would have to be restricted to meet egg take needs, the Parties shall discuss management measures to respond to the shortfall in steelhead returns. Potential management measures include, but are not limited to: prioritizing releases for the 2009-2019 brood years, restrictions on sport and/or tribal tributary fishery, additional broodstock collection. Releases of Clearwater B steelhead in the Clearwater Basin will be prioritized over releases in the Salmon Basin. All Parties agree to take appropriate actions to equitably address a forecasted or actual broodstock shortfall. If the Parties are unable to agree on management measures to respond to the shortfall, the Parties shall modify both supplementation and fishery production actions to reflect the anticipated broodstock return.
10. Parties support collecting adults returning to South Fork Clearwater River and Lolo Creek with infrastructure development, funding support, and HGMPs to accomplish broodstock transition to locally returning adults by broodyear 2010. Parties commit to further discussion of supplementation options and release locations in the South Fork of the Clearwater.
11. The Parties support continuing collection of locally returning adults to the East Fork Salmon River with infrastructure development, funding support, and HGMPs by broodyear 2010. The Parties commit to further discussions of supplementation options and release locations for this local broodstock.
12. Parties support collecting adults returning to Yankee Fork with infrastructure development, funding support, and HGMPs to accomplish broodstock transition to locally returning adults by broodyear 2010. If surplus production from local broodstock is available, Parties will discuss release options.
13. The Parties agree on three locations for planting these eggs including Indian Creek, Panther Creek, and Yankee Fork and will investigate local broodstock collection opportunity for transitioning the program. Releases into Indian Creek will be limited to 100,000 eggs. In 2013, the Parties will review information from monitoring and evaluation of the program to assess effectiveness, and if eggs from local broodstock are available will consider expanding release locations to other streams including Basin Creek and Morgan Creek.
14. Klickitat Basin Steelhead Master Plan is in development and may include changes to the current program. The master plan is expected to be submitted in 2008. The YKFP will collaborate per Part III.H of this Agreement on proposed changes to this program.

Table B7. Coho Production for Brood Years 2008-2017.

Basin **Columbia River Above McNary**

Release Site	Rearing Facility	Stock	Life stage	Target Release Number	Mark [1]	Non-Ad-Clipped [2]	Primary Program Purpose	Funding
Naches River	Eagle Creek	Eagle Cr./ Yakima	Smolt	500,000	TBD	0	Supplementation Fishery	BPA/MA
Upper Yakima River	Prosser	Yakima/Eagle Cr.	Smolt	500,000	TBD	0	Supplementation Fishery	BPA/MA
Icicle Creek (at the NFH)[3]	Cascade/Willard	Mid Col Local/Tanner	Smolt	300,000	100% CWT only	300,000	Supplementation	BPA/MA/PUD
Nason Creek [3]	Cascade/Willard	Mid Col Local/Tanner	Smolt	400,000	100% CWT and 100% body tagged	400,000	Supplementation	BPA/MA/PUD
Beaver Creek [3]	Cascade/Willard	Mid Col Local/Tanner	Smolt	100,000	100% CWT and 100% body tagged	100,000	Supplementation	BPA/MA/PUD
Wells Fish Hatchery [3,4]	Cascade	Mid Col Local/Tanner	Smolt	150,000	100% CWT only	150,000	Supplementation	BPA/MA
Wenatchee Tribs (Nason and Beaver Cks/Entiat [3,5]	Entiat NFH	Mid-Col local	Smolt	200,000	TBD	TBD	Supplementation/ Fishery	BPA/BR
On Station [3]	Winthrop NFH	Mid Col Local	Smolt	350,000 [6]	100% CWT only	350,000	Supplementation	BPA/MA/PUD
Subtotal				**2,500,000**		**1,300,000**		

Basin ***Snake River***

Release Site	Rearing Facility	Stock	Life stage	Target Release Number	Mark [1]	Non-Ad-Clipped [2]	Primary Program Purpose	Funding
Clear Cr., Lapwai Cr., Nez Perce Tribal Hatchery	Eagle Creek	Early	Smolt	550,000	TBD	490,000	Supplementation	MA/PCSRF
Clear Creek	Dworshak/Kooskia	Early	Smolt	280,000	100K CWT	280,000	Supplementation	PCSRF
Wallowa River [7]	Cascade	Early	Smolt	TBD up to 500,000	TBD	TBD	Reintroduction	MA/BPA FCRPS
Subtotal				**+830,000**		**+770,000**		

Table B7. Coho – Continued

Basin *Columbia Bonneville to McNary*

Release Site	Rearing Facility	Stock	Life stage	Target Release Number	Mark [1]	Non-Ad-Clipped [2]	Primary Program Purpose	Funding
Umatilla R (Pendleton Acclimation Pond)	Cascade	Early	Smolt	500,000 [6]	50K CWT only [7] 450K Ad-Clip	50,000	Supplementation/ Fishery	MA/BPA
Umatilla R. (Pendleton Acclimation Pond)	Herman Cr.	Early	Smolt	500,000	50K CWT only [8] 450K Ad-Clip	50,000	Supplementation/ Fishery	MA/BPA
Klickitat River [9]	Klickitat Hatchery	Late	Smolt	1,000,000	100% Ad-Clip, 45K CWT	0	Fishery	MA
Klickitat River	Washougal	Late	Smolts	2,500,000	100% Ad-Clip 75K Ad-CWT	0	Fishery	MA
Subtotal				4,500,000		100,000		
Grand Total	**Coho**			**7,830,000**		**+2,170,000**		

Footnotes for Table B7: Coho Salmon

1. The category 'Mark' may include fish that are adipose fin clipped (Ad-Clip), regardless of funding source. The tribes do not agree with the concept of mass marking production using an adipose fin clip for anything other than evaluation purposes. Non-treaty Parties may propose to use mark-selective fishing techniques that allow for a higher harvest rate on hatchery fish marked with an adipose fin clip compared to fish not so marked. Non-tribal Parties also recognize that mass marking by adipose clipping facilitates broodstock management and hatchery/natural-origin stock assessment.
2. The category "Non-Ad-Clipped" may include fish marked by other means such as CWT, PIT, or VIE tags. Nothing in this Agreement shall be interpreted to prevent the federal Parties and/or states from mass marking fish required to be marked under Section 113 of the Consolidated Appropriations Act, 2008 (PL 110-161); or other Congressional acts directing the mass marking of Chinook, coho, and steelhead released from federally operated or financed hatcheries. In the event USFWS and/or states mark fish inconsistent with Tables B1-B7, nothing in this Agreement prevents any Party from challenging these acts. In the event of insufficient funding to carry out such marking, the federal Parties will consult with the other Parties to review and revise the

priorities in any marking plan provided for under this Agreement. The federal Parties will, to the extent required by law, consider the other Parties' recommendations and the United States' trust and treaty responsibility to the Tribes before deciding marking priorities.

3. Upper Columbia Reintroduction Program is in transition from feasibility phase to long term production phase. Production numbers and release locations may change based on agreement of the Parties.
4. Requires formal agreement of the Wells HCP.
5. The long term goal for Entiat NFH is under review and the coho production numbers will be determined based on the feasibility test currently planned. Initial experimental transition release is at the 200,000 level. The Parties will collaboratively develop implementation guidelines for program objectives, size, release locations, and marking protocols per Part III.H of this Agreement.
6. The 350,000 smolts identified for release at Winthrop NFH includes 250,000 reared at the hatchery and 100,000 transferred in from Cascade Hatchery for acclimation and release.
7. Pending funding for implementation, Parties commit to transferring Cascade Hatchery coho smolts from Umatilla River to Grande Ronde River. Parties will develop reintroduction plan and agree to release numbers, acclimation location (Wallowa Hatchery) marking plan, M&E plan. If the final release number in the Wallowa /Grande Ronde River is less than 500,000 the balance of the production will revert back to release in the Umatilla River.
8. The current Ad-CWT mark for Umatilla coho is 25K for each Cascade and Herman Creek release. However, the Parties would agree to increase this to 50K Ad-CWT for each release group if funding becomes available.
9. Klickitat Basin Coho Master Plan is in development and may include changes to the current program. The master plan is expected to be submitted in 2008.

Attachment C

Grande Ronde Spring Chinook Marking Guidelines

A. <u>Interim period with Captive Brood programs at production levels</u>

1. Upper Grande Ronde (through BY 2012)
   - Conventional CWT only
   - Captive Brood ADCWT
   - If all production is from conventional brood mark 50% AD with represented CWT group
2. Catherine Creek (through BY 2010)
   - Conventional AD with represented CWT group
   - Captive Brood ADCWTVIE
3. Lookingglass Creek (through BY 2010)
   - Conventional AD with represented CWT groups
   - CC Captive Brood ADCWT

B. <u>Long term period with primarily Conventional Production and captive brood safety net programs maintained for Upper Grande Ronde and Catherine Creek</u>.

1. Upper Grande Ronde

Upper Grande Ronde sliding scale for adult escapement and fish marking		
Adult Escapement	Marking	Assumptions
<300	Follow Interim Marking Strategy	Use captive brood safety net production
300-750	First 125,000 CWT only Balance Ad with represented 62.5K CWT	
751-1500	First 62,500 CWT only Balance Ad with represented 62.5K CWT	
>1500	Ad with represented 62.5K CWT	

2. Catherine Creek

Catherine Creek sliding scale for adult escapement and fish marking		
Adult Escapement	Marking	Assumptions
<150	Follow Interim Marking Strategy	Use captive brood safety net production
≥150	Ad with represented 62.5K CWT	

3. ***Lookingglass Creek***
   - Ad with represented 62.5KCWT group

GLOSSARY

For the purposes of this Agreement:

Ad-Clip or **Ad** means: A means of marking fish by removing the adipose fin.

AEQ means: Adult equivalent.

anadromous fish means: Fish that ascend freshwater rivers and streams to reproduce after maturing in the ocean.

AOP means: Annual Operations Plan developed for an artificial production program.

artificial production or **artificial propagation** means: Spawning, incubating, hatching or rearing fish in a facility constructed for fish production.

BA means: A biological assessment prepared under 16 U.S.C. § 1536(c).

BIA means: Bureau of Indian Affairs, an agency of the United States Department of the Interior.

BOR or **BR** means: United States Bureau of Reclamation, an agency of the United States Department of the Interior.

BPA means: Bonneville Power Administration.

BPH means: Bonneville Pool Hatchery; tule fall Chinook salmon produced in artificial production facilities between Bonneville and The Dalles Dams.

BUB means: Bonneville Upriver Bright; bright fall Chinook salmon produced in Bonneville Hatchery.

BY means: Brood year.

C&S means: Ceremonial and subsistence.

ceremonial fish means: Those fish caught and used pursuant to tribal authorization for religious or other traditional Indian cultural purposes of the tribes and which may not be sold, bartered or offered for sale.

COE means: United States Army Corps of Engineers.

Columbia River Compact or **Compact** means: The Oregon-Washington Columbia River Compact, enacted in Oregon as 1915 Or. Laws ch. 188, § 20 (codified at ORS 507.010), in Washington as 1915 Wash. Laws ch. 31, § 116 (codified as amended at RCW 77.75.010 (2006)), and ratified by Congress in the Act of April 8, 1918, ch. 47, 40 Stat. 515.

Columbia River Treaty Tribes means: The Confederated Tribes of the Warm Springs Reservation of Oregon, the Confederated Tribes of the Umatilla Indian Reservation, the Nez Perce Tribe, and the Confederated Tribes and Bands of the Yakama Nation.

commercial fish means: Those fish that are sold or bartered or are caught for that purpose (except subsistence fish).

conversion rate means: The estimated survival of adult fish during upstream migration. Conversion rates are calculated by dividing the count of a particular group of adult fish at the uppermost dam by the count of that group at the lowest dam.

CTUIR means: Confederated Tribes of the Umatilla Indian Reservation.

CTWSRO means: Confederated Tribes of the Warm Spring Indian Reservation of Oregon.

CWT means: Coded Wire Tag, a means of marking fish by inserting numeric-coded wires into their snouts.

DPS means: Distinct Population Segment under 16 U.S.C. § 1532(16), as defined in 61 Fed. Reg. 4722 (Feb. 7, 1996).

emergency means: Unanticipated change in fish resource status, abundance, timing or harvest level for which the relevant data was not available during preseason planning and which requires immediate management response to achieve the objectives of this Agreement.

enhancement means: The use of artificial propagation to increase the abundance of fish for harvest and spawning purposes.

ER means: Exploitation rate.

ESA means: Endangered Species Act, 16 U.S.C. §§ 1531-1544.

escapement means: The total number of adult fish that are passed through fisheries for purposes of artificial or natural production.

ESU means: Evolutionarily Significant Unit as defined in 56 Fed. Reg. 58,612 (Nov. 20, 1991) for the purpose of identifying salmon “species” under 16 U.S.C. § 1532(16).

FCRPS means: Federal Columbia River Power System.

FH means: Fish Hatchery.

fishery impact or **harvest impact** means: Incidental fishery-related mortalities, measured as a percentage of run size at some geographical point.

FWS means: United States Fish and Wildlife Service, an agency of the United States Department of the Interior.

harvestable fish means: Those fish determined pursuant to this Agreement to be available for harvest.

hatchery fish means: Fish spawned, incubated, hatched or reared in an artificial production facility.

HCP means: A habitat conservation plan prepared under 16 U.S.C. § 1539.

HGMP means: A Hatchery and Genetics Management Plan prepared under 50 C.F.R. § 223.203(b)(5).

HR means: Harvest rate.

IDFG means: Idaho Department of Fish and Game.

IPC means: Idaho Power Company.

ISS means: Idaho Supplementation Study.

Joint State Staff or **Joint Staff** means: Joint Columbia River Management Staff of the Oregon and Washington Departments of Fish and Wildlife.

LCR means: Lower Columbia River, that portion of the Columbia River downstream from Bonneville Dam.

listed means: Determined to be a threatened or endangered species under 16 U.S.C. § 1533.

LM means: A means of marking fish by clipping the left maxillary.

lower river means: That portion of the Columbia River downstream from Bonneville Dam.

LRB means: Lower River Bright; bright fall Chinook salmon that spawn naturally in the Columbia River approximately three miles downstream of Bonneville Dam.

LRH means: Lower River Hatchery; tule fall Chinook salmon produced in artificial production facilities in the Columbia River basin downstream of Bonneville Dam.

LRW means: Lower River Wild; naturally-produced bright fall Chinook salmon from Columbia River tributaries downstream of Bonneville Dam.

LSRCP means: The Lower Snake River Fish and Wildlife Compensation Plan, initially authorized by Pub. L. No. 94-587, § 102, 90 Stat. 2917, 2921 (1976).

LV means: A means of marking fish by clipping the left ventral fin.

MA means: Mitchell Act, Act of May 11, 1938, ch. 193, 52 Stat. 345 (codified as amended at 16 U.S.C. §§ 755-757).

mainstem means: The Columbia River between its mouth and McNary Dam, except where expressly indicated otherwise.

management entity means: The agency (tribal, state, or federal) having fisheries management or production authority over the specific area and subject matter involved. The Parties designate the following as their management entities for purposes of this Agreement:

Idaho Idaho Departme nt of Fish and Game

Nez Perce Tribe Nez Perce Department of Fisheries

Oregon Oregon Department of Fish and Wildlife

Shoshone-Bannock Tribes Shoshone -Bannock Fish and Wildlife

United States

National Marine Fisheries Service (ocean fisheries)

United States Fish and Wildlife Service (National Fish Hatcheries)

Umatilla Tribe Umatilla Department of Natural Resources, Fisheries Program

Warm Springs Tribe Warm Springs Natural Resources Branch, Fish, Wildlife, and Parks Department

Washington Washington Depar tment of Fish and Wildlife

Yakama Nation Yakama Nation Fisheries Resource Management

A party may change the designation by notifying the Chair of the Policy Committee in writing.

management goal means: A desired adult fish run size, usually composed of an aggregate of individual stocks, as measured at a given geographic point.

marked fish means: Fish to which humans have applied some external or internal means of identification.

M&E means: Monitoring and evaluation.

Mid Columbia fall Chinook or **MCB** means: Bright fall Chinook salmon originating from the Columbia River and its tributaries from about three miles downstream of Bonneville Dam upstream to McNary Dam.

Mid Columbia coho means: Coho salmon originating from the Wenatchee, Entiat, and Methow watersheds.

Mid-Columbia HCP means: The Habitat Conservation Plans prepared under 16 U.S.C. § 1539 for the operation of Rock Island Dam, Rocky Reach Dam, and the Wells Hydroelectric Project.

natural origin fish, **natural spawning fish**, or **naturally produced fish** means: Fish produced by spawning and rearing in natural habitat, regardless of the parentage of the spawners.

NEOH means: Northeast Oregon Hatchery.

NFH means: National Fish Hatchery.

NI means: Non-Indian.

NMFS means: The National Marine Fisheries Service, a subdivision of NOAA.

NOAA means: The National Oceanic and Atmospheric Administration, a subdivision of the United States Department of Commerce.

NOAA Fisheries means: The National Marine Fisheries Service, a subdivision of NOAA.

non-treaty fisheries means: All fisheries within the United States portion of the Columbia River Basin except those open only to members of the Columbia River Treaty Tribes or the Shoshone-Bannock Tribes, and all ocean fisheries in the United States' Exclusive Economic Zone and shoreward off the coasts of Washington and Oregon except those open only to members of the Makah, Quileute, Hoh, or Quinault Tribes.

North of Falcon Forum or **NOF** means: A series of public meetings associated with the annual planning of salmon fisheries in Washington and Oregon north of Cape Falcon.

NPCC means: The Northwest Power and Conservation Council established by 16 U.S.C. § 839b.

NPT means: Nez Perce Tribe.

NPTH means: Nez Perce Tribal Hatchery.

ODFW means: Oregon Department of Fish and Wildlife.

outplant means: A form of supplementation releasing adults in streams to increase or establish natural spawning fish populations.

PCSRF means: Pacific Coastal Salmon Recovery Fund, initially authorized by Pub. L. No. 106-113—Appendix A, § 623, 113 Stat. 1501, 1501A-56 (1999).

PFMC means: The Pacific Fishery Management Council established by 16 U.S.C. § 1852.

PIT tag means: A means of marking fish with passive integrated transponders.

point of disagreement means: A disagreement over the interpretation or application of this Agreement.

PUB means: Pool Upriver Bright; artificially-produced bright fall Chinook salmon released in areas between Bonneville and McNary Dams.

PUD means: Public Utility District.

rebuilding means: Progress toward achieving an abundance of fish that meets the long-term natural production and harvest goals of the Parties.

RM means: A means of marking fish by clipping the right maxillary.

run means: An aggregate of one or more stocks of the same species migrating at a discrete time.

RV means: A means of marking fish by clipping the right ventral fish.

SAB means: Select Area Bright; artificially-produced bright fall Chinook salmon derived from a Rogue River stock.

sanctuary means: A specific location closed to fishing for the protection of certain fish populations that may be present.

SBT means: Shoshone-Bannock Tribes.

spawning escapement means: The number of fish arriving at a natal stream, river, or artificial production facility to spawn.

spawning escapement goal or **spawning objective** means: The numerical target for a given population, stock, or run of adult fish for artificial or natural production.

SR means: Snake River.

SRW means: Snake River Wild; natural-origin Snake River fall Chinook salmon, a component of upriver bright fall Chinook salmon.

stock means: An aggregation of fish spawning in a particular stream or lake during a particular season which to a substantial degree do not interbreed with any group spawning at a different time.

subbasin or **sub-basin** means: A geographic area upstream from Bonneville Dam containing—tributaries to the Columbia River mainstem or to the Snake River that produce anadromous fish.

subsistence fish means: Those fish caught by enrolled members of a federally-recognized Indian Tribe or the Wanapum Band for the personal consumption of tribal members, or their immediate family, or for trade, sale or barter to other Indians for their consumption, or for consumption at a tribally approved function for which no admission or other fee is charged.

subsistence gear, as applied to treaty Indians, means: Dipnet or bagnet, spear, gaff, club, fouling hook, hook and line or other methods as determined by the management entities.

supplementation means: The release of artificially propagated fish or fertilized eggs in streams to increase or establish natural spawning fish populations.

tributary means: Any portion of the Columbia River system other than the mainstem of the Columbia River.

unclipped fish means: Fish with all fins intact.

upper river or upriver means: The portion of the Columbia River and its tributaries upstream from Bonneville Dam.

URB means: Upriver bright fall Chinook salmon.

USACOE means: United States Army Corps of Engineers.

USFWS means: United States Fish and Wildlife Service, an agency of the United States Department of the Interior.

VIE means: Visible Implant Elastomer or Visual Implant Elastomer, a means of marking fish by injecting a small amount of colored or fluorescent material under the skin.

WDFW means: Washington Department of Fish and Wildlife.

YIN means: Yakama Nation.

YKFP means: the Yakima/Klickitat Fisheries Project that is the subject of a Memorandum of Understanding Between the Confederated Tribes and Bands of the Yakama Indian Nation and the State of Washington, dated May 19, 1994.

Zones 1-5 means: The statistical zones of the Columbia River commercial fishing area downstream from Bonneville Dam, as defined in Section 635-042-0001 of the Oregon Administrative Rules. Zones 1 through 5 encompass the Columbia River mainstem easterly of a line projected from the knuckle of the south jetty on the Oregon bank to the inshore end of the north jetty on the Washington bank, and westerly of a line projected from a deadline marker on the Oregon bank (approximately four miles downstream from Bonneville Dam Powerhouse 1) in a straight line through the western tip of Pierce Island, to a deadline marker on the

Washington bank at Beacon Rock.

Zone 6 means: The statistical zone of the Columbia River treaty Indian commercial fishing area upstream from Bonneville Dam running from Bonneville to McNary Dams.

CONFEDERATED TRIBES OF THE WARM SPRINGS RESERVATION OF OREGON

By: Ron Suppah

RON SUPPAH, SR., Chairman
Tribal Council

Date: May 9, 2008

CONFEDERATED TRIBES OF THE UMATILLA INDIAN RESERVATION

By: Antone Minthorn
ANTONE MINTHORN, Chairman
Board of Trustees

Date: 5/20/08

NEZ PERCE TRIBE

By: *Samuel N. Penney*
SAMUEL N. PENNEY, Chairman
Nez Perce Tribal Executive Committee

Date: May 20, 2008.

TONIA B. GARCIA, Secretary
Nez Perce Tribal Executive Committee

Date: May 20th, 2008.

Tonia B. Garcia

CONFEDERATED TRIBES AND BANDS OF THE YAKAMA NATION

By: *Ralph Sampson Jr.*
RALPH SAMPSON, Jr., Chairman
Tribal Council

Date: *August 6, 2008*

STATE OF WASHINGTON

By:

JEFFREY P. KOENINGS, PH.D., Director
Washington Department of Fish and Wildlife

Date: 5/21/08

STATE OF OREGON

By: [signature]
ROY ELICKER, Director
Oregon Department of Fish and Wildlife

Date: 5/20/08

STATE OF IDAHO

By: Cal Groen

CAL GROEN, Director
Idaho Department of Fish and Game

Date: 4/30/08

SHOSHONE-BANNOCK TRIBES

By: ______________________
ALONZO COBY, Chairman
Fort Hall Business Council

Date: 5/8/08

UNITED STATES OF AMERICA
U.S. Department of the Interior

By: Ren Lohoefener

Ren Lohoefener, Regional Director
U.S. Fish and Wildlife Service

Date: May 5, 2008

UNITED STATES OF AMERICA
U.S. Department of the Interior

By:
STAN SPEAKS, Regional Director,
Bureau of Indian Affairs, Northwest Region

Date: 5/05/08

UNITED STATES OF AMERICA
U.S. Department of Commerce

By: D. Robert Lohn

D. ROBERT LOHN, Regional Administrator
National Marine Fisheries Service

Date: 5/5/2008

Appendix C

Hatchery Performance and Production by Alternative for Chinook Salmon

Appendix C1. Hatchery Performance by Alternative for Chinook Salmon

Revised - 2-24-10

Legend
Primary
Contributing
Stabilizing
Not in ESU

Legend
Supporting
Consistent
Not Consistent

Upper Willamette River Chinook

Pop #	ID	Population Name	ESU	Designation	Subbasin	Alternative 1 Population Type	pHOS	PNI	Productivity	NOS	Alternative 2 Population Type	pHOS	PNI	Productivity	NOS	Alternative 3 Population Type	pHOS	PNI	Productivity	NOS
1	733	Clackamas Spring Chinook	Upper Willamette River Chinook	1	Willamette	Natural	2%	0.00	2.39	1,395	Natural	0%	0.00	2.7	1,617	Natural	2%	0.00	2.4	1,397
2	416	McKenzie Spring Chinook	Upper Willamette River Chinook	1	Willamette	Integrated	9%	0.73	3.03	4,168	Integrated	9%	0.73	3.0	4,195	Integrated	9%	0.73	3.0	4,168
3	419	North Santiam Spring Chinook	Upper Willamette River Chinook	1	Willamette	Integrated	72%	0.01	0.76	383	Integrated	72%	0.01	0.8	382	Integrated	72%	0.01	0.8	383
4	417	MF Willamette Spring Chinook	Upper Willamette River Chinook	2	Willamette	Integrated	78%	0.01	0.42	522	Integrated	78%	0.01	0.4	525	Integrated	78%	0.01	0.4	522
5	420	South Santiam Spring Chinook	Upper Willamette River Chinook	2	Willamette	Integrated	32%	0.24	1.19	466	Integrated	9%	0.52	1.7	701	Integrated	9%	0.52	1.7	688
6	736	Callappoia Spring Chinook	Upper Willamette River Chinook	3	Willamette	Natural	45%	0.00	0.58	9	Natural	45%	0.00	0.6	9	Natural	45%	0.00	0.6	9
7	730	Coast Fork Spring Chinook	Upper Willamette River Chinook	3	Willamette	Natural	49%	0.00	0.52	7	Natural	49%	0.00	0.5	7	Natural	49%	0.00	0.5	7
8	418	Molalla Spring Chinook	Upper Willamette River Chinook	3	Willamette	Integrated	85%	0.00	0.42	39	Integrated	84%	0.00	0.4	39	Integrated	85%	0.00	0.4	39
9	415	Clackamas Spring Chinook(Hatchery)	Upper Willamette River Chinook	4	Willamette	Segregated	100%	0.00	0.00	0	Segregated	0%	0.00	0.0	0	Segregated	100%	0.00	0.0	0

Upper Columbia River Summer/Fall-run Chinook

Pop #	ID	Population Name	ESU	Designation	Subbasin	Alternative 1 Population Type	pHOS	PNI	Productivity	NOS	Alternative 2 Population Type	pHOS	PNI	Productivity	NOS	Alternative 3 Population Type	pHOS	PNI	Productivity	NOS
1	286	Columbia Lower Middle Hanford Fall Chinook (Priest Rapids Upriver Brights)	Upper Columbia River Summer/Fall-ru	1	Hanford Reach	Integrated	16%	0.11	2.03	30,837	Integrated	7%	0.88	3.8	51,251	Integrated	10%	0.83	3.6	50,238
2	240	Okanogan-Similkimeen Summer Chinook	Upper Columbia River Summer/Fall-ru	1	Okanogan	Integrated	30%	0.70	3.31	4,980	Integrated	27%	0.72	3.4	5,034	Integrated	27%	0.72	3.4	4,980
3	249	Wenatchee Summer Chinook	Upper Columbia River Summer/Fall-ru	1	Wenatchee	Integrated	24%	0.80	2.99	7,602	Integrated	24%	0.803	3.0	7,671	Integrated	24%	0.80	3.0	7,584
4	300	Umatilla Fall Chinook	Upper Columbia River Summer/Fall-ru	2	Umatilla	Integrated	67%	0.13	0.47	729	Integrated	69%	0.50	0.6	839	Integrated	70%	0.50	0.6	856
5	313	Yakima Fall Chinook	Upper Columbia River Summer/Fall-ru	2	Yakima	Integrated	53%	0.09	0.70	1,920	Integrated	30%	0.00	0.7	506	Integrated	24%	0.51	1.0	1,249
6	311	Marion Drain Fall Chinook	Upper Columbia River Summer/Fall-ru	2	Yakima	Integrated	84%	0.23	0.45	93	Integrated	77%	0.24	0.5	72	Integrated	82%	0.23	0.4	85
7	678	Entiat Summer-Fall Chinook (Late Run)	Upper Columbia River Summer/Fall-rur	3	Entiat	Natural	75%	0.00	0.52	80	Natural	75%	0.00	0.5	81	Natural	75%	0.00	0.5	80
8	635	Klickitat Fall Chinook	Upper Columbia River Summer/Fall-rur	3	Klickitat	Natural	84%	0.00	0.88	1,133	Natural	0%	0.00	1.8	829	Natural	84%	0.00	0.9	1,131
9	236	Methow Summer Chinook	Upper Columbia River Summer/Fall-rur	3	Methow	Natural	69%	0.00	0.51	305	Natural	69%	0.00	0.5	306	Natural	69%	0.00	0.5	302
10	819	Upper Middle Columbia Mainstem Summer Chinook	Upper Columbia River Summer/Fall-rur	3	Upper Columbia Mainste	Natural	49%	0.00	1.30	1,522	Natural	49%	0.00	1.3	1,536	Natural	49%	0.00	1.3	1,519
11	692	Columbia Lower Middle Columbia Fall Chinook (URB-Ringold-Hatchery)	Upper Columbia River Summer/Fall-ru	4	Hanford Reach	Segregated	100%	0.00	0.00	0	Segregated	0%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
12	270	Klickitat Fall Chinook (URB-Hatchery)	Upper Columbia River Summer/Fall-ru	4	Klickitat	Segregated	100%	0.00	0.00	0	Segregated	0%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
13	826	Methow Summer Chinook (Wells Hatchery)	Upper Columbia River Summer/Fall-ru	4	Methow	Segregated	100%	0.00	0.00	0	Segregated	100%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
14	809	Umatilla Fall Chinook (Stepping Stone HAtchery)	Upper Columbia River Summer/Fall-ru	4	Umatilla	Segregated	100%	0.00	0.00	0	Segregated	100%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
15	694	Upper Middle Columbia Summer Chinook (Wells Hatchery)	Upper Columbia River Summer/Fall-ru	4	pper Columbia Mainste	Segregated	100%	0.00	0.00	0	Segregated	100%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
16	245	Mainstem Summer Chinook (Turtle Rock-Hatchery)	Upper Columbia River Summer/Fall-ru	4	pper Columbia Mainste	Segregated	100%	0.00	0.00	0	Segregated	100%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
17	794	Yakima Fall Chinook (Little White Salmon-Hatchery)	Upper Columbia River Summer/Fall-ru	4	Yakima	Segregated	100%	0.00	0.00	0	Segregated	0%	0.00	0.0	0	Segregated	0%	0.00	0.0	0

Appendix 1D

Upper Columbia River Spring-run Chinook

Pop #	ID	Population Name	ESU	Designation	Subbasin	Alternative 1 Population Type	pHOS	PNI	Productivity	NOS	Alternative 2 Population Type	pHOS	PNI	Productivity	NOS	Alternative 3 Population Type	pHOS	PNI	Productivity	NOS
1	231	Entiat Spring Chinook	Upper Columbia River Spring-run Chin	1	Entiat	Natural	27%	0.00	0.90	57	Natural	18%	0.00	0.9	43	Natural	5%	0.00	1.2	69
2	234	Methow (Methow-Chewuch) Spring Chinook	Upper Columbia River Spring-run Chin	1	Methow	Integrated	73%	0.06	0.87	435	Integrated	53%	0.65	1.4	399	Integrated	53%	0.65	1.4	399
3	821	Methow (Twisp) Spring Chinook	Upper Columbia River Spring-run Chin	1	Methow	Integrated	78%	0.28	0.88	83	Integrated	82%	0.55	1.2	35	Integrated	82%	0.55	1.2	35
4	247	Wenatchee (Chiwawa) Spring Chinook	Upper Columbia River Spring-run Chin	1	Wenatchee	Integrated	74%	0.33	2.36	286	Integrated	25%	0.58	3.4	276	Integrated	25%	0.58	3.4	276
5	822	Wenatchee (Nason) Spring Chinook	Upper Columbia River Spring-run Chin	1	Wenatchee	Natural	24%	0.00	1.26	110	Natural	3%	0.00	2.0	166	Natural	3%	0.00	2.0	166
6	823	Wenatchee (White) Spring Chinook	Upper Columbia River Spring-run Chin	1	Wenatchee	Integrated	41%	0.00	2.17	133	Integrated	22%	0.69	3.7	153	Integrated	22%	0.69	3.7	153
7	597	Okanogan Spring Chinook	Upper Columbia River Spring-run Chinc	3	Okanogan	Natural	0%	0.00	0.81	0	Natural	0%	0.00	0.8	0	Natural	0%	0.00	0.8	0
8	232	Entiat Spring Chinook (NFH)- Hatchery	Upper Columbia River Spring-run Chin	4	Entiat	Segregated	0%	0.00	0.01	0	Segregated	0%	0.00	0.0	0	Segregated	0%	0.00	0.0	0
9	235	Methow Spring Chinook (Winthrop Hatchery)	Upper Columbia River Spring-run Chin	4	Methow	Segregated	100%	0.00	0.00	0	Segregated	100%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
10	248	Wenatchee Spring Chinook (Leavenworth NFH)- Hatchery	Upper Columbia River Spring-run Chin	4	Wenatchee	Segregated	100%	0.00	0.00	0	Segregated	100%	0.00	0.0	0	Segregated	100%	0.00	0.0	0

Appendix C1. Hatchery Performance by Alternative for Chinook Salmon

Revised - 2-24-10

Legend	
Primary	Supporting
Contributing	Consistent
Stabilizing	Not Consistent
Not in ESU	

Upper Willamette River Chinook

Pop #	ID	Population Name	ESU	Designation	Subbasin	Alt 4 Population Type	Alt 4 pHOS	Alt 4 PNI	Alt 4 Produc-tivity	Alt 4 NOS Escapement	Alt 5 Population Type	Alt 5 pHOS	Alt 5 PNI	Alt 5 Produc-tivity	Alt 5 NOS
1	733	Clackamas Spring Chinook	Upper Willamette River Chinook	1	Willamette	Natural	2%	-	2.38	1,394	Natural	2%	0.00	2.4	1,394
2	416	McKenzie Spring Chinook	Upper Willamette River Chinook	1	Willamette	Integrated	9%	0.73	3.02	4,160	Integrated	9%	0.73	3.0	4,160
3	419	North Santiam Spring Chinook	Upper Willamette River Chinook	1	Willamette	Integrated	72%	0.01	0.76	382	Integrated	72%	0.01	0.8	382
4	417	MF Willamette Spring Chinook	Upper Willamette River Chinook	2	Willamette	Integrated	78%	0.01	0.42	521	Integrated	78%	0.01	0.4	521
5	420	South Santiam Spring Chinook	Upper Willamette River Chinook	2	Willamette	Integrated	9%	0.51	1.71	683	Integrated	9%	0.51	1.7	683
6	736	Callappoia Spring Chinook	Upper Willamette River Chinook	3	Willamette	Natural	45%	-	0.58	9	Natural	45%	0.00	0.6	9
7	730	Coast Fork Spring Chinook	Upper Willamette River Chinook	3	Willamette	Natural	49%	-	0.52	7	Natural	49%	0.00	0.5	7
8	418	Molalla Spring Chinook	Upper Willamette River Chinook	3	Willamette	Integrated	85%	-	0.42	39	Integrated	85%	0.00	0.4	39
9	415	Clackamas Spring Chinook(Hatchery)	Upper Willamette River Chinook	4	Willamette	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0

Upper Columbia River Summer/Fall-run Chinook

Pop #	ID	Population Name	ESU	Designation	Subbasin	Alt 4 Population Type	Alt 4 pHOS	Alt 4 PNI	Alt 4 Produc-tivity	Alt 4 NOS	Alt 5 Population Type	Alt 5 pHOS	Alt 5 PNI	Alt 5 Produc-tivity	Alt 5 NOS
1	286	Columbia Lower Middle Hanford Fall Chinook (Priest Rapids Upriver Brights)	Upper Columbia River Summer/Fall-ru	1	Hanford Reach	Integrated	10%	0.83	3.6197785	50028.83	Integrated	10%	0.83	3.6	50,133
2	240	Okanogan-Similkimeen Summer Chinook	Upper Columbia River Summer/Fall-ru	1	Okanogan	Integrated	22%	0.76	4.0585791	6182.78	Integrated	31%	0.68	3.6	5,419
3	249	Wenatchee Summer Chinook	Upper Columbia River Summer/Fall-ru	1	Wenatchee	Integrated	24%	0.80	2.9739402	7549.208	Integrated	23%	0.81	2.8	6,919
4	300	Umatilla Fall Chinook	Upper Columbia River Summer/Fall-ru	2	Umatilla	Integrated	70%	0.50	0.619075	849.818	Integrated	70%	0.50	0.6	856
5	313	Yakima Fall Chinook	Upper Columbia River Summer/Fall-ru	2	Yakima	Integrated	24%	0.51	0.9625135	1230.931	Integrated	24%	0.51	1.0	1,240
6	311	Marion Drain Fall Chinook	Upper Columbia River Summer/Fall-ru	2	Yakima	Integrated	82%	0.23	0.445548	85.11678	Integrated	82%	0.23	0.4	85
7	678	Entiat Summer-Fall Chinook (Late Run)	Upper Columbia River Summer/Fall-rur	3	Entiat	Natural	75%	0.00	0.5140481	79.24615	Natural	76%	0.00	0.5	73
8	635	Klickitat Fall Chinook	Upper Columbia River Summer/Fall-rur	3	Klickitat	Natural	84%	0.00	0.8791278	1126.967	Natural	84%	0.00	0.9	1,129
9	236	Methow Summer Chinook	Upper Columbia River Summer/Fall-rur	3	Methow	Natural	69%	0.00	0.5085731	300.2086	Natural	70%	0.00	0.5	278
10	819	Upper Middle Columbia Mainstem Summer Chinook	Upper Columbia River Summer/Fall-rur	3	Jpper Columbia Mainste	Natural	49%	0.00	1.2927248	1512.094	Natural	49%	0.00	1.2	1,391
11	692	Columbia Lower Middle Columbia Fall Chinook (URB-Ringold-Hatchery)	Upper Columbia River Summer/Fall-ru	4	Hanford Reach	Segregated	100%	0	0.0022942	0.003820713	Segregated	100%	0.00	0.0	0
12	270	Klickitat Fall Chinook (URB-Hatchery)	Upper Columbia River Summer/Fall-ru	4	Klickitat	Segregated	100%	0	0.0011694	0.002655528	Segregated	100%	0.00	0.0	0
13	826	Methow Summer Chinook (Wells Hatchery)	Upper Columbia River Summer/Fall-ru	4	Methow	Segregated	100%	0	0.0028896	0.004622986	Segregated	100%	0.00	0.0	0
14	809	Umatilla Fall Chinook (Stepping Stone HAtchery)	Upper Columbia River Summer/Fall-ru	4	Umatilla	Segregated	100%	0	0.0024244	0.003734514	Segregated	100%	0.00	0.0	0
15	694	Upper Middle Columbia Summer Chinook (Wells Hatchery)	Upper Columbia River Summer/Fall-ru	4	pper Columbia Mainste	Segregated	100%	0	0.0028896	0.004736908	Segregated	100%	0.00	0.0	0
16	245	Mainstem Summer Chinook (Turtle Rock-Hatchery)	Upper Columbia River Summer/Fall-ru	4	pper Columbia Mainste	Segregated	100%	0	0.0025854	0.004793361	Segregated	100%	0.00	0.0	0
17	794	Yakima Fall Chinook (Little White Salmon-Hatchery)	Upper Columbia River Summer/Fall-ru	4	Yakima	Segregated	0%	0	0.0048193	8.69802E-11	Segregated	0%	0.00	0.0	0

Appendix 1D

Upper Columbia River Spring-run Chinook

Pop #	ID	Population Name	ESU	Designation	Subbasin	Alt 4 Population Type	Alt 4 pHOS	Alt 4 PNI	Alt 4 Produc-tivity	Alt 4 NOS	Alt 5 Population Type	Alt 5 pHOS	Alt 5 PNI	Alt 5 Produc-tivity	Alt 5 NOS
1	231	Entiat Spring Chinook	Upper Columbia River Spring-run Chin	1	Entiat	Natural	5%	-	1.21	69	Natural	0%	0.00	1.8	145
2	234	Methow (Methow-Chewuch) Spring Chinook	Upper Columbia River Spring-run Chin	1	Methow	Integrated	53%	0.65	1.39	399	Integrated	30%	0.66	1.4	343
3	821	Methow (Twisp) Spring Chinook	Upper Columbia River Spring-run Chin	1	Methow	Integrated	82%	0.55	1.20	35	Integrated	49%	0.67	1.4	76
4	247	Wenatchee (Chiwawa) Spring Chinook	Upper Columbia River Spring-run Chin	1	Wenatchee	Integrated	25%	0.58	3.40	276	Integrated	18%	0.69	3.8	328
5	822	Wenatchee (Nason) Spring Chinook	Upper Columbia River Spring-run Chin	1	Wenatchee	Natural	3%	-	1.95	166	Natural	3%	0.00	2.0	172
6	823	Wenatchee (White) Spring Chinook	Upper Columbia River Spring-run Chin	1	Wenatchee	Integrated	22%	0.69	3.66	153	Integrated	22%	0.69	3.6	150
7	597	Okanogan Spring Chinook	Upper Columbia River Spring-run Chinc	3	Okanogan	Natural	0%	-	0.81	0	Natural	0%	0.00	0.8	0
8	232	Entiat Spring Chinook (NFH)- Hatchery	Upper Columbia River Spring-run Chin	4	Entiat	Segregated	0%	-	0.01	0	Segregated	0%	0.00	0.0	0
9	235	Methow Spring Chinook (Winthrop Hatchery)	Upper Columbia River Spring-run Chin	4	Methow	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0
10	248	Wenatchee Spring Chinook (Leavenworth NFH)- Hatchery	Upper Columbia River Spring-run Chin	4	Wenatchee	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0

Revised - 2-24-10

Legend
Primary
Contributing
Stabilizing
Not in ESU

Legend
Supporting
Consistent
Not Consistent

Snake River Spring/Summer-run Chinook

Pop #	ID	Population Name	ESU	Designation	Subbasin	Alt. 1 Population Type	Alt. 1 pHOS	Alt. 1 PNI	Alt. 1 Produc-tivity	Alt. 1 NOS	Alt. 2 Population Type	Alt. 2 pHOS	Alt. 2 PNI	Alt. 2 Produc-tivity	Alt. 2 NOS	Alt. 3 Population Type	Alt. 3 pHOS	Alt. 3 PNI	Alt. 3 Produc-tivity	Alt. 3 NOS
1	296	Tucannon Spring Chinook	Snake River Spring/Summer-run Chinc	1	Tucannon	Integrated	47%	0.52	1.37	199	Integrated	45%	0.53	1.4	192	Integrated	45%	0.53	1.4	192
2	459	SF Salmon Summer Chinook	Snake River Spring/Summer-run Chinc	1	S.F. Salmon R	Natural	30%	0.00	1.26	654	Natural	10%	0.00	1.4	551	Natural	10%	0.00	1.4	551
3	525	Secesh Spring Chinook	Snake River Spring/Summer-run Chinc	1	S.F. Salmon R	Natural	1%	0.00	1.41	375	Natural	0%	0.00	1.4	393	Natural	0%	0.00	1.4	393
4	458	EF-SF Johnson Creek Summer Chinook	Snake River Spring/Summer-run Chinc	1	S.F. Salmon R	Integrated	34%	0.75	1.15	520	Integrated	34%	0.75	1.1	519	Integrated	34%	0.75	1.1	519
5	526	Chamberlain Creek Spring Chinook	Snake River Spring/Summer-run Chinc	1	M.F Salmon R	Natural	1%	0.00	1.75	420	Natural	0%	0.00	1.8	430	Natural	0%	0.00	1.8	430
6	527	Big Creek Spring Chinook	Snake River Spring/Summer-run Chinc	1	M.F Salmon R	Natural	1%	0.00	1.40	469	Natural	0%	0.00	1.4	485	Natural	0%	0.00	1.4	485
7	529	Camas Creek Spring Chinook	Snake River Spring/Summer-run Chinc	1	M.F Salmon R	Natural	0%	0.00	1.10	63	Natural	0%	0.00	1.1	69	Natural	0%	0.00	1.1	69
8	530	Loon Creek Spring Chinook	Snake River Spring/Summer-run Chinc	1	M.F Salmon R	Natural	0%	0.00	1.16	101	Natural	0%	0.00	1.2	103	Natural	0%	0.00	1.2	103
9	524	Middle Fork_Upper Mainstem Spring-Summer Chinook	Snake River Spring/Summer-run Chinc	1	M.F Salmon R	Natural	0%	0.00	1.35	246	Natural	0%	0.00	1.4	247	Natural	0%	0.00	1.4	247
10	531	Sulphur Creek Spring Chinook	Snake River Spring/Summer-run Chinc	1	M.F Salmon R	Natural	0%	0.00	1.62	134	Natural	0%	0.00	1.6	134	Natural	0%	0.00	1.6	134
11	532	Bear Valley Spring Chinook	Snake River Spring/Summer-run Chinc	1	M.F Salmon R	Natural	0%	0.00	2.26	780	Natural	0%	0.00	2.3	780	Natural	0%	0.00	2.3	780
12	533	Marsh Creek Spring Chinook	Snake River Spring/Summer-run Chinc	1	M.F Salmon R	Natural	0%	0.00	1.16	80	Natural	0%	0.00	1.2	83	Natural	0%	0.00	1.2	83
13	453	Lemhi River Spring Chinook	Snake River Spring/Summer-run Chinc	1	Upper Salmon R	Natural	1%	0.00	1.13	427	Natural	0%	0.00	1.2	488	Natural	0%	0.00	1.2	488
14	460	Pahsimeroi Summer Chinook	Snake River Spring/Summer-run Chinc	1	Upper Salmon R	Natural	23%	0.00	0.74	131	Natural	6%	0.00	0.9	257	Natural	6%	0.00	0.9	257
15	700	Upper Selway Spring Chinook	Snake River Spring/Summer-run Chinc	1	Clearwater	Natural	53%	0.00	0.59	117	Natural	53%	0.00	0.6	117	Natural	53%	0.00	0.6	117
16	510	Wenaha Spring Chinook	Snake River Spring/Summer-run Chinc	1	rande Ronde-Imnaha MI	Natural	4%	0.00	3.48	310	Natural	2%	0.00	4.1	354	Natural	2%	0.00	4.1	354
17	456	Upper Salmon Mainstem Spring Chinook	Snake River Spring/Summer-run Chinc	1	Upper Salmon R	Natural	7%	0.00	0.94	167	Natural	5%	0.00	1.0	211	Natural	5%	0.00	1.0	211
18	439	Lolo Creek Spring Chinook	Snake River Spring/Summer-run Chinc	1	Clearwater	Integrated	39%	0.00	0.59	67	Integrated	40%	0.71	1.0	313	Integrated	40%	0.71	1.0	313
19	551	Minam Spring Chinook)	Snake River Spring/Summer-run Chinc	1	rande Ronde-Imnaha MI	Natural	6%	0.00	3.23	193	Natural	3%	0.00	4.1	236	Natural	3%	0.00	4.1	236
20	215	Lostine Spring Chinook	Snake River Spring/Summer-run Chinc	1	rande Ronde-Imnaha MI	Integrated	45%	0.53	2.21	677	Integrated	15%	0.77	2.8	698	Integrated	15%	0.77	2.8	698
21	222	Imnaha Spring-Summer Chinook	Snake River Spring/Summer-run Chinc	1	rande Ronde-Imnaha MI	Integrated	56%	0.39	1.92	726	Integrated	34%	0.51	2.3	803	Integrated	34%	0.51	2.3	746
22	214	Catherine Creek Spring Chinook	Snake River Spring/Summer-run Chinc	1	rande Ronde-Imnaha MI	Integrated	49%	0.38	1.29	188	Integrated	46%	0.55	1.6	203	Integrated	46%	0.55	1.6	203
23	528	Middle Fork_Lower Mainstem Spring-Summer Chinook	Snake River Spring/Summer-run Chinc	2	M.F Salmon R	Natural	5%	0.00	0.94	58	Natural	1%	0.00	1.2	141	Natural	1%	0.00	1.2	141
24	785	Lower Selway Spring Chinook	Snake River Spring/Summer-run Chinc	2	Clearwater	Integrated	75%	0.00	0.59	174	Integrated	75%	0.00	0.6	172	Integrated	75%	0.00	0.6	172
25	534	NF Salmon River Spring Chinook	Snake River Spring/Summer-run Chinc	2	Upper Salmon R	Natural	5%	0.00	1.00	59	Natural	1%	0.00	1.3	125	Natural	1%	0.00	1.3	125
26	536	Lower Salmon Mainstem Spring Chinook	Snake River Spring/Summer-run Chinc	2	Upper Salmon R	Natural	4%	0.00	0.97	171	Natural	2%	0.00	1.2	288	Natural	2%	0.00	1.2	288
27	454	East Fork Salmon River Spring-Summer Chinook	Snake River Spring/Summer-run Chinc	2	Upper Salmon R	Natural	1%	0.00	1.19	235	Natural	1%	0.00	1.3	302	Natural	1%	0.00	1.3	302
28	537	Valley Spring Chinook	Snake River Spring/Summer-run Chinc	2	Upper Salmon R	Natural	3%	0.00	1.09	105	Natural	1%	0.00	1.3	177	Natural	1%	0.00	1.3	177
29	828	South Fork Clearwater_Newsome Creek Spring Chinook	Snake River Spring/Summer-run Chinc	2	Clearwater	Integrated	44%	0.08	0.59	42	Integrated	57%	0.64	0.9	136	Integrated	57%	0.64	0.9	136
30	695	Lochsa Spring Chinook	Snake River Spring/Summer-run Chinoo	3	Clearwater	Natural	58%	0.00	0.56	204	Natural	58%	0.00	0.6	204	Natural	58%	0.00	0.6	204
31	522	Little Salmon Spring-Summer Chinook	Snake River Spring/Summer-run Chinoo	3	S.F. Salmon R	Natural	52%	0.00	0.55	168	Natural	52%	0.00	0.5	167	Natural	52%	0.00	0.5	167
32	509	Asotin Spring-Summer Chinook	Snake River Spring/Summer-run Chinoo	3	Asotin	Natural	12%	0.00	1.14	89	Natural	5%	0.00	1.4	134	Natural	4%	0.00	1.5	144
33	457	Yankee Fork Spring Chinook	Snake River Spring/Summer-run Chinoo	3	Upper Salmon R	Natural	31%	0.00	0.66	25	Natural	28%	0.00	0.7	18	Natural	28%	0.00	0.7	18
34	538	Panther Creek Spring Chinook (Extirpated)	Snake River Spring/Summer-run Chinoo	3	Upper Salmon R	Natural	94%	0.00	0.05	0	Natural	94%	0.00	0.0	0	Natural	94%	0.00	0.0	0
35	442	South Fork Clearwater Spring Chinook	Snake River Spring/Summer-run Chinoo	3	Clearwater	Natural	49%	0.00	0.53	183	Natural	49%	0.00	0.5	183	Natural	49%	0.00	0.5	183
36	698	Lower Clearwater Spring Chinook	Snake River Spring/Summer-run Chinoo	3	Clearwater	Natural	77%	0.00	0.59	113	Natural	77%	0.00	0.6	113	Natural	77%	0.00	0.6	113
37	213	Lookingglass Creek Spring Chinook	Snake River Spring/Summer-run Chinoo	3	rande Ronde-Imnaha MF	Integrated	42%	0.00	1.37	85	Integrated	41%	0.00	1.4	84	Integrated	41%	0.00	1.4	84
38	216	Upper Grande RondeSpring Chinook	Snake River Spring/Summer-run Chinoo	3	rande Ronde-Imnaha MF	Integrated	76%	0.06	0.46	95	Integrated	76%	0.06	0.5	94	Integrated	76%	0.06	0.5	94
39	455	Little Salmon Spring Chinook (Rapid River-Hatchery)	Snake River Spring/Summer-run Chinc	4	S.F. Salmon R	Segregated	100%	0.00	0.00	0	Segregated	100%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
40	523	SF Salmon Summer Chinook (McCall-Hatchery)	Snake River Spring/Summer-run Chinc	4	S.F. Salmon R	Segregated	100%	0.00	0.00	0	Segregated	100%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
41	508	Lochsa Spring Chinook (Hatchery)	Snake River Spring/Summer-run Chinc	4	Clearwater	Segregated	100%	0.00	0.00	0	Segregated	100%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
42	535	Pahsimeroi Summer Chinook (Pahsimeroi Hatchery)	Snake River Spring/Summer-run Chinc	4	Upper Salmon R	Segregated	100%	0.00	0.00	0	Segregated	100%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
43	518	Lower Selway Spring Chinook (Hatchery)	Snake River Spring/Summer-run Chinc	4	Clearwater	Segregated	100%	0.00	0.00	0	Segregated	100%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
44	788	Upper Salmon Mainstem Spring Chinook (Sawtooth Hatchery)	Snake River Spring/Summer-run Chinc	4	Upper Salmon R	Segregated	100%	0.00	0.00	0	Segregated	100%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
45	786	Upper Selway Spring Chinook (Hatchery)	Snake River Spring/Summer-run Chinc	4	Clearwater	Segregated	100%	0.00	0.00	0	Segregated	100%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
46	519	South Fork Clearwater Spring Chinook (Hatchery)	Snake River Spring/Summer-run Chinc	4	Clearwater	Segregated	100%	0.00	0.00	0	Segregated	100%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
47	444	Middle Fork Clearwater Spring Chinook (Kooskia-Hatchery)	Snake River Spring/Summer-run Chinc	4	Clearwater	Segregated	100%	0.00	0.00	0	Segregated	100%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
48	443	Spring Chinook (Dworshak-Hatchery)	Snake River Spring/Summer-run Chinc	4	Clearwater	Segregated	100%	0.00	0.00	0	Segregated	100%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
49	820	Lower Mainstem_Spring Chinook (NPTH-Hatchery)	Snake River Spring/Summer-run Chinc	4	Clearwater	Segregated	100%	0.00	0.00	0	Segregated	100%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
50	982	Imnaha Spring-Summer Chinook (Stepping Stone Hatchery)	Snake River Spring/Summer-run Chinc	4	rande Ronde-Imnaha MI	Segregated	0%	0.00	0.01	0	Segregated	0%	0.00	0.0	0	Segregated	0%	0.00	0.0	0
51	228	Snake Hells Canyon Spring Chinook (Oxbow Hatchery)	Snake River Spring/Summer-run Chinc	4	Snake Hells Canyon	Segregated	100%	0.00	0.00	0	Segregated	100%	0.00	0.0	0	Segregated	100%	0.00	0.0	0

Snake River Fall-run Chinook

Pop #	ID	Population Name	ESU	Designation	Subbasin	Alt. 1 Population Type	Alt. 1 pHOS	Alt. 1 PNI	Alt. 1 Produc-tivity	Alt. 1 NOS	Alt. 2 Population Type	Alt. 2 pHOS	Alt. 2 PNI	Alt. 2 Produc-tivity	Alt. 2 NOS	Alt. 3 Population Type	Alt. 3 pHOS	Alt. 3 PNI	Alt. 3 Produc-tivity	Alt. 3 NOS
1	224	Snake Hells Canyon Fall Chinook	Snake River Fall-run Chinook	1	Snake Hells Canyon	Integrated	78%	0.06	0.73	1,602	Integrated	42%	0.54	1.0	1,091	Integrated	43%	0.54	1.0	1,115

Appendix C1. Hatchery Performance by Alternative for Chinook Salmon

Revised - 2-24-10

Legend
Primary
Contributing
Stabilizing
Not in ESU

Legend
Supporting
Consistent
Not Consistent

Snake River Spring/Summer-run Chinook

Pop #	ID	Population Name	ESU	Designation	Subbasin	Alternative 4 Population Type	Alternative 4 pHOS	Alternative 4 PNI	Alternative 4 Productivity	Alternative 4 NOS	Alternative 5 Population Type	Alternative 5 pHOS	Alternative 5 PNI	Alternative 5 Productivity	Alternative 5 NOS
1	296	Tucannon Spring Chinook	Snake River Spring/Summer-run Chinc	1	Tucannon	Integrated	45%	0.53	1.40	192	Integrated	29%	0.68	1.6	217
2	459	SF Salmon Summer Chinook	Snake River Spring/Summer-run Chinc	1	S.F. Salmon R	Natural	10%	-	1.41	551	Integrated	15%	0.67	2.1	986
3	525	Secesh Spring Chinook	Snake River Spring/Summer-run Chinc	1	S.F. Salmon R	Natural	0%	-	1.43	393	Natural	1%	0.00	1.4	335
4	458	EF-SF Johnson Creek Summer Chinook	Snake River Spring/Summer-run Chinc	1	S.F. Salmon R	Integrated	34%	0.75	1.15	519	Integrated	34%	0.74	1.1	505
5	526	Chamberlain Creek Spring Chinook	Snake River Spring/Summer-run Chinc	1	M.F Salmon R	Natural	0%	-	1.78	430	Natural	1%	0.00	1.7	403
6	527	Big Creek Spring Chinook	Snake River Spring/Summer-run Chinc	1	M.F Salmon R	Natural	0%	-	1.42	485	Natural	1%	0.00	1.4	429
7	529	Camas Creek Spring Chinook	Snake River Spring/Summer-run Chinc	1	M.F Salmon R	Natural	0%	-	1.12	69	Natural	1%	0.00	1.0	37
8	530	Loon Creek Spring Chinook	Snake River Spring/Summer-run Chinc	1	M.F Salmon R	Natural	0%	-	1.17	103	Natural	0%	0.00	1.1	87
9	524	Middle Fork_Upper Mainstem Spring-Summer Chinook	Snake River Spring/Summer-run Chinc	1	M.F Salmon R	Natural	0%	-	1.35	247	Natural	0%	0.00	1.3	234
10	531	Sulphur Creek Spring Chinook	Snake River Spring/Summer-run Chinc	1	M.F Salmon R	Natural	0%	-	1.62	134	Natural	0%	0.00	1.6	129
11	532	Bear Valley Spring Chinook	Snake River Spring/Summer-run Chinc	1	M.F Salmon R	Natural	0%	-	2.26	780	Natural	0%	0.00	2.2	764
12	533	Marsh Creek Spring Chinook	Snake River Spring/Summer-run Chinc	1	M.F Salmon R	Natural	0%	-	1.16	83	Natural	1%	0.00	1.1	67
13	453	Lemhi River Spring Chinook	Snake River Spring/Summer-run Chinc	1	Upper Salmon R	Natural	0%	-	1.16	488	Natural	0%	0.00	1.1	445
14	460	Pahsimeroi Summer Chinook	Snake River Spring/Summer-run Chinc	1	Upper Salmon R	Natural	6%	-	0.94	257	Integrated	27%	0.73	1.2	479
15	700	Upper Selway Spring Chinook	Snake River Spring/Summer-run Chinc	1	Clearwater	Natural	53%	-	0.59	117	Natural	53%	0.00	0.6	114
16	510	Wenaha Spring Chinook	Snake River Spring/Summer-run Chinc	1	ande Ronde-Imnaha MI	Natural	2%	-	4.13	354	Natural	2%	0.00	4.2	354
17	456	Upper Salmon Mainstem Spring Chinook	Snake River Spring/Summer-run Chinc	1	Upper Salmon R	Natural	5%	-	1.01	211	Integrated	26%	0.74	1.3	447
18	439	Lolo Creek Spring Chinook	Snake River Spring/Summer-run Chinc	1	Clearwater	Integrated	40%	0.71	0.99	313	Integrated	41%	0.71	1.0	300
19	551	Minam Spring Chinook)	Snake River Spring/Summer-run Chinc	1	ande Ronde-Imnaha MI	Natural	3%	-	4.15	236	Natural	3%	0.00	4.2	238
20	215	Lostine Spring Chinook	Snake River Spring/Summer-run Chinc	1	ande Ronde-Imnaha MI	Integrated	15%	0.77	2.84	698	Integrated	15%	0.77	2.8	683
21	222	Imnaha Spring-Summer Chinook	Snake River Spring/Summer-run Chinc	1	ande Ronde-Imnaha MI	Integrated	34%	0.51	2.33	746	Integrated	31%	0.68	2.8	906
22	214	Catherine Creek Spring Chinook	Snake River Spring/Summer-run Chinc	1	ande Ronde-Imnaha MI	Integrated	46%	0.55	1.62	203	Integrated	24%	0.70	1.9	222
23	528	Middle Fork_Lower Mainstem Spring-Summer Chinook	Snake River Spring/Summer-run Chinc	2	M.F Salmon R	Natural	1%	-	1.24	141	Natural	12%	0.00	0.8	27
24	785	Lower Selway Spring Chinook	Snake River Spring/Summer-run Chinc	2	Clearwater	Integrated	75%	-	0.59	172	Integrated	75%	0.00	0.6	170
25	534	NF Salmon River Spring Chinook	Snake River Spring/Summer-run Chinc	2	Upper Salmon R	Natural	1%	-	1.31	125	Natural	11%	0.00	0.8	30
26	536	Lower Salmon Mainstem Spring Chinook	Snake River Spring/Summer-run Chinc	2	Upper Salmon R	Natural	2%	-	1.16	288	Natural	17%	0.00	0.7	59
27	454	East Fork Salmon River Spring-Summer Chinook	Snake River Spring/Summer-run Chinc	2	Upper Salmon R	Natural	1%	-	1.27	302	Natural	4%	0.00	0.9	105
28	537	Valley Spring Chinook	Snake River Spring/Summer-run Chinc	2	Upper Salmon R	Natural	1%	-	1.30	177	Natural	9%	0.00	0.8	42
29	828	South Fork Clearwater_Newsome Creek Spring Chinook	Snake River Spring/Summer-run Chinc	2	Clearwater	Integrated	57%	0.64	0.91	136	Integrated	58%	0.63	0.9	131
30	695	Lochsa Spring Chinook	Snake River Spring/Summer-run Chino	3	Clearwater	Natural	58%	-	0.56	204	Natural	58%	0.00	0.6	200
31	522	Little Salmon Spring-Summer Chinook	Snake River Spring/Summer-run Chino	3	S.F. Salmon R	Natural	52%	-	0.55	167	Natural	52%	0.00	0.5	164
32	509	Asotin Spring-Summer Chinook	Snake River Spring/Summer-run Chino	3	Asotin	Natural	4%	-	1.48	144	Natural	4%	0.00	1.5	144
33	457	Yankee Fork Spring Chinook	Snake River Spring/Summer-run Chino	3	Upper Salmon R	Natural	28%	-	0.67	18	Natural	33%	0.00	0.7	30
34	538	Panther Creek Spring Chinook (Extirpated)	Snake River Spring/Summer-run Chino	3	Upper Salmon R	Natural	94%	-	0.05	0	Natural	94%	0.00	0.0	0
35	442	South Fork Clearwater Spring Chinook	Snake River Spring/Summer-run Chino	3	Clearwater	Natural	49%	-	0.53	183	Natural	50%	0.00	0.5	179
36	698	Lower Clearwater Spring Chinook	Snake River Spring/Summer-run Chino	3	Clearwater	Natural	77%	-	0.59	113	Natural	77%	0.00	0.6	112
37	213	Lookingglass Creek Spring Chinook	Snake River Spring/Summer-run Chino	3	rande Ronde-Imnaha MP	Integrated	41%	-	1.37	84	Integrated	45%	0.00	1.4	87
38	216	Upper Grande RondeSpring Chinook	Snake River Spring/Summer-run Chino	3	rande Ronde-Imnaha MP	Integrated	76%	0.06	0.46	94	Integrated	76%	0.06	0.5	92
39	455	Little Salmon Spring Chinook (Rapid River-Hatchery)	Snake River Spring/Summer-run Chinc	4	S.F. Salmon R	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0
40	523	SF Salmon Summer Chinook (McCall-Hatchery)	Snake River Spring/Summer-run Chinc	4	S.F. Salmon R	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0
41	508	Lochsa Spring Chinook (Hatchery)	Snake River Spring/Summer-run Chinc	4	Clearwater	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0
42	535	Pahsimeroi Summer Chinook (Pahsimeroi Hatchery)	Snake River Spring/Summer-run Chinc	4	Upper Salmon R	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0
43	518	Lower Selway Spring Chinook (Hatchery)	Snake River Spring/Summer-run Chinc	4	Clearwater	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0
44	788	Upper Salmon Mainstem Spring Chinook (Sawtooth Hatchery)	Snake River Spring/Summer-run Chinc	4	Upper Salmon R	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0
45	786	Upper Selway Spring Chinook (Hatchery)	Snake River Spring/Summer-run Chinc	4	Clearwater	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0
46	519	South Fork Clearwater Spring Chinook (Hatchery)	Snake River Spring/Summer-run Chinc	4	Clearwater	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0
47	444	Middle Fork Clearwater Spring Chinook (Kooskia-Hatchery)	Snake River Spring/Summer-run Chinc	4	Clearwater	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0
48	443	Spring Chinook (Dworshak-Hatchery)	Snake River Spring/Summer-run Chinc	4	Clearwater	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0
49	820	Lower Mainstem_Spring Chinook (NPTH-Hatchery)	Snake River Spring/Summer-run Chinc	4	Clearwater	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0
50	982	Imnaha Spring-Summer Chinook (Stepping Stone Hatchery)	Snake River Spring/Summer-run Chinc	4	ande Ronde-Imnaha MI	Segregated	0%	-	0.01	0	Segregated	100%	0.00	0.0	0
51	228	Snake Hells Canyon Spring Chinook (Oxbow Hatchery)	Snake River Spring/Summer-run Chinc	4	Snake Hells Canyon	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0

Snake River Fall-run Chinook

Pop #	ID	Population Name	ESU	Designation	Subbasin	Alternative 4 Population Type	Alternative 4 pHOS	Alternative 4 PNI	Alternative 4 Productivity	Alternative 4 NOS	Alternative 5 Population Type	Alternative 5 pHOS	Alternative 5 PNI	Alternative 5 Productivity	Alternative 5 NOS
1	224	Snake Hells Canyon Fall Chinook	Snake River Fall-run Chinook	1	Snake Hells Canyon	Integrated	43%	0.54	1.02	1,115	Integrated	27%	0.79	1.3	1,432

Appendix C1. Hatchery Performance by Alternative for Chinook Salmon

Revised - 2-24-10

Primary
Contributing
Stabilizing
Not in ESU

Supporting
Consistent
Not Consistent

Middle Columbia River Spring-run Chinook

						Alternative 1					Alternative 2					Alternative 3				
Pop #	ID	Population Name	ESU	Designation	Subbasin	Population Type	pHOS	PNI	Produc-tivity	NOS	Population Type	pHOS	PNI	Produc-tivity	NOS	Population Type	pHOS	PNI	Produc-tivity	NOS
1	290	Deschutes Spring Chinook	Middle Columbia River Spring-run Chi	1	Deschutes	Integrated	5%	0.65	3.42	869	Integrated	5%	0.66	3.5	876	Integrated	5%	0.65	3.4	867
2	802	MF John Day Spring Chinook	Middle Columbia River Spring-run Chi	1	John Day	Natural	1%	0.00	3.09	1,011	Natural	0%	0.00	3.1	1,017	Natural	1%	0.00	3.1	1,011
3	803	NF John Day Spring Chinook	Middle Columbia River Spring-run Chi	1	John Day	Natural	0%	0.00	4.60	2,333	Natural	0%	0.00	4.6	2,336	Natural	0%	0.00	4.6	2,333
4	271	Klickitat Spring Chinook	Middle Columbia River Spring-run Chi	1	Klickitat	Integrated	36%	0.10	1.85	343	Integrated	7%	0.00	2.2	352	Integrated	15%	0.62	2.9	376
5	308	American Spring Chinook	Middle Columbia River Spring-run Chi	1	Yakima	Natural	1%	0.00	2.87	233	Natural	1%	0.00	2.9	235	Natural	1%	0.00	2.9	236
6	309	Naches Spring Chinook	Middle Columbia River Spring-run Chi	1	Yakima	Natural	2%	0.00	1.87	830	Natural	1%	0.00	1.9	844	Natural	1%	0.00	1.9	845
7	312	Upper Yakima Spring Chinook	Middle Columbia River Spring-run Chi	1	Yakima	Integrated	47%	0.68	2.32	2,704	Integrated	47%	0.68	2.3	2,704	Integrated	47%	0.68	2.3	2,704
8	292	Upper Mainstem John Day Spring Chinook	Middle Columbia River Spring-run Chi	2	John Day	Natural	0%	0.00	3.54	1,074	Natural	0%	0.00	3.6	1,080	Natural	0%	0.00	3.5	1,074
9	301	Umatilla Spring Chinook	Middle Columbia River Spring-run Chi	2	Umatilla	Integrated	84%	0.07	1.08	492	Integrated	67%	0.53	1.6	399	Integrated	67%	0.53	1.6	398
10	304	Walla Walla Spring Chinook	Middle Columbia River Spring-run Chi	2	Walla Walla	Integrated	69%	0.00	1.83	266	Integrated	68%	0.00	1.8	265	Integrated	12%	0.56	2.8	254
11	693	Mainstem Columbia Spring Chinook (Ringold Via LWS-Hatchery)	Middle Columbia River Spring-run Chi	4	Hanford Reach	Segregated	100%	0.00	0.00	0	Segregated	100%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
12	289	Deschutes Spring Chinook (RoundButte-Hatchery)	Middle Columbia River Spring-run Chi	4	Deschutes	Segregated	100%	0.00	0.00	0	Segregated	100%	0.00	0.0	0	Segregated	100%	0.00	0.0	0

Lower Columbia River Chinook

						Alternative 1					Alternative 2					Alternative 3				
Pop #	ID	Population Name	ESU	Designation	Subbasin	Population Type	pHOS	PNI	Produc-tivity	NOS	Population Type	pHOS	PNI	Produc-tivity	NOS	Population Type	pHOS	PNI	Produc-tivity	NOS
1	601	Clatskanie Fall Chinook	Lower Columbia River Chinook	1	Clatskanie	Natural	24%	0.00	12.02	117	Natural	3%	0.00	19.1	150	Natural	0.06	0.00	15.8	135
2	353	Coweeman Fall Chinook	Lower Columbia River Chinook	1	Cowlitz	Natural	3%	0.00	1.99	684	Natural	1%	0.00	2.4	839	Natural	1%	0.00	2.3	813
3	609	Upper Cowlitz Spring Chinook	Lower Columbia River Chinook	1	Cowlitz	Integrated	30%	0.00	0.83	751	Integrated	7%	0.58	1.3	1,049	Integrated	0.07	0.58	1.3	1,073
4	339	Elochoman Fall Chinook	Lower Columbia River Chinook	1	Elochoman	Integrated	59%	0.09	1.06	470	Integrated	1%	0.00	2.0	620	Integrated	5%	0.00	1.5	385
5	347	Grays Fall Chinook	Lower Columbia River Chinook	1	Grays	Natural	44%	0.00	1.04	142	Natural	1%	0.00	2.0	203	Natural	0.0957	0.00	1.2	80
6	261	Hood Spring Chinook	Lower Columbia River Chinook	1	Hood	Integrated	50%	0.00	0.55	214	Integrated	63%	0.62	0.8	358	Integrated	0.63	0.62	0.8	363
7	366	Kalama Fall Chinook	Lower Columbia River Chinook	1	Kalama	Natural	66%	0.00	1.09	650	Natural	1%	0.00	2.1	669	Natural	9%	0.00	1.3	291
8	367	Kalama Spring Chinook	Lower Columbia River Chinook	1	Kalama	Integrated	58%	0.00	0.61	185	Integrated	55%	0.00	0.6	169	Integrated	0.5550	0.00	0.6	170
9	561	EF Lewis Fall Chinook (Tule)	Lower Columbia River Chinook	1	Lewis	Natural	37%	0.00	0.67	224	Natural	4%	0.00	0.9	179	Natural	0.25	0.00	0.7	63
10	376	NF Lewis Fall Chinook (Lower River Brights)	Lower Columbia River Chinook	1	Lewis	Natural	1%	0.00	9.94	11,475	Natural	0%	0.00	10.3	11,752	Natural	0.00	0.00	10.1	11,606
11	378	NF Lewis Spring Chinook	Lower Columbia River Chinook	1	Lewis	Natural	29%	0.00	1.63	652	Natural	9%	0.00	1.8	602	Natural	10%	0.00	1.8	595
12	401	Sandy Fall Chinook (Late)	Lower Columbia River Chinook	1	Sandy	Natural	1%	0.00	3.09	3,422	Natural	0%	0.00	3.3	3,594	Natural	0.01	0.00	3.1	3,415
13	402	Sandy Spring Chinook	Lower Columbia River Chinook	1	Sandy	Integrated	10%	0.91	3.61	1,364	Integrated	2%	0.00	3.2	1,444	Integrated	0.11	0.90	3.6	1,365
14	407	Washougal Fall Chinook	Lower Columbia River Chinook	1	Washougal	Natural	55%	0.00	1.06	626	Natural	0%	0.00	2.1	773	Natural	0.10	0.00	1.2	295
15	664	Mill-Aber-Germ Fall Chinook	Lower Columbia River Chinook	2	Mill-Aber-Germ	Natural	16%	0.00	1.29	306	Natural	0%	0.00	2.5	685	Natural	0.01	0.00	2.3	645
16	354	Lower Cowlitz Fall Chinook	Lower Columbia River Chinook	2	Cowlitz	Integrated	26%	0.00	1.66	3,102	Integrated	9%	0.77	3.0	4,663	Integrated	10%	0.75	3.0	4,611
17	253	White Salmon Fall Chinook (Tule)	Lower Columbia River Chinook	2	White Salmon	Natural	74%	0.00	1.32	326	Natural	0%	0.00	2.6	347	Natural	0.74	0.00	1.3	326
18	649	White Salmon Spring Chinook	Lower Columbia River Chinook	2	White Salmon	Integrated	44%	0.00	0.63	0	Integrated	43%	0.00	0.6	0	Integrated	44%	0.00	0.6	0
19	413	Clackamas Fall Chinook	Lower Columbia River Chinook	2	Willamette	Natural	50%	0.00	0.53	64	Natural	0%	0.00	1.1	22	Natural	0.47	0.00	0.5	42
20	662	Big Creek Fall Chinook (Tules)	Lower Columbia River Chinook	3	Big Creek	Natural	91%	0.00	0.61	83	Natural	21%	0.00	0.7	2	Natural	0.91	0.00	0.6	83
21	321	Chinook River Fall Chinook	Lower Columbia River Chinook	3	Chinook River	Natural	89%	0.00	0.41	32	Natural	0%	0.00	0.8	0	Natural	0.68	0.00	0.4	13
22	602	Scapoose Fall Chinook	Lower Columbia River Chinook	3	Scapoose	Natural	44%	0.00	0.82	46	Natural	22%	0.00	0.8	17	Natural	34%	0.00	0.8	31
23	727	Youngs Bay Tribs Fall Chinook	Lower Columbia River Chinook	3	Youngs Bay	Natural	90%	0.00	0.16	12	Natural	0%	0.00	0.3	1	Natural	0.83	0.00	0.2	3
25	659	Tributaries Fall Chinook (Tules- Oregon)	Lower Columbia River Chinook	3	Columbia Gorge	Natural	52%	0.00	0.65	33	Natural	0%	0.00	1.3	30	Natural	52%	0.00	0.7	33
26	356	Toutle Fall Chinook	Lower Columbia River Chinook	3	Cowlitz	Natural	31%	0.00	0.87	740	Natural	1%	0.00	1.6	1,523	Natural	30%	0.00	0.9	700
27	260	Hood Fall Chinook	Lower Columbia River Chinook	3	Hood	Natural	65%	0.00	0.32	102	Natural	0%	0.00	0.6	0	Natural	65%	0.00	0.3	102
28	646	Little White Salmon Fall Chinook (Tule)	Lower Columbia River Chinook	3	Little White Salmon	Natural	95%	0.00	0.24	106	Natural	0%	0.00	0.5	0	Natural	95%	0.00	0.2	105
29	669	LC Tribs Fall Chinook (Tules-Oregon)	Lower Columbia River Chinook	3	Lower Columbia	Natural	44%	0.00	0.86	52	Natural	0%	0.00	1.7	77	Natural	42%	0.00	0.9	49
30	400	Sandy Fall Chinook (Early)	Lower Columbia River Chinook	3	Sandy	Natural	3%	0.00	2.34	2,514	Natural	0%	0.00	3.0	3,184	Natural	1%	0.00	2.8	2,976
31	281	Wind Fall Chinook (Tule)	Lower Columbia River Chinook	3	Wind	Natural	83%	0.00	0.99	199	Natural	0%	0.00	2.0	160	Natural	83%	0.00	1.0	199
32	652	Wind Spring Chinook	Lower Columbia River Chinook	3	Wind	Natural	74%	0.00	1.30	112	Natural	19%	0.00	1.3	57	Natural	74%	0.00	1.3	113
24	257	Spring Creek Fall Chinook (Tules-Hatchery)	Lower Columbia River Chinook	4	Columbia Gorge	Segregated	100%	0.00	0.00	0	Segregated	0%	0.00	0.0	0	Segregated	1.00	0.00	0.0	0
33	322	Big Creek Fall Chinook (Tules-Hatchery)	Lower Columbia River Chinook	4	Big Creek	Segregated	100%	0.00	0.00	0	Segregated	0%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
34	323	Deep River Spring Chinook (Cowlitz-Merwin-Grays-Hatchery)	Lower Columbia River Chinook	4	Columbia Estuary	Segregated	100%	0.00	0.00	0	Segregated	100%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
35	320	Youngs Bay Fall Chinook (Rogue Brights-CEDC SAFE-Hatchery)	Lower Columbia River Chinook	4	Youngs Bay	Segregated	100%	0.00	0.00	0	Segregated	0%	0.00	0.0	0	Segregated	0%	0.00	0.0	0
36	566	Youngs Bay Spring Chinook (CEDC SAFE-Willamette-Hatchery)	Lower Columbia River Chinook	4	Youngs Bay	Segregated	100%	0.00	0.00	0	Segregated	100%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
37	722	Toutle Fall Chinook (Hatchery)	Lower Columbia River Chinook	4	Cowlitz	Segregated	100%	0.00	0.00	0	Segregated	0%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
38	578	Kalama Fall Chinook (Hatchery)	Lower Columbia River Chinook	4	Kalama	Segregated	100%	0.00	0.00	0	Segregated	0%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
39	724	NF Lewis Spring Chinook (Hatchery)	Lower Columbia River Chinook	4	Lewis	Segregated	100%	0.00	0.00	0	Segregated	100%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
40	277	Little White Salmon Fall Chinook (URB-Hatchery)	Lower Columbia River Chinook	4	Little White Salmon	Segregated	100%	0.00	0.00	0	Segregated	0%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
41	278	Little White Salmon Spring Chinook (Hatchery)	Lower Columbia River Chinook	4	Little White Salmon	Segregated	100%	0.00	0.00	0	Segregated	100%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
42	390	Bonneville Fall Chinook (Hatchery)	Lower Columbia River Chinook	4	Lower Columbia	Segregated	100%	0.00	0.00	0	Segregated	0%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
43	581	Washougal Fall Chinook (Hatchery)	Lower Columbia River Chinook	4	Washougal	Segregated	100%	0.00	0.00	0	Segregated	0%	0.00	0.0	0	Segregated	100%	0.00	0.0	0
44	283	Wind Spring Chinook (Hatchery)	Lower Columbia River Chinook	4	Wind	Segregated	100%	0.00	0.00	0	Segregated	0%	0.00	0.0	0	Segregated	100%	0.00	0.0	0

Deschutes River Summer/Fall-run Chinook

						Alternative 1					Alternative 2					Alternative 3				
Pop #	ID	Population Name	ESU	Designation	Subbasin	Population Type	pHOS	PNI	Produc-tivity	NOS	Population Type	pHOS	PNI	Produc-tivity	NOS	Population Type	pHOS	PNI	Produc-tivity	NOS
1	288	Deschutes Fall Chinook	Deschutes River Summer/Fall-run Chir	1	Deschutes	Natural	2%	0.00	2.43	8,840	Natural	0%	0.00	2.8	10,194	Natural	2%	0.00	2.4	8,702

Appendix C1. Hatchery Performance by Alternative for Chinook Salmon

Revised - 2-24-10

Legend	
Primary	Supporting
Contributing	Consistent
Stabilizing	Not Consistent
Not in ESU	

Middle Columbia River Spring-run Chinook

Pop #	ID	Population Name	ESU	Designation	Subbasin	Alternative 4 Population Type	Alt 4 pHOS	Alt 4 PNI	Alt 4 Productivity	Alt 4 NOS	Alternative 5 Population Type	Alt 5 pHOS	Alt 5 PNI	Alt 5 Productivity	Alt 5 NOS
1	290	Deschutes Spring Chinook	Middle Columbia River Spring-run Chi	1	Deschutes	Integrated	5%	0.66	3.44	873	Integrated	6%	0.77	3.6	797
2	802	MF John Day Spring Chinook	Middle Columbia River Spring-run Chi	1	John Day	Natural	0%	-	3.10	1,015	Natural	1%	0.00	3.1	995
3	803	NF John Day Spring Chinook	Middle Columbia River Spring-run Chi	1	John Day	Natural	0%	-	4.61	2,335	Natural	0%	0.00	4.6	2,301
4	271	Klickitat Spring Chinook	Middle Columbia River Spring-run Chi	1	Klickitat	Integrated	9%	0.74	4.20	573	Integrated	12%	0.72	4.1	502
5	308	American Spring Chinook	Middle Columbia River Spring-run Chi	1	Yakima	Natural	1%	-	2.90	236	Natural	1%	0.00	2.9	232
6	309	Naches Spring Chinook	Middle Columbia River Spring-run Chi	1	Yakima	Natural	1%	-	1.89	845	Natural	1%	0.00	1.9	823
7	312	Upper Yakima Spring Chinook	Middle Columbia River Spring-run Chi	1	Yakima	Integrated	47%	0.68	2.32	2,704	Integrated	47%	0.68	2.3	2,655
8	292	Upper Mainstem John Day Spring Chinook	Middle Columbia River Spring-run Chi	2	John Day	Natural	0%	-	3.55	1,077	Natural	0%	0.00	3.5	1,058
9	301	Umatilla Spring Chinook	Middle Columbia River Spring-run Chi	2	Umatilla	Integrated	67%	0.53	1.60	398	Integrated	67%	0.53	1.6	389
10	304	Walla Walla Spring Chinook	Middle Columbia River Spring-run Chi	2	Walla Walla	Integrated	12%	0.56	2.85	254	Integrated	11%	0.58	2.9	252
11	693	Mainstem Columbia Spring Chinook (Ringold Via LWS-Hatchery)	Middle Columbia River Spring-run Chi	4	Hanford Reach	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0
12	289	Deschutes Spring Chinook (RoundButte-Hatchery)	Middle Columbia River Spring-run Chi	4	Deschutes	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0

Lower Columbia River Chinook

Pop #	ID	Population Name	ESU	Designation	Subbasin	Alternative 4 Population Type	Alt 4 pHOS	Alt 4 PNI	Alt 4 Productivity	Alt 4 NOS	Alternative 5 Population Type	Alt 5 pHOS	Alt 5 PNI	Alt 5 Productivity	Alt 5 NOS
1	601	Clatskanie Fall Chinook	Lower Columbia River Chinook	1	Clatskanie	Natural	1%	-	23.27	166	Natural	6%	0.00	15.9	135
2	353	Coweeman Fall Chinook	Lower Columbia River Chinook	1	Cowlitz	Natural	2%	-	2.10	730	Natural	1%	0.00	2.3	813
3	609	Upper Cowlitz Spring Chinook	Lower Columbia River Chinook	1	Cowlitz	Integrated	4%	0.69	1.46	1,421	Integrated	7%	0.58	1.3	1,073
4	339	Elochoman Fall Chinook	Lower Columbia River Chinook	1	Elochoman	Integrated	4%	-	1.57	442	Integrated	5%	0.00	1.5	385
5	347	Grays Fall Chinook	Lower Columbia River Chinook	1	Grays	Integrated	5%	0.83	1.94	168	Natural	10%	0.00	1.2	80
6	261	Hood Spring Chinook	Lower Columbia River Chinook	1	Hood	Integrated	49%	0.67	0.84	412	Integrated	63%	0.61	0.8	349
7	366	Kalama Fall Chinook	Lower Columbia River Chinook	1	Kalama	Natural	5%	-	1.47	388	Natural	9%	0.00	1.3	291
8	367	Kalama Spring Chinook	Lower Columbia River Chinook	1	Kalama	Integrated	46%	0.68	1.00	170	Integrated	55%	0.00	0.6	170
9	561	EF Lewis Fall Chinook (Tule)	Lower Columbia River Chinook	1	Lewis	Natural	1%	-	1.28	510	Natural	25%	0.00	0.7	63
10	376	NF Lewis Fall Chinook (Lower River Brights)	Lower Columbia River Chinook	1	Lewis	Natural	1%	-	10.03	11,521	Natural	0%	0.00	10.1	11,606
11	378	NF Lewis Spring Chinook	Lower Columbia River Chinook	1	Lewis	Integrated	7%	0.78	2.99	908	Natural	10%	0.00	1.8	595
12	401	Sandy Fall Chinook (Late)	Lower Columbia River Chinook	1	Sandy	Natural	1%	-	3.08	3,409	Natural	1%	0.00	3.1	3,415
13	402	Sandy Spring Chinook	Lower Columbia River Chinook	1	Sandy	Integrated	10%	0.91	3.61	1,360	Integrated	11%	0.90	3.6	1,362
14	407	Washougal Fall Chinook	Lower Columbia River Chinook	1	Washougal	Integrated	4%	-	1.55	486	Natural	10%	0.00	1.2	295
15	664	Mill-Aber-Germ Fall Chinook	Lower Columbia River Chinook	2	Mill-Aber-Germ	Natural	1%	-	2.42	677	Natural	1%	0.00	2.3	644
16	354	Lower Cowlitz Fall Chinook	Lower Columbia River Chinook	2	Cowlitz	Integrated	25%	0.55	2.35	3,230	Integrated	10%	0.75	3.0	4,611
17	253	White Salmon Fall Chinook (Tule)	Lower Columbia River Chinook	2	White Salmon	Natural	74%	-	1.32	326	Natural	74%	0.00	1.3	327
18	649	White Salmon Spring Chinook	Lower Columbia River Chinook	2	White Salmon	Integrated	44%	-	0.63	-	Integrated	44%	0.00	0.6	0
19	413	Clackamas Fall Chinook	Lower Columbia River Chinook	2	Willamette	Natural	49%	-	0.53	53	Natural	47%	0.00	0.5	43
20	662	Big Creek Fall Chinook (Tules)	Lower Columbia River Chinook	3	Big Creek	Natural	91%	-	0.61	84	Natural	91%	0.00	0.6	83
21	321	Chinook River Fall Chinook	Lower Columbia River Chinook	3	Chinook River	Natural	93%	-	0.41	36	Natural	68%	0.00	0.4	13
22	602	Scapoose Fall Chinook	Lower Columbia River Chinook	3	Scapoose	Natural	38%	-	0.82	38	Natural	34%	0.00	0.8	31
23	727	Youngs Bay Tribs Fall Chinook	Lower Columbia River Chinook	3	Youngs Bay	Natural	92%	-	0.16	15	Natural	83%	0.00	0.2	3
25	659	Tributaries Fall Chinook (Tules- Oregon)	Lower Columbia River Chinook	3	Columbia Gorge	Natural	52%	-	0.65	33	Natural	52%	0.00	0.7	33
26	356	Toutle Fall Chinook	Lower Columbia River Chinook	3	Cowlitz	Natural	31%	-	0.87	728	Natural	30%	0.00	0.9	700
27	260	Hood Fall Chinook	Lower Columbia River Chinook	3	Hood	Natural	65%	-	0.32	102	Natural	65%	0.00	0.3	103
28	646	Little White Salmon Fall Chinook (Tule)	Lower Columbia River Chinook	3	Little White Salmon	Natural	95%	-	0.24	106	Natural	95%	0.00	0.2	106
29	669	LC Tribs Fall Chinook (Tules-Oregon)	Lower Columbia River Chinook	3	Lower Columbia	Natural	43%	-	0.86	51	Natural	42%	0.00	0.9	49
30	400	Sandy Fall Chinook (Early)	Lower Columbia River Chinook	3	Sandy	Natural	2%	-	2.61	2,813	Natural	1%	0.00	2.8	2,976
31	281	Wind Fall Chinook (Tule)	Lower Columbia River Chinook	3	Wind	Natural	83%	-	0.99	199	Natural	83%	0.00	1.0	199
32	652	Wind Spring Chinook	Lower Columbia River Chinook	3	Wind	Natural	74%	-	1.30	112	Natural	74%	0.00	1.3	111
24	257	Spring Creek Fall Chinook (Tules-Hatchery)	Lower Columbia River Chinook	4	Columbia Gorge	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0
33	322	Big Creek Fall Chinook (Tules-Hatchery)	Lower Columbia River Chinook	4	Big Creek	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0
34	323	Deep River Spring Chinook (Cowlitz-Merwin-Grays-Hatchery)	Lower Columbia River Chinook	4	Columbia Estuary	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0
35	320	Youngs Bay Fall Chinook (Rogue Brights-CEDC SAFE-Hatchery)	Lower Columbia River Chinook	4	Youngs Bay	Segregated	100%	-	0.00	0	Segregated	0%	0.00	0.0	0
36	566	Youngs Bay Spring Chinook (CEDC SAFE-Willamette-Hatchery)	Lower Columbia River Chinook	4	Youngs Bay	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0
37	722	Toutle Fall Chinook (Hatchery)	Lower Columbia River Chinook	4	Cowlitz	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0
38	578	Kalama Fall Chinook (Hatchery)	Lower Columbia River Chinook	4	Kalama	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0
39	724	NF Lewis Spring Chinook (Hatchery)	Lower Columbia River Chinook	4	Lewis	Segregated	0%	-	0.01	0	Segregated	100%	0.00	0.0	0
40	277	Little White Salmon Fall Chinook (URB-Hatchery)	Lower Columbia River Chinook	4	Little White Salmon	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0
41	278	Little White Salmon Spring Chinook (Hatchery)	Lower Columbia River Chinook	4	Little White Salmon	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0
42	390	Bonneville Fall Chinook (Hatchery)	Lower Columbia River Chinook	4	Lower Columbia	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0
43	581	Washougal Fall Chinook (Hatchery)	Lower Columbia River Chinook	4	Washougal	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0
44	283	Wind Spring Chinook (Hatchery)	Lower Columbia River Chinook	4	Wind	Segregated	100%	-	0.00	0	Segregated	100%	0.00	0.0	0

Deschutes River Summer/Fall-run Chinook

Pop #	ID	Population Name	ESU	Designation	Subbasin	Alternative 4 Population Type	Alt 4 pHOS	Alt 4 PNI	Alt 4 Productivity	Alt 4 NOS	Alternative 5 Population Type	Alt 5 pHOS	Alt 5 PNI	Alt 5 Productivity	Alt 5 NOS
1	288	Deschutes Fall Chinook	Deschutes River Summer/Fall-run Chi	1	Deschutes	Natural	2%	-	2.39	8,651	Natural	2%	0.00	2.4	8,673

Appendix C2 . Hatchery Production by Alternative for Chinook Salmon

Revised - 2-24-10

Primary
Contributing
Stabilizing
Not in ESU

Upper Willamette River Chinook

Pop #	ID	Population Name	ESU	Designation	Subbasin	Alternative 1										Alternative 2										Alternative 3									
						Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	733	Clackamas Spring Chinook	Upper Willamette River Chinook	1	Willamette	-	-			95%	50%	26,524	-	348	0%	-	-			95%	50%	30,228	-	399	0%	-	-			95%	50%	26,558	-	349	0%
2	416	McKenzie Spring Chinook	Upper Willamette River Chinook	1	Willamette	1,265,568	4,250	0.34%		0%	20%	202,286	1,928	1,155	25%	1,265,568	4,250	0.34%		0%	20%	202,747	1,918	1,141	25%	1,265,568	4,250	0.34%		0%	20%	202,286	1,931	1,156	25%
3	419	North Santiam Spring Chinook	Upper Willamette River Chinook	1	Willamette	752,168	4,026	0.54%		0%	50%	11,878	1,873	106	1%	752,168	4,026	0.54%		0%	50%	11,808	1,863	104	1%	752,168	4,026	0.54%		0%	50%	11,867	1,875	106	1%
4	417	MF Willamette Spring Chinook	Upper Willamette River Chinook	2	Willamette	1,256,592	7,800	0.62%		0%	50%	16,032	3,632	145	1%	1,256,592	7,800	0.62%		0%	50%	16,067	3,612	144	1%	1,256,592	7,800	0.62%		0%	50%	16,032	3,635	145	1%
5	420	South Santiam Spring Chinook	Upper Willamette River Chinook	2	Willamette	1,123,163	4,336	0.39%		0%	10%	16,241	2,015	145	10%	1,007,544	3,889	0.39%		0%	3%	22,563	1,794	203	10%	1,007,544	3,889	0.39%		0%	3%	22,269	1,806	203	10%
6	736	Callappoia Spring Chinook	Upper Willamette River Chinook	3	Willamette	-	-			0%	0%	259	-	2	0%	-	-			0%	0%	260	-	2	0%	-	-			0%	0%	259	-	2	0%
7	730	Coast Fork Spring Chinook	Upper Willamette River Chinook	3	Willamette	-	-			0%	0%	235	-	2	0%	-	-			0%	0%	236	-	2	0%	-	-			0%	0%	235	-	2	0%
8	418	Molalla Spring Chinook	Upper Willamette River Chinook	3	Willamette	99,111	421	0.42%		0%	0%	1,196	196	11	0%	99,111	421	0.42%		0%	0%	1,177	195	10	0%	99,111	421	0.42%		0%	0%	1,195	196	11	0%
9	415	Clackamas Spring Chinook(Hatchery)	Upper Willamette River Chinook	4	Willamette	1,077,846	2,814	0.26%	MAF	0%	50%	-	1,315	-	0%	-	-			0%	50%	-	-	-	0%	1,077,846	2,814	0.26%	MAF	0%	50%	-	1,317	-	0%

Upper Columbia River Summer/Fall-run Chinook

Pop #	ID	Population Name	ESU	Designation	Subbasin	Alternative 1										Alternative 2										Alternative 3									
						Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	286	Columbia Lower Middle Hanford Fall Chinook (Priest Rapids	Upper Columbia River Summer/Fall-run Chinook	1	Hanford Reach	6,691,168	34,050	0.51%		0%	25%	6,346,669	18,568	36,506	2%	6,700,993	34,100	0.51%		0%	25%	10,246,670	18,301	61,159	50%	6,700,993	34,100	0.51%		0%	25%	10,165,890	18,464	61,006	50%
2	240	Okanogan-Similkimeen Summer Chinook	Upper Columbia River Summer/Fall-run Chinook	1	Okanogan	574,088	5,355	0.93%		0%	80%	1,593,944	2,655	4,448	70%	574,088	5,355	0.93%		0%	70%	1,597,525	2,634	4,432	70%	574,088	5,355	0.93%		0%	70%	1,593,328	2,660	4,464	70%
3	249	Wenatchee Summer Chinook	Upper Columbia River Summer/Fall-run Chinook	1	Wenatchee	737,100	4,116	0.56%		0%	99%	1,471,582	1,605	4,631	99%	737,100	4,116	0.56%		0%	99%	1,475,235	1,589	4,596	99%	737,100	4,116	0.56%		0%	99%	1,470,568	1,610	4,641	99%
4	300	Umatilla Fall Chinook	Upper Columbia River Summer/Fall-run Chinook	2	Umatilla	399,168	4,368	1.09%		0%	60%	141,595	2,184	724	10%	398,998	4,366	1.09%		0%	90%	193,127	2,160	1,000	70%	398,998	4,366	1.09%		0%	90%	198,111	2,179	1,034	70%
5	313	Yakima Fall Chinook	Upper Columbia River Summer/Fall-run Chinook	2	Yakima	346,573	1,200	0.35%	MAF	0%	55%	509,724	669	2,249	5%	-	-			0%	10%	138,529	-	600	25%	346,573	1,200	0.35%	MAF	0%	10%	343,779	689	1,549	25%
6	311	Marion Drain Fall Chinook	Upper Columbia River Summer/Fall-run Chinook	2	Yakima	20,493	144	0.70%		0%	50%	5,998	82	116	25%	20,493	144	0.70%		0%	50%	4,646	81	90	25%	20,493	144	0.70%		0%	50%	5,535	82	107	25%
7	678	Entiat Summer-Fall Chinook (Late Run)	Upper Columbia River Summer/Fall-run Chinook	3	Entiat	-	-			0%	0%	17,691	-	45	0%	-	-			0%	0%	17,714	-	45	0%	-	-			0%	0%	17,644	-	45	0%
8	635	Klickitat Fall Chinook	Upper Columbia River Summer/Fall-run Chinook	3	Klickitat	-	-			0%	0%	191,006	-	1,946	0%	-	-			0%	0%	129,441	-	1,407	0%	-	-			0%	0%	190,953	-	1,948	0%
9	236	Methow Summer Chinook	Upper Columbia River Summer/Fall-run Chinook	3	Methow	-	-			0%	0%	85,304	-	196	0%	-	-			0%	0%	85,199	-	194	0%	-	-			0%	0%	84,755	-	196	0%
10	819	Upper Middle Columbia Mainstem Summer Chinook	Upper Columbia River Summer/Fall-run Chinook	3	Upper Columbia	-	-			0%	0%	404,562	-	1,242	0%	-	-			0%	0%	405,769	-	1,237	0%	-	-			0%	0%	404,259	-	1,244	0%
11	692	Columbia Lower Middle Columbia Fall Chinook (URB-Ringold	Upper Columbia River Summer/Fall-run Chinook	4	Hanford Reach	3,499,468	8,200	0.23%	MAF	0%	78%	-	4,491	-	0%	-	-			0%	78%	-	-	-	0%	3,499,468	8,200	0.23%	MAF	0%	78%	-	4,500	-	0%
12	270	Klickitat Fall Chinook (URB-Hatchery)	Upper Columbia River Summer/Fall-run Chinook	4	Klickitat	3,867,242	20,934	0.54%	MAF	0%	0%	-	9,480	-	0%	-	-			0%	0%	-	-	-	0%	3,867,242	20,934	0.54%	MAF	0%	0%	-	12,413	-	0%
13	826	Methow Summer Chinook (Wells Hatchery)	Upper Columbia River Summer/Fall-run Chinook	4	Methow	340,808	785	0.23%		0%	0%	-	346	-	0%	340,808	785	0.23%		0%	0%	-	343	-	0%	340,808	785	0.23%		0%	0%	-	347	-	0%
14	809	Umatilla Fall Chinook (Stepping Stone HAtchery)	Upper Columbia River Summer/Fall-run Chinook	4	Umatilla	648,000	1,200	0.19%		0%	20%	-	609	-	0%	411,480	762	0.19%		0%	20%	-	384	-	0%	411,480	762	0.19%		0%	20%	-	387	-	0%
15	694	Upper Middle Columbia Summer Chinook (Wells Hatchery)	Upper Columbia River Summer/Fall-run Chinook	4	Upper Columbia	803,024	3,765	0.47%		0%	55%	-	1,619	-	0%	803,024	3,765	0.47%		0%	55%	-	1,604	-	0%	803,024	3,765	0.47%		0%	55%	-	1,624	-	0%
16	245	Mainstem Summer Chinook (Turtle Rock-Hatchery)	Upper Columbia River Summer/Fall-run Chinook	4	Upper Columbia	1,277,939	2,472	0.19%		0%	0%	-	1,212	-	0%	1,277,939	2,472	0.19%		0%	0%	-	1,202	-	0%	1,277,939	2,472	0.19%		0%	0%	-	1,214	-	0%
17	794	Yakima Fall Chinook (Little White Salmon-Hatchery)	Upper Columbia River Summer/Fall-run Chinook	4	Yakima	1,700,974	4,674	0.27%	MAF	0%	95%	-	2,713	-	0%	-	-			0%	95%	-	-	-	0%	-	-			0%	10%	-	-	-	0%

Appendix 2D

Upper Columbia River Spring-run Chinook

Pop #	ID	Population Name	ESU	Designation	Subbasin	Alternative 1										Alternative 2										Alternative 3									
						Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	231	Entiat Spring Chinook	Upper Columbia River Spring-run Chinook	1	Entiat	-	-			0%	0%	11,311	-	5	0%	-	-			0%	0%	8,691	-	3	0%	-	-			60%	0%	13,609	-	5	0%
2	234	Methow (Methow-Chewuch) Spring Chinook	Upper Columbia River Spring-run Chinook	1	Methow	359,100	1,200	0.33%		0%	60%	87,479	124	46	5%	150,642	503	0.33%		0%	0%	89,756	113	51	100%	150,642	503	0.33%		0%	0%	89,756	113	51	100%
3	821	Methow (Twisp) Spring Chinook	Upper Columbia River Spring-run Chinook	1	Methow	183,025	255	0.14%		0%	60%	22,395	26	12	31%	126,182	176	0.14%		0%	0%	19,943	41	11	100%	126,182	176	0.14%		0%	0%	19,943	41	11	100%
4	247	Wenatchee (Chiwawa) Spring Chinook	Upper Columbia River Spring-run Chinook	1	Wenatchee	351,546	1,540	0.44%		0%	70%	67,753	363	41	36%	351,546	1,540	0.44%		0%	5%	62,102	346	38	35%	351,546	1,540	0.44%		0%	5%	62,104	346	38	35%
5	822	Wenatchee (Nason) Spring Chinook	Upper Columbia River Spring-run Chinook	1	Wenatchee	-	-			0%	0%	19,692	-	10	0%	-	-			0%	0%	28,644	-	14	0%	-	-			0%	0%	28,644	-	14	0%
6	823	Wenatchee (White) Spring Chinook	Upper Columbia River Spring-run Chinook	1	Wenatchee	65,915	122	0.18%		0%	0%	24,023	28	14	0%	65,915	122	0.18%		0%	50%	30,150	26	17	50%	65,915	122	0.18%		0%	50%	30,150	26	17	50%
7	597	Okanogan Spring Chinook	Upper Columbia River Spring-run Chinook	3	Okanogan	-	-			0%	0%	-	-	0	0%	-	-			0%	0%	1	-	0	0%	-	-			0%	0%	1	-	0	0%
8	232	Entiat Spring Chinook (NFH)- Hatchery	Upper Columbia River Spring-run Chinook	4	Entiat	-	-			0%	0%	-	-	-	0%	-	-			0%	0%	-	-	-	0%	-	-			0%	0%	-	-	-	0%
9	235	Methow Spring Chinook (Winthrop Hatchery)	Upper Columbia River Spring-run Chinook	4	Methow	601,492	1,507	0.25%		0%	60%	-	157	-	0%	601,492	1,507	0.25%		0%	10%	-	363	-	0%	601,492	1,507	0.25%		0%	10%	-	363	-	0%
10	248	Wenatchee Spring Chinook (Leavenworth NFH)- Hatchery	Upper Columbia River Spring-run Chinook	4	Wenatchee	1,650,192	2,755	0.17%		0%	2%	-	1,663	-	0%	1,650,192	2,755	0.17%		0%	2%	-	1,647	-	0%	1,650,192	2,755	0.17%		0%	2%	-	1,647	-	0%

Revised - 2-24-10

Primary
Contributing
Stabilizing
Not in ESU

Upper Willamette River Chinook

						Alternative 4										Alternative 5									
Pop #	ID	Population Name	ESU	Designation	Subbasin	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	733	Clackamas Spring Chinook	Upper Willamette River Chinook	1	Willamette	-	-			95%	50%	26,528	-	351	0%	-	-			95%	50%	26,528	-	349	0%
2	416	McKenzie Spring Chinook	Upper Willamette River Chinook	1	Willamette	1,265,568	4,250	0.34%		0%	20%	202,134	1,935	1,161	25%	1,265,568	4,250	0.34%		0%	20%	202,134	1,930	1,158	25%
3	419	North Santiam Spring Chinook	Upper Willamette River Chinook	1	Willamette	752,168	4,026	0.54%		0%	50%	11,861	1,879	106	1%	752,168	4,026	0.54%		0%	50%	11,861	1,875	106	1%
4	417	MF Willamette Spring Chinook	Upper Willamette River Chinook	2	Willamette	1,256,592	7,800	0.62%		0%	50%	16,021	3,643	146	1%	1,256,592	7,800	0.62%		0%	50%	16,021	3,636	146	1%
5	420	South Santiam Spring Chinook	Upper Willamette River Chinook	2	Willamette	1,007,544	3,889	0.39%		0%	3%	22,163	1,809	203	10%	1,007,544	3,889	0.39%		0%	3%	22,163	1,806	202	10%
6	736	Callappoia Spring Chinook	Upper Willamette River Chinook	3	Willamette	-	-			0%	0%	258	-	2	0%	-	-			0%	0%	258	-	2	0%
7	730	Coast Fork Spring Chinook	Upper Willamette River Chinook	3	Willamette	-	-			0%	0%	235	-	2	0%	-	-			0%	0%	235	-	2	0%
8	418	Molalla Spring Chinook	Upper Willamette River Chinook	3	Willamette	99,111	421	0.42%		0%	0%	1,194	196	11	0%	99,111	421	0.42%		0%	0%	1,194	196	11	0%
9	415	Clackamas Spring Chinook(Hatchery)	Upper Willamette River Chinook	4	Willamette	1,077,846	2,814	0.26%	MAF	0%	50%	-	1,319	-	0%	1,077,846	2,814	0.26%	MAF	0%	50%	-	1,317	-	0%

Upper Columbia River Summer/Fall-run Chinook

						Alternative 4										Alternative 5									
Pop #	ID	Population Name	ESU	Designation	Subbasin	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	286	Columbia Lower Middle Hanford Fall Chinook (Priest Rapids	Upper Columbia River Summer/Fall-run Chinook	1	Hanford Reach	6,700,993	34,100	0.51%		0%	25%	10,153,910	18,522	61,115	50%	6,700,993	34,100	0.51%		0%	25%	10,159,920	18,477	61,008	50%
2	240	Okanogan-Similkimeen Summer Chinook	Upper Columbia River Summer/Fall-run Chinook	1	Okanogan	574,088	5,355	0.93%		0%	70%	1,676,364	2,791	3,935	70%	1,002,376	9,350	0.93%	MAF	0%	60%	1,610,202	4,832	3,825	65%
3	249	Wenatchee Summer Chinook	Upper Columbia River Summer/Fall-run Chinook	1	Wenatchee	737,100	4,116	0.56%		0%	99%	1,468,646	1,617	4,657	99%	737,100	4,116	0.56%		0%	99%	1,428,313	1,792	4,551	99%
4	300	Umatilla Fall Chinook	Upper Columbia River Summer/Fall-run Chinook	2	Umatilla	398,998	4,366	1.09%		0%	90%	197,568	2,186	1,035	70%	398,998	4,366	1.09%		0%	90%	198,089	2,180	1,035	70%
5	313	Yakima Fall Chinook	Upper Columbia River Summer/Fall-run Chinook	2	Yakima	346,573	1,200	0.35%	MAF	0%	10%	340,029	691	1,536	25%	346,573	1,200	0.35%	MAF	0%	10%	341,885	690	1,541	25%
6	311	Marion Drain Fall Chinook	Upper Columbia River Summer/Fall-run Chinook	2	Yakima	20,493	144	0.70%		0%	50%	5,527	82	107	25%	20,493	144	0.70%		0%	50%	5,531	82	107	25%
7	678	Entiat Summer-Fall Chinook (Late Run)	Upper Columbia River Summer/Fall-run Chinook	3	Entiat	-	-			0%	0%	17,603	-	45	0%	-	-			0%	0%	17,187	-	44	0%
8	635	Klickitat Fall Chinook	Upper Columbia River Summer/Fall-run Chinook	3	Klickitat	-	-			0%	0%	190,847	-	1,951	0%	-	-			0%	0%	190,945	-	1,949	0%
9	236	Methow Summer Chinook	Upper Columbia River Summer/Fall-run Chinook	3	Methow	-	-			0%	0%	84,386	-	196	0%	-	-			0%	0%	82,663	-	191	0%
10	819	Upper Middle Columbia Mainstem Summer Chinook	Upper Columbia River Summer/Fall-run Chinook	3	Upper Columbia	-	-			0%	0%	403,650	-	1,247	0%	-	-			0%	0%	392,515	-	1,209	0%
11	692	Columbia Lower Middle Columbia Fall Chinook (URB-Ringold	Upper Columbia River Summer/Fall-run Chinook	4	Hanford Reach	3,499,468	8,200	0.23%	MAF	0%	78%	-	4,515	-	0%	3,499,468	8,200	0.23%	MAF	0%	78%	-	4,503	-	0%
12	270	Klickitat Fall Chinook (URB-Hatchery)	Upper Columbia River Summer/Fall-run Chinook	4	Klickitat	3,867,242	20,934	0.54%	MAF	0%	0%	-	12,440	-	0%	3,867,242	20,934	0.54%	MAF	0%	0%	-	12,419	-	0%
13	826	Methow Summer Chinook (Wells Hatchery)	Upper Columbia River Summer/Fall-run Chinook	4	Methow	340,808	785	0.23%		0%	0%	-	348	-	0%	340,808	785	0.23%		0%	0%	-	347	-	0%
14	809	Umatilla Fall Chinook (Stepping Stone HAtchery)	Upper Columbia River Summer/Fall-run Chinook	4	Umatilla	411,480	762	0.19%		0%	20%	-	389	-	0%	411,480	762	0.19%		0%	20%	-	388	-	0%
15	694	Upper Middle Columbia Summer Chinook (Wells Hatchery)	Upper Columbia River Summer/Fall-run Chinook	4	Upper Columbia	803,024	3,765	0.47%		0%	55%	-	1,631	-	0%	803,024	3,765	0.47%		0%	55%	-	1,625	-	0%
16	245	Mainstem Summer Chinook (Turtle Rock-Hatchery)	Upper Columbia River Summer/Fall-run Chinook	4	Upper Columbia	1,277,939	2,472	0.19%		0%	0%	-	1,219	-	0%	1,277,939	2,472	0.19%		0%	0%	-	1,215	-	0%
17	794	Yakima Fall Chinook (Little White Salmon-Hatchery)	Upper Columbia River Summer/Fall-run Chinook	4	Yakima	-	-			0%	10%	-	-	-	0%	-	-			0%	10%	-	-	-	0%

Appendix 2D

Upper Columbia River Spring-run Chinook

						Alternative 4										Alternative 5									
Pop #	ID	Population Name	ESU	Designation	Subbasin	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	231	Entiat Spring Chinook	Upper Columbia River Spring-run Chinook	1	Entiat	-	-			60%	0%	13,609	-	5	0%	-	-			95%	0%	27,466	-	13	0%
2	234	Methow (Methow-Chewuch) Spring Chinook	Upper Columbia River Spring-run Chinook	1	Methow	150,642	503	0.33%		0%	0%	89,756	113	51	100%	89,775	300	0.33%		0%	30%	69,946	69	43	60%
3	821	Methow (Twisp) Spring Chinook	Upper Columbia River Spring-run Chinook	1	Methow	126,182	176	0.14%		0%	0%	19,943	41	11	100%	50,094	70	0.14%		0%	0%	19,408	16	12	100%
4	247	Wenatchee (Chiwawa) Spring Chinook	Upper Columbia River Spring-run Chinook	1	Wenatchee	351,546	1,540	0.44%		0%	5%	62,104	346	38	35%	249,012	1,091	0.44%		0%	5%	68,497	253	46	40%
5	822	Wenatchee (Nason) Spring Chinook	Upper Columbia River Spring-run Chinook	1	Wenatchee	-	-			0%	0%	28,644	-	14	0%	-	-			0%	0%	29,873	-	17	0%
6	823	Wenatchee (White) Spring Chinook	Upper Columbia River Spring-run Chinook	1	Wenatchee	65,915	122	0.18%		0%	50%	30,150	26	17	50%	65,915	122	0.18%		0%	50%	29,984	27	19	50%
7	597	Okanogan Spring Chinook	Upper Columbia River Spring-run Chinook	3	Okanogan	-	-			0%	0%	1	-	0	0%	-	-			0%	0%	1	-	0	0%
8	232	Entiat Spring Chinook (NFH)- Hatchery	Upper Columbia River Spring-run Chinook	4	Entiat	-	-			0%	0%	-	-	-	0%	-	-			0%	0%	-	-	-	0%
9	235	Methow Spring Chinook (Winthrop Hatchery)	Upper Columbia River Spring-run Chinook	4	Methow	601,492	1,507	0.25%		0%	10%	-	363	-	0%	601,492	1,507	0.25%		0%	10%	-	378	-	0%
10	248	Wenatchee Spring Chinook (Leavenworth NFH)- Hatchery	Upper Columbia River Spring-run Chinook	4	Wenatchee	1,650,192	2,755	0.17%		0%	2%	-	1,647	-	0%	1,650,192	2,755	0.17%		0%	2%	-	1,663	-	0%

Appendix C2 . Hatchery Production by Alternative for Chinook Salmon

Revised - 2-24-10

Primary
Contributing
Stabilizing
Not in ESU

Snake River Spring/Summer-run Chinook

Alternative 1

Pop #	ID	Population Name	ESU	Designation	Subbasin	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	296	Tucannon Spring Chinook	Snake River Spring/Summer-run Chinook	1	Tucannon	132,556	268	0.20%		0%	80%	21,709	24	21	50%
2	459	SF Salmon Summer Chinook	Snake River Spring/Summer-run Chinook	1	S.F. Salmon R	-	-			0%	0%	88,845	-	121	0%
3	525	Secesh Spring Chinook	Snake River Spring/Summer-run Chinook	1	S.F. Salmon R	-	-			0%	0%	46,311	-	37	0%
4	458	EF-SF Johnson Creek Summer Chinook	Snake River Spring/Summer-run Chinook	1	S.F. Salmon R	101,810	371	0.36%		0%	0%	69,277	54	38	100%
5	526	Chamberlain Creek Spring Chinook	Snake River Spring/Summer-run Chinook	1	M.F Salmon R	-	-			0%	0%	50,470	-	41	0%
6	527	Big Creek Spring Chinook	Snake River Spring/Summer-run Chinook	1	M.F Salmon R	-	-			0%	0%	57,993	-	47	0%
7	529	Camas Creek Spring Chinook	Snake River Spring/Summer-run Chinook	1	M.F Salmon R	-	-			0%	0%	8,272	-	7	0%
8	530	Loon Creek Spring Chinook	Snake River Spring/Summer-run Chinook	1	M.F Salmon R	-	-			0%	0%	13,038	-	11	0%
9	524	Middle Fork_Upper Mainstem Spring-Summer Chinook	Snake River Spring/Summer-run Chinook	1	M.F Salmon R	-	-			0%	0%	30,650	-	25	0%
10	531	Sulphur Creek Spring Chinook	Snake River Spring/Summer-run Chinook	1	M.F Salmon R	-	-			0%	0%	16,169	-	13	0%
11	532	Bear Valley Spring Chinook	Snake River Spring/Summer-run Chinook	1	M.F Salmon R	-	-			0%	0%	92,467	-	75	0%
12	533	Marsh Creek Spring Chinook	Snake River Spring/Summer-run Chinook	1	M.F Salmon R	-	-			0%	0%	10,363	-	8	0%
13	453	Lemhi River Spring Chinook	Snake River Spring/Summer-run Chinook	1	Upper Salmon R	-	-			0%	0%	55,813	-	45	0%
14	460	Pahsimeroi Summer Chinook	Snake River Spring/Summer-run Chinook	1	Upper Salmon R	-	-			0%	5%	18,885	-	26	0%
15	700	Upper Selway Spring Chinook	Snake River Spring/Summer-run Chinook	1	Clearwater	-	-			0%	0%	14,450	-	11	0%
16	510	Wenaha Spring Chinook	Snake River Spring/Summer-run Chinook	1	Grande Ronde-I	-	-			0%	0%	37,833	-	28	0%
17	456	Upper Salmon Mainstem Spring Chinook	Snake River Spring/Summer-run Chinook	1	Upper Salmon R	-	-			0%	0%	23,502	-	32	0%
18	439	Lolo Creek Spring Chinook	Snake River Spring/Summer-run Chinook	1	Clearwater	148,837	99	0.07%		0%	50%	8,621	13	4	0%
19	551	Minam Spring Chinook	Snake River Spring/Summer-run Chinook	1	Grande Ronde-I	-	-			0%	0%	23,954	-	17	0%
20	215	Lostine Spring Chinook	Snake River Spring/Summer-run Chinook	1	Grande Ronde-I	249,480	1,815	0.73%		0%	45%	97,828	569	124	50%
21	222	Imnaha Spring-Summer Chinook	Snake River Spring/Summer-run Chinook	1	Grande Ronde-I	359,178	2,439	0.68%		0%	65%	108,310	1,041	154	35%
22	214	Catherine Creek Spring Chinook	Snake River Spring/Summer-run Chinook	1	Grande Ronde-I	130,032	516	0.40%		0%	45%	26,394	123	22	30%
23	528	Middle Fork_Lower Mainstem Spring-Summer Chinook	Snake River Spring/Summer-run Chinook	2	M.F Salmon R	-	-			0%	0%	7,544	-	6	0%
24	785	Lower Selway Spring Chinook	Snake River Spring/Summer-run Chinook	2	Clearwater	429,771	186	0.04%		0%	0%	21,917	18	17	0%
25	534	NF Salmon River Spring Chinook	Snake River Spring/Summer-run Chinook	2	Upper Salmon R	-	-			0%	0%	7,656	-	6	0%
26	536	Lower Salmon Mainstem Spring Chinook	Snake River Spring/Summer-run Chinook	2	Upper Salmon R	-	-			0%	0%	22,291	-	17	0%
27	454	East Fork Salmon River Spring-Summer Chinook	Snake River Spring/Summer-run Chinook	2	Upper Salmon R	-	-			0%	0%	30,287	-	24	0%
28	537	Valley Spring Chinook	Snake River Spring/Summer-run Chinook	2	Upper Salmon R	-	-			0%	0%	13,493	-	10	0%
29	828	South Fork Clearwater_Newsome Creek Spring Chinook	Snake River Spring/Summer-run Chinook	2	Clearwater	75,411	57	0.08%		0%	50%	5,570	6	4	10%
30	695	Lochsa Spring Chinook	Snake River Spring/Summer-run Chinook	3	Clearwater	-	-			0%	0%	26,371	-	29	0%
31	522	Little Salmon Spring-Summer Chinook	Snake River Spring/Summer-run Chinook	3	S.F. Salmon R	-	-			0%	0%	22,438	-	30	0%
32	509	Asotin Spring-Summer Chinook	Snake River Spring/Summer-run Chinook	3	Asotin	-	-			0%	0%	11,372	-	8	0%
33	457	Yankee Fork Spring Chinook	Snake River Spring/Summer-run Chinook	3	Upper Salmon R	-	-			0%	0%	3,224	-	2	0%
34	538	Panther Creek Spring Chinook (Extirpated)	Snake River Spring/Summer-run Chinook	3	Upper Salmon R	-	-			0%	0%	20	-	0	0%
35	442	South Fork Clearwater Spring Chinook	Snake River Spring/Summer-run Chinook	3	Clearwater	-	-			0%	0%	25,096	-	38	0%
36	698	Lower Clearwater Spring Chinook	Snake River Spring/Summer-run Chinook	3	Clearwater	-	-			0%	0%	14,297	-	11	0%
37	213	Lookingglass Creek Spring Chinook	Snake River Spring/Summer-run Chinook	3	Grande Ronde-I	249,480	1,485	0.60%		0%	5%	10,654	361	9	0%
38	216	Upper Grande RondeSpring Chinook	Snake River Spring/Summer-run Chinook	3	Grande Ronde-I	250,992	830	0.33%		0%	50%	12,727	201	11	10%
39	455	Little Salmon Spring Chinook (Rapid River-Hatchery)	Snake River Spring/Summer-run Chinook	4	S.F. Salmon R	2,736,596	10,470	0.38%		0%	5%	-	7,496	-	0%
40	523	SF Salmon Summer Chinook (McCall-Hatchery)	Snake River Spring/Summer-run Chinook	4	S.F. Salmon R	1,060,883	5,700	0.54%		0%	10%	-	3,005	-	0%
41	508	Lochsa Spring Chinook (Hatchery)	Snake River Spring/Summer-run Chinook	4	Clearwater	700,812	2,472	0.35%		0%	20%	-	906	-	0%
42	535	Pahsimeroi Summer Chinook (Pahsimeroi Hatchery)	Snake River Spring/Summer-run Chinook	4	Upper Salmon R	999,400	3,156	0.32%		0%	5%	-	1,069	-	0%
43	518	Lower Selway Spring Chinook (Hatchery)	Snake River Spring/Summer-run Chinook	4	Clearwater	300,326	634	0.21%		0%	0%	-	239	-	0%
44	788	Upper Salmon Mainstem Spring Chinook (Sawtooth Hatcher	Snake River Spring/Summer-run Chinook	4	Upper Salmon R	1,034,880	1,100	0.11%		0%	5%	-	372	-	0%
45	786	Upper Selway Spring Chinook (Hatchery)	Snake River Spring/Summer-run Chinook	4	Clearwater	300,326	180	0.06%		0%	0%	-	18	-	0%
46	519	South Fork Clearwater Spring Chinook (Hatchery)	Snake River Spring/Summer-run Chinook	4	Clearwater	1,099,981	3,880	0.35%		0%	10%	-	2,229	-	0%
47	444	Middle Fork Clearwater Spring Chinook (Kooskia-Hatchery)	Snake River Spring/Summer-run Chinook	4	Clearwater	600,652	2,800	0.47%		0%	10%	-	1,476	-	0%
48	443	Spring Chinook (Dworshak-Hatchery)	Snake River Spring/Summer-run Chinook	4	Clearwater	1,051,143	4,900	0.47%		0%	10%	-	2,584	-	0%
49	820	Lower Mainstem_Spring Chinook (NPTH-Hatchery)	Snake River Spring/Summer-run Chinook	4	Clearwater	124,635	349	0.28%		0%	10%	-	44	-	0%
50	982	Imnaha Spring-Summer Chinook (Stepping Stone Hatchery)	Snake River Spring/Summer-run Chinook	4	Grande Ronde-I	-	-			0%	0%	-	-	-	0%
51	228	Snake Hells Canyon Spring Chinook (Oxbow Hatchery)	Snake River Spring/Summer-run Chinook	4	Snake Hells Can	299,536	707	0.24%		0%	5%	-	239	-	0%

Alternative 2

Pop #	ID	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	296	132,556	268	0.20%		0%	80%	21,058	56	22	50%
2	459	-	-			0%	0%	75,428	-	96	0%
3	525	-	-			0%	0%	48,326	-	34	0%
4	458	101,810	371	0.36%		0%	0%	69,186	80	57	100%
5	526	-	-			0%	0%	51,520	-	37	0%
6	527	-	-			0%	0%	59,801	-	43	0%
7	529	-	-			0%	0%	9,060	-	6	0%
8	530	-	-			0%	0%	13,391	-	10	0%
9	524	-	-			0%	0%	30,739	-	22	0%
10	531	-	-			0%	0%	16,231	-	12	0%
11	532	-	-			0%	0%	92,486	-	66	0%
12	533	-	-			0%	0%	10,773	-	8	0%
13	453	-	-			0%	0%	63,327	-	45	0%
14	460	-	-			0%	5%	36,065	-	46	0%
15	700	-	-			0%	0%	14,445	-	10	0%
16	510	-	-			0%	0%	42,613	-	28	0%
17	456	-	-			0%	0%	29,271	-	37	0%
18	439	100,459	281	0.28%		0%	0%	45,656	61	38	100%
19	551	-	-			0%	0%	28,643	-	19	0%
20	215	249,480	1,815	0.73%		0%	10%	97,745	548	122	50%
21	222	162,000	1,100	0.68%		0%	65%	110,500	449	154	35%
22	214	129,757	515	0.40%		0%	45%	30,277	115	25	55%
23	528	-	-			0%	0%	17,950	-	13	0%
24	785	429,771	186	0.04%		0%	0%	21,679	41	17	0%
25	534	-	-			0%	0%	15,691	-	11	0%
26	536	-	-			0%	0%	37,196	-	26	0%
27	454	-	-			0%	0%	38,218	-	27	0%
28	537	-	-			0%	0%	22,234	-	16	0%
29	828	75,279	239	0.32%		0%	0%	22,942	53	20	100%
30	695	-	-			0%	0%	26,408	-	27	0%
31	522	-	-			0%	0%	22,359	-	29	0%
32	509	-	-			0%	0%	16,597	-	10	0%
33	457	-	-			0%	0%	2,425	-	2	0%
34	538	-	-			0%	0%	13	-	0	0%
35	442	-	-			0%	0%	25,169	-	36	0%
36	698	-	-			0%	0%	14,306	-	10	0%
37	213	249,480	1,485	0.60%		0%	5%	10,476	345	9	0%
38	216	250,992	830	0.33%		0%	50%	12,645	192	10	10%
39	455	2,736,596	10,470	0.38%		0%	5%	-	7,441	-	0%
40	523	223,344	1,200	0.54%		0%	10%	-	624	-	0%
41	508	700,812	2,472	0.35%		0%	20%	-	1,050	-	0%
42	535	380,000	1,200	0.32%		0%	5%	-	395	-	0%
43	518	300,326	634	0.21%		0%	0%	-	233	-	0%
44	788	1,034,880	1,100	0.11%		0%	5%	-	362	-	0%
45	786	300,326	180	0.06%		0%	0%	-	43	-	0%
46	519	1,099,981	3,880	0.35%		0%	10%	-	2,203	-	0%
47	444	600,652	2,800	0.47%		0%	10%	-	1,456	-	0%
48	443	1,051,143	4,900	0.47%		0%	10%	-	2,548	-	0%
49	820	124,635	349	0.28%		0%	10%	-	92	-	0%
50	982	-	-			0%	0%	-	-	-	0%
51	228	299,536	707	0.24%		0%	5%	-	233	-	0%

Alternative 3

Pop #	ID	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	296	132,556	268	0.20%		0%	80%	21,040	56	22	50%
2	459	-	-			0%	0%	75,428	-	96	0%
3	525	-	-			0%	0%	48,326	-	34	0%
4	458	101,810	371	0.36%		0%	0%	69,186	80	57	100%
5	526	-	-			0%	0%	51,520	-	37	0%
6	527	-	-			0%	0%	59,801	-	43	0%
7	529	-	-			0%	0%	9,060	-	6	0%
8	530	-	-			0%	0%	13,391	-	10	0%
9	524	-	-			0%	0%	30,739	-	22	0%
10	531	-	-			0%	0%	16,231	-	12	0%
11	532	-	-			0%	0%	92,486	-	66	0%
12	533	-	-			0%	0%	10,773	-	8	0%
13	453	-	-			0%	0%	63,327	-	45	0%
14	460	-	-			0%	5%	36,065	-	46	0%
15	700	-	-			0%	0%	14,445	-	10	0%
16	510	-	-			0%	0%	42,675	-	28	0%
17	456	-	-			0%	0%	29,271	-	37	0%
18	439	100,459	281	0.28%		0%	0%	45,656	61	38	100%
19	551	-	-			0%	0%	28,709	-	19	0%
20	215	249,480	1,815	0.73%		0%	10%	97,746	548	122	50%
21	222	324,000	2,200	0.68%		0%	30%	107,383	914	153	35%
22	214	129,757	515	0.40%		0%	45%	30,275	115	25	55%
23	528	-	-			0%	0%	17,950	-	13	0%
24	785	429,771	186	0.04%		0%	0%	21,679	41	17	0%
25	534	-	-			0%	0%	15,691	-	11	0%
26	536	-	-			0%	0%	37,196	-	26	0%
27	454	-	-			0%	0%	38,218	-	27	0%
28	537	-	-			0%	0%	22,234	-	16	0%
29	828	75,279	239	0.32%		0%	0%	22,942	53	20	100%
30	695	-	-			0%	0%	26,408	-	27	0%
31	522	-	-			0%	0%	22,359	-	29	0%
32	509	-	-			0%	0%	17,771	-	11	0%
33	457	-	-			0%	0%	2,425	-	2	0%
34	538	-	-			0%	0%	13	-	0	0%
35	442	-	-			0%	0%	25,169	-	36	0%
36	698	-	-			0%	0%	14,306	-	10	0%
37	213	249,480	1,485	0.60%		0%	5%	10,476	345	9	0%
38	216	250,992	830	0.33%		0%	50%	12,645	192	10	10%
39	455	2,736,596	10,470	0.38%		0%	5%	-	7,441	-	0%
40	523	223,344	1,200	0.54%		0%	10%	-	624	-	0%
41	508	700,812	2,472	0.35%		0%	20%	-	1,050	-	0%
42	535	380,000	1,200	0.32%		0%	5%	-	395	-	0%
43	518	300,326	634	0.21%		0%	0%	-	233	-	0%
44	788	1,034,880	1,100	0.11%		0%	5%	-	362	-	0%
45	786	300,326	180	0.06%		0%	0%	-	43	-	0%
46	519	1,099,981	3,880	0.35%		0%	10%	-	2,203	-	0%
47	444	600,652	2,800	0.47%		0%	10%	-	1,456	-	0%
48	443	1,051,143	4,900	0.47%		0%	10%	-	2,548	-	0%
49	820	124,635	349	0.28%		0%	10%	-	92	-	0%
50	982	-	-			0%	0%	-	-	-	0%
51	228	299,536	707	0.24%		0%	5%	-	233	-	0%

Snake River Fall-run Chinook

Pop #	ID	Population Name	ESU	Designation	Subbasin	Alternative	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	224	Snake Hells Canyon Fall Chinook	Snake River Fall-run Chinook	1	Snake Hells Can	Alternative 1	5,802,745	24,808	0.43%		0%	50%	352,516	18,394	2,497	5%
						Alternative 2	330,076	1,411	0.43%		0%	85%	223,892	1,020	1,614	50%
						Alternative 3	330,076	1,411	0.43%		0%	85%	228,802	1,021	1,651	50%

Appendix C2 . Hatchery Production by Alternative for Chinook Salmon

Revised - 2-24-10

Primary
Contributing
Stabilizing
Not in ESU

Snake River Spring/Summer-run Chinook

Pop #	ID	Population Name	ESU	Designation	Subbasin	Alternative 4										Alternative 5									
						Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	296	Tucannon Spring Chinook	Snake River Spring/Summer-run Chinook	1	Tucannon	132,556	268	0.20%		0%	80%	21,040	56	22	50%	75,735	153	0.20%		0%	80%	21,999	32	25	60%
2	459	SF Salmon Summer Chinook	Snake River Spring/Summer-run Chinook	1	S.F. Salmon R	-	-			0%	0%	75,428	-	96	0%	253,800	900	0.35%	MAF	0%	10%	135,657	451	218	30%
3	525	Secesh Spring Chinook	Snake River Spring/Summer-run Chinook	1	S.F. Salmon R	-	-			0%	0%	48,326	-	34	0%	-	-			0%	0%	42,263	-	34	0%
4	458	EF-SF Johnson Creek Summer Chinook	Snake River Spring/Summer-run Chinook	1	S.F. Salmon R	101,810	371	0.36%		0%	0%	69,186	80	57	100%	101,810	371	0.36%		0%	0%	68,184	84	62	100%
5	526	Chamberlain Creek Spring Chinook	Snake River Spring/Summer-run Chinook	1	M.F Salmon R	-	-			0%	0%	51,520	-	37	0%	-	-			0%	0%	49,064	-	39	0%
6	527	Big Creek Spring Chinook	Snake River Spring/Summer-run Chinook	1	M.F Salmon R	-	-			0%	0%	59,801	-	43	0%	-	-			0%	0%	53,988	-	43	0%
7	529	Camas Creek Spring Chinook	Snake River Spring/Summer-run Chinook	1	M.F Salmon R	-	-			0%	0%	9,060	-	6	0%	-	-			0%	0%	5,016	-	4	0%
8	530	Loon Creek Spring Chinook	Snake River Spring/Summer-run Chinook	1	M.F Salmon R	-	-			0%	0%	13,391	-	10	0%	-	-			0%	0%	11,508	-	9	0%
9	524	Middle Fork_Upper Mainstem Spring-Summer Chinook	Snake River Spring/Summer-run Chinook	1	M.F Salmon R	-	-			0%	0%	30,739	-	22	0%	-	-			0%	0%	29,590	-	24	0%
10	531	Sulphur Creek Spring Chinook	Snake River Spring/Summer-run Chinook	1	M.F Salmon R	-	-			0%	0%	16,231	-	12	0%	-	-			0%	0%	15,808	-	13	0%
11	532	Bear Valley Spring Chinook	Snake River Spring/Summer-run Chinook	1	M.F Salmon R	-	-			0%	0%	92,486	-	66	0%	-	-			0%	0%	91,614	-	74	0%
12	533	Marsh Creek Spring Chinook	Snake River Spring/Summer-run Chinook	1	M.F Salmon R	-	-			0%	0%	10,773	-	8	0%	-	-			0%	0%	8,857	-	7	0%
13	453	Lemhi River Spring Chinook	Snake River Spring/Summer-run Chinook	1	Upper Salmon R	-	-			0%	0%	63,327	-	45	0%	-	-			50%	0%	58,577	-	47	0%
14	460	Pahsimeroi Summer Chinook	Snake River Spring/Summer-run Chinook	1	Upper Salmon R	-	-			0%	5%	36,065	-	46	0%	285,000	900	0.32%	MAF	0%	25%	81,465	282	122	75%
15	700	Upper Selway Spring Chinook	Snake River Spring/Summer-run Chinook	1	Clearwater	-	-			0%	0%	14,445	-	10	0%	-	-			0%	0%	14,284	-	11	0%
16	510	Wenaha Spring Chinook	Snake River Spring/Summer-run Chinook	1	Grande Ronde-I	-	-			0%	0%	42,675	-	28	0%	-	-			0%	0%	43,081	-	32	0%
17	456	Upper Salmon Mainstem Spring Chinook	Snake River Spring/Summer-run Chinook	1	Upper Salmon R	-	-			0%	0%	29,271	-	37	0%	197,443	420	0.21%	MAF	0%	50%	70,014	129	106	75%
18	439	Lolo Creek Spring Chinook	Snake River Spring/Summer-run Chinook	1	Clearwater	100,459	281	0.28%		0%	0%	45,656	61	38	100%	100,459	281	0.28%		0%	0%	44,534	65	41	100%
19	551	Minam Spring Chinook	Snake River Spring/Summer-run Chinook	1	Grande Ronde-I	-	-			0%	0%	28,709	-	19	0%	-	-			0%	0%	29,209	-	22	0%
20	215	Lostine Spring Chinook	Snake River Spring/Summer-run Chinook	1	Grande Ronde-I	249,480	1,815	0.73%		0%	10%	97,746	548	122	50%	249,480	1,815	0.73%		0%	10%	96,947	565	130	50%
21	222	Imnaha Spring-Summer Chinook	Snake River Spring/Summer-run Chinook	1	Grande Ronde-I	324,000	2,200	0.68%		0%	30%	107,383	914	153	35%	113,400	770	0.68%		0%	30%	124,760	316	185	65%
22	214	Catherine Creek Spring Chinook	Snake River Spring/Summer-run Chinook	1	Grande Ronde-I	129,757	515	0.40%		0%	45%	30,275	115	25	55%	75,600	300	0.40%		0%	30%	30,055	69	27	55%
23	528	Middle Fork_Lower Mainstem Spring-Summer Chinook	Snake River Spring/Summer-run Chinook	2	M.F Salmon R	-	-			0%	0%	17,950	-	13	0%	-	-			0%	0%	3,613	-	3	0%
24	785	Lower Selway Spring Chinook	Snake River Spring/Summer-run Chinook	2	Clearwater	429,771	186	0.04%		0%	0%	21,679	41	17	0%	429,771	186	0.04%		0%	0%	21,574	43	19	0%
25	534	NF Salmon River Spring Chinook	Snake River Spring/Summer-run Chinook	2	Upper Salmon R	-	-			0%	0%	15,691	-	11	0%	-	-			0%	0%	4,017	-	3	0%
26	536	Lower Salmon Mainstem Spring Chinook	Snake River Spring/Summer-run Chinook	2	Upper Salmon R	-	-			0%	0%	37,196	-	26	0%	-	-			0%	0%	8,049	-	6	0%
27	454	East Fork Salmon River Spring-Summer Chinook	Snake River Spring/Summer-run Chinook	2	Upper Salmon R	-	-			0%	0%	38,218	-	27	0%	-	-			0%	0%	13,954	-	11	0%
28	537	Valley Spring Chinook	Snake River Spring/Summer-run Chinook	2	Upper Salmon R	-	-			0%	0%	22,234	-	16	0%	-	-			0%	0%	5,597	-	4	0%
29	828	South Fork Clearwater_Newsome Creek Spring Chinook	Snake River Spring/Summer-run Chinook	2	Clearwater	75,279	239	0.32%		0%	0%	22,942	53	20	100%	75,279	239	0.32%		0%	0%	22,513	56	21	100%
30	695	Lochsa Spring Chinook	Snake River Spring/Summer-run Chinook	3	Clearwater	-	-			0%	0%	26,408	-	27	0%	-	-			0%	0%	26,149	-	29	0%
31	522	Little Salmon Spring-Summer Chinook	Snake River Spring/Summer-run Chinook	3	S.F. Salmon R	-	-			0%	0%	22,359	-	29	0%	-	-			0%	0%	22,218	-	30	0%
32	509	Asotin Spring-Summer Chinook	Snake River Spring/Summer-run Chinook	3	Asotin	-	-			0%	0%	17,771	-	11	0%	-	-			0%	0%	17,956	-	13	0%
33	457	Yankee Fork Spring Chinook	Snake River Spring/Summer-run Chinook	3	Upper Salmon R	-	-			0%	0%	2,425	-	2	0%	-	-			0%	0%	3,886	-	3	0%
34	538	Panther Creek Spring Chinook (Extirpated)	Snake River Spring/Summer-run Chinook	3	Upper Salmon R	-	-			0%	0%	13	-	0	0%	-	-			0%	0%	26	-	0	0%
35	442	South Fork Clearwater Spring Chinook	Snake River Spring/Summer-run Chinook	3	Clearwater	-	-			0%	0%	25,169	-	36	0%	-	-			0%	0%	24,799	-	38	0%
36	698	Lower Clearwater Spring Chinook	Snake River Spring/Summer-run Chinook	3	Clearwater	-	-			0%	0%	14,306	-	10	0%	-	-			0%	0%	14,242	-	11	0%
37	213	Lookingglass Creek Spring Chinook	Snake River Spring/Summer-run Chinook	3	Grande Ronde-I	249,480	1,485	0.60%		0%	5%	10,476	345	9	0%	325,080	1,935	0.60%	MAF	0%	5%	11,013	471	10	0%
38	216	Upper Grande RondeSpring Chinook	Snake River Spring/Summer-run Chinook	3	Grande Ronde-I	250,992	830	0.33%		0%	50%	12,645	192	10	10%	250,992	830	0.33%		0%	50%	12,543	200	11	10%
39	455	Little Salmon Spring Chinook (Rapid River-Hatchery)	Snake River Spring/Summer-run Chinook	4	S.F. Salmon R	2,736,596	10,470	0.38%		0%	5%	-	7,441	-	0%	2,736,596	10,470	0.38%		0%	5%	-	7,496	-	0%
40	523	SF Salmon Summer Chinook (McCall-Hatchery)	Snake River Spring/Summer-run Chinook	4	S.F. Salmon R	223,344	1,200	0.54%		0%	10%	-	624	-	0%	752,940	2,670	0.35%		0%	10%	-	1,408	-	0%
41	508	Lochsa Spring Chinook (Hatchery)	Snake River Spring/Summer-run Chinook	4	Clearwater	700,812	2,472	0.35%		0%	20%	-	1,050	-	0%	700,812	2,472	0.35%		0%	20%	-	1,070	-	0%
42	535	Pahsimeroi Summer Chinook (Pahsimeroi Hatchery)	Snake River Spring/Summer-run Chinook	4	Upper Salmon R	380,000	1,200	0.32%		0%	5%	-	395	-	0%	1,045,000	3,300	0.32%		0%	5%	-	1,584	-	0%
43	518	Lower Selway Spring Chinook (Hatchery)	Snake River Spring/Summer-run Chinook	4	Clearwater	300,326	634	0.21%		0%	0%	-	233	-	0%	300,326	634	0.21%		0%	0%	-	239	-	0%
44	788	Upper Salmon Mainstem Spring Chinook (Sawtooth Hatcher	Snake River Spring/Summer-run Chinook	4	Upper Salmon R	1,034,880	1,100	0.11%		0%	5%	-	362	-	0%	1,223,040	2,600	0.21%	MAF	0%	5%	-	1,248	-	0%
45	786	Upper Selway Spring Chinook (Hatchery)	Snake River Spring/Summer-run Chinook	4	Clearwater	300,326	180	0.06%		0%	0%	-	43	-	0%	300,326	180	0.06%		0%	0%	-	45	-	0%
46	519	South Fork Clearwater Spring Chinook (Hatchery)	Snake River Spring/Summer-run Chinook	4	Clearwater	1,099,981	3,880	0.35%		0%	10%	-	2,203	-	0%	1,099,981	3,880	0.35%		0%	10%	-	2,229	-	0%
47	444	Middle Fork Clearwater Spring Chinook (Kooskia-Hatchery)	Snake River Spring/Summer-run Chinook	4	Clearwater	600,652	2,800	0.47%		0%	10%	-	1,456	-	0%	600,652	2,800	0.47%		0%	10%	-	1,476	-	0%
48	443	Spring Chinook (Dworshak-Hatchery)	Snake River Spring/Summer-run Chinook	4	Clearwater	1,051,143	4,900	0.47%		0%	10%	-	2,548	-	0%	1,051,143	4,900	0.47%		0%	10%	-	2,584	-	0%
49	820	Lower Mainstem_Spring Chinook (NPTH-Hatchery)	Snake River Spring/Summer-run Chinook	4	Clearwater	124,635	349	0.28%		0%	10%	-	92	-	0%	124,635	349	0.28%		0%	10%	-	95	-	0%
50	982	Imnaha Spring-Summer Chinook (Stepping Stone Hatchery)	Snake River Spring/Summer-run Chinook	4	Grande Ronde-I	-	-			0%	0%	-	-	-	0%	246,240	1,672	0.68%	MAF	0%	30%	-	724	-	0%
51	228	Snake Hells Canyon Spring Chinook (Oxbow Hatchery)	Snake River Spring/Summer-run Chinook	4	Snake Hells Can	299,536	707	0.24%		0%	5%	-	233	-	0%	299,536	707	0.24%		0%	5%	-	239	-	0%

Snake River Fall-run Chinook

Pop #	ID	Population Name	ESU	Designation	Subbasin	Alternative 4										Alternative 5									
						Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	224	Snake Hells Canyon Fall Chinook	Snake River Fall-run Chinook	1	Snake Hells Can	330,076	1,411	0.43%		0%	85%	228,719	1,021	1,652	50%	109,915	470	0.43%		0%	0%	272,162	340	1,999	100%

Appendix C2 . Hatchery Production by Alternative for Chinook Salmon

Revised - 2-24-10

Primary
Contributing
Stabilizing
Not in ESU

Appendix Table 2B

Middle Columbia River Spring-run Chinook

Pop #	ID	Population Name	ESU	Designation	Subbasin	Alternative 1										Alternative 2										Alternative 3									
						Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	290	Deschutes Spring Chinook	Middle Columbia River Spring-run Chinook	1	Deschutes	746,928	2,400	0.32%		50%	5%	17,329	1,050	165	10%	746,928	2,400	0.32%		50%	5%	17,451	1,029	163	10%	746,928	2,400	0.32%		50%	5%	17,293	1,029	162	10%
2	802	MF John Day Spring Chinook	Middle Columbia River Spring-run Chinook	1	John Day	-	-			0%	0%	17,585	-	90	0%	-	-			0%	0%	17,680	-	80	0%	-	-			0%	0%	17,584	-	80	0%
3	803	NF John Day Spring Chinook	Middle Columbia River Spring-run Chinook	1	John Day	-	-			0%	0%	41,220	-	232	0%	-	-			0%	0%	41,267	-	209	0%	-	-			0%	0%	41,219	-	209	0%
4	271	Klickitat Spring Chinook	Middle Columbia River Spring-run Chinook	1	Klickitat	831,164	1,663	0.20%	MAF	0%	20%	11,212	796	275	4%	-	-			0%	20%	10,713	-	219	4%	484,345	1,290	0.27%	MAF	0%	5%	13,347	628	300	25%
5	308	American Spring Chinook	Middle Columbia River Spring-run Chinook	1	Yakima	-	-			0%	0%	6,388	-	57	0%	-	-			0%	0%	6,437	-	55	0%	-	-			0%	0%	6,447	-	55	0%
6	309	Naches Spring Chinook	Middle Columbia River Spring-run Chinook	1	Yakima	-	-			0%	0%	22,842	-	202	0%	-	-			0%	0%	23,193	-	196	0%	-	-			0%	0%	23,212	-	196	0%
7	312	Upper Yakima Spring Chinook	Middle Columbia River Spring-run Chinook	1	Yakima	810,720	3,973	0.49%		0%	95%	119,048	1,336	811	100%	810,720	3,973	0.49%		0%	95%	119,042	1,294	785	100%	810,720	3,973	0.49%		0%	95%	119,041	1,294	785	100%
8	292	Upper Mainstem John Day Spring Chinook	Middle Columbia River Spring-run Chinook	2	John Day	-	-			0%	0%	18,720	-	96	0%	-	-			0%	0%	18,803	-	85	0%	-	-			0%	0%	18,720	-	85	0%
9	301	Umatilla Spring Chinook	Middle Columbia River Spring-run Chinook	2	Umatilla	925,324	5,733	0.62%		0%	80%	15,326	2,251	132	6%	277,617	1,720	0.62%		0%	80%	14,986	653	132	75%	277,617	1,720	0.62%		0%	80%	14,943	653	131	75%
10	304	Walla Walla Spring Chinook	Middle Columbia River Spring-run Chinook	2	Walla Walla	249,480	770	0.31%		0%	0%	7,583	168	25	0%	249,480	770	0.31%		0%	0%	7,551	160	24	0%	99,792	308	0.31%		0%	10%	7,203	62	23	15%
11	693	Mainstem Columbia Spring Chinook (Ringold Via LWS-Hatch	Middle Columbia River Spring-run Chinook	4	Hanford Reach	487,110	770	0.16%		0%	30%	-	177	-	0%	487,110	770	0.16%		0%	30%	-	170	-	0%	487,110	770	0.16%		0%	30%	-	170	-	0%
12	289	Deschutes Spring Chinook (RoundButte-Hatchery)	Middle Columbia River Spring-run Chinook	4	Deschutes	320,554	1,030	0.32%		0%	5%	-	456	-	0%	320,554	1,030	0.32%		0%	5%	-	450	-	0%	320,554	1,030	0.32%		0%	5%	-	450	-	0%

53,873,607.3

7% 4,012,812.4

Appendix Table 2A

Lower Columbia River Chinook

Pop #	ID	Population Name	ESU	Designation	Subbasin	Alternative 1										Alternative 2										Alternative 3									
						Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	601	Clatskanie Fall Chinook	Lower Columbia River Chinook	1	Clatskanie	-	-			0%	0%	7,329	-	74	0%	-	-			0%	0%	8,952	-	95	0%	-	-			50%	0%	8,212	-	85	0%
2	353	Coweeman Fall Chinook	Lower Columbia River Chinook	1	Cowlitz	-	-			0%	0%	120,566	-	397	0%	-	-			0%	0%	145,021	-	490	0%	-	-			0%	0%	141,216	-	475	0%
3	609	Upper Cowlitz Spring Chinook	Lower Columbia River Chinook	1	Cowlitz	1,263,553	3,640	0.29%		0%	20%	18,428	1,987	284	0%	833,112	2,400	0.29%		0%	5%	27,177	1,315	421	10%	833,112	2,400	0.29%		0%	5%	27,677	1,314	428	10%
4	339	Elochoman Fall Chinook	Lower Columbia River Chinook	1	Elochoman	2,072,070	7,700	0.37%	MAF	0%	12%	125,870	2,884	321	6%	-	-			0%	12%	138,969	-	362	6%	-	-			50%	0%	89,540	-	220	0%
5	347	Grays Fall Chinook	Lower Columbia River Chinook	1	Grays	-	-			0%	0%	33,359	-	82	0%	-	-			0%	0%	45,342	-	119	0%	-	-			50%	0%	19,180	-	47	0%
6	261	Hood Spring Chinook	Lower Columbia River Chinook	1	Hood	125,910	616	0.49%		0%	50%	2,970	172	21	0%	125,800	1,231	0.98%		0%	75%	6,822	117	17	100%	125,827	1,231	0.98%		0%	75%	6,890	329	48	100%
7	366	Kalama Fall Chinook	Lower Columbia River Chinook	1	Kalama	-	-			0%	0%	154,714	-	380	0%	-	-			0%	0%	149,103	-	391	0%	-	-			50%	0%	69,416	-	171	0%
8	367	Kalama Spring Chinook	Lower Columbia River Chinook	1	Kalama	501,336	2,640	0.53%		0%	20%	4,851	1,446	70	0%	501,336	2,640	0.53%		0%	20%	4,423	780	34	0%	501,336	2,640	0.53%		0%	20%	4,445	1,446	64	0%
9	561	EF Lewis Fall Chinook (Tule)	Lower Columbia River Chinook	1	Lewis	-	-			0%	0%	55,893	-	190	0%	-	-			0%	0%	45,908	-	156	0%	-	-			0%	0%	16,532	-	56	0%
10	376	NF Lewis Fall Chinook (Lower River Brights)	Lower Columbia River Chinook	1	Lewis	-	-			0%	0%	923,111	-	7,441	0%	-	-			0%	0%	939,845	-	7,589	0%	-	-			0%	0%	932,935	-	7,547	0%
11	378	NF Lewis Spring Chinook	Lower Columbia River Chinook	1	Lewis	-	-			0%	0%	29,098	-	233	0%	-	-			0%	0%	26,656	-	213	0%	-	-			0%	0%	26,342	-	210	0%
12	401	Sandy Fall Chinook (Late)	Lower Columbia River Chinook	1	Sandy	-	-			0%	0%	572,787	-	1,424	0%	-	-			0%	0%	597,309	-	1,489	0%	-	-			0%	0%	572,409	-	1,425	0%
13	402	Sandy Spring Chinook	Lower Columbia River Chinook	1	Sandy	300,548	1,749	0.58%	MAF	0%	10%	115,657	603	378	100%	-	-			0%	10%	109,534	-	327	100%	300,548	1,749	0.58%	MAF	0%	10%	115,779	604	379	100%
14	407	Washougal Fall Chinook	Lower Columbia River Chinook	1	Washougal	-	-			0%	0%	147,645	-	363	0%	-	-			0%	0%	171,682	-	452	0%	-	-			50%	0%	70,982	-	174	0%
15	664	Mill-Aber-Germ Fall Chinook	Lower Columbia River Chinook	2	Mill-Aber-Germ	-	-			0%	0%	49,894	-	170	0%	-	-			0%	0%	104,390	-	382	0%	-	-			0%	0%	98,871	-	359	0%
16	354	Lower Cowlitz Fall Chinook	Lower Columbia River Chinook	2	Cowlitz	4,807,421	7,920	0.16%		0%	25%	570,924	2,940	1,842	0%	2,185,189	3,600	0.16%		0%	25%	865,111	1,330	2,930	30%	2,185,189	3,600	0.16%		0%	25%	858,351	1,330	2,902	30%
17	253	White Salmon Fall Chinook (Tule)	Lower Columbia River Chinook	2	White Salmon	-	-			0%	0%	35,837	-	339	0%	-	-			0%	0%	35,345	-	359	0%	-	-			0%	0%	35,835	-	339	0%
18	649	White Salmon Spring Chinook	Lower Columbia River Chinook	2	White Salmon	-	-			0%	0%	2	-	0	0%	-	-			0%	0%	2	-	0	0%	-	-			0%	0%	2	-	0	0%
19	413	Clackamas Fall Chinook	Lower Columbia River Chinook	2	Willamette	-	-			0%	0%	8,346	-	40	0%	-	-			0%	0%	3,165	-	16	0%	-	-			0%	0%	5,620	-	27	0%
20	662	Big Creek Fall Chinook (Tules)	Lower Columbia River Chinook	3	Big Creek	-	-			0%	25%	19,326	-	91	0%	-	-			0%	25%	512	-	2	0%	-	-			0%	25%	19,182	-	91	0%
21	321	Chinook River Fall Chinook	Lower Columbia River Chinook	3	Chinook River	-	-			0%	0%	5,566	-	20	0%	-	-			0%	0%	0	-	0	0%	-	-			0%	0%	2,151	-	8	0%
22	602	Scapoose Fall Chinook	Lower Columbia River Chinook	3	Scapoose	-	-			0%	0%	77,811	-	28	0%	-	-			0%	0%	29,622	-	11	0%	-	-			0%	0%	52,472	-	19	0%
23	727	Youngs Bay Tribs Fall Chinook	Lower Columbia River Chinook	3	Youngs Bay	-	-			0%	0%	97,982	-	70	0%	-	-			0%	0%	2,956	-	2	0%	-	-			0%	0%	27,700	-	20	0%
25	659	Tributaries Fall Chinook (Tules- Oregon)	Lower Columbia River Chinook	3	Columbia Gorge	-	-			0%	0%	6,991	-	33	0%	-	-			0%	0%	6,522	-	34	0%	-	-			0%	0%	6,988	-	33	0%
26	356	Toutle Fall Chinook	Lower Columbia River Chinook	3	Cowlitz	-	-			0%	0%	87,684	-	431	0%	-	-			0%	0%	172,882	-	903	0%	-	-			0%	0%	83,299	-	409	0%
27	260	Hood Fall Chinook	Lower Columbia River Chinook	3	Hood	-	-			0%	0%	9,015	-	104	0%	-	-			0%	0%	0	-	0	0%	-	-			0%	0%	9,006	-	103	0%
28	646	Little White Salmon Fall Chinook (Tule)	Lower Columbia River Chinook	3	Little White Saln	-	-			0%	0%	17,873	-	176	0%	-	-			0%	0%	0	-	0	0%	-	-			0%	0%	17,871	-	176	0%
29	669	LC Tribs Fall Chinook (Tules-Oregon)	Lower Columbia River Chinook	3	Lower Columbia	-	-			0%	0%	83,037	-	28	0%	-	-			0%	0%	118,297	-	43	0%	-	-			0%	0%	79,297	-	27	0%
30	400	Sandy Fall Chinook (Early)	Lower Columbia River Chinook	3	Sandy	-	-			0%	0%	494,765	-	1,420	0%	-	-			0%	0%	612,667	-	1,820	0%	-	-			0%	0%	577,224	-	1,699	0%
31	281	Wind Fall Chinook (Tule)	Lower Columbia River Chinook	3	Wind	-	-			0%	0%	129,765	-	207	0%	-	-			0%	0%	96,942	-	166	0%	-	-			0%	0%	129,756	-	207	0%
32	652	Wind Spring Chinook	Lower Columbia River Chinook	3	Wind	-	-			0%	0%	5,716	-	10	0%	-	-			0%	0%	2,836	-	4	0%	-	-			0%	0%	5,728	-	9	0%
24	257	Spring Creek Fall Chinook (Tules-Hatchery)	Lower Columbia River Chinook	4	Columbia Gorge	15,044,850	76,800	0.51%	MAF	0%	10%	-	33,518	-	0%	-	-			0%	10%	-	-	-	0%	15,044,850	76,800	0.51%	MAF	0%	10%	-	33,490	-	0%
33	322	Big Creek Fall Chinook (Tules-Hatchery)	Lower Columbia River Chinook	4	Big Creek	5,826,626	10,624	0.18%	MAF	0%	25%	-	5,382	-	0%	-	-			0%	25%	-	-	-	0%	5,826,626	10,624	0.18%	MAF	0%	25%	-	5,379	-	0%
34	323	Deep River Spring Chinook (Cowlitz-Merwin-Grays-Hatche	Lower Columbia River Chinook	4	Columbia Estuai	362,250	2,392	0.66%		0%	0%	-	2,030	-	0%	362,250	2,392	0.66%		0%	0%	-	2,032	-	0%	362,250	2,392	0.66%		0%	0%	-	2,030	-	0%
35	320	Youngs Bay Fall Chinook (Rogue Brights-CEDC SAFE-Hat	Lower Columbia River Chinook	4	Youngs Bay	1,174,050	8,120	0.69%		0%	90%	-	6,149	-	0%	-	-			0%	90%	-	-	-	0%	-	-			0%	90%	-	-	-	0%
36	566	Youngs Bay Spring Chinook (CEDC SAFE-Willamette-Hatc	Lower Columbia River Chinook	4	Youngs Bay	850,096	4,500	0.53%		0%	0%	-	4,040	-	0%	850,096	4,500	0.53%		0%	0%	-	4,032	-	0%	850,096	4,500	0.53%		0%	0%	-	4,041	-	0%
37	722	Toutle Fall Chinook (Hatchery)	Lower Columbia River Chinook	4	Cowlitz	2,500,399	4,260	0.17%	MAF	0%	15%	-	1,602	-	0%	-	-			0%	15%	-	-	-	0%	2,500,399	4,260	0.17%	MAF	0%	15%	-	1,602	-	0%
38	578	Kalama Fall Chinook (Hatchery)	Lower Columbia River Chinook	4	Kalama	5,040,033	11,660	0.23%	MAF	0%	25%	-	4,386	-	0%	-	-			0%	25%	-	-	-	0%	199,310	461	0.23%	MAF	0%	25%	-	173	-	0%
39	724	NF Lewis Spring Chinook (Hatchery)	Lower Columbia River Chinook	4	Lewis	1,351,351	4,186	0.31%		0%	20%	-	2,514	-	0%	297,000	920	0.31%		0%	20%	-	553	-	0%	500,444	1,550	0.31%		0%	10%	-	931	-	0%
40	277	Little White Salmon Fall Chinook (URB-Hatchery)	Lower Columbia River Chinook	4	Little White Salr	2,007,246	9,680	0.48%	MAF	0%	25%	-	5,356	-	0%	-	-			0%	25%	-	-	-	0%	2,007,246	9,680	0.48%	MAF	0%	25%	-	5,364	-	0%
41	278	Little White Salmon Spring Chinook (Hatchery)	Lower Columbia River Chinook	4	Little White Salr	1,005,193	3,330	0.33%	MAF	0%	10%	-	1,572	-	0%	-	-			0%	10%	-	-	-	0%	1,005,193	3,330	0.33%	MAF	0%	10%	-	1,552	-	0%
42	390	Bonneville Fall Chinook (Hatchery)	Lower Columbia River Chinook	4	Lower Columbia	4,493,088	12,844	0.29%	MAF	0%	10%	-	4,042	-	0%	-	-			0%	10%	-	-	-	0%	4,493,088	12,844	0.29%	MAF	0%	10%	-	4,057	-	0%
43	581	Washougal Fall Chinook (Hatchery)	Lower Columbia River Chinook	4	Washougal	4,002,563	12,152	0.30%	MAF	0%	14%	-	4,571	-	0%	-	-			0%	14%	-	-	-	0%	175,623	533	0.30%	MAF	0%	14%	-	201	-	0%
44	283	Wind Spring Chinook (Hatchery)	Lower Columbia River Chinook	4	Wind	1,145,024	3,620	0.32%	MAF	0%	20%	-	1,709	-	0%	-	-			0%	20%	-	-	-	0%	1,145,024	3,620	0.32%	MAF	0%	20%	-	1,688	-	0%

Deschutes River Summer/Fall-run Chinook

Pop #	ID	Population Name	ESU	Designation	Subbasin	Alternative 1										Alternative 2										Alternative 3									
						Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	288	Deschutes Fall Chinook	Deschutes River Summer/Fall-run Chinook	1	Deschutes	-	-			0%	0%	817,188	-	7,929	0%	-	-			0%	0%	924,733	-	9,064	0%	-	-			0%	0%	806,465	-	7,827	0%

Revised - 2-24-10

Primary
Contributing
Stabilizing
Not in ESU

Appendix Table 2B

Middle Columbia River Spring-run Chinook

						Alternative 4										Alternative 5									
Pop #	ID	Population Name	ESU	Designation	Subbasin	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	290	Deschutes Spring Chinook	Middle Columbia River Spring-run Chinook	1	Deschutes	746,928	2,400	0.32%		50%	5%	17,394	1,029	163	10%	746,928	2,400	0.32%		50%	5%	17,167	1,044	171	20%
2	802	MF John Day Spring Chinook	Middle Columbia River Spring-run Chinook	1	John Day	-	-			0%	0%	17,640	-	80	0%	-	-			0%	0%	17,486	-	89	0%
3	803	NF John Day Spring Chinook	Middle Columbia River Spring-run Chinook	1	John Day	-	-			0%	0%	41,247	-	209	0%	-	-			0%	0%	41,086	-	231	0%
4	271	Klickitat Spring Chinook	Middle Columbia River Spring-run Chinook	1	Klickitat	800,784	2,133	0.27%	MAF	0%	5%	15,875	1,505	227	25%	800,784	2,133	0.27%	MAF	0%	5%	14,993	1,512	220	30%
5	308	American Spring Chinook	Middle Columbia River Spring-run Chinook	1	Yakima	-	-			0%	0%	6,447	-	55	0%	-	-			0%	0%	6,406	-	57	0%
6	309	Naches Spring Chinook	Middle Columbia River Spring-run Chinook	1	Yakima	-	-			0%	0%	23,212	-	196	0%	-	-			0%	0%	22,875	-	202	0%
7	312	Upper Yakima Spring Chinook	Middle Columbia River Spring-run Chinook	1	Yakima	810,720	3,973	0.49%		0%	95%	119,041	1,294	785	100%	810,720	3,973	0.49%		0%	95%	118,470	1,327	816	100%
8	292	Upper Mainstem John Day Spring Chinook	Middle Columbia River Spring-run Chinook	2	John Day	-	-			0%	0%	18,769	-	85	0%	-	-			0%	0%	18,634	-	95	0%
9	301	Umatilla Spring Chinook	Middle Columbia River Spring-run Chinook	2	Umatilla	277,617	1,720	0.62%		0%	80%	14,943	653	131	75%	277,617	1,720	0.62%		0%	80%	14,864	666	136	75%
10	304	Walla Walla Spring Chinook	Middle Columbia River Spring-run Chinook	2	Walla Walla	99,792	308	0.31%		0%	10%	7,203	62	23	15%	99,792	308	0.31%		0%	10%	7,217	64	26	15%
11	693	Mainstem Columbia Spring Chinook (Ringold Via LWS-Hatch	Middle Columbia River Spring-run Chinook	4	Hanford Reach	487,110	770	0.16%		0%	30%	-	170	-	0%	486,816	770	0.16%		0%	30%	-	177	-	0%
12	289	Deschutes Spring Chinook (RoundButte-Hatchery)	Middle Columbia River Spring-run Chinook	4	Deschutes	320,554	1,030	0.32%		0%	5%	-	450	-	0%	320,554	1,030	0.32%		0%	5%	-	456	-	0%

Appendix Table 2A

Lower Columbia River Chinook

						Alternative 4										Alternative 5									
Pop #	ID	Population Name	ESU	Designation	Subbasin	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	601	Clatskanie Fall Chinook	Lower Columbia River Chinook	1	Clatskanie	-	-			95%	0%	9,754	-	106	0%	-	-			50%	0%	8,215	-	85	0%
2	353	Coweeman Fall Chinook	Lower Columbia River Chinook	1	Cowlitz	-	-			0%	0%	128,020	-	425	0%	-	-			0%	0%	141,212	-	475	0%
3	609	Upper Cowlitz Spring Chinook	Lower Columbia River Chinook	1	Cowlitz	624,833	1,800	0.29%		0%	5%	34,940	979	551	10%	833,112	2,400	0.29%		0%	5%	27,677	1,314	428	10%
4	339	Elochoman Fall Chinook	Lower Columbia River Chinook	1	Elochoman	-	-			95%	0%	101,875	-	253	0%	-	-			50%	0%	89,398	-	220	0%
5	347	Grays Fall Chinook	Lower Columbia River Chinook	1	Grays	94,185	350	0.37%	MAF	95%	5%	40,678	127	108	25%	-	-			50%	0%	19,168	-	47	0%
6	261	Hood Spring Chinook	Lower Columbia River Chinook	1	Hood	60,421	591	0.98%		0%	0%	6,481	155	44	100%	125,773	1,231	0.98%		0%	75%	6,775	339	52	100%
7	366	Kalama Fall Chinook	Lower Columbia River Chinook	1	Kalama	-	-			95%	0%	90,054	-	221	0%	-	-			50%	0%	69,416	-	171	0%
8	367	Kalama Spring Chinook	Lower Columbia River Chinook	1	Kalama	75,033	395	0.53%		0%	90%	5,419	213	80	100%	501,336	2,640	0.53%		0%	20%	4,445	1,445	64	0%
9	561	EF Lewis Fall Chinook (Tule)	Lower Columbia River Chinook	1	Lewis	-	-			95%	0%	125,931	-	458	0%	-	-			0%	0%	16,532	-	56	0%
10	376	NF Lewis Fall Chinook (Lower River Brights)	Lower Columbia River Chinook	1	Lewis	-	-			0%	0%	928,150	-	7,508	0%	-	-			0%	0%	932,935	-	7,549	0%
11	378	NF Lewis Spring Chinook	Lower Columbia River Chinook	1	Lewis	500,148	1,549	0.31%	MAF	0%	10%	41,867	915	369	25%	-	-			0%	0%	26,343	-	210	0%
12	401	Sandy Fall Chinook (Late)	Lower Columbia River Chinook	1	Sandy	-	-			0%	0%	572,085	-	1,427	0%	-	-			0%	0%	572,409	-	1,425	0%
13	402	Sandy Spring Chinook	Lower Columbia River Chinook	1	Sandy	300,548	1,749	0.58%	MAF	0%	10%	115,503	606	380	100%	300,548	1,749	0.58%	MAF	0%	10%	115,689	604	379	100%
14	407	Washougal Fall Chinook	Lower Columbia River Chinook	1	Washougal	-	-			95%	0%	112,205	-	278	0%	-	-			50%	0%	70,982	-	174	0%
15	664	Mill-Aber-Germ Fall Chinook	Lower Columbia River Chinook	2	Mill-Aber-Germ	-	-			95%	0%	103,336	-	377	0%	-	-			0%	0%	98,861	-	359	0%
16	354	Lower Cowlitz Fall Chinook	Lower Columbia River Chinook	2	Cowlitz	4,807,421	7,920	0.16%		0%	25%	692,626	2,934	2,305	30%	2,185,189	3,600	0.16%		0%	25%	858,345	1,330	2,902	30%
17	253	White Salmon Fall Chinook (Tule)	Lower Columbia River Chinook	2	White Salmon	-	-			0%	0%	35,840	-	339	0%	-	-			0%	0%	35,844	-	339	0%
18	649	White Salmon Spring Chinook	Lower Columbia River Chinook	2	White Salmon	-	-			0%	0%	2	-	0	0%	-	-			0%	0%	2	-	0	0%
19	413	Clackamas Fall Chinook	Lower Columbia River Chinook	2	Willamette	-	-			0%	0%	6,999	-	34	0%	-	-			0%	0%	5,627	-	27	0%
20	662	Big Creek Fall Chinook (Tules)	Lower Columbia River Chinook	3	Big Creek	-	-			0%	25%	19,419	-	92	0%	-	-			0%	25%	19,187	-	91	0%
21	321	Chinook River Fall Chinook	Lower Columbia River Chinook	3	Chinook River	-	-			0%	0%	6,211	-	22	0%	-	-			0%	0%	2,154	-	8	0%
22	602	Scapoose Fall Chinook	Lower Columbia River Chinook	3	Scapoose	-	-			0%	0%	63,222	-	23	0%	-	-			0%	0%	52,577	-	19	0%
23	727	Youngs Bay Tribs Fall Chinook	Lower Columbia River Chinook	3	Youngs Bay	-	-			0%	0%	124,799	-	89	0%	-	-			0%	0%	27,746	-	20	0%
25	659	Tributaries Fall Chinook (Tules- Oregon)	Lower Columbia River Chinook	3	Columbia Gorge	-	-			0%	0%	6,987	-	33	0%	-	-			0%	0%	6,994	-	33	0%
26	356	Toutle Fall Chinook	Lower Columbia River Chinook	3	Cowlitz	-	-			0%	0%	86,398	-	424	0%	-	-			0%	0%	83,300	-	409	0%
27	260	Hood Fall Chinook	Lower Columbia River Chinook	3	Hood	-	-			0%	0%	8,997	-	103	0%	-	-			0%	0%	9,015	-	104	0%
28	646	Little White Salmon Fall Chinook (Tule)	Lower Columbia River Chinook	3	Little White Saln	-	-			0%	0%	17,871	-	176	0%	-	-			0%	0%	17,874	-	176	0%
29	669	LC Tribs Fall Chinook (Tules-Oregon)	Lower Columbia River Chinook	3	Lower Columbia	-	-			0%	0%	81,005	-	28	0%	-	-			0%	0%	79,297	-	27	0%
30	400	Sandy Fall Chinook (Early)	Lower Columbia River Chinook	3	Sandy	-	-			0%	0%	548,356	-	1,601	0%	-	-			0%	0%	577,224	-	1,699	0%
31	281	Wind Fall Chinook (Tule)	Lower Columbia River Chinook	3	Wind	-	-			0%	0%	129,765	-	207	0%	-	-			0%	0%	129,783	-	207	0%
32	652	Wind Spring Chinook	Lower Columbia River Chinook	3	Wind	-	-			0%	0%	5,716	-	9	0%	-	-			0%	0%	5,714	-	10	0%
24	257	Spring Creek Fall Chinook (Tules-Hatchery)	Lower Columbia River Chinook	4	Columbia Gorge	15,044,850	76,800	0.51%	MAF	0%	10%	-	33,446	-	0%	15,044,850	76,800	0.51%	MAF	0%	10%	-	33,480	-	0%
33	322	Big Creek Fall Chinook (Tules-Hatchery)	Lower Columbia River Chinook	4	Big Creek	5,826,626	10,624	0.18%	MAF	0%	25%	-	5,375	-	0%	5,826,626	10,624	0.18%	MAF	0%	25%	-	5,378	-	0%
34	323	Deep River Spring Chinook (Cowlitz-Merwin-Grays-Hatche	Lower Columbia River Chinook	4	Columbia Estuar	362,250	2,392	0.66%		0%	0%	-	2,029	-	0%	362,250	2,392	0.66%		0%	0%	-	2,030	-	0%
35	320	Youngs Bay Fall Chinook (Rogue Brights-CEDC SAFE-Hat	Lower Columbia River Chinook	4	Youngs Bay	2,168,815	15,000	0.69%		0%	90%	-	11,379	-	0%	-	-			0%	90%	-	-	-	0%
36	566	Youngs Bay Spring Chinook (CEDC SAFE-Willamette-Hatc	Lower Columbia River Chinook	4	Youngs Bay	850,096	4,500	0.53%		0%	0%	-	4,043	-	0%	850,096	4,500	0.53%		0%	0%	-	4,041	-	0%
37	722	Toutle Fall Chinook (Hatchery)	Lower Columbia River Chinook	4	Cowlitz	2,500,399	4,260	0.17%	MAF	0%	15%	-	1,602	-	0%	2,500,399	4,260	0.17%	MAF	0%	15%	-	1,602	-	0%
38	578	Kalama Fall Chinook (Hatchery)	Lower Columbia River Chinook	4	Kalama	1,603,648	3,710	0.23%	MAF	0%	25%	-	1,395	-	0%	199,310	461	0.23%	MAF	0%	25%	-	173	-	0%
39	724	NF Lewis Spring Chinook (Hatchery)	Lower Columbia River Chinook	4	Lewis	-	-			0%	10%	-	-	-	0%	500,444	1,550	0.31%		0%	10%	-	930	-	0%
40	277	Little White Salmon Fall Chinook (URB-Hatchery)	Lower Columbia River Chinook	4	Little White Salr	2,007,246	9,680	0.48%	MAF	0%	25%	-	5,377	-	0%	2,007,246	9,680	0.48%	MAF	0%	25%	-	5,367	-	0%
41	278	Little White Salmon Spring Chinook (Hatchery)	Lower Columbia River Chinook	4	Little White Salr	1,005,193	3,330	0.33%	MAF	0%	10%	-	1,552	-	0%	1,005,193	3,330	0.33%	MAF	0%	10%	-	1,572	-	0%
42	390	Bonneville Fall Chinook (Hatchery)	Lower Columbia River Chinook	4	Lower Columbia	4,493,088	12,844	0.29%	MAF	0%	10%	-	4,080	-	0%	4,493,088	12,844	0.29%	MAF	0%	10%	-	4,062	-	0%
43	581	Washougal Fall Chinook (Hatchery)	Lower Columbia River Chinook	4	Washougal	2,001,281	6,076	0.30%	MAF	0%	14%	-	2,285	-	0%	175,623	533	0.30%	MAF	0%	14%	-	201	-	0%
44	283	Wind Spring Chinook (Hatchery)	Lower Columbia River Chinook	4	Wind	1,145,024	3,620	0.32%	MAF	0%	20%	-	1,688	-	0%	1,145,024	3,620	0.32%	MAF	0%	20%	-	1,709	-	0%

Deschutes River Summer/Fall-run Chinook

						Alternative 4										Alternative 5									
Pop #	ID	Population Name	ESU	Designation	Subbasin	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	288	Deschutes Fall Chinook	Deschutes River Summer/Fall-run Chinook	1	Deschutes	-	-			0%	0%	804,110	-	7,831	0%	-	-			0%	0%	805,040	-	7,819	0%

Appendix D

Hatchery Performance and Production by Alternative for Coho Salmon and Steelhead

Appendix D1. Hatchery Performance by Alternative for Coho Salmon

Primary	Supporting
Contributing	Consistent
Stabilizing	Not Consistent
Not in ESU	

ESU	Designation	Subbasin	Alternative 1 Population Type	Alt 1 pHOS	Alt 1 PNI	Alt 1 Productivity	Alt 1 NOS	Alternative 2 Population Type	Alt 2 pHOS	Alt 2 PNI	Alt 2 Productivity	Alt 2 NOS	Alternative 3 Population Type	Alt 3 pHOS	Alt 3 PNI	Alt 3 Productivity	Alt 3 NOS	Alternative 4 Population Type	Alt 4 pHOS	Alt 4 PNI	Alt 4 Productivity	Alt 4 NOS	Alternative 5 Population Type	Alt 5 pHOS	Alt 5 PNI	Alt 5 Productivity	Alt 5 NOS
Upper Columbia Coho	3	Clearwater	Integrated	71%	-	0.57	316	Integrated		1.00	1.14	91	Integrated	71%	-	0.57	316	Integrated	71%		0.57	316	Integrated	71%		0.57	316
Upper Columbia Coho	3	Methow	Integrated	53%	0.02	0.51	97	Integrated	53%	0.02	0.51	97	Integrated	53%	0.02	0.51	97	Integrated	53%	0.019	0.51	97	Integrated	53%	0.018677	0.51	97
Upper Columbia Coho	3	Umatilla	Natural	90%	-	0.17	538	Natural		-	0.33	0.0	Natural	90%	-	0.17	538	Natural	90%		0.17	538	Natural	90%		0.17	538
Upper Columbia Coho	3	Wenatchee	Integrated	81%	0.04	0.60	872	Integrated	81%	0.04	0.60	872	Integrated	81%	0.04	0.60	872	Integrated	81%	0.042	0.60	872	Integrated	81%	0.042493	0.60	872
Upper Columbia Coho	3	Yakima	Integrated	80%	0.20	0.73	1,384	Integrated	22%	-	0.75	134	Integrated	80%	0.20	0.73	1,384	Integrated	80%	0.2	0.73	1,384	Integrated	80%	0.199744	0.73	1,384
Upper Columbia Coho	4	Umatilla	Segregated	100%	-	0.00	0	Segregated		-	0.01	0	Segregated	100%	-	0.00	0	Segregated	100%		0.00	0	Segregated	100%		0.00	0
Upper Columbia Coho	4	Yakima	Segregated	100%	-	0.00	0	Segregated		-	0.01	0	Segregated	100%	-	0.00	0	Segregated	100%		0.00	0	Segregated	100%		0.00	0

ESU	Designation	Subbasin	Alternative 1 Population Type	Alt 1 pHOS	Alt 1 PNI	Alt 1 Productivity	Alt 1 NOS	Alternative 2 Population Type	Alt 2 pHOS	Alt 2 PNI	Alt 2 Productivity	Alt 2 NOS	Alternative 3 Population Type	Alt 3 pHOS	Alt 3 PNI	Alt 3 Productivity	Alt 3 NOS	Alternative 4 Population Type	Alt 4 pHOS	Alt 4 PNI	Alt 4 Productivity	Alt 4 NOS	Alternative 5 Population Type	Alt 5 pHOS	Alt 5 PNI	Alt 5 Productivity	Alt 5 NOS
Lower Columbia River Coho	1	Columbia Estuary	Natural	33%	-	1.95	204	Natural	0%	-	3.88	323	Natural	4%	-	2.76	241	Integrated	24%	0.679	3.21	197	Natural	4.483%	-	2.76	241
Lower Columbia River Coho	1	Columbia Estuary	Natural	28%	-	1.67	152	Natural	4%	-	2.47	196	Natural	5%	-	2.22	174	Natural	1%		3.24	254	Natural	5%	-	2.22	174
Lower Columbia River Coho	1	Columbia Gorge	Natural	75%	-	0.71	45	Natural		-	2.79	86	Natural	61%	-	0.74	35	Natural	48%		0.78	27	Natural	61%	-	0.74	35
Lower Columbia River Coho	1	Cowlitz	Natural	2%	-	2.34	1,300	Natural	0%	-	2.71	1,518	Natural	1%	-	2.68	1,498	Natural	0%		2.70	1,508	Natural	1%	-	2.68	1,498
Lower Columbia River Coho	1	Cowlitz	Natural	60%	-	1.47	2,516	Integrated	23%	0.52	2.09	2,371	Integrated	47%	0.52	1.99	1,943	Integrated	30%	0.667	2.39	2,370	Integrated	47%	0.52	1.99	1,943
Lower Columbia River Coho	1	Cowlitz	Natural	60%	-	0.88	2,648	Natural	0%	-	1.71	2,666	Natural	8%	-	1.06	922	Integrated	22%	0.695	1.46	2,085	Natural	8%	-	1.06	922
Lower Columbia River Coho	1	Elochoman	Integrated	66%	0.04	1.51	648	Natural	1%	-	2.94	780	Integrated	26%	0.53	2.16	566	Integrated	13%	0.796	2.77	655	Integrated	26%	0.53	2.16	566
Lower Columbia River Coho	1	Grays	Natural	24%	-	1.52	518	Natural	7%	-	1.80	537	Natural	8%	-	1.76	522	Integrated	3%	0.861	2.92	885	Natural	8%	-	1.76	522
Lower Columbia River Coho	1	Lewis	Natural	3%	-	3.34	1,694	Natural	1%	-	4.23	2,046	Natural	0%	-	4.29	2,068	Natural	1%		4.24	2,049	Natural	0%	-	4.29	2,068
Lower Columbia River Coho	1	Sandy	Natural	7%	-	2.97	6,619	Natural	0%	-	4.93	9,887	Natural	6%	-	3.22	7,104	Natural	4%		3.54	7,684	Natural	6%	-	3.22	7,104
Lower Columbia River Coho	1	Willamette	Natural	0%	-	3.80	1,470	Natural		-	3.81	1,470	Natural	0%	-	3.80	1,470	Natural	0%		3.80	1,470	Natural	0%	-	3.80	1,470
Lower Columbia River Coho	2	Columbia Estuary	Natural	6%	-	2.45	1,180	Natural	1%	-	3.65	1,698	Natural	5%	-	2.74	1,321	Natural	6%		2.50	1,206	Natural	4.64%	-	2.74	1,321
Lower Columbia River Coho	2	Hood	Natural	67%	-	0.60	30	Natural		-	1.19	13	Natural	44%	-	0.60	10	Natural	41%		0.60	7	Natural	44%	-	0.60	10
Lower Columbia River Coho	2	Kalama	Natural	57%	-	1.55	311	Natural	10%	-	1.70	212	Natural	4%	-	2.21	289	Natural	8%		1.80	225	Natural	4%	-	2.21	289
Lower Columbia River Coho	2	Lewis	Integrated	67%	0.60	3.24	1,766	Integrated	56%	0.64	3.40	1,736	Integrated	45%	0.69	3.57	1,712	Integrated	27%	0.529	3.07	1,654	Integrated	45%	0.69	3.57	1,712
Lower Columbia River Coho	2	Washougal	Integrated	64%	0.04	0.98	647	Integrated	1%	-	1.91	675	Integrated	49%	0.51	1.33	588	Integrated	56%	0.518	1.34	625	Integrated	49%	0.51	1.33	588
Lower Columbia River Coho	2	White Salmon	Natural	38%	-	0.86	105	Natural		-	2.90	371	Natural	3%	-	2.41	308	Natural	2%		2.63	337	Natural	3%	-	2.41	308
Lower Columbia River Coho	3	Columbia Estuary	Natural	64%	-	1.46	47	Natural	4%	-	2.12	41	Natural	62%	-	1.46	47	Natural	71%		1.46	50	Natural	62%	-	1.46	47
Lower Columbia River Coho	3	Columbia Estuary	Natural	8%	-	1.92	147	Natural	0%	-	3.32	259	Natural	2%	-	2.85	226	Natural	6%		2.11	164	Natural	2%	-	2.85	226
Lower Columbia River Coho	3	Columbia Estuary	Natural	72%	-	0.63	38	Natural	1%	-	1.17	13	Natural	45%	-	0.63	14	Natural	52%		0.63	19	Natural	45%	-	0.63	14
Lower Columbia River Coho	3	Columbia Estuary	Natural	24%	-	1.66	145	Natural	0%	-	3.29	256	Natural	23%	-	1.66	144	Natural	31%		1.66	155	Natural	23%	-	1.66	144
Lower Columbia River Coho	3	Columbia Gorge	Natural	71%	-	0.75	51	Natural		-	1.50	35	Natural	59%	-	0.75	39	Natural	47%		0.75	27	Natural	59%	-	0.75	39
Lower Columbia River Coho	3	Cowlitz	Integrated	33%	-	1.00	2,821	Integrated	4%	0.86	1.54	3,177	Integrated	4%	0.86	1.54	3,177	Integrated	4%	0.855	1.54	3,177	Integrated	4%	0.86	1.54	3,177
Lower Columbia River Coho	3	Fifteenmile	Natural	63%	-	0.60	27	Natural		-	1.19	13	Natural	52%	-	0.60	16	Natural	45%		0.60	10	Natural	52%	-	0.60	16
Lower Columbia River Coho	3	Klickitat	Natural	93%	-	0.17	77	Natural		-	0.33	1	Natural	83%	-	0.17	17	Natural	83%		0.17	16	Natural	83%	-	0.17	17
Lower Columbia River Coho	3	Lewis	Natural	0%	-	3.78	9,658	Natural	0%	-	3.80	9,693	Natural	0%	-	3.80	9,707	Natural	0%		3.80	9,708	Natural	0%	-	3.80	9,707
Lower Columbia River Coho	3	Willamette	Natural	38%	-	0.61	6	Natural		-	1.21	14	Natural	38%	-	0.61	6	Natural	38%		0.61	6	Natural	38%	-	0.61	6
Lower Columbia River Coho	3	Willamette	Natural	71%	-	0.73	280	Natural		-	1.46	190	Natural	71%	-	0.73	280	Natural	71%		0.73	280	Natural	71%	-	0.73	280
Lower Columbia River Coho	3	Willamette	Natural	19%	-	0.72	15	Natural		-	1.33	121	Natural	19%	-	0.72	15	Natural	19%		0.72	15	Natural	19%	-	0.72	15
Lower Columbia River Coho	4	Columbia Estuary	Segregated	100%	-	0.00	0	Segregated		-	0.01	0	Segregated	100%	-	0.00	0	Segregated	100%		0.00	0	Segregated	100%	-	0.00	0
Lower Columbia River Coho	4	Columbia Estuary	Segregated	100%	-	0.00	0	Segregated		-	0.00	0	Segregated		-	0.00	0	Segregated			0.00	0	Segregated		-	0.00	0
Lower Columbia River Coho	4	Columbia Estuary	Segregated	100%	-	0.00	0	Segregated	100%	-	0.00	0	Segregated	100%	-	0.00	0	Segregated	100%		0.00	0	Segregated	100%	-	0.00	0
Lower Columbia River Coho	4	Columbia Estuary	Segregated	100%	-	0.00	0	Segregated		-	0.01	0	Segregated	100%	-	0.00	0	Segregated	100%		0.00	0	Segregated	100%	-	0.00	0
Lower Columbia River Coho	4	Cowlitz	Segregated	100%	-	0.00	0	Segregated		-	0.01	0	Segregated		-	0.01	0	Segregated	100%		0.00	0	Segregated		-	0.01	0
Lower Columbia River Coho	4	Cowlitz	Segregated	100%	-	0.00	0	Segregated		-	0.01	0	Segregated	100%	-	0.00	0	Segregated			0.01	0	Segregated	100%	-	0.00	0
Lower Columbia River Coho	4	Elochoman	Segregated	100%	-	0.00	0	Segregated		-	0.01	0	Segregated		-	0.01	0	Segregated	100%		0.00	0	Segregated		-	0.01	0
Lower Columbia River Coho	4	Grays	Segregated	100%	-	0.00	0	Segregated		-	0.01	0	Segregated		-	0.01	0	Segregated	100%		0.00	0	Segregated		-	0.01	0
Lower Columbia River Coho	4	Kalama	Segregated	100%	-	0.00	0	Segregated		-	0.01	0	Segregated		-	0.01	0	Segregated	100%		0.00	0	Segregated		-	0.01	0
Lower Columbia River Coho	4	Kalama	Segregated	100%	-	0.00	0	Segregated		-	0.01	0	Segregated		-	0.01	0	Segregated	100%		0.00	0	Segregated		-	0.01	0
Lower Columbia River Coho	4	Klickitat	Segregated	100%	-	0.00	0	Segregated		-	0.00	0	Segregated	100%	-	0.00	0	Segregated	100%		0.00	0	Segregated	100%	-	0.00	0
Lower Columbia River Coho	4	Klickitat	Segregated	100%	-	0.00	0	Segregated		-	0.00	0	Segregated		-	0.00	0	Segregated			0.00	0	Segregated		-	0.00	0
Lower Columbia River Coho	4	Lewis	Segregated	100%	-	0.00	0	Segregated	100%	-	0.00	0	Segregated	100%	-	0.00	0	Segregated	100%		0.00	0	Segregated	100%	-	0.00	0
Lower Columbia River Coho	4	Lewis	Segregated	100%	-	0.00	0	Segregated	100%	-	0.00	0	Segregated	100%	-	0.00	0	Segregated			0.01	0	Segregated	100%	-	0.00	0
Lower Columbia River Coho	4	Little White Salmon	Segregated		-	0.01	0	Segregated		-	0.01	0	Segregated		-	0.01	0	Segregated			0.01	0	Segregated		-	0.01	0
Lower Columbia River Coho	4	Lower Columbia River	Segregated	100%	-	0.00	0	Segregated		-	0.01	0	Segregated	100%	-	0.00	0	Segregated	100%		0.00	0	Segregated	100%	-	0.00	0
Lower Columbia River Coho	4	Sandy	Segregated	100%	-	0.00	0	Segregated		-	0.01	0	Segregated	100%	-	0.00	0	Segregated	100%		0.00	0	Segregated	100%	-	0.00	0
Lower Columbia River Coho	4	Washougal	Segregated		-	0.01	0	Segregated		-	0.01	0	Segregated		-	0.01	0	Segregated	100%		0.00	0	Segregated		-	0.01	0
Lower Columbia River Coho	4	Willamette	Segregated	100%	-	0.00	0	Segregated		-	0.01	0	Segregated	100%	-	0.00	0	Segregated	100%		0.00	0	Segregated	100%	-	0.00	0

Appendix D2. Hatchery Production by Alternative for Coho Salmon

Primary
Contributing
Stabilizing
Not in ESU

Upper Columbia Coho

						Alternative 1										Alternative 2										Alternative 3									
Pop #	ID	Population Name	ESU	Designation	Subbasin	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	446	Clearwater Coho	Upper Columbia Coho	3	Clearwater	833,921	2,199	0.26%	MAF	0%	60%	35,136	770	80	0%	-	-			0%	60%	10,369	-	30	0%	833,921	2,199	0.26%	MAF	0%	60%	35,136	2,065	216	0%
2	237	Methow Coho	Upper Columbia Coho	3	Methow	495,378	1,260	0.25%		0%	10%	26,433	514	35	1%	495,378	1,260	0.25%		0%	10%	26,433	1,915	132	1%	495,378	1,260	0.25%		0%	10%	26,433	1,395	96	1%
3	302	Umatilla Coho	Upper Columbia Coho	3	Umatilla	-	-			0%		15,934	-	24	0%	-	-			0%		0	-	0	0%	-	-			0%		15,934	-	59	0%
4	250	Wenatchee Coho	Upper Columbia Coho	3	Wenatchee	1,048,040	8,756	0.84%		0%	70%	184,031	1,199	86	4%	1,048,040	8,756	0.84%		0%	70%	184,031	4,348	313	4%	1,048,040	8,756	0.84%		0%	70%	184,031	3,168	228	4%
5	315	Upper Yakima-Naches Coho	Upper Columbia Coho	3	Yakima	452,068	5,356	1.18%	MAF	0%	75%	77,276	2,010	386	20%	-	-			0%	75%	7,422	-	29	20%	452,068	5,356	1.18%	MAF	0%	75%	77,276	1,524	293	20%
6	686	Umatilla Coho (Bonneville-Cascade-Ox	Upper Columbia Col	4	Umatilla	1,530,000	8,840	0.58%	MAF	0%		-	2,592	-	0%	-	-			0%		-	-	0	0%	1,530,000	8,840	0.58%	MAF	0%		-	6,354	0	0%
7	314	Coho (Hatchery)	Upper Columbia Col	4	Yakima	427,928	5,070	1.18%	MAF	0%		-	2,173	-	0%	-	-			0%		-	-	0	0%	427,928	5,070	1.18%	MAF	0%		-	1,497	0	0%

Lower Columbia River Coho

						Alternative 1										Alternative 2										Alternative 3									
Pop #	ID	Population Name	ESU	Designation	Subbasin	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	603	Big Creek Coho	Lower Columbia Riv	1	Columbia Estuary	-	-			0%	10%	6,093	-	202	0%	-	-			0%	10%	9,051	-	74	0%	-	-			0%	10%	6,943	-	85	0%
2	714	Scappoose Coho	Lower Columbia Riv	1	Columbia Estuary	-	-			0%		4,450	-	6	0%	-	-			0%		4,643	-	37	0%	-	-			50%		4,413	-	40	0%
3	653	Columbia Gorge Tributaries Coho (WA)	Lower Columbia Riv	1	Columbia Gorge	-	-			0%		1,269	-	2	0%	-	-			0%		2,138	-	11	0%	-	-			0%		978	-	4	0%
4	619	Coweeman Coho (Type N)	Lower Columbia Riv	1	Cowlitz	-	-			0%		9,383	-	21	0%	-	-			0%		11,793	-	105	0%	-	-			0%		11,646	-	112	0%
5	358	Lower Cowlitz Coho (Type N)	Lower Columbia Riv	1	Cowlitz	-	-			0%		21,070	-	47	0%	596,924	14,300	2.40%		0%	10%	19,988	8,376	663	25%	1,432,622	34,320	2.40%		0%	10%	20,422	14,321	481	50%
6	797	Toutle Coho (Early-Type S Natural)	Lower Columbia Riv	1	Cowlitz	-	-			0%		22,053	-	293	0%	-	-			0%		20,965	-	137	0%	-	-			0%	5%	7,527	-	55	0%
7	342	Elochoman Coho (Late- Type N)	Lower Columbia Riv	1	Elochoman	496,062	10,160	2.05%	MAF	0%	10%	14,614	4,855	154	3%	-	-			0%	10%	16,047	-	142	3%	200,182	4,100	2.05%	MAF	60%	10%	13,228	1,892	141	30%
8	667	Grays Coho (Late-Type N)	Lower Columbia Riv	1	Grays	-	-			0%		10,665	-	40	0%	-	-			0%		10,930	-	116	0%	-	-			60%		10,665	-	116	0%
9	626	EF Lewis Coho	Lower Columbia Riv	1	Lewis	-	-			0%	17%	38,725	-	87	0%	-	-			0%	17%	45,857	-	406	0%	-	-			0%	17%	46,293	-	447	0%
10	403	Sandy Coho	Lower Columbia Riv	1	Sandy	-	-			0%	5%	211,931	-	1,028	0%	-	-			0%	5%	303,795	-	1,549	0%	-	-			0%	5%	225,870	-	1,109	0%
11	421	Upper Clackamas Coho	Lower Columbia Riv	1	Willamette	-	-			99%		29,280	-	239	0%	-	-			99%		29,285	-	237	0%	-	-			99%		29,280	-	240	0%
12	681	Mill-Aber-Germ Coho (Type N)	Lower Columbia Riv	2	Columbia Estuary	-	-			0%		31,201	-	43	0%	-	-			0%		44,797	-	353	0%	-	-			0%		35,592	-	319	0%
13	395	Hood Coho	Lower Columbia Riv	2	Hood	-	-			0%		865	-	1	0%	-	-			0%		380	-	2	0%	-	-			0%		278	-	1	0%
14	580	Kalama Coho (Natural)	Lower Columbia Riv	2	Kalama	-	-			0%	10%	2,019	-	5	0%	-	-			0%	10%	1,342	-	12	0%	-	-			0%	10%	1,727	-	17	0%
15	381	NF Lewis Coho (Late-Type N)	Lower Columbia Riv	2	Lewis	40,023	1,721	4.30%		0%		47,622	285	189	100%	40,023	1,721	4.30%		0%		46,525	547	359	100%	40,023	1,721	4.30%		0%		45,607	472	306	100%
16	409	Washougal Coho	Lower Columbia Riv	2	Washougal	497,876	13,803	2.77%	MAF	0%	10%	13,120	5,184	111	3%	-	-			0%	10%	12,698	-	113	3%	202,624	5,618	2.77%	MAF	0%	10%	12,977	2,079	112	50%
17	651	White Salmon Coho (Early- Type S)	Lower Columbia Riv	2	White Salmon	-	-			0%		3,232	-	6	0%	-	-			0%		10,238	-	71	0%	-	-			0%		8,659	-	44	0%
18	333	Chinook River Coho	Lower Columbia Rive	3	Columbia Estuary	-	-			0%		1,406	-	10	0%	-	-			0%		1,171	-	8	0%	-	-			0%		1,388	-	9	0%
19	327	Clatskanie Coho (Late-Type N)	Lower Columbia Rive	3	Columbia Estuary	-	-			0%		4,035	-	6	0%	-	-			0%		6,779	-	53	0%	-	-			0%		6,004	-	54	0%
20	393	Gnat Creek Coho	Lower Columbia Rive	3	Columbia Estuary	-	-			0%		1,056	-	5	0%	-	-			0%		373	-	2	0%	-	-			0%		371	-	2	0%
21	328	Youngs Bay Tribs Coho	Lower Columbia Rive	3	Columbia Estuary	-	-			0%		4,052	-	22	0%	-	-			0%		6,749	-	38	0%	-	-			0%		4,024	-	22	0%
22	394	Columbia Gorge Tributaries Coho (Oregor	Lower Columbia Rive	3	Columbia Gorge	-	-			0%		1,333	-	2	0%	-	-			0%		906	-	5	0%	-	-			0%		1,005	-	4	0%
23	612	Cowlitz Upper Cowlitz Coho	Lower Columbia Rive	3	Cowlitz	238,770	6,320	2.65%		0%		180,101	661	359	0%	238,770	6,320	2.65%		0%	10%	140,026	1,041	647	25%	238,770	6,320	2.65%		0%	10%	140,026	836	520	25%
24	648	Fifteenmile Creek Coho	Lower Columbia Rive	3	Fifteenmile	-	-			0%		764	-	1	0%	-	-			0%		380	-	2	0%	-	-			0%		469	-	2	0%
25	643	Klickitat Coho	Lower Columbia Rive	3	Klickitat	-	-			0%		9,654	-	32	0%	-	-			0%		43	-	1	0%	-	-			0%		2,070	-	3,269	0%
27	732	Upper Willamette Tribs coho	Lower Columbia Rive	3	Willamette	-	-			0%		120	-	1	0%	-	-			0%		309	-	2	0%	-	-			0%		120	-	1	0%
28	422	Lower Clackamas Coho	Lower Columbia Rive	3	Willamette	-	-			0%		5,883	-	48	0%	-	-			0%		3,888	-	31	0%	-	-			0%		5,883	-	48	0%
29	731	Lower Willamette Tribs Coho	Lower Columbia Rive	3	Willamette	-	-			0%		326	-	3	0%	-	-			0%		2,539	-	16	0%	-	-			0%		326	-	2	0%
30	335	Bernie Creek Coho (Late-Type N-FFA)	Lower Columbia Riv	4	Columbia Estuary	16,538	300	1.81%	MAF	0%	90%	-	175	-	0%	-	-			0%	90%	-	-	0	0%	16,538	300	1.81%	MAF	0%	90%	-	169	0	0%
31	329	Big Creek Coho (Hatchery)	Lower Columbia Riv	4	Columbia Estuary	582,120	6,300	1.08%	MAF	0%	10%	-	7,443	-	0%	-	-			0%	10%	-	-	0	0%	-	-			0%	10%	-	-	0	0%
32	334	Deep River Coho (Early-Type S-Grays-I	Lower Columbia Riv	4	Columbia Estuary	401,310	7,280	1.81%		0%	90%	-	5,499	-	0%	203,962	3,700	1.81%		0%	90%	-	3,672	0	0%	401,310	7,280	1.81%		0%	90%	-	5,500	0	0%
33	331	Youngs Bay Coho (Bonneville-Sandy-H	Lower Columbia Riv	4	Columbia Estuary	1,726,186	22,080	1.28%	MAF	0%		-	23,654	-	0%	-	-			0%		-	-	0	0%	1,726,186	22,080	1.28%	MAF	0%		-	23,656	0	0%
34	795	Lower Cowlitz Coho (Type N Hatchery)	Lower Columbia Riv	4	Cowlitz	3,223,393	77,220	2.40%		0%	10%	-	34,091	-	0%	-	-			0%	10%	-	-	0	0%	-	-			0%	10%	-	-	0	0%
35	796	Toutle Coho (Early-Type S Hatchery)	Lower Columbia Riv	4	Cowlitz	801,287	30,531	3.81%	MAF	0%	25%	-	6,935	-	0%	-	-			0%	25%	-	-	0	0%	56,034	2,135	3.81%	MAF	0%	5%	-	372	0	0%
36	341	Elochoman Coho (Early-Type S Hatche	Lower Columbia Riv	4	Elochoman	415,012	8,500	2.05%	MAF	0%	10%	-	3,592	-	0%	-	-			0%	10%	-	-	0	0%	-	-			0%	10%	-	-	0	0%
37	685	Grays Coho (Early-Type S-Hatchery)	Lower Columbia Riv	4	Grays	150,381	770	0.51%		0%	10%	-	1,302	-	0%	-	-			0%	10%	-	-	0	0%	-	-			0%	10%	-	-	0	0%
38	371	Kalama Coho (Early- Type S)	Lower Columbia Riv	4	Kalama	353,144	3,904	1.11%	MAF	0%	10%	-	3,056	-	0%	-	-			0%	10%	-	-	0	0%	-	-			0%	10%	-	-	0	0%
39	370	Kalama Coho (Late- Type N)	Lower Columbia Riv	4	Kalama	350,828	3,878	1.11%	MAF	0%	10%	-	3,710	-	0%	-	-			0%	10%	-	-	0	0%	-	-			0%	10%	-	-	0	0%
40	272	Klickitat Coho (Lewis-Hatchery)	Lower Columbia Riv	4	Klickitat	1,238,563	9,298	0.75%	MAF	0%		-	36,114	-	0%	-	-			0%		-	-	0	0%	1,238,563	9,298	0.75%	MAF	0%	10%	-	19,208	0	0%
41	273	Klickitat Coho (Washougal-Hatchery)	Lower Columbia Riv	4	Klickitat	2,461,861	6,097	0.25%	MAF	0%		-	8,169	-	0%	-	-			0%		-	-	0	0%	-	-			0%		-	-	0	0%
42	781	NF Lewis Coho (Early-Type S Hatchery)	Lower Columbia Riv	4	Lewis	879,967	25,992	2.95%		0%	10%	-	7,616	-	0%	439,984	12,996	2.95%		0%	10%	-	3,965	0	0%	115,785	3,420	2.95%		0%	10%	-	769	0	0%
43	777	NF Lewis Coho (Late-Type N Hatchery)	Lower Columbia Riv	4	Lewis	815,127	24,077	2.95%		0%	10%	-	8,621	-	0%	301,041	8,892	2.95%		0%	10%	-	4,469	0	0%	75,260	2,223	2.95%		0%	10%	-	767	0	0%
44	279	Litte White Coho (Hatchery)	Lower Columbia Riv	4	Little White Salmon	-	-			0%	10%	-	-	-	0%	-	-			0%	10%	-	-	0	0%	-	-			0%	10%	-	-	0	0%
45	396	Bonneville Coho (Hatchery)	Lower Columbia Riv	4	Lower Columbia Riv	1,247,734	22,078	1.77%	MAF	0%	10%	-	8,865	-	0%	-	-			0%	10%	-	-	0	0%	1,247,734	22,078	1.77%	MAF	0%	10%	-	6,394	0	0%
46	404	Sandy Coho (Hatchery)	Lower Columbia Riv	4	Sandy	700,081	9,750	1.39%	MAF	0%	5%	-	5,336	-	0%	-	-			0%	5%	-	-	0	0%	700,081	9,750	1.39%	MAF	0%	5%	-	3,941	0	0%
47	582	Washougal Coho (Stepping Stone Hatc	Lower Columbia Riv	4	Washougal	-	-			0%		-	-	-	0%	-	-			0%		-	-	0	0%	-	-			0%		-	-	0	0%
48	423	Clackamas-Eagle Creek Coho (Hatchery	Lower Columbia Riv	4	Willamette	349,067	8,800	2.52%	MAF	0%	15%	-	3,021	-	0%	-	-			0%	15%	-	-	0	0%	349,067	8,800	2.52%	MAF	0%	15%	-	2,318	0	0%

Primary
Contributing
Stabilizing
Not in ESU

Upper Columbia Coho

Pop #	ID	Population Name	ESU	Designation	Subbasin	Alternative 4 Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Alternative 5 Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	446	Clearwater Coho	Upper Columbia Coho	3	Clearwater	833,921	2,199	0.26%	MAF	0%	60%	35,136	2,258	236	0%	833,921	2,199	0.26%	MAF	0%	60%	35,136	2,065	216	0%
2	237	Methow Coho	Upper Columbia Coho	3	Methow	495,378	1,260	0.25%		0%	10%	26,433	1,528	105	1%	495,378	1,260	0.25%		0%	10%	26,433	1,395	96	1%
3	302	Umatilla Coho	Upper Columbia Coho	3	Umatilla	-	-			0%		15,934	-	70	0%	-	-			0%		15,934	-	59	0%
4	250	Wenatchee Coho	Upper Columbia Coho	3	Wenatchee	1,048,040	8,756	0.84%		0%	70%	184,031	3,494	252	4%	1,048,040	8,756	0.84%		0%	70%	184,031	3,168	228	4%
5	315	Upper Yakima-Naches Coho	Upper Columbia Coho	3	Yakima	452,068	5,356	1.18%	MAF	0%	75%	77,276	1,681	323	20%	452,068	5,356	1.18%	MAF	0%	75%	77,276	1,524	293	20%
6	686	Umatilla Coho (Bonneville-Cascade-Ox	Upper Columbia Col	4	Umatilla	1,530,000	8,840	0.58%	MAF	0%		-	6,932	0	0%	1,530,000	8,840	0.58%	MAF	0%		-	6,354	0	0%
7	314	Coho (Hatchery)	Upper Columbia Col	4	Yakima	427,928	5,070	1.18%	MAF	0%		-	1,632	0	0%	427,928	5,070	1.18%	MAF	0%		-	1,497	0	0%

Lower Columbia River Coho

Pop #	ID	Population Name	ESU	Designation	Subbasin	Alternative 4 Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Alternative 5 Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	603	Big Creek Coho	Lower Columbia Riv	1	Columbia Estuary	138,600	1,500	1.08%	MAF	0%	10%	7,345	1,610	102	50%	-	-			0%	10%	6,943	-	85	0%
2	714	Scappoose Coho	Lower Columbia Riv	1	Columbia Estuary	-	-			90%		6,636	-	59	0%	-	-			50%		4,413	-	40	0%
3	653	Columbia Gorge Tributaries Coho (WA)	Lower Columbia Riv	1	Columbia Gorge	-	-			0%		753	-	4	0%	-	-			0%		978	-	4	0%
4	619	Coweeman Coho (Type N)	Lower Columbia Riv	1	Cowlitz	-	-			0%		11,716	-	113	0%	-	-			0%		11,646	-	112	0%
5	358	Lower Cowlitz Coho (Type N)	Lower Columbia Riv	1	Cowlitz	850,021	20,363	2.40%		0%	5%	22,107	8,346	520	60%	1,432,622	34,320	2.40%		0%	10%	20,422	14,321	481	50%
6	797	Toutle Coho (Early-Type S Natural)	Lower Columbia Riv	1	Cowlitz	560,340	21,350	3.81%	MAF	0%	5%	18,712	3,983	228	50%	-	-			0%	5%	7,527	-	55	0%
7	342	Elochoman Coho (Late- Type N)	Lower Columbia Riv	1	Elochoman	146,475	3,000	2.05%	MAF	90%	10%	15,050	1,375	163	50%	200,182	4,100	2.05%	MAF	60%	10%	13,228	1,892	141	30%
8	667	Grays Coho (Late-Type N)	Lower Columbia Riv	1	Grays	155,925	2,550	1.64%	MAF	90%	10%	17,809	1,493	290	20%	-	-			60%		10,665	-	116	0%
9	626	EF Lewis Coho	Lower Columbia Riv	1	Lewis	-	-			0%	17%	45,929	-	444	0%	-	-			0%	17%	46,293	-	447	0%
10	403	Sandy Coho	Lower Columbia Riv	1	Sandy	-	-			0%	5%	242,532	-	1,209	0%	-	-			0%	5%	225,870	-	1,109	0%
11	421	Upper Clackamas Coho	Lower Columbia Riv	1	Willamette	-	-			99%		29,280	-	240	0%	-	-			99%		29,280	-	240	0%
12	681	Mill-Aber-Germ Coho (Type N)	Lower Columbia Riv	2	Columbia Estuary	-	-			0%		32,722	-	291	0%	-	-			0%		35,592	-	319	0%
13	395	Hood Coho	Lower Columbia Riv	2	Hood	-	-			0%		209	-	1	0%	-	-			0%		278	-	1	0%
14	580	Kalama Coho (Natural)	Lower Columbia Riv	2	Kalama	-	-			90%	10%	1,420	-	14	0%	-	-			0%	10%	1,727	-	17	0%
15	381	NF Lewis Coho (Late-Type N)	Lower Columbia Riv	2	Lewis	231,012	6,293	2.72%	MAF	0%	10%	39,449	2,023	306	30%	40,023	1,721	4.30%		0%		45,607	472	306	100%
16	409	Washougal Coho	Lower Columbia Riv	2	Washougal	225,781	6,259	2.77%	MAF	0%	10%	14,260	2,313	123	60%	202,624	5,618	2.77%	MAF	0%	10%	12,977	2,079	112	50%
17	651	White Salmon Coho (Early- Type S)	Lower Columbia Riv	2	White Salmon	-	-			0%		9,416	-	56	0%	-	-			0%		8,659	-	44	0%
18	333	Chinook River Coho	Lower Columbia Rive	3	Columbia Estuary	-	-			0%		1,499	-	10	0%	-	-			0%		1,388	-	9	0%
19	327	Clatskanie Coho (Late-Type N)	Lower Columbia Rive	3	Columbia Estuary	-	-			0%		4,465	-	40	0%	-	-			0%		6,004	-	54	0%
20	393	Gnat Creek Coho	Lower Columbia Rive	3	Columbia Estuary	-	-			0%		527	-	3	0%	-	-			0%		371	-	2	0%
21	328	Youngs Bay Tribs Coho	Lower Columbia Rive	3	Columbia Estuary	-	-			0%		4,339	-	23	0%	-	-			0%		4,024	-	22	0%
22	394	Columbia Gorge Tributaries Coho (Oregor	Lower Columbia Rive	3	Columbia Gorge	-	-			0%		715	-	4	0%	-	-			0%		1,005	-	4	0%
23	612	Cowlitz Upper Cowlitz Coho	Lower Columbia Rive	3	Cowlitz	238,770	6,320	2.65%		0%	10%	140,026	835	519	25%	238,770	6,320	2.65%		0%	10%	140,026	836	520	25%
24	648	Fifteenmile Creek Coho	Lower Columbia Rive	3	Fifteenmile	-	-			0%		291	-	1	0%	-	-			0%		469	-	2	0%
25	643	Klickitat Coho	Lower Columbia Rive	3	Klickitat	-	-			0%		1,863	-	2,609	0%	-	-			0%		2,070	-	3,269	0%
27	732	Upper Willamette Tribs coho	Lower Columbia Rive	3	Willamette	-	-			0%		120	-	1	0%	-	-			0%		120	-	1	0%
28	422	Lower Clackamas Coho	Lower Columbia Rive	3	Willamette	-	-			0%		5,883	-	48	0%	-	-			0%		5,883	-	48	0%
29	731	Lower Willamette Tribs Coho	Lower Columbia Rive	3	Willamette	-	-			0%		326	-	2	0%	-	-			0%		326	-	2	0%
30	335	Bernie Creek Coho (Late-Type N-FFA)	Lower Columbia Riv	4	Columbia Estuary	16,538	300	1.81%	MAF	0%	90%	-	168	0	0%	16,538	300	1.81%	MAF	0%	90%	-	169	0	0%
31	329	Big Creek Coho (Hatchery)	Lower Columbia Riv	4	Columbia Estuary	-	-			0%	10%	-	-	0	0%	-	-			0%	10%	-	-	0	0%
32	334	Deep River Coho (Early-Type S-Grays-H	Lower Columbia Riv	4	Columbia Estuary	401,310	7,280	1.81%		0%	90%	-	5,373	0	0%	401,310	7,280	1.81%		0%	90%	-	5,500	0	0%
33	331	Youngs Bay Coho (Bonneville-Sandy-H	Lower Columbia Riv	4	Columbia Estuary	2,701,857	34,560	1.28%	MAF	0%		-	36,177	0	0%	1,726,186	22,080	1.28%	MAF	0%		-	23,656	0	0%
34	795	Lower Cowlitz Coho (Type N Hatchery)	Lower Columbia Riv	4	Cowlitz	850,021	20,363	2.40%		0%	5%	-	8,652	0	0%	-	-			0%	10%	-	-	0	0%
35	796	Toutle Coho (Early-Type S Hatchery)	Lower Columbia Riv	4	Cowlitz	-	-			0%	25%	-	-	0	0%	56,034	2,135	3.81%	MAF	0%	5%	-	372	0	0%
36	341	Elochoman Coho (Early-Type S Hatche	Lower Columbia Riv	4	Elochoman	415,012	8,500	2.05%	MAF	0%	10%	-	3,014	0	0%	-	-			0%	10%	-	-	0	0%
37	685	Grays Coho (Early-Type S-Hatchery)	Lower Columbia Riv	4	Grays	150,381	770	0.51%		0%	10%	-	1,092	0	0%	-	-			0%	10%	-	-	0	0%
38	371	Kalama Coho (Early- Type S)	Lower Columbia Riv	4	Kalama	202,624	2,240	1.11%	MAF	0%	10%	-	1,471	0	0%	-	-			0%	10%	-	-	0	0%
39	370	Kalama Coho (Late- Type N)	Lower Columbia Riv	4	Kalama	202,624	2,240	1.11%	MAF	0%	10%	-	2,062	0	0%	-	-			0%	10%	-	-	0	0%
40	272	Klickitat Coho (Lewis-Hatchery)	Lower Columbia Riv	4	Klickitat	1,238,563	9,298	0.75%	MAF	0%	10%	-	19,497	0	0%	1,238,563	9,298	0.75%	MAF	0%	10%	-	19,208	0	0%
41	273	Klickitat Coho (Washougal-Hatchery)	Lower Columbia Riv	4	Klickitat	-	-			0%		-	-	0	0%	-	-			0%		-	-	0	0%
42	781	NF Lewis Coho (Early-Type S Hatchery)	Lower Columbia Riv	4	Lewis	115,785	3,420	2.95%		0%	10%	-	841	0	0%	115,785	3,420	2.95%		0%	10%	-	769	0	0%
43	777	NF Lewis Coho (Late-Type N Hatchery)	Lower Columbia Riv	4	Lewis	-	-			0%	10%	-	-	0	0%	75,260	2,223	2.95%		0%	10%	-	767	0	0%
44	279	Litte White Coho (Hatchery)	Lower Columbia Riv	4	Little White Salmon	-	-			0%	10%	-	-	0	0%	-	-			0%	10%	-	-	0	0%
45	396	Bonneville Coho (Hatchery)	Lower Columbia Riv	4	Lower Columbia Riv	500,032	8,848	1.77%	MAF	0%	10%	-	2,792	0	0%	1,247,734	22,078	1.77%	MAF	0%	10%	-	6,394	0	0%
46	404	Sandy Coho (Hatchery)	Lower Columbia Riv	4	Sandy	700,081	9,750	1.39%	MAF	0%	5%	-	4,301	0	0%	700,081	9,750	1.39%	MAF	0%	5%	-	3,941	0	0%
47	582	Washougal Coho (Stepping Stone Hatc	Lower Columbia Riv	4	Washougal	272,095	7,543	2.77%	MAF	0%	10%	-	2,770	0	0%	-	-			0%		-	-	0	0%
48	423	Clackamas-Eagle Creek Coho (Hatcher	Lower Columbia Riv	4	Willamette	349,067	8,800	2.52%	MAF	0%	15%	-	2,535	0	0%	349,067	8,800	2.52%	MAF	0%	15%	-	2,318	0	0%

Appendix D3. Hatchery Performance by Alternative for Steelhead

Legend	Legend
Primary	Supporting
Contributing	Consistent
Stabilizing	Not Consistent
Not in ESU	

Upper Willamette River Steelhead

						Alternative 1						Alternative 2						Alternative 3					
Pop #	ID	Population Name	ESU	Designatio	Subbasin	Population Type	pHOS	PNI	Produc-tivity	NOS	HOS/ NOS	Population Type	pHOS	PNI	Produc-tivity	NOS	HOS/ NOS	Population Type	pHOS	PNI	Produc-tivity	NOS	HOS/ NOS
1	426	Mollalla Winter Steelhead	Upper Willamette River Steelhead	1	Willamette	Natural	0.00	0.00	5.1	1,713	0.00	Natural	0.00	0.00	5.1	1,713	0.00	Natural	0.00	0.00	5.1	1,713	0.00
2	427	North Santiam Winter Steelhead (Late)	Upper Willamette River Steelhead	1	Willamette	Natural	0.16	0.00	3.2	1,979	1.10	Natural	0.07	0.00	3.7	2,169	0.43	Natural	0.09	0.00	3.5	2,070	0.54
3	429	South Santiam Winter Steelhead	Upper Willamette River Steelhead	1	Willamette	Natural	0.02	0.00	5.6	3,094	0.15	Natural	0.02	0.00	5.8	3,160	0.12	Natural	0.02	0.00	5.8	3,151	0.13
4	424	Calapooia Winter Steelhead(Late)	Upper Willamette River Steelhead	2	Willamette	Natural	0.02	0.00	3.6	550	0.13	Natural	0.02	0.00	3.7	559	0.12	Natural	0.02	0.00	3.6	558	0.12
5	431	WestSide Tribs Winter Steelhead (Late)	Upper Willamette River Steelhead	3	Willamette	Natural	0.03	0.00	1.4	71	0.14	Natural	0.02	0.00	1.5	79	0.10	Natural	0.03	0.00	1.4	71	0.14
6	688	MF Willamette Summer Steelhead (S.Santiam-Hatchery)	Upper Willamette River Steelhead	4	Willamette	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
7	435	Mainstem Willamette Summer Steelhead (S.Santiam-Hatchery)	Upper Willamette River Steelhead	4	Willamette	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
8	687	McKenzie Summer Steelhead (S.Santiam-Hatchery)	Upper Willamette River Steelhead	4	Willamette	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
9	689	North Santiam Summer Steelhead (S. Santiam Hatchery)	Upper Willamette River Steelhead	4	Willamette	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
10	690	South Santiam Summer Steelhead (Hatchery)	Upper Willamette River Steelhead	4	Willamette	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A

Upper Columbia River Steelhead

						Alternative 1						Alternative 2						Alternative 3					
Pop #	ID	Population Name	ESU	Designatio	Subbasin	Population Type	pHOS	PNI	Produc-tivity	NOS	HOS/ NOS	Population Type	pHOS	PNI	Produc-tivity	NOS	HOS/ NOS	Population Type	pHOS	PNI	Produc-tivity	NOS	HOS/ NOS
1	233	Entiat Summer Steelhead	Upper Columbia River Steelhead	1	Entiat	Natural	0.86	0.00	0.42	84	7.55	Natural	0.75	0.00	0.4	57	3.84	Natural	0.75	0.00	0.4	57	3.84
2	238	Methow Summer Steelhead	Upper Columbia River Steelhead	1	Methow	Integrated	0.76	0.00	0.57	850	4.04	Integrated	0.49	0.67	0.9	714	1.18	Integrated	0.49	0.67	0.9	714	1.18
3	593	Okanogan Summer Steelhead	Upper Columbia River Steelhead	1	Okanogan	Integrated	0.93	0.21	0.73	76	15.65	Integrated	0.74	0.25	0.7	54	3.61	Integrated	0.74	0.25	0.7	54	3.61
4	252	Wenatchee Summer Steelhead	Upper Columbia River Steelhead	1	Wenatchee	Integrated	0.81	0.38	1.20	380	5.18	Integrated	0.73	0.51	1.4	391	3.40	Integrated	0.73	0.51	1.4	391	3.40
5	287	Ringold Summer Steelhead (Wells)	Upper Columbia River Steelhead	4	Hanford Reach	Segregated	1.00	0.00	0.00	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
6	824	Methow Summer Steelhead (Stepping Stone Hatchery)	Upper Columbia River Steelhead	4	Methow	Segregated	0.00	0.00	0.01	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A
7	813	Okanogan Summer Steelhead (Wells-Hatchery)	Upper Columbia River Steelhead	4	Okanogan	Segregated	1.00	0.00	0.00	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A
8	825	Wenatchee Summer Steelhead (Stepping Stone Hatchery)	Upper Columbia River Steelhead	4	Wenatchee	Segregated	0.00	0.00	0.01	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A

Southwest Washington Steelhead

						Alternative 1						Alternative 2						Alternative 3					
Pop #	ID	Population Name	ESU	Designatio	Subbasin	Population Type	pHOS	PNI	Produc-tivity	NOS	HOS/ NOS	Population Type	pHOS	PNI	Produc-tivity	NOS	HOS/ NOS	Population Type	pHOS	PNI	Produc-tivity	NOS	HOS/ NOS
1	666	Mill-Aber-Germ Winter Steelhead (Late)	Southwest Washington Steelhead	1	Mill-Aber-Germ	Natural	0.00	0.00	4.7	669	0.01	Natural	0.00	0.00	4.7	670	0.00	Natural	0.00	0.00	4.7	668	0.01
2	351	Grays Winter Steelhead (Late)	Southwest Washington Steelhead	1	Grays	Natural	0.01	0.00	4.2	869	0.13	Natural	0.00	0.00	4.6	918	0.00	Natural	0.01	0.00	4.2	869	0.13
3	344	Elochoman Winter Steelhead (Late)	Southwest Washington Steelhead	2	Elochoman	Natural	0.06	0.00	4.6	348	0.40	Natural	0.00	0.00	7.0	459	0.00	Natural	0.06	0.00	4.6	348	0.40
4	663	Big Creek Winter Steelhead (Late)	Southwest Washington Steelhead	3	Big Creek	Natural	0.03	0.00	2.9	61	0.28	Natural	0.00	0.00	3.6	73	0.00	Natural	0.03	0.00	2.9	61	0.28
5	589	Clatskanie Winter Steelhead (Late)	Southwest Washington Steelhead	3	Clatskanie	Natural	0.01	0.00	3.6	190	0.06	Natural	0.01	0.00	3.7	192	0.04	Natural	0.01	0.00	3.6	190	0.06
6	599	Gnat Creek Winter Steelhead (Late)	Southwest Washington Steelhead	3	Gnat Creek	Natural	0.16	0.00	1.9	10	1.69	Natural	0.00	0.00	3.6	18	0.00	Natural	0.16	0.00	1.9	10	1.69
7	588	Youngs Bay Tribs Winter Steelhead (Late)	Southwest Washington Steelhead	3	Young Bay Tribs	Natural	0.15	0.00	1.4	60	1.56	Natural	0.00	0.00	2.7	127	0.00	Natural	0.15	0.00	1.4	60	1.56
8	590	Big Creek Winter Steelhead (Hatchery)	Southwest Washington Steelhead	4	Big Creek	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
9	598	Gnat Creek Winter Steelhead (Hatchery)	Southwest Washington Steelhead	4	Gnat Creek	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
10	684	Youngs Bay Tribs Winter Steelhead (Hatchery)	Southwest Washington Steelhead	4	Young Bay Tribs	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
11	345	Elochoman Summer Steelhead (Merwin-Hatchery)	Southwest Washington Steelhead	4	Elochoman	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
12	343	Elochoman Winter Steelhead (Early-Hatchery)	Southwest Washington Steelhead	4	Elochoman	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
13	352	Grays Winter Steelhead (Early-Elochoman-Hatchery)	Southwest Washington Steelhead	4	Grays	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A

Snake River Basin Steelhead

						Alternative 1						Alternative 2						Alternative 3					
Pop #	ID	Population Name	ESU	Designatio	Subbasin	Population Type	pHOS	PNI	Produc-tivity	NOS	HOS/ NOS	Population Type	pHOS	PNI	Produc-tivity	NOS	HOS/ NOS	Population Type	pHOS	PNI	Produc-tivity	NOS	HOS/ NOS
1	448	Lochsa Summer Steelhead (B-Run)	Snake River Basin Steelhead	1	Clearwater	Natural	0.01	0.00	1.9	810	0.06	Natural	0.01	0.00	1.9	810	0.06	Natural	0.01	0.00	1.9	810	0.06
2	299	Tucannon Summer Steelhead	Snake River Basin Steelhead	1	Tucannon	Integrated	0.75	0.57	1.2	158	5.61	Integrated	0.78	0.56	1.2	163	4.46	Integrated	0.78	0.56	1.2	163	4.46
3	220	Wallowa Summer Steelhead	Snake River Basin Steelhead	1	Grande Ronde	Natural	0.01	0.00	2.6	1,225	0.01	Natural	0.00	0.00	2.6	1,238	0.01	Natural	0.01	0.00	2.6	1,225	0.01
4	554	Upper Grande Ronde Summer Steelhead	Snake River Basin Steelhead	1	Grande Ronde	Natural	0.01	0.00	1.6	1,331	0.01	Natural	0.00	0.00	1.6	1,381	0.00	Natural	0.01	0.00	1.6	1,331	0.01
5	548	South Fork Summer Steelhead (B-Run)	Snake River Basin Steelhead	1	Salmon	Natural	0.01	0.00	2.3	569	0.03	Natural	0.01	0.00	2.3	569	0.03	Natural	0.01	0.00	2.3	569	0.03
6	547	Secesh Summer Steelhead (B-Run)	Snake River Basin Steelhead	1	Salmon	Natural	0.01	0.00	2.3	169	0.05	Natural	0.01	0.00	2.3	169	0.05	Natural	0.01	0.00	2.3	169	0.05
7	546	Chamberlain Summer Steelhead (A-Run)	Snake River Basin Steelhead	1	Salmon	Natural	0.00	0.00	2.6	245	0.01	Natural	0.00	0.00	2.6	245	0.01	Natural	0.00	0.00	2.6	245	0.01
8	544	Lower Middle Fork Salmon Summer Steelhead (B-Run)	Snake River Basin Steelhead	1	Salmon	Natural	0.00	0.00	2.0	705	0.02	Natural	0.00	0.00	2.0	705	0.02	Natural	0.00	0.00	2.0	705	0.02
9	545	Upper Middle Fork Salmon Summer Steelhead (B-Run)	Snake River Basin Steelhead	1	Salmon	Natural	0.00	0.00	2.0	758	0.00	Natural	0.00	0.00	2.0	758	0.00	Natural	0.00	0.00	2.0	758	0.00
10	542	North Fork Salmon Summer Steelhead (A-Run)	Snake River Basin Steelhead	1	Salmon	Natural	0.01	0.00	2.5	132	0.05	Natural	0.01	0.00	2.6	135	0.03	Natural	0.01	0.00	2.5	132	0.05
11	521	Selway Summer Steelhead (B-Run)	Snake River Basin Steelhead	1	Clearwater	Natural	0.01	0.00	1.9	1,055	0.04	Natural	0.01	0.00	1.9	1,055	0.04	Natural	0.01	0.00	1.9	1,055	0.04
12	541	Lemhi Summer Steelhead (A-Run)	Snake River Basin Steelhead	1	Salmon	Natural	0.35	0.00	0.8	197	2.19	Natural	0.00	0.00	1.6	396	0.02	Natural	0.00	0.00	1.6	395	0.02
13	467	East Fork Salmon Summer Steelhead	Snake River Basin Steelhead	1	Salmon	Integrated	0.59	0.08	0.6	255	4.21	Integrated	0.38	0.72	1.0	312	0.82	Integrated	0.39	0.72	1.0	312	0.83
14	223	Imnaha Summer Steelhead	Snake River Basin Steelhead	1	Imnaha	Natural	0.01	0.00	2.7	1,184	0.01	Natural	0.00	0.00	2.8	1,201	0.00	Natural	0.00	0.00	2.8	1,201	0.00
15	447	Lower Clearwater Summer Steelhead (A-Run)	Snake River Basin Steelhead	1	Clearwater	Natural	0.02	0.00	4.0	1,005	0.09	Natural	0.02	0.00	4.0	1,005	0.09	Natural	0.02	0.00	4.0	1,005	0.09
16	217	Lower Grande Ronde Summer Steelhead	Snake River Basin Steelhead	1	Grande Ronde	Natural	0.05	0.00	3.0	1,243	0.10	Natural	0.04	0.00	3.0	1,252	0.09	Natural	0.05	0.00	3.0	1,243	0.10
17	553	Joseph Summer Steelhead	Snake River Basin Steelhead	1	Grande Ronde	Natural	0.00	0.00	2.7	2,236	0.00	Natural	0.00	0.00	2.7	2,237	0.00	Natural	0.00	0.00	2.7	2,236	0.00
18	208	Asotin Summer Steelhead (A-run)	Snake River Basin Steelhead	2	Asotin	Natural	0.13	0.00	1.2	335	0.29	Natural	0.08	0.00	1.3	370	0.13	Natural	0.08	0.00	1.3	370	0.13
19	464	Pahsimeroi Summer Steelhead (A-Run)	Snake River Basin Steelhead	2	Salmon	Natural	0.17	0.00	0.8	52	0.83	Natural	0.02	0.00	1.3	231	0.07	Natural	0.02	0.00	1.3	225	0.07
20	981	Little Sheep Summer Steelhead	Snake River Basin Steelhead	2	Imnaha	Integrated	0.65	0.13	1.4	91	2.32	Integrated	0.47	0.51	1.9	79	1.11	Integrated	0.47	0.51	1.9	79	1.11
21	827	SF Clearwater_Crooked River Summer Steelhead (B-Run)	Snake River Basin Steelhead	2	Clearwater	Integrated	0.79	0.56	0.9	192	4.98	Integrated	0.79	0.56	0.9	192	4.98	Integrated	0.79	0.56	0.9	192	4.98
22	744	Lolo Summer Steelhead (A+B-Run)	Snake River Basin Steelhead	2	Clearwater	Integrated	0.68	0.00	0.9	93	8.28	Integrated	0.67	0.60	1.4	105	7.99	Integrated	0.83	0.55	1.3	123	6.81
23	549	Little Salmon Summer Steelhead (A-Run)	Snake River Basin Steelhead	3	Salmon	Natural	0.68	0.00	1.6	270	8.52	Natural	0.68	0.00	1.6	270	8.52	Natural	0.68	0.00	1.6	270	8.52
24	543	Panther Creek Summer Steelhead (A-Run)	Snake River Basin Steelhead	3	Salmon	Natural	0.00	0.00	1.8	178	0.02	Integrated	0.00	0.00	1.8	178	0.02	Integrated	0.00	0.00	1.8	178	0.02
25	540	Upper Salmon Summer Steelhead (A-Run)	Snake River Basin Steelhead	3	Salmon	Natural	0.47	0.00	0.7	242	3.44	Natural	0.46	0.00	0.7	234	3.32	Natural	0.46	0.35	0.7	234	3.32
26	229	Snake Hells Canyon Summer Steelhead	Snake River Basin Steelhead	3	Snake Hells Canyo	Natural	0.64	0.00	0.9	223	3.50	Natural	0.59	0.00	0.9	205	2.01	Natural	0.59	0.00	0.9	205	2.01
27	449	SF Clearwater Summer Steelhead (B-Run)	Snake River Basin Steelhead	3	Clearwater	Integrated	0.91	0.00	0.6	195	42.65	Integrated	0.91	0.00	0.6	195	42.66	Integrated	0.91	0.00	0.6	195	42.64
28	512	Wallowa Summer Steelhead (Hatchery)	Snake River Basin Steelhead	4	Grande Ronde	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
29	550	Little Salmon Summer Steelhead (A-Run-Pahsimeroi-Oxbow-Hatche	Snake River Basin Steelhead	4	Salmon	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
30	791	Little Salmon Summer Steelhead (B-Run-Dworshak-Hatchery)	Snake River Basin Steelhead	4	Salmon	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
31	298	Tucannon Summer Steelhead (Lyons Ferry)	Snake River Basin Steelhead	4	Tucannon	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A
32	790	Lemhi Summer Steelhead (A-Run-Pahsimeroi Hatchery)	Snake River Basin Steelhead	4	Salmon	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A
33	539	Pahsimeroi Summer Steelhead (A-Run-Pahsimeroi-Hatchery)	Snake River Basin Steelhead	4	Salmon	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
34	792	East Fork Salmon Summer Steelhead (B-Run Dworshak-Hatchery)	Snake River Basin Steelhead	4	Salmon	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A
35	814	East Fork Salmon Summer Steelhead (A-Run Pahasimeroi-Hatchery	Snake River Basin Steelhead	4	Salmon	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A
36	465	Upper Salmon Summer Steelhead (A-Run Sawtooth-Pahsimeroi-Ha	Snake River Basin Steelhead	4	Salmon	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
37	466	Upper Salmon Summer Steelhead (B-Run Dworshak-Hatchery)	Snake River Basin Steelhead	4	Salmon	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
38	793	Upper Salmon Summer Steelhead (Upper Salmon B-Run Program)	Snake River Basin Steelhead	4	Salmon	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
39	983	Little Sheep Summer Steelhead (Stepping Stone Hatchery)	Snake River Basin Steelhead	4	Imnaha	Segregated	0.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A
40	230	Snake Hells Canyon Summer Steelhead (Oxbow-Hatchery)	Snake River Basin Steelhead	4	nake Hells Canyo	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
41	789	SF Clearwater Summer Steelhead (B-Run Hatchery)	Snake River Basin Steelhead	4	Clearwater	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
42	450	NF Clearwater Summer Steelhead (B-Run-Hatchery)	Snake River Basin Steelhead	4	Clearwater	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
43	738	Lower Clearwater Summer Steelhead (B-Run-Hatchery)	Snake River Basin Steelhead	4	Clearwater	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
44	218	Cottonwood Creek Summer Steelhead (Wallowa-Lyons Ferry-Hatch	Snake River Basin Steelhead	4	Grande Ronde	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
45	295	Snake Lower Summer Steelhead (Lyons Ferry)	Snake River Basin Steelhead	4	Lower Snake	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A

Appendix D3. Hatchery Performance by Alternative for Steelhead

Designation	Alternative key
Primary	Supporting
Contributing	Consistent
Stabilizing	Not Consistent
Not in ESU	

Upper Willamette River Steelhead

Pop #	ID	Population Name	ESU	Designatio	Subbasin	Alternative 4						Alternative 5					
						Population Type	pHOS	PNI	Productivity	NOS	HOS/ NOS	Population Type	pHOS	PNI	Productivity	NOS	HOS/ NOS
1	426	Mollalla Winter Steelhead	Upper Willamette River Steelhead	1	Willamette	Natural	0.00	0.00	5.1	1,713	0.00	Natural	0.00	0.00	5.1	1,713	0.00
2	427	North Santiam Winter Steelhead (Late)	Upper Willamette River Steelhead	1	Willamette	Natural	0.02	0.00	5.3	2,834	0.13	Natural	0.09	0.00	3.5	2,070	0.54
3	429	South Santiam Winter Steelhead	Upper Willamette River Steelhead	1	Willamette	Natural	0.02	0.00	5.9	3,189	0.11	Natural	0.02	0.00	5.8	3,151	0.13
4	424	Calapooia Winter Steelhead(Late)	Upper Willamette River Steelhead	2	Willamette	Natural	0.02	0.00	3.7	563	0.11	Natural	0.02	0.00	3.6	558	0.12
5	431	WestSide Tribs Winter Steelhead (Late)	Upper Willamette River Steelhead	3	Willamette	Natural	0.02	0.00	1.5	78	0.13	Natural	0.03	0.00	1.4	71	0.14
6	688	MF Willamette Summer Steelhead (S.Santiam-Hatchery)	Upper Willamette River Steelhead	4	Willamette	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
7	435	Mainstem Willamette Summer Steelhead (S.Santiam-Hatchery)	Upper Willamette River Steelhead	4	Willamette	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
8	687	McKenzie Summer Steelhead (S.Santiam-Hatchery)	Upper Willamette River Steelhead	4	Willamette	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
9	689	North Santiam Summer Steelhead (S. Santiam Hatchery)	Upper Willamette River Steelhead	4	Willamette	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
10	690	South Santiam Summer Steelhead (Hatchery)	Upper Willamette River Steelhead	4	Willamette	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A

Upper Columbia River Steelhead

Pop #	ID	Population Name	ESU	Designatio	Subbasin	Alternative 4						Alternative 5					
						Population Type	pHOS	PNI	Productivity	NOS	HOS/ NOS	Population Type	pHOS	PNI	Productivity	NOS	HOS/ NOS
1	233	Entiat Summer Steelhead	Upper Columbia River Steelhead	1	Entiat	Natural	0.75	0.00	0.4	57	3.84	Natural	0.71	0.00	0.4	46	3.09
2	238	Methow Summer Steelhead	Upper Columbia River Steelhead	1	Methow	Integrated	0.49	0.67	0.9	714	1.18	Integrated	0.50	0.67	0.9	730	1.23
3	593	Okanogan Summer Steelhead	Upper Columbia River Steelhead	1	Okanogan	Integrated	0.74	0.25	0.7	54	3.61	Integrated	0.92	0.05	0.7	72	15.31
4	252	Wenatchee Summer Steelhead	Upper Columbia River Steelhead	1	Wenatchee	Integrated	0.73	0.51	1.4	391	3.40	Integrated	0.46	0.69	1.8	449	1.05
5	287	Ringold Summer Steelhead (Wells)	Upper Columbia River Steelhead	4	Hanford Reach	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A
6	824	Methow Summer Steelhead (Stepping Stone Hatchery)	Upper Columbia River Steelhead	4	Methow	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
7	813	Okanogan Summer Steelhead (Wells-Hatchery)	Upper Columbia River Steelhead	4	Okanogan	Segregated	0.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A
8	825	Wenatchee Summer Steelhead (Stepping Stone Hatchery)	Upper Columbia River Steelhead	4	Wenatchee	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A

Southwest Washington Steelhead

Pop #	ID	Population Name	ESU	Designatio	Subbasin	Alternative 4						Alternative 5					
						Population Type	pHOS	PNI	Productivity	NOS	HOS/ NOS	Population Type	pHOS	PNI	Productivity	NOS	HOS/ NOS
1	666	Mill-Aber-Germ Winter Steelhead (Late)	Southwest Washington Steelhead	1	Mill-Aber-Germ	Natural	0.00	0.00	4.7	668	0.01	Natural	0.00	0.00	4.7	668	0.01
2	351	Grays Winter Steelhead (Late)	Southwest Washington Steelhead	1	Grays	Natural	0.01	0.00	4.2	869	0.13	Natural	0.01	0.00	4.2	868	0.13
3	344	Elochoman Winter Steelhead (Late)	Southwest Washington Steelhead	2	Elochoman	Natural	0.04	0.00	5.1	374	0.27	Natural	0.06	0.00	4.6	348	0.40
4	663	Big Creek Winter Steelhead (Late)	Southwest Washington Steelhead	3	Big Creek	Natural	0.02	0.00	3.2	66	0.17	Natural	0.02	0.00	3.2	66	0.17
5	589	Clatskanie Winter Steelhead (Late)	Southwest Washington Steelhead	3	Clatskanie	Natural	0.02	0.00	3.4	181	0.07	Natural	0.02	0.00	3.4	180	0.07
6	599	Gnat Creek Winter Steelhead (Late)	Southwest Washington Steelhead	3	Gnat Creek	Natural	0.11	0.00	2.0	10	1.08	Natural	0.11	0.00	1.9	10	1.08
7	588	Youngs Bay Tribs Winter Steelhead (Late)	Southwest Washington Steelhead	3	Young Bay Tribs	Natural	0.15	0.00	1.4	60	1.56	Natural	0.15	0.00	1.4	60	1.56
8	590	Big Creek Winter Steelhead (Hatchery)	Southwest Washington Steelhead	4	Big Creek	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
9	598	Gnat Creek Winter Steelhead (Hatchery)	Southwest Washington Steelhead	4	Gnat Creek	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
10	684	Youngs Bay Tribs Winter Steelhead (Hatchery)	Southwest Washington Steelhead	4	Young Bay Tribs	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
11	345	Elochoman Summer Steelhead (Merwin-Hatchery)	Southwest Washington Steelhead	4	Elochoman	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
12	343	Elochoman Winter Steelhead (Early-Hatchery)	Southwest Washington Steelhead	4	Elochoman	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
13	352	Grays Winter Steelhead (Early-Elochoman-Hatchery)	Southwest Washington Steelhead	4	Grays	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A

Snake River Basin Steelhead

Pop #	ID	Population Name	ESU	Designatio	Subbasin	Alternative 4						Alternative 5					
						Population Type	pHOS	PNI	Productivity	NOS	HOS/ NOS	Population Type	pHOS	PNI	Productivity	NOS	HOS/ NOS
1	448	Lochsa Summer Steelhead (B-Run)	Snake River Basin Steelhead	1	Clearwater	Natural	0.01	0.00	1.9	810	0.06	Natural	0.00	0.00	2.0	903	0.01
2	299	Tucannon Summer Steelhead	Snake River Basin Steelhead	1	Tucannon	Integrated	0.78	0.56	1.2	163	4.46	Integrated	0.44	0.70	1.4	121	0.99
3	220	Wallowa Summer Steelhead	Snake River Basin Steelhead	1	Grande Ronde	Natural	0.01	0.00	2.6	1,225	0.01	Natural	0.01	0.00	2.6	1,226	0.01
4	554	Upper Grande Ronde Summer Steelhead	Snake River Basin Steelhead	1	Grande Ronde	Natural	0.01	0.00	1.6	1,331	0.01	Natural	0.01	0.00	1.6	1,331	0.01
5	548	South Fork Summer Steelhead (B-Run)	Snake River Basin Steelhead	1	Salmon	Natural	0.01	0.00	2.3	569	0.03	Natural	0.01	0.00	2.4	576	0.03
6	547	Secesh Summer Steelhead (B-Run)	Snake River Basin Steelhead	1	Salmon	Natural	0.01	0.00	2.3	169	0.05	Natural	0.01	0.00	2.3	173	0.04
7	546	Chamberlain Summer Steelhead (A-Run)	Snake River Basin Steelhead	1	Salmon	Natural	0.00	0.00	2.6	245	0.01	Natural	0.00	0.00	2.6	245	0.01
8	544	Lower Middle Fork Salmon Summer Steelhead (B-Run)	Snake River Basin Steelhead	1	Salmon	Natural	0.00	0.00	2.0	705	0.02	Natural	0.00	0.00	2.0	709	0.02
9	545	Upper Middle Fork Salmon Summer Steelhead (B-Run)	Snake River Basin Steelhead	1	Salmon	Natural	0.00	0.00	2.0	758	0.00	Natural	0.00	0.00	2.0	758	0.00
10	542	North Fork Salmon Summer Steelhead (A-Run)	Snake River Basin Steelhead	1	Salmon	Natural	0.01	0.00	2.5	132	0.05	Natural	0.01	0.00	2.5	133	0.04
11	521	Selway Summer Steelhead (B-Run)	Snake River Basin Steelhead	1	Clearwater	Natural	0.01	0.00	1.9	1,055	0.04	Natural	0.00	0.00	2.0	1,132	0.01
12	541	Lemhi Summer Steelhead (A-Run)	Snake River Basin Steelhead	1	Salmon	Natural	0.00	0.00	1.6	395	0.02	Natural	0.00	0.00	1.6	406	0.01
13	467	East Fork Salmon Summer Steelhead	Snake River Basin Steelhead	1	Salmon	Integrated	0.39	0.72	1.0	312	0.83	Integrated	0.49	0.67	1.0	318	1.46
14	223	Imnaha Summer Steelhead	Snake River Basin Steelhead	1	Imnaha	Natural	0.00	0.00	2.8	1,201	0.00	Natural	0.00	0.00	2.8	1,198	0.00
15	447	Lower Clearwater Summer Steelhead (A-Run)	Snake River Basin Steelhead	1	Clearwater	Natural	0.02	0.00	4.0	1,005	0.09	Natural	0.01	0.00	4.5	1,099	0.02
16	217	Lower Grande Ronde Summer Steelhead	Snake River Basin Steelhead	1	Grande Ronde	Natural	0.05	0.00	3.0	1,243	0.10	Natural	0.05	0.00	3.0	1,243	0.10
17	553	Joseph Summer Steelhead	Snake River Basin Steelhead	1	Grande Ronde	Natural	0.00	0.00	2.7	2,236	0.00	Natural	0.00	0.00	2.7	2,236	0.00
18	208	Asotin Summer Steelhead (A-run)	Snake River Basin Steelhead	2	Asotin	Natural	0.08	0.00	1.3	370	0.13	Natural	0.01	0.00	2.1	743	0.03
19	464	Pahsimeroi Summer Steelhead (A-Run)	Snake River Basin Steelhead	2	Salmon	Natural	0.02	0.00	1.3	225	0.07	Natural	0.00	0.00	1.5	308	0.01
20	981	Little Sheep Summer Steelhead	Snake River Basin Steelhead	2	Imnaha	Integrated	0.47	0.51	1.9	79	1.11	Integrated	0.65	0.50	1.8	90	2.30
21	827	SF Clearwater_Crooked River Summer Steelhead (B-Run)	Snake River Basin Steelhead	2	Clearwater	Integrated	0.79	0.56	0.9	193	4.94	Integrated	0.84	0.54	0.9	189	6.79
22	744	Lolo Summer Steelhead (A+B-Run)	Snake River Basin Steelhead	2	Clearwater	Integrated	0.83	0.55	1.3	123	6.78	Integrated	0.82	0.55	1.3	122	5.95
23	549	Little Salmon Summer Steelhead (A-Run)	Snake River Basin Steelhead	3	Salmon	Natural	0.68	0.00	1.6	270	8.52	Natural	0.64	0.00	1.6	262	7.19
24	543	Panther Creek Summer Steelhead (A-Run)	Snake River Basin Steelhead	3	Salmon	Integrated	0.00	0.00	1.8	178	0.02	Integrated	0.00	0.00	1.8	179	0.01
25	540	Upper Salmon Summer Steelhead (A-Run)	Snake River Basin Steelhead	3	Salmon	Natural	0.46	0.10	0.7	234	3.32	Natural	0.44	0.35	0.7	212	3.01
26	229	Snake Hells Canyon Summer Steelhead	Snake River Basin Steelhead	3	Snake Hells Canyo	Natural	0.59	0.00	0.9	205	2.01	Natural	0.38	0.00	0.9	128	1.16
27	449	SF Clearwater Summer Steelhead (B-Run)	Snake River Basin Steelhead	3	Clearwater	Integrated	0.96	0.00	0.6	210	39.63	Integrated	0.74	0.00	0.6	136	5.95
28	512	Wallowa Summer Steelhead (Hatchery)	Snake River Basin Steelhead	4	Grande Ronde	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
29	550	Little Salmon Summer Steelhead (A-Run-Pahsimeroi-Oxbow-Hatche	Snake River Basin Steelhead	4	Salmon	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
30	791	Little Salmon Summer Steelhead (B-Run-Dworshak-Hatchery)	Snake River Basin Steelhead	4	Salmon	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
31	298	Tucannon Summer Steelhead (Lyons Ferry)	Snake River Basin Steelhead	4	Tucannon	Segregated	0.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A
32	790	Lemhi Summer Steelhead (A-Run-Pahsimeroi Hatchery)	Snake River Basin Steelhead	4	Salmon	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
33	539	Pahsimeroi Summer Steelhead (A-Run-Pahsimeroi-Hatchery)	Snake River Basin Steelhead	4	Salmon	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
34	792	East Fork Salmon Summer Steelhead (B-Run Dworshak-Hatchery)	Snake River Basin Steelhead	4	Salmon	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
35	814	East Fork Salmon Summer Steelhead (A-Run Pahasimeroi-Hatchery	Snake River Basin Steelhead	4	Salmon	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
36	465	Upper Salmon Summer Steelhead (A-Run Sawtooth-Pahsimeroi-Ha	Snake River Basin Steelhead	4	Salmon	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
37	466	Upper Salmon Summer Steelhead (B-Run Dworshak-Hatchery)	Snake River Basin Steelhead	4	Salmon	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
38	793	Upper Salmon Summer Steelhead (Upper Salmon B-Run Program)	Snake River Basin Steelhead	4	Salmon	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
39	983	Little Sheep Summer Steelhead (Stepping Stone Hatchery)	Snake River Basin Steelhead	4	Imnaha	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
40	230	Snake Hells Canyon Summer Steelhead (Oxbow-Hatchery)	Snake River Basin Steelhead	4	nake Hells Canyo	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
41	789	SF Clearwater Summer Steelhead (B-Run Hatchery)	Snake River Basin Steelhead	4	Clearwater	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
42	450	NF Clearwater Summer Steelhead (B-Run-Hatchery)	Snake River Basin Steelhead	4	Clearwater	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
43	738	Lower Clearwater Summer Steelhead (B-Run-Hatchery)	Snake River Basin Steelhead	4	Clearwater	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
44	218	Cottonwood Creek Summer Steelhead (Wallowa-Lyons Ferry-Hatch	Snake River Basin Steelhead	4	Grande Ronde	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
45	295	Snake Lower Summer Steelhead (Lyons Ferry)	Snake River Basin Steelhead	4	Lower Snake	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A

Appendix D3. Hatchery Performance by Alternative for Steelhead

Legend	Legend
Primary	Supporting
Contributing	Consistent
Stabilizing	Not Consistent
Not in ESU	

Middle Columbia River Steelhead

Pop #	ID	Population Name	ESU	Designatio	Subbasin	Alternative 1 Population Type	pHOS	PNI	Produc-tivity	NOS	HOS/NOS	Alternative 2 Population Type	pHOS	PNI	Produc-tivity	NOS	HOS/NOS	Alternative 3 Population Type	pHOS	PNI	Produc-tivity	NOS	HOS/NOS
1	291	Eastside Tributaries Summer Steelhead	Middle Columbia River Steelhead	1	Deschutes	Natural	0.21	0.00	1.9	2,665	0.64	Natural	0.10	0.00	2.1	2,644	0.36	Natural	0.09	0.00	2.1	2,687	0.26
2	670	Westside Tributaries Summer Steelhead	Middle Columbia River Steelhead	1	Deschutes	Natural	0.19	0.00	1.0	254	0.55	Natural	0.06	0.00	1.2	344	0.18	Natural	0.07	0.00	1.1	315	0.18
3	259	Fifteenmile Creek Winter Steelhead	Middle Columbia River Steelhead	1	Fifteenmile Creek	Natural	0.00	0.00	1.9	726	0.01	Natural	0.00	0.00	1.9	728	0.00	Natural	0.00	0.00	1.9	726	0.01
4	293	Lower Mainstem Summer Steelhead	Middle Columbia River Steelhead	1	John Day	Natural	0.05	0.00	3.1	2,512	0.11	Natural	0.02	0.00	4.0	3,154	0.04	Natural	0.05	0.00	3.1	2,512	0.11
5	673	Middle Fork Summer Steelhead	Middle Columbia River Steelhead	1	John Day	Natural	0.05	0.00	2.4	885	0.12	Natural	0.02	0.00	3.2	1,147	0.05	Natural	0.05	0.00	2.4	885	0.12
6	672	North Fork Summer Steelhead	Middle Columbia River Steelhead	1	John Day	Natural	0.04	0.00	2.6	2,144	0.10	Natural	0.01	0.00	3.2	2,649	0.04	Natural	0.04	0.00	2.6	2,144	0.10
7	274	Klickitat Summer-Winter Steelhead	Middle Columbia River Steelhead	1	Klickitat	Natural	0.09	0.00	2.3	1,230	0.55	Natural	0.00	0.00	4.1	2,041	0.00	Natural	0.09	0.00	2.3	1,234	0.55
8	303	Umatilla Summer Steelhead	Middle Columbia River Steelhead	1	Umatilla	Integrated	0.25	0.80	1.6	1,993	0.44	Integrated	0.23	0.81	1.6	1,972	0.40	Integrated	0.24	0.80	1.6	1,986	0.42
9	305	Walla Walla Summer Steelhead	Middle Columbia River Steelhead	1	Walla Walla	Natural	0.14	0.00	0.9	208	0.32	Natural	0.03	0.00	1.3	489	0.06	Natural	0.03	0.00	1.3	489	0.06
10	307	Touchet Summer Steelhead	Middle Columbia River Steelhead	1	Touchet	Integrated	0.45	0.69	1.3	322	1.25	Integrated	0.49	0.67	1.3	340	1.24	Integrated	0.49	0.67	1.3	340	1.24
11	316	Naches Summer Steelhead	Middle Columbia River Steelhead	1	Yakima	Natural	0.01	0.00	1.4	520	0.01	Natural	0.00	0.00	1.4	536	0.01	Natural	0.00	0.00	1.4	536	0.01
12	317	Satus Summer Steelhead	Middle Columbia River Steelhead	1	Yakima	Natural	0.00	0.00	3.6	866	0.00	Natural	0.00	0.00	3.7	869	0.00	Natural	0.00	0.00	3.7	869	0.00
13	674	South Fork Summer Steelhead	Middle Columbia River Steelhead	2	John Day	Natural	0.04	0.00	2.2	315	0.13	Natural	0.03	0.00	2.5	348	0.10	Natural	0.04	0.00	2.2	315	0.13
14	675	Upper Mainstem Summer Steelhead	Middle Columbia River Steelhead	2	John Day	Natural	0.04	0.00	2.3	640	0.11	Natural	0.02	0.00	2.8	788	0.06	Natural	0.04	0.00	2.3	640	0.11
15	318	Toppenish Summer Steelhead	Middle Columbia River Steelhead	2	Yakima	Natural	0.00	0.00	3.3	720	0.01	Natural	0.00	0.00	3.3	723	0.00	Natural	0.00	0.00	3.3	723	0.00
16	319	Upper Yakima Summer Steelhead	Middle Columbia River Steelhead	2	Yakima	Natural	0.24	0.00	0.6	11	0.37	Natural	0.18	0.00	0.6	12	0.26	Natural	0.18	0.00	0.6	12	0.26
17	595	White Salmon Summer-Winter Steelhead	Middle Columbia River Steelhead	3	Big White Salmon	Natural	0.95	0.00	1.7	6	>100	Natural	0.58	0.00	1.7	5	1.98	Natural	0.95	0.00	1.7	6	>100
18	559	Deschutes Summer Steelhead (RoundButte-Hatchery)	Middle Columbia River Steelhead	4	Deschutes	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
19	276	Klickitat Summer Steelhead (Skamania-Hatchery)	Middle Columbia River Steelhead	4	Klickitat	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
20	306	Walla Walla Summer Steelhead (Lyons Ferry-Hatchery)	Middle Columbia River Steelhead	4	Walla Walla	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A
21	806	Walla Walla Touchet Summer Steelhead (Lyons Ferry-Hatchery)	Middle Columbia River Steelhead	4	Touchet	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A
22	254	White Salmon Summer Steelhead (Skamania-Hatchery)	Middle Columbia River Steelhead	4	Big White Salmor	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
23	256	White Salmon Winter Steelhead (Skamania-Hatchery)	Middle Columbia River Steelhead	4	Big White Salmor	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A

Lower Columbia River Steelhead

Pop #	ID	Population Name	ESU	Designatio	Subbasin	Alternative 1 Population Type	pHOS	PNI	Produc-tivity	NOS	HOS/NOS	Alternative 2 Population Type	pHOS	PNI	Produc-tivity	NOS	HOS/NOS	Alternative 3 Population Type	pHOS	PNI	Produc-tivity	NOS	HOS/NOS
1	623	Coweeman Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Coweeman	Natural	0.02	0.00	2.8	469	0.17	Natural	0.00	0.00	3.1	516	0.01	Natural	0.02	0.00	2.7	463	0.17
2	622	NF Toutle Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Toutle	Natural	0.05	0.00	1.8	481	0.31	Natural	0.01	0.00	2.5	719	0.02	Natural	0.06	0.00	1.7	447	0.34
3	621	SF Toutle Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Toutle	Natural	0.04	0.00	2.6	705	0.21	Natural	0.00	0.00	3.3	875	0.01	Natural	0.04	0.00	2.5	680	0.23
4	265	Hood Summer Steelhead	Lower Columbia River Steelhead	1	Hood	Integrated	0.33	0.75	1.5	233	0.66	Integrated	0.32	0.76	1.5	232	0.60	Integrated	0.33	0.75	1.5	233	0.66
5	267	Hood Winter Steelhead	Lower Columbia River Steelhead	1	Hood	Integrated	0.28	0.78	1.4	855	0.48	Integrated	0.28	0.78	1.4	855	0.48	Integrated	0.28	0.78	1.4	855	0.48
6	372	Kalama Summer Steelhead	Lower Columbia River Steelhead	1	Kalama	Integrated	0.04	0.96	2.8	628	0.09	Integrated	0.00	0.00	2.9	661	0.00	Integrated	0.04	0.83	2.7	638	0.09
7	375	Kalama Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Kalama	Integrated	0.08	0.93	2.7	348	0.17	Integrated	0.00	0.00	2.7	437	0.00	Integrated	0.06	0.84	2.6	400	0.14
8	630	EF Lewis Summer Steelhead	Lower Columbia River Steelhead	1	Lewis	Natural	0.04	0.00	2.1	429	0.23	Natural	0.00	0.00	2.8	565	0.01	Natural	0.04	0.00	2.1	437	0.21
9	628	EF Lewis Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Lewis	Natural	0.13	0.00	2.1	339	1.40	Natural	0.00	0.00	4.1	566	0.01	Natural	0.06	0.00	2.5	388	0.61
10	406	Sandy Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Sandy	Integrated	0.05	0.95	2.8	1,484	0.15	Integrated	0.00	1.00	2.8	1,664	0.00	Integrated	0.05	0.95	2.8	1,484	0.15
11	676	Washougal Summer Steelhead	Lower Columbia River Steelhead	1	Washougal	Natural	0.05	0.00	2.7	385	0.30	Natural	0.00	0.00	3.8	515	0.00	Natural	0.05	0.00	2.7	385	0.30
12	734	Lower Clackamas Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Willamette	Integrated	0.38	0.00	1.5	510	0.89	Integrated	0.32	0.55	2.2	642	0.64	Integrated	0.33	0.55	2.2	641	0.71
13	433	Upper Clackamas Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Willamette	Natural	0.00	0.00	9.7	3,222	0.00	Natural	0.00	0.00	9.7	3,222	0.00	Natural	0.00	0.00	9.7	3,222	0.00
14	284	Wind Summer Steelhead	Lower Columbia River Steelhead	1	Wind	Natural	0.00	0.00	3.6	1,139	0.00	Natural	0.00	0.00	3.6	1,139	0.00	Natural	0.00	0.00	3.6	1,139	0.00
15	398	Upper Gorge Tributaries Winter Steelhead (Late)	Lower Columbia River Steelhead	2	Columbia Gorge	Natural	0.00	0.00	2.6	149	0.00	Natural	0.00	0.00	2.6	149	0.00	Natural	0.00	0.00	2.6	149	0.00
16	363	Lower Cowlitz Winter Steelhead (Late)	Lower Columbia River Steelhead	2	Cowlitz	Integrated	0.18	0.00	1.3	337	1.13	Integrated	0.12	0.67	2.2	525	0.71	Integrated	0.13	0.66	2.2	523	0.73
17	606	Upper Cowlitz Winter Steelhead (Late)	Lower Columbia River Steelhead	2	Cowlitz	Integrated	0.00	1.00	1.2	293	0.00	Integrated	0.35	0.74	1.0	291	1.19	Integrated	0.35	0.74	1.0	292	1.21
18	383	NF Lewis Winter Steelhead (Late)	Lower Columbia River Steelhead	2	Lewis	Natural	0.19	0.00	1.6	202	1.69	Natural	0.08	0.00	1.9	214	0.50	Natural	0.09	0.00	1.8	210	0.55
19	558	Washougal Winter Steelhead (Late)	Lower Columbia River Steelhead	2	Washougal	Natural	0.02	0.00	3.0	332	0.12	Natural	0.00	0.00	3.3	359	0.00	Natural	0.02	0.00	3.0	332	0.12
20	629	NF Lewis Summer Steelhead	Lower Columbia River Steelhead	3	Lewis	Natural	0.12	0.00	2.6	231	0.78	Natural	0.07	0.00	3.0	255	0.42	Natural	0.07	0.00	2.9	249	0.46
21	632	Salmon Creek Winter Steelhead (Late)	Lower Columbia River Steelhead	3	Washougal	Natural	0.21	0.00	1.1	24	1.95	Natural	0.00	0.00	2.2	48	0.00	Natural	0.21	0.00	1.1	24	1.95
22	362	Coweeman Winter Steelhead (Early Elochoman-Hatchery)	Lower Columbia River Steelhead	4	Coweeman	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
23	365	Lower Cowlitz Summer Steelhead (Skamania-Hatchery)	Lower Columbia River Steelhead	4	Cowlitz	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
24	361	Lower Cowlitz Winter Steelhead (Early-Hatchery)	Lower Columbia River Steelhead	4	Cowlitz	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
25	620	NF Toutle Summer Steelhead (Hatchery)	Lower Columbia River Steelhead	4	Toutle	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
26	364	SF Toutle Summer Steelhead (Hatchery)	Lower Columbia River Steelhead	4	Toutle	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
27	775	Hood Summer Steelhead (Santiam-Hatchery)	Lower Columbia River Steelhead	4	Hood	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
28	373	Kalama Summer Steelhead (Skamania-Hatchery)	Lower Columbia River Steelhead	4	Kalama	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
29	374	Kalama Winter Steelhead (Early-Hatchery)	Lower Columbia River Steelhead	4	Kalama	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
30	385	EF Lewis Summer Steelhead (Skamania-Hatchery)	Lower Columbia River Steelhead	4	Lewis	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
31	387	EF Lewis Winter Steelhead (Skamania-Hatchery)	Lower Columbia River Steelhead	4	Lewis	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
32	388	NF Lewis Summer Steelhead (Merwin-Hatchery)	Lower Columbia River Steelhead	4	Lewis	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
33	384	NF Lewis Winter Steelhead (Merwin-Hatchery)	Lower Columbia River Steelhead	4	Lewis	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A
34	572	Salmon Creek Winter Steelhead (Skamania-Hatchery)	Lower Columbia River Steelhead	4	Washougal	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
35	405	Sandy Summer Steelhead (South Santiam-Hatchery)	Lower Columbia River Steelhead	4	Sandy	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.1	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
36	412	Washougal Summer Steelhead (Skamania-Hatchery)	Lower Columbia River Steelhead	4	Washougal	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
37	411	Washougal Winter Steelhead (Early-Skamania-Hatchery)	Lower Columbia River Steelhead	4	Washougal	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
38	434	Clackamas Summer Steelhead (Hatchery)	Lower Columbia River Steelhead	4	Willamette	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
39	432	Clackamas-Eagle Creek Winter Steelhead (Early-Hatchery)	Lower Columbia River Steelhead	4	Willamette	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A

Appendix D3. Hatchery Performance by Alternative for Steelhead

Legend		Legend
Primary		Supporting
Contributing		Consistent
Stabilizing		Not Consistent
Not in ESU		

Middle Columbia River Steelhead

Pop #	ID	Population Name	ESU	Designatio	Subbasin	Alt 4 Population Type	Alt 4 pHOS	Alt 4 PNI	Alt 4 Productivity	Alt 4 NOS	Alt 4 HOS/NOS	Alt 5 Population Type	Alt 5 pHOS	Alt 5 PNI	Alt 5 Productivity	Alt 5 NOS	Alt 5 HOS/NOS
1	291	Eastside Tributaries Summer Steelhead	Middle Columbia River Steelhead	1	Deschutes	Natural	0.09	0.00	2.1	2,688	0.26	Natural	0.03	0.00	3.2	4,005	0.06
2	670	Westside Tributaries Summer Steelhead	Middle Columbia River Steelhead	1	Deschutes	Natural	0.07	0.00	1.1	315	0.18	Natural	0.01	0.00	1.7	733	0.03
3	259	Fifteenmile Creek Winter Steelhead	Middle Columbia River Steelhead	1	Fifteenmile Creek	Natural	0.00	0.00	1.9	726	0.01	Natural	0.00	0.00	1.9	728	0.00
4	293	Lower Mainstem Summer Steelhead	Middle Columbia River Steelhead	1	John Day	Natural	0.05	0.00	3.1	2,512	0.11	Natural	0.02	0.00	3.9	3,051	0.05
5	673	Middle Fork Summer Steelhead	Middle Columbia River Steelhead	1	John Day	Natural	0.05	0.00	2.4	885	0.12	Natural	0.02	0.00	3.1	1,119	0.05
6	672	North Fork Summer Steelhead	Middle Columbia River Steelhead	1	John Day	Natural	0.04	0.00	2.6	2,144	0.10	Natural	0.02	0.00	3.1	2,595	0.04
7	274	Klickitat Summer-Winter Steelhead	Middle Columbia River Steelhead	1	Klickitat	Integrated	0.09	0.00	2.3	1,235	0.55	Integrated	0.01	0.96	4.2	2,027	0.02
8	303	Umatilla Summer Steelhead	Middle Columbia River Steelhead	1	Umatilla	Integrated	0.24	0.80	1.6	1,986	0.42	Integrated	0.24	0.80	1.6	1,984	0.42
9	305	Walla Walla Summer Steelhead	Middle Columbia River Steelhead	1	Walla Walla	Natural	0.03	0.00	1.3	489	0.06	Natural	0.03	0.00	1.3	505	0.05
10	307	Touchet Summer Steelhead	Middle Columbia River Steelhead	1	Touchet	Integrated	0.49	0.67	1.3	340	1.24	Integrated	0.49	0.67	1.3	340	1.23
11	316	Naches Summer Steelhead	Middle Columbia River Steelhead	1	Yakima	Natural	0.00	0.00	1.4	536	0.01	Natural	0.00	0.00	1.4	558	0.00
12	317	Satus Summer Steelhead	Middle Columbia River Steelhead	1	Yakima	Natural	0.00	0.00	3.7	869	0.00	Natural	0.00	0.00	3.7	873	0.00
13	674	South Fork Summer Steelhead	Middle Columbia River Steelhead	2	John Day	Natural	0.04	0.00	2.2	315	0.13	Natural	0.04	0.00	2.2	315	0.13
14	675	Upper Mainstem Summer Steelhead	Middle Columbia River Steelhead	2	John Day	Natural	0.04	0.00	2.3	640	0.11	Natural	0.04	0.00	2.3	640	0.11
15	318	Toppenish Summer Steelhead	Middle Columbia River Steelhead	2	Yakima	Natural	0.00	0.00	3.3	723	0.00	Natural	0.00	0.00	3.3	728	0.00
16	319	Upper Yakima Summer Steelhead	Middle Columbia River Steelhead	2	Yakima	Natural	0.18	0.00	0.6	12	0.26	Natural	0.00	0.00	1.1	144	0.01
17	595	White Salmon Summer-Winter Steelhead	Middle Columbia River Steelhead	3	Big White Salmon	Natural	0.63	0.00	1.7	5	4.03	Natural	0.94	0.00	1.7	6	75.41
18	559	Deschutes Summer Steelhead (RoundButte-Hatchery)	Middle Columbia River Steelhead	4	Deschutes	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
19	276	Klickitat Summer Steelhead (Skamania-Hatchery)	Middle Columbia River Steelhead	4	Klickitat	Segregated	1.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A
20	306	Walla Walla Summer Steelhead (Lyons Ferry-Hatchery)	Middle Columbia River Steelhead	4	Walla Walla	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
21	806	Walla Walla Touchet Summer Steelhead (Lyons Ferry-Hatchery)	Middle Columbia River Steelhead	4	Touchet	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
22	254	White Salmon Summer Steelhead (Skamania-Hatchery)	Middle Columbia River Steelhead	4	Big White Salmon	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
23	256	White Salmon Winter Steelhead (Skamania-Hatchery)	Middle Columbia River Steelhead	4	Big White Salmon	Segregated	0.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A

Lower Columbia River Steelhead

Pop #	ID	Population Name	ESU	Designatio	Subbasin	Alt 4 Population Type	Alt 4 pHOS	Alt 4 PNI	Alt 4 Productivity	Alt 4 NOS	Alt 4 HOS/NOS	Alt 5 Population Type	Alt 5 pHOS	Alt 5 PNI	Alt 5 Productivity	Alt 5 NOS	Alt 5 HOS/NOS
1	623	Coweeman Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Coweeman	Natural	0.02	0.00	2.7	461	0.18	Natural	0.02	0.00	2.7	461	0.18
2	622	NF Toutle Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Toutle	Integrated	0.10	0.76	2.4	629	0.15	Integrated	0.06	0.00	1.6	437	0.35
3	621	SF Toutle Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Toutle	Natural	0.01	0.00	3.2	866	0.02	Natural	0.04	0.00	2.4	671	0.23
4	265	Hood Summer Steelhead	Lower Columbia River Steelhead	1	Hood	Integrated	0.33	0.75	1.5	233	0.65	Integrated	0.32	0.75	1.5	232	0.61
5	267	Hood Winter Steelhead	Lower Columbia River Steelhead	1	Hood	Integrated	0.28	0.78	1.4	855	0.48	Integrated	0.28	0.78	1.4	855	0.48
6	372	Kalama Summer Steelhead	Lower Columbia River Steelhead	1	Kalama	Integrated	0.10	0.72	2.5	588	0.14	Integrated	0.04	0.83	2.7	638	0.09
7	375	Kalama Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Kalama	Integrated	0.14	0.70	2.4	338	0.21	Integrated	0.06	0.84	2.6	400	0.14
8	630	EF Lewis Summer Steelhead	Lower Columbia River Steelhead	1	Lewis	Integrated	0.16	0.86	2.7	527	0.24	Natural	0.04	0.00	2.1	437	0.21
9	628	EF Lewis Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Lewis	Integrated	0.08	0.92	4.0	501	0.12	Integrated	0.06	0.00	2.5	388	0.61
10	406	Sandy Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Sandy	Integrated	0.05	0.95	2.8	1,485	0.15	Integrated	0.05	0.95	2.8	1,484	0.15
11	676	Washougal Summer Steelhead	Lower Columbia River Steelhead	1	Washougal	Integrated	0.29	0.78	3.4	412	0.62	Integrated	0.05	0.00	2.6	385	0.30
12	734	Lower Clackamas Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Willamette	Integrated	0.18	0.69	2.5	719	0.36	Integrated	0.33	0.55	2.2	641	0.71
13	433	Upper Clackamas Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Willamette	Natural	0.00	0.00	9.7	3,223	0.00	Natural	0.00	0.00	9.7	3,222	0.00
14	284	Wind Summer Steelhead	Lower Columbia River Steelhead	1	Wind	Natural	0.00	0.00	3.6	1,139	0.00	Natural	0.00	0.00	3.6	1,139	0.00
15	398	Upper Gorge Tributaries Winter Steelhead (Late)	Lower Columbia River Steelhead	2	Columbia Gorge	Natural	0.00	0.00	2.6	149	0.00	Natural	0.00	0.00	2.6	149	0.00
16	363	Lower Cowlitz Winter Steelhead (Late)	Lower Columbia River Steelhead	2	Cowlitz	Integrated	0.23	0.68	2.2	487	0.96	Integrated	0.23	0.68	2.2	487	0.97
17	606	Upper Cowlitz Winter Steelhead (Late)	Lower Columbia River Steelhead	2	Cowlitz	Integrated	0.35	0.74	1.0	293	1.19	Integrated	0.35	0.74	1.0	292	1.21
18	383	NF Lewis Winter Steelhead (Late)	Lower Columbia River Steelhead	2	Lewis	Natural	0.10	0.00	1.8	205	0.55	Natural	0.09	0.00	1.8	210	0.55
19	558	Washougal Winter Steelhead (Late)	Lower Columbia River Steelhead	2	Washougal	Natural	0.02	0.00	3.0	325	0.13	Natural	0.02	0.00	3.0	332	0.12
20	629	NF Lewis Summer Steelhead	Lower Columbia River Steelhead	3	Lewis	Natural	0.09	0.00	2.8	241	0.46	Natural	0.07	0.00	2.9	249	0.46
21	632	Salmon Creek Winter Steelhead (Late)	Lower Columbia River Steelhead	3	Washougal	Natural	0.28	0.00	1.1	26	1.90	Natural	0.21	0.00	1.1	24	1.95
22	362	Coweeman Winter Steelhead (Early Elochoman-Hatchery)	Lower Columbia River Steelhead	4	Coweeman	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
23	365	Lower Cowlitz Summer Steelhead (Skamania-Hatchery)	Lower Columbia River Steelhead	4	Cowlitz	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
24	361	Lower Cowlitz Winter Steelhead (Early-Hatchery)	Lower Columbia River Steelhead	4	Cowlitz	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
25	620	NF Toutle Summer Steelhead (Hatchery)	Lower Columbia River Steelhead	4	Toutle	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
26	364	SF Toutle Summer Steelhead (Hatchery)	Lower Columbia River Steelhead	4	Toutle	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
27	775	Hood Summer Steelhead (Santiam-Hatchery)	Lower Columbia River Steelhead	4	Hood	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
28	373	Kalama Summer Steelhead (Skamania-Hatchery)	Lower Columbia River Steelhead	4	Kalama	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
29	374	Kalama Winter Steelhead (Early-Hatchery)	Lower Columbia River Steelhead	4	Kalama	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
30	385	EF Lewis Summer Steelhead (Skamania-Hatchery)	Lower Columbia River Steelhead	4	Lewis	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
31	387	EF Lewis Winter Steelhead (Skamania-Hatchery)	Lower Columbia River Steelhead	4	Lewis	Segregated	0.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
32	388	NF Lewis Summer Steelhead (Merwin-Hatchery)	Lower Columbia River Steelhead	4	Lewis	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
33	384	NF Lewis Winter Steelhead (Merwin-Hatchery)	Lower Columbia River Steelhead	4	Lewis	Segregated	0.00	0.00	0.0	0	N/A	Segregated	0.00	0.00	0.0	0	N/A
34	572	Salmon Creek Winter Steelhead (Skamania-Hatchery)	Lower Columbia River Steelhead	4	Washougal	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
35	405	Sandy Summer Steelhead (South Santiam-Hatchery)	Lower Columbia River Steelhead	4	Sandy	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
36	412	Washougal Summer Steelhead (Skamania-Hatchery)	Lower Columbia River Steelhead	4	Washougal	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
37	411	Washougal Winter Steelhead (Early-Skamania-Hatchery)	Lower Columbia River Steelhead	4	Washougal	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
38	434	Clackamas Summer Steelhead (Hatchery)	Lower Columbia River Steelhead	4	Willamette	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A
39	432	Clackamas-Eagle Creek Winter Steelhead (Early-Hatchery)	Lower Columbia River Steelhead	4	Willamette	Segregated	1.00	0.00	0.0	0	N/A	Segregated	1.00	0.00	0.0	0	N/A

Appendix D4 Hatchery Production by Alternative for Steelhead

Primary
Contributing
Stabilizing

Upper Willamette River Steelhead

Pop #	ID	Population Name	ESU	Desig	Subbasin	Alternative 1 Upper Willamette										Alternative 2 Upper Willamette										Alternative 3 Upper Willamette									
						Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	426	Mollalla Winter Steelhead	Upper Willamette River Steelhead	1	Willamette	0	0			0%	0%	38,894	0	53	0%	0	0			0%	0%	38,894	-	53	0%	0	0			0%	0%	38,894	0	53	0%
2	427	North Santiam Winter Steelhead (Late)	Upper Willamette River Steelhead	1	Willamette	0	0			0%	0%	52,139	0	248	0%	0	0			0%	0%	56,271	-	272	0%	0	0			0%	0%	54,003	0	260	0%
3	429	South Santiam Winter Steelhead	Upper Willamette River Steelhead	1	Willamette	0	0			0%	0%	72,276	0	127	0%	0	0			0%	0%	73,623	-	130	0%	0	0			0%	0%	73,429	0	130	0%
4	424	Calapooia Winter Steelhead(Late)	Upper Willamette River Steelhead	2	Willamette	0	0			0%	0%	12,600	0	17	0%	0	0			0%	0%	12,790	-	17	0%	0	0			0%	0%	12,763	0	17	0%
5	431	WestSide Tribs Winter Steelhead (Late)	Upper Willamette River Steelhead	3	Willamette	0	0			0%	0%	1,828	0	9	0%	0	0			0%	0%	2,004	-	10	0%	0	0			0%	0%	1,828	0	9	0%
6	688	MF Willamette Summer Steelhead (S.Santiam-Hatchery)	Upper Willamette River Steelhead	4	Willamette	114,468	901	0.79%		0%	10%	0	480	0	0%	114,468	901	0.79%		0%	10%	0	480	-	0%	114,468	901	0.79%		0%	10%	0	480	0	0%
7	435	Mainstem Willamette Summer Steelhead (S.Santiam-Hatchery)	Upper Willamette River Steelhead	4	Willamette	51,174	403	0.79%		0%	0%	0	215	0	0%	51,174	403	0.79%		0%	0%	0	215	0	0%	51,174	403	0.79%		0%	0%	0	215	0	0%
8	687	McKenzie Summer Steelhead (S.Santiam-Hatchery)	Upper Willamette River Steelhead	4	Willamette	123,502	2,790	2.26%		0%	0%	0	1488	0	0%	123,502	2,790	2.26%		0%	0%	0	1,488	0	0%	123,502	2,790	2.26%		0%	0%	0	1488	0	0%
9	689	North Santiam Summer Steelhead (S. Santiam Hatchery)	Upper Willamette River Steelhead	4	Willamette	161,116	6,490	4.03%		0%	60%	0	3461	0	0%	68,270	2,750	4.03%		0%	60%	0	1,467	0	0%	81,923	3,300	4.03%		0%	60%	0	1760	0	0%
10	690	South Santiam Summer Steelhead (Hatchery)	Upper Willamette River Steelhead	4	Willamette	144,095	8,346	5.79%		0%	10%	0	5643	0	0%	144,095	8,346	5.79%		0%	10%	0	5,643	0	0%	144,095	8,346	5.79%		0%	10%	0	5643	0	0%

Upper Columbia River Steelhead

Pop #	ID	Population Name	ESU	Desig	Subbasin	Alternative 1 Upper Columbia										Alternative 2 Upper Columbia										Alternative 3 Upper Columbia									
						Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	233	Entiat Summer Steelhead	Upper Columbia River Steelhead	1	Entiat	0	0			0%	0%	18,738	0	8	0%	0	0			0%	0%	**12,404**	-	5	0%	0	0			0%	0%	12,404	0	5	0%
2	238	Methow Summer Steelhead	Upper Columbia River Steelhead	1	Methow	420,137	4,437	1.06%		0%	94%	199,724	1615	83	0%	100,201	1,058	1.06%		0%	94%	**170,237**	385	75	100%	100,201	1,058	1.06%		0%	94%	170,237	385	75	100%
3	593	Okanogan Summer Steelhead	Upper Columbia River Steelhead	1	Okanogan	19,995	212	1.06%		0%	70%	19,550	77	10	25%	19,995	212	1.06%		0%	70%	**13,808**	77	8	25%	19,995	212	1.06%		0%	70%	13,808	77	8	25%
4	252	Wenatchee Summer Steelhead	Upper Columbia River Steelhead	1	Wenatchee	400,950	4,513	1.13%		0%	40%	99,528	859	38	50%	300,591	3,383	1.13%		0%	40%	**102,234**	644	40	75%	300,591	3,383	1.13%		0%	40%	102,234	644	40	75%
5	287	Ringold Summer Steelhead (Wells)	Upper Columbia River Steelhead	4	Hanford Reach	171,131	1,020	0.60%	MAF	0%	0%	1	251	0	0%	0	0			0%	0%	**0**	-	0	0%	171,131	1,020	0.60%	MAF	0%	0%	1	251	0	0%
6	824	Methow Summer Steelhead (Stepping Stone Hatchery)	Upper Columbia River Steelhead	4	Methow	0	0			0%	94%	0	0	0	0%	0	0			0%	94%	**0**	-	0	0%	0	0			0%	94%	0	0	0	0%
7	813	Okanogan Summer Steelhead (Wells-Hatchery)	Upper Columbia River Steelhead	4	Okanogan	138,853	1,472	1.06%		0%	0%	2	536	0	0%	0	0			0%	0%	**0**	-	0	0%	0	0			0%	0%	0	0	0	0%
8	825	Wenatchee Summer Steelhead (Stepping Stone Hatchery)	Upper Columbia River Steelhead	4	Wenatchee	0	0			0%	0%	0	0	0	0%	0	0			0%	0%	**0**	-	0	0%	0	0			0%	0%	0	0	0	0%

Southwest Washington Steelhead

Pop #	ID	Population Name	ESU	Desig	Subbasin	Alternative 1 SW WA										Alternative 2 SW WA										Alternative 3 SW WA									
						Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	666	Mill-Aber-Germ Winter Steelhead (Late)	Southwest Washington Steelhead	1	Mill-Aber-Germ	0	0			0%	50%	4,561	0	39	0%	0	0			0%	50%	4,563	-	39	0%	0	0			0%	50%	4,557	0	39	0%
2	351	Grays Winter Steelhead (Late)	Southwest Washington Steelhead	1	Grays	0	0			0%	50%	15,788	0	59	0%	0	0			0%	50%	16,577	-	63	0%	0	0			0%	50%	15,788	0	59	0%
3	344	Elochoman Winter Steelhead (Late)	Southwest Washington Steelhead	2	Elochoman	0	0			0%	25%	6,710	0	26	0%	0	0			0%	25%	8,556	-	34	0%	0	0			0%	25%	6,710	0	26	0%
4	663	Big Creek Winter Steelhead (Late)	Southwest Washington Steelhead	3	Big Creek	0	0			0%	5%	596	0	6	0%	0	0			0%	5%	704	-	7	0%	0	0			0%	5%	596	0	6	0%
5	589	Clatskanie Winter Steelhead (Late)	Southwest Washington Steelhead	3	Clatskanie	0	0			0%	0%	4,365	0	9	0%	0	0			0%	0%	4,406	-	9	0%	0	0			0%	0%	4,365	0	9	0%
6	599	Gnat Creek Winter Steelhead (Late)	Southwest Washington Steelhead	3	Gnat Creek	0	0			0%	10%	103	0	1	0%	0	0			0%	10%	176	-	2	0%	0	0			0%	10%	103	0	1	0%
7	588	Youngs Bay Tribs Winter Steelhead (Late)	Southwest Washington Steelhead	3	Young Bay Tribs	0	0			0%	25%	609	0	6	0%	0	0			0%	25%	1,218	-	13	0%	0	0			0%	25%	609	0	6	0%
8	590	Big Creek Winter Steelhead (Hatchery)	Southwest Washington Steelhead	4	Big Creek	60,008	720	1.20%	MAF	0%	5%	0	420	0	0%	0	0			0%	5%	0	-	0	0%	60,008	720	1.20%	MAF	0%	5%	0	420	0	0%
9	598	Gnat Creek Winter Steelhead (Hatchery)	Southwest Washington Steelhead	4	Gnat Creek	40,005	200	0.50%	MAF	0%	10%	0	117	0	0%	0	0			0%	10%	0	-	0	0%	40,005	200	0.50%	MAF	0%	10%	0	117	0	0%
10	684	Youngs Bay Tribs Winter Steelhead (Hatchery)	Southwest Washington Steelhead	4	Young Bay Tribs	60,008	720	1.20%	MAF	0%	25%	0	420	0	0%	0	0			0%	25%	0	-	0	0%	60,008	720	1.20%	MAF	0%	25%	0	420	0	0%
11	345	Elochoman Summer Steelhead (Merwin-Hatchery)	Southwest Washington Steelhead	4	Elochoman	30,881	300	0.97%	MAF	0%	0%	0	239	0	0%	0	0			0%	0%	0	-	0	0%	30,881	300	0.97%	MAF	0%	0%	0	239	0	0%
12	343	Elochoman Winter Steelhead (Early-Hatchery)	Southwest Washington Steelhead	4	Elochoman	90,720	1,510	1.66%	MAF	0%	25%	0	1492	0	0%	0	0			0%	25%	0	-	0	0%	90,720	1,510	1.66%	MAF	0%	25%	0	1492	0	0%
13	352	Grays Winter Steelhead (Early-Elochoman-Hatchery)	Southwest Washington Steelhead	4	Grays	40,014	261	0.65%	MAF	0%	0%	0	180	0	0%	0	0			0%	0%	0	-	0	0%	40,014	261	0.65%	MAF	0%	0%	0	180	0	0%

Snake River Basin Steelhead

Pop #	ID	Population Name	ESU	Desig	Subbasin	Alternative 1 Snake										Alternative 2 Snake										Alternative 3 Snake									
						Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	448	Lochsa Summer Steelhead (B-Run)	Snake River Basin Steelhead	1	Clearwater	0	0			0%	0%	48,251	0	227	0%	0	0			0%	0%	48,284	-	227	0%	0	0			0%	0%	48,251	0	227	0%
2	299	Tucannon Summer Steelhead	Snake River Basin Steelhead	1	Tucannon	50,860	691	1.36%		0%	25%	6,263	73	19	100%	50,860	691	1.36%		0%	0%	6,447	73	20	100%	50,860	691	1.36%		0%	0%	6,447	73	20	100%
3	220	Wallowa Summer Steelhead	Snake River Basin Steelhead	1	Grande Ronde	0	0			0%	0%	54,565	0	139	0%	0	0			0%	0%	55,086	-	140	0%	0	0			0%	0%	54,565	0	139	0%
4	554	Upper Grande Ronde Summer Steelhead	Snake River Basin Steelhead	1	Grande Ronde	0	0			0%	0%	60,445	0	151	0%	0	0			0%	0%	62,530	-	157	0%	0	0			0%	0%	60,445	0	151	0%
5	548	South Fork Summer Steelhead (B-Run)	Snake River Basin Steelhead	1	Salmon	0	0			0%	0%	33,631	0	160	0%	0	0			0%	0%	33,631	-	160	0%	0	0			0%	0%	33,631	0	160	0%
6	547	Secesh Summer Steelhead (B-Run)	Snake River Basin Steelhead	1	Salmon	0	0			0%	0%	10,033	0	48	0%	0	0			0%	0%	10,033	-	48	0%	0	0			0%	0%	10,033	0	48	0%
7	546	Chamberlain Summer Steelhead (A-Run)	Snake River Basin Steelhead	1	Salmon	0	0			0%	0%	11,944	0	36	0%	0	0			0%	0%	11,944	-	36	0%	0	0			0%	0%	11,944	0	36	0%
8	544	Lower Middle Fork Salmon Summer Steelhead (B-Run)	Snake River Basin Steelhead	1	Salmon	0	0			0%	0%	41,670	0	198	0%	0	0			0%	0%	41,670	-	198	0%	0	0			0%	0%	41,670	0	198	0%
9	545	Upper Middle Fork Salmon Summer Steelhead (B-Run)	Snake River Basin Steelhead	1	Salmon	0	0			0%	0%	44,671	0	213	0%	0	0			0%	0%	44,671	-	213	0%	0	0			0%	0%	44,671	0	213	0%
10	542	North Fork Salmon Summer Steelhead (A-Run)	Snake River Basin Steelhead	1	Salmon	0	0			0%	0%	6,470	0	19	0%	0	0			0%	0%	6,612	-	20	0%	0	0			0%	0%	6,470	0	19	0%
11	521	Selway Summer Steelhead (B-Run)	Snake River Basin Steelhead	1	Clearwater	0	0			0%	0%	62,629	0	296	0%	0	0			0%	0%	62,656	-	296	0%	0	0			0%	0%	62,629	0	296	0%
12	541	Lemhi Summer Steelhead (A-Run)	Snake River Basin Steelhead	1	Salmon	0	0			0%	0%	10,201	0	29	0%	0	0			0%	0%	19,746	-	58	0%	0	0			50%	0%	19,691	0	57	0%
13	467	East Fork Salmon Summer Steelhead	Snake River Basin Steelhead	1	Salmon	49,513	256	0.52%		0%	80%	14,291	65	72	5%	50,888	262	0.51%		0%	0%	18,024	67	95	100%	50,888	262	0.51%		0%	0%	18,037	67	95	100%
14	223	Imnaha Summer Steelhead	Snake River Basin Steelhead	1	Imnaha	0	0			0%	0%	46,494	0	123	0%	0	0			0%	0%	47,120	-	125	0%	0	0			0%	0%	47,120	0	125	0%
15	447	Lower Clearwater Summer Steelhead (A-Run)	Snake River Basin Steelhead	1	Clearwater	0	0			0%	0%	50,050	0	146	0%	0	0			0%	0%	50,064	-	146	0%	0	0			0%	0%	50,050	0	146	0%
16	217	Lower Grande Ronde Summer Steelhead	Snake River Basin Steelhead	1	Grande Ronde	0	0			0%	0%	56,335	0	141	0%	0	0			0%	0%	56,682	-	142	0%	0	0			0%	0%	56,335	0	141	0%
17	553	Joseph Summer Steelhead	Snake River Basin Steelhead	1	Grande Ronde	0	0			0%	0%	99,495	0	254	0%	0	0			0%	0%	99,534	-	254	0%	0	0			0%	0%	99,495	0	254	0%
18	208	Asotin Summer Steelhead (A-run)	Snake River Basin Steelhead	2	Asotin	0	0			0%	0%	14,817	0	36	0%	0	0			0%	0%	16,215	-	39	0%	0	0			0%	0%	16,206	0	39	0%
19	464	Pahsimeroi Summer Steelhead (A-Run)	Snake River Basin Steelhead	2	Salmon	0	0			0%	0%	2,833	0	8	0%	0	0			0%	0%	11,920	-	34	0%	0	0			50%	0%	11,667	0	33	0%
20	981	Little Sheep Summer Steelhead	Snake River Basin Steelhead	2	Imnaha	212,268	1,815	0.86%		0%	30%	4,340	1348	11	10%	87,714	750	0.86%		0%	30%	4,173	557	11	50%	87,714	750	0.86%		0%	30%	4,173	557	11	50%
21	827	SF Clearwater_Crooked River Summer Steelhead (B-Run)	Snake River Basin Steelhead	2	Clearwater	84,177	1,187	1.41%		0%	80%	13,734	304	63	100%	84,177	1,187	1.41%		0%	80%	13,734	304	63	100%	84,177	1,187	1.41%		0%	80%	13,734	304	63	100%
22	744	Lolo Summer Steelhead (A+B-Run)	Snake River Basin Steelhead	2	Clearwater	49,662	700	1.41%		0%	90%	5,326	101	13	0%	49,413	697	1.41%		0%	0%	6,882	101	18	100%	49,413	697	1.41%		0%	0%	8,041	101	21	100%
23	549	Little Salmon Summer Steelhead (A-Run)	Snake River Basin Steelhead	3	Salmon	0	0			0%	90%	14,234	0	39	0%	0	0			0%	90%	14,234	-	39	0%	0	0			0%	90%	14,234	0	39	0%
24	543	Panther Creek Summer Steelhead (A-Run)	Snake River Basin Steelhead	3	Salmon	0	0			0%	0%	8,754	0	26	0%	0	0			0%	0%	8,754	-	26	0%	0	0			0%	0%	8,754	0	26	0%
25	540	Upper Salmon Summer Steelhead (A-Run)	Snake River Basin Steelhead	3	Salmon	0	0			0%	0%	12,346	0	35	0%	0	0			0%	0%	11,960	-	34	0%	0	0			0%	0%	11,973	0	34	0%
26	229	Snake Hells Canyon Summer Steelhead	Snake River Basin Steelhead	3	Snake Hells Canyon	0	0			0%	0%	10,751	0	26	0%	0	0			0%	0%	9,809	-	24	0%	0	0			0%	0%	9,809	0	24	0%
27	449	SF Clearwater Summer Steelhead (B-Run)	Snake River Basin Steelhead	3	Clearwater	399,776	5,635	1.41%		0%	90%	12,497	1442	55	0%	399,776	5,635	1.41%		0%	90%	12,498	1,442	55	0%	399,776	5,635	1.41%		0%	90%	12,504	1442	55	0%
28	512	Wallowa Summer Steelhead (Hatchery)	Snake River Basin Steelhead	4	Grande Ronde	799,288	7,391	0.92%		0%	50%	0	5648	0	0%	227,934	2,108	0.92%		0%	50%	0	1,611	-	0%	799,288	7,391	0.92%		0%	50%	0	5648	0	0%
29	550	Little Salmon Summer Steelhead (A-Run-Pahsimeroi-Oxbow-Hatchery)	Snake River Basin Steelhead	4	Salmon	645,044	5,909	0.92%		0%	90%	0	4319	0	0%	645,044	5,909	0.92%		0%	90%	0	4,319	0	0%	645,044	5,909	0.92%		0%	90%	0	4319	0	0%
30	791	Little Salmon Summer Steelhead (B-Run-Dworshak-Hatchery)	Snake River Basin Steelhead	4	Salmon	316,333	1,633	0.52%		0%	90%	0	1293	0	0%	316,333	1,633	0.52%		0%	90%	0	1,293	0	0%	316,333	1,633	0.52%		0%	90%	0	1293	0	0%
31	298	Tucannon Summer Steelhead (Lyons Ferry)	Snake River Basin Steelhead	4	Tucannon	100,674	4,535	4.51%		0%	88%	0	3765	0	0%	0	0			0%	88%	0	-	-	0%	0	0			0%	88%	0	0	0	0%
32	790	Lemhi Summer Steelhead (A-Run-Pahsimeroi Hatchery)	Snake River Basin Steelhead	4	Salmon	119,656	1,096	0.92%		0%	90%	0	801	0	0%	0	0			0%	90%	0	-	0	0%	0	0			0%	90%	0	0	0	0%
33	539	Pahsimeroi Summer Steelhead (A-Run-Pahsimeroi-Hatchery)	Snake River Basin Steelhead	4	Salmon	1,086,781	7,434	0.68%		0%	10%	0	5433	0	0%	497,340	3,402	0.68%		0%	10%	0	2,486	0	0%	1,086,781	7,434	0.68%		0%	10%	0	5433	0	0%
34	792	East Fork Salmon Summer Steelhead (B-Run Dworshak-Hatchery)	Snake River Basin Steelhead	4	Salmon	324,806	2,024	0.62%		0%	90%	0	1603	0	0%	0	0			0%	90%	0	-	0	0%	0	0			0%	90%	0	0	0	0%
35	814	East Fork Salmon Summer Steelhead (A-Run Pahasimeroi-Hatchery)	Snake River Basin Steelhead	4	Salmon	180,516	1,118	0.62%		0%	90%	0	817	0	0%	0	0			0%	90%	0	-	0	0%	0	0			0%	90%	0	0	0	0%
36	465	Upper Salmon Summer Steelhead (A-Run Sawtooth-Pahsimeroi-Hatchery)	Snake River Basin Steelhead	4	Salmon	1,284,595	9,324	0.73%		0%	30%	0	6813	0	0%	1,284,595	9,324	0.73%		0%	30%	0	6,813	0	0%	1,284,595	9,324	0.73%		0%	30%	0	6813	0	0%
37	466	Upper Salmon Summer Steelhead (B-Run Dworshak-Hatchery)	Snake River Basin Steelhead	4	Salmon	250,316	455	0.18%		0%	75%	0	360	0	0%	250,316	455	0.18%		0%	75%	0	360	0	0%	250,316	455	0.18%		0%	75%	0	360	0	0%
38	793	Upper Salmon Summer Steelhead (Upper Salmon B-Run Program)	Snake River Basin Steelhead	4	Salmon	59,228	330	0.56%		0%	75%	0	261	0	0%	59,228	330	0.56%		0%	75%	0	261	0	0%	59,228	330	0.56%		0%	75%	0	261	0	0%
39	983	Little Sheep Summer Steelhead (Stepping Stone Hatchery)	Snake River Basin Steelhead	4	Imnaha	0	0			0%	0%	0	0	0	0%	0	0			0%	0%	0	-	0	0%	0	0			0%	0%	0	0	0	0%
40	230	Snake Hells Canyon Summer Steelhead (Oxbow-Hatchery)	Snake River Basin Steelhead	4	Snake Hells Canyon	525,388	2,537	0.48%		0%	5%	0	1947	0	0%	525,388	2,537	0.48%		0%	5%	0	1,947	0	0%	525,388	2,537	0.48%		0%	5%	0	1947	0	0%
41	789	SF Clearwater Summer Steelhead (B-Run Hatchery)	Snake River Basin Steelhead	4	Clearwater	911,292	12,845	1.41%		0%	90%	0	10173	0	0%	911,292	12,845	1.41%		0%	90%	0	10,173	0	0%	911,292	12,845	1.41%		0%	90%	0	10173	0	0%
42	450	NF Clearwater Summer Steelhead (B-Run-Hatchery)	Snake River Basin Steelhead	4	Clearwater	1,199,329	16,905	1.41%		0%	5%	0	13389	0	0%	1,199,329	16,905	1.41%		0%	5%	0	13,389	0	0%	1,199,329	16,905	1.41%		0%	5%	0	13389	0	0%
43	738	Lower Clearwater Summer Steelhead (B-Run-Hatchery)	Snake River Basin Steelhead	4	Clearwater	297,970	4,200	1.41%		0%	90%	0	3326	0	0%	297,970	4,200	1.41%		0%	90%	0	3,326	0	0%	297,970	4,200	1.41%		0%	90%	0	3326	0	0%
44	218	Cottonwood Creek Summer Steelhead (Wallowa-Lyons Ferry-Hatchery)	Snake River Basin Steelhead	4	Grande Ronde	160,056	3,032	1.89%		0%	15%	0	2795	0	0%	160,056	3,032	1.89%		0%	15%	0	2,795	-	0%	160,056	3,032	1.89%		0%	15%	0	2795	0	0%
45	295	Snake Lower Summer Steelhead (Lyons Ferry)	Snake River Basin Steelhead	4	Lower Snake	60,601	1,092	1.80%		0%	45%	0	820	0	0%	60,601	1,092	1.80%		0%	15%	0	820	-	0%	60,601	1,092	1.80%		0%	15%	0	820	0	0%

Appendix D4 Hatchery Production by Alternative for Steelhead

Primary
Contributing
Stabilizing

Upper Willamette River Steelhead

						Alternative 4 Upper Willamette										Alternative 5 Upper Willamette									
Pop #	ID	Population Name	ESU	Desig	Subbasin	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	426	Mollalla Winter Steelhead	Upper Willamette River Steelhead	1	Willamette	0	0			0%	0%	38894	0	52.6	0%	0	0			0	0%	38,894	0	53	0%
2	427	North Santiam Winter Steelhead (Late)	Upper Willamette River Steelhead	1	Willamette	0	0			0%	0%	71354	0	355.6	0%	0	0			0	0%	54,003	0	260	0%
3	429	South Santiam Winter Steelhead	Upper Willamette River Steelhead	1	Willamette	0	0			0%	0%	74203	0	131.4	0%	0	0			0	0%	73,429	0	130	0%
4	424	Calapooia Winter Steelhead(Late)	Upper Willamette River Steelhead	2	Willamette	0	0			0%	0%	12872	0	17.3	0%	0	0			0	0%	12,763	0	17	0%
5	431	WestSide Tribs Winter Steelhead (Late)	Upper Willamette River Steelhead	3	Willamette	0	0			0%	0%	1976	0	9.8	0%	0	0			0	0%	1,828	0	9	0%
6	688	MF Willamette Summer Steelhead (S.Santiam-Hatchery)	Upper Willamette River Steelhead	4	Willamette	114,468	901	0.79%		0%	10%	0	480.4894	-	0%	114,468	901	0.79%		0	10%	0	480	0	0%
7	435	Mainstem Willamette Summer Steelhead (S.Santiam-Hatchery)	Upper Willamette River Steelhead	4	Willamette	51,174	403	0.79%		0%	0%	0	214.807	-	0%	51,174	403	0.79%		0	0%	0	215	0	0%
8	687	McKenzie Summer Steelhead (S.Santiam-Hatchery)	Upper Willamette River Steelhead	4	Willamette	123,502	2,790	2.26%		0%	0%	0	1487.864	-	0%	123,502	2,790	2.26%		0	0%	0	1,488	0	0%
9	689	North Santiam Summer Steelhead (S. Santiam Hatchery)	Upper Willamette River Steelhead	4	Willamette	161,116	6,490	4.03%		0%	10%	0	3461.016	-	0%	81,923	3,300	4.03%		0	60%	0	1,760	0	0%
10	690	South Santiam Summer Steelhead (Hatchery)	Upper Willamette River Steelhead	4	Willamette	144,095	8,346	5.79%		0%	10%	0	5643.354	-	0%	144,095	8,346	5.79%		0	10%	0	5,643	0	0%

Upper Columbia River Steelhead

						Alternative 4 Upper Columbia										Alternative 5 Upper Columbia									
Pop #	ID	Population Name	ESU	Desig	Subbasin	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	233	Entiat Summer Steelhead	Upper Columbia River Steelhead	1	Entiat	0	0			0%	0%	12404	0	5	0%	0	0			0	0%	9,947	0	4	0%
2	238	Methow Summer Steelhead	Upper Columbia River Steelhead	1	Methow	100,201	1,058	1.06%		0%	94%	170237	385	75	100%	100,201	1,058	1.06%		0	75%	173,801	385	76	100%
3	593	Okanogan Summer Steelhead	Upper Columbia River Steelhead	1	Okanogan	19,995	212	1.06%		0%	70%	13808	77	8	25%	199,949	2,120	1.06%	MAF	0	65%	19,378	772	10	5%
4	252	Wenatchee Summer Steelhead	Upper Columbia River Steelhead	1	Wenatchee	300,591	3,383	1.13%		0%	40%	102234	644	40	75%	100,055	1,126	1.13%		0	25%	96,985	214	39	100%
5	287	Ringold Summer Steelhead (Wells)	Upper Columbia River Steelhead	4	Hanford Reach	171,131	1,020	0.60%	MAF	0%	0%	1	251	0	0%	0	0			0	0%	0	0	0	0%
6	824	Methow Summer Steelhead (Stepping Stone Hatchery)	Upper Columbia River Steelhead	4	Methow	0	0			0%	0%	0	0	0	0%	319,750	3,377	1.06%	MAF	0	10%	2	1,229	0	0%
7	813	Okanogan Summer Steelhead (Wells-Hatchery)	Upper Columbia River Steelhead	4	Okanogan	0	0			0%	0%	0	0	0	0%	0	0			0	0%	0	0	0	0%
8	825	Wenatchee Summer Steelhead (Stepping Stone Hatchery)	Upper Columbia River Steelhead	4	Wenatchee	0	0			0%	0%	0	0	0	0%	300,712	3,385	1.13%	MAF	0	5%	1	644	0	0%

Southwest Washington Steelhead

						Alternative 4 SW WA										Alternative 5 SW WA									
Pop #	ID	Population Name	ESU	Desig	Subbasin	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	666	Mill-Aber-Germ Winter Steelhead (Late)	Southwest Washington Steelhead	1	Mill-Aber-Germ	0	0			0%	0%	4555	0	39	0%	0	0			0	0%	4,554	0	39	0%
2	351	Grays Winter Steelhead (Late)	Southwest Washington Steelhead	1	Grays	0	0			0%	0%	15789	0	59	0%	0	0			0	0%	15,785	0	59	0%
3	344	Elochoman Winter Steelhead (Late)	Southwest Washington Steelhead	2	Elochoman	0	0			0%	10%	7156	0	28	0%	0	0			0	10%	6,713	0	26	0%
4	663	Big Creek Winter Steelhead (Late)	Southwest Washington Steelhead	3	Big Creek	0	0			0%	2%	647	0	7	0%	0	0			0	2%	646	0	7	0%
5	589	Clatskanie Winter Steelhead (Late)	Southwest Washington Steelhead	3	Clatskanie	0	0			0%	0%	4180	0	8	0%	0	0			0	0%	4,173	0	8	0%
6	599	Gnat Creek Winter Steelhead (Late)	Southwest Washington Steelhead	3	Gnat Creek	0	0			0%	10%	104	0	1	0%	0	0			0	10%	103	0	1	0%
7	588	Youngs Bay Tribs Winter Steelhead (Late)	Southwest Washington Steelhead	3	Young Bay Tribs	0	0			0%	25%	609	0	6	0%	0	0			0	25%	609	0	6	0%
8	590	Big Creek Winter Steelhead (Hatchery)	Southwest Washington Steelhead	4	Big Creek	60,008	720	1.20%	MAF	0%	2%	0	420	0	0%	60,008	720	1.20%	MAF	0	2%	0	420	0	0%
9	598	Gnat Creek Winter Steelhead (Hatchery)	Southwest Washington Steelhead	4	Gnat Creek	40,005	200	0.50%	MAF	0%	10%	0	117	0	0%	40,005	200	0.50%	MAF	0	10%	0	117	0	0%
10	684	Youngs Bay Tribs Winter Steelhead (Hatchery)	Southwest Washington Steelhead	4	Young Bay Tribs	60,008	720	1.20%	MAF	0%	25%	0	420	0	0%	60,008	720	1.20%	MAF	0	25%	0	420	0	0%
11	345	Elochoman Summer Steelhead (Merwin-Hatchery)	Southwest Washington Steelhead	4	Elochoman	30,881	300	0.97%	MAF	0%	0%	0	239	0	0%	30,881	300	0.97%	MAF	0	0%	0	239	0	0%
12	343	Elochoman Winter Steelhead (Early-Hatchery)	Southwest Washington Steelhead	4	Elochoman	90,720	1,510	1.66%	MAF	0%	5%	0	1492	0	0%	90,720	1,510	1.66%	MAF	0	25%	0	1,492	0	0%
13	352	Grays Winter Steelhead (Early-Elochoman-Hatchery)	Southwest Washington Steelhead	4	Grays	40,014	261	0.65%	MAF	0%	0%	0	180	0	0%	40,014	261	0.65%	MAF	0	0%	0	180	0	0%

Snake River Basin Steelhead

						Alternative 4 Snake										Alternative 5 Snake									
Pop #	ID	Population Name	ESU	Desig	Subbasin	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	448	Lochsa Summer Steelhead (B-Run)	Snake River Basin Steelhead	1	Clearwater	0	0			0%	0%	48,251	0	227	0%	0	0			0	0%	53,265	0	253	0%
2	299	Tucannon Summer Steelhead	Snake River Basin Steelhead	1	Tucannon	50,860	691	1.36%		0%	0%	6,456	73	20	100%	33,850	460	1.36%		0	25%	4,570	49	14	100%
3	220	Wallowa Summer Steelhead	Snake River Basin Steelhead	1	Grande Ronde	0	0			0%	0%	54,565	0	139	0%	0	0			0	0%	54,603	0	139	0%
4	554	Upper Grande Ronde Summer Steelhead	Snake River Basin Steelhead	1	Grande Ronde	0	0			0%	0%	60,445	0	151	0%	0	0			0	0%	60,445	0	151	0%
5	548	South Fork Summer Steelhead (B-Run)	Snake River Basin Steelhead	1	Salmon	0	0			0%	0%	33,631	0	160	0%	0	0			0	0%	33,979	0	162	0%
6	547	Secesh Summer Steelhead (B-Run)	Snake River Basin Steelhead	1	Salmon	0	0			0%	0%	10,033	0	48	0%	0	0			0	0%	10,219	0	48	0%
7	546	Chamberlain Summer Steelhead (A-Run)	Snake River Basin Steelhead	1	Salmon	0	0			0%	0%	11,944	0	36	0%	0	0			0	0%	11,964	0	36	0%
8	544	Lower Middle Fork Salmon Summer Steelhead (B-Run)	Snake River Basin Steelhead	1	Salmon	0	0			0%	0%	41,670	0	198	0%	0	0			0	0%	41,897	0	199	0%
9	545	Upper Middle Fork Salmon Summer Steelhead (B-Run)	Snake River Basin Steelhead	1	Salmon	0	0			0%	0%	44,671	0	213	0%	0	0			0	0%	44,671	0	213	0%
10	542	North Fork Salmon Summer Steelhead (A-Run)	Snake River Basin Steelhead	1	Salmon	0	0			0%	0%	6,470	0	19	0%	0	0			0	0%	6,516	0	19	0%
11	521	Selway Summer Steelhead (B-Run)	Snake River Basin Steelhead	1	Clearwater	0	0			0%	0%	62,629	0	296	0%	0	0			0	0%	66,753	0	317	0%
12	541	Lemhi Summer Steelhead (A-Run)	Snake River Basin Steelhead	1	Salmon	0	0			50%	0%	19,691	0	57	0%	0	0			0.95	0%	20,206	0	59	0%
13	467	East Fork Salmon Summer Steelhead	Snake River Basin Steelhead	1	Salmon	50,888	262	0.51%		0%	0%	18,037	67	95	100%	100,009	514	0.51%	MAF	0	75%	19,643	132	103	100%
14	223	Imnaha Summer Steelhead	Snake River Basin Steelhead	1	Imnaha	0	0			0%	0%	47,120	0	125	0%	0	0			0	0%	46,992	0	124	0%
15	447	Lower Clearwater Summer Steelhead (A-Run)	Snake River Basin Steelhead	1	Clearwater	0	0			0%	0%	50,050	0	146	0%	0	0			0	0%	54,182	0	160	0%
16	217	Lower Grande Ronde Summer Steelhead	Snake River Basin Steelhead	1	Grande Ronde	0	0			0%	0%	56,335	0	141	0%	0	0			0	0%	56,335	0	141	0%
17	553	Joseph Summer Steelhead	Snake River Basin Steelhead	1	Grande Ronde	0	0			0%	0%	99,495	0	254	0%	0	0			0	0%	99,495	0	254	0%
18	208	Asotin Summer Steelhead (A-run)	Snake River Basin Steelhead	2	Asotin	0	0			0%	0%	16,206	0	39	0%	0	0			0	0%	30,780	0	79	0%
19	464	Pahsimeroi Summer Steelhead (A-Run)	Snake River Basin Steelhead	2	Salmon	0	0			50%	0%	11,667	0	33	0%	0	0			0.95	0%	15,531	0	45	0%
20	981	Little Sheep Summer Steelhead	Snake River Basin Steelhead	2	Imnaha	87,714	750	0.86%		0%	30%	4,173	557	11	50%	87,714	750	0.86%		0	30%	4,997	557	13	65%
21	827	SF Clearwater_Crooked River Summer Steelhead (B-Run)	Snake River Basin Steelhead	2	Clearwater	84,177	1,187	1.41%		0%	80%	13,837	304	64	100%	123,906	1,747	1.41%	MAF	0	80%	14,631	447	67	100%
22	744	Lolo Summer Steelhead (A+B-Run)	Snake River Basin Steelhead	2	Clearwater	49,413	697	1.41%		0%	0%	8,080	101	21	100%	49,413	697	1.41%		0	0%	8,003	101	21	100%
23	549	Little Salmon Summer Steelhead (A-Run)	Snake River Basin Steelhead	3	Salmon	0	0			0%	90%	14,234	0	39	0%	0	0			0	90%	13,805	0	38	0%
24	543	Panther Creek Summer Steelhead (A-Run)	Snake River Basin Steelhead	3	Salmon	0	0			0%	0%	8,754	0	26	0%	0	0			0	0%	8,795	0	26	0%
25	540	Upper Salmon Summer Steelhead (A-Run)	Snake River Basin Steelhead	3	Salmon	0	0			0%	0%	11,973	0	34	0%	0	0			0	0%	10,880	0	31	0%
26	229	Snake Hells Canyon Summer Steelhead	Snake River Basin Steelhead	3	Snake Hells Canyon	0	0			0%	0%	9,810	0	24	0%	0	0			0	0%	6,102	0	15	0%
27	449	SF Clearwater Summer Steelhead (B-Run)	Snake River Basin Steelhead	3	Clearwater	399,776	5,635	1.41%		0%	90%	13,543	1442	59	0%	248,308	3,500	1.41%		0	10%	8,502	896	38	0%
28	512	Wallowa Summer Steelhead (Hatchery)	Snake River Basin Steelhead	4	Grande Ronde	799,288	7,391	0.92%		0%	50%	0	5648	-	0%	799,288	7,391	0.92%		0	50%	0	5,648	0	0%
29	550	Little Salmon Summer Steelhead (A-Run-Pahsimeroi-Oxbow-Hatchery)	Snake River Basin Steelhead	4	Salmon	645,044	5,909	0.92%		0%	90%	0	4319	0	0%	645,044	5,909	0.92%		0	90%	0	4,319	0	0%
30	791	Little Salmon Summer Steelhead (B-Run-Dworshak-Hatchery)	Snake River Basin Steelhead	4	Salmon	316,333	1,633	0.52%		0%	90%	0	1293	0	0%	316,333	1,633	0.52%		0	10%	0	1,293	0	0%
31	298	Tucannon Summer Steelhead (Lyons Ferry)	Snake River Basin Steelhead	4	Tucannon	0	0			0%	88%	0	0	-	0%	0	0			0	88%	0	0	0	0%
32	790	Lemhi Summer Steelhead (A-Run-Pahsimeroi Hatchery)	Snake River Basin Steelhead	4	Salmon	0	0			0%	90%	0	0	0	0%	119,656	1,096	0.92%		0	10%	0	801	0	0%
33	539	Pahsimeroi Summer Steelhead (A-Run-Pahsimeroi-Hatchery)	Snake River Basin Steelhead	4	Salmon	1,086,781	7,434	0.68%		0%	10%	0	5433	0	0%	1,086,781	7,434	0.68%		0	10%	0	5,433	0	0%
34	792	East Fork Salmon Summer Steelhead (B-Run Dworshak-Hatchery)	Snake River Basin Steelhead	4	Salmon	0	0			0%	90%	0	0	0	0%	324,806	2,024	0.62%		0	10%	0	1,603	0	0%
35	814	East Fork Salmon Summer Steelhead (A-Run Pahasimeroi-Hatchery)	Snake River Basin Steelhead	4	Salmon	0	0			0%	90%	0	0	0	0%	180,516	1,118	0.62%		0	10%	0	817	0	0%
36	465	Upper Salmon Summer Steelhead (A-Run Sawtooth-Pahsimeroi-Hatchery)	Snake River Basin Steelhead	4	Salmon	1,284,595	9,324	0.73%		0%	30%	0	6813	0	0%	1,284,595	9,324	0.73%		0	30%	0	6,813	0	0%
37	466	Upper Salmon Summer Steelhead (B-Run Dworshak-Hatchery)	Snake River Basin Steelhead	4	Salmon	250,316	455	0.18%		0%	75%	0	360	0	0%	250,316	455	0.18%		0	10%	0	360	0	0%
38	793	Upper Salmon Summer Steelhead (Upper Salmon B-Run Program)	Snake River Basin Steelhead	4	Salmon	59,228	330	0.56%		0%	75%	0	261	0	0%	134,608	750	0.56%	MAF	0	10%	0	594	0	0%
39	983	Little Sheep Summer Steelhead (Stepping Stone Hatchery)	Snake River Basin Steelhead	4	Imnaha	0	0			0%	0%	0	0	0	0%	126,308	1,080	0.86%	MAF	0	30%	0	802	0	0%
40	230	Snake Hells Canyon Summer Steelhead (Oxbow-Hatchery)	Snake River Basin Steelhead	4	Snake Hells Canyon	525,388	2,537	0.48%		0%	5%	0	1947	0	0%	525,388	2,537	0.48%		0	5%	0	1,947	0	0%
41	789	SF Clearwater Summer Steelhead (B-Run Hatchery)	Snake River Basin Steelhead	4	Clearwater	911,292	12,845	1.41%		0%	90%	0	10173	0	0%	911,292	12,845	1.41%		0	10%	0	10,173	0	0%
42	450	NF Clearwater Summer Steelhead (B-Run-Hatchery)	Snake River Basin Steelhead	4	Clearwater	1,199,329	16,905	1.41%		0%	5%	0	13389	0	0%	1,199,329	16,905	1.41%		0	5%	0	13,389	0	0%
43	738	Lower Clearwater Summer Steelhead (B-Run-Hatchery)	Snake River Basin Steelhead	4	Clearwater	297,970	4,200	1.41%		0%	90%	0	3326	0	0%	297,970	4,200	1.41%		0	10%	0	3,326	0	0%
44	218	Cottonwood Creek Summer Steelhead (Wallowa-Lyons Ferry-Hatchery)	Snake River Basin Steelhead	4	Grande Ronde	160,056	3,032	1.89%		0%	15%	0	2795	-	0%	160,056	3,032	1.89%		0	15%	0	2,795	0	0%
45	295	Snake Lower Summer Steelhead (Lyons Ferry)	Snake River Basin Steelhead	4	Lower Snake	60,601	1,092	1.80%		0%	15%	0	820	-	0%	60,601	1,092	1.80%		0	15%	0	820	0	0%

Appendix D4 Hatchery Production by Alternative for Steelhead

Middle Columbia River Steelhead

Alternative 1 Mid-C

Pop #	ID	Population Name	ESU	Desig	Subbasin	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	291	Eastside Tributaries Summer Steelhead	Middle Columbia River Steelhead	1	Deschutes	0	0			0%	0%	71,740	0	201	0%
2	670	Westside Tributaries Summer Steelhead	Middle Columbia River Steelhead	1	Deschutes	0	0			0%	0%	7,029	0	19	0%
3	259	Fifteenmile Creek Winter Steelhead	Middle Columbia River Steelhead	1	Fifteenmile Creek	0	0			0%	0%	10,835	0	104	0%
4	293	Lower Mainstem Summer Steelhead	Middle Columbia River Steelhead	1	John Day	0	0			0%	0%	57,510	0	256	0%
5	673	Middle Fork Summer Steelhead	Middle Columbia River Steelhead	1	John Day	0	0			0%	0%	20,210	0	90	0%
6	672	North Fork Summer Steelhead	Middle Columbia River Steelhead	1	John Day	0	0			0%	0%	48,680	0	219	0%
7	274	Klickitat Summer-Winter Steelhead	Middle Columbia River Steelhead	1	Klickitat	0	0			0%	0%	24,149	0	597	0%
8	303	Umatilla Summer Steelhead	Middle Columbia River Steelhead	1	Umatilla	149,901	888	0.59%		0%	99%	53,800	271	163	97%
9	305	Walla Walla Summer Steelhead	Middle Columbia River Steelhead	1	Walla Walla	0	0			0%	0%	9,466	0	22	0%
10	307	Touchet Summer Steelhead	Middle Columbia River Steelhead	1	Touchet	49,202	201	0.41%		0%	0%	14,506	21	37	100%
11	316	Naches Summer Steelhead	Middle Columbia River Steelhead	1	Yakima	0	0			0%	0%	21,027	0	84	0%
12	317	Satus Summer Steelhead	Middle Columbia River Steelhead	1	Yakima	0	0			0%	0%	33,729	0	140	0%
13	674	South Fork Summer Steelhead	Middle Columbia River Steelhead	2	John Day	0	0			0%	0%	7,119	0	32	0%
14	675	Upper Mainstem Summer Steelhead	Middle Columbia River Steelhead	2	John Day	0	0			0%	0%	14,529	0	65	0%
15	318	Toppenish Summer Steelhead	Middle Columbia River Steelhead	2	Yakima	0	0			0%	0%	28,007	0	117	0%
16	319	Upper Yakima Summer Steelhead	Middle Columbia River Steelhead	2	Yakima	0	0			0%	0%	475	0	2	0%
17	595	White Salmon Summer-Winter Steelhead	Middle Columbia River Steelhead	3	Big White Salmon	0	0			0%	0%	403	0	1	0%
18	559	Deschutes Summer Steelhead (RoundButte-Hatchery)	Middle Columbia River Steelhead	4	Deschutes	162,053	2,520	1.56%		0%	5%	0	389	0	0%
19	276	Klickitat Summer Steelhead (Skamania-Hatchery)	Middle Columbia River Steelhead	4	Klickitat	100,505	4,184	4.16%	MAF	0%	0%	0	3847	0	0%
20	306	Walla Walla Summer Steelhead (Lyons Ferry-Hatchery)	Middle Columbia River Steelhead	4	Walla Walla	100,236	1,805	1.80%		0%	77%	0	1557	0	0%
21	806	Walla Walla Touchet Summer Steelhead (Lyons Ferry-Hatchery)	Middle Columbia River Steelhead	4	Touchet	84,409	1,600	1.90%		0%	74%	0	1336	0	0%
22	254	White Salmon Summer Steelhead (Skamania-Hatchery)	Middle Columbia River Steelhead	4	Big White Salmon	20,100	566	2.81%	MAF	0%	0%	0	186	0	0%
23	256	White Salmon Winter Steelhead (Skamania-Hatchery)	Middle Columbia River Steelhead	4	Big White Salmon	19,782	342	1.73%	MAF	0%	0%	0	163	0	0%

Alternative 2 Mid-C

Pop #	ID	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	291	0	0			0%	0%	70,786	-	200	0%
2	670	0	0			0%	0%	9,276	-	26	0%
3	259	0	0			0%	0%	10,864	-	104	0%
4	293	0	0			0%	0%	70,619	-	322	0%
5	673	0	0			0%	0%	25,605	-	117	0%
6	672	0	0			0%	0%	59,024	-	270	0%
7	274	0	0			0%	0%	38,158	-	991	0%
8	303	149,901	888	0.59%		0%	99%	53,263	271	162	97%
9	305	0	0			0%	0%	21,171	-	51	0%
10	307	49,202	618	1.26%		0%	65%	15,308	65	38	100%
11	316	0	0			0%	0%	21,614	-	87	0%
12	317	0	0			0%	0%	33,826	-	141	0%
13	674	0	0			0%	0%	7,809	-	36	0%
14	675	0	0			0%	0%	17,577	-	80	0%
15	318	0	0			0%	0%	28,123	-	117	0%
16	319	0	0			0%	0%	514	-	2	0%
17	595	0	0			0%	0%	309	-	1	0%
18	559	162,053	2,520	1.56%		0%	5%	0	389	0	0%
19	276	0	0			0%	0%	0	-	0	0%
20	306	0	0			0%	0%	0	-	0	0%
21	806	0	0			0%	0%	0	-	0	0%
22	254	0	0			0%	0%	0	-	0	0%
23	256	0	0			0%	0%	0	-	0	0%

Alternative 3 Mid-C

Pop #	ID	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	291	0	0			60%	0%	71,795	0	203	0%
2	670	0	0			60%	0%	8,536	0	24	0%
3	259	0	0			0%	0%	10,835	0	104	0%
4	293	0	0			0%	0%	57,510	0	256	0%
5	673	0	0			0%	0%	20,210	0	90	0%
6	672	0	0			0%	0%	48,680	0	219	0%
7	274	0	0			0%	0%	24,211	0	599	0%
8	303	149,901	888	0.59%		0%	99%	53,630	271	163	97%
9	305	0	0			0%	0%	21,171	0	51	0%
10	307	49,202	618	1.26%		0%	65%	15,308	65	38	100%
11	316	0	0			0%	0%	21,614	0	87	0%
12	317	0	0			0%	0%	33,826	0	141	0%
13	674	0	0			0%	0%	7,119	0	32	0%
14	675	0	0			0%	0%	14,529	0	65	0%
15	318	0	0			0%	0%	28,123	0	117	0%
16	319	0	0			0%	0%	514	0	2	0%
17	595	0	0			0%	0%	403	0	1	0%
18	559	162,053	2,520	1.56%		0%	5%	0	389	0	0%
19	276	100,505	4,184	4.16%	MAF	0%	0%	0	3847	0	0%
20	306	0	0			0%	0%	0	0	0	0%
21	806	0	0			0%	0%	0	0	0	0%
22	254	20,100	566	2.81%	MAF	0%	0%	0	186	0	0%
23	256	19,782	342	1.73%	MAF	0%	0%	0	163	0	0%

Lower Columbia River Steelhead

Alternative 1 Lower Columbia

Pop #	ID	Population Name	ESU	Desig	Subbasin	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	623	Coweeman Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Coweeman	0	0			0%	0%	3,217	0	27	0%
2	622	NF Toutle Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Toutle	0	0			0%	0%	9,961	0	28	0%
3	621	SF Toutle Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Toutle	0	0			0%	0%	14,445	0	41	0%
4	265	Hood Summer Steelhead	Lower Columbia River Steelhead	1	Hood	31,374	623	1.98%		0%	30%	6,952	271	42	100%
5	267	Hood Winter Steelhead	Lower Columbia River Steelhead	1	Hood	49,159	648	1.32%		0%	0%	24,362	313	151	100%
6	372	Kalama Summer Steelhead	Lower Columbia River Steelhead	1	Kalama	30,537	872	2.86%	MAF	0%	10%	8,616	694	70	100%
7	375	Kalama Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Kalama	45,160	734	1.63%	MAF	0%	10%	1,734	506	39	100%
8	630	EF Lewis Summer Steelhead	Lower Columbia River Steelhead	1	Lewis	0	0			0%	0%	5,864	0	25	0%
9	628	EF Lewis Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Lewis	0	0			0%	0%	4,110	0	20	0%
10	406	Sandy Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Sandy	159,875	1,480	0.93%	MAF	0%	8%	17,079	863	109	100%
11	676	Washougal Summer Steelhead	Lower Columbia River Steelhead	1	Washougal	0	0			0%	25%	5,591	0	41	0%
12	734	Lower Clackamas Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Willamette	164,875	3,688	2.24%		0%	20%	8,202	2250	21	0%
13	433	Upper Clackamas Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Willamette	0	0			95%	10%	49,402	0	116	0%
14	284	Wind Summer Steelhead	Lower Columbia River Steelhead	1	Wind	0	0			95%	0%	12,337	0	380	0%
15	398	Upper Gorge Tributaries Winter Steelhead (Late)	Lower Columbia River Steelhead	2	Columbia Gorge	0	0			0%	0%	1,486	0	21	0%
16	363	Lower Cowlitz Winter Steelhead (Late)	Lower Columbia River Steelhead	2	Cowlitz	288,663	767	0.27%		0%	10%	2,429	529	20	0%
17	606	Upper Cowlitz Winter Steelhead (Late)	Lower Columbia River Steelhead	2	Cowlitz	199,078	8	0.00%		100%	25%	5,163	6	17	0%
18	383	NF Lewis Winter Steelhead (Late)	Lower Columbia River Steelhead	2	Lewis	0	0			0%	0%	3,235	0	12	0%
19	558	Washougal Winter Steelhead (Late)	Lower Columbia River Steelhead	2	Washougal	0	0			0%	25%	5,662	0	54	0%
20	629	NF Lewis Summer Steelhead	Lower Columbia River Steelhead	3	Lewis	0	0			0%	0%	3,283	0	13	0%
21	632	Salmon Creek Winter Steelhead (Late)	Lower Columbia River Steelhead	3	Washougal	0	0			0%	25%	379	0	1	0%
22	362	Coweeman Winter Steelhead (Early Elochoman-Hatchery)	Lower Columbia River Steelhead	4	Coweeman	20,160	192	0.95%	MAF	0%	0%	0	132	0	0%
23	365	Lower Cowlitz Summer Steelhead (Skamania-Hatchery)	Lower Columbia River Steelhead	4	Cowlitz	549,248	10,941	1.99%		0%	5%	0	8709	0	0%
24	361	Lower Cowlitz Winter Steelhead (Early-Hatchery)	Lower Columbia River Steelhead	4	Cowlitz	302,372	3,471	1.15%		0%	25%	0	2394	0	0%
25	620	NF Toutle Summer Steelhead (Hatchery)	Lower Columbia River Steelhead	4	Toutle	24,728	548	2.22%	MAF	0%	0%	0	436	0	0%
26	364	SF Toutle Summer Steelhead (Hatchery)	Lower Columbia River Steelhead	4	Toutle	24,728	578	2.34%	MAF	0%	0%	0	522	0	0%
27	775	Hood Summer Steelhead (Santiam-Hatchery)	Lower Columbia River Steelhead	4	Hood	31,500	624	1.98%		0%	5%	0	271	0	0%
28	373	Kalama Summer Steelhead (Skamania-Hatchery)	Lower Columbia River Steelhead	4	Kalama	30,670	876	2.86%	MAF	0%	10%	0	697	0	0%
29	374	Kalama Winter Steelhead (Early-Hatchery)	Lower Columbia River Steelhead	4	Kalama	45,801	541	1.18%	MAF	0%	10%	0	373	0	0%
30	385	EF Lewis Summer Steelhead (Skamania-Hatchery)	Lower Columbia River Steelhead	4	Lewis	24,728	287	1.16%	MAF	0%	0%	0	228	0	0%
31	387	EF Lewis Winter Steelhead (Skamania-Hatchery)	Lower Columbia River Steelhead	4	Lewis	90,694	1,160	1.28%	MAF	0%	0%	0	800	0	0%
32	388	NF Lewis Summer Steelhead (Merwin-Hatchery)	Lower Columbia River Steelhead	4	Lewis	284,828	4,397	1.54%		0%	25%	0	3500	0	0%
33	384	NF Lewis Winter Steelhead (Merwin-Hatchery)	Lower Columbia River Steelhead	4	Lewis	100,224	1,621	1.62%		0%	25%	0	1118	0	0%
34	572	Salmon Creek Winter Steelhead (Skamania-Hatchery)	Lower Columbia River Steelhead	4	Washougal	24,728	369	1.49%	MAF	0%	25%	0	254	0	0%
35	405	Sandy Summer Steelhead (South Santiam-Hatchery)	Lower Columbia River Steelhead	4	Sandy	75,000	5,900	7.87%	MAF	0%	5%	7	3439	0	0%
36	412	Washougal Summer Steelhead (Skamania-Hatchery)	Lower Columbia River Steelhead	4	Washougal	60,300	1,493	2.48%	MAF	0%	25%	0	1189	0	0%
37	411	Washougal Winter Steelhead (Early-Skamania-Hatchery)	Lower Columbia River Steelhead	4	Washougal	59,400	366	0.62%	MAF	0%	25%	0	252	0	0%
38	434	Clackamas Summer Steelhead (Hatchery)	Lower Columbia River Steelhead	4	Willamette	174,770	1,357	0.78%		0%	10%	0	724	0	0%
39	432	Clackamas-Eagle Creek Winter Steelhead (Early-Hatchery)	Lower Columbia River Steelhead	4	Willamette	150,965	1,665	1.10%	MAF	0%	10%	0	1016	0	0%

Alternative 2 Lower Columbia

Pop #	ID	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	623	0	0			0%	0%	3,500	-	30	0%
2	622	0	0			0%	0%	14,391	-	42	0%
3	621	0	0			0%	0%	17,553	-	51	0%
4	265	31,374	623	1.98%		0%	30%	6,913	271	41	100%
5	267	49,159	648	1.32%		0%	0%	24,362	313	151	100%
6	372	0	0			0%	10%	8,710	-	71	100%
7	375	0	0			0%	10%	1,876	-	42	100%
8	630	0	0			0%	0%	7,538	-	33	0%
9	628	0	0			0%	0%	6,494	-	33	0%
10	406	0	0			0%	8%	17,811	-	114	100%
11	676	0	0			0%	25%	7,260	-	55	0%
12	734	164,875	3,688	2.24%		0%	20%	10,759	2,250	28	40%
13	433	0	0			95%	10%	49,405	-	116	0%
14	284	0	0			95%	0%	12,340	-	380	0%
15	398	0	0			0%	0%	1,486	-	21	0%
16	363	288,265	766	0.27%		0%	10%	3,895	528	33	25%
17	606	99,340	398	0.40%		0%	0%	5,976	275	20	100%
18	383	0	0			0%	0%	3,386	-	12	0%
19	558	0	0			0%	25%	6,082	-	59	0%
20	629	0	0			0%	0%	3,565	-	15	0%
21	632	0	0			0%	25%	723	-	3	0%
22	362	0	0			0%	0%	0	-	0	0%
23	365	549,248	10,941	1.99%		0%	5%	0	8,709	0	0%
24	361	302,372	3,471	1.15%		0%	25%	0	2,394	0	0%
25	620	0	0			0%	0%	0	-	0	0%
26	364	0	0			0%	0%	0	-	0	0%
27	775	31,500	624	1.98%		0%	5%	0	271	0	0%
28	373	0	0			0%	10%	0	-	0	0%
29	374	0	0			0%	10%	0	-	0	0%
30	385	0	0			0%	0%	0	-	0	0%
31	387	0	0			0%	0%	0	-	0	0%
32	388	184,655	2,850	1.54%		0%	25%	0	2,269	0	0%
33	384	0	0			0%	25%	0	-	0	0%
34	572	0	0			0%	25%	0	-	0	0%
35	405	0	0			0%	5%	0	-	0	0%
36	412	0	0			0%	25%	0	-	0	0%
37	411	0	0			0%	25%	0	-	0	0%
38	434	174,770	1,357	0.78%		0%	10%	0	724	0	0%
39	432	0	0			0%	10%	0	-	0	0%

Alternative 3 Lower Columbia

Pop #	ID	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	623	0	0			0%	0%	3,179	-	27	0%
2	622	0	0			0%	0%	9,288	-	26	0%
3	621	0	0			0%	0%	13,979	-	39	0%
4	265	31,374	623	1.98%		0%	30%	6,942	271	42	100%
5	267	49,159	648	1.32%		0%	0%	24,362	313	151	100%
6	372	30,003	857	2.86%	MAF	0%	10%	8,501	682	69	20%
7	375	45,140	734	1.63%	MAF	0%	10%	1,804	506	40	33%
8	630	0	0			0%	0%	5,971	-	25	0%
9	628	0	0			0%	0%	4,631	-	23	0%
10	406	159,875	1,480	0.93%	MAF	0%	8%	17,079	863	109	100%
11	676	0	0			0%	25%	5,591	-	41	0%
12	734	164,875	3,688	2.24%		0%	20%	10,753	2,250	28	40%
13	433	0	0			95%	10%	49,402	-	116	0%
14	284	0	0			95%	0%	12,337	-	380	0%
15	398	0	0			0%	0%	1,486	-	21	0%
16	363	288,265	766	0.27%		0%	10%	3,886	528	33	25%
17	606	99,340	398	0.40%		0%	0%	5,998	275	20	100%
18	383	0	0			0%	0%	3,332	-	12	0%
19	558	0	0			0%	25%	5,662	-	54	0%
20	629	0	0			0%	0%	3,488	-	14	0%
21	632	0	0			0%	25%	379	-	1	0%
22	362	20,160	192	0.95%	MAF	0%	0%	0	132	0	0%
23	365	549,248	10,941	1.99%		0%	5%	0	8,709	0	0%
24	361	302,372	3,471	1.15%		0%	25%	0	2,394	0	0%
25	620	24,728	548	2.22%	MAF	0%	0%	0	436	0	0%
26	364	24,728	578	2.34%	MAF	0%	0%	0	522	0	0%
27	775	31,500	624	1.98%		0%	5%	0	271	0	0%
28	373	30,670	876	2.86%	MAF	0%	10%	0	697	0	0%
29	374	45,801	541	1.18%	MAF	0%	10%	0	373	0	0%
30	385	24,728	287	1.16%	MAF	0%	0%	0	228	0	0%
31	387	44,898	574	1.28%	MAF	0%	0%	0	396	0	0%
32	388	184,655	2,850	1.54%		0%	25%	0	2,269	0	0%
33	384	0	0			0%	25%	0	-	0	0%
34	572	24,728	369	1.49%	MAF	0%	25%	0	254	0	0%
35	405	75,000	5,900	7.87%	MAF	0%	5%	7	3,439	0	0%
36	412	60,300	1,493	2.48%	MAF	0%	25%	0	1,189	0	0%
37	411	59,400	366	0.62%	MAF	0%	25%	0	252	0	0%
38	434	174,770	1,357	0.78%		0%	10%	0	724	0	0%
39	432	150,965	1,665	1.10%	MAF	0%	10%	0	1,016	0	0%

Appendix D4 Hatchery Production by Alternative for Steelhead

Middle Columbia River Steelhead

						Alternative 4 Mid-C										Alternative 5 Mid-C									
Pop #	ID	Population Name	ESU	Desig	Subbasin	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natura Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	291	Eastside Tributaries Summer Steelhead	Middle Columbia River Steelhead	1	Deschutes	0	0			60%	10%	71817	0	203.0	0%	0	0			0.85	10%	103,288	0	302	0%
2	670	Westside Tributaries Summer Steelhead	Middle Columbia River Steelhead	1	Deschutes	0	0			60%	0%	8536	0	23.8	0%	0	0			0.85	0%	18,831	0	55	0%
3	259	Fifteenmile Creek Winter Steelhead	Middle Columbia River Steelhead	1	Fifteenmile Creek	0	0			0%	0%	10835	0	103.9	0%	0	0			0	0%	10,864	0	104	0%
4	293	Lower Mainstem Summer Steelhead	Middle Columbia River Steelhead	1	John Day	0	0			0%	0%	57510	0	256.4	0%	0	0			0.5	0%	68,559	0	312	0%
5	673	Middle Fork Summer Steelhead	Middle Columbia River Steelhead	1	John Day	0	0			0%	0%	20210	0	90.4	0%	0	0			0.5	0%	25,033	0	114	0%
6	672	North Fork Summer Steelhead	Middle Columbia River Steelhead	1	John Day	0	0			0%	0%	48680	0	218.9	0%	0	0			0.5	0%	57,935	0	265	0%
7	274	Klickitat Summer-Winter Steelhead	Middle Columbia River Steelhead	1	Klickitat	0	0			0%	0%	24222	0	599.3	0%	120,448	2,172	1.80%	MAF	0	5%	38,201	1,982	992	25%
8	303	Umatilla Summer Steelhead	Middle Columbia River Steelhead	1	Umatilla	149,901	888	0.59%		0%	99%	53630	270.7826	162.9	97%	149,901	888	0.59%		0	99%	53,583	271	163	97%
9	305	Walla Walla Summer Steelhead	Middle Columbia River Steelhead	1	Walla Walla	0	0			0%	0%	21171	0	50.7	0%	0	0			0	0%	21,845	0	52	0%
10	307	Touchet Summer Steelhead	Middle Columbia River Steelhead	1	Touchet	49,202	618	1.26%		0%	65%	15308	65.25973	38.4	100%	49,202	618	1.26%		0	65%	15,312	65	38	100%
11	316	Naches Summer Steelhead	Middle Columbia River Steelhead	1	Yakima	0	0			0%	0%	21614	0	86.9	0%	0	0			0	0%	22,445	0	91	0%
12	317	Satus Summer Steelhead	Middle Columbia River Steelhead	1	Yakima	0	0			0%	0%	33826	0	140.9	0%	0	0			0	0%	33,978	0	142	0%
13	674	South Fork Summer Steelhead	Middle Columbia River Steelhead	2	John Day	0	0			0%	0%	7119	0	32.1	0%	0	0			0	0%	7,119	0	32	0%
14	675	Upper Mainstem Summer Steelhead	Middle Columbia River Steelhead	2	John Day	0	0			0%	0%	14529	0	65.4	0%	0	0			0	0%	14,529	0	65	0%
15	318	Toppenish Summer Steelhead	Middle Columbia River Steelhead	2	Yakima	0	0			0%	0%	28123	0	117.3	0%	0	0			0	0%	28,300	0	118	0%
16	319	Upper Yakima Summer Steelhead	Middle Columbia River Steelhead	2	Yakima	0	0			0%	0%	514	0	1.9	0%	0	0			0	0%	6,202	0	23	0%
17	595	White Salmon Summer-Winter Steelhead	Middle Columbia River Steelhead	3	Big White Salmon	0	0			0%	0%	321	0	0.8	0%	0	0			0	0%	399	0	1	0%
18	559	Deschutes Summer Steelhead (RoundButte-Hatchery)	Middle Columbia River Steelhead	4	Deschutes	162,053	2,520	1.56%		0%	5%	0	388.7779	0.0	0%	162,053	2,520	1.56%		0	5%	0	389	0	0%
19	276	Klickitat Summer Steelhead (Skamania-Hatchery)	Middle Columbia River Steelhead	4	Klickitat	100,505	4,184	4.16%	MAF	0%	0%	0	3846.991	0.0	0%	0	0			0	0%	0	0	0	0%
20	306	Walla Walla Summer Steelhead (Lyons Ferry-Hatchery)	Middle Columbia River Steelhead	4	Walla Walla	0	0			0%	0%	0	0	0.0	0%	100,236	1,805	1.80%		0	10%	0	1,557	0	0%
21	806	Walla Walla Touchet Summer Steelhead (Lyons Ferry-Hatchery)	Middle Columbia River Steelhead	4	Touchet	0	0			0%	0%	0	0	0.0	0%	21,102	400	1.90%		0	10%	0	334	0	0%
22	254	White Salmon Summer Steelhead (Skamania-Hatchery)	Middle Columbia River Steelhead	4	Big White Salmon	0	0			0%	0%	0	0	0.0	0%	20,100	566	2.81%	MAF	0	0%	0	186	0	0%
23	256	White Salmon Winter Steelhead (Skamania-Hatchery)	Middle Columbia River Steelhead	4	Big White Salmon	0	0			0%	0%	0	0	0.0	0%	0	0			0	0%	0	0	0	0%

Lower Columbia River Steelhead

						Alternative 4 Lower Columbia										Alternative 5 Lower Columbia									
Pop #	ID	Population Name	ESU	Desig	Subbasin	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natura Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	623	Coweeman Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Coweeman	0	0			0%	0%	3165	-	27	0%	0	0			0	0%	3,165	0	27	0%
2	622	NF Toutle Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Toutle	142,183	2,380	1.67%	MAF	0%	10%	13472	1,895	39	30%	0	0			0	0%	9,102	0	25	30%
3	621	SF Toutle Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Toutle	0	0			0%	0%	17379	-	50	0%	0	0			0	0%	13,806	0	39	0%
4	265	Hood Summer Steelhead	Lower Columbia River Steelhead	1	Hood	31,374	623	1.98%		0%	30%	6938	271	42	100%	31,374	623	1.98%		0	30%	6,918	271	41	100%
5	267	Hood Winter Steelhead	Lower Columbia River Steelhead	1	Hood	49,159	648	1.32%		0%	0%	24362	313	151	100%	49,159	648	1.32%		0	0%	24,362	313	151	100%
6	372	Kalama Summer Steelhead	Lower Columbia River Steelhead	1	Kalama	86,410	2,467	2.86%	MAF	0%	10%	8081	1,964	65	25%	30,003	857	2.86%	MAF	0	10%	8,501	682	69	20%
7	375	Kalama Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Kalama	99,707	1,621	1.63%	MAF	0%	10%	1646	1,118	37	33%	45,140	734	1.63%	MAF	0	10%	1,804	506	40	33%
8	630	EF Lewis Summer Steelhead	Lower Columbia River Steelhead	1	Lewis	40,677	472	1.16%	MAF	0%	80%	7553	375	33	100%	0	0			0	0%	5,971	0	25	0%
9	628	EF Lewis Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Lewis	40,319	516	1.28%	MAF	0%	25%	6343	356	32	100%	0	0			0	0%	4,631	0	23	0%
10	406	Sandy Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Sandy	159,875	1,480	0.93%	MAF	0%	8%	17100	863	109	100%	159,875	1,480	0.93%	MAF	0	8%	17,079	863	109	100%
11	676	Washougal Summer Steelhead	Lower Columbia River Steelhead	1	Washougal	100,357	2,485	2.48%	MAF	0%	25%	7010	1,978	53	100%	0	0			0	0%	5,588	0	41	0%
12	734	Lower Clackamas Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Willamette	80,427	1,799	2.24%		0%	20%	11416	1,098	31	40%	164,875	3,688	2.24%		0	20%	10,753	2,250	28	40%
13	433	Upper Clackamas Winter Steelhead (Late)	Lower Columbia River Steelhead	1	Willamette	0	0			95%	10%	49407	-	116	0%	0	0			0.95	10%	49,402	0	116	0%
14	284	Wind Summer Steelhead	Lower Columbia River Steelhead	1	Wind	0	0			95%	0%	12339	-	380	0%	0	0			0.95	0%	12,339	0	380	0%
15	398	Upper Gorge Tributaries Winter Steelhead (Late)	Lower Columbia River Steelhead	2	Columbia Gorge	0	0			0%	0%	1486	-	21	0%	0	0			0	0%	1,486	0	21	0%
16	363	Lower Cowlitz Winter Steelhead (Late)	Lower Columbia River Steelhead	2	Cowlitz	288,663	2,893	1.00%		0%	10%	3925	1,995	33	50%	288,663	2,893	1.00%		0	10%	3,924	1,995	33	50%
17	606	Upper Cowlitz Winter Steelhead (Late)	Lower Columbia River Steelhead	2	Cowlitz	99,340	398	0.40%		0%	0%	6004	275	20	100%	99,340	398	0.40%		0	0%	6,002	275	20	100%
18	383	NF Lewis Winter Steelhead (Late)	Lower Columbia River Steelhead	2	Lewis	0	0			0%	0%	3262	-	12	0%	0	0			0	0%	3,332	0	12	0%
19	558	Washougal Winter Steelhead (Late)	Lower Columbia River Steelhead	2	Washougal	0	0			0%	10%	5564	-	53	0%	0	0			0	10%	5,663	0	54	0%
20	629	NF Lewis Summer Steelhead	Lower Columbia River Steelhead	3	Lewis	0	0			0%	0%	3399	-	14	0%	0	0			0	0%	3,488	0	14	0%
21	632	Salmon Creek Winter Steelhead (Late)	Lower Columbia River Steelhead	3	Washougal	0	0			0%	25%	413	-	1	0%	0	0			0	25%	379	0	1	0%
22	362	Coweeman Winter Steelhead (Early Elochoman-Hatchery)	Lower Columbia River Steelhead	4	Coweeman	20,160	192	0.95%	MAF	0%	0%	0	132	0	0%	20,160	192	0.95%	MAF	0	0%	0	132	0	0%
23	365	Lower Cowlitz Summer Steelhead (Skamania-Hatchery)	Lower Columbia River Steelhead	4	Cowlitz	549,248	10,941	1.99%		0%	5%	0	8,709	0	0%	549,248	10,941	1.99%		0	5%	0	8,709	0	0%
24	361	Lower Cowlitz Winter Steelhead (Early-Hatchery)	Lower Columbia River Steelhead	4	Cowlitz	302,372	3,471	1.15%		0%	25%	0	2,394	0	0%	302,372	3,471	1.15%		0	25%	0	2,394	0	0%
25	620	NF Toutle Summer Steelhead (Hatchery)	Lower Columbia River Steelhead	4	Toutle	0	0			0%	0%	0	-	0	0%	24,728	548	2.22%	MAF	0	0%	0	436	0	0%
26	364	SF Toutle Summer Steelhead (Hatchery)	Lower Columbia River Steelhead	4	Toutle	24,728	578	2.34%	MAF	0%	10%	0	522	0	0%	24,728	578	2.34%	MAF	0	0%	0	522	0	0%
27	775	Hood Summer Steelhead (Santiam-Hatchery)	Lower Columbia River Steelhead	4	Hood	31,500	624	1.98%		0%	5%	0	271	0	0%	31,500	624	1.98%		0	5%	0	271	0	0%
28	373	Kalama Summer Steelhead (Skamania-Hatchery)	Lower Columbia River Steelhead	4	Kalama	0	0			0%	10%	0	-	0	0%	30,670	876	2.86%	MAF	0	10%	0	697	0	0%
29	374	Kalama Winter Steelhead (Early-Hatchery)	Lower Columbia River Steelhead	4	Kalama	0	0			0%	10%	0	-	0	0%	45,801	541	1.18%	MAF	0	10%	0	373	0	0%
30	385	EF Lewis Summer Steelhead (Skamania-Hatchery)	Lower Columbia River Steelhead	4	Lewis	0	0			0%	0%	0	-	0	0%	24,728	287	1.16%	MAF	0	0%	0	228	0	0%
31	387	EF Lewis Winter Steelhead (Skamania-Hatchery)	Lower Columbia River Steelhead	4	Lewis	0	0			0%	0%	0	-	0	0%	44,898	574	1.28%	MAF	0	0%	0	396	0	0%
32	388	NF Lewis Summer Steelhead (Merwin-Hatchery)	Lower Columbia River Steelhead	4	Lewis	184,655	2,850	1.54%		0%	25%	0	2,269	0	0%	184,655	2,850	1.54%		0	25%	0	2,269	0	0%
33	384	NF Lewis Winter Steelhead (Merwin-Hatchery)	Lower Columbia River Steelhead	4	Lewis	0	0			0%	25%	0	-	0	0%	0	0			0	25%	0	0	0	0%
34	572	Salmon Creek Winter Steelhead (Skamania-Hatchery)	Lower Columbia River Steelhead	4	Washougal	24,728	369	1.49%	MAF	0%	25%	0	254	0	0%	24,728	369	1.49%	MAF	0	25%	0	254	0	0%
35	405	Sandy Summer Steelhead (South Santiam-Hatchery)	Lower Columbia River Steelhead	4	Sandy	75,000	5,900	7.87%	MAF	0%	5%	7	3,439	0	0%	75,000	5,900	7.87%	MAF	0	5%	7	3,439	0	0%
36	412	Washougal Summer Steelhead (Skamania-Hatchery)	Lower Columbia River Steelhead	4	Washougal	28,714	711	2.48%	MAF	0%	25%	0	566	0	0%	60,300	1,493	2.48%	MAF	0	25%	0	1,189	0	0%
37	411	Washougal Winter Steelhead (Early-Skamania-Hatchery)	Lower Columbia River Steelhead	4	Washougal	63,000	388	0.62%	MAF	0%	25%	0	267	0	0%	59,400	366	0.62%	MAF	0	25%	0	252	0	0%
38	434	Clackamas Summer Steelhead (Hatchery)	Lower Columbia River Steelhead	4	Willamette	174,770	1,357	0.78%		0%	10%	0	724	0	0%	174,770	1,357	0.78%		0	10%	0	724	0	0%
39	432	Clackamas-Eagle Creek Winter Steelhead (Early-Hatchery)	Lower Columbia River Steelhead	4	Willamette	150,965	1,665	1.10%	MAF	0%	10%	0	1,016	0	0%	150,965	1,665	1.10%	MAF	0	10%	0	1,016	0	0%

Appendix E

Hatchery Performance and Production by Alternative for Chum Salmon

Appendix E1. Hatchery Performance by Alternative for Chum Salmon

Primary
Contributing
Stabilizing
Not in ESU

Supporting
Consistent
Not Consistent

Columbia River Chum

Pop #	ID	Population Name	ESU	Designatio	Subbasin	Alternative 1 Population Type	pHOS	PNI	Produc-tivity	NOS	Alternative 2 Population Type	pHOS	PNI	Produc-tivity	NOS	Alternative 3 Population Type	pHOS	PNI	Produc-tivity	NOS
1	348	Columbia Estuary_Grays-Chinook River Chum	Columbia River Chum	1	Grays	Integrated	0.54	0.00	2.2	1,291	Integrated	0.56	0.64	2.4	1,187	Integrated	0.63	0.62	2.4	1,239
2	671	Columbia Estuary_Mill-Aber-Germ Chum	Columbia River Chum	1	Columbia Estuary	Natural	0.01	0.00	1.8	631	Natural	0.01	0.00	1.9	631	Natural	0.02	0.00	1.8	631
3	717	Columbia Estuary_Youngs Bay Tribs Chum	Columbia River Chum	1	Columbia Estuary	Natural	0.09	0.00	1.4	357	Natural	0.09	0.00	1.5	357	Natural	0.11	0.00	1.4	373
4	340	Elochoman Chum	Columbia River Chum	1	Elochoman	Natural	0.03	0.00	1.9	1,754	Natural	0.03	0.00	1.9	1,754	Natural	0.04	0.00	1.9	1,756
5	379	Lewis Chum	Columbia River Chum	1	Lewis	Natural	0.01	0.00	2.4	8,203	Natural	0.01	0.00	2.4	8,203	Natural	0.01	0.00	2.4	8,203
6	392	Lower Columbia_Duncan Creek Chum	Columbia River Chum	1	Washougal	Integrated	0.37	0.62	3.5	1,652	Integrated	0.37	0.62	3.5	1,652	Integrated	0.37	0.62	3.5	1,652
7	737	Sandy Chum	Columbia River Chum	1	Sandy	Natural	0.12	0.00	1.4	375	Natural	0.12	0.00	1.4	375	Natural	0.12	0.00	1.4	375
8	408	Washougal Chum	Columbia River Chum	1	Washougal	Natural	0.01	0.00	2.9	1,988	Natural	0.01	0.00	2.9	1,988	Natural	0.01	0.00	2.9	1,988
9	711	Columbia Estuary_Big Creek Chum	Columbia River Chum	2	Columbia Estuary	Natural	0.53	0.00	0.7	31	Natural	0.53	0.00	1.5	31	Natural	0.58	0.00	0.7	36
10	713	Columbia Estuary_Clatskanie Creek Chum	Columbia River Chum	2	Columbia Estuary	Natural	0.53	0.00	0.7	31	Natural	0.53	0.00	1.5	31	Natural	0.58	0.00	0.7	36
11	660	Columbia Gorge_Tributaries Chum (Lower Gorge)	Columbia River Chum	2	Columbia Gorge	Natural	0.00	0.00	1.5	33	Natural	0.00	0.00	1.5	33	Natural	0.00	0.00	1.5	33
12	661	Columbia Gorge_Tributaries Chum (Upper Gorge)	Columbia River Chum	2	Columbia Gorge	Natural	0.00	0.00	1.5	33	Natural	0.00	0.00	1.5	33	Natural	0.00	0.00	1.5	33
13	357	Cowlitz Chum	Columbia River Chum	2	Cowlitz	Natural	0.02	0.00	1.5	2,661	Natural	0.02	0.00	1.6	2,661	Natural	0.03	0.00	1.5	2,667
14	369	Kalama Chum	Columbia River Chum	2	Kalama	Natural	0.00	0.00	1.5	327	Natural	0.00	0.00	1.5	327	Natural	0.00	0.00	1.5	327
15	745	Willamette_Clackamas Chum	Columbia River Chum	2	Willamette	Natural	0.00	0.00	1.5	33	Natural	0.00	0.00	1.5	33	Natural	0.00	0.00	1.5	33
16	960	Columbia Estuary_Chum (Sea Resources)	Columbia River Chum	3	Columbia Estuary	Natural	0.00	0.00	2.4	287	Natural	0.00	0.00	2.4	287	Natural	0.00	0.00	2.4	287
17	633	Salmon Creek Chum	Columbia River Chum	3	Lower Columbia	Natural	0.06	0.00	1.4	341	Natural	0.06	0.00	1.4	341	Natural	0.06	0.00	1.4	341

Appendix E1. Hatchery Performance by Alternative for Chum Salmon

Legend
Primary
Contributing
Stabilizing
Not in ESU

Legend
Supporting
Consistent
Not Consistent

Columbia River Chum

Pop #	ID	Population Name	ESU	Designation	Subbasin	Alternative 4 Population Type	Alternative 4 pHOS	Alternative 4 PNI	Alternative 4 Productivity	Alternative 4 NOS	Alternative 5 Population Type	Alternative 5 pHOS	Alternative 5 PNI	Alternative 5 Productivity	Alternative 5 NOS
1	348	Columbia Estuary_Grays-Chinook River Chum	Columbia River Chum	1	Grays	Integrated	0.50	0.67	2.4	1,229	Integrated	0.63	0.62	2.4	1,239
2	671	Columbia Estuary_Mill-Aber-Germ Chum	Columbia River Chum	1	Columbia Estuary	Integrated	0.45	0.69	1.8	902	Natural	0.02	0.00	1.8	631
3	717	Columbia Estuary_Youngs Bay Tribs Chum	Columbia River Chum	1	Columbia Estuary	Integrated	0.50	0.67	1.4	584	Natural	0.11	0.00	1.4	373
4	340	Elochoman Chum	Columbia River Chum	1	Elochoman	Integrated	0.45	0.69	1.9	2,407	Natural	0.04	0.00	1.9	1,756
5	379	Lewis Chum	Columbia River Chum	1	Lewis	Integrated	0.23	0.81	2.4	9,274	Natural	0.01	0.00	2.4	8,203
6	392	Lower Columbia_Duncan Creek Chum	Columbia River Chum	1	Washougal	Integrated	0.38	0.72	3.6	1,629	Integrated	0.37	0.62	3.5	1,652
7	737	Sandy Chum	Columbia River Chum	1	Sandy	Integrated	0.49	0.67	1.4	578	Natural	0.12	0.00	1.4	375
8	408	Washougal Chum	Columbia River Chum	1	Washougal	Integrated	0.49	0.67	2.9	2,269	Natural	0.01	0.00	2.9	1,988
9	711	Columbia Estuary_Big Creek Chum	Columbia River Chum	2	Columbia Estuary	Natural	0.49	0.00	0.7	27	Natural	0.58	0.00	0.7	36
10	713	Columbia Estuary_Clatskanie Creek Chum	Columbia River Chum	2	Columbia Estuary	Natural	0.49	0.00	0.7	27	Natural	0.58	0.00	0.7	36
11	660	Columbia Gorge_Tributaries Chum (Lower Gorge)	Columbia River Chum	2	Columbia Gorge	Natural	0.00	0.00	1.5	33	Natural	0.00	0.00	1.5	33
12	661	Columbia Gorge_Tributaries Chum (Upper Gorge)	Columbia River Chum	2	Columbia Gorge	Natural	0.00	0.00	1.5	33	Natural	0.00	0.00	1.5	33
13	357	Cowlitz Chum	Columbia River Chum	2	Cowlitz	Natural	0.09	0.00	1.5	2,834	Natural	0.03	0.00	1.5	2,667
14	369	Kalama Chum	Columbia River Chum	2	Kalama	Natural	0.33	0.00	1.3	529	Natural	0.00	0.00	1.5	327
15	745	Willamette_Clackamas Chum	Columbia River Chum	2	Willamette	Natural	0.00	0.00	1.5	33	Natural	0.00	0.00	1.5	33
16	960	Columbia Estuary_Chum (Sea Resources)	Columbia River Chum	3	Columbia Estuary	Integrated	0.67	0.60	2.4	359	Natural	0.00	0.00	2.4	287
17	633	Salmon Creek Chum	Columbia River Chum	3	Lower Columbia	Natural	0.14	0.00	1.3	390	Natural	0.06	0.00	1.4	341

Appendix E2 Hatchery Production by Alternative for Chum Salmon

Primary
Contributing
Stabilizing

Columbia River Chum

Pop #	ID	Population Name	ESU	Designatio	Subbasin	Alternative 1 Columbia River Chum: Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	HatcheryHarvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Alternative 2 Columbia River Chum: Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	348	Columbia Estuary_Grays-Chinook River Chum	Columbia River Chum	1	Grays	200,070	1,997	1.00%			73%	117,021	45	26								88,942	-	26	
2	671	Columbia Estuary_Mill-Aber-Germ Chum	Columbia River Chum	1	Columbia Estuary							140,975		13								140,618	-	13	
3	717	Columbia Estuary_Youngs Bay Tribs Chum	Columbia River Chum	1	Columbia Estuary							107,915		7								100,236	-	7	
4	340	Elochoman Chum	Columbia River Chum	1	Elochoman							521,741		36								520,521	-	36	
5	379	Lewis Chum	Columbia River Chum	1	Lewis							2,431,111		167								2,431,111	-	167	
6	392	Lower Columbia_Duncan Creek Chum	Columbia River Chum	1	Washougal	99,853	998	1.00%			95%	382,857	22	35	61%	99,853	998	1.00%			95%	382,857	22	35	61%
7	737	Sandy Chum	Columbia River Chum	1	Sandy							112,601		8								112,601	-	8	
8	408	Washougal Chum	Columbia River Chum	1	Washougal							442,697		41								442,697	-	41	
9	711	Columbia Estuary_Big Creek Chum	Columbia River Chum	2	Columbia Estuary							2,911		1								3,007	-	1	
10	713	Columbia Estuary_Clatskanie Creek Chum	Columbia River Chum	2	Columbia Estuary							2,911		1								3,007	-	1	
11	660	Columbia Gorge_Tributaries Chum (Lower Gorge)	Columbia River Chum	2	Columbia Gorge							3,039		1								3,039	-	1	
12	661	Columbia Gorge_Tributaries Chum (Upper Gorge)	Columbia River Chum	2	Columbia Gorge							3,039		1								3,039	-	1	
13	357	Cowlitz Chum	Columbia River Chum	2	Cowlitz							483,096		54								480,267	-	54	
14	369	Kalama Chum	Columbia River Chum	2	Kalama							100,236		7								100,236	-	7	
15	745	Willamette_Clackamas Chum	Columbia River Chum	2	Willamette							3,007		1								3,007	-	1	
16	960	Columbia Estuary_Chum (Sea Resources)	Columbia River Chum	3	Columbia Estuary							25,504		6								25,504	-	6	
17	633	Salmon Creek Chum	Columbia River Chum	3	Lower Columbia							77,628		7								77,628	-	7	

Appendix E2 Hatchery Production by Alternative for Chum Salmon

Primary
Contributing
Stabilizing

		Columbia River Chum				Alternative 3 Columbia River Chum										Alternative 4 Columbia River Chum									
Pop #	ID	Population Name	ESU	Designatio	Subbasin	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	348	Columbia Estuary_Grays-Chinook River Chum	Columbia River Chum	1	Grays	199,942	1,997	1.00%				125,689	45	28	100%	115,297	1,152	1.00%				119,806	26	27	100%
2	671	Columbia Estuary_Mill-Aber-Germ Chum	Columbia River Chum	1	Columbia Estuary							140,991	-	13		61,432	614	1.00%	MAF			212,173	14	19	100%
3	717	Columbia Estuary_Youngs Bay Tribs Chum	Columbia River Chum	1	Columbia Estuary							112,007	-	8		96,059	960	1.00%	MAF			225,531	21	16	100%
4	340	Elochoman Chum	Columbia River Chum	1	Elochoman							522,538	-	36		181,987	1,818	1.00%	MAF			758,692	41	52	100%
5	379	Lewis Chum	Columbia River Chum	1	Lewis							2,431,111	-	167		256,372	2,560	1.00%	MAF			2,813,447	57	194	100%
6	392	Lower Columbia_Duncan Creek Chum	Columbia River Chum	1	Washougal	99,853	998	1.00%			95%	382,857	22	35	61%	99,907	998	1.00%			95%	384,497	22	35	100%
7	737	Sandy Chum	Columbia River Chum	1	Sandy							112,601	-	8		96,059	960	1.00%	MAF			233,233	21	16	100%
8	408	Washougal Chum	Columbia River Chum	1	Washougal							442,697	-	41		217,897	2,176	1.00%	MAF			552,339	49	50	100%
9	711	Columbia Estuary_Big Creek Chum	Columbia River Chum	2	Columbia Estuary							3,323	-	1								2,619		1	
10	713	Columbia Estuary_Clatskanie Creek Chum	Columbia River Chum	2	Columbia Estuary							3,323	-	1								2,619		1	
11	660	Columbia Gorge_Tributaries Chum (Lower Gorge)	Columbia River Chum	2	Columbia Gorge							3,039	-	1								3,039		1	
12	661	Columbia Gorge_Tributaries Chum (Upper Gorge)	Columbia River Chum	2	Columbia Gorge							3,039	-	1								3,039		1	
13	357	Cowlitz Chum	Columbia River Chum	2	Cowlitz							483,980	-	54								510,821		58	
14	369	Kalama Chum	Columbia River Chum	2	Kalama							100,236	-	7								157,658		11	
15	745	Willamette_Clackamas Chum	Columbia River Chum	2	Willamette							3,007	-	1								3,007		1	
16	960	Columbia Estuary_Chum (Sea Resources)	Columbia River Chum	3	Columbia Estuary							25,504	-	6		63,997	640	1.00%	MAF			37,061	14	8	100%
17	633	Salmon Creek Chum	Columbia River Chum	3	Lower Columbia							77,628	-	7								93,722		9	

Primary
Contributing
Stabilizing

		Columbia River Chum				Alternative 5 Columbia River Chum									
Pop #	ID	Population Name	ESU	Designatio	Subbasin	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	348	Columbia Estuary_Grays-Chinook River Chum	Columbia River Chum	1	Grays	199,942	1,997	1.00%				125,689	45	28	100%
2	671	Columbia Estuary_Mill-Aber-Germ Chum	Columbia River Chum	1	Columbia Estuary							140,991		13	
3	717	Columbia Estuary_Youngs Bay Tribs Chum	Columbia River Chum	1	Columbia Estuary							112,007		8	
4	340	Elochoman Chum	Columbia River Chum	1	Elochoman							522,538		36	
5	379	Lewis Chum	Columbia River Chum	1	Lewis							2,431,111		167	
6	392	Lower Columbia_Duncan Creek Chum	Columbia River Chum	1	Washougal	99,853	998	1.00%			95%	382,857	22	35	61%
7	737	Sandy Chum	Columbia River Chum	1	Sandy							112,601		8	
8	408	Washougal Chum	Columbia River Chum	1	Washougal							442,697		41	
9	711	Columbia Estuary_Big Creek Chum	Columbia River Chum	2	Columbia Estuary							3,323		1	
10	713	Columbia Estuary_Clatskanie Creek Chum	Columbia River Chum	2	Columbia Estuary							3,323		1	
11	660	Columbia Gorge_Tributaries Chum (Lower Gorge)	Columbia River Chum	2	Columbia Gorge							3,039		1	
12	661	Columbia Gorge_Tributaries Chum (Upper Gorge)	Columbia River Chum	2	Columbia Gorge							3,039		1	
13	357	Cowlitz Chum	Columbia River Chum	2	Cowlitz							483,980		54	
14	369	Kalama Chum	Columbia River Chum	2	Kalama							100,236		7	
15	745	Willamette_Clackamas Chum	Columbia River Chum	2	Willamette							3,007		1	
16	960	Columbia Estuary_Chum (Sea Resources)	Columbia River Chum	3	Columbia Estuary							25,504		6	
17	633	Salmon Creek Chum	Columbia River Chum	3	Lower Columbia							77,628		7	

Appendix F

Hatchery Performance and Production by Alternative for Sockeye Salmon

Appendix F1. Hatchery Performance by Alternative for Sockeye Salmon

Primary	Supporting
Contributing	Consistent
Stabilizing	Not Consistent
Not in ESU	

						Alternative 1					Alternative 2					Alternative 3					Alternative 4					Alternative 5				
Pop #	ID	Population Name	ESU	Desig	Subbasin	Population Type	pHOS	PNI	Productivity	NOS	Population Type	pHOS	PNI	Productivity	NOS	Population Type	pHOS	PNI	Productivity	NOS	Population Type	pHOS	PNI	Productivity	NOS	Population Type	pHOS	PNI	Productivity	NOS
1	461	Salmon_Redfish Lake Sockeye	Snake River Sockeye	1	Salmon River	Integrated	92%	-	0.07	13	Integrated		1.00	0.14	0	Integrated	92%	-	0.07	27	Integrated	92%		0.07	27	Integrated	92%		0.07	27
2	251	Wenatchee Sockeye	Wenatchee River Sockeye	1	Wentachee River	Integrated	0%	1.00	9.60	14,232	Integrated	0%	1.00	9.60	14,232	Integrated	0%	1.00	9.60	14,232	Integrated	0%	0.996	9.60	14,232	Integrated	0%	0.996	9.60	14,232

Appendix F2. Hatchery Production by Alternative for Sockeye Salmon

Primary
Contributing
Stabilizing
Not in ESU

Snake River Sockeye

Pop #	ID	Population Name	ESU	Designat	Subbasin	Alternative 1: Hatchery Smolt Release	Alternative 1: Adult Hatchery Production	Alternative 1: Hatchery SAR	Alternative 1: Mitchell Act Funded	Alternative 1: Weir Factor	Alternative 1: Stray Rate	Alternative 1: Natural Smolts	Alternative 1: Hatchery Harvest Contrib.	Alternative 1: Natural Harvest Contrib.	Alternative 1: pNOB Goal	Alternative 2: Hatchery Smolt Release	Alternative 2: Adult Hatchery Production	Alternative 2: Hatchery SAR	Alternative 2: Mitchell Act Funded	Alternative 2: Weir Factor	Alternative 2: Stray Rate	Alternative 2: Natural Smolts	Alternative 2: Hatchery Harvest Contrib.	Alternative 2: Natural Harvest Contrib.	Alternative 2: pNOB Goal
1	461	Salmon_Redfish Lake Sockeye	Snake River Sockeye	1	Salmon River	151,710	222	0.15%	MAF			6,363	10	1		-	-					0	-	0	
2	251	Wenatchee Sockeye	Wenatchee River So	1	Wentachee River	211,709	60	0.03%				802,414	3	611	100%	211,709	60	0.03%				802,414	3	611	100%

Appendix F2. Hatchery Production by Alternative for Sockeye Salmon

Primary
Contributing
Stabilizing
Not in ESU

Snake River Sockeye

Pop #	ID	Population Name	ESU	Designat	Subbasin	Alternative 3										Alternative 4									
						Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal	Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Nattural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	461	Salmon_Redfish Lake Sockeye	Snake River Sockey	1	Salmon River	750,751	1,351	0.18%	MAF		25%	12,969	84	2		750,751	1,351	0.18%	MAF		25%	12,969	84	2	
2	251	Wenatchee Sockeye	Wenatchee River So	1	Wentachee River	211,709	60	0.03%				802,414	3	611	100%	211,709	60	0.03%				802,414	3	611	100%

Primary
Contributing
Stabilizing
Not in ESU

Snake River Sockeye

Pop #	ID	Population Name	ESU	Designat	Subbasin	Alternative 5 Hatchery Smolt Release	Adult Hatchery Production	Hatchery SAR	Mitchell Act Funded	Weir Factor	Stray Rate	Natural Smolts	Hatchery Harvest Contrib.	Natural Harvest Contrib.	pNOB Goal
1	461	Salmon_Redfish Lake Sockeye	Snake River Sockey	1	Salmon River	750,751	1,351	0.18%	MAF		25%	12,969	84	2	
2	251	Wenatchee Sockeye	Wenatchee River So	1	Wentachee River	211,709	60	0.03%				802,414	3	611	100%

APPENDIX G

OVERVIEW OF THE "ALL H ANALYZER"

PREPARED FOR:

National Marine Fisheries Service
1201 NE Lloyd Blvd, Suite 1100
Portland, Oregon 97232
Contact: Allyson Purcell
(503) 736-4736

PREPARED BY:

ICF International
PO Box 724
Vashon, WA 98070
Contact: Greg Blair
(206) 463-6020

February 2010

ICF INTERNATIONAL

ICF International. 2010. Overview of the "All H Analyzer". February. (ICF 00901.09.) Vashon, WA. Prepared for National Marine Fisheries Service, Portland, Oregon.

Contents

Chapter 1
Overview

The purpose of the analysis was to compare the average, long-term effects of different hatchery strategies on conservation and harvest. Conservation of natural populations was assessed in terms of estimated abundance and productivity as well as via an index of the relative magnitude of natural versus artificial selection pressures on individual populations and their potential impacts on fitness. Harvest was assessed by estimating the average number of hatchery- and natural-origin fish taken in various fisheries. The analysis of these factors entailed the integration of habitat in terms of population-specific productivity and capacity parameters, harvest rates for hatchery- and natural-origin fish in all applicable fisheries, hydrosystem survival for adults and juveniles, and hatchery operations, with special emphasis on broodstock and escapement management and hatchery stray rates. The calculations entailed by these goals were simple in concept, but involved the simultaneous tracking of many populations and their interactions.

The approach used in this analysis involved an accounting for natural and hatchery reproduction, natural survival, and the fate of fish that survived to be caught the marine fishery or to return to the Columbia River. In turn, the fate of adults returning to the Columbia River was assessed in terms of homing fidelity, the composition of spawning escapement, relative reproductive success, relative contribution to the conservation of Evolutionarily Significant Units (ESUs) in the Columbia River Basin, and relative contributions to harvest by fishery.

1.1 Analysis Tool

The AHA tool is a Microsoft Excel-based application to evaluate salmon management options in the context of the four “Hs”—**H**abitat, passage through a **H**ydroelectric system (when appropriate), **H**arvest, and **H**atcheries. The AHA calculator integrates the four “Hs” using the methods to estimate equilibrium natural escapement, broodstock requirements, and harvest by fishery for natural- and hatchery-origin fish.

Most importantly, AHA estimates reflect a measure of hatchery influence on natural populations that is a function of both the percent hatchery-origin spawners in the natural escapement and the percent of natural-origin broodstock incorporated into the hatchery program. The assumptions underlying these fitness impacts are based on recently published work (Ford 2002, Lynch and O’Hely, 2001) and further development of these ideas by D. Campton (USFWS), C. Busack (WDFW), and K. Currens (NWIFC).

The AHA tool consists of a battery of interconnected modules for each H incorporating the equations described previously to estimate total recruits, escapement, and harvest for populations and hatchery programs. A critical feature of the analytical tool is the distribution of hatchery recruits to harvest, those recovered back at the point of release, and those straying to spawn in natural populations. In turn, the number of strays to natural populations affects the degree of hatchery influence in all natural populations receiving strays, and thus the fitness, abundance, and harvest potential for each population.

The purpose of the AHA tool is to allow managers to explore the implications of alternative ways of balancing hatcheries, harvest, habitat, and hydrosystem constraints. This tool is not used to make decisions nor to judge the "correctness" of management policies. Rather, it illustrates the implications of alternative ways of balancing the four "Hs" so that informed decisions can be made.

AHA should not be viewed as a new tool to predict habitat, harvest, or hydro effects to populations, but rather as a platform for integrating existing analyses. AHA makes relatively few new assumptions; instead, it brings together the results of other models. It does not replace these other models but instead relies on them for input. AHA is thus a relatively simple aid to regional decision making which, by incorporating the results of other models, can rapidly explore the impacts of very detailed scenarios relating to one or more of the "Hs".

Chapter 2
Analytical Methods

This rest of this paper describes the analytical methods embedded in the AHA tool. Methods, which depend upon a variety of information, include:

- The basic Beverton-Holt survival function which was assumed to describe recruitment for all fish spawning in nature
- Calculations of broodstock composition in terms of hatchery- and natural-origin adults, survival of hatchery fish by life stage in nature and in the hatchery, and the fate of returning hatchery adults
- Calculations of the mean number of fish taken in each of four fisheries
- Computations of ecological and genetic interactions between natural- and hatchery-origin fish reproducing in the natural environment

The analysis does not attempt to estimate what might happen in any particular year; rather, it projects the average outcome after many generations. The analysis tracked each hatchery and natural population component over 100 generations.

The methods compute survival and number of recruits of natural and hatchery production. Survival in nature depends on:

- Quantity and quality of habitat used by the population
- Fish passage survival through migration corridors
- Estuarine and ocean survival conditions
- Fitness of the natural population
- Relative ability of hatchery fish to spawn and their progeny to survive in nature

Survival of hatchery production depends on:

- Number broodstock collected and spawned
- Pre-spawn survival, fecundity, and sex ratio of the broodstock
- Survival in the hatchery to time of release, including culling
- Post-release survival of hatchery fish

The analysis recognizes and accounts for ecological and genetic interactions between natural and hatchery production. Ecological interactions occur via competition in nature, whereas genetic interactions are expressed in terms of gene flow between the production groups.

Ecological interactions depend on:

- Composition of the naturally spawning population
- Ability of hatchery fish to spawn successfully and the survival of their progeny in nature
- Number of hatchery fish spawning in nature

Genetic interactions depend on:

- Composition of the hatchery broodstock
- Percentage of the hatchery return recovered at the point of release and that spawn in nature
- Composition of the naturally spawning population
- Ability of hatchery fish to spawn successfully and survival of their progeny in nature
- Differences in selection pressure between the natural and hatchery environments

2.1 Natural Production

The abundance of natural progeny from adults spawning in nature is computed using the multi-stage, Beverton-Holt (B-H) survival function (Beverton and Holt 1957; Moussalli and Hilborn 1986). The survival function is based on life parameters for productivity (density-independent survival) and capacity (maximum number of fish that can survive). The two-parameter B-H survival function was assumed for each of the following life stages:

1. Spawning to emergent fry
2. Emergent fry to juveniles leaving the subbasin (smolts)
3. Juvenile mainstem migration in the Snake and Columbia rivers and ocean rearing
4. Adults entering the Columbia River and migration to the mouth of the subbasin
5. Pre-spawning adults, i.e. fish from the point of subbasin entry to the initiation of spawning

The B-H survival function assumed for each life stage was as follows:

$$N_{i+1} = \frac{N_i \cdot p_i}{1 + \frac{N_i \cdot p_i}{c_i}} \tag{1}$$

where:

N_i = Number of fish alive at the beginning of life stage i

N_{i+1} = Number of fish alive at end of life stage $i+1$

p_i = Density-independent survival of life stage i

c_i = Capacity of life stage i (maxium number fish survive in life stage)

Abundance of hatchery-origin fish spawning in nature and their off-spring were adjusted to include the relative reproductive success of hatchery fish in nature, such that the total number of spawners, N_i, was:

$$N_i = N_{i,Nat} + N_{i,Hatch} \cdot Rel\_Surv_{i,Hatch} \tag{2}$$

where:

$N_{i,Nat}$ = Number of progeny from natural-origin spawners in life stage *i*

$N_{i,Hatch}$ = Number of progeny from hatchery-origin spawners in life stage *i*

$Rel\_Surv_{i,Hatch}$ = An estimate of the phenotypic impact of hatchery rearing on life stage productivity in nature for life stage *i*

More specifically, Rel_Survi,Hatch is a user-provided estimate of the phenotypic depression of the reproductive success of hatchery spawners in nature.

The B-H productivity and capacity1 parameters were adjusted for the relative fitness, F, of the natural population over the complete (adult-to-adult) life cycle. The formulas used to estimate fitness of the natural population are described in Section 2.4.3 of this appendix. The fitness multiplier was apportioned over each life stage i as follows:

$$f_i = F^{Rel\_Loss_i} \tag{3}$$

where:

f_i = Life-stage specific fitness

Rel_Loss_i = Assumed proportion of the total fitness effect occuring in life stage *i*

The overall survival function for life stage *i* was as follows:

$$N_{i+1} = \frac{p_i \cdot f_i \cdot (N_{i,Nat} + N_{i,Hatch} \cdot Rel\_Surv_{i,Hatch})}{1 + \dfrac{p_i \cdot f_i \cdot (N_{i,Nat} + N_{i,Hatch} \cdot Rel\_Surv_{i,Hatch})}{c_i \cdot f_i}} \tag{4}$$

Cumulative productivity and capacity for a population included an assumed average smolt-to-adult return rate (SAR), calculated at the mouth of the subbasin of origin. Productivity and capacity parameters were adjusted as necessary to ensure that predicted SARs equaled the latest observed SAR by means of the following adjustment:

$$P_{Adj} = P_{Base} \cdot \left(SAR_{Obs} / SAR_{Base} \right) \tag{5}$$

where:

P_{Adj} = Adjusted Spawner-Spawner Productivity

P_{Base} = Base line period Spawner-Spawner Productivity

SAR_{Obs} = Latest observed subbasin-to-subbasin SAR

SAR_{Base} = SAR assumed in baseline estimate of Productivity

[1] Capacity is affected by both the quantity of key habitat and productivity by the equation:

$$C_i = p_i / \left(1/C_{i-1} + p_i/c_i \right).$$

A comparable adjustment for spawner-to-spawner capacity made use of the multi-stage B-H equation (Moussalli and Hilborn 1986) as follows:

$$C_{Adj} = \frac{p_{Smolt} \cdot SAR_{Obs} \cdot p_{Prespawn}}{\left(1/c_{Spawn} + p_{Smolt}/c_{Smolt} + p_{Smolt} \cdot SAR_{Obs} \cdot p_{Prespawn}/c_{Prespawn} \right)} \quad (6)$$

where:

C_{adj} = Adjusted Spawner-Spawner Capacity

p_{smolt} = Productivity for the period emergent fry to smolt leaving the subbasin

$p_{prespawn}$ = Productivity for the period adult entering subbasin to spawning

c_{spawn} = Life stage capacity from spawner to emgerent fry (relative index)

c_{smolt} = Life stage capacity from emergent fry to smolt leaving subbasin

$c_{prespawn}$ = Life stage capacity from adult entering subbasin to spawning

Productivity and capacity for the pre-spawn and spawner-to-fry life stages were user-supplied input variables. Given these values, productivity (P_{Smolt}) and capacity (c_{Smolt}) for the fry-to-smolt life stage was calculated as follows:

$$p_{Smolt} = \frac{P}{p_{Egg-fry} \cdot SAR_{Obs} \cdot p_{Pre-spawn}} \quad (7)$$

and

$$c_{Smolt} = \frac{1}{\left[\left(p_{Pre-spawn} \cdot SAR_{Obs} \right) \cdot \left(1/C - 1/c_{Pre-spawn} \right) \right]} \quad (8)$$

Finally, productivity and capacity of the population from spawner to smolt leaving the subbasin was computed to provide a means of reporting and validating cumulative productivity and capacity parameters and life stage parameters used in the analysis.

Productivity from spawn to smolt was computed by the following expression:

$$p_{Spawn-smolt} = \frac{P}{SAR_{Obs} \cdot p_{Pre-spawn}} \quad (9)$$

Capacity for the spawner-to-smolt life stage ($c_{Spawn\text{-}smolt}$) was computed as follows:

$$c_{spawn-smolt} = \frac{C}{\left[\left(SAR_{Obs} \cdot p_{Pre-spawn} \right) \cdot \left(1 - C/c_{Pre-spawn} \right) - 1/\left(p_{Spawn-smolt} \cdot c_{Spawn-egg} \right) \right]} \quad (10)$$

Data sources

The cumulative B-H productivity (P) and capacity (C) parameters define the maximum adult recruitment rate (density-independent recruitment) and maximum number of spawners (adult "carrying capacity") for a population over the complete life cycle (spawner to spawner). The specific parameters used in analyses can come from a variety of sources, depending on the population. Habitat-based models like Ecosystem Diagnosis and Treatment (EDT) can be used to estimate productivity and capacity, or these parameters can be estimated by fitting a B-H function to observed abundance data. It is also possible to estimate these parameters were from a time series of dam counts, with a subsequent allocation of returns to populations based on the relative quantity and quality of habitat in spawning tributaries above the reference dam.

Life stage specific parameters can be obtained from fish passage survival models, ESU recovery plans, and hatchery managers.

2.2 Hatchery Production

Hatchery production was evaluated in terms of whether a given hatchery program was segregated or integrated. A hatchery program was considered segregated if the management intent was to create a distinct population that is reproductively isolated from naturally spawning populations. A hatchery program was considered to be integrated if the management intent was to create a composite hatchery/natural population for which the dominant selective pressure was the natural environment. The concepts underlying the computation of net natural vs. artificial selection in integrated programs and the impact of net selective pressure on genetic fitness of the natural population are described in more detail in Section 2.4. In some cases, more than one release strategy was used in a program; for example, some programs release both late summer subyearling parr and spring yearling smolts. In such cases, information was required for both release groups. The combined number of hatchery juveniles produced (H_{Rel}) was computed as follows:

$$H_{Rel} = \sum_{a} BS_{HOB} \cdot S_{Spawn-egg} \cdot S_{Egg-rel,a} + BS_{NOB} \cdot S_{Spawn-egg} \cdot S_{Egg-rel,a} \cdot Rel\_Surv_{NOB} \quad (11)$$

where:

$$S_{Spawn-egg} = S_{Pre-spawn} \cdot Fecundity \cdot \%Females \cdot \left(1 - \%EggsCulled\right)$$

and:

BS_{NOB} = Number of natural-origin adults in broodstock (integrated programs)

BS_{HOB} = Number of hatchery-origin adults in broodstock (local and imported)

$S_{Spawn-rel,a}$ = Survival from egg to release for release group a

$\%R_a$ = Proportion of release comprised of juveniles from release group a

$S_{Pre-spawn}$ = Survival in hatchery of broodstock adults

$Fecundity$ = Average number of eggs per female in broodstock

$\%Females$ = Percent females in broodstock

$\%Culled$ = Percent of eggs in broodstock destroyed, typically for disease management

Survival from release to adult was based on total recruits per hatchery spawner (R/S). Recruits per spawner for hatchery fish (R/S_{Hatch}) is analogous to the productivity value for the natural population. Sometimes called the hatchery return rate, it represents the mean number of hatchery-origin recruits (HORs) produced (harvest plus escapement) per hatchery spawner. Hatchery spawners are the number of adults collected to meet broodstock needs before pre-spawn mortality and culling. The hatchery recruits per spawner value was usually computed from coded wire tag data or other hatchery information and was a user-supplied input variable.

The combined recruits per spawner value (R/S_{Hatch}) for programs that included more than one release strategy was calculated as follows:

$$R / S_{Hatch} = \frac{R / S_{\text{R}1} \cdot \%R_1 \cdot S_{\text{R}2\_egg-rel} + R / S_{\text{R}2} \cdot \%R_2 \cdot S_{\text{R}1\_egg-rel}}{\%R_1 \cdot S_{\text{R}2\_egg-rel} + \%R_2 \cdot S_{\text{R}1\_egg-rel}} \quad (12)$$

where:

R / S_{R1} & R / S_{R2} = Recruits per spawner for release groups 1 and 2

$S_{R1\_egg-rel}$ = Egg to release survival of hatchery juveniles for group 1, includes eggs culled

$S_{R2\_egg-rel}$ = Egg to release survival of hatchery juveniles for group 2, includes eggs culled

$\%R_1$ & $\%R_2$ = Proportion of program release comprised of release groups 1 and 2

Survival of hatchery fish from release to adult recruitment was computed to provide a means of reporting and validating hatchery inputs for recruit per spawner and in-hatchery survival to release. SAR_{Hat} was calculated by the following expression:

$$SAR_{Hatch} = \frac{R / S_{Hatch}}{\left(S_{Spawn-rel,R1} \cdot \%R_1 + S_{Spawn-rel,R2} \cdot \%R_2\right) \cdot S_{Spawn-egg}} \quad (13)$$

Finally, SAR_{Hat} was adjusted as necessary to ensure that predicted hatchery SAR equaled the latest observed SAR by means of the following adjustment:

$$SAR_{Hat\_Adj} = SAR_{Hat} \cdot \left(SAR_{Obs} / SAR_{Base} \right) \quad (14)$$

where SAR_{Obs} and SAR_{Base} are as previously defined in Equation 5.

In the analysis, hatchery recruits included strays, fish taken in the harvest, fish recovered at the point of release, fish recovered at an adult in-river weir, and fish that spawned in nature. Methods to calculate the number of fish harvested are described in more detail in Section 2.3. The following section describes how the escapement, i.e. fish that were not harvested, was distributed.

The number of hatchery adults recovered at the point of release ($\#Hatch$) was calculated by the following expression:

$$\#Hatch = H_{Rel} \cdot SAR_{Hat\_Adj} \cdot \left(1 - TotalExploitation\right) \cdot \%Hatch \quad (15)$$

where:

$TotalExploitation$ = Total exploitation rate across all fisheries

$\%Hatch$ = Percent hatchery origin escapement recovered and/or that died at the point of release.

The analysis estimated hatchery surplus as the number of hatchery adults collected at the hatchery and other locations such as weirs *(%Weir*), but not used for broodstock. Hatchery surplus was calculated as follows:

$$Surplus_{Hatch} = H_{Rel} \cdot SAR_{Hat\_Adj} \cdot \left(1 - TotalExploitation\right) \cdot \%Weir \cdot \%Hatch - BS_{HOB} \qquad (16)$$

The number of hatchery returns surviving to spawn in nature (N_{hat}) was calculated as follows:

$$N_{Hatch} = H_{Rel} \cdot SAR_{Hat\_Adj} \cdot \left(1 - TotalExploitation\right) \cdot \left(1 - \%Hatch\right) \qquad (17)$$

The number of hatchery adults spawning in a particular natural population is calculated as follows:

$$N_{Hatch} = \sum_{p=1}^{P} N_{Hatch,p} \cdot \left(1 - \%Weir\right) \qquad (18)$$

In the previous equation hatchery fish are assumed to originate from one or more hatchery programs *p*. Methods to distribute hatchery fish spawning in nature to natural populations will be described in detail in the Interaction section of this appendix.

Data Sources

Hatchery Genetic Management Plans (HGMPs) are a good source of information for hatchery programs. Although HGMPs vary in completeness and quality, comprehensive HGMPs include information on a wide range of parameters including:

- Hatchery type (Segregated/Integrated)
- Broodstock target (number of fish) and hatchery/natural composition in the broodstock
- Broodstock collection procedures
- Contribution of hatchery fish to natural escapement
- Proportion of broodstock imported and/or exported
- Smolt release size and life stage
- Hatchery survival by life stage
- Hatchery return rates
- Hatchery stray rates

2.3 Harvest

Harvest analysis in the methods was relatively simple. Harvest was estimated for major fisheries (defined by harvest area) as a function of user-supplied harvest rates and the estimated number of HOR and NOR fish available in each fishery. Mark-selective fisheries on hatchery fish were analyzed by imposing differential harvest rates on NORs and HORs. Harvest analysis does not incorporate age-specific harvest rates; harvest rates represent total harvest on a brood over all ages.

The number of natural fish surviving to marine fisheries (NMar, Nat) was calculated as follows:

$$N_{Mar,Nat} = N_{Smolt} \cdot S_{Juv} \tag{19}$$

where:

N_{Smolt} = Estimated number of natural-origin juveniles leaving subbasin.
S_{Juv} = Survival of natural fish during juvenile mainstem passage and in the ocean.

The number of *hatchery* fish surviving to marine fisheries ($N_{Mar, Hat}$) was calculated by a similar expression:

$$N_{Mar,Hatch} = H_{Rel} \cdot S_{Juv,Hatch} \tag{20}$$

where:

H_{Rel} = Number of hatchery fish released.
$S_{Juv,Hatch}$ = Survival of hatchery fish during juvenile mainstem passage and in the ocean.

The number of fish harvested was calculated sequentially, beginning with the number of fish harvested in marine fisheries ($Harv_{Mar, i}$):

$$Harv_{Mar,i} = N_{Mar,i} \cdot HR_{Mar,i} \tag{21}$$

where:

$N_{Mar,i}$ = Number of fish surviving to enter marine fisheries for production type *i*.
$\mathrm{HR}_{Mar,i}$ = Marine harvest rate on adults for production type *i*.

The number of fish harvested in the lower reaches of a major river and in fisheries further upstream entail sequential calculations in which each successive harvest makes use of the fish remaining after previous harvests.

Data Sources

Harvest rate is the number of fish harvested divided by the total number of fish available to the fishery. Harvest rates are taken from recent brood year averages or from target harvest rates described in management plans. Future harvest rates applied to the analysis came from proposed harvest plans or recommendations.

2.4 Interactions – (Ecological and Genetic)

The analytical methods evaluated interactions between hatchery and natural fish in two ways: 1) through ecological interactions between progeny of naturally spawning hatchery and natural-origin parents and 2) through long-term genetic interactions resulting from hatchery adults spawning with natural fish. The methods to compute effects of these interactions for each of these ways are described in the following sections. The sections describe the quantitative assessment of ecological and genetic interactions in the analysis. First, however, an overview of methods to compute the number of hatchery fish spawning in nature and their distribution among natural populations is presented, followed by descriptions of methods to compute effects of ecological and genetic interactions.

2.4.1 Distribution of Hatchery Adults Spawning in Nature

Hatchery returns may be recovered at the point of release, at a weir, on the spawning grounds within the subbasin of origin, on spawning grounds outside the subbasin of origin, or they may die after escaping the fisheries, but before spawning. The analytical methods included assumptions about the fate of all hatchery return escaping fisheries. The procedure tracked the eventual fate of all returning hatchery adults from every population/program.

All hatchery adults not recovered in fisheries or at hatchery racks or weirs at their point of release are considered strays. Strays were allocated to a natural population within their respective basin of origin (within-basin strays), to natural populations outside of the originating basin (out-of-basin strays), or designated as adults returning to areas with no spawning populations. The purpose of the straying component in the analysis is to account for the effect of reproductive interactions between natural populations ("recipient populations") and hatchery programs ("donor populations").

The proportion and source of hatchery strays in the natural spawning escapement is used to estimate relative genetic fitness (see following section) of recipient natural populations. Recall from equation 17, the number of hatchery strays (N_{Hatch}) spawning in nature from the donor population p was calculated as follows:

$$N_{Hatch} = H_{Rel} \cdot SAR_{Hatch} \cdot \left(1 - TotalExploitation\right) \cdot \left(1 - \%Hatch\right) \qquad (22)$$

The number of strays from donor hatchery p to a particular recipient natural population was calculated as follows:

$$Recip_{Hatch,p} = N_{Hatch,p} \cdot \%Recip \qquad (23)$$

where *%Recip* is an estimate of the proportion of the adults that stray to the recipient natural population.

Generally the *%Recip* would sum to 100% for a donor population, i.e. all strays were assumed to spawn with a natural population. However, information suggested that, in some cases, a portion of the hatchery return not recovered at the hatchery does not attempt to spawn with a natural population (e.g., programs that release fish a long distance away from natural populations).

The actual number of hatchery fish spawning in a recipient natural population is the sum of hatchery fish from all donor populations:

$$Strays_{Hatch} = \sum_{p=1}^{P} Recip_{Hatch,p} \cdot \left(1 - \%Weir\right) \qquad (24)$$

where *%Weir* is the proportion of the hatchery adults destined to spawn with the natural population, but are recovered at an adult weir either below the population or within the boundaries of the natural population.

Data Sources

Assumptions regarding strays can often be obtained from hatchery managers. Such data typically consists of a time series of coded wire tagged releases from the originating hatchery and adult recoveries at the originating hatchery adult trap, at hatchery adult traps other than the originating hatchery, and from spawning ground surveys. Recoveries of hatchery adults at hatchery traps other than the release hatchery can be used to provide a measure of straying outside of the basin of origin. Observations of the number of hatchery adults on the spawning grounds or at weirs can be used to validate or revise default assumptions.

2.4.2 Ecological Interactions

The analysis considered the effect of hatchery fish in nature on survival of natural fish through competitive interactions (reviewed in Kostow 2008). While the number of hatchery fish that "effectively" interbreed may be low, the census number of fish present may be very large and may have a significant ecological effect (Kostow 2003, Kostow 2004, Kostow and Zhou 2006). The concern is that hatchery fish may compete effectively at the juvenile stage, but have inferior reproductive success.

The analytical approach computed an adjusted survival of progeny of natural-origin spawners based on estimates of productivity and competition factors for hatchery fish relative to natural-origin fish.

The number of fish from natural-origin parents surviving to the next life stage was adjusted based on the quantity of fish from hatchery-origin parents. In other words, Equation 4 described previously was modified to account for competition between the progeny of hatchery and natural spawners in nature. The following equation was used to compute number of fish surviving to the next life stage from natural-origin parents ($N_{i,Nat}$):

$$N_{i+1,Nat} = \frac{p_i \cdot f_i \cdot N_{i,Nat}}{1 + \frac{p_i \cdot f_i \cdot (N_{i,Nat} + N_{i,Hatch} \cdot Rel\_Surv_{i,Hatch} \cdot Rel\_Comp_{i,Hatch})}{c_i \cdot f_i}} \qquad (25)$$

The number of fish surviving to the next life stage from hatchery-origin parents ($N_{i,Hatch}$) was computed by the following:

$$N_{i+1,Hatch} = \frac{p_i \cdot f_i \cdot Rel\_Surv_{i,Hatch} \cdot N_{i,Hatch}}{1 + \frac{p_i \cdot f_i \cdot (N_{i,Hatch} \cdot Rel\_Surv_{i,Hatch} + N_{i,Nat})}{c_i \cdot f_i}} \qquad (26)$$

In the previous equations, $N_{i,Nat}$ is the number of natural progeny from natural-origin parents and $N_{i,Hatch}$ is the number of natural progeny from hatchery-origin parents. The competition effect of offspring from hatchery spawners may be adjusted based on the $Rel\_Comp_{i,Hatch}$ parameter. A value of 1.0 results in equal competition between the off-spring of hatchery spawners and natural spawners. Values less than 1.0 signify that off-spring from hatchery fish are less competitive in nature.

Hatchery and natural fish can potentially interact after release when returning as pre-spawners and as spawners on the spawning grounds. The analysis considered these potential effects by considering a variety of factors such as the number of fish released, life stages at release, release strategies, and the percent of the natural spawning abundance that is comprised of hatchery-origin fish.

Data Sources

The analysis can incorporate any relative survival value deemed appropriate for the population of interest. Many hatchery releases are outplant programs based on domesticated hatchery stocks. Hatchery fish from such programs make a relatively small direct genetic contribution to the naturally spawning populations because of differences in spawn timing and behavior (Lieder et al. 1984). For example, in the Columbia River, the analysis assumed 11% relative survival of highly domesticated winter steelhead in nature and 18% relative survival of domesticated summer steelhead in nature.

2.4.3 Genetic Interactions

The analysis of genetic interactions comprises the long-term effects on fitness of hatchery adults spawning with natural populations. A more detailed description of the basis for these equations is described in the HSRG white paper on Fitness and Local Adaptation (Appendix B). The application of the Ford (2002) model in the analytical methods is described below.

The Ford model is based on gene flow between hatchery and natural fish. Two parameters represent the mean proportional genetic contributions in each generation of hatchery and natural fish to natural-origin and hatchery-origin progeny. The proportion of hatchery broodstock composed of natural-origin adults (proportion of natural-origin broodstock or pNOB) was calculated as the following:

$$pNOB = \frac{BS_{NOR}}{BS_{NOR} + BS_{HOR}} \qquad (27)$$

The proportion of naturally spawning fish composed of hatchery-origin spawners (proportion of effective hatchery-origin spawners or $pHOS_{Eff}$) was calculated as the following:

$$pHOS_{Eff} = \frac{N_{HOS} \cdot Rel\_Surv_{HOS}}{\left(N_{HOS} \cdot Rel\_Surv_{HOS}\right) + N_{NOS}} \qquad (28)$$

where NHOS and NNOS were the number of natural spawning hatchery and natural adults, respectively. Effective hatchery spawners were those that successfully produced progeny that survived to spawn to the next generation.

The proportional influence of the natural environment on the mean phenotypic values (and genetic constitutions) of natural and hatchery fish is referred to as PNI 2 (proportionate natural influence). An approximate index of PNI for natural and hatchery fish when pNOB and pHOS were both greater than zero was calculated as the following:

[2] The term *proportionate natural influence* (*PNI*) was first coined by C. Busack, Washington Department of Fish and Wildlife, Olympia, WA.

$$PNI_{Approx} = \frac{pNOB}{(pNOB + pHOS)} \tag{29}$$

When *pHOS* or *pNOB* were zero, the calculated *PNI* depends on assumptions regarding selection intensities and "heritabilities" associated with a specific trait. If *pNOB* = 0 then PNI_{Hatch} = 0 and the following equation was used to calculate PNI_{Nat}:

$$PNI_{Nat} = \frac{h^2 + (1.0 - h^2 + \omega^2) \cdot pNOB}{h^2 + (1.0 - h^2 + \omega^2) \cdot (pNOB + pHOS)} \tag{30}$$

where:

h^2 = Heritability of the trait ≡ proportion of the total phenotypic variance resulting from heritable genetic variance among individuals $(0 < \mathrm{h}^2 < 1.0)$

ω^2 = Variance of the probability distribution of fitness as a function of phenotypic values for individuals in the population

The analysis assumed σ^2 and ω^2 to be equal between natural and hatchery fish. Note that the inverse of ω^2, i.e. $1/\omega^2$, is the intensity selection towards the phenotypic optimum. In other words, as ω^2 increases the selection intensity decreases. According to Ford (2002), $\omega^2 = 10\sigma^2$ is considered "strong selection", whereas $\omega^2 = 100\sigma^2$ would be considered "weak selection".

Fitness is computed for each generation (*g*) in the analysis based on *pHOS* and *pNOB* in the parent generation (*g-1*).

Population fitness in generation *g* is calculated as the following:

$$F_g = e^{-\frac{1}{2}\cdot\left(\frac{\bar{P}_{Nat,g} - \theta_{Nat}}{\omega^2 + \sigma}\right)^2} \tag{31}$$

where:

θ_{Nat} = Phenotypic optimum or expected value (mean) of the phenotypic probability distribution for the natural population

θ_{Hatch} = Phenotypic optimum or expected value (mean) of the phenotypic probability distribution for the hatchery population

σ^2 = Phenotypic variance for the trait in question

$\bar{P}_{Nat,g}$ = Mean phenotypic value of the natural population in generation g

$\bar{\mathrm{P}}_{Nat}$-θ_{Nat} = Deviation from the optimum phenotypic value for the natural environment

The mean phenotypic value of the natural population ($\bar{P}_{Nat,g}$) and hatchery population ($\bar{P}_{Hatch,g}$) in generation *g* is calculated as the following:

$$\bar{P}_{Nat,g} = \left(1 - pHOS_{g-1}\right) \cdot \left[\bar{P}_{Nat,g-1} + \left(\left(\left(\bar{P}_{Nat,g-1} \cdot \omega^2 + \theta_{Nat} \cdot \sigma^2 \right) / \left(\omega^2 + \sigma^2 \right) \right) - \bar{P}_{Nat,g-1} \right) \cdot h^2 \right] + pHOS_{g-1} \cdot \left[\bar{P}_{Hatch,g-1} + \left(\left(\left(\bar{P}_{Hatch,g-1} \cdot \omega^2 + \theta_{Nat} \cdot \sigma^2 \right) / \left(\omega^2 + \sigma^2 \right) \right) - \bar{P}_{Hatch,g-1} \right) \cdot h^2 \right] \quad (32)$$

and:

$$\bar{P}_{Hatch,g} = \left(1 - pNOB_{g-1}\right) \cdot \left[\bar{P}_{Hatch,g-1} + \left(\left(\left(\bar{P}_{Hatch,g-1} \cdot \omega^2 + \theta_{Hatch} \cdot \sigma^2 \right) / \left(\omega^2 + \sigma^2 \right) \right) - \bar{P}_{Hatch,g-1} \right) \cdot h^2 \right] + pNOB_{g-1} \cdot \left[\bar{P}_{Nat,g-1} + \left(\left(\left(\bar{P}_{Nat,g-1} \cdot \omega^2 + \theta_{Hatch} \cdot \sigma^2 \right) / \left(\omega^2 + \sigma^2 \right) \right) - \bar{P}_{Nat,g-1} \right) \cdot h^2 \right] \quad (33)$$

Data sources

The analytical methods applied in this analysis used the following parameter values in all analyses in order to model the long-term genetic effects of the natural population of hatchery-origin fish spawning naturally:

$$\sigma^2_{Nat} = \sigma^2_{Hatch} = 10.0$$
$$\theta_{Hatch} = 80.0$$
$$\theta_{Nat} = 100.0$$
$$h^2_{Nat} = h^2_{Hatch} = 0.5$$
$$\omega^2 = 10 \cdot \sigma^2 = 100.0 \text{ (Strong selection)}$$

The calculations described above are contained within “All H Analyzer” (AHA) analytical tool.

Beverton, R. J. H. and S. J. Holt. 1957. On the Dynamics of Exploited Fish Populations. Chapman & Hall, London.

Ford, M. J. 2002. Selection in captivity during supportive breeding may reduce fitness in the wild. *Conservation Biology* 16:815–825.

Kostow, K. E. 2003. Factors that influence Evolutionarily Significant Unit boundaries and status assessment in a highly polymorphic species, *Oncorhynchus mykiss*, in the Columbia River. Oregon Department of Fish and Wildlife Information Report No. 2003-04. Clackamas, OR, 122 pp.

Kostow, K. E. 2004. Differences in juvenile phenotypes and survival between hatchery stocks and a natural population provide evidence for modified selection due to captive breeding. Can J Fish Aquat Sci 61:577–589.

Kostow, K. E. 2008. Factors that contribute to the ecological risks of salmon and steelhead hatchery programs and some mitigating strategies. Rev Fish Biol Fisheries. 2008.

Kostow K.E. and S. Zhou. 2006. The effect of an introduced summer steelhead hatchery stock on the productivity of a wild winter steelhead population. Trans Am Fish Soc 135:825–841.

Leider S., Chilcote M.W., Loch J.J. 1984. Spawning characteristics of sympatric populations of steelhead trout (Salmo gairdneri): evidence for partial reproductive isolation. Can J Fish Aquat Sci 41:1454-1462.

Lynch, M. and M. O'Hely. 2001. Captive breeding and the genetic fitness of natural populations. Conservation Genetics 2**:**363–378.

Moussalli, E. and R. Hilborn. 1986. Optimal stock size and harvest rate in multistage life history models. Can J Fish Aquat Sci 43:135-141.

Appendix H

Assessment of Operational Effectiveness of Columbia River Hatchery Programs (HPV Analysis)

ICF – Jones & Stokes
June 2009

OVERVIEW

The Hatchery Scientific Review Group (HSRG), in collaboration with ICF-Jones & Stokes, developed a standardized procedure to determine the degree to which hatchery programs are operated according to widely accepted best management practices (BMPs). The procedure covers all operational phases of hatchery operation except program size (number of juveniles released) and some aspects of broodstock composition. These elements were excluded from the BMP analysis because their impact on the performance of hatchery programs and associated natural populations is so direct, and because these impacts are evaluated by another assessment tool, the All H Analyzer (AHA).

Employing operational BMPs is clearly a necessary if not a sufficient condition for a meeting an overall hatchery goal. The goal of a hatchery is determined by its *purpose* and *type*. Hatchery purposes are considered to be either the augmentation of harvest, or the conservation of a natural population. Hatchery types are classified either as segregated or integrated. Segregated programs attempt to minimize all interactions between hatchery-reared and natural fish, especially genetic interactions. Adaptations to an artificial spawning and rearing environment are promoted, and every effort is made to exclude natural fish from brood stock and to limit the number of hatchery fish that spawn naturally. According to current genetic theory, one of the most important characteristics of segregated programs is that the proportion of hatchery-origin fish in the natural spawning escapement (pHOS) be five percent or less. Conversely, the focus of integrated programs is the natural population, of which hatchery fish are considered to be a part. The ultimate goal of an integrated program is that the adaptation of the combined hatchery and natural population is driven primarily by the characteristics of the natural environment. This goal implies that the proportion of natural-origin fish in the broodstock (pNOB) must, on average, exceed pHOS, the proportion of hatchery-origin spawners in nature (Ford 2002). This fundamental requirement has been quantified by a metric termed the PNI, or the Proportionate Natural Influence[1], which is approximated by pNOB/(pNOB + pHOS). If adaptations are to be driven by the natural environment, PNI must be greater than 0.5.

In terms of the HSRG classification scheme, there are four qualitatively different goals for a hatchery depending on whether it is an Integrated Harvest program, an Integrated Conservation program, a Segregated Harvest program or a Segregated Conservation program. Very broadly, the fundamental goals for these four distinct kinds of hatcheries are as follows. Integrated harvest programs should increase harvest opportunity by

[1] The term *proportionate natural influence* (*PNI*) was first coined by C. Busack, Washington Department of Fish and Wildlife, Olympia, WA.

increasing the productivity of a composite population that continues to be adapted the characteristics and carrying capacity of the natal watershed. Integrated conservation programs focus exclusively on increasing the viability of a composite population by increasing its overall productivity, abundance, life history diversity and geographic distribution. Segregated harvest programs attempt to breed a hatchery population uniquely suited to a particular fishery and, ideally, incapable of ecological or genetic interactions with natural fish of the same species. Segregated conservation programs are typically used to prevent the extinction of a population whose natal watershed has been severely degraded. Such programs attempt to preserve a population either by sequestering it entirely within a hatchery environment, as in a captive brood stock program, or by marking and releasing fish of known ancestry such that essentially all spawning occurs in the hatchery. These broad goals underlie the scheme developed by the HSRG to evaluate salmon and steelhead hatcheries in terms of the BMPs expected of hatchery programs of a specific type and purpose.

DETAILS OF ANALYSIS

Assessment of Operational Effectiveness

The tool developed by the HSRG to assess operational effectiveness[2] is called the Hatchery Program Viewer (HPV). The HPV is built around a list of 87 questions distributed over 11 operationally distinct hatchery operational components. In order of the sequence in which they typically occur, the 11 hatchery operational components evaluated are: 1) broodstock choice, 2) broodstock collection, 3) adult holding, 4) spawning, 5) incubation, 6) rearing, 7) release, 8) facilities, 9) monitoring, 10) effectiveness and 11) accountability. Each question is tied to effects on one or more of the following impact categories: impacts on the target population[3], impacts on non-target populations, impacts on the environment, or impacts on monitoring and effectiveness. Impact categories for target and non-target populations are, in turn, broken down into impacts on productivity and abundance, impacts on diversity and spatial structure, and impacts on harvest. Answers to these questions generate a total score by impact category for a specific program under four different management scenarios. The HPV is intended to highlight specific benefits and risks associated with each of the hatchery practices covered by the questions, and to identify overall operational deficiencies (or operational effectiveness) by impact category. Ratings take the values of “High operational effectiveness”, “Medium operational effectiveness” or “Low operational effectiveness” according to whether the score is, respectively, above 60% of the total possible, between 60 and 40% of the total possible, or less than 40% of the total possible. It should be noted that the 87 questions comprising the HPV are assigned weights between 0 (not

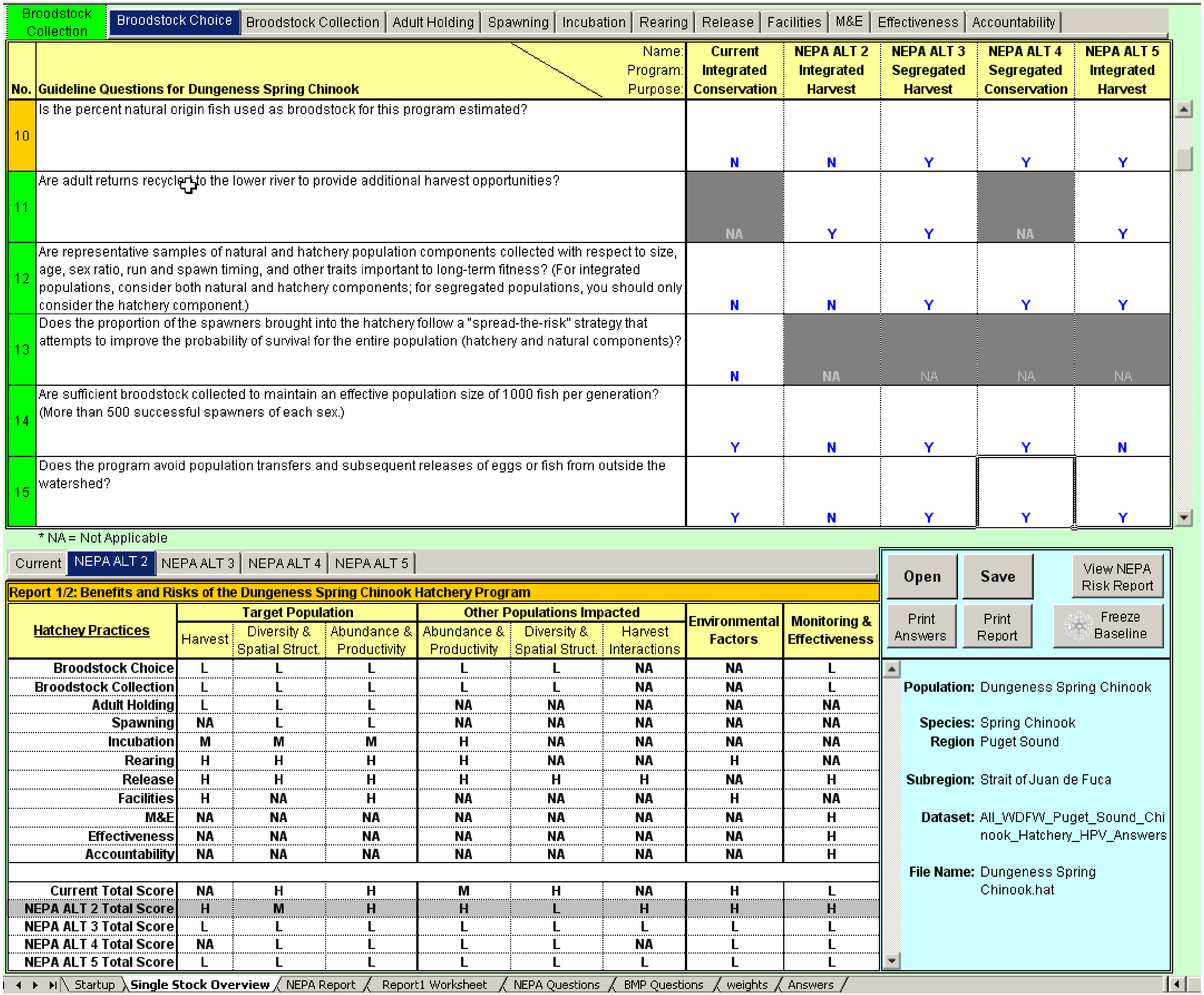
[2] The phrase “operational effectiveness” is to be understood in this document as “the degree to which appropriate Best Management Practices are implemented for a hatchery program of a particular type and purpose”.

[3] The phrase “target population” is to be understood as the hatchery population as well as the associated natural population of the same species and race. Sometimes no “associated natural population” exists, as in the case of a segregated harvest fall Chinook program in which smolts are released into a very small tributary that has never been capable of supporting a natural population of fall Chinook. The target population, however, does include a natural component whenever the subbasin of release supports a natural population of the same species and race.

applicable for a specific program type and purpose) to 10 (extremely important for a specific program type and purpose). The weights were the basis for computing an overall BMP score for a particular hatchery operational component. This weighting scheme was developed by ICF Jones & Stokes and several HSRG members, and was intended to reflect the thinking of the HSRG with regard to the importance of each question to programs of a specific purpose and type. Appendix Table 1.1 lists all of the questions included in the HPV analysis as well as the risks and benefits attributed to each BMP. Appendix Table 1.2 provides a full list of citations that were considered in developing the BMPs. Appendix Tables 1.3 through 1.6 shows the weightings assigned to each question for programs that are, respectively, Integrated Harvest, Integrated Conservation, Segregated Harvest or Segregated Conservation programs.

Figure 1 illustrates the matrix of hatchery operations and impact categories as they appear in the HPV "Single Stock Overview". Although the hatchery program identified in Figure 1 is real, the answers to the operational effectiveness questions are hypothetical. In this hypothetical example, the current program is an integrated conservation program while NEPA alternatives 2 through 5 are, respectively, integrated harvest, segregated harvest, segregated conservation and integrated harvest programs (see the yellow-shaded Name/Program/Purpose headers at top of Figure 1). The six rows in the top half of the Figure represent five Broodstock Collection questions and one Broodstock Choice question, the answers to which appear to the right in columns under the five alternatives. (In the HPV computer application, all 90 questions are viewed and answered in this upper section using the scroll button on the right in Figure 1 to display additional questions). Note that most answers are "Yes/No", with the correct BMP response usually being "Yes", although some require a numeric response. The grayed cells in the matrix in the top half of Figure 1 indicate programs for which a particular question is inapplicable. For example, question 11, "Are adult returns recycled to the lower river to provide additional harvest opportunities," does not apply to conservation programs. Other questions are similarly applicable to some kinds of programs but not to others.

The bottom half of Figure 1 is the operational effectiveness matrix, in which rows are distinct hatchery operations and columns are impact categories. The bottom-most five rows represent the sum of the scores across all operations within a given impact category for a given NEPA alternative. More precisely, the bottom five rows represent the categorical ratings associated with the sum of scores by impact category and alternative. In the computer application, the user clicks on one of the "alternative tabs" at the top of the effectiveness matrix to highlight the overall rating in the appropriate "Total Score" row at the bottom and to display in the upper 11 rows the effects individual hatchery operations have on individual impact categories. In the example shown in Figure 1, "NEPA alternative 2" has been selected and the operation-by-impact category ratings for alternative 2 are displayed in the upper 11 rows.



Broodstock Collection | Broodstock Choice | Broodstock Collection | Adult Holding | Spawning | Incubation | Rearing | Release | Facilities | M&E | Effectiveness | Accountability

No.	Guideline Questions for Dungeness Spring Chinook (Name: / Program: / Purpose:)	Current Integrated Conservation	NEPA ALT 2 Integrated Harvest	NEPA ALT 3 Segregated Harvest	NEPA ALT 4 Segregated Conservation	NEPA ALT 5 Integrated Harvest
10	Is the percent natural origin fish used as broodstock for this program estimated?	N	N	Y	Y	Y
11	Are adult returns recycled to the lower river to provide additional harvest opportunities?	NA	Y	Y	NA	Y
12	Are representative samples of natural and hatchery population components collected with respect to size, age, sex ratio, run and spawn timing, and other traits important to long-term fitness? (For integrated populations, consider both natural and hatchery components; for segregated populations, you should only consider the hatchery component.)	N	N	Y	Y	Y
13	Does the proportion of the spawners brought into the hatchery follow a "spread-the-risk" strategy that attempts to improve the probability of survival for the entire population (hatchery and natural components)?	N	NA	NA	NA	NA
14	Are sufficient broodstock collected to maintain an effective population size of 1000 fish per generation? (More than 500 successful spawners of each sex.)	Y	N	Y	Y	N
15	Does the program avoid population transfers and subsequent releases of eggs or fish from outside the watershed?	Y	N	Y	Y	Y

* NA = Not Applicable

Current | NEPA ALT 2 | NEPA ALT 3 | NEPA ALT 4 | NEPA ALT 5

Open | Save | View NEPA Risk Report | Print Answers | Print Report | Freeze Baseline

Report 1/2: Benefits and Risks of the Dungeness Spring Chinook Hatchery Program

Hatchey Practices	Target Population			Other Populations Impacted			Environmental Factors	Monitoring & Effectiveness
	Harvest	Diversity & Spatial Struct.	Abundance & Productivity	Abundance & Productivity	Diversity & Spatial Struct.	Harvest Interactions		
Broodstock Choice	L	L	L	L	L	NA	NA	L
Broodstock Collection	L	L	L	L	L	NA	NA	L
Adult Holding	L	L	L	NA	NA	NA	NA	NA
Spawning	NA	L	L	NA	NA	NA	NA	NA
Incubation	M	M	M	H	NA	NA	NA	NA
Rearing	H	H	H	H	NA	NA	H	NA
Release	H	H	H	H	H	H	NA	H
Facilities	H	NA	H	NA	NA	NA	H	NA
M&E	NA	NA	NA	NA	NA	NA	NA	H
Effectiveness	NA	NA	NA	NA	NA	NA	NA	H
Accountability	NA	NA	NA	NA	NA	NA	NA	H
Current Total Score	NA	H	H	M	H	NA	H	L
NEPA ALT 2 Total Score	H	M	H	H	L	H	H	H
NEPA ALT 3 Total Score	L	L	L	L	L	L	L	L
NEPA ALT 4 Total Score	NA	L	L	L	L	NA	L	L
NEPA ALT 5 Total Score	L	L	L	L	L	L	L	L

Population: Dungeness Spring Chinook

Species: Spring Chinook

Region Puget Sound

Subregion: Strait of Juan de Fuca

Dataset: All_WDFW_Puget_Sound_Chinook_Hatchery_HPV_Answers

File Name: Dungeness Spring Chinook.hat

Startup | Single Stock Overview | NEPA Report | Report1 Worksheet | NEPA Questions | BMP Questions | weights | Answers

Figure 1. Example of HPV analysis output

The overall rating for target population Diversity and Spatial Structure under alternative 2 is “M”, and this rating is attributable to “L” ratings assigned to Broodstock Choice, Broodstock Collection Adult Holding and Spawning..

Identification of BMP-specific Risks and Benefits

One feature of the HPV analysis should be mentioned in some detail because it provides direction in diagnosing the causes of operational ineffectiveness and in evaluating the nature and severity of the impact of not employing a particular BMP. The HSRG and ICF-Jones & Stokes developed a benefit and a risk statement for each of the 87 questions in the HPV analysis. In the computer application, the user can view the specific benefits and risks associated with every hatchery operation by opening up a benefit/risk sheet in the Workbook. An example of what they see when they do so is shown below.

Excerpt from a Benefit/Risk statements list.

Broodstock Choice

Benefit Statements

Current

This program uses a broodstock representing populations native or adapted to the watershed, which increases the likelihood of long term survival of the stock, helps avoid loss of among population diversity, and reduces the likelihood of unexpected ecological interactions.

Choice of a broodstock with similar morphological and life history traits improves the likelihood of the stock's adaptation to the natural environment.

The broodstock chosen poses no threat to other populations in the watershed from pathogen transmission

Estimating the proportion of natural fish used for broodstock makes it possible to determine whether composition targets have been met and prevents masking of the status of both the hatchery and natural populations.

Risk Statements

Current

None

Broodstock Collection

Benefit Statements

Current

Collection of representative samples of both the natural and hatchery populations reduces the risk of domestication and loss of within population diversity.

The proportion of spawners brought into the hatchery improves the likelihood that the population will survive a catastrophic loss from natural events or hatchery failure.

Risk Statements

Current

Sufficient broodstock are not collected to maintain genetic variation in the population

Stock transfers from outside the watershed pose a risk to local adaptation and increases the risk of pathogen transmission.

Pre-spawning mortality greater than 10% poses a risk to maintaining effective population size and a risk of domestication selection

Lack of established guidelines for acceptable contribution of hatchery origin fish to natural spawning makes program evaluation difficult.

This excerpt shows the benefit/risk tabulation for a hypothetical population and hatchery program. A complete list would cover all hatchery operations, not just Broodstock Choice and Broodstock collection. Whenever the response to a particular question indicates a particular BMP is employed, the benefit of doing so appears in a list. Conversely, risk statements appear only when particular BMPs are not employed. It is particularly useful to managers to scan the risks associated with their program, because they highlight the nature and severity of existing problems and define the objectives for an improvement program.

Appendix Table 1.1 Hatchery Best Management Practices advocated by the HSRG, benefits risks and rationales for each Best Management Practice, and supporting documents from the scientific literature.

Category	#	Question	Correct Answer	Question Amplification (if needed)	Applicable Program Types and Purposes	Benefit	Risk
Brood Stock Choice	**1**	Does the broodstock chosen represent natural populations native or adapted to the watersheds in which hatchery fish will be released?	Y	Answer is "No" if program is supplemented at any time with out-of-basin broodstock or eggs when egg-take goals are not met by in-basin returns.		This program uses a broodstock representing populations native or adapted to the watershed, which increases the likelihood of long term survival of the stock, helps avoid loss of among population diversity, and reduces the likelihood of unexpected ecological interactions.	Selection of a broodstock not representing populations native or adapted to the watershed poses a risk of loss of among population diversity and may pose additional risks of adverse ecological interactions with non-target stocks.
Brood Stock Choice	**2**	If stock has been extirpated, is the broodstock chosen likely to adapt to the system based on life history and evolutionary history?	Y	Answer "Yes" if not extirpated. Note as much in comments	Not applicable to conservation programs	Choice of a broodstock with a similar life history and evolutionary history to the extirpated stock improves the likelihood of successful re-introduction.	Choice of a broodstock with a dissimilar life history and evolutionary history to the extirpated stock reduces the likelihood of successful re-introduction.
Brood Stock Choice	**3**	Does the broodstock chosen display morphological and life history traits similar to the natural population?	Y	If there's purposeful domestication (run advancement, etc) then answer N even if original brood is indigenous stock. But the answer is "Yes" if program always sustained by returns to watershed even if wild fish are never used as broodstock. For example, the answer would be "Yes" for the Green River Chinook program, which began with endemic fish, but has never since its inception included NORs as broodstock.		Choice of a broodstock with similar morphological and life history traits improves the likelihood of the stock's adaptation to the natural environment.	Choice of a broodstock with dissimilar morphological and life history traits poses a risk that the stock will not adapt well to the natural environment.

Category	#	Question	Correct Answer	Question Amplification (if needed)	Applicable Program Types and Purposes	Benefit	Risk
Brood Stock Choice	**4**	Does the broodstock chosen have a pathogen history that indicates no threat to other populations in the watershed?	Y	Usually based on use of imported broodstock. If the broodstock represents the natural population -- or reflects conditions inside the targeted watershed -- then answer Yes. Answer Yes (no threat) if broodstock was imported in the distant past, but routine importation has long been discontinued.		The broodstock chosen poses no threat to other populations in the watershed from pathogen transmission	The broodstock chosen poses a risk to other populations in the watershed from pathogen transmission
Brood Stock Choice	**5**	Does the broodstock chosen have the desired life history traits to meet harvest goals? (e.g. timing and migration patterns that result in full recruitment to target fisheries)?	Y	Is the stock known to return at times and in places where it can be harvested effectively and with minimal adverse impacts on commingled non-target stocks?	Applies only to Segregated Harvest programs	The broodstock chosen is likely to have the life history traits to meet harvest goals for the target stocks without adversely impacting other stocks.	The broodstock chosen is unlikely to have the life history traits to successfully meet harvest goals and may contribute to overharvest of comingled stocks.
Brood Stock Choice	**6**	What is the percent natural origin fish in the hatchery broodstock?		Answers to this question trigger subsequent questions.		NA	NA
Brood Stock Choice	**7**	Do natural origin fish make up less than 5% of the broodstock for this program?	Y		Applies only to segregated harvest programs.	Maintaining a hatchery population composed of less than 5% natural fish reduces the risk of loss of among population diversity.	Maintaining a hatchery population composed of more than 5% natural fish increases the risk of loss of among population diversity.
Brood Stock Choice	**10**	Is the percent natural origin fish used as broodstock for this program estimated?	Y			Estimating the proportion of natural fish used for broodstock makes it possible to determine whether composition targets have been met and prevents masking of the status of both the hatchery and natural populations.	Percent wild fish used as broodstock for this program is not accurately estimated . Not estimating of the proportion of natural fish used for broodstock makes it impossible to determine whether composition targets have been met and it masks the status of both the hatchery and natural populations.
Brood Stock Collection	**11**	Are adult returns recycled to the lower river to provide additional harvest opportunities?	N	Answer is "Yes" even if recycling doesn't occur in the "lower river", but to some area supporting a fishery, and even if the HGMP says there is "no directed harvest" on the stock.	Applies only to harvest programs	Not recycling adults to the lower river to provide additional harvest reduces the likelihood of straying and unintended contribution to natural spawning	Recycling adults to provide additional harvest benefits can increase the likelihood of straying and increase the contribution of hatchery fish on the spawning grounds

Category	#	Question	Correct Answer	Question Amplification (if needed)	Applicable Program Types and Purposes	Benefit	Risk
Brood Stock Collection	**12**	Are representative samples of natural and hatchery population components collected with respect to size, age, sex ratio, run and spawn timing, and other traits important to long-term fitness? (For integrated populations, consider both natural and hatchery components; for segregated populations, you should only consider the hatchery component.)	Y	Answer is "No" for integrated programs that do not collect NORs. Answer is "No" even when NORs are collected if the collection occurs only at a hatchery rack, especially if the hatchery is located on a smaller tributary (Chinook programs). The answer is "Yes" only when all fish are stopped by a weir on a lower portion of the main migratory corridor, or brood is collected throughout the watershed, and brood are randomly selected from all available returns.		Collection of representative samples of both the natural and hatchery populations reduces the risk of domestication and loss of within population diversity.	Failure to collect representative samples of both the natural and hatchery populations poses a risk of loss of within population diversity and viability.
Brood Stock Collection	**13**	Does the proportion of the spawners brought into the hatchery follow a “spread-the-risk” strategy that attempts to improve the probability of survival for the entire population (hatchery and natural components)?	Y	A "spread-the-risk" strategy consists of an explicit discussion of relative extinction risk to the natural population as a function of natural productivity, hatchery recruitment rates, and genetic and demographic risks associated with hatchery production.	Applies only to Integrated Conservation programs	The proportion of spawners brought into the hatchery improves the likelihood that the population will survive a catastrophic loss from natural events or hatchery failure.	The proportion of spawners brought into the hatchery increases the risk that the population not will survive a catastrophic loss from natural events or hatchery failure.
Brood Stock Collection	**14**	Are sufficient broodstock collected to maintain an effective population size of 1000 fish per generation? (More than 500 successful spawners of each sex.)	Y	Minimal effective population size is approximately 1000/(mean age of maturity). Therefore minimum population size for Chinook is usually = 1000/4 =250; for Coho = 1000/(2 or 3), or 500/333. Answer is based on the source of the broodstock -- the total number of fish used for broodstock -- and not just the broodstock needed to fulfill a specific program's (or sub-program's) needs.		Sufficient broodstock are collected to maintain genetic variation in the population	Sufficient broodstock are not collected to maintain genetic variation in the population
Brood Stock Collection	**15**	Does the program avoid stock transfers and subsequent releases of eggs or fish from outside the watershed?	Y	Answer "No" even if outside stocks are used very infrequently (e.g., once, 12 years ago).		Avoidance of stock transfers from outside the watershed promotes local adaptation and reduces the risk of pathogen transmission.	Stock transfers from outside the watershed pose a risk to local adaptation and increases the risk of pathogen transmission.

Category	#	Question	Correct Answer	Question Amplification (if needed)	Applicable Program Types and Purposes	Benefit	Risk
Brood Stock Collection	**16**	Is the broodstock collected and held in a manner that results in less than 10% prespawning mortality?	Y			Maintaining pre-spawning survival higher than 90% maintains effective population size and reduces domestication selection.	Pre-spawning mortality greater than 10% poses a risk to maintaining effective population size and a risk of domestication selection
Brood Stock Collection	**17**	Do you have guidelines for acceptable contribution of hatchery origin fish to natural spawning?	Y	Answer is "No" if explicit guidelines have not been developed. Answer is "No" even if only NORs are passed above the hatchery if HORs are allowed to spawn at will below the hatchery.		Having established guidelines for acceptable contribution of hatchery origin fish to natural spawning provides a clear performance standard for evaluating the program.	Lack of established guidelines for acceptable contribution of hatchery origin fish to natural spawning makes program evaluation difficult.
Brood Stock Collection	**18**	Are guidelines for hatchery contribution to natural spawning met for all affected naturally spawning populations?	Y			The rate of hatchery contribution to natural spawning populations maintains among population diversity and promotes adaptation to the natural environment.	The rate of hatchery contribution to natural spawning populations poses a risk of loss of among population diversity and domestication selection.
Adult Holding	**19**	Is the water source [for adult holding] specific-pathogen free?	Y	Answer is Yes if well or spring water is the only water source. If surface water is the source, need to consider list of specific pathogens, fish presence, etc. Co-Manager's regulated pathogens are IHNV, IPNV, VHSV, and M. cerebralis. Short-cut answers: Well or spring=Y, surface water =N.		Fish health is promoted by the absence of specific pathogens during adult holding.	There is a risk to fish health due to the lack of specific-pathogen free water for adult holding.
Adult Holding	**20**	Does the water used [for adult holding] result in natural water temperature profiles that provide optimum maturation and gamete development?	Y	A 2-part answer: is the temperature profile natural (that of local surface water)? If yes, then, "is the temperature profile suitable"? The answer is "Yes" only if the answers to both questions are affirmative.		Use of water resulting in natural water temperature profiles for adult holding ensures maturation and gamete development synchronous with natural stocks.	Lack of natural water temperature profiles may lead to domestication selection for adult maturation and gamete development.

Category	#	Question	Correct Answer	Question Amplification (if needed)	Applicable Program Types and Purposes	Benefit	Risk
Adult Holding	**21**	Is the water supply [for adult holding] protected by alarms?	Y	No Answer if the HGMP does not indicate specifically that the adult holding is protected by alarms		Broodstock security is maintained by flow and/or level alarms at the holding ponds.	Absence of flow and/or level alarms at the holding pond may pose a risk to broodstock security.
Adult Holding	**22**	Is the water supply [for adult holding] protected by back-up power generation?	Y	Answer Y if gravity fed. Question is getting at whether hatchery evaluation should be downgraded for not having back-up water supply. Gravity feed = no need for back-up power, therefore Y.		Broodstock security is maintained by back-up power generation for the pumped water supply.	Lack of back-up power generation for the pumped water supply may pose a risk to broodstock security.
Spawning	**23**	Are males and females available for spawning on a given day randomly mated?	Y			Random mating maintains within population diversity.	Non-random mating increases the risk of loss of within population diversity.
Spawning	**24**	Are gametes pooled prior to fertilization?	N	Use of backup males does not = pooled gametes.		Single family pairing increases the effective population size of the hatchery stock.	Pooling of gametes poses a risk to maintaining genetic diversity in the hatchery population.
Spawning	**25**	Are back-up males used in the spawning protocol?	Y	Typical use of back-up males is to spawn one male, wait a minute and then spawn a second male. However, if male gametes are pooled prior to fertilization (#24=Yes), then answer is Yes. Y for 24 not necessarily Y for 25. Only if males are pooled.		Use of back-up males in the spawning protocol increases the likelihood of fertilization of eggs from each female.	Not using of back-up males in the spawning protocol increases the risk of unfertilized eggs and loss of genetic diversity in the broodstock.
Spawning	**26**	Are precocious males (mini-jacks and jacks) used for spawning as a set percentage or in proportion to their contribution to the adult run? (note whether mini-jacks are used in the comment box.)	Y	Answer "no" only if jacks/mini-jacks are not used.		Use of precocious males for spawning as a set percentage or in proportion to their contribution to the adult run promotes within population diversity.	Not using precocious males for spawning as a set percentage or in proportion to their contribution to the adult run increases the risk of loss of within population diversity.

Category	#	Question	Correct Answer	Question Amplification (if needed)	Applicable Program Types and Purposes	Benefit	Risk
Incubation	**27**	Is the water source [for incubation] pathogen-free?	Y	Answer Yes if spring or well water and No if surface water. If eggs from a program are incubated at multiple facilities, answer "No" even if only one of the incubation facilities is not pathogen-free.	Applies only to Conservation programs	Fish health is promoted by the use of pathogen-free water during incubation.	There is a risk to fish health due to the lack of pathogen-free water for incubation.
Incubation	**28**	Is the water source [for incubation] specific-pathogen free?	Y	Answer is Yes if well or spring water is the only water source. If surface water is the source, need to consider list of specific pathogens, fish presence, etc. Co-Manager's regulated pathogens are IHNV, IPNV, VHSV, and M. cerebralis.	Does not apply to Integrated Conservation programs	Fish health is promoted by the absence of specific pathogens during incubation.	There is a risk to fish health due to the lack of specific-pathogen free water for incubation.
Incubation	**29**	Does the water used [for incubation] provide natural water temperature profiles that result in hatching/emergence timing similar to that of the naturally produced stock?	Y	Answer Yes if the water source provides natural temperature profiles (surface water). Answer No if well or spring water is used.		Use of water resulting in natural water temperature profiles for incubation ensures hatching and emergence timing similar to naturally produced stocks with attendant survival benefits.	Lack of natural water temperature profiles may contribute to domestication selection during incubation.
Incubation	**30**	Can incubation water [for incubation] be heated or chilled to approximate natural water temperature profiles?	Y	Does not apply to the use of heaters or chillers for otolith marking.	Applies only to Conservation programs	The ability to heat or chill incubation water to approximate natural water temperature profiles ensures hatching and emergence timing similar to naturally produced stocks with attendant survival benefits.	The inability to heat or chill incubation water to approximate natural water temperature profiles may contribute to domestication selection during incubation.
Incubation	**31**	Is the water supply [for incubation] protected by flow alarms?	Y	No Answer if the HGMP does not indicate specifically that incubation is protected by alarms.		Security during incubation is maintained by flow alarms at the incubation units.	Absence of flow alarms at the incubation units may pose a risk to the security of incubating eggs and alevin.
Incubation	**32**	Is the water supply [for incubation] protected by back-up power generation?	Y	Answer Y if gravity fed. Question is getting at whether hatchery evaluation should be downgraded for not having back-up water supply. Gravity feed = no need for back-up power, therefore Y.		Security during incubation is maintained by back-up power generation for the pumped water supply.	Absence of back-up power generation for the pumped water supply may pose a risk to the security of incubating eggs and alevin.

Category	#	Question	Correct Answer	Question Amplification (if needed)	Applicable Program Types and Purposes	Benefit	Risk
Incubation	**33**	Are eggs incubated under conditions that result in equal survival of all segments of the population to ponding? (Does any portion of the eggs derive a survival advantage or disadvantage from incubation procedures? If yes, then mark NO for response)	Y	HGMP almost never answers this question. Refer to Managers for resolution.		Incubation conditions that result in equal survival of all segments of the population reduce the likelihood of domestication selection and loss of genetic variability.	Incubation conditions that result in unequal survival of all segments of the population pose a risk of domestication selection and loss of genetic variability.
Incubation	**34**	Are families incubated individually? (Includes both eying and hatching.)	Y	HGMP almost never answers this question. Refer to Managers for resolution.	Applies only to Conservation programs	Incubating families individually maintains genetic variability during incubation.	Not incubating families individually poses a risk of loss of genetic variability.
Incubation	**35**	Does the program use water sources that result in hatching/emergence timing similar to that of the naturally produced population?	Y	Answer Yes if the water source provides natural temperature profiles (surface water). Answer No if well or spring water is used.		Use of water resulting in natural water temperature profiles for incubation ensures hatching and emergence timing similar to naturally produced stocks.	Lack of natural water temperature profiles may lead to domestication selection during incubation.
Incubation	**36**	Are agency, tribal, or IHOT species-specific incubation recommendations followed for flows?	Y	No Answer if the standards are not specified. Following the guidelines set forth in Piper et al. is not considered YES unless there is a discussion of these guidelines being specifically developed for that particular station's conditions. IHOT does not apply to Puget Sound.		Use of IHOT flow recommendations during incubation promote survival of eggs and alevin and allow for optimum fry development.	Failing to meet IHOT flow recommendations during incubation poses a risk to the survival of eggs and alevin and may not allow for optimum fry development.
Incubation	**37**	Are agency, tribal, or IHOT species-specific incubation recommendations followed for substrate?	Y	No Answer if the standards are not specified. Following the guidelines set forth in Piper et al. is not considered YES unless there is a discussion of these guidelines being specifically developed for that particular station's conditions. IHOT does not apply to Puget Sound.		Use of IHOT recommendations for use of substrate during incubation limits excess alevin movement and promotes energetic efficiently.	Failing to meet IHOT recommendations for using substrate during incubation may allow excess alevin movement and reduces energetic efficiency.
Incubation	**38**	Are agency, tribal, or IHOT species-specific incubation recommendations followed for density parameters?	Y	No Answer if the standards are not specified. Following the guidelines set forth in Piper et al. is not considered YES unless there is a discussion of these guidelines being specifically developed for that particular station's conditions. IHOT does not apply to Puget Sound.		Use of IHOT density recommendations during incubation promote survival of eggs and alevin and allow for optimum fry development.	Failing to meet IHOT density recommendations during incubation poses a risk to the survival of eggs and alevin and may not allow for optimum fry development.

Category	#	Question	Correct Answer	Question Amplification (if needed)	Applicable Program Types and Purposes	Benefit	Risk
Incubation	**39**	Are disinfection procedures implemented during incubation that prevent pathogen transmission between stocks of fish on site? (Do you have written protocols? If so, describe in the data comment box.)	Y	1998 Co-Managers Fish Health Policy does not provide protocols to address this question. Answer "Yes" if only 1 stock of on site regardless of procedures.		Proper disinfection procedures increase the likelihood of preventing dissemination and amplification of pathogens in the hatchery.	Lack of proper disinfection procedures increase the risk of dissemination and amplification of pathogens in the hatchery.
Incubation	**40**	If eggs are culled, is culling done randomly over all segments of the egg-take?	Y			Random culling of eggs over all segments of the egg-take maintains genetic variability during incubation.	Non-random culling of eggs increases the risk of loss of genetic variability during incubation.
Rearing	**41**	Is the water source [for rearing] specific-pathogen free?	Y	Answer is Yes if well or spring water is the only water source. If surface water is the source, need to consider list of specific pathogens, fish presence, etc. Co-Manager's regulated pathogens are IHNV, IPNV, VHSV, and M. cerebralis but answer to this question derived from water source. Well or spring=Y, surface water =N.		Fish health is promoted by the absence of specific pathogens during rearing.	There is a risk to fish health due to the lack of specific-pathogen free water for rearing.
Rearing	**42**	Does the water used [for rearing] provide natural water temperature profiles that result in fish similar in size to naturally produced fish of the same species?	Y	Answer Yes if the water source provides natural temperature profiles (surface water). Answer No if well or spring water is used.		Use of water resulting in natural water temperature profiles for rearing promotes growth of fish and smoltification synchronous with naturally produced stocks.	Lack of natural water temperature profiles may lead to domestication selection during rearing.
Rearing	**43**	Does the hatchery operate to allow all migrating species of all ages to by-pass or pass through hatchery related structures?	Y	Answer "Yes" if hatchery located at headwater spring. Answer "Yes" if operations pass only NOR fish and retain HOR fish, and passage delay doesn't matter.		Providing upstream and downstream passage of juveniles and adults supports natural distribution and productivity of naturally produced stocks.	Inhibiting upstream and downstream passage of juveniles and adults poses a risk to distribution and productivity of naturally produced stocks.
Rearing	**44**	Is the water supply [for rearing] protected by alarms?	Y	No Answer if the HGMP does not indicate specifically that the adult holding is protected by alarms.		Security during rearing is maintained by flow and/or level alarms at the rearing ponds.	Absence of flow and/or level alarms at rearing ponds may pose a risk to the security of the cultured fish.

Category	#	Question	Correct Answer	Question Amplification (if needed)	Applicable Program Types and Purposes	Benefit	Risk
Rearing	**45**	Is the water supply [for rearing] protected by back-up power generation?	Y	Answer "Yes" if gravity fed. Question is getting at whether hatchery should be downgraded for not having back up on water supply.		Security during rearing is maintained by back-up power generation for the pumped water supply.	Absence of back-up power generation for the pumped water supply may pose a risk to the security of the cultured fish.
Rearing	**46**	Are fish reared under conditions that result in equal survival of all segments of the population to release? (In other words, does any portion of the population derive a survival advantage or disadvantage from rearing procedures? If yes, then mark NO in box.)	Y	Usually this will have to be resolved by Managers. Answer "No" if spring water used for eggs collected later in season to compensate for rising temperatures in surface water.		Rearing conditions that result in equal survival of all segments of the population reduce the likelihood of domestication selection and loss of genetic variability.	Rearing conditions that result in unequal survival of all segments of the population pose a risk of domestication selection and loss of genetic variability.
Rearing	**47**	If juveniles are culled, is culling done randomly over all segments of the population? (respond yes if juveniles are not culled). Make sure to capture in the comments box the number culled, and the rational for culling.	Y	Note: fry outplanting is juvenile culling.		Random culling of juveniles over all segments of the population maintains genetic variability during rearing.	Non-random culling of juveniles increases the risk of loss of genetic variability during rearing.
Rearing	**48**	Is the correct amount and type of food provided to achieve the desired growth rate?	Y	"No" if HGMP does not specify desired growth rate.		Following proper feeding rates to achieve the desired growth rate improves the likelihood of producing fish that are physiologically fit, properly smolted, and that maintain the age structure of natural populations.	Improper feeding that does not achieve desired growth rate increases the risk of producing fish that are not physiologically fit, that are not properly smolted, and that exhibit an age structure not representative of natural populations.
Rearing	**49**	Is the correct amount and type of food provided to achieve the desired condition factors for the species and life stage being reared?	Y	No Answer if HGMP does not specify desired CF.		Feeding to achieve the desired condition factor is an indicator of proper fish health and physiological smolt quality.	Feeding that does not achieve the desired condition factor may be an indicator of poor fish health and physiological smolt quality.
Rearing	**50**	Does the program use a diet and growth regime that mimics natural seasonal growth patterns? If not, describe the differences in the comment field?	Y	Does the size profile of hatchery fish through time match that of the associated natural stock? HGMPs usually do not discuss.		Use of diet and growth regimes that mimic natural seasonal growth patterns promote proper smoltification and should produce adults that maintain the age structure of the natural population.	Use of diet and growth regimes that do not mimic natural seasonal growth patterns pose a risk to proper smoltification and may alter the age structure of the hatchery population.

Category	#	Question	Correct Answer	Question Amplification (if needed)	Applicable Program Types and Purposes	Benefit	Risk
Rearing	**51**	Is the program attempting to better mimic the natural stream environment by providing natural or artificial cover?	Y	Answer "No" if no "NATURES" practices implemented (Section 9.2.9), or if a significant effort is not made to replicate natural habitat during rearing.		Providing artificial cover increases the development of appropriate body camouflage and may improve behavioral fitness.	Lack of overhead and in-pond structure does not produce fish with the same cryptic coloration or behavior as do using enhanced environments.
Rearing	**52**	Are fish reared in multiple facilities or with redundant systems to reduce the risk of catastrophic loss?	Y	Answer "Yes" if interim rearing occurs at several facilities but all program fish are then acclimated and released from a single facility.	Applies only to Conservation programs	Maintaining the stock in multiple facilities or with redundant systems reduces the risk of catastrophic loss from facility failure.	Not maintaining the stock in multiple facilities or with redundant systems increases the risk of catastrophic loss from facility failure.
Rearing	**53**	Are agency, tribal, or IHOT juvenile rearing standards followed for loading?	Y	No if the standards are not specified. Following the guidelines set forth in Piper et al. is not considered YES unless there is a discussion of these guidelines being specifically developed for that particular station's conditions. IHOT does not apply to Puget Sound.		Following IHOT standards for juvenile loading maintains proper dissolved oxygen levels promoting fish health, growth and survival, and increases the likelihood of preventing dissemination and amplification of fish pathogens.	Not following IHOT standards for juvenile loading poses a risk to maintaining proper dissolved oxygen levels, compromising fish health and growth and increases the likelihood of dissemination and amplification of fish pathogens.
Rearing	**54**	Are agency, tribal, or IHOT juvenile rearing standards followed for density?	Y	No Answer if the standards are not specified. Following the guidelines set forth in Piper et al. is not considered YES unless there is a discussion of these guidelines being specifically developed for that particular station's conditions. IHOT does not apply to Puget Sound.		Following IHOT standards for juvenile density maintain fish health, growth, and survival, and increases the likelihood of preventing dissemination and amplification of fish pathogens.	Not following IHOT standards for juvenile density poses a risk to maintaining fish health, growth, and survival, and increases the likelihood of dissemination and amplification of fish pathogens.
Rearing	**55**	For captive broodstocks, are fish maintained on natural photoperiod to ensure normal maturation?	Y	If a conservation program, answer "yes" even if not a captive brood program.	Applies only to Conservation programs	Maintaining captive broodstock on natural photoperiods ensures normal maturation.	Maintaining captive broodstock on unnatural photoperiods poses a risk to normal maturation.

Category	#	Question	Correct Answer	Question Amplification (if needed)	Applicable Program Types and Purposes	Benefit	Risk
Rearing	**56**	For captive broodstocks, are fish maintained reared at 12C to minimize disease?	Y	If a conservation program, answer "yes" even if not a captive brood program.	Applies only to Conservation programs	Maintaining captive broodstock on rearing water below 12^{o}C reduces the risk of loss from disease.	Maintaining captive broodstock on rearing water above 12^{o}C increases the risk of loss from disease.
Rearing	**57**	For captive broodstocks, are diets and growth regimes selected that produce potent, fertile gametes and reduce excessive early maturation of fish?	Y	If a conservation program, answer "yes" even if not a captive brood program.	Applies only to Conservation programs	Producing viable gametes and maintaining age structure of the population in captive breeding increases the likelihood of meeting conservation goals.	Failure to produce viable gametes and maintain age structure of the population in captive breeding reduces the likelihood of meeting conservation goals.
Rearing	**58**	For captive broodstocks, are families reared individually to maintain pedigrees?	Y	If a conservation program, answer "yes" even if not a captive brood program.	Applies only to Conservation programs	Rearing families separately for captive broodstock programs maintains pedigrees to reduce the risk of inbreeding depression.	Inability to rear families separately for captive broodstock programs increases the risk of inbreeding depression.
Release	**59**	Are the fish produced qualitatively similar to natural fish in size (fpp and length)?	Y	Send back to Managers unless sizes of natural fish are explicitly compared to hatchery fish. Don't assume answer is "No" for yearling fall chinook programs unless all hatchery fall chinook production is yearling.		Producing fish that are qualitatively similar to natural fish in size may improve performance and reduce adverse ecological interactions.	Producing fish that are not qualitatively similar to natural fish in size may adversely affect performance and increase adverse ecological interactions.
Release	**60**	Are the fish produced qualitatively similar to natural fish in morphology?	Y	Answer "Yes" if NOR are incorporated into the broodstock. Otherwise, answer "No"..	Applies only to Integrated programs	Producing fish that are qualitatively similar to natural fish in morphology may improve performance and reduce adverse ecological interactions.	Producing fish that are not qualitatively similar to natural fish in morphology may adversely affect performance.
Release	**61**	Are the fish produced qualitatively similar to natural fish in behavior?	Y	Question addresses out-migration timing primarily. Answer "Yes" if NATURES rearing applied AND release is volitional. Answer "No" if hatchery releases occur after natural outmigration, regardless of whether the release is "volitional" or not.		Producing fish that are qualitatively similar to natural fish in behavior may improve performance and reduce adverse ecological interactions.	Producing fish that are not qualitatively similar to natural fish in behavior may adversely affect performance and increase adverse ecological interactions.

Category	#	Question	Correct Answer	Question Amplification (if needed)	Applicable Program Types and Purposes	Benefit	Risk
Release	**62**	Are the fish produced qualitatively similar to natural fish in growth rate?	Y	This question addresses the "size profile" -- the pattern of size through time. But it reduces to the relative sizes of hatchery and natural fish when hatchery fish are released. Therefore, answer "No" if the HOR are larger than the NOR outmigrants.		Producing fish that are qualitatively similar to natural fish in growth rate may improve performance and reduce adverse ecological interactions.	Producing fish that are not qualitatively similar to natural fish in growth rate may adversely affect performance and increase adverse ecological interactions.
Release	**63**	Are the fish produced qualitatively similar to natural fish in physiological status?	Y	Answer Yes if truly volitional releases of smolts occurs. Answer No if forced or quasi-volitional releases without ATPase or other hormonal testing.		Producing fish that are qualitatively similar to natural fish in physiological status may improve performance and reduce adverse ecological interactions.	Producing fish that are not qualitatively similar to natural fish in physiological status may adversely affect performance and increase adverse ecological interactions.
Release	**64**	Are fish released at sizes and life history stages similar to those of natural fish of the same species?	Y	Answer No if the HOR are larger than the NOR outmigrants. Answer No when fish are released at multiple life stages (e.g. fingerlings & yearlings), but the proportion does not match the proportion of those life stages in the natural population.		Releasing fish at sizes and life history stages similar to those of natural fish of the same species may improve performance and reduce adverse ecological interactions.	Releasing fish at sizes and life history stages dissimilar to those of natural fish of the same species may reduce performance and increase the risk of adverse ecological interaction.
Release	**65**	Are volitional releases during natural out-migration timing practiced?	Y	Answer Yes if releases are truly volitional (at least one week), and if they occur during the natural outmigration period.		Volitionally releasing smolts during the natural outmigration timing may improve homing, survival, and reduce adverse ecological interactions.	Failure to volitionally release smolts during the natural outmigration timing may adversely affect homing, survival, and increase risk of adverse ecological interactions.
Release	**66**	Are fish released in a manner that simulates natural seasonal migratory patterns?	Y	Usually leave for managers to answer.	Inapplicable to Integrated Conservation programs	Releasing fish in a manner that simulates natural seasonal migratory patterns improves the likelihood that harvest and conservation goals will be met and may reduce potential adverse ecological impacts.	Failing to release fish in a manner that simulates natural seasonal migratory patterns decreases the likelihood that harvest and conservation goals will be met and may increase the potential for adverse ecological impacts.

Category	#	Question	Correct Answer	Question Amplification (if needed)	Applicable Program Types and Purposes	Benefit	Risk
Release	**67**	Are fish released in stream reaches within the historic range of that stock?	Y	This question addresses whether or not the fish are being released in a portion of the stream where they could be expected to sustain themselves naturally.; the stock being released is not important.		Releasing fish within the historic range of that stock increases the likelihood that habitat conditions will support the type of fish being released and does not pose new risks of adverse ecological interactions with other stocks.	Releasing fish outside the historic range of that stock poses a risk that habitat conditions will not support the type of fish being released and poses new risks of adverse ecological interactions with other stocks.
Release	**68**	Are fish released in the same subbasin as rearing facility? This question is trying to determine if fish (juveniles) are transported into the subbasin.	Y	Answer this on a watershed scale (e.g. Skokomish River) and not a subbasin scale (e.g. Hood Canal). Answer "No" if hauled out for a portion of the rearing and brought back for release.		Releasing fish in the same subbasin as the rearing facility reduces the risk of dissemination of fish pathogens to the receiving watershed.	Not releasing fish in the same subbasin as the rearing facility increases the risk of dissemination of fish pathogens to the receiving watershed.
Release	**69**	Has the carrying capacity of the subbasin been taken into consideration in sizing this program in regards to determining the number of fish released?	Y	Answer No if PNI<0.5 (Integrated Programs) or if proportion of HOR naturally spawning >5% (Segregated Programs). Do not answer "Yes" unless the relationship between natural carrying capacity and hatchery production is explicitly analyzed and determined to be compatible ecologically and genetically.		Taking the carrying capacity of the subbasin into consideration when sizing the hatchery program increases the likelihood that stock productivity will be high and may limit the limit the risk of adverse ecological and harvest interactions.	Failing to take the carrying capacity of the subbasin into consideration when sizing the hatchery program poses a risk to the productivity of the stock and may increase the risk of adverse ecological and harvest interactions.
Release	**70**	Are 100% of the hatchery fish marked so that they can be distinguished from the natural populations?	Y			Marking 100% of the hatchery population allows them to be distinguished from the natural population and prevents the masking of the status of that population and prevent overharvest of weaker stocks.	Not marking 100% of the hatchery population prevents them from being distinguished from the natural population and may the mask the status of that population and cause over harvest of weaker stocks.
Facilities	**71**	Does hatchery intake screening comply with Integrated Hatchery Operations Team (IHOT), National Marine Fisheries Service, or other agency facility standards?	Y			Compliance with these standards reduces the likelihood that intake structures cause entrapment in hatchery facilities and impingement of migrating or rearing juveniles	Failure to comply with these standards increases the risk of entrapment in hatchery facilities and impingement of migrating or rearing juveniles

Category	#	Question	Correct Answer	Question Amplification (if needed)	Applicable Program Types and Purposes	Benefit	Risk
Facilities	**72**	Does the facility operate within the limitations established in its National Pollution Discharge Elimination System (NPDES) permit?	Y	Questions 72 & 72 may be mutually exclusive unless multiple facilities having different NPDES reporting requirements are used: 72 for > 20,000 lbs, 73 for <= 20,000 lbs. If small, usually not answered		Compliance with NDPES discharge limitations maintain water quality in downstream receiving habitat	Hatchery discharge may pose a risk to water quality in downstream receiving habitat
Facilities	**73**	If the production from this facility falls below the minimum production requirement for an NPDES permit, does the facility operate in compliance with state or federal regulations for discharge?	Y	Answer “yes” if the facility is large enough to require NPDES permitting.		Compliance with NDPES discharge limitations maintain water quality in downstream receiving habitat	Hatchery discharge may pose a risk to water quality in downstream receiving habitat
Facilities	**74**	Is the facility sited so as to minimize the risk of catastrophic fish loss from flooding?	Y	If HGMP explicitly sates that there is no vulnerability to flooding, then answer “Yes”. Otherwise leave blank and allow Manger to answer.		Siting the facility where it is not susceptible to flooding decreases the likelihood of catastrophic loss.	Siting the facility where it is susceptible to flooding increases the likelihood of catastrophic loss.
Facilities	**75**	Is staff notified of emergency situations at the facility through the use of alarms, autodialer, and pagers?	Y	Leave blank unless HGMP specifies.		Notification to staff of emergency situations using alarms, autodialers, and pagers reduces the likelihood of catastrophic loss.	Inability to notify staff of emergency situations using alarms, autodialers, and pagers increases the likelihood of catastrophic loss.
Facilities	**76**	Is the facility continuously staffed to ensure the security of fish stocks on-site?	Y	Leave blank unless HGMP specifies.		Continuous facility staffing reduces the likelihood of catastrophic loss.	Lack of continuous facility staffing increases the likelihood of catastrophic loss.
M&E	**77**	Do you have a numerical goal for total catch in all fisheries?	Y	No Answer if numerical goal not explicitly stated. A goal for a harvest rate does not suffice: need numbers of fish.	Applies only to Harvest programs	This program has a numerical goal for total catch in all fisheries, which makes it possible to evaluate its success and implement information responsive management.	Lack of numerical goals for fishery contributions from this program makes it impossible to define and evaluate its success and difficult to implement information responsive management.

Category	#	Question	Correct Answer	Question Amplification (if needed)	Applicable Program Types and Purposes	Benefit	Risk
M&E	**78**	Do you have a goal for broodstock composition (hatchery vs. natural) in the hatchery?	Y	No Answer if numerical goal not explicitly stated.		This program has a specific policy for hatchery broodstock composition (hatchery vs. natural), which makes it possible to monitor and evaluate its effectiveness and to test the validity of the policy.	This program lacks a specific policy for hatchery broodstock composition (hatchery vs. natural), which makes it difficult to monitor and evaluate its effectiveness and to test the validity of the policy.
M&E	**79**	Do you have a goal for spawning escapement composition (hatchery vs. natural) in the wild?	Y	No Answer if numerical goal not explicitly stated.		This program has a specific policy for natural spawning composition (hatchery vs natural), which makes it possible to monitor and evaluate its effectiveness and to test the validity of the policy.	This program lacks a specific policy for natural spawning composition (hatchery vs natural), which makes it difficult to monitor and evaluate its effectiveness and to test the validity of the policy.
M&E	**80**	Do you have a goal for smolt-to-adult return survival?	Y	No Answer if numerical goal not explicitly stated, and a "goal" = to 10-year average is acceptable.		This program has an explicit goal smolt to adult survival, which makes it possible to evaluate success and implement information responsive management.	Programs lacking SAR goals run the risk of becoming inefficient and ultimately "mining" natural fish (integrated programs) just to keep the hatchery in operation.
Effectiveness	**81**	What is the percent hatchery origin fish (first generation) in the natural spawning escapement (for the same species/race)?		Not likely to be answered in HGMP. Return to Managers if can't answer for the watershed of release.		NA	NA
Effectiveness	**82**	Do adults from this program make up less than 5% of the natural spawning escapement (for the species/race) in the subbasin?	-	Answers to 82, 83, and 84 are computed from answer to 81.			
Effectiveness	**83**	Do adults from this program make up between 5 and 30% of the natural spawning escapement (for the species/race) in the subbasin.	-	Answers to 82, 83, and 84 are computed from answer to 81.			Maintaining a natural spawning population composed of greater than 5% hatchery fish increases the risk of loss of among population diversity.
Effectiveness	**84**	Do adults from this program make up more than 30% of the natural spawning escapement (for the species/race) in the subbasin.	-	Answers to 82, 83, and 84 are computed from answer to 81.			Maintaining a natural spawning population composed of greater than 30% hatchery fish increases the risk of loss of among population diversity.

Category	#	Question	Correct Answer	Question Amplification (if needed)	Applicable Program Types and Purposes	Benefit	Risk
Effectiveness	**85**	Is the percent hatchery origin fish (first generation) spawning in the wild estimated?	Y	If not explicitly answered, return to Managers.		Estimating the proportion of hatchery fish spawning in the wild allows evaluation of composition targets and prevents hatchery returns from masking the status of the natural population.	Percent hatchery fish spawning in the wild is not estimated! Not estimating the proportion of hatchery fish spawning in the wild prevents evaluation of composition targets and allows hatchery returns to mask the status of the natural population.
Accountability	**86**	Are standards specified for in-culture performance of hatchery fish?	Y	CV of length can be noted in comments but does not suffice as "YES" if it is the only goal identified. A "Yes" requires goals for survival by life stage as well as release size targets.		Explicit standards for survival, size, condition, etc., make it easier to detect cultural problems before they become impossible to rectify.	The program lacks standards for in-culture performance of hatchery fish, making it difficult to determine causes for program successes and failures.
Accountability	**87**	Are in-culture performance standards met?	Y	Usually will require input from local Managers.			
Accountability	**88**	Are standards specified for post release performance of hatchery fish and their offspring?	Y	"No" unless explicit objectives are stated. 10-yr average SAR can be noted in comments, but does not suffice as YES.			The program lacks specified standards for post release performance of hatchery fish and their offspring., making it difficult to determine success and failures and their causes.
Accountability	**89**	Are post-release performance standards met?	Y	Usually will require input from local Managers.			
Accountability	**90**	Are hatchery programming and operational decisions based on an Adaptive Management Plan? (For example, is an annual report produced describing hatchery operations, results of studies, program changes etc? If a written plan does not exist then the answer is No.)	Y	Typical answer is "No" for harvest programs because there are no structured adaptive management plans in Puget Sound except for a few conservation programs. Existence of Annual Reports alone does not merit a "Yes" unless they specify responses to be taken in the event of adverse/unforeseen developments.			This program lacks an annually updated, written plan describing program goals and operations. This makes it difficult to base hatchery programming and operations on adaptive management principles.

Appendix Table 1.2. Publications used in the development of hatchery Best Management Practices.

Abbot, J. C., R. L. Dunbrack, and C. D. Orr. 1985. The interaction of size and experience in dominance relationships of juvenile steelhead trout (Salmo gairdneri). Animal Behavior 92: 241-253.

Allee, B. J. 1974. Spatial requirements and behavioral interaction of juvenile coho salmon (Oncorhynchus kisutch) and steelhead trout (Salmo gairdneri). Ph.D. Thesis, Univ. Washington, Seattle.

Allen, K. R. 1969. Limitations on production in salmonid populations in streams. Pages 3-18 in T. G. Northcote, editor. Symposium on salmon and trout in streams. University of British Columbia.

Altukhov, Y.P. and Salmenkova, E.A. 1994. Straying intensity and genetic differentiation in salmon populations. Aquaculture and Fisheries Management 25: 99-120.

Bachman, R. A. 1984. Foraging behavior of free-ranging wild and hatchery brown trout in a stream. Transactions of the American Fisheries Society 113: 1-32.

Bams, R. A. 1967. Difference in performance of naturally and artificially propagated sockeye salmon migrant fry, as measured with swimming and predation tests. J. Fish. Res. Board Can. 24:1117-1153.

Bams, R. A. 1976. Survival and propensity for homing as affected by presence or absence of locally adapted paternal genes in two transplanted populations of pink salmon (Oncorhynchus gorbuscha). J. Fish. Res. Bd. Can. 33: 2716-2725.

Banks, J. L. 1994. Raceway density and water flow as factors affecting spring Chinook salmon (Oncorhynchus tshawytscha) during rearing and release. Aquaculture 119: 201-207.

Barrows, F.T., and W.A. Lellis. 1999. The effect of dietary protein and lipid sources on dorsal fin erosion on dorsal fin erosion in rainbow trout, Oncorhynchus mykiss. Aquaculture 180:167-175.

Bartley, D., M. Bagley, G. Gall, and B. Bentley. 1992. Use of Linkage Disequilibrium Data to Estimate Effective Size of Hatchery and Natural Fish Populations. Conservation Biology 6: 365-375.

Baube, C. L. 1997. Manipulations of signaling environment affect male competitive success in threespined sticklebacks. Anim. Behav. 53: 819-833.

Beacham, T. D. and C. B. Murray. 1993. Fecundity and egg size variation in North American Pacific salmon (Oncorhynchus). Journal of Fish Biology 42: 485-508.

Beacham, T. D. and T. P. T. Evelyn. 1992. Genetic variation in disease resistance and growth of Chinook, coho, and chum salmon with respect to vibriosis, furunculosis, and bacterial kidney disease. Trans. Amer. Fish. Soc. 121: 456-485.

Beamesderfer, R. C. and B. E. Rieman. 1991. Abundance and distribution of northern squawfish, walleyes, and smallmouth bass in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120: 439-447.

Beamish, R.J. and D. Bouillon. 1993. Pacific salmon production trends in relation to climate. Can. J. Fish. Aquat. Sci. 50:1002-1016.

Beckman B.R., DA Larsen, C Sharpe, B Lee-Pawlak, CB Schreck, and WW Dickhoff. 2000. Physiological status of naturally reared juvenile spring chinook salmon in the Yakima River: Seasonal dynamics and changes associated with smolting. Transactions of the American Fisheries Society. 129 (3): 727-753.

Beckman, B.R., D.A. Larsen, B. Lee-Pawlak and W.W. Dickhoff. 1998. Relation of fish size and growth rate to migration of spring chinook salmon smolts. North American Journal of

Fisheries Management 18:537-546.

Beckman, B.R., W.W. Dickhoff, W.S. Zaugg, C. Sharpe, S. Hirtzel, R. Schrock, D.A. Larsen, R.D. Ewing, A. Plamisano, C.B. Schreck and C.V.W. Mahnken. 1999. Growth, smoltification, and smolt-to-adult return of spring chinook salmon (Oncorhynchus tshawytscha) from hatcheries on the Deschutes River, Oregon. Trans. Am. Fish. Soc. 128:1125-1150.

Beckman, BR, DA Larsen, B. Lee-Pawlak, and WW Dickhoff. 1996. Physiological assessment and behavior interaction of wild and hatchery juvenile salmonids: The relationship of fish size and growth to smoltification in spring Chinook salmon. BPA Report, October 1996.

Beechie, T. J., and T. H. Sibley. 1997. Relationships between channel characteristics, woody debris, and fish habitat in northwestern Washington streams. Transactions of the American Fisheries Society 126: 217-229.

Beechie, T., E. Beamer, and L. Wasserman. 1994. Estimating coho salmon rearing habitat and smolt production losses in a large river basin, and implications for habitat restoration. 14: 797-811.

Bell, M.C. 1986. Fisheries handbook of engineering requirements and biological criteria. Fish passage development and evaluation program, Corps of Engineers, North Pacific Division.

Berejikian, B. A. 1995. The effects of hatchery and wild ancestry and experience on the relative ability of steelhead trout fry (Oncorhynchus mykiss) to avoid a benthic predator. Can. J. Fish. Aquat. Sci. 52: 2476-2482.

Berejikian, B. A., E. P. Tezak, A. LaRae, T. A. Flagg, E. Kummerow, and C. V. W. Mahnken. 2000. Social dominance, growth and habitat use of age-0 steelhead (Oncorhynchus mykiss) grown in enriched and conventional hatchery rearing environments. Can. J. Fish. Aquat. Sci. 57: 628-636.

Berejikian, B. A., E. P. Tezak, S. L. Schroder, C. M. Knudsen, and J. J. Hard. 1997. Reproductive behavioral interactions between wild and captively reared coho salmon (Oncorhynchus kisutch). ICES Journal of Marine Science, 54: 1040-1050.

Berejikian, B. A., E. P. Tezak, S. L. Schroder, K. M. Knudsen, and T. A. Flagg. 1999. Competitive differences between newly emerged offspring of captively reared and wild coho salmon (Oncorhynchus kisutch). Trans. Am. Fish. Soc. 128:832-839.

Berejikian, B. A., S. B. Mathew, and T. P. Quinn. 1996. Effects of hatchery and wild ancestry and rearing environments on the development of agonistic behavior in steelhead trout (Oncorhynchus mykiss) fry. Can. J. Fish. Aquat. Sci 53: 2004-2014.

Bigler, S. B., D. W. Welch, and J. H. Helle. 1996. A review of size trends among north Pacific salmon (Oncorhynchus spp.). Can. J. Aquat. Sci. 53:455-465.

Bilby, R. E., B. R. Fransen, and P. A. Bisson. 1996. Incorporation of nitrogen and carbon from spawning coho salmon into the trophic system of small streams: evidence from stable isotopes. Can. J. Fish. Aquat. Sci. 53: 164-173.

Bilby, R. E., B. R. Fransen, P. A. Bisson, and J. K. Walter. 1998. Response of juvenile coho salmon (Oncorhynchus kisutch) and steelhead (Oncorhynchus mykiss) to the addition of salmon carcasses to two streams in southwestern Washington, U.S.A. Canadian Journal of Fisheries and Aquatic Sciences 55: 1909-1918.

Bilby, R.E., B.R. Fransen, J.K. Walter, C.J. Cederholm, W.J. Scarlett. 2001. Preliminary evaluation of the use of nitrogen stable isotope ratios to establish escapement levels for Pacific salmon. Fisheries 26:6-14.

Bilton, H. T. 1980. Returns of adult coho salmon in relation to mean size and time release of juveniles to the catch and escapement. Can. Tech. Rep. Fish. Aquatic Sci. 941.

Bilton, H. T. 1984. Returns of Chinook salmon in relation to juvenile size at release. Can. Tech. Rep.Fish. Aquatic Sci. 1245.

Bisson, P. A., K. Sullivan, and J. L. Nielsen. 1988. Channel hydraulics, habitat use, and body form ofjuvenile coho salmon, steelhead, and cutthroat trout in streams. Transactions of the AmericanFisheries Society 117: 262-273.

Bjornn, T. C., and D. W. Reiser. 1991. Habitat requirements of salmonids in streams. Pages 83-138 In W. R. Meehan, editor. Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society, Bethesda, Maryland.

Boersen, G., and H. Westers. 1986. Waste solids control in hatchery raceways. Progressive Fish Culturist 48: 151-153.

Brannon, E. L. 1967. Genetic control of migrating behavior of newly emerged sockeye salmon fry. Int.Pac. Salmon Fish. Comm. Prog. Rep. 16: 31p.

Brannon, E. L. 1987. Mechanisms stabilizing salmonid fry emergence timing. Pages 120-124 in E. L.Margolis and C. C. Woods, editors. Sockeye salmon (Oncorhynchus nerka) population biology and future management. Can. Spec. Pub. Fish. Aquat. Sci. 96.

Brannon, E. L., K. P. Currens, D. Goodman, J. A. Lichatowich, W. E. McConnaha, B. E. Riddell, and R. N. Williams. 1999. Review of Artificial Production of Anadromous and Resident Fish in the Columbia River Basin, Part 1: A Scientific Basis for Columbia River Production Program, Northwest Power Planning Council, 139 pp.

Brannon, E.L. 1982. Orientation mechanisms of homing salmonids. Pages 219-227 in E.L. Brannon and E.O. Salo, Editors. Proceedings of the salmon and trout migratory behaviour symposium. School of Fisheries, University of Washington, Seattle.

Brannon, E.L., R.P. Whitman and T. P. Quinn. 1984. Responses of returning adult coho salmon to home water and population-specific odors. Transactions of the American Fisheries Society 113:374-377.

Bugert, R. M. 1998. Mechanics of supplementation in the Columbia River. Fisheries 23: 11-20.

Bugert, R. M., Hopley, C. W., Busack, C. A., and Mendel, G. W. 1995. Maintenance of stock integrity in Snake River Fall Chinook Salmon. Am. Fish. Soc. Symp. 15: 267-276.

Busack, C. A., and K. P. Currens. 1995. Genetic risks and hazards in hatchery operations: Fundamental concepts and issues. Pages 71-80 in H. L. Schramm , Jr. and R. G. Piper, editors. Uses and effects of cultured fishes in aquatic ecosystems. American Fisheries Society Symposium 15, Bethesda, MD.

Campton, D. E. 1995. Genetic effects of hatchery fish on wild populations of Pacific salmon and steelhead: What do we really know? Pages 337-353 in H. L. Schramm, Jr. and R. G. Piper, editors. Uses and effects of cultured fishes in aquatic ecosystems. American Fisheries Society Symposium 15, Bethesda, MD.

Campton, D.E. 2004. Sperm competition in salmon hatcheries: the need to institutionalize genetically benign spawning protocols. Transactions of the American Fisheries Society 133: in press.

Candy, J. R. and T. D. Beacham. 2000. Patterns of homing and straying in southern British Columbia coded-wire tagged Chinook salmon (Oncorhynchus tshawytscha) populations. Fisheries Research 47: 41-56.

Cannamela, D. A. 1993. Hatchery steelhead smolt predation of wild and natural juvenile Chinook salmon fry in the upper Salmon River, Idaho. Idaho Dept. of Fish and Game. 42 pp.

Cederholm, C.J., M.D. Kunze, T. Murota, and A. Sibantani. 1999. Pacific salmon carcasses: essential contributions of nutrients and energy for aquatic and terrestial ecosystems. Fisheries 24:6-15.

Chapman, D. W. 1962. Aggressive behavior in juvenile coho salmon as a cause of emigration. J. Fish.Res. Board Can. 19: 1047-1080.

Chebanov, N. A. and B. E. Riddell. 1998. The spawning behavior, selection of mates, and reproductive success of Chinook salmon (Oncorhynchus tshawytscha) spawners of natural and hatchery origin under conditions of joint spawning. J. Ichthyol 38: 517-526.

Chebanov, N. A., N. V. Varnavskaya, and V. S. Varnavsky. 1983. Effectiveness of spawning of male sockeye salmon, Oncorhynchus nerka (Salmonidae), of differing hierarchical rank by means of genetic-biochemical markers. J. Ichthyol 23: 51-55.

Chilcote, M. W., S. A. Leider, and J. J. Loch. 1986. Differential reproductive success of hatchery and wild summer-run steelhead under natural conditions. Transactions of the American Fisheries Society 115: 726-735.

Cho, C.Y., and D. P. Bureau. 1997 Reduction of waste output from salmonid aquaculture through feeds and feeding. Progressive Fish Culturist 59: 155-160.

Clarke, W. C., J. E. Shelbourne, T. Ogasawara, and T. Hirano. Effect of initial day length on growth, seawater adaptability and plasma growth hormone levels in under-yearling coho, Chinook, and chum salmon. Salmonid Smoltification III. Proceedings of a workshop sponsored by the Directorate for Nature Management, Norwegian Fisheries Research Council, Norwegian Smolt producers Association and Statkraft, held at the University of Trondheim, Norway, 27 June-1 July 1988., Elsevier, Amsterdam (Netherlands), 1989 pp. 51-62 Aquaculture. vol. 82.no. 1-4.

Clay, C.H. 1961. Design of fishways and other fish facilities. Canada Department of Fisheries, Ottawa.

Collis, K., R. E. Beaty, and B. R. Crain. 1995. Changes in catch rate and diet of northern squawfish associated with the release of hatchery-reared juvenile salmonids in a Columbia River reservoir. North American Journal of Fisheries Management 15: 346-357. Columbia Basin Fish and Wildlife Authority. 1994. Integrated Hatchery Operations Team. Columbia Basin anadromous salmonid hatchery policies and procedures. Portland, Oregon.

Cooper, R. and T. Johnson. 1992. Trends in steelhead abundance in Washington and along the Pacific Coast of North America. Washington Department of Wildlife and Fisheries, Management Report 92-20.

Cramer, S.P. 2000. The effect of environmentally driven recruitment variation on sustainable yield from salmon populations. p. 485-503. In E. E. Knudsen, C. R Steward, D. D. MacDonald, J. E. Williams, and D. W. Reiser, eds. Sustainable fisheries management: Pacific salmon. Lewis Publishers, Boca Raton, Florida.

Crow, J. F. 1954. Breeding structure of populations. II. Effective population number. Pages 543-556 in O. Kempthorne, T. A. Bancroft, J. W. Gowen, and J. L. Lush, editors. Statistics and mathematics in biology. Iowa State College Press, Ames, Iowa.

Currens, K. P., C. B. Schreck, and H. W. Li. 1990. Allozyme and morphological divergence of rainbow trout (Oncorhynchus mykiss) above and below waterfalls in the Deschutes River, Oregon. Copeia 1990: 730-746.

Dickhoff, W.W., B.R. Beckman, D.A. Larsen, C. Duan and S. Moriyama. 1997. The role of growth in the endocrine regulation of salmon smoltification. Fish Physiol. Biochem. 17:231-236.

Dickson, T.A. and H.R. MacCrimmon. 1982. Influence of hatchery experience on growth and behavior of juvenile atlantic salmon (salmo-salar) within allopatric and sympatric stream populations. Canadian Journal of Fisheries And Aquatic Sciences 39 (11): 1453-1458.

Dittman, A. H., T. P. Quinn, and G. A. Nevitt. 1995. Timing of imprinting to natural and artificial odors by coho salmon (Oncorhynchus kisutch). Can. J. Fish. Aquat. Sci. 53: 434-442.

Dittman, A.H., T.P. Quinn, and G.A. Nevitt. 1996. Timing of imprinting to natural and artificial odors by coho salmon. Canadian Journal of Fisheries and Aquatic Sciences 53:434-442.

Dixon, B. A. 1994. Antibiotic resistance of bacterial pathogens. J. World Aquacult. Soc. 25: 60-63.

Donnelly, W. A. and F. G. Whoriskey, Jr. 1991. Background-color acclimation of brook trout for crypsis reduces risk of predation by hooded mergansers Lophodytes cucullatus. North American Journal of Fisheries Management 11: 206-211.

Doppelt, B., M. Scurlock, C. Frissell, and J. Karr. 1993. Entering the watershed: a new approach to save America's river ecosystems. Island Press. Covelo, California.

Dosanjh, B.S., D.A. Higgs, D.J. McKenzie, D.J. Randall, J.G. Eales, N. Rowshandeli, M. Rowshandeli, and G. Deacon. 1998. Influence of dietary blends of menhaden oil and canola oil on growth, muscle lipid composition, and thyroidal status of Atlantic salmon (Salmo salar) in sea water. Fish Physiology And Biochemistry. 19 (2): 123-134

Egglishaw, H. H. 1967. The food, growth and population structure of salmon and trout in two streams in the Scottish Highlands. Freshwater Salmon Fish. Res 38: 1-32.

Emlen, J. M. 1991. Heterosis and outbreeding depression: a multi-locus model and an application to salmon production. Fisheries research (Amsterdam) 12: 187-212.

Evelyn, T. P. T., L. Prosperi-Porta, and J. E. Ketcheson. 1986a. Persistence of the kidney disease bacterium, Renibacterium salmoninarum, in coho salmon Oncorhynchus kisutch, eggs treated during and after water hardening with povidone-iodine. J. Fish. Dis. 9: 461-464.

Evelyn, T. P. T., L. Prosperi-Porta, and J. E. Ketcheson. 1986b. Experimental intra-ovum infection of salmonid eggs with Renibacterium salmoninarum and vertical transmission of the pathogen with such eggs despite their treatment with erythromycin. Dis. Aquat. Org. 1: 197-202.

Ewing, R. D. and S. K. Ewing. 1995. Review of the effects of rearing density on survival to adulthood for Pacific salmon. Progressive Fish Culturist 57: 1-25.

Falconer, D. S. and T. D. F. MacKay. 1996. Introduction to Quantitative Genetics, 4th ed. Longman Press. London.

Fausch, K. D. 1984. Profitable stream positions for salmonids: relating specific growth rate to net energy gain. Can. J. Zool. 62: 441-451.

Felsenstein, J. 1997. Population differentiation and evolutionary processes. Pages 31-43 in W. S. Grant, editor. Genetic effects of straying on non-native hatchery fish into natural populations: Proceedings of the workshop. W. S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSDC-30, 130 p.

Felton, S. P., L. S. Smith, W. Ji, and J. E. Halver. 1989. Implications of selenium involvement during chemical and physical stresses in salmonids. Proc. Soc. Exp. Biol. and Med. 190 (3): 303.

Fenderson, O. C. and M. R. Carpenter. 1971. Effects of crowding on the behavior of juvenile hatchery and wild landlocked Atlantic salmon (Salmo salar L.). Anim. Behav. 19: 439-447.

Fenderson, O. C., W. H. Everhart, and K. M. Muth. 1968. Comparative agonistic and feeding behavior of hatchery-reared and wild salmon in aquaria. J. Fish. Res. Board Can. 25: 1-14.

Flagg, T. A., B. A. Berejikian, J. E. Colt, W. W. Dickhoff, L. W. Harrell, D. J. Maynard, C. E. Nash, M. S. Strom, R. N. Iwamoto, and C. W. W. Mahnken. 2000. Ecological and behavioral impacts of artificial production strategies on the abundance of wild salmon populations. U. S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-41: 92 p.

Flagg, T. A., F. W. Waknitz, D. J. Maynard, G. B. Milner, and C. V. W. Mahnken. 1995. The effect of hatcheries on native coho salmon populations in the Lower Columbia River. Pages 366-375. in

H. L. Schramm, Jr. and R. G. Piper, editors. Uses and effects of cultured fishes in aquatic ecosystems. American Fisheries Society Symposium 15, Bethesda, MD.

Flagg, T.A., R.N. Iwamoto, and C.V.W. Mahnken. In press. Conservation Hatchery Protocols for Pacific Salmon. Am. Fish. Soc. Symp. Series., Prop. Fish Res. Manag. xx:xx-xx.

Flagg, T. A., F. W. Waknitz, D. J. Maynard, G. B. Milner, and C. V. W. Mahnken. 1995. The effect of hatcheries on native coho salmon populations in the Lower Columbia River. Pages 366-375. in H. L. Schramm, Jr. and R. G. Piper, editors. Uses and effects of cultured fishes in aquatic ecosystems. American Fisheries Society Symposium 15, Bethesda, MD.

Fleming, D.F., and J. B. Reynolds. 1991. Effects of spawning-run delay on spawning migration of Arctic grayling. In J. Colt and R. White, Editors. Fisheries Bioengineering Symposium. American Fisheries Society Symposium 10:299-305.

Fleming, I. A. 1996. Captive breeding and the conservation of wild salmon populations. Cons. Biol. 8:886-888.

Fleming, I. A. and M. Gross. 1993. Breeding success of hatchery and wild coho salmon (Oncorhynchus kisutch): does it differ? Ecological Applications 3: 230-245.

Fleming, I. A. and M. R. Gross. 1989. Evolution of adult female life history and morphology in aPacific salmon (coho: Oncorhynchus kisutch). Evolution 43: 141-157.

Fleming, I. A. and M. R. Gross. 1992. Reproductive behavior of hatchery and wild coho salmon(Oncorhynchus kisutch): does it differ? Aquaculture 103: 101-121.

Fleming, I. A. and M. R. Gross. 1994. Breeding competition in a Pacific salmon (coho: Oncorhynchus kisutch) : measures of natural and sexual selection. Evolution 48: 637-657.

Fleming, I. A., B. Jonson, M. R. Gross, and A. Lamberg. 1996. An experimental study of thereproductive behavior and success of farmed and wild Atlantic salmon (Salmo salar). J. Appl.Ecol. 33: 893-905.

Foote, C. J., G. S. Brown, and C. C. Wood. 1997. Spawning success of males using alternative mating tactics in sockeye salmon, Oncorhynchus nerka. Can. J. Fish. Aquat. Sci. 54: 1785-1795.

Forster, I. P. and R. W. Hardy. 1995. Captive broodstock literature review. Bonneville Power Administration annual report for Project 93-56, 4:1-38.

Fowler, L. G. and J. L . Banks. 1980. Survival rates for three sizes of hatchery reared fall Chinook salmon. U.S. Fish and Wildlife Service, Abernathy Salmon Cultural Development Center.Technology Transfer Series 80-1.

Franklin, I. R. 1980. Evolutionary change in small populations. Pages 135-149 in M. E. Soule and B.A. Wilcox, editors. Conservation biology: An evolutionary-ecological perspective. SinauerAssoc., Sunderland, MA.

Fresh, K. L. 1997. The role of competition and predation in the decline of Pacific salmon and steelhead. Pages 245-275 in D. Stouder and R. Naiman, editors. Pacific salmon and their ecosystems. Chapman Hall Inc.

Fresh, K. L. and S. L. Schroder. 1987. Influence of the abundance, size, and yolk reserves of juvenile chum salmon (Oncorhynchus keta) on predation by freshwater fishes in a small coastal stream.Can. J. Fish. Aquat. Sci. 44: 236-243.

Fuss, H. J. and C. Johnson. 1988. Effects of artificial substrate and covering on growth and survival of hatchery-reared coho salmon. Progressive Fish-Culturist 50: 232-237.

Gabaudan, J. and R.W. Hardy. 2000. Vitamin sources for fish feeds. In: The Encyclopedia of Aquaculture, R.R. Stickney (Ed.), John Wiley and Sons, Inc., New York, pp. 961-965.

Geiger, H. J., W. W. Smoker, L. A. Zhivotovsky, and A. J. Gharrett. 1997. Variability of family size and marine survival in pink salmon has implications for conservation biology and human use. Canadian Journal of Fisheries and Aquatic Sciences 54: 5684-2690.

Gharrett, A. J. and S. M. Shirley. 1985. A genetic examination of spawning methodology in a salmon hatchery. Aquaculture 47: 245-256.

Gharrett, A. J. and W. W. Smoker. 1991. Two generations of hybrids between even-year and odd-year pink salmon (Oncorhynchus gorbuscha): a test for outbreeding depression. Can. J. Fish.Aquat. Sci. 48: 1744-1749.

Gharrett, A. J. and W. W. Smoker. 1993b. A perspective on the adaptive importance of genetic

infrastructure in salmon populations to ocean ranching in Alaska. Fishery Research 18: 45-58.

Gharrett, A. J., and W. W. Smoker. 1993a. Genetic components in life history traits contribute to population structure. Pages 197-202 in J. G. Cloud and G. H. Thorgaard, editors. Genetic conservation of salmonid fishes. Plenum Press, New York.

Gharrett, A. J., W. W. Smoker, R. R. Reisenbichler, and S. G. Taylor. 1999. Outbreeding depression in hybrids between odd- and even-brood year pink salmon. Aquaculture 73: 117-130.

Gilk, S. E., Wang, I. A., Hoover, C. L., Smoker, W. W., Taylor, S. G., Gray, A. K., and Gharrett, A. J.2004. Outbreeding depression in hybrids between spatially separated pink salmon, Oncorhynchus gorbuscha, populations: Marine survival, homing ability, and variability in family size. Environmental Biology of Fishes In Press.

Gilpin, M. 1993. Metapopulations and wildlife conservation: approaches to modeling spatial structure. Pages 11-27 in D. R. McCullough, editor. Metapopulations and wildlife conservation. Island Press, Washington D. C.

Ginetz, R. M. and P. A. Larkin. 1976. Factors affecting rainbow trout (Salmo gairdneri) predation on migrant fry of sockeye salmon (Oncorhynchus nerka). J. Fish. Res. Board Can. 33: 19-24.

Golley, F. G. 1993. A history of the ecosystem concept in ecology: more than the sum of its parts.Yale University Press. New Haven.

Granath, K. L., Smoker, W. W., Gharrett, A. J., and Hard, J. J. 2004. Effects on embryo development time and survival of intercrossing three geographically separate populations of southeast Alaska coho salmon, Oncorhynchus kisutch . Environmental Biology of Fishes In Press.

Grant, J. W. A. and D. L. Kramer. 1990. Territory size as a predictor of the upper limit to population density of juvenile salmonids in streams. Can. J. Fish. Aquat. Sci. 47: 1724-1737.

Grant, W. S. 1997. Genetic effects of straying on non-native hatchery fish into natural populations: Proceedings of the workshop. W. S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSDC-30, 130 p.

Grant, W.S. (editor). 1997. Genetic effects of straying of non-native fish hatchery fish into natural populations: proceedings of the workshop. U.S. Dept. Commer., NOAA Tech.Memo. NMFSNWFSC-30, 130 p.

Gresh, T., Lichatowich, J., Schoonmaker, P. 2000. An estimation of historic and current levels of salmon production in the Northeast Pacific Ecosystem. Fisheries 25: 15-21

Groot, C. and L. Margolis. 1991. Pacific Salmon Life Histories. UBC Press. Vancouver, B. C.

Hager, R. C. and R. E. Noble. 1976. Relation of size at release of hatchery-reared coho salmon to age,size and sex composition of returning adults. Progressive Fish-Culturist 38(3): 144-147.

Hall, J. D., and M. S. Field-Dodgeson. 1981. Improvement of spawning and rearing habitat forsalmon. Pages 21-28 in C. L. Hopkins, editor. Proceedings of the salmon symposium. New Zealand

Ministry of Agriculture and Fisheries Research Division, Occasional Publ. 30,Wellington.

Hankin, D. G. 1990. Effects of month of release of hatchery-reared Chinook salmon on size at age, maturation schedule and fishery contribution. OR Dept. Fish and Wildlife Information Report90-4.

Hankin, D. G., J. W. Nicholas, and T. W. Downey. 1993. Evidence for inheritance of age maturity in Chinook salmon (Oncorhynchus tshawytscha). Can. J. Fish. Aquat. Sci. 50: 347-358.

Hanson, A. J. and H. D. Smith. 1967. Mate selection in a population of sockeye salmon (Oncorhynchus nerka) of mixed age groups. J. Fish. Res. Board Can. 24: 1977-1995.

Hard, J. J. and W. R. Heard. 1999. Analysis of straying variation in Alaskan hatchery Chinook salmon (Oncorhynchus tshawytscha) following transplantation. Can. J. Fish. Aquat. Sci. 56: 578-589.

Hard, J. J., A. C. Wertheimer, W. R. Heard, and R. M. Martin. 1985. Early male maturity in twostocks of Chinook salmon (Oncorhynchus tshawytscha) transplanted to an experimental hatchery in Southeastern Alaska. Aquaculture 48: 351-359.

Hard, J. J., and W. K. Hershberger. 1995. Quantitative genetic consequences of captive broodstock programs for anadromous Pacific salmon (Oncorhynchus spp.) . Page (2)1-(2)75 in T. A.

Flagg and C. V. W. Mahnken (editors), editor. An assessment of the status of captive broodstock technology for Pacific salmon.

Hard, J. J., B. A. Berejikian, E. P. Tezak, S. L. Schroder, C. M. Knidsen, and L. T. Parker. 2000.Evidence for morphometric differentiation of wild and captively reared adult coho salmon: a geometric analysis . Environmental Biology of Fishes 59: 61-73.

Hard, J. J., G. A. Winans, and J. C. Richardson. 1999. Phenotypic and genetic architecture of juvenile morphometry in Chinook salmon. Journal of Heredity 90: 597-606.

Hardy, R.W. and D.D. Roley, 2000. Lipid oxidation and antioxidants. In: The Encyclopedia of Aquaculture, R.R. Stickney (Ed.), John Wiley and Sons, Inc., New York, pp. 470-476.

Harrison, S., and A. D. Taylor. 1997. Empirical evidence for metapopulation dynamics. Pages 27-42in I. Hanski and M. E. Gilpin, editors. Metapopulation Biology. Academic Press Inc, SanDiego.

Haskell, B. D., B. G. Norton, and R. Costanza. 1992. Introduction: what is ecosystem health and why should we worry about it? Pages 3-20 in R. Costanza, B. G. Norton, and B. D. Haskell,editors. Ecosystem Health: new goals for environmental management. Island Press, Covelo,

California.Healey, M. C. 1991. Life history of Chinook salmon (Oncorhynchus tshawytscha) . Pages 311-394 in C. Groot and L. Margolis, editors. Pacific salmon life histories. University of British Columbia Press, Vancouver, B.C.

Healey, M. C. and W. R. Heard. 1984. Inter- and intra-population variation in the fecundity ofChinook salmon (Oncorhynchus tshawytscha) and its relevance to life history theory. Can. J.

Fish. Aquat. Sci. 41: 476-483.Healey, M.C. 1991. Life history of chinook salmon. Pages 311-393 in C. Groot and L. Margolis, editors. Pacific salmon life histories. University of Briths Columbia Press, Vancouver.

Heath, D. D. 1992. Genetic, environmental, and physiological factors involved in the precocious sexual maturation of Chinook salmon (Oncorhynchus tshawytscha). Ph. D. Thesis. University of British Columbia, Vancouver, Canada. 166 p.

Heath, D.H., J. W. Heath, C.A. Bryden, R. A. Johnson, and C.W. Fox. 2003. Rapid evolution of egg size in captive salmon. Science 299:1738-1740.

Hebert, K. P., P. L. Goddard, W. W. Smoker, and A. J. Gharrett. 1998. Quantitative genetic variation and genotype by environment interaction of embryo development rate in pink salmon (Oncorhynchus gorbuscha). Canadian Journal of Fisheries & Aquatic Sciences. 55: 2048-2057.

Hedrick, P. W. and Hedgecock, D. 1994. Effective population size in winter-run chinook salmon. Conservation Biology 890-892.

Hemmingsen, A. R., R. A. Holt, R. D. Ewing, and J. D. McIntyre. 1986. Susceptibility of progeny from crosses among three stocks of coho salmon to infection by Ceratomyxa shasta. Transactions of the American Fisheries Society 115: 492-495.

Henderson, M. A. and A. J. Cass. 1991. Effect of smolt size on smolt-to-adult survival for Chilko Lakesockeye salmon (Oncorhynchus nerka). Can. J. Fish. Aquat. Sci. 48: 988-994.

Herwig, R. P., J. P. Gray, and D. P. Weston. 1997. Antibacterial resistant bacteria in surficial sediments near salmon net-cage farms in Puget Sound, Washington. Aquacult. 149: 263-283.

Hickson, B., and D. Leith. 1996. Review of feeds and feed delivery systems suitable for the NATURES program. Bonneville Power Administration annual report for Project 91-005, Pp.191-216.

Hickson, B., and D. Leith. 1996. Review of feeds and feed delivery systems suitable for the

NATURES program. Bonneville Power Administration annual report for Project 91-005, Pp.191-216.

Higgs, D.A., and F.M. Dong. 2000. Lipids and fatty acids. In: The Encyclopedia of Aquaculture, R.R. Stickney (Ed.), John Wiley and Sons, Inc., New York, pp. 476-496.

Higgs, D.A., J.S. Macdonald, C.D. Levings and B.S. Dosanjh. 1995a. Nutrition and feeding habits of Pacific salmon (Oncorhynchus species) in relation to life history stage. In: C. Groot, L.

Margolis and W.C. Clarke (Eds). The Physiology Ecology of Pacific Salmon, U.B.C. Press, Vancouver, B.C., pp. 159-315.

Hilborn, R. and C. Walters. 1992. Quantitative fisheries stock assessment: choice, dynamics &uncertainty. Routledge, Chapman and Hall. New York.

Hilborn, R., T. P. Quinn, P., D.E. Schindler, and D.E. Rogers. 2003. Biocomplexity and fisheries sustainability. Proc. Natl. Acad. Sci. 100: 6564-6568.

Hillman, T. W., and J. W. Mullan. 1989. Effect of hatchery releases on the abundance and behavior of wild juvenile salmonids. Pages 265-285 in D. W. Chapman Consultants, editor. Summer and winter ecology of juvenile Chinook salmon and steelhead trout in the Wenatchee River, Washington. Report of D. W. Chapman Consultants, Boise, Idaho, to Chelan County Public Utilities District, Wenatchee, Washington.

Hindar, K., N. Ryman, and F. Utter. 1991. Genetic effects of cultured fish on natural fish populations. Can. J. Fish. Aquat. Sci. 48: 945-957.

Hjort, R. C. and C. B. Schreck. 1982. Phenotypic differences among stocks of hatchery and wild coho salmon, Oncorhynchus kisutch, in Oregon, Washington and California. Fishery Bulletin 80(1):105-119.

Hoar, W. S. 1951. The behavior of chum, pink, and coho salmon fry in relation to their seaward migration. J. Fish. Res. Board Can. 12: 178-185.

Hochachka, P. W. 1961. Liver glycogen reserves of interacting resident and introduced trout populations. J. Fish. Res. Board Can. 18: 125-135.

Holtby, L. B., B. C. Andersen, and R. K. Kadowski. 1990. Importance of smolt size and early ocean growth to interannual variability in marine survival of coho salmon (Oncorhynchus kisutch).Can J. Fish . Aquat. Sci. 47:2181-2194.

Holtby, L. B., D. P. Swain, and G. M. Allan. 1993. Mirror-elicited agonistic behavior and body morphology as predictors of dominance status in juvenile coho salmon (Oncorhynchus kisutch). Can. J. Fish. Aquat. Sci. 50: 676-684.

Hunter, C. J. 1991. Better trout habitat. A guide to Stream Restoration and Management. Island Press. Covelo, CA.

Hyatt, K. D. and J. G. Stockner. 1985. Responses of sockeye salmon (Oncorhynchus nerka) to fertilization of British Columbia coastal lakes. Can. J. Fish. Aquat. Sci. 42: 320-331.

Ibarra, A., R. Hedrick, and G. A. E. Gall. 1994. Genetic analysis of rainbow trout susceptibility to the myxosporean, Ceratomyxa shasta. Aquaculture 120: 239-262.

Integrated Hatchery Operations Team. 1994a. Implementation plan for integrating regional hatchery policies. Portland, Oregon: Bonneville Power Administration.

Integrated Hatchery Operations Team. 1994b. Columbia Basin anadromous salmonid hatchery policiesand procedures. Portland, Oregon: Columbia Basin Fish and Wildlife Authority.

Integrated Hatchery Operations Team. 1997. Audit Reports . Notes: (Section 2 of each Hatchery report), Bonneville Power Administration, Portland, OR.

Jenkins, T. M. 1969. Social structure, position choice and micro-distribution of two trout species (Salmo trutta and Salmo gairdneri) resident in mountain streams. Anim. Behav. 2: 57-123.

Johnston, N.T., J.S. Macdonald, K.J. Hall, and P.J. Tschaplinski. 1997. A preliminary study of the role of sockeye salmon (Oncorhynchus nerka) carcasses as carbon and nitrogen sources for benthic insects and fishes in the 'Early Stuart' stock spawning streams, 1050 km from the ocean. Fisheries project report no. RD55, Fisheries Branch, Ministry of Environment, Lands, and Parks, British Columbia, Canada.

Jonasson, B. C., R. W. Carmichael, and T. A. Whitesell. 1993. Residual hatchery steelhead: Characteristics and potential interactions with spring Chinook salmon in Northeast Oregon.Report to U. S. Fish and Wildlife Service, Contract number 14-16-0001-92541. 39 p.

Jonasson, B. C., R. W. Carmichael, and T. A. Whitesell. 1994. Residual hatchery steelhead: Characteristics and potential interactions with spring Chinook salmon in Northeast Oregon.Report to U. S. Fish and Wildlife Service, Contract number 14-48-0001-93538. 45 p.

Jonasson, B. C., R. W. Carmichael, and T. A. Whitesell. 1995. Residual hatchery steelhead: Characteristics and potential interactions with spring Chinook salmon in Northeast Oregon.Report to U. S. Fish and Wildlife Service, Contract number 14-48-0001-93538. 39 p.

Kanaga, D., and E.D. Evans. 1982. The effect of the Platte River Anadromous Fish Hatchery on fish, benthic macroinvertebrates and nutrients in the Platte Lake. Michigan Department of NaturalResources, Water Quality Division, Lansing.

Kapuscinski, A. R. 1996. Rehabilitation of Pacific salmon in their ecosystems: What can artificial propagation contribute? Pages 493-512 in Pacific Salmon and their ecosystems. Chapman Hall, Inc..

Karr, J. R. 1992. Ecological integrity: protecting earth's life support systems. Pages 223-238 in R.

Costanza, B. G. Norton, and B. D. Haskell, editors. Ecosystem Health: New Goals for Environmental Management. Island Press, Covelo, CA.

Keenleyside, M. H. A. and H. M. C. Dupuis. 1988. Courtship and spawning competition in pinksalmon (Oncorhynchus gorbuscha). Canadian Journal of Zoology 66: 262-265.

Keith, R. M., T. C. Bjorn, W. R. Meehan, N. J. Hetrick, and M. A.Brusven. 1998. Response of juvenile salmonids to riparian and instream cover modifications in small streams flowing through second-growth forests of SE Alaska. Transactions of the American Fisheries Society127: 889-907.

Kendra, W. 1991. Quality of salmonid hatchery effluents during a summer low-flow season. Transactions of the American Fisheries Society 120:43-50.

Kindschi, G. A. 1987. Method for quantifying degree of fin erosion. Prog. Fish Cult. 49:314-315.

Kindschi, G. A., H. T. Shaw, and D. S. Bruhn. 1991. Effects of baffles and isolation on dorsal fin erosion in steelhead trout, Oncorhynchus mykiss (Walbaum). Aquac. Fish. Manage. 22:3443-350.

Kindschi, G.A. 1987. Method for quantifying degree of fin erosion. Progressive Fish-Culturist. 49 (4):314-315.

Kindschi, G.A., R.G. Thompson, and A.P. Mendoza. 1991. Use of raceway baffles in rainbow-trout culture. Progressive Fish-Culturist. 53 (2): 97-101.

Kirn, R. A., R. D. Ledgerwood, and R. A. Nelson. 1986. Increased abundance and the food

onsumption of northern squawfish (Ptychocheilus oregonensis) at river kilometer 75 in the Columbia River. Northwest Science 60: 197-200.

Kline, T.C. Jr., J.J. Goering, O.A. Mathisen, P.H. Poe, P.L. Parker. 1990. Recycling of elements transported upstream by runs of Pacific salmon. 15N and 13C evidence in Sashin Creek, southeastern Alaska. Can. J. Fish. Aquat. Sci. 47: 136-144.

Klontz G.W., M.G. Maskill, and H. Kaiser. 1991. Effects of reduced continuous versus intermittent feeding of steelhead. Progressive Fish-Culturist. 53 (4): 229-235.

Kodric-Brown, A. 1995. Does past reproductive history predict competitive interactions and male mating success in pupfish? Anim. Behav. 50: 1433-1440.

Kramer, D. L., D. Manley, and R. Bourgeois. 1983. The effect of respiratory mode and oxygen concentration on the risk of aerial predation in fishes. Can. J. Zool. 61: 653-665.

Lall, S.P. 2002. The minerals. In Fish Nutrition, 3rd Edition, (J. R. Halver and R.W. Hardy, eds.), Academic Press, San Diego, California, pp. 260-308.

Lande, R. 1988. Genetics and demography in biological conservation. Science 241: 1455-1460.

Lande, R. 1995. Mutation and conservation. Conservation Biology 9: 782-791.

Larkin, G. A. and P. A. Slaney. 1996. Trends in marine-derived nutrient sources to south coastal British Columbia streams: impending implications to salmonid production. Province of British Columbia, Ministry of Environment, Lands and Parks, and Ministry of Forests. Watershed Restoration Project Report No. 3: 56p.

Larkin, G. and P. A. Slaney. 1997. Implications of trends in marine-derived nutrient influx to southcoastal British Columbia salmonid production. Fisheries 22(11): 16-24.

Larmoyeux, J.D., and R.G. Piper. 1971. Reducing eroded fin condition in hatchery trout. U.S. TroutNews. 1971(5):8-9.

Larsen D.A., B.R. Beckman, K.A. Cooper, D. Barrett, M. Johnston, P. Swanson, and W.W. Dickhoff. Assessment of high rates of precocious male maturation in a spring Chinook salmon supplementation hatchery program. Transactions of The American Fisheries Society. 133 (1):98-120.

Larsen, D.A. and six coauthors. 2004. Assessment of high rates of precocious male maturation in a spring Chinook salmon supplementation hatchery program. Trans. Am. Fish. Soc. 133:98-120.

Larsen, D.A., B.R. Beckman, K.A. Cooper, P. Swanson, and W.W. Dickhoff. 2004. Assessment of high rates of precocious male maturation in a spring Chinook salmon supplementation hatchery program. Trans. Am. Fish. Soc. 133:98-120.

Leider, S. A., P. L. Hulett, J. J. Loch, and M. W. Chilcote. 1990. Electrophoretic comparison of the reproductive success of naturally spawning transplanted and wild steelhead trout through the returning adult stage. Aquaculture 88: 239-252.

Leon, K. A. and W. A. Bonney. 1979. Effects of artificial substrate and covering on growth and survival of hatchery-reared coho salmon. Aquaculture 41: 20-25.

Lestelle, L. C., L. E. Mobrand, J. A. Lichatowich, and T. S. Vogel. 1996. Applied ecosystem analysis - a primer, EDT: the ecosystem diagnosis and treatment method, Bonneville Power Administration, Portland, Oregon.

Levin, P.S., R.W. Zabel and J.G. Williams. 2001. The road to extinction is paved with good intentions: negative association of fish hatcheries with threatened salmon. Proceedings of the RoyalSociety of London B (268), 1-6. Li, M.H., and R.W. Hardy. 2000. Protein sources for feeds. In: The Encyclopedia of Aquaculture, R.R. Stickney (Ed.), John Wiley and Sons, Inc., New York, pp.688-695.

Lichatowich, J. 1999. Salmon Without Rivers- A History of the Pacific Salmon Crisis. Island Press. Covelo, CA.

Lichatowich, J., L. E. Mobrand, L. Lestelle, and T. Vogel. 1995. An approach to the diagnosis and treatment of depleted Pacific salmon populations in freshwater ecosystems. Fisheries 20: 10-18.

Lichatowich, J., T. Quinn, W. Hershberger, and A. Kapuscinski. 1994. Written reviews of IHOT Policy as requested by BPA. Mobrand Biometrics Inc., compiler. Development of proceduresfor integrating genetic risks and benefits into the planning processes. Vashon, Washington: Mobrand Biometrics, Inc.

Lichatowich, J.A. 1993. Ocean carrying capacity. Technical Report No. 6, Recovery issues for threatened and endangered Snake River salmon. Prepared for Bonneville Power Administration, Portland, OR.

Lynch, M. 1991. The genetic interpretation of inbreeding depression and outbreeding depression. Evolution 45: 622-629.

Lynch, M. 1996. A quantitative-genetic perspective on conservation issues. Pages 471-501 in J. C.

Avise and J. L. Hamrick, editors. Conservation genetics: case histories from nature. Chapman& Hall, New York, NY.

Lynch, M. 1997. Inbreeding depression and outbreeding depression. Pages 59-70 in W. S. Grant, editor. Genetic effects of straying on non-native hatchery fish into natural populations: Proceedings of the workshop. W. S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSDC-30, 130 p.

Lynch, M., and M. O'Hely. 2001. Supplementation and the genetic fitness of natural populations. Conservation Genetics 2: 363-378.

Mackey, G., McLean, J.E., and Quinn, T.P. 2001. Comparisons of run timing, spatial distribution, and length of wild and newly established hatchery populations of steelhead in Forks Creek,Washington. North Am. J. Fisheries Management 21: 717-724.

Maheshkumar, S., S. M. Goyal, and P. P. Economon. 1992. Evaluation of a concentration procedure to detect infectious pancreatic necrosis in water. J. Aquat. Health 4: 58-62.

Mahnken, C.V.W., G.T. Ruggerone, F.W. Waknitz, and T. A. Flagg. 1998. A historical perspective on salmonid production from Pacific Rim hatcheries. N. Pac. Anadr. Fish. Comm. Bull. 1:38-53.

Mason, J. C. and D. W. Chapman. 1965. Significance of early emergence, environmental rearing capacity, and behavioral ecology of juvenile coho salmon in stream channels. J. Fish. Res. Board Can. 22: 172-190.

Mathisen, O.A., P.L. Parker, J.J. Goering, T.C. Kline, P.H. Poe and R.S. Scalan. 1988. Recycling of marine elements transported into freshwater systems by anadromous salmon. Verb. Internal. Verein. Limnol. 23:2,249-258.

Maynard, D. J. 1987. Status signaling and the social structure of juvenile coho salmon. University Microfilms, Ann Arbor, MI., 226 p.

Maynard, D. J., T. A. Flagg, and C. V. W. Mahnken. 1995. A review of innovative culture strategies for enhancing the post-release survival of anadromous salmonids. Am. Fish. Soc. Symp.15:307-314.Maynard, D. J., T. A. Flagg, and C. V. W. Mahnken. 1995. A review of innovative culture strategies for enhancing the post-release survival of anadromous salmonids. Pages 307

314 in H. L.Schramm, Jr. and R. G. Piper, editors. Uses and effects of cultured fishes in aquatic ecosystems. American Fisheries Society Symposium 15, Bethesda, MD.

Maynard, D. J., T. A. Flagg, C. V. W. Mahnken, and S. L. Schroder. 1996. Natural rearing technologies for increasing postrelease survival of hatchery-reared salmon. Bull. Nat. Res.Inst. Aqua., Supp. 2:71-77.

Maynard, D. J., T. A. Flagg, C. V. W. Mahnken, and S. L. Schroder. 1996. Natural rearing technologies for increasing post-release survival of hatchery-reared salmon. Bull. Natl. Res.Inst. Aquacult., Supplement 2: 71-77.

Mazur, C. F., D. Tillapaugh, and G. K. Iwama. 1993. The effects of feeding level and rearing densityon the prevalence of Renibacterium salmoninarum in Chinook salmon (Oncorhynchus tshawytscha) reared in salt water. Aquaculture 117: 141-147.McAllister, K. W. and P. E. McAllister. 1988. Transmission of infectious pancreatic necrosis virus from carrier striped bass to trout. Dis. Aquat. Org. 4: 101-104.

McCubbing, D. J. F. and B. R. Ward. 2000. Stream rehabilitation in British Columbia's Watershed Restoration Program: juvenile salmonid response in the Keogh and Waukwaas rivers, 1998.Province of British Columbia, Ministry of Environment, Lands and Parks, and Ministry of Forests. Watershed Restoration Project Report No. 12: 22.

McElhany, P., M.H. Ruckleshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Department of Commerce, Seattle, Washington

McGinnity, P., C. Stone, J. B. Taggart, D. Cooke, D. Cotter, R. Hynes, C. McCamley, T. Cross, andA. Ferguson. 1997. Genetic impact of escaped farmed Atlantic salmon (Salmo salar L.) Nonnative populations: use of DNA profiling to assess freshwater performance of wild, farmed and hybrid progeny in a natural river environment. ICES Journal of Marine Science 54: 998-1008.

McGregor, A. J., S. Lane, M. A. Thomason, L. A. Zhivotovsky, W. W. Smoker, and A. J. Gharrett.1998. Migration timing, a life history trait important in the genetic structure of pink salmon. North Pacific Anadromous Fish Commission Bulletin 1: 262-273.

McIsaac, D. O. and T. P. Quinn. 1988. Evidence for a hereditary component in homing behavior of Chinook salmon (Oncorhynchus tshawytscha). Can, J. Fish. Aquat. Sci. 45: 2201-2205.

McKibben, C. L. and R. J. Pascho. 1999. Shedding of Renibacterium salmoninarum by infected

Chinook salmon Oncorhynchus tshawytscha. Dis. Aquat. Org. 38: 75-79.

McMichael, G. A., T. N. Pearsons, and S. A. Leider. 1999. Minimizing ecological impacts of hatchery reared juvenile steelhead trout on wild salmonids in a Yakima basin watershed. Pages 365-380in E. E. Knudsen and others, editors. Sustainable fisheries management: balancing the conservation, and use of Pacific salmon. CRC Press, Boca Raton, Florida .

McNicol, R. E. and D. L. G. Noakes. 1984. Environmental influences on territoriality of juvenile brook char, Salvelinus fontinalis, in a stream environment. Environmental Biology of Fishes10: 29-42

Meade, J. 1989. Aquaculture Management. Van Nostrand Reinhold. New York.

Metcalfe, N. B. 1986. Intraspecific variation in competitive ability and food intake in salmonids: consequences for energy budgets and growth rates. J. Fish Biol. 28: 525-531.

Mighell, J. L. 1981. Culture of Atlantic salmon, Salmo salar, in Puget Sound. Mar. Fish. Rev. 43: 1-8.

Miller, R. B. 1952. Survival of hatchery-reared cutthroat trout in an Alberta stream. Transactions of the American Fisheries Society 81: 35-42.

Mjolnerod, I. B., I. A. Fleming, U. H. Refseth, and K. Hindar. 1998. Mate and sperm-competition during multiple-male spawnings of Atlantic salmon. Can. J. Zool. 76: 70-75.

Mobrand, L. E., J. A. Lichatowich, L. C. Lestelle, and T. S. Vogel. 1997. An approach to describing ecosystem performance "through the eyes of salmon". Canadian Journal of Fisheries andAquatic Sciences 54: 2964-2973.

Modin, J. 1998. Whirling disease in California: a review of its history, distribution, and impacts, 1965-1997. Aquat. J. Anim. Health 10: 132-142.

Moyle, P. B. 1969. Comparative behavior of young brook trout of domestic and wild origin. Prog. Fish-Cult. 31: 51-59.

Mulcahy, D., R. J. Pascho, and C. K. Jenes. 1983. Detection of infectious haematopoietic necrosis virus in river water and demonstration of water-borne transmission. J. Fish. Dis. 6: 321-330.

Mundie, J. H., K. S. Simpson, and C. J. Perrin. 1991. Responses of stream periphyton and benthic insects to increases in dissolved inorganic phosphorus in a mesocosm. Can. J. Fish. Aquat.Sci. 48: 2061-2072.

Mundie, J. H., S. M. McKinell, and R. E. Traber. 1983. Responses of stream zoobenthos to enrichment

Murray, C. B. and T. D. Beacham. 1986. Effect of incubation density and substrate on the development of chum salmon eggs and alevins. Progressive Fish-Culturist 48: 242-249.

Nickelson, T. E. 1986. A model for determining factors limiting abundance, and thereby carrying capacity of fishes in stream systems. Pages 13-17 in J. W. Buell, editor. Stream habitat enhancement evaluation workshop: level I. Project 86-107. U.S. Department of Energy, Bonneville Power Administration, Portland, OR.

Nickelson, T.E., M.F. Solazzi, and S.L. Johnson. 1986. Use of hatchery coho salmon (Oncorhynchus kisutch) pre-smolts to rebuild wild populations in Oregon coastal streams. Can. J. Fish. Aquat.

Sci. 43: 2443-2449.Nickelson, T.E., M.F. Solazzi, S.L. Johnson, and J.D. Rodgers. 1993. An approach to determining stream carrying capacity and limiting habitat for coho salmon (Oncorhynchus kisutch). Pages251-260 in L. Berg and P. W. Delaney, editors. Proceeding of the Coho Workshop, Nanaimo,B. C., May 26-28, 1992.

Nielsen, J.L. 1994. Invasive cohorts-impacts of hatchery-reared coho salmon on the trophic, developmental, and genetic ecology of wild stocks. Pages 361-385 in Theory and Application in the Fish Feeding Ecology. The Belle Baruch Library in Marine Science, University ofSouth Carolina, Columbia.

Noakes, D. L. G. 1980. Social behavior in young charrs. Pages 383-702 in E. K. Balon, editor. Charrs, salmonid fishes of the genus Salvelinus. Junk Publishers, The Hague.

Norton, B. G. 1994. Thoreau and Leopold on science and values. Pages 31-46 in K. C. Kim and R. D.

Weaver, editors. Biodiversity and landscapes. Cambridge University Press, New York.NRC (National Research Council, US). 1993. Nutrient Requirements of Fish, National Academy Press, Washington, DC, 114 p.

Olla, B. L., M. W. Davis, and C. H. Ryer. 1988. Understanding how the hatchery environment represses or promotes the development of behavioral survival skills. Bull. Mar. Sci. 62: 531-550.

Olla, B. L., M. W. Davis, and C. H. Ryer. 1990. Foraging and predator avoidance in hatchery-reared Pacific salmon: achievement of behavioral potential. Pages 5-12 in J. E. Thorpe and F. A. Huntingford, editors. The importance of feeding behavior for the efficient culture of salmonid fishes. World Aquaculture Society, Baton Rouge, LA.

Olsen, D. and J. Richards. 1994. Inter-basin comparison study: Columbia River salmon production compared to other west coast production areas, Phase II analysis. Report to the Army Corps of

Engineers, Portland, OR. 29 p.Pascual, M. A., Quinn, T. P., and Fuss, H. 1995. Factors affecting the homing of fall Chinook salmon from Columbia River hatcheries. Transactions of the American Fisheries Society 124: 308-320.Pearce, R.O., and R. T. Lee. 1991. Some design considerations for approach velocities at juvenile screening facilities. In J. Colt and R. White, Editors. Fisheries Bioengineering Symposium. American Fisheries Society Symposium 10:237-248.

Pennell, W. and B. A. Barton. 1996. Principles of Salmonid Culture. Elsevier Science. B. V.,Amsterdam, The Netherlands.

Perez, M. J., A. I. G. Fernandez, L. A. Rodriguez, and T. P. Nieto. 1996. Differential susceptibility to furunculosis of turbot and rainbow trout and release of the furunculosis agent from furunculosis-affected fish. Dis. Aquat. Org. 26: 133-137.

Perry, E. A. 1995. Salmon stock restoration and enhancement: strategies and experiences in British Columbia. American Fisheries Society Symposium 15: 152-160.

Peterman, R. M. and M. Gatto. 1978. Estimation of functional responses of predators on juvenile salmon. J. Fish. Res. Board Can. 35: 797-808.

Petersen, J. H. and D. L. DeAngelis. 1992. Functional response and capture timing in an individual based model: predation by northern squawfish (Ptychocheilus oregonensis) on juvenile salmonids in the Columbia River. Can. J. Fish. Aquat. Sci. 49: 2551-2565.

Phelps, S. R., L. L. Leclair, S. Young, and H. L. Blankenship. 1994. Genetic diversity patterns of chum salmon in the Pacific Northwest. Canadian Journal of Fisheries and Aquatic Sciences51: 65-83.

Piper, R. G., I. B. McElwain, L. E. Orme, J. P. McCraren, L. G. Fowler, and J. R. Leonard. 1992. Fish Hatchery Management, 5th edition. U. S. Fish and Wildlife Service. Washington D. C.

Poe, T. P., H. C. Hansel, S. Vigg, D. E. Palmer, and L. A. Prendergast. 1991. Feeding of predaceous fishes on out-migrating juvenile salmonids in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120: 405-420.

Poon, D. C. 1977. Quality of salmon fry from gravel incubators. Ph.D. Thesis, Oregon State Univ. Corvallis.

Quinn, T. 1997. Homing, straying, and colonization. Pages 73-85 in W. S. Grant, editor. Genetic effects of straying on non-native hatchery fish into natural populations: Proceedings of the workshop. U. S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSDC-30, 130 p.

Quinn, T. P. 1993. A review of homing and straying of wild and hatchery-produced salmon. Fisheries Research 18: 29-44.

Quinn, T. P. and C. J. Foote. 1994. The effect of body size and sexual dimorphisms on the reproductive behavior of sockeye salmon, Oncorhynchus nerka. Anim. Behav. 48: 751-761.

Raleigh, R. F. 1967. Genetic control in the lakeward migrations of sockeye salmon (Oncorhynchus nerka) fry. J. Fish. Res. Board Can. 24: 2613-2622.

Raleigh, R. F. 1971. Innate control of migrations of salmon and trout fry from natal gravels to rearing areas. Ecology 52: 291-297.

RASP. 1992. Supplementation in the Columbia Basin: summary report series. Final Report, Project No. 85-62, Bonneville Power Administration, PortlandOR.

Reeves, G. H., J. D. Hall, T. D. Roelofs, T. L. Hickman, and C. O. Baker. 1991. Rehabilitating and Modifying Stream Habitats. Pages 519-557 in W. R. Meehan, editor. Influences of forest and rangeland management on salmonid fishes and their habitats, American Fisheries Society Special Publication 19. American Fisheries Society, Bethesda, Maryland.

Reimchen, T.E. 1994. Further studies of predator and scavenger use of chum salmon in stream and estuarine habitats at Bag Harbour, Gwaii Haanas. Technical report prepared for Canadian Parks Service. Queen Charlotte City, British Columbia, Canada.

Reimers, N. 1963. Body condition, water temperature, and over-winter survival of hatchery-reared trout in Convict Creek, California. Transactions of the American Fisheries Society 92: 39-46.

Reisenbichler, R. R. 1997. Genetic factors contributing to declines of anadromous salmonids in the Pacific Northwest. Pages 223-244 in Pacific salmon and their ecosystems. Chapman Hall, Inc..

Reisenbichler, R. R. and S. P. Rubin. 1999. Genetic changes from artificial propagation of Pacific salmon affect the productivity and viability of supplemented populations. ICES Journal ofMarine Science 56: 459-466.

Rhodes, J. S. and T. P. Quinn. 1998. Factors affecting the outcome of territorial contests between hatchery and naturally reared coho salmon parr in the laboratory. J. Fish. Biol. 53: 1220-1230.

Ricker, W. E. 1972. Hereditary and environmental factors affecting certain salmonid populations. Pages 19-160 in R. C. Simon and P. A. Larkin, editors. The stock concept in Pacific salmon. H.R. MacMillan Lectures in Fisheries, Institute of Animal Resource Ecology, University of British Columbia.

Riddell, B. E. and D. P. Swain. 1991. Competition between hatchery and wild coho salmon (Oncorhynchus kisutch): genetic variation for agonistic behavior in newly emerged wild fry.

Aquaculture 98: 161-172.Rieman, B. E., R. C. Beamesderfer, S. Vigg, and T. P. Poe. 1991. Estimated loss of juvenile salmonids to predation by northern squawfish, walleyes, and smallmouth bass in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120: 448-458.

Rose, A. S., A. E. Ellis, and A. L. S. Munro. 1989. The infectivity by different routes of exposure and shedding rates of Aeromonas salmonicida subsp. salmonicida in Atlantic salmon, Salmo salar L., held in sea water. J. Fish. Dis. 12: 573-578.

Ruggerone, G. T. and D. E. Rogers. 1984. Arctic char predation an sockeye salmon smolts at Little Togiak River, Alaska. Fish. Bull. 82: 401-410.

Ryman, N. and L. Laikre. 1991. Effects of supportive breeding on the genetically effective population size. Conservation Biology 5: 325-3329.

Ryman, N., Jorde, P. E., and Laikre, L. 1995. Supportive breeding and variance effective population size. Conservation Biology 9: 1619-1628.

Sakamoto, T. and T. Hirano. 1993. Expression of insulin-like growth factor I gene in osmoregulatory organs during seawater adaptation of the salmonid fish: Possible mode of osmoregulatory action of growth hormone . Proc. Natl. Acad. Sci. USA 90: 1912-1916.

Salo, E. O. and W. H. Bayliff. 1958. Artificial and natural production of silver salmon, Oncorhynchus kisutch, at Minter Creek, Washington. Wash. Dep. Fish. Res. Bull. 4.

Sandercock, F. K. 1991. Life history of coho salmon (Oncorhynchus kisutch) . Pages 397-445 in C. Groot and L. Margolis, editors. Pacific salmon life histories. University of British ColumbiaPress, Vancouver, B. C., Canada.

Schiewe, M. H., Flagg, T. A., and Berejikian, B. A. 1997. The use of captive broodstocks for gene conservation of salmon in the western United States. Bull. Natl. Res. Inst. Aquacult. Suppl. 3:29-34.

Schreck, C. B. 1996. Immunomodulation: endogenous factors. Pages 311-337 in G. Iwama and T.Nakanishi, editors. The fish immune system: organism, pathogen, and environment. Academic Press, San Diego.

Schroder, S. L. 1981. The role of sexual selection in determining the overall mating patterns and matechoice in chum salmon. Ph.D. dissertation, University of Washington, Seattle, 241 p.

Schroder, S. L. 1982. The influence of intrasexual competition on the distribution of chum salmon in an experimental stream. Pages 275-285 in E. L. Brannon and E. O. Salo, editors. Salmon and trout migratory behavior. University of Washington Press, Seattle.

Seeb, L. W., J. E. Seeb, R. L. Allen, and W. K. Hershberger. 1990. Evaluation of adult returns of genetically marked chum salmon, with suggested future applications. Pages 418-425 in N. C. Parker and others, editors. Fish-marking techniques, American Fisheries Society Symposium7.

Shepherd, B. G. 1991. On choosing well: bioengineering reconnaissance of new hatchery sites. In J.Colt and R. White, Editors. Fisheries Bioengineering Symposium. American Fisheries Society Symposium 10:354-364.

Sheridan, W. L. 1962. Relation of stream temperatures to timing of pink salmon escapements insoutheast Alaska. Pages 87-102 in N. J. Wilimovsky, editor. Symposium on Pink Salmon. H.R. Mac Millan Lectures in Fisheries. Institute of Fisheries, University of British Columbia ,Vancouver, BC.

Shively, R. S., T. P. Poe, and S. T. Sauter. 1996. Feeding response by northern squawfish to a hatchery release of juvenile salmonids in the Clearwater River, Idaho. Transactions of the American Fisheries Society 125: 230-236.

Siitonen, L. and G. A. E. Gall. 1989. Response to selection for early spawn date in rainbow trout Salmo gairdneri. Aquaculture 78: 153-161.

Silverstein, J. T. and W. K. Hershberger. 1992. Precocious maturation in coho salmon (Oncorhynchuskisutch): Estimation of heritability. Proceedings, 1992 Meeting of the Aquaculture Association of Canada, 1-3 June, 1992, University of British Columbia, Vancouver, BC. Bull. Aquacult. Assoc. Can. 92: 34-36.

Silverstein, J.T., K.D. Shearer, W.W. Dickhoff and E.M. Plisetskaya. 1998. The effects of growth and fatness on sexual development of chinook salmon (Oncorhynchus tshawytscha) parr. Can. J.Fish. Aquat. Sci. 55:2376-2382.

Simberloff, D. 1988. The contribution of population and community biology to conservation science. Annual Review of Ecology and Systematics 19: 473-511.

Simon, R. C., J. D. McIntyre, and A. R. Hemmingsen. 1986. Family size and effective population size in a hatchery stock of coho salmon (Oncorhynchus kisutch). Can. J. Fish. Aquat. Sci 43: 2434-2443.

Smoker, W. W., A. J. Gharrett, and M. S. Stekoll. 1998. Genetic variation of return date in apopulation of pink salmon: a consequence of fluctuating environment and dispersive selection? Alaska Fishery Research Bulletin 5: 46-54.

Smoker, W. W., A. J. Gharrett, M. S. Stekoll, and J. E. Joyce. 1994. Genetic analysis of size in an anadromous population of pink salmon. Canadian Journal of Fisheries and Aquatic Sciences51 (Suppl. 1): 9-15.

Smoker, W. W., and F. P. Thrower. 1995. Homing propensity in transplanted and native chum salmon. Pages 575-576 in H. L. Schramm, Jr. and R. G. Piper, editors. Effects and Uses of Cultured Fishes in Aquatic Ecosystems. Special Symposium. American Fisheries Society Symposium15.

Soule, M. E. 1980. Thresholds for survival: Maintaining fitness and evolutionary potential. Pages 151-169 in M. E. Soule and B. A. Wilcox, editors. Conservation biology: An evolutionary ecological perspective. Sinauer Assoc., Sunderland, MA.

Stalnaker, C.B., B.L. Lamb, J. Henriksen, K. Bovee, and J. Bartholow. 1995. The instream flow incremental methodology: a primer for IFIM. Biological Report 29. U.S. Department of theInterior, U.S. Geological Survey. Fort Collins, Colorado.

Stockner, J. G. and K. R. S. Shortreed. 1978. Enhancement of autotrophic production by nutrient addition in a coastal rainforest stream on Vancouver Island. J. Fish. Res. Board Can. 35: 28-34.

Su, G.-S., L.-E. Liljedahl, and G. A. E. Gall. 1996. Genetic and environmental variation of bodyweight in rainbow trout (Oncorhynchus mykiss). Aquaculture 144: 71-80.

Su, G.-S., L.-E. Liljedahl, and G. A. E. Gall. 1997. Genetic and environmental variation of female reproductive traits in rainbow trout (Oncorhynchus mykiss) . Aquaculture 154: 113-122.

Su, G.-S., L.-E. Liljedahl, and G. A. E. Gall. 1999. Estimates of phenotypic and genetic parameters forwithin-season, date and age at spawning of female rainbow trout. Aquaculture 171: 209-220.

Swain, D. P. and B. E. Riddell. 1990. Variation in agonistic behavior between newly emerged juveniles from hatchery and wild populations of coho salmon, Oncorhynchus kisutch. Can. J.Fish. Aquat. Sci. 47: 565-571.

Swain, D. P., B. E. Riddell, and C. B. Murray. 1991. Morphological differences between hatchery and wild populations of coho salmon (Oncorhynchus kisutch): environmental versus genetic origin. Can. J. Fish. Aquat. Sci. 48: 1783-1791.

Symons, P. E. K. 1968. Increase in aggression and in strength of the social hierarchy among juvenile Atlantic salmon deprived of food. J. Fish. Res. Board Can. 25: 2387-2401.

Tallman, R. F. and M. C. Healey. 1994. Homing, straying, and gene flow among seasonally separated populations of chum salmon (Oncorhynchus keta). Can. J. Fish. Aquat. Sci. 51: 577-588.

Taylor, E. B. 1991. A review of local adaptation in Salmonidae with particular reference to Pacific and Atlantic salmon. Aquaculture 98: 185-207.

Taylor, E. B., and J. D. McPhail. 1985. Variation in burst and prolonged swimming performance among British Columbia populations of coho salmon, Oncorhynchus kisutch. Can. J.

Fish.Aquat. Sci. 42:2029-2033.

Taylor, E.B. and J.D. McPhail. 1985. Variation in burst and prolonged swimming performance among British Columbia populations of coho salmon, Oncorhynchus-kisutch. Canadian Journal Of Fisheries And Aquatic Sciences. 42 (12): 2029-2033.

Taylor, E.B., and P.A. Larken. 1986. Current response and agonistic behavior in newly emerged fry of chinook salmon, Oncorhynchus-tshawytscha, from ocean-type and stream-type populations. Canadian Journal Of Fisheries And Aquatic Sciences. 43 (3): 565-573.

Templeton, A. 1986. Coadaptation and outbreeding depression. Pages 105-116 in M. E. Soule, editor. Conservation Biology: The Science of Scarcity and Diversity. Sinauer, Sunderland, MA.

Tipping, J. M. 1997. Effect of smolt length at release on adult returns of hatchery-reared winter steelhead. Progressive Fish-Culturist 59: 310-311.

Tipping, J. M. and H. L. Blankenship. 1993. Effect of condition factor at release on smolt-to-adult survival of hatchery sea-run cutthroat trout. Progressive Fish-Culturist 55: 184-186.

Uchida, K., K. Tsukamotot, S. Ishii, R. Ishida, and T. Kajihara. 1989. Larval competition for food between wild and hatchery-reared ayu (Plecoglossus altivelis) in culture ponds. Journal of Fish Biology 34:399-407.

USFWS. 1992. Biological assessment of proposed 1992 LSRCP steelhead and rainbow trout releases. USFWS, 4696 Overland Rd, Boise ID 83702.

Vander Haegen, G., and D. Doty. 1995. Homing of coho and fall chinook salmon in Washington. Washington Department of Fish and Wildlife #H95-08. Olympia.

Varnavsky, V.S., T. Sakamoto, And T. Hirano. 1992. Stunting of wild coho salmon (Oncorhynchus kisutch) in seawater - patterns of plasma thyroid-hormones, cortisol, and growth-hormone. Canadian Journal Of Fisheries And Aquatic Sciences. 49 (3): 458-461.

Vincent, R. E. 1960. Some influences of domestication upon three stocks of brook trout (Salvelinus fontinalis Mitchill). Transactions of the American Fisheries Society 89: 35-52.

Wade, M. 1986. The relative effects of Ceratomyxa shasta on crosses of resistant and susceptible stocks of summer steelhead. M.S. Thesis, Oregon State University, Corvallis, Oregon.

Wagner, H.H., F.P. Conte, and J.L. Fessler. 1969. Development of osmotic and ionic regulation in two races of chinook salmon Oncorhynchus tshawytscha. Comparitive Biochemistry and Physiology 29: 325-341.

Wahl, D. H., R. A. Stein, and D. R. DeVries. 1995. An ecological framework for evaluating the success and effects of stocked fishes. Pages 176-189 in H. L. Schramm, Jr. and R. G. Piper, editors. Uses and effects of cultured fishes in aquatic ecosystems. American Fisheries Society Symposium 15.

Waples, R. S. 1989. A generalized approach for estimating effective population size from temporal changes in allele frequency. Genetics 121: 379-391.

Waples, R. S. 1990a. Conservation genetics of Pacific salmon II. Effective population size and the rateof loss of genetic variability. J. Hered. 81: 267-276.

Waples, R. S. 1990b. Conservation genetics of Pacific salmon .III. Estimating effective population size. J. Hered. 81: 277-289.

Waples, R. S. and D. J. Teel. 1990. Conservation genetics of Pacific salmon I. Temporal changes in allele frequency. Cons. Biol. 4: 144-156.

Waples, R. S., R. P. Jones Jr., B. R. Beckman, and G. A. Swan. 1991. Status review for Snake Riverfall Chinook salmon. NOAA (National Oceanic and Atmospheric Administration) Technical memorandum NMFS (National Marine Fisheries Service) F/NWC-201, Northwest Fisheries Science Center, Seattle.

Waples. R. S. and C. Do. 1994. Genetic risk associated with supplementation of Pacific salmonids: captive broodstock programs. Canadian Journal of Fisheries and Aquatic Sciences 51: 310-329.

Warren, J. W. 1991. Diseases of hatchery fish. U.S. Fish and Wildlife Service Publication. 90p.

Washington Department of Ecology. 2002. A guide to instream flow setting in Washington state. Olympia

Washington Department of Fish and Wildlife. 1997. Fish Health Manual of the Washington Department of Fish and Wildlife.

Washington Department of Fish and Wildlife. 2000. Fish passage barrier and surface water diversion screening assessment and prioritization manual. Environmental restoration division, Habitat program, Washington Department of Fish and Wildlife. Olympia.

Washington Fish and Wildlife Commission. 1997a. Policy of Washington Department of Fish and Wildlife and Western Washington Treaty Tribes concerning wild salmonids. Olympia, WA. 46p.

Washington Fish and Wildlife Commission. 1997b. Additional policy guidance on deferred issues concerning wild samonid policy. Olympia, WA. 21p.

Wedemeyer, G. A. 1996. Physiology of fish in intensive culture systems. Chapman and Hall. New York.

Williams, R. N., J. A. Lichatowich, P. R. Mundy, and M. Powell. 2003. Integrating artificial production with salmonid life history, genetic, and ecosystem diversity: a landscape perspective. Issue Paper for Trout Unlimited, West Coast Conservation Office, Portland.

Willoughby, H., H.N. Larsen, and J.T. Bowen. 1972. The pollutional effect of fish hatcheries. American Fishes and US Trout News 17(3):6-7, 20-21.

Winfree, R.A., G.A. Kindschi, and H.T. Shaw. 1998. Elevated water temperature, crowding, and food deprivation accelerate fin erosion in juvenile steelhead. Prog. Fish. Cult. 60:192-199.

Winter, G. W., C. B. Schreck, and J. D. McIntyre. 1980. Resistance of different stocks and transferring genotypes of coho salmon, Oncorhynchus kisutch, and steelhead trout, Salmo gairdneri, to bacterial kidney disease and vibriosis. Fish. Bull 77: 795-802.

Wishard, L. N., J. E. Seeb, F. M. Utter, and D. Stefan. 1984. A genetic investigation of suspected redband trout populations. Copeia 1984(1): 120-132.

Withler, F. C. 1982. Transplanting Pacific salmon. Can. Tech. Rep. Fish. Aquat. Sci. 1079: 27.

Withler, R. 1997. Conclusions of panel. Pages 117-130 in W. S. Grant, editor. Genetic effects of straying of non-native hatchery fish into natural populations: Proceedings of the workshop. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-NWFSDC-30, 130 p.

Withler, R. E. 1988. Genetic consequences of fertilizing Chinook salmon (Oncorhynchus tshawytscha) eggs with pooled milt. Aquaculture 68: 15-25.

Withler, R. E. and T. D. Beacham. 1994. Genetic consequences of the simultaneous or sequential addition of semen from multiple males during hatchery spawning of Chinook salmon(Oncorhynchus tshawytscha). Aquaculture 126: 11-23.

Wolf, L.E. 1938. Effect of amount of food on fin condition of fingerling trout. Prog. Fish. Cult. 39:16-

18.

Wright, A. 1936. A report of four years experience with fin rot and some remarks on octomitiasis.Prog. Fish. Cult. 24:1-26.

Zhang, Y. and J. L. Congleton. 1994. Detection of infectious hematopoietic necrosis (IHN) virus in rearing units for steelhead before and during IHN epizootics. J. Aquat. Anim. Health 6: 281-287.

Appendix Table 1.3 Weights assigned to hatchery BMPs for Integrated Harvest Programs. BMPs listed in descending order of importance

Integrated Harvest

#	BMP Question	Target Population			Other Populations			Environmental Factors	Monitoring & Effectiveness	Sum of Weights
		Harvest	Diversity & Spatial Struct.	Abundance & Productivity	Abundance & Productivity	Diversity & Spatial Struct.	Harvest Interactions			
69	Has the carrying capacity of the subbasin been taken into consideration in sizing this program in regards to determining the number of fish released?	10	0	10	10	10	10	0	0	50
3	Does the broodstock chosen display morphological and life history traits similar to the natural population?	8	10	8	8	8	0	0	0	42
1	Does the broodstock chosen represent natural populations native or adapted to the watersheds in which hatchery fish will be released?	8	10	8	5	10	0	0	0	41
2	If population has been extirpated, is the broodstock chosen likely to adapt to the system based on life history and evolutionary history?	8	10	8	5	10	0	0	0	41
67	Are fish released in stream reaches within the historic range of that population?	8	10	8	10	0	0	0	0	36
70	Are 100% of the hatchery fish marked so that they can be distinguished from the natural populations?	8	0	8	3	3	3	0	10	35
48	Is the correct amount and type of food provided to achieve the desired growth rate?	8	8	8	10	0	0	0	0	34
49	Is the correct amount and type of food provided to achieve the desired condition factors for the species and life stage being reared?	8	8	8	10	0	0	0	0	34
50	Does the program use a diet and growth regime that mimics natural seasonal growth patterns? If not, describe the differences in the comment field?	8	8	8	10	0	0	0	0	34
62	Are the fish produced qualitatively similar to natural fish in growth rate?	8	8	8	10	0	0	0	0	34
63	Are the fish produced qualitatively similar to natural fish in physiological status?	8	8	8	10	0	0	0	0	34

Integrated Harvest

#	BMP Question	Target Population: Harvest	Target Population: Diversity & Spatial Struct.	Target Population: Abundance & Productivity	Other Populations: Abundance & Productivity	Other Populations: Diversity & Spatial Struct.	Other Populations: Harvest Interactions	Environmental Factors	Monitoring & Effectiveness	Sum of Weights
64	Are fish released at sizes and life history stages similar to those of natural fish of the same species?	8	8	8	10	0	0	0	0	34
65	Are volitional releases during natural out-migration timing practiced?	8	8	8	10	0	0	0	0	34
66	Are fish released in a manner that simulates natural seasonal migratory patterns?	8	8	8	10	0	0	0	0	34
11	Are adult returns recycled to lower to provide additional harvest opportunities?	8	0	8	5	5	0	0	0	26
12	Are representative samples of natural and hatchery population components collected with respect to size, age, sex ratio, run and spawn timing, and other traits important to long-term fitness? (For integrated populations, consider both natural and hatchery components; for segregated populations, you should only consider the hatchery component.)	0	10	5	5	5	0	0	0	25
42	Does the water used [for rearing] provide natural water temperature profiles that result in fish similar in size to naturally produced fish of the same species?	5	5	5	10	0	0	0	0	25
59	Are the fish produced qualitatively similar to natural fish in size (fpp and length)?	5	5	5	10	0	0	0	0	25
61	Are the fish produced qualitatively similar to natural fish in behavior?	5	5	5	5	0	0	0	0	20
74	Is the facility sited so as to minimize the risk of catastrophic fish loss from flooding?	8	0	8	0	0	0	0	0	16
23	Are males and females available for spawning on a given day randomly mated?	0	10	5	0	0	0	0	0	15
24	Are gametes pooled prior to fertilization?	0	10	5	0	0	0	0	0	15

Integrated Harvest

#	BMP Question	Target Population: Harvest	Target Population: Diversity & Spatial Struct.	Target Population: Abundance & Productivity	Other Populations: Abundance & Productivity	Other Populations: Diversity & Spatial Struct.	Other Populations: Harvest Interactions	Environmental Factors	Monitoring & Effectiveness	Sum of Weights
33	Are eggs incubated under conditions that result in equal survival of all segments of the population to ponding? (Does any portion of the eggs derive a survival advantage or disadvantage from incubation procedures? If yes, then mark NO for response)	0	10	5	0	0	0	0	0	15
40	If eggs are culled, is culling done randomly over all segments of the egg-take?	0	10	5	0	0	0	0	0	15
46	Are fish reared under conditions that result in equal survival of all segments of the population to release? (In other words, does any portion of the population derive a survival advantage or disadvantage from rearing procedures? If yes, then mark NO in box.)	0	10	5	0	0	0	0	0	15
47	If juveniles are culled, is culling done randomly over all segments of the population? (respond yes if juveniles are not culled). Make sure to capture in the comments box the number culled, and the rational for culling.	0	10	5	0	0	0	0	0	15
68	Are fish released in the same subbasin as rearing facility? This question is trying to determine if fish (juveniles) are transported into the subbasin.	5	0	5	5	0	0	0	0	15
39	Are disinfection procedures implemented during incubation that prevent pathogen transmission between populations of fish on site? (Do you have written protocols? If so, describe in the data comment box.)	4	0	4	4	0	0	0	0	12
14	Are sufficient broodstock collected to maintain an effective population size of 1000 fish per generation? (More than 500 successful spawners of each sex.)	0	8	3	0	0	0	0	0	11
10	Is the percent natural origin fish used as broodstock for this program estimated?	0	0	0	0	0	0	0	10	10

Integrated Harvest											
#	BMP Question	Target Population			Other Populations			Environmental Factors	Monitoring & Effectiveness	Sum of Weights
		Harvest	Diversity & Spatial Struct.	Abundance & Productivity	Abundance & Productivity	Diversity & Spatial Struct.	Harvest Interactions			
17	Do you have guidelines for acceptable contribution of hatchery origin fish to natural spawning?	0	0	0	0	0	0	0	10	10
18	Are guidelines for hatchery contribution to natural spawning met for all affected naturally spawning populations?	0	0	0	0	0	0	0	10	10
21	Is the water supply [for adult holding] protected by alarms?	5	0	5	0	0	0	0	0	10
22	Is the water supply [for adult holding] protected by back-up power generation?	5	0	5	0	0	0	0	0	10
31	Is the water supply [for incubation] protected by flow alarms?	5	0	5	0	0	0	0	0	10
32	Is the water supply [for incubation] protected by back-up power generation?	5	0	5	0	0	0	0	0	10
36	Are agency, tribal, or IHOT species-specific incubation recommendations followed for flows?	5	0	5	0	0	0	0	0	10
37	Are agency, tribal, or IHOT species-specific incubation recommendations followed for substrate?	5	0	5	0	0	0	0	0	10
38	Are agency, tribal, or IHOT species-specific incubation recommendations followed for density parameters?	5	0	5	0	0	0	0	0	10
43	Does the hatchery operate to allow all migrating species of all ages to by-pass or pass through hatchery related structures?	0	0	0	0	0	0	10	0	10
44	Is the water supply [for rearing] protected by alarms?	5	0	5	0	0	0	0	0	10
45	Is the water supply [for rearing] protected by back-up power generation?	5	0	5	0	0	0	0	0	10
53	Are agency, tribal, or IHOT juvenile rearing standards followed for loading?	5	0	5	0	0	0	0	0	10
54	Are agency, tribal, or IHOT juvenile rearing standards followed for density?	5	0	5	0	0	0	0	0	10
75	Is staff notified of emergency situations at the facility through the use of alarms, autodialer, and pagers?	5	0	5	0	0	0	0	0	10

#	BMP Question	Target Population: Harvest	Target Population: Diversity & Spatial Struct.	Target Population: Abundance & Productivity	Other Populations: Abundance & Productivity	Other Populations: Diversity & Spatial Struct.	Other Populations: Harvest Interactions	Environmental Factors	Monitoring & Effectiveness	Sum of Weights
77	Do you have a numerical goal for total catch in all fisheries?	0	0	0	0	0	0	0	10	10
78	Do you have a goal for broodstock composition (hatchery vs. natural) in the hatchery?	0	0	0	0	0	0	0	10	10
79	Do you have a goal for spawning escapement composition (hatchery vs. natural) in the wild?	0	0	0	0	0	0	0	10	10
80	Do you have a goal for smolt-to-adult return survival?	0	0	0	0	0	0	0	10	10
85	Is the percent hatchery origin fish (first generation) spawning in the wild estimated?	0	0	0	0	0	0	0	10	10
86	Are standards specified for in-culture performance of hatchery fish?	0	0	0	0	0	0	0	10	10
87	Are in-culture performance standards met?	0	0	0	0	0	0	0	10	10
88	Are standards specified for post release performance of hatchery fish and their offspring?	0	0	0	0	0	0	0	10	10
89	Are post-release performance standards met?	0	0	0	0	0	0	0	10	10
90	Are hatchery programming and operational decisions based on an Adaptive Management Plan? (For example, is an annual report produced describing hatchery operations, results of studies, program changes etc? If a written plan does not exist then the answer is No.)	0	0	0	0	0	0	0	10	10
51	Is the program attempting to better mimic the natural stream environment by providing natural or artificial cover?	2	0	2	5	0	0	0	0	9
16	Is the broodstock collected and held in a manner that results in less than 10% prespawning mortality?	4	0	4	0	0	0	0	0	8

Integrated Harvest

Integrated Harvest

#	BMP Question	Target Population			Other Populations			Environmental Factors	Monitoring & Effectiveness	Sum of Weights
		Harvest	Diversity & Spatial Struct.	Abundance & Productivity	Abundance & Productivity	Diversity & Spatial Struct.	Harvest Interactions			
71	Does hatchery intake screening comply with Integrated Hatchery Operations Team (IHOT), National Marine Fisheries Service, or other agency facility standards?	0	0	0	0	0	0	8	0	8
26	Are precocious males (mini-jacks and jacks) used for spawning as a set percentage or in proportion to their contribution to the adult run? (note whether mini-jacks are used in the comment box.)	0	7	0	0	0	0	0	0	7
19	Is the water source [for adult holding] specific-pathogen free?	3	0	3	0	0	0	0	0	6
20	Does the water used [for adult holding] result in natural water temperature profiles that provide optimum maturation and gamete development?	0	3	3	0	0	0	0	0	6
28	Is the water source [for incubation] specific-pathogen free?	3	0	3	0	0	0	0	0	6
29	Does the water used [for incubation] provide natural water temperature profiles that result in hatching/emergence timing similar to that of the naturally produced population?	0	3	3	0	0	0	0	0	6
41	Is the water source [for rearing] specific-pathogen free?	3	0	3	0	0	0	0	0	6
76	Is the facility continuously staffed to ensure the security of fish populations on-site?	3	0	3	0	0	0	0	0	6
4	Does the broodstock chosen have a pathogen history that indicates no threat to other populations in the watershed?	0	0	0	5	0	0	0	0	5
60	Are the fish produced qualitatively similar to natural fish in morphology?	0	2	3	0	0	0	0	0	5
72	Does the facility operate within the limitations established in its National Pollution Discharge Elimination System (NPDES) permit?	0	0	0	0	0	0	5	0	5
73	If the production from this facility falls below the minimum production requirement for an NPDES permit, does the facility operate in compliance with state or federal regulations for discharge?	0	0	0	0	0	0	5	0	5

Integrated Harvest

#	BMP Question	Target Population			Other Populations			Environmental Factors	Monitoring & Effectiveness	Sum of Weights
		Harvest	Diversity & Spatial Struct.	Abundance & Productivity	Abundance & Productivity	Diversity & Spatial Struct.	Harvest Interactions			
15	Does the program avoid population transfers and subsequent releases of eggs or fish from outside the watershed?	0	1	1	1	1	0	0	0	4
25	Are back-up males used in the spawning protocol?	0	4	0	0	0	0	0	0	4
5	Does the broodstock chosen have the desired life history traits to meet harvest goals? (e.g. timing and migration patterns that result in full recruitment to target fisheries)?	0	0	0	0	0	0	0	0	0
6	What is the percent natural origin fish in the hatchery broodstock?	0	0	0	0	0	0	0	0	0
7	Do natural origin fish make up less than 5% of the broodstock for this program?	0	0	0	0	0	0	0	0	0
13	Does the proportion of the spawners brought into the hatchery follow a “spread-the-risk” strategy that attempts to improve the probability of survival for the entire population (hatchery and natural components)?	0	0	0	0	0	0	0	0	0
27	Is the water source [for incubation] pathogen-free?	0	0	0	0	0	0	0	0	0
30	Can incubation water [for incubation] be heated or chilled to approximate natural water temperature profiles?	0	0	0	0	0	0	0	0	0
34	Are families incubated individually? (Includes both eying and hatching.)	0	0	0	0	0	0	0	0	0
52	Are fish reared in multiple facilities or with redundant systems to reduce the risk of catastrophic loss?	0	0	0	0	0	0	0	0	0
55	For captive broodstocks, are fish maintained on natural photoperiod to ensure normal maturation?	0	0	0	0	0	0	0	0	0
56	For captive broodstocks, are fish maintained reared at 12C to minimize disease?	0	0	0	0	0	0	0	0	0

Integrated Harvest

#	BMP Question	Target Population: Harvest	Target Population: Diversity & Spatial Struct.	Target Population: Abundance & Productivity	Other Populations: Abundance & Productivity	Other Populations: Diversity & Spatial Struct.	Other Populations: Harvest Interactions	Environmental Factors	Monitoring & Effectiveness	Sum of Weights
57	For captive broodstocks, are diets and growth regimes selected that produce potent, fertile gametes and reduce excessive early maturation of fish?	0	0	0	0	0	0	0	0	0
58	For captive broodstocks, are families reared individually to maintain pedigrees?	0	0	0	0	0	0	0	0	0
81	What is the percent hatchery origin fish (first generation) in the natural spawning escapement (for the same species/race)?	0	0	0	0	0	0	0	0	0
82	Do adults from this program make up less than 5% of the natural spawning escapement (for the species/race) in the subbasin?	0	0	0	0	0	0	0	0	0
83	Do adults from this program make up between 5 and 30% of the natural spawning escapement (for the species/race) in the subbasin.	0	0	0	0	0	0	0	0	0
84	Do adults from this program make up more than 30% of the natural spawning escapement (for the species/race) in the subbasin.	0	0	0	0	0	0	0	0	0

Appendix Table 1.4 Weights assigned to hatchery BMPs for Integrated Conservation Programs. BMPs listed in descending order of importance

Integrated Conservation

#	BMP Question	Target Population			Other Populations			Environmental Factors	Monitoring and Effectiveness	Sum of Weights
		Harvest	Diversity & Spatial Struct.	Abundance & Productivity	Abundance & Productivity	Diversity & Spatial Struct.	Harvest Interactions			
15	Does the program avoid population transfers and subsequent releases of eggs or fish from outside the watershed?	0	7	7	7	7	0	0	0	28
3	Does the broodstock chosen display morphological and life history traits similar to the natural population?	0	10	8	4	4	0	0	0	26
1	Does the broodstock chosen represent natural populations native or adapted to the watersheds in which hatchery fish will be released?	0	10	8	2	5	0	0	0	25
2	If population has been extirpated, is the broodstock chosen likely to adapt to the system based on life history and evolutionary history?	0	10	8	2	5	0	0	0	25
67	Are fish released in stream reaches within the historic range of that population?	0	10	8	5	0	0	0	0	23
12	Are representative samples of natural and hatchery population components collected with respect to size, age, sex ratio, run and spawn timing, and other traits important to long-term fitness? (For integrated populations, consider both natural and hatchery components; for segregated populations, you should only consider the hatchery component.)	0	10	5	3	3	0	0	0	21
48	Is the correct amount and type of food provided to achieve the desired growth rate?	0	8	8	5	0	0	0	0	21
49	Is the correct amount and type of food provided to achieve the desired condition factors for the species and life stage being reared?	0	8	8	5	0	0	0	0	21
50	Does the program use a diet and growth regime that mimics natural seasonal growth patterns? If not, describe the differences in the comment field?	0	8	8	5	0	0	0	0	21
62	Are the fish produced qualitatively similar to natural fish in growth rate?	0	8	8	5	0	0	0	0	21

Integrated Conservation

#	BMP Question	Target Population: Harvest	Target Population: Diversity & Spatial Struct.	Target Population: Abundance & Productivity	Other Populations: Abundance & Productivity	Other Populations: Diversity & Spatial Struct.	Other Populations: Harvest Interactions	Environmental Factors	Monitoring and Effectiveness	Sum of Weights
63	Are the fish produced qualitatively similar to natural fish in physiological status?	0	8	8	5	0	0	0	0	21
13	Does the proportion of the spawners brought into the hatchery follow a "spread-the-risk" strategy that attempts to improve the probability of survival for the entire population (hatchery and natural components)?	0	10	10	0	0	0	0	0	20
25	Are back-up males used in the spawning protocol?	0	10	10	0	0	0	0	0	20
52	Are fish reared in multiple facilities or with redundant systems to reduce the risk of catastrophic loss?	0	10	10	0	0	0	0	0	20
69	Has the carrying capacity of the subbasin been taken into consideration in sizing this program in regards to determining the number of fish released?	0	0	10	5	5	0	0	0	20
70	Are 100% of the hatchery fish marked so that they can be distinguished from the natural populations?	0	0	8	1	1	0	0	10	20
64	Are fish released at sizes and life history stages similar to those of natural fish of the same species?	0	8	5	5	0	0	0	0	18
65	Are volitional releases during natural out-migration timing practiced?	0	8	5	5	0	0	0	0	18
66	Are fish released in a manner that simulates natural seasonal migratory patterns?	0	8	5	5	0	0	0	0	18
55	For captive broodstocks, are fish maintained on natural photoperiod to ensure normal maturation?	0	8	8	0	0	0	0	0	16
56	For captive broodstocks, are fish maintained reared at 12C to minimize disease?	0	8	8	0	0	0	0	0	16
57	For captive broodstocks, are diets and growth regimes selected that produce potent, fertile gametes and reduce excessive early maturation of fish?	0	8	8	0	0	0	0	0	16

Integrated Conservation

#	BMP Question	Target Population: Harvest	Target Population: Diversity & Spatial Struct.	Target Population: Abundance & Productivity	Other Populations: Abundance & Productivity	Other Populations: Diversity & Spatial Struct.	Other Populations: Harvest Interactions	Environmental Factors	Monitoring and Effectiveness	Sum of Weights
23	Are males and females available for spawning on a given day randomly mated?	0	10	5	0	0	0	0	0	15
24	Are gametes pooled prior to fertilization?	0	10	5	0	0	0	0	0	15
33	Are eggs incubated under conditions that result in equal survival of all segments of the population to ponding? (Does any portion of the eggs derive a survival advantage or disadvantage from incubation procedures? If yes, then mark NO for response)	0	10	5	0	0	0	0	0	15
34	Are families incubated individually? (Includes both eying and hatching.)	0	10	5	0	0	0	0	0	15
40	If eggs are culled, is culling done randomly over all segments of the egg-take?	0	10	5	0	0	0	0	0	15
42	Does the water used [for rearing] provide natural water temperature profiles that result in fish similar in size to naturally produced fish of the same species?	0	5	5	5	0	0	0	0	15
46	Are fish reared under conditions that result in equal survival of all segments of the population to release? (In other words, does any portion of the population derive a survival advantage or disadvantage from rearing procedures? If yes, then mark NO in box.)	0	10	5	0	0	0	0	0	15
47	If juveniles are culled, is culling done randomly over all segments of the population? (respond yes if juveniles are not culled). Make sure to capture in the comments box the number culled, and the rational for culling.	0	10	5	0	0	0	0	0	15
59	Are the fish produced qualitatively similar to natural fish in size (fpp and length)?	0	5	3	5	0	0	0	0	13
61	Are the fish produced qualitatively similar to natural fish in behavior?	0	5	5	2	0	0	0	0	12

Integrated Conservation

#	BMP Question	Target Population: Harvest	Target Population: Diversity & Spatial Struct.	Target Population: Abundance & Productivity	Other Populations: Abundance & Productivity	Other Populations: Diversity & Spatial Struct.	Other Populations: Harvest Interactions	Environmental Factors	Monitoring and Effectiveness	Sum of Weights
14	Are sufficient broodstock collected to maintain an effective population size of 1000 fish per generation? (More than 500 successful spawners of each sex.)	0	8	3	0	0	0	0	0	11
10	Is the percent natural origin fish used as broodstock for this program estimated?	0	0	0	0	0	0	0	10	10
17	Do you have guidelines for acceptable contribution of hatchery origin fish to natural spawning?	0	0	0	0	0	0	0	10	10
18	Are guidelines for hatchery contribution to natural spawning met for all affected naturally spawning populations?	0	0	0	0	0	0	0	10	10
21	Is the water supply [for adult holding] protected by alarms?	0	0	10	0	0	0	0	0	10
22	Is the water supply [for adult holding] protected by back-up power generation?	0	0	10	0	0	0	0	0	10
26	Are precocious males (mini-jacks and jacks) used for spawning as a set percentage or in proportion to their contribution to the adult run? (note whether mini-jacks are used in the comment box.)	0	10	0	0	0	0	0	0	10
28	Is the water source [for incubation] specific-pathogen free?	0	0	10	0	0	0	0	0	10
31	Is the water supply [for incubation] protected by flow alarms?	0	0	10	0	0	0	0	0	10
32	Is the water supply [for incubation] protected by back-up power generation?	0	0	10	0	0	0	0	0	10
36	Are agency, tribal, or IHOT species-specific incubation recommendations followed for flows?	0	0	10	0	0	0	0	0	10
37	Are agency, tribal, or IHOT species-specific incubation recommendations followed for substrate?	0	0	10	0	0	0	0	0	10
38	Are agency, tribal, or IHOT species-specific incubation recommendations followed for density parameters?	0	0	10	0	0	0	0	0	10

Integrated Conservation

#	BMP Question	Target Population: Harvest	Target Population: Diversity & Spatial Struct.	Target Population: Abundance & Productivity	Other Populations: Abundance & Productivity	Other Populations: Diversity & Spatial Struct.	Other Populations: Harvest Interactions	Environmental Factors	Monitoring and Effectiveness	Sum of Weights
39	Are disinfection procedures implemented during incubation that prevent pathogen transmission between populations of fish on site? (Do you have written protocols? If so, describe in the data comment box.)	0	0	10	0	0	0	0	0	10
41	Is the water source [for rearing] specific-pathogen free?	0	0	10	0	0	0	0	0	10
44	Is the water supply [for rearing] protected by alarms?	0	0	10	0	0	0	0	0	10
45	Is the water supply [for rearing] protected by back-up power generation?	0	0	10	0	0	0	0	0	10
53	Are agency, tribal, or IHOT juvenile rearing standards followed for loading?	0	0	10	0	0	0	0	0	10
54	Are agency, tribal, or IHOT juvenile rearing standards followed for density?	0	0	10	0	0	0	0	0	10
68	Are fish released in the same subbasin as rearing facility? This question is trying to determine if fish (juveniles) are transported into the subbasin.	0	0	5	5	0	0	0	0	10
74	Is the facility sited so as to minimize the risk of catastrophic fish loss from flooding?	0	0	10	0	0	0	0	0	10
75	Is staff notified of emergency situations at the facility through the use of alarms, autodialer, and pagers?	0	0	10	0	0	0	0	0	10
76	Is the facility continuously staffed to ensure the security of fish populations on-site?	0	0	10	0	0	0	0	0	10
78	Do you have a goal for broodstock composition (hatchery vs. natural) in the hatchery?	0	0	0	0	0	0	0	10	10
79	Do you have a goal for spawning escapement composition (hatchery vs. natural) in the wild?	0	0	0	0	0	0	0	10	10
80	Do you have a goal for smolt-to-adult return survival?	0	0	0	0	0	0	0	10	10
85	Is the percent hatchery origin fish (first generation) spawning in the wild estimated?	0	0	0	0	0	0	0	10	10
86	Are standards specified for in-culture performance of hatchery fish?	0	0	0	0	0	0	0	10	10

Integrated Conservation

#	BMP Question	Target Population: Harvest	Target Population: Diversity & Spatial Struct.	Target Population: Abundance & Productivity	Other Populations: Abundance & Productivity	Other Populations: Diversity & Spatial Struct.	Other Populations: Harvest Interactions	Environmental Factors	Monitoring and Effectiveness	Sum of Weights
87	Are in-culture performance standards met?	0	0	0	0	0	0	0	10	10
88	Are standards specified for post release performance of hatchery fish and their offspring?	0	0	0	0	0	0	0	10	10
89	Are post-release performance standards met?	0	0	0	0	0	0	0	10	10
90	Are hatchery programming and operational decisions based on an Adaptive Management Plan? (For example, is an annual report produced describing hatchery operations, results of studies, program changes etc? If a written plan does not exist then the answer is No.)	0	0	0	0	0	0	0	10	10
16	Is the broodstock collected and held in a manner that results in less than 10% prespawning mortality?	0	0	8	0	0	0	0	0	8
19	Is the water source [for adult holding] specific-pathogen free?	0	0	8	0	0	0	0	0	8
27	Is the water source [for incubation] pathogen-free?	0	0	8	0	0	0	0	0	8
58	For captive broodstocks, are families reared individually to maintain pedigrees?	0	8	0	0	0	0	0	0	8
71	Does hatchery intake screening comply with Integrated Hatchery Operations Team (IHOT), National Marine Fisheries Service, or other agency facility standards?	0	0	0	0	0	0	8	0	8
51	Is the program attempting to better mimic the natural stream environment by providing natural or artificial cover?	0	2	5	0	0	0	0	0	7
20	Does the water used [for adult holding] result in natural water temperature profiles that provide optimum maturation and gamete development?	0	3	3	0	0	0	0	0	6
29	Does the water used [for incubation] provide natural water temperature profiles that result in hatching/emergence timing similar to that of the naturally produced population?	0	3	3	0	0	0	0	0	6

Integrated Conservation

#	BMP Question	Target Population: Harvest	Target Population: Diversity & Spatial Struct.	Target Population: Abundance & Productivity	Other Populations: Abundance & Productivity	Other Populations: Diversity & Spatial Struct.	Other Populations: Harvest Interactions	Environmental Factors	Monitoring and Effectiveness	Sum of Weights
30	Can incubation water [for incubation] be heated or chilled to approximate natural water temperature profiles?	0	3	3	0	0	0	0	0	6
4	Does the broodstock chosen have a pathogen history that indicates no threat to other populations in the watershed?	0	0	0	5	0	0	0	0	5
43	Does the hatchery operate to allow all migrating species of all ages to by-pass or pass through hatchery related structures?	0	0	0	0	0	0	5	0	5
60	Are the fish produced qualitatively similar to natural fish in morphology?	0	2	3	0	0	0	0	0	5
72	Does the facility operate within the limitations established in its National Pollution Discharge Elimination System (NPDES) permit?	0	0	0	0	0	0	5	0	5
73	If the production from this facility falls below the minimum production requirement for an NPDES permit, does the facility operate in compliance with state or federal regulations for discharge?	0	0	0	0	0	0	5	0	5
5	Does the broodstock chosen have the desired life history traits to meet harvest goals? (e.g. timing and migration patterns that result in full recruitment to target fisheries)?	0	0	0	0	0	0	0	0	0
6	What is the percent natural origin fish in the hatchery broodstock?	0	0	0	0	0	0	0	0	0
7	Do natural origin fish make up less than 5% of the broodstock for this program?	0	0	0	0	0	0	0	0	0
11	Are adult returns recycled to lower to provide additional harvest opportunities?	0	0	0	0	0	0	0	0	0
77	Do you have a numerical goal for total catch in all fisheries?	0	0	0	0	0	0	0	0	0
81	What is the percent hatchery origin fish (first generation) in the natural spawning escapement (for the same species/race)?	0	0	0	0	0	0	0	0	0

Integrated Conservation											
#	BMP Question	Target Population			Other Populations			Environmental Factors	Monitoring and Effectiveness	Sum of Weights
		Harvest	Diversity & Spatial Struct.	Abundance & Productivity	Abundance & Productivity	Diversity & Spatial Struct.	Harvest Interactions			
82	Do adults from this program make up less than 5% of the natural spawning escapement (for the species/race) in the subbasin?	0	0	0	0	0	0	0	0	0
83	Do adults from this program make up between 5 and 30% of the natural spawning escapement (for the species/race) in the subbasin.	0	0	0	0	0	0	0	0	0
84	Do adults from this program make up more than 30% of the natural spawning escapement (for the species/race) in the subbasin.	0	0	0	0	0	0	0	0	0

Appendix Table 1.5 Weights assigned to hatchery BMPs for Segregated Harvest Programs. BMPs listed in descending order of importance

		Segregated Harvest									
		Target Population			Other Populations						
#	BMP Question	Harvest	Diversity & Spatial Struct.	Abundance & Productivity	Abundance & Productivity	Diversity & Spatial Struct.	Harvest Interactions	Environmental Factors	Monitoring and Effectiveness	Sum of Weights
5	Does the broodstock chosen have the desired life history traits to meet harvest goals? (e.g. timing and migration patterns that result in full recruitment to target fisheries)?	10	10	10	8	10	8	0	0	56
12	Are representative samples of natural and hatchery population components collected with respect to size, age, sex ratio, run and spawn timing, and other traits important to long-term fitness? (For integrated populations, consider both natural and hatchery components; for segregated populations, you should only consider the hatchery component.)	0	10	10	8	10	8	0	0	46
23	Are males and females available for spawning on a given day randomly mated?	0	10	10	8	10	8	0	0	46
69	Has the carrying capacity of the subbasin been taken into consideration in sizing this program in regards to determining the number of fish released?	4	0	4	10	10	10	0	0	38
1	Does the broodstock chosen represent natural populations native or adapted to the watersheds in which hatchery fish will be released?	8	0	8	8	10	0	0	0	34
2	If population has been extirpated, is the broodstock chosen likely to adapt to the system based on life history and evolutionary history?	8	0	8	8	10	0	0	0	34
48	Is the correct amount and type of food provided to achieve the desired growth rate?	8	8	8	10	0	0	0	0	34
49	Is the correct amount and type of food provided to achieve the desired condition factors for the species and life stage being reared?	8	8	8	10	0	0	0	0	34

Segregated Harvest

#	BMP Question	Target Population			Other Populations			Environmental Factors	Monitoring and Effectiveness	Sum of Weights
		Harvest	Diversity & Spatial Struct.	Abundance & Productivity	Abundance & Productivity	Diversity & Spatial Struct.	Harvest Interactions			
50	Does the program use a diet and growth regime that mimics natural seasonal growth patterns? If not, describe the differences in the comment field?	8	8	8	10	0	0	0	0	34
62	Are the fish produced qualitatively similar to natural fish in growth rate?	8	8	8	10	0	0	0	0	34
63	Are the fish produced qualitatively similar to natural fish in physiological status?	8	8	8	10	0	0	0	0	34
11	Are adult returns recycled to lower to provide additional harvest opportunities?	8	0	8	8	8	0	0	0	32
15	Does the program avoid population transfers and subsequent releases of eggs or fish from outside the watershed?	6	6	6	0	10	0	0	0	28
67	Are fish released in stream reaches within the historic range of that population?	5	8	5	10	0	0	0	0	28
64	Are fish released at sizes and life history stages similar to those of natural fish of the same species?	5	5	5	10	0	0	0	0	25
3	Does the broodstock chosen display morphological and life history traits similar to the natural population?	0	0	5	8	10	0	0	0	23
70	Are 100% of the hatchery fish marked so that they can be distinguished from the natural populations?	3	0	0	3	3	3	0	10	22
40	If eggs are culled, is culling done randomly over all segments of the egg-take?	0	10	10	0	0	0	0	0	20
47	If juveniles are culled, is culling done randomly over all segments of the population? (respond yes if juveniles are not culled). Make sure to capture in the comments box the number culled, and the rational for culling.	0	10	10	0	0	0	0	0	20

Segregated Harvest

#	BMP Question	Target Population: Harvest	Target Population: Diversity & Spatial Struct.	Target Population: Abundance & Productivity	Other Populations: Abundance & Productivity	Other Populations: Diversity & Spatial Struct.	Other Populations: Harvest Interactions	Environmental Factors	Monitoring and Effectiveness	Sum of Weights
42	Does the water used [for rearing] provide natural water temperature profiles that result in fish similar in size to naturally produced fish of the same species?	3	3	3	10	0	0	0	0	19
59	Are the fish produced qualitatively similar to natural fish in size (fpp and length)?	3	3	3	10	0	0	0	0	19
65	Are volitional releases during natural out-migration timing practiced?	3	3	3	10	0	0	0	0	19
66	Are fish released in a manner that simulates natural seasonal migratory patterns?	3	3	3	10	0	0	0	0	19
7	Do natural origin fish make up less than 5% of the broodstock for this program?	0	10	8	0	0	0	0	0	18
14	Are sufficient broodstock collected to maintain an effective population size of 1000 fish per generation? (More than 500 successful spawners of each sex.)	0	8	8	0	0	0	0	0	16
74	Is the facility sited so as to minimize the risk of catastrophic fish loss from flooding?	8	0	8	0	0	0	0	0	16
24	Are gametes pooled prior to fertilization?	0	10	5	0	0	0	0	0	15
61	Are the fish produced qualitatively similar to natural fish in behavior?	3	3	3	5	0	0	0	0	14
68	Are fish released in the same subbasin as rearing facility? This question is trying to determine if fish (juveniles) are transported into the subbasin.	3	0	3	5	0	0	0	0	11
4	Does the broodstock chosen have a pathogen history that indicates no threat to other populations in the watershed?	0	0	0	10	0	0	0	0	10
10	Is the percent natural origin fish used as broodstock for this program estimated?	0	0	0	0	0	0	0	10	10

Segregated Harvest

#	BMP Question	Target Population: Harvest	Target Population: Diversity & Spatial Struct.	Target Population: Abundance & Productivity	Other Populations: Abundance & Productivity	Other Populations: Diversity & Spatial Struct.	Other Populations: Harvest Interactions	Environmental Factors	Monitoring and Effectiveness	Sum of Weights
17	Do you have guidelines for acceptable contribution of hatchery origin fish to natural spawning?	0	0	0	0	0	0	0	10	10
18	Are guidelines for hatchery contribution to natural spawning met for all affected naturally spawning populations?	0	0	0	0	0	0	0	10	10
21	Is the water supply [for adult holding] protected by alarms?	5	0	5	0	0	0	0	0	10
22	Is the water supply [for adult holding] protected by back-up power generation?	5	0	5	0	0	0	0	0	10
31	Is the water supply [for incubation] protected by flow alarms?	5	0	5	0	0	0	0	0	10
32	Is the water supply [for incubation] protected by back-up power generation?	5	0	5	0	0	0	0	0	10
36	Are agency, tribal, or IHOT species-specific incubation recommendations followed for flows?	5	0	5	0	0	0	0	0	10
37	Are agency, tribal, or IHOT species-specific incubation recommendations followed for substrate?	5	0	5	0	0	0	0	0	10
38	Are agency, tribal, or IHOT species-specific incubation recommendations followed for density parameters?	5	0	5	0	0	0	0	0	10
43	Does the hatchery operate to allow all migrating species of all ages to by-pass or pass through hatchery related structures?	0	0	0	0	0	0	10	0	10
44	Is the water supply [for rearing] protected by alarms?	5	0	5	0	0	0	0	0	10
45	Is the water supply [for rearing] protected by back-up power generation?	5	0	5	0	0	0	0	0	10
53	Are agency, tribal, or IHOT juvenile rearing standards followed for loading?	5	0	5	0	0	0	0	0	10
54	Are agency, tribal, or IHOT juvenile rearing standards followed for density?	5	0	5	0	0	0	0	0	10
75	Is staff notified of emergency situations at the facility through the use of alarms, autodialer, and pagers?	5	0	5	0	0	0	0	0	10

Segregated Harvest

#	BMP Question	Target Population: Harvest	Target Population: Diversity & Spatial Struct.	Target Population: Abundance & Productivity	Other Populations: Abundance & Productivity	Other Populations: Diversity & Spatial Struct.	Other Populations: Harvest Interactions	Environmental Factors	Monitoring and Effectiveness	Sum of Weights
77	Do you have a numerical goal for total catch in all fisheries?	0	0	0	0	0	0	0	10	10
78	Do you have a goal for broodstock composition (hatchery vs. natural) in the hatchery?	0	0	0	0	0	0	0	10	10
79	Do you have a goal for spawning escapement composition (hatchery vs. natural) in the wild?	0	0	0	0	0	0	0	10	10
80	Do you have a goal for smolt-to-adult return survival?	0	0	0	0	0	0	0	10	10
85	Is the percent hatchery origin fish (first generation) spawning in the wild estimated?	0	0	0	0	0	0	0	10	10
86	Are standards specified for in-culture performance of hatchery fish?	0	0	0	0	0	0	0	10	10
87	Are in-culture performance standards met?	0	0	0	0	0	0	0	10	10
88	Are standards specified for post release performance of hatchery fish and their offspring?	0	0	0	0	0	0	0	10	10
89	Are post-release performance standards met?	0	0	0	0	0	0	0	10	10
90	Are hatchery programming and operational decisions based on an Adaptive Management Plan? (For example, is an annual report produced describing hatchery operations, results of studies, program changes etc? If a written plan does not exist then the answer is No.)	0	0	0	0	0	0	0	10	10
51	Is the program attempting to better mimic the natural stream environment by providing natural or artificial cover?	2	0	2	5	0	0	0	0	9
16	Is the broodstock collected and held in a manner that results in less than 10% prespawning mortality?	4	0	4	0	0	0	0	0	8

		Segregated Harvest								
#	BMP Question	Target Population			Other Populations			Environmental Factors	Monitoring and Effectiveness	Sum of Weights
		Harvest	Diversity & Spatial Struct.	Abundance & Productivity	Abundance & Productivity	Diversity & Spatial Struct.	Harvest Interactions			
39	Are disinfection procedures implemented during incubation that prevent pathogen transmission between populations of fish on site? (Do you have written protocols? If so, describe in the data comment box.)	4	0	4	0	0	0	0	0	8
71	Does hatchery intake screening comply with Integrated Hatchery Operations Team (IHOT), National Marine Fisheries Service, or other agency facility standards?	0	0	0	0	0	0	8	0	8
26	Are precocious males (mini-jacks and jacks) used for spawning as a set percentage or in proportion to their contribution to the adult run? (note whether mini-jacks are used in the comment box.)	0	7	0	0	0	0	0	0	7
19	Is the water source [for adult holding] specific-pathogen free?	3	0	3	0	0	0	0	0	6
28	Is the water source [for incubation] specific-pathogen free?	3	0	3	0	0	0	0	0	6
41	Is the water source [for rearing] specific-pathogen free?	3	0	3	0	0	0	0	0	6
76	Is the facility continuously staffed to ensure the security of fish populations on-site?	3	0	3	0	0	0	0	0	6
72	Does the facility operate within the limitations established in its National Pollution Discharge Elimination System (NPDES) permit?	0	0	0	0	0	0	5	0	5
73	If the production from this facility falls below the minimum production requirement for an NPDES permit, does the facility operate in compliance with state or federal regulations for discharge?	0	0	0	0	0	0	5	0	5
25	Are back-up males used in the spawning protocol?	0	4	0	0	0	0	0	0	4

Segregated Harvest

#	BMP Question	Target Population: Harvest	Target Population: Diversity & Spatial Struct.	Target Population: Abundance & Productivity	Other Populations: Abundance & Productivity	Other Populations: Diversity & Spatial Struct.	Other Populations: Harvest Interactions	Environmental Factors	Monitoring and Effectiveness	Sum of Weights
33	Are eggs incubated under conditions that result in equal survival of all segments of the population to ponding? (Does any portion of the eggs derive a survival advantage or disadvantage from incubation procedures? If yes, then mark NO for response)	0	3	1	0	0	0	0	0	4
46	Are fish reared under conditions that result in equal survival of all segments of the population to release? (In other words, does any portion of the population derive a survival advantage or disadvantage from rearing procedures? If yes, then mark NO in box.)	0	3	1	0	0	0	0	0	4
20	Does the water used [for adult holding] result in natural water temperature profiles that provide optimum maturation and gamete development?	0	1	1	0	0	0	0	0	2
29	Does the water used [for incubation] provide natural water temperature profiles that result in hatching/emergence timing similar to that of the naturally produced population?	0	1	1	0	0	0	0	0	2
6	What is the percent natural origin fish in the hatchery broodstock?	0	0	0	0	0	0	0	0	0
13	Does the proportion of the spawners brought into the hatchery follow a “spread-the-risk” strategy that attempts to improve the probability of survival for the entire population (hatchery and natural components)?	0	0	0	0	0	0	0	0	0
27	Is the water source [for incubation] pathogen-free?	0	0	0	0	0	0	0	0	0
30	Can incubation water [for incubation] be heated or chilled to approximate natural water temperature profiles?	0	0	0	0	0	0	0	0	0
34	Are families incubated individually? (Includes both eying and hatching.)	0	0	0	0	0	0	0	0	0
52	Are fish reared in multiple facilities or with redundant systems to reduce the risk of catastrophic loss?	0	0	0	0	0	0	0	0	0

Segregated Harvest

#	BMP Question	Target Population			Other Populations			Environmental Factors	Monitoring and Effectiveness	Sum of Weights
		Harvest	Diversity & Spatial Struct.	Abundance & Productivity	Abundance & Productivity	Diversity & Spatial Struct.	Harvest Interactions			
55	For captive broodstocks, are fish maintained on natural photoperiod to ensure normal maturation?	0	0	0	0	0	0	0	0	0
56	For captive broodstocks, are fish maintained reared at 12C to minimize disease?	0	0	0	0	0	0	0	0	0
57	For captive broodstocks, are diets and growth regimes selected that produce potent, fertile gametes and reduce excessive early maturation of fish?	0	0	0	0	0	0	0	0	0
58	For captive broodstocks, are families reared individually to maintain pedigrees?	0	0	0	0	0	0	0	0	0
60	Are the fish produced qualitatively similar to natural fish in morphology?	0	0	0	0	0	0	0	0	0
81	What is the percent hatchery origin fish (first generation) in the natural spawning escapement (for the same species/race)?	0	0	0	0	0	0	0	0	0
82	Do adults from this program make up less than 5% of the natural spawning escapement (for the species/race) in the subbasin?	0	0	0	0	0	0	0	0	0
83	Do adults from this program make up between 5 and 30% of the natural spawning escapement (for the species/race) in the subbasin.	0	0	0	0	0	0	0	0	0
84	Do adults from this program make up more than 30% of the natural spawning escapement (for the species/race) in the subbasin.	0	0	0	0	0	0	0	0	0

Appendix Table 1.6 Weights assigned to hatchery BMPs for Segregated Conservation Programs. BMPs listed in descending order of importance.

Segregated Conservation

#	BMP Question	Target Population			Other Populations			Environmental Factors	Monitoring and Effectiveness	Sum of Weights
		Harvest	Diversity & Spatial Struct.	Abundance & Productivity	Abundance & Productivity	Diversity & Spatial Struct.	Harvest Interactions			
3	Does the broodstock chosen display morphological and life history traits similar to the natural population?	0	10	8	4	4	0	0	0	26
1	Does the broodstock chosen represent natural populations native or adapted to the watersheds in which hatchery fish will be released?	0	10	8	2	5	0	0	0	25
67	Are fish released in stream reaches within the historic range of that population?	0	10	8	5	0	0	0	0	23
70	Are 100% of the hatchery fish marked so that they can be distinguished from the natural populations?	0	0	10	1	1	0	0	10	22
12	Are representative samples of natural and hatchery population components collected with respect to size, age, sex ratio, run and spawn timing, and other traits important to long-term fitness? (For integrated populations, consider both natural and hatchery components; for segregated populations, you should only consider the hatchery component.)	0	10	5	3	3	0	0	0	21
48	Is the correct amount and type of food provided to achieve the desired growth rate?	0	8	8	5	0	0	0	0	21
49	Is the correct amount and type of food provided to achieve the desired condition factors for the species and life stage being reared?	0	8	8	5	0	0	0	0	21
50	Does the program use a diet and growth regime that mimics natural seasonal growth patterns? If not, describe the differences in the comment field?	0	8	8	5	0	0	0	0	21
62	Are the fish produced qualitatively similar to natural fish in growth rate?	0	8	8	5	0	0	0	0	21
63	Are the fish produced qualitatively similar to natural fish in physiological status?	0	8	8	5	0	0	0	0	21
25	Are back-up males used in the spawning protocol?	0	10	10	0	0	0	0	0	20
52	Are fish reared in multiple facilities or with redundant systems to reduce the risk of catastrophic loss?	0	10	10	0	0	0	0	0	20

Segregated Conservation											
#	BMP Question	Target Population			Other Populations			Environmental Factors	Monitoring and Effectiveness	Sum of Weights
		Harvest	Diversity & Spatial Struct.	Abundance & Productivity	Abundance & Productivity	Diversity & Spatial Struct.	Harvest Interactions			
64	Are fish released at sizes and life history stages similar to those of natural fish of the same species?	0	8	5	5	0	0	0	0	18
65	Are volitional releases during natural out-migration timing practiced?	0	8	5	5	0	0	0	0	18
66	Are fish released in a manner that simulates natural seasonal migratory patterns?	0	8	5	5	0	0	0	0	18
55	For captive broodstocks, are fish maintained on natural photoperiod to ensure normal maturation?	0	8	8	0	0	0	0	0	16
56	For captive broodstocks, are fish maintained reared at 12C to minimize disease?	0	8	8	0	0	0	0	0	16
57	For captive broodstocks, are diets and growth regimes selected that produce potent, fertile gametes and reduce excessive early maturation of fish?	0	8	8	0	0	0	0	0	16
23	Are males and females available for spawning on a given day randomly mated?	0	10	5	0	0	0	0	0	15
24	Are gametes pooled prior to fertilization?	0	10	5	0	0	0	0	0	15
33	Are eggs incubated under conditions that result in equal survival of all segments of the population to ponding? (Does any portion of the eggs derive a survival advantage or disadvantage from incubation procedures? If yes, then mark NO for response)	0	10	5	0	0	0	0	0	15
34	Are families incubated individually? (Includes both eying and hatching.)	0	10	5	0	0	0	0	0	15
42	Does the water used [for rearing] provide natural water temperature profiles that result in fish similar in size to naturally produced fish of the same species?	0	5	5	5	0	0	0	0	15
46	Are fish reared under conditions that result in equal survival of all segments of the population to release? (In other words, does any portion of the population derive a survival advantage or disadvantage from rearing procedures? If yes, then mark NO in box.)	0	10	5	0	0	0	0	0	15
59	Are the fish produced qualitatively similar to natural fish in size (fpp and length)?	0	5	3	5	0	0	0	0	13
61	Are the fish produced qualitatively similar to natural fish in behavior?	0	5	5	2	0	0	0	0	12

Segregated Conservation

#	BMP Question	Target Population: Harvest	Target Population: Diversity & Spatial Struct.	Target Population: Abundance & Productivity	Other Populations: Abundance & Productivity	Other Populations: Diversity & Spatial Struct.	Other Populations: Harvest Interactions	Environmental Factors	Monitoring and Effectiveness	Sum of Weights
14	Are sufficient broodstock collected to maintain an effective population size of 1000 fish per generation? (More than 500 successful spawners of each sex.)	0	8	3	0	0	0	0	0	11
10	Is the percent natural origin fish used as broodstock for this program estimated?	0	0	0	0	0	0	0	10	10
16	Is the broodstock collected and held in a manner that results in less than 10% prespawning mortality?	0	0	10	0	0	0	0	0	10
17	Do you have guidelines for acceptable contribution of hatchery origin fish to natural spawning?	0	0	0	0	0	0	0	10	10
18	Are guidelines for hatchery contribution to natural spawning met for all affected naturally spawning populations?	0	0	0	0	0	0	0	10	10
19	Is the water source [for adult holding] specific-pathogen free?	0	0	10	0	0	0	0	0	10
21	Is the water supply [for adult holding] protected by alarms?	0	0	10	0	0	0	0	0	10
22	Is the water supply [for adult holding] protected by back-up power generation?	0	0	10	0	0	0	0	0	10
26	Are precocious males (mini-jacks and jacks) used for spawning as a set percentage or in proportion to their contribution to the adult run? (note whether mini-jacks are used in the comment box.)	0	10	0	0	0	0	0	0	10
27	Is the water source [for incubation] pathogen-free?	0	0	10	0	0	0	0	0	10
28	Is the water source [for incubation] specific-pathogen free?	0	0	10	0	0	0	0	0	10
30	Can incubation water [for incubation] be heated or chilled to approximate natural water temperature profiles?	0	5	5	0	0	0	0	0	10
31	Is the water supply [for incubation] protected by flow alarms?	0	0	10	0	0	0	0	0	10
32	Is the water supply [for incubation] protected by back-up power generation?	0	0	10	0	0	0	0	0	10
36	Are agency, tribal, or IHOT species-specific incubation recommendations followed for flows?	0	0	10	0	0	0	0	0	10
37	Are agency, tribal, or IHOT species-specific incubation recommendations followed for substrate?	0	0	10	0	0	0	0	0	10
38	Are agency, tribal, or IHOT species-specific incubation recommendations followed for density parameters?	0	0	10	0	0	0	0	0	10

Segregated Conservation										
#	BMP Question	Target Population			Other Populations			Environmental Factors	Monitoring and Effectiveness	Sum of Weights
		Harvest	Diversity & Spatial Struct.	Abundance & Productivity	Abundance & Productivity	Diversity & Spatial Struct.	Harvest Interactions			
39	Are disinfection procedures implemented during incubation that prevent pathogen transmission between populations of fish on site? (Do you have written protocols? If so, describe in the data comment box.)	0	0	10	0	0	0	0	0	10
41	Is the water source [for rearing] specific-pathogen free?	0	0	10	0	0	0	0	0	10
44	Is the water supply [for rearing] protected by alarms?	0	0	10	0	0	0	0	0	10
45	Is the water supply [for rearing] protected by back-up power generation?	0	0	10	0	0	0	0	0	10
53	Are agency, tribal, or IHOT juvenile rearing standards followed for loading?	0	0	10	0	0	0	0	0	10
54	Are agency, tribal, or IHOT juvenile rearing standards followed for density?	0	0	10	0	0	0	0	0	10
74	Is the facility sited so as to minimize the risk of catastrophic fish loss from flooding?	0	0	10	0	0	0	0	0	10
75	Is staff notified of emergency situations at the facility through the use of alarms, autodialer, and pagers?	0	0	10	0	0	0	0	0	10
76	Is the facility continuously staffed to ensure the security of fish populations on-site?	0	0	10	0	0	0	0	0	10
78	Do you have a goal for broodstock composition (hatchery vs. natural) in the hatchery?	0	0	0	0	0	0	0	10	10
79	Do you have a goal for spawning escapement composition (hatchery vs. natural) in the wild?	0	0	0	0	0	0	0	10	10
80	Do you have a goal for smolt-to-adult return survival?	0	0	0	0	0	0	0	10	10
85	Is the percent hatchery origin fish (first generation) spawning in the wild estimated?	0	0	0	0	0	0	0	10	10
86	Are standards specified for in-culture performance of hatchery fish?	0	0	0	0	0	0	0	10	10
87	Are in-culture performance standards met?	0	0	0	0	0	0	0	10	10

Segregated Conservation

#	BMP Question	Target Population: Harvest	Target Population: Diversity & Spatial Struct.	Target Population: Abundance & Productivity	Other Populations: Abundance & Productivity	Other Populations: Diversity & Spatial Struct.	Other Populations: Harvest Interactions	Environmental Factors	Monitoring and Effectiveness	Sum of Weights
88	Are standards specified for post release performance of hatchery fish and their offspring?	0	0	0	0	0	0	0	10	10
89	Are post-release performance standards met?	0	0	0	0	0	0	0	10	10
90	Are hatchery programming and operational decisions based on an Adaptive Management Plan? (For example, is an annual report produced describing hatchery operations, results of studies, program changes etc? If a written plan does not exist then the answer is No.)	0	0	0	0	0	0	0	10	10
58	For captive broodstocks, are families reared individually to maintain pedigrees?	0	8	0	0	0	0	0	0	8
71	Does hatchery intake screening comply with Integrated Hatchery Operations Team (IHOT), National Marine Fisheries Service, or other agency facility standards?	0	0	0	0	0	0	8	0	8
51	Is the program attempting to better mimic the natural stream environment by providing natural or artificial cover?	0	2	5	0	0	0	0	0	7
20	Does the water used [for adult holding] result in natural water temperature profiles that provide optimum maturation and gamete development?	0	3	3	0	0	0	0	0	6
29	Does the water used [for incubation] provide natural water temperature profiles that result in hatching/emergence timing similar to that of the naturally produced population?	0	3	3	0	0	0	0	0	6
43	Does the hatchery operate to allow all migrating species of all ages to by-pass or pass through hatchery related structures?	0	0	0	0	0	0	5	0	5
68	Are fish released in the same subbasin as rearing facility? This question is trying to determine if fish (juveniles) are transported into the subbasin.	0	0	0	5	0	0	0	0	5
72	Does the facility operate within the limitations established in its National Pollution Discharge Elimination System (NPDES) permit?	0	0	0	0	0	0	5	0	5
73	If the production from this facility falls below the minimum production requirement for an NPDES permit, does the facility operate in compliance with state or federal regulations for discharge?	0	0	0	0	0	0	5	0	5

Segregated Conservation											
#	BMP Question	Target Population			Other Populations			Environmental Factors	Monitoring and Effectiveness	Sum of Weights
		Harvest	Diversity & Spatial Struct.	Abundance & Productivity	Abundance & Productivity	Diversity & Spatial Struct.	Harvest Interactions			
15	Does the program avoid population transfers and subsequent releases of eggs or fish from outside the watershed?	0	1	1	1	1	0	0	0	4
69	Has the carrying capacity of the subbasin been taken into consideration in sizing this program in regards to determining the number of fish released?	0	0	0	2	2	0	0	0	4
40	If eggs are culled, is culling done randomly over all segments of the egg-take?	0	1	1	0	0	0	0	0	2
47	If juveniles are culled, is culling done randomly over all segments of the population? (respond yes if juveniles are not culled). Make sure to capture in the comments box the number culled, and the rational for culling.	0	1	1	0	0	0	0	0	2
4	Does the broodstock chosen have a pathogen history that indicates no threat to other populations in the watershed?	0	0	0	1	0	0	0	0	1
2	If population has been extirpated, is the broodstock chosen likely to adapt to the system based on life history and evolutionary history?	0	0	0	0	0	0	0	0	0
5	Does the broodstock chosen have the desired life history traits to meet harvest goals? (e.g. timing and migration patterns that result in full recruitment to target fisheries)?	0	0	0	0	0	0	0	0	0
6	What is the percent natural origin fish in the hatchery broodstock?	0	0	0	0	0	0	0	0	0
7	Do natural origin fish make up less than 5% of the broodstock for this program?	0	0	0	0	0	0	0	0	0
11	Are adult returns recycled to lower to provide additional harvest opportunities?	0	0	0	0	0	0	0	0	0
13	Does the proportion of the spawners brought into the hatchery follow a “spread-the-risk” strategy that attempts to improve the probability of survival for the entire population (hatchery and natural components)?	0	0	0	0	0	0	0	0	0
60	Are the fish produced qualitatively similar to natural fish in morphology?	0	0	0	0	0	0	0	0	0
77	Do you have a numerical goal for total catch in all fisheries?	0	0	0	0	0	0	0	0	0

Segregated Conservation

#	BMP Question	Target Population: Harvest	Target Population: Diversity & Spatial Struct.	Target Population: Abundance & Productivity	Other Populations: Abundance & Productivity	Other Populations: Diversity & Spatial Struct.	Other Populations: Harvest Interactions	Environmental Factors	Monitoring and Effectiveness	Sum of Weights
81	What is the percent hatchery origin fish (first generation) in the natural spawning escapement (for the same species/race)?	0	0	0	0	0	0	0	0	0
82	Do adults from this program make up less than 5% of the natural spawning escapement (for the species/race) in the subbasin?	0	0	0	0	0	0	0	0	0
83	Do adults from this program make up between 5 and 30% of the natural spawning escapement (for the species/race) in the subbasin.	0	0	0	0	0	0	0	0	0
84	Do adults from this program make up more than 30% of the natural spawning escapement (for the species/race) in the subbasin.	0	0	0	0	0	0	0	0	0

Appendix I

Draft Socioeconomics Resource Report Submitted by The Research Group to NMFS

2008[1]

[1]This draft resource report was submitted by the Research Group to NMFS in 2008. It was never completed or peer reviewed. It should not be considered a NMFS report or cited as NMFS data.

Chapter 3: AFFECTED ENVIRONMENT

3.3 Socioeconomic Environment

3.3.1 Background[1]

The Mitchell Act (MA) (Public Law 75-502) was passed in 1938 and amended in 1946. The amendments in 1946 were significant because they allowed funding for states to carry out the law's purpose. The MA responded to decreases in the fishery resources, and the original purpose was primarily to provide harvest for the local fishery. The law and the appropriation recognized that between 1905 and 1931 the federal government had received more than $500,000 in payments from commercial fishers for leasing seining grounds adjacent to Sand Island and Peacock Spit in the Columbia River estuary. The MA included an initial appropriation in 1949 of $500,000 for surveys and improvements in the Columbia River watershed for the benefit of salmon and steelhead and other anadromous fish. Through the authorization, Congress intended to invest money received by the government for the use of fishing grounds in efforts to rebuild and conserve the fish runs. The MA recognized that anadromous fish populations were in a serious decline, and that the decline was caused by impacts on spawning and rearing habitat from deforestation, pollution, hydroelectric dams, and diversion of water for irrigation.

The funding was first directed through implementation of the Lower Columbia River Fishery Development Plan (LCRFDP) prepared by the U.S. Army Corps of Engineers. The Corps outlined in its November 1948 report a $20 million plan to build fish ladders, irrigation screens, and fish hatcheries and to improve spawning and rearing habitat for salmon and steelhead, all focused on the on the lower Columbia River. The impacts of dams on salmon and steelhead that spawned in the upper Columbia River Basin would be addressed by "developing the salmon runs in the lower tributaries to the highest level of productivity," according to the report. The Plan's objective was to move salmon populations lost to upstream hydropower development to lower river hatchery production. The original plan outlined projects to improve habitat and create sanctuaries. The state legislatures did not favor the sanctuaries creation. Legislation that did pass in Washington was overturned by a Washington Supreme Court ruling. The proportion of MA funds devoted to hatcheries increased from 50 percent in 1950 to over 80 percent in recent years (NPCC undated). The hatchery activities funded by the MA represent an important share (about half in recent years) of overall Columbia River Basin hatchery salmon and steelhead production.

In 1956 Congress ordered that the program be implemented above McNary Dam as well as below it. Idaho joined the program in 1957, and the word "Lower" was dropped from the name. The CRFDP was originally administered by the Bureau of Sport Fisheries and Wildlife under the Department of the Interior. In 1970, with the reorganization of the federal fisheries responsibilities, the oversight of the CRFDP was transferred to the National Marine Fisheries Service (also known as NOAA Fisheries) under the Department of Commerce. It is administered out of the Salmon Recovery Division office in Portland, Oregon. Cooperating agencies include

1. Portions of this section are paraphrased and/or repeated from NPCC (undated), IDFG et al. (2005), and the NOAA Fisheries MA EIS workscope.

the U.S. Fish and Wildlife Service (USFWS), Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fish and Wildlife (WDFW), Idaho Department of Fish and Game (IDFG), and the Confederated Tribes and Bands of the Yakama Nation (Yakama).

In the 50 years it has been in effect, 25 hatcheries and major rearing ponds have been funded. More recently, there is extensive involvement in the placement and maintenance of fish screens and fishways in the three states. Due to MA appropriation restraints and the rising cost of hatchery operations, there are now 18 hatcheries in Oregon and Washington that are funded. The hatcheries, with the exception of the WDFW Ringold Hatchery, are located along the mainstem Columbia and its tributaries below The Dalles Dam. Some of these hatcheries receive other than Mitchell Act funds for their operations. Figure 3.1 shows the share of funding by cooperating agency in 2005. Figure 3.2 shows funding levels by category in 2005. Figure 3.3 shows trends of funding for hatchery operation and maintenance since 1998.

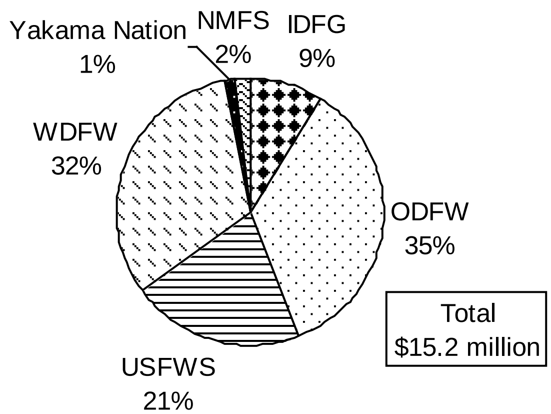
Total smolt production by all Columbia River Basin hatcheries in the early 2000's was about 136 million, which is about 48 percent of all hatchery and wild production (IEAB 2005). There are many other hatcheries not funded by the MA in the Columbia River Basin. The estimated production of hatcheries wholly or partially funded by the Mitchell Act is about 63 million smolts.

Columbia River commercial, tribal, and recreational fisheries are of major economic importance in Pacific Northwest states. Due to the migratory behavior of Pacific salmon and steelhead, fish originating in the Columbia River also contribute to distant fisheries. For example, a large proportion of the Chinook catch in southeast Alaska and British Columbia salmon fisheries are from the Columbia River. The U.S.-Canada Pacific Salmon Treaty adjusts allocations between countries, depending on production origin abundances. Any changes in MA hatchery production will have implications to many north Pacific regional economies that depend on access to ocean salmon fisheries.

With the severely depressed wild anadromous fish populations in the Pacific Northwest and the accompanying federal actions to protect many of the stocks by listing them under the Endangered Species Act (ESA), it was recognized there was a need to examine and evaluate the focus of the MA hatcheries. The existing base goals of MA are to produce anadromous salmonids, maintain sustainable fisheries, and improve and maintain irrigation diversion screens and fishways while conserving indigenous genetic resources, assist with the recovery of naturally spawning populations, and improve the quality and cost-effectiveness of the facilities. Each program must contribute benefits to the overall resource. The program must also be aligned with current court agreements, address the trust relationship for the Tribes, and be responsive to harvest agreements for in-river and distant fisheries.

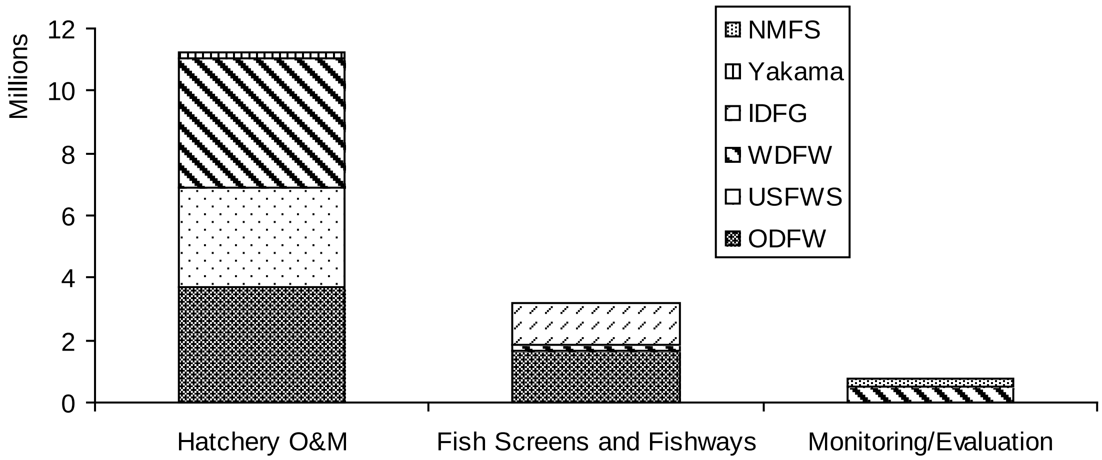
The MA funded hatcheries are being reviewed under several hatchery reform reviews (see Appendix A for their description). The programs developed for the individual hatcheries will depend upon their locations, water supplies, facilities designs, rearing conditions, and other factors relating to their capabilities. Regional fishery plans being developed by the management entities, federal, state, and tribal, address a broad range of issues including habitat, fisheries and hatcheries that incorporate reform. The need to coordinate and implement existing and new

Figure 3.1
Cooperative Agency Funding Share of MA Existing Activities in 2005



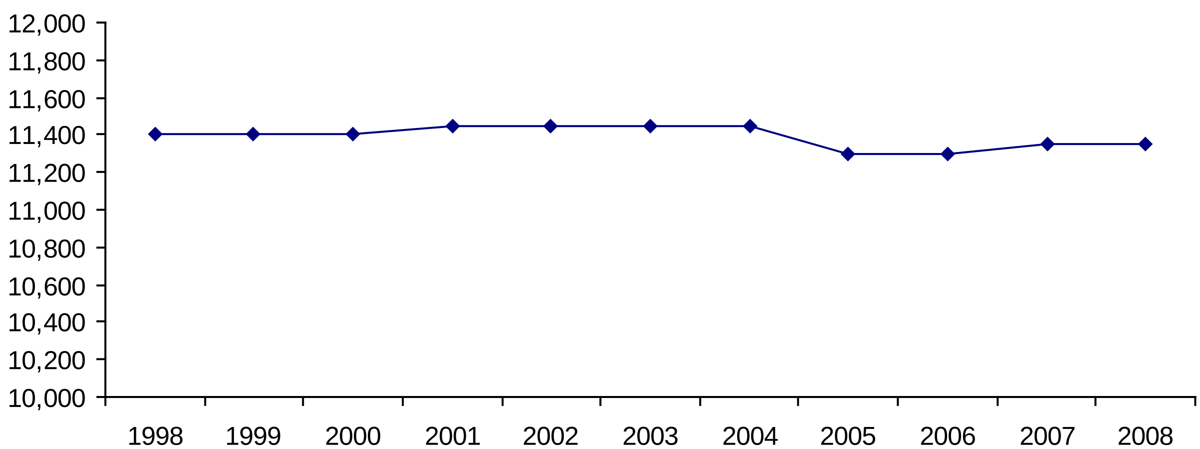
Source: IDFG et al. (2005).

Figure 3.2
Program Funding for MA Existing Activities in 2005



Source: IDFG et al. (2005).

Figure 3.3
MA Appropriations Used for Hatchery Operations and Maintenance in 1998 to 2008



Source: NOAA Fisheries.

information is essential for the success of salmon and steelhead hatcheries. Structural changes within the hatcheries will be required to implement new strategies for rearing, separation of hatchery and wild fish, and to allow accessibility of hatchery juveniles for mass marking. Tracking hatchery reform and recovery of wild salmon and fisheries is essential for monitoring the progress toward the eventual recovery of salmonid populations.

The NOAA Fisheries needed a decision document to show the impacts of alternative hatchery programs that will meet the needs of hatchery reforms. The decision making process and document will be accomplished through the preparation of an EIS. The EIS will show analysis results for the allocation and distribution of Mitchell Act funds for hatchery operations. The EIS will also include an analysis of economic effects associated with ESA determinations related to MA supported hatchery programs.

3.3.2 Fishery Management Governance[1]

For thousands of years Native Americans have fished for salmon and steelhead, as well as other species, in the tributaries and mainstem of the Columbia River for ceremonial, subsistence, and economic purposes. A wide variety of gears and methods were used, including hoop and dip nets at cascades such as Celilo and Willamette Falls; to spears, weirs, and traps (usually in smaller streams and headwater areas). Commercial fishing developed rapidly with the arrival of European settlers and the advent of canning technologies in the late 1800's. The development of non-Indian fisheries began circa 1830, and by 1861 commercial fishing was an important economic activity. Fishing pressure, especially in the late nineteenth and early twentieth centuries, has long been recognized as a significant factor in the decline of Columbia River salmon runs. Hydropower development, hatchery practices, and habitat degradation are other categories of factors contributing to the decline (NRC 1999).

The Mitchell Act (MA) was to mitigate for impacts from water diversions, dams on the mainstem of the Columbia River, and other effects in order to conserve fish resources. The hatchery activities funded by the MA represent an important share (about half in recent years) of overall Columbia River Basin hatchery salmon and steelhead production. The production contributes to not only the Columbia River commercial, tribal, and recreational fisheries, but also because of the migratory nature of anadromous fish, to distant ocean fisheries occurring off Oregon's coast and north to Alaska. The legal framework under which fisheries in which MA production contributes are managed in a complex quilt of states and provinces, tribes, federal, and international governance.

Among the treaties, laws, agreements, plans, and understandings between these jurisdictions are the court interpretations about how they apply. A partial list of agencies and organizations that are involved in management while fish are in the ocean or river and subject to harvest mortalities are (NMFS 2003):

- The United States Departments of State, Interior, and Commerce;
- The States of California, Oregon, Washington, Idaho, and Alaska;
- More than 30 tribal jurisdictions;
- The Pacific Fishery Management Council (PFMC);
- The North Pacific Fishery Management Council (NPFMC);
- North Pacific Anadromous Fish Commission (NPAFC);
- The Pacific Salmon Commission (PSC); and
- Fisheries and Oceans Canada (DFO).

The legal framework can be categorized as *international understandings*, such as the 1992 International North Pacific Fisheries Commission Convention, the 1982 United Nations Convention on the Law of the Sea which entered into force in November 1994, the 1985 Pacific Salmon Treaty (PST) between the United States and Canada; *harvest management agreement processes* such as the 1976 Magnuson-Stevens Fisheries Conservation and Management Act (MSA); *agreements to rebuild the stocks* such as such as through subbasin planning under the

1. Parts of this section are paraphrased from ISAB (2005).

1980 Northwest Power Planning Act; *court decisions* that have defined the obligations to Indian Tribes such as the 1969 judgment from *United States v. Oregon* that became the forum for allocating the harvest of fish that enter the Columbia River system; and other *federal actions to protect salmon* stocks such as the 1915 Columbia River Compact and the 1973 Endangered Species Act.

While the understandings and agreements might have originally been driven for managing fisheries in which production from Mitchell Act funded hatcheries contribute stocks, there are now mandated and guidance directories in the agreements and understandings under which the hatcheries must operate. This EIS is to evaluate the impacts from alternatives to satisfy the directories and to evaluate possible new hatchery funding levels. The alternatives being evaluated do not include any other flexibility for spending authority that might be contained in the Mitchell Act that that might be consistent with its purpose to mitigate for declines in salmon production. For example, approximately 20 percent of distributed Mitchell Act funds of recent years have not been used for hatchery operations, but have been directed to such programs as fish screen and raceway projects.

3.3.2.1 International Understandings

The stage was set for resolving the contentious relationship between Canada and the U.S. for the equitable division salmon harvest when other players were removed. The 1973-1982 United Nations Convention on the Law of the Sea (LOSC) prevented high seas fishing for salmon and other anadromous fish and enabling exclusive jurisdiction within a 200 nautical mile Exclusive Economic Zone (EEZ). This removed the complication of Russian, Japanese, and other nations' fishing fleets' interceptions and allowed Canada and the U.S. to focus on cooperative management. The PST was first signed in 1985, updated in 1999, and updated again in 2008. (The 2008 updates have yet to be authorized by the U.S. and Canadian governments as of the publication date of this EIS.) The treaty is a bilateral agreement under which the U.S. and Canada cooperate on management, research and enhancement of Pacific salmon that swim through the waters of both countries. The treaty and its annexes stipulate management goals and measures for important Chinook and coho stocks that are taken in Southeast Alaska, Canada, and off the U.S. West Coast. Included among these stocks are several Columbia River listed ESU's. The 1999 agreement establishes an abundance-based Chinook management regime for the stocks and fisheries. The 2008 agreement adds stocks to the management regime and reduces the allowable Chinook catch levels for fisheries off the west coast of Vancouver Island in B.C. by 30 percent, and in southeast Alaska by 15 percent. The most recent agreement will increase funding for accounting and monitoring.

3.3.2.2 Harvest Management Directed Through Federal Mandates and Court Decisions

The MSA (enacted in 1976, amended in 1996, and amended again to be called the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006) provides parameters and guidance for federal fisheries management, requiring the PFMC and NPFMC to adhere to a broad array of policymaking and national standards in crafting fisheries management regimes. The regimes must address the purposes of the international agreements, and more importantly, address the purposes of the ESA. The ESA provides a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved to provide a program for the conservation of such species, and to take steps as may appropriate to achieve the purposes of various international treaties and conventions. The ESA is a process for listing, protection and recovery of certain species, subspecies, and distinct populations (PFMC 2008). Starting in 1992, several evolutionarily significant units of salmon and steelhead in the Columbia River Basin were listed as threatened or endangered under the ESA. The listings further complicated fishery management since the ESA prohibits "take" of listed species. The NFMS became a key decision maker in harvest management because of the ESA consultation process and resulting biological opinions which authorize "incidental take."[1] Without the biological opinions, all commercial and recreational fishers would have to obtain incidental take permits. The biological opinions for ESA listed stocks require fisheries management practices to meet objectives to avoid jeopardizing the recovery of the listed stocks. The PFMC and the NPFMC develop management plans to achieve the stock recovery plans. The PFMC and NPFMC set ocean management regimes to meet PST defined harvest shared catch levels, while allowing sufficient Columbia River escapements contained in stock recovery plans.

The Columbia River fisheries are managed under a continuing jurisdiction of the U.S. District Court for the District of Oregon in the Case of *United States v. Oregon* (Belloni Decision). The court affirmed that the treaties reserved to the tribes 50 percent of the harvestable surplus of fish destined to pass through their usual and accustomed fishing areas. A parallel case is *U.S. v. Washington* or Boldt Decision (interpreting the same treaty language for tribes in the Puget Sound area), where the courts have established a large body of case law setting forth the fundamental principles of treaty rights and the permissible limits of conservation regulation of

---

1. A "Section 7 consultation" occurs when a set of consultation standards found in an applicable BO applies to the subject activity and mandates those actions that must be taken in order to avoid jeopardy. As listings have occurred, NMFS has initiated formal Section 7 consultations and issued BO's that consider the impacts to listed salmonid species resulting from proposed implementation of the fishery management plans, or in some cases, from proposed implementation of the annual management measures. The consultation standards, which are quantitative targets that must be met to avoid jeopardy, are also incorporated into the management plans and play an important part in developing annual management measures. A Section 7 consultation may be reinitiated periodically as environmental conditions change, and new measures may be required to avoid jeopardy.

   In addition to the Section 7 consultation, actions that fall under the jurisdiction of the ESA may also be permitted through ESA Section 10 and ESA Section 4(d). Section 10 generally covers scientific, research, and propagation activities that may affect ESA listed species. Section 4(d) covers the activities of state and local governments and private citizens.

   Section 4(d) of the ESA requires NMFS and the U.S. Fish and Wildlife Service to promulgate "protective regulations" for threatened species (Section 4(d) is not applicable to species listed as endangered) whenever it is deemed "necessary and advisable to provide for the conservation of such species."

   In proposing and finalizing a 4(d) rule, NMFS may establish exemptions to the take prohibition for specified categories of activities that NMFS finds contribute to conserving listed salmonids. Other exemptions cover habitat-degrading activities, hatchery operations, etc. that NMFS believes are governed by a program that adequately limits impacts on listed salmonids. The NMFS uses hatchery genetic management plans (HGMP's) to assess whether exemptions can be issued for propagation activities that may lead to harvests of ESA listed stocks.

treaty fisheries. The treaty rights for the Shoshone-Bannock Tribes are protected by the Fort Bridges Treaty as interpreted in *State of Idaho v. Tinno*. The parties to *U.S. v. Oregon* are the United States acting through the Department of the Interior (U.S. Fish and Wildlife Service and Bureau of Indian Affairs) and the Department of Commerce (NOAA Fisheries), the Confederated Tribes of the Warm Springs Reservation of Oregon, the Confederated Tribes of the Umatilla Indian Reservation, the Nez Perce Tribe, the Confederated Tribes and Bands of the Yakama Nation, and the Shoshone-Bannock Tribes, and the states of Oregon, Washington, and Idaho.

The parties developed a Columbia River Fish Management Plan (CRFMP), which after expiring has been extended in a series of interim agreements. The last CRFMP expired in 1998 and the most recent 10 year (through 2017) agreement was decided by the parties and affirmed by the court in August 2008. The agreements are devised to be consistent with stock recovery plans and address the non-Indian and treaty allocations.

With the allocation as a given, the WFWC and OFWC have broad discretion to decide further allocation between recreational and commercial fisheries in representing the public interest. Commissions consider economic factors along with social, recreational, aesthetic and resource management factors. Since Washington and Oregon must act jointly to determine the allocations, the commissions provide guidance to staff in how the staff should carry out negotiations for the actual season regulations. The negotiations use the process stipulated in the Columbia River Compact. The Compact does not have rule making authority, and instead decisions are exercised through the states' respective directors as administrative rules.

3.3.2.3 Other Cross-Cutting Federal Mandates

Fisheries management governance is also subject to legislation and executive orders applicable to all federal planning and management initiatives. Legislation and executive orders are shown in Table 3.1.

Table 3.1
Fisheries Management Cross-Cutting Legislation and Executive Orders

Legislation

Coastal Zone Management Act. Section 307(c)(1) of the federal Coastal Zone Management Act (CZMA) requires all federal activities that directly affect the coastal zone be consistent with approved state coastal zone management programs to the maximum extent practicable. The preferred alternative would be implemented in a manner that is consistent to the maximum extent practicable with the enforceable policies of the approved coastal zone management programs of the states.

Marine Mammal Protection Act. The Marine Mammal Protection Act (MMPA) of 1972 is the principal federal legislation that guides marine mammal species protection and conservation policy in the United States. Under the MMPA, NMFS is responsible for the management and conservation of 153 stocks of whales, dolphins, and porpoise, as well as seals, sea lions, and fur seals, while the U.S. Fish and Wildlife Service is responsible for walrus, sea otters, and the West Indian manatee. Off the West Coast, the southern resident killer whale (*Orcinus orca*), Steller sea lion (*Eumetopias jubatus*) eastern stock, Guadalupe fur seal (*Arctocephalus townsendi*), and southern sea otter (*Enhydra lutris*) California stock are listed as threatened under the ESA, and the sperm whale (*Physeter macrocephalus*) Washington, Oregon, and California (WOC) stock, humpback whale (*Megaptera novaeangliae*) WOC - Mexico Stock, blue whale (*Balaenoptera musculus*) eastern north Pacific stock, and fin whale (*Balaenoptera physalus*) WOC stock are listed as depleted under the MMPA. Any species listed as endangered or threatened under the ESA is automatically considered depleted under the MMPA. The West Coast ocean salmon fisheries are considered a Category III fishery, indicating a remote likelihood of or no known serious injuries or mortalities to marine mammals, in the annual list of fisheries published in the Federal Register.

Migratory Bird Treaty Act. The Migratory Bird Treaty Act of 1918 was designed to end the commercial trade of migratory birds and their feathers that, by the early years of the 20th century, had diminished populations of many native bird species. The act states that it is unlawful to take, kill, or possess migratory birds and their parts (including eggs, nests, and feathers) and is a shared agreement between the United States, Canada, Japan, Mexico, and Russia to protect a common migratory bird resource. The Migratory Bird Treaty Act prohibits the directed take of seabirds, but the incidental take of seabirds does occur.

Paperwork Reduction Act. The Paperwork Reduction Act (PRA) requires that agencies receive Office of Management and Budget (OMB) clearance before requesting most types of information from the public ("information collections").

Regulatory Flexibility Act. The purpose of the Regulatory Flexibility Act (RFA) is to relieve small businesses, small organizations, and small governmental entities of burdensome regulations and record-keeping requirements. Major goals of the RFA are: (1) to increase agency awareness and understanding of the impact of their regulations on small business, (2) to require agencies communicate and explain their findings to the public, and (3) to encourage agencies to use flexibility and to provide regulatory relief to small entities. The RFA emphasizes predicting impacts on small entities as a group distinct from other entities and the consideration of alternatives that may minimize the impacts while still achieving the stated objective of the action. An initial regulatory flexibility analysis (IRFA) is conducted unless it is determined that an action will not have a significant economic impact on a substantial number of small entities. The RFA requires that an IRFA include elements that are similar to those required by Executive Order (EO) 12866 and NEPA.

A fish-harvesting business is considered a "small" business by the Small Business Administration (SBA) if it has annual receipts not in excess of $3.5 million. For related fish-processing businesses, a small business is one that employs 500 or fewer persons. For marinas and charter/party boats, a small business is one with annual receipts not in excess of $5.0 million. Commercial salmon harvesting vessels, buyers/processors, and charter/party boats are expected to be the only type of small entities directly impacted by the proposed action. Section 603 (b) of the RFA identifies the elements that should be included in the IRFA.

Other laws sometimes necessary to address in fisheries management include:

- Administrative Procedures Act
- Data Quality Act
- The Fishermen's Protective Act (Pelly Amendment)
- Marine Protection, Research and Sanctuaries Act

Table 3.1 (cont.)

Executive Orders

Executive Order 12866 (Regulatory Planning and Review). EO 12866, Regulatory Planning and Review, was signed on September 30, 1993, and established guidelines for promulgating new regulations and reviewing existing regulations. The EO covers a variety of regulatory policy considerations and establishes procedural requirements for analysis of the benefits and costs of regulatory actions. Section 1 of the EO deals with the regulatory philosophy and principles that were to guide agency development of regulations. It stresses that in deciding whether and how to regulate, agencies should assess all of the costs and benefits across all regulatory alternatives. Based on this analysis, NMFS should choose those approaches that maximize net benefits to society, unless a statute requires another regulatory approach.

Executive Order 12898 (Environmental Justice). EO 12898 obligates federal agencies to identify and address "disproportionately high adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations in the United States" as part of any overall environmental impact analysis associated with an action. NOAA guidance, NAO 216-6, at '7.02, states that "consideration of EO 12898 should be specifically included in the NEPA documentation for decision-making purposes." Agencies should also encourage public participation, especially by affected communities during scoping, as part of a broader strategy to address environmental justice issues. The environmental justice analysis must first identify minority and low-income groups that live in the project area and may be affected by the action. Typically, census data are used to document the occurrence and distribution of these groups. Agencies should be cognizant of distinct cultural, social, economic, or occupational factors that could amplify the adverse effects of the proposed action. (For example, if a particular kind of fish is an important dietary component, fishery management actions affecting the availability or price of that fish could have a disproportionate effect.) In the case of Indian tribes, pertinent treaty or other special rights should be considered. Once communities have been identified and characterized, and potential adverse impacts of the alternatives are identified, the analysis must determine whether these impacts are disproportionate. Because of the context in which environmental justice is developed, health effects are usually considered, and three factors may be used in an evaluation: whether the effects are deemed significant, as the term is employed by NEPA; whether the rate or risk of exposure to the effect appreciably exceeds the rate for the general population or some other comparison group; and whether the group in question may be affected by cumulative or multiple sources of exposure. If disproportionately high adverse effects are identified, mitigation measures should be proposed. Community input into appropriate mitigation is encouraged. Participation in decisions about the proposed action by communities that could experience disproportionately high and adverse impacts is another important principle of the EO.

Executive Order 12962 (Recreational Fishing). In order to conserve, restore, and enhance aquatic systems to provide for increased recreational fishing opportunities nationwide, it is ordered that federal agencies shall, to the extent permitted by law and where practicable, and in cooperation with States and Tribes, improve the quantity, function, sustainable productivity, and distribution of U.S. aquatic resources for increased recreational fishing opportunities. A National Recreational Fisheries Coordination Council is established to assess the implementation of the Conservation Plan; and develop a biennial report of accomplishments of the Conservation Plan. All Federal agencies will aggressively work to identify and minimize conflicts between recreational fisheries and their respective responsibilities under the Endangered Species Act of 1973. To assist in the implementation of this order, the Secretary of the Interior shall expand the role of the Sport Fishing and Boating Partnership Council to monitor, review, and evaluate the relation of federal policies and activities to the status and conditions of recreational fishery resources; and prepare an annual report of its activities, findings, and recommendations for submission to the Recreational Fisheries Coordination Council. Amended in September 2008, Section 1(d) requires that recreational fishing shall be managed as a sustainable activity in national wildlife refuges, national parks, national monuments, national marine sanctuaries, marine protected areas, or any other relevant conservation or management areas or activities under any Federal authority, consistent with applicable law.

Executive Order 13132 (Federalism). EO 13132 enumerates eight fundamental federalism principles. The first of these principles states "Federalism is rooted in the belief that issues that are not national in scope or significance are most appropriately addressed by the level of government closest to the people." In this spirit, the EO directs agencies to consider the implications of policies that may limit the scope of or preempt states' legal authority. Preemptive action having such federalism implications is subject to a consultation process with the states; such actions should not create unfunded mandates for the states; and any final rule published must be accompanied by a federalism summary impact statement. The Council process offers many opportunities for states and Indian tribes (through their agencies, Council appointees, advisory bodies, consultations, and meetings) to participate in the formulation of this FMP amendment. This process encourages states and tribes to institute complementary measures to manage fisheries under their jurisdiction that may affect federally managed stocks.

Executive Order 13175 (Consultation and Coordination with Indian Tribal Government). EO 13175 is intended to ensure regular and meaningful consultation and collaboration with tribal officials in the development of federal policies that have tribal implications, to strengthen the United States government-to-government relationships with Indian tribes, and to reduce the imposition of unfunded mandates upon Indian tribes. The Secretary recognizes the sovereign status and co-manager role of Indian tribes over shared federal and tribal fishery resources. At Section 302(b)(5), the Magnuson-Stevens Act reserves a seat on the Council for a representative of an Indian tribe with federally-recognized fishing rights from California, Oregon, Washington, or Idaho.

Executive Order 13186 (Responsibilities of Federal Agencies to Protect Migratory Birds). EO 13186 supplements the MBTA (above) by requiring federal agencies to work with the U.S. Fish and Wildlife Service to develop memoranda of agreement to conserve migratory birds. NMFS is in the process of implementing a memorandum of understanding. The protocols developed by this consultation will guide agency regulatory actions and policy decisions in order to address this conservation goal. The EO also directs agencies to evaluate the effects of their actions on migratory birds in environmental documents prepared pursuant to the NEPA.

3.3.3 Study Area Regional Overview

MA funded hatchery production affects the human environment wherever harvests occur. The anadromous fish migrate throughout the north Pacific and recovered CWT's are regularly reported in fisheries from the Oregon Coast to Alaska. (See Figure 3.4 schematic depicting the fish migration range.) The modeled harvest levels from all Columbia River production (natural and hatchery) and the MA hatchery production share as represented by the status quo alternative is shown on Figure 3.5. This section will show the benefits to regional economies from the fisheries in which Columbia River production in general and MA funded hatcheries in particular contribute. A study area is defined where that contribution is a higher proportion of salmon and steelhead fisheries. Additional socioeconomic measures are offered for the study area to give a backdrop for detailed analysis about the importance and impact from the contributed fisheries.

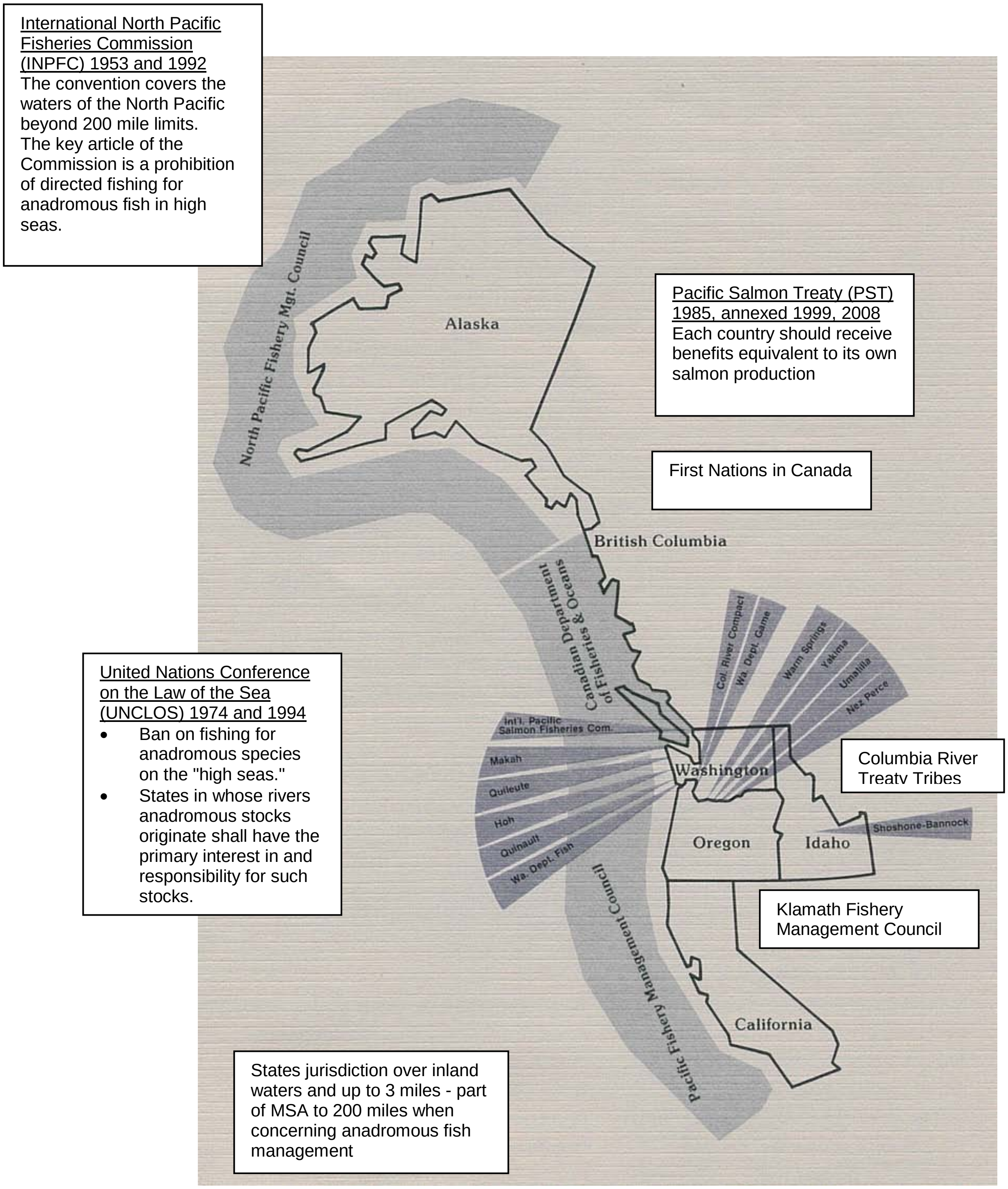
An important consideration for describing effects from hatchery production is not only showing impacts to the human environment where harvests occur, but also showing impacts from spending on labor and other items for hatchery operations and management. The spending makes an impact on regional economies where hatchery operators live and where businesses from which materials and services are purchased are located. This extends to where administration and management (referred to as headquarter costs in the cost analysis) spending occurs. The hatchery operations and headquarter activity impacts are an additional calculation.

The study area is necessarily concerned with "downriver" locations where the hatcheries are located, i.e. where MA production is released and adults are expected to return. The study area consists of the Columbia Basin provinces for Columbia Estuary, Lower Columbia, Columbia Gorge, Columbia Plateau, Columbia Cascade, Blue Mountain, and Mountain Snake. Figure 3.6 shows province boundaries, subbasin boundaries, and county boundaries. Table 3.2 describes how counties are assigned to the study area provinces. The assignment was necessary because demographic data is readily accessible and generally has other study interpretations when political boundaries are used. While impacts on other upriver areas would also likely occur because of the interrelationships between salmon populations (see Chapter 1) and spillover effects from displaced fishing opportunities, the effects are likely not to be qualitatively different. The targeted effects of the changes due to the alternatives being considered would result in impacts that are substantially more focused on the defined study area.

The study area consists of large regions that are primarily agriculture and natural resource oriented. There are several urban concentrations whose historical development was tied to river navigation. While there will be local effects from the alternatives being considered, there will also be relative effects to state economies. Study area population and unemployment trends are shown in Figure 3.7 and 3.8. Provinces with urban population centers, such as the Lower Columbia, grew faster relative to 1969 than the mid-Columbia provinces. The unemployment rate for the provinces is considerably higher than the U.S.

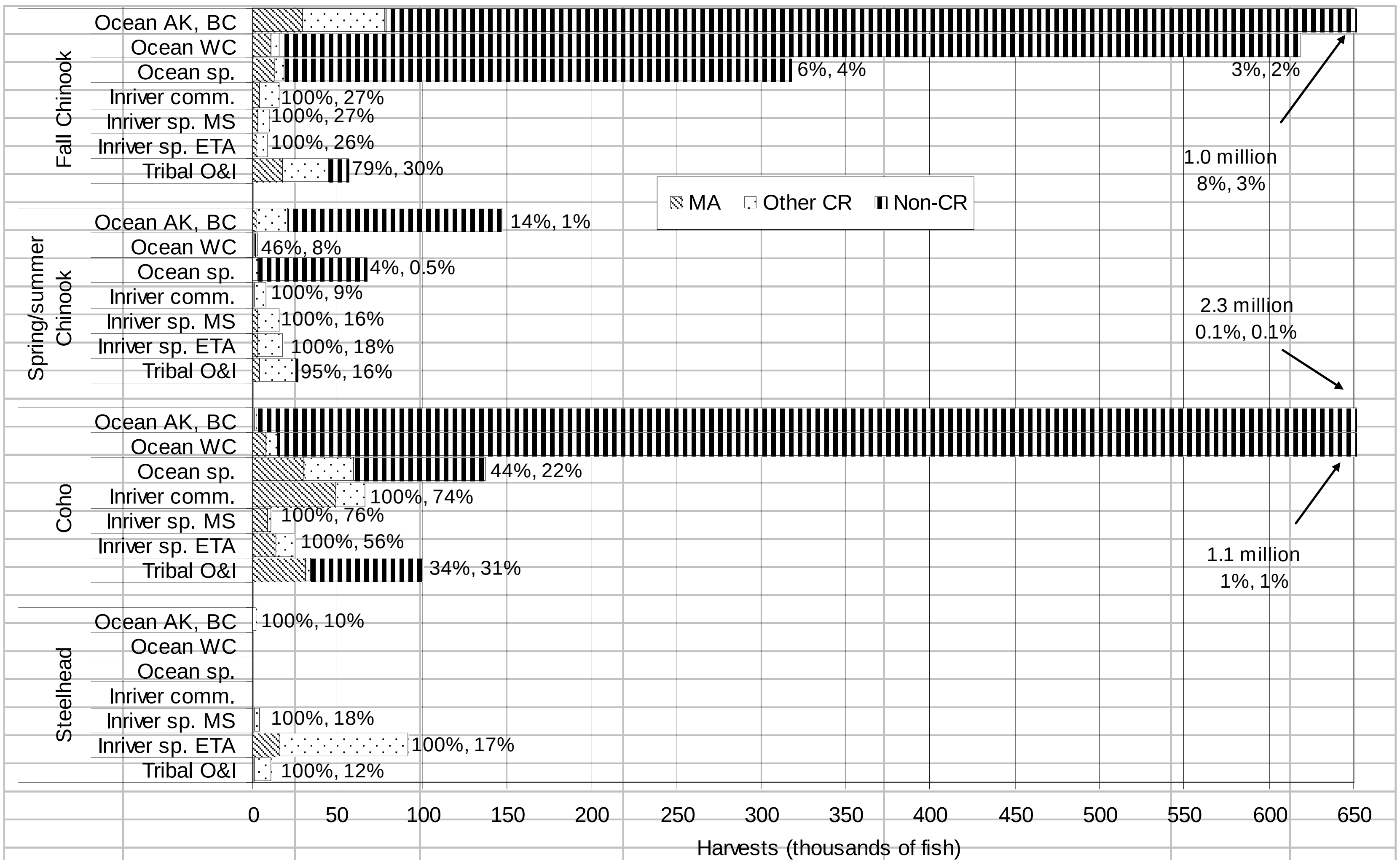
The two states where hatcheries are located (Oregon and Washington) have had similar experiences with divergent forces affecting the urban and rural economies. Each state has a major urban area along the Columbia River that has experienced significant growth in "high tech" industries while rural areas have largely continued to rely on their traditional industries.

Figure 3.4
Governance Depiction for Various Stocks of Salmon and Steelhead Produced in the Columbia River



Source: NMFS (1984).

Figure 3.5
Harvests by Fisheries and by Species for Mitchell Act and Other Population Origins for Status Quo Alternative



Notes: 1.	Abbreviations:	
	Ocean AK, BC	Ocean commercial, Alaska and British Columbia
	Ocean WC	Ocean commercial, West Coast
	Ocean sp.	Ocean sport
	Inriver comm.	Inriver commercial
	Inriver sp. MS	Inriver sport mainstem
	Inriver sp. ETA	Inriver sport extreme terminal area
	Tribal O&I	Tribal ocean and inriver
2.	Percents indicate the share that total Columbia River production and MA funded hatcheries production, respectively, contribute to the shown fisheries.	
3.	Tribal C&S harvests are not included in the shown fisheries.	

Figure 3.6
Columbia River Basin Provinces and Subbasins Superimposed on Counties

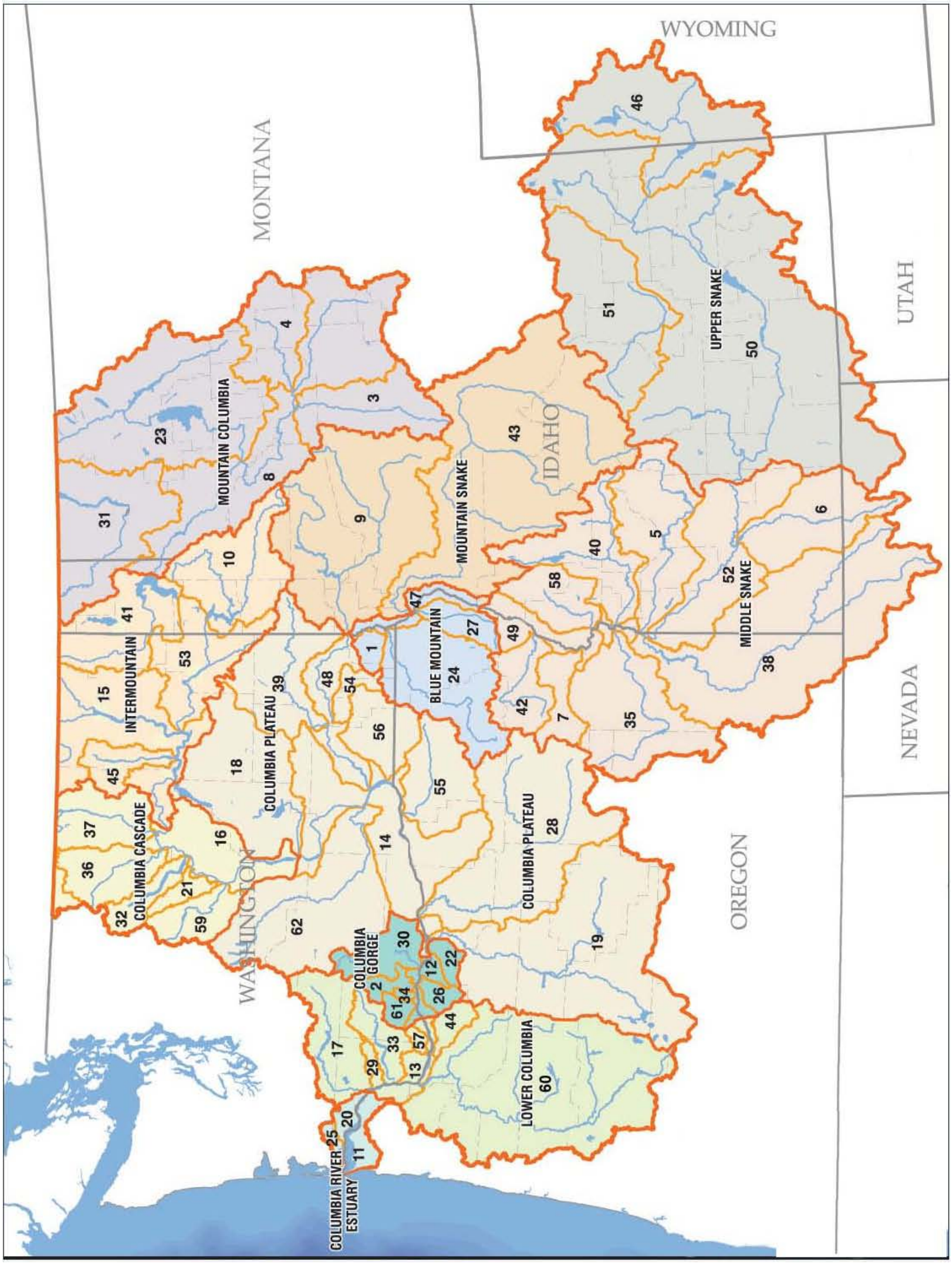


Table 3.2
Major Counties Within Provinces

Province	Major Counties
Columbia Estuary	Pacific, WA
	Wahkiakum, WA
	Clatsop, OR
Lower Columbia	Clark, WA
	Cowlitz, WA
	Lewis, WA
	Columbia, OR
	Linn, OR
	Marion, OR
	Lane, OR
	Benton, OR
	Polk, OR
	Yamhill, OR
	Washington, OR
	Clackamas, OR
	Multnomah, OR
Columbia Gorge	Klickitat, WA
	Skamania, WA
	Hood River, OR
	Wasco, OR

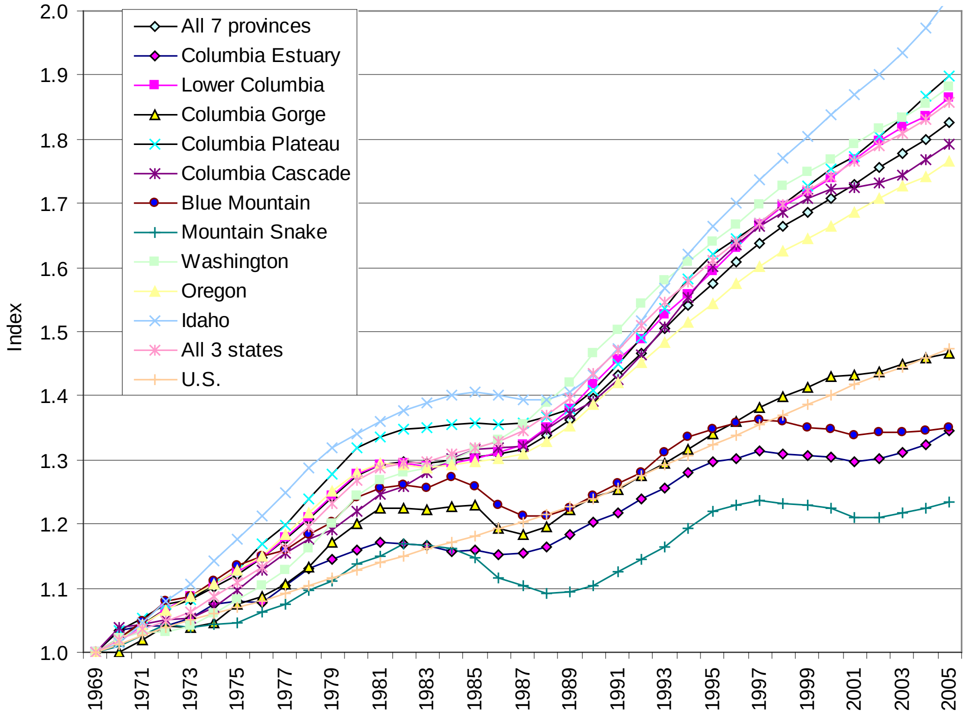
Province	Major Counties
Columbia Plateau	Yakima, WA
	Kittitas, WA
	Benton, WA
	Grant, WA
	Lincoln, WA
	Adams, WA
	Whitman, WA
	Garfield, WA
	Walla Walla, WA
	Columbia, WA
	Franklin, WA
	Latah, ID
	Deschutes, OR
	Crook, OR
	Jefferson, OR
	Sherman, OR
	Gilliam, OR
	Morrow, OR
	Umatilla, OR
	Wheeler, OR
	Grant, OR

Province	Major Counties
Columbia Cascade	Douglas, WA
	Okanogan, WA
	Chelan, WA
Blue Mountain	Asotin, WA
	Union, OR
	Wallowa, OR
Mountain Snake	Idaho, ID
	Clearwater, ID
	Nez Perce, ID
	Lewis, ID
	Custer, ID
	Lemhi, ID
	Valley, ID

Note: Considerations for assigning counties to provinces included relationship of land area, centers of population, and major watersheds to province boundaries. There are small exclusions of land area and, to a lesser extent, population from the assigning.

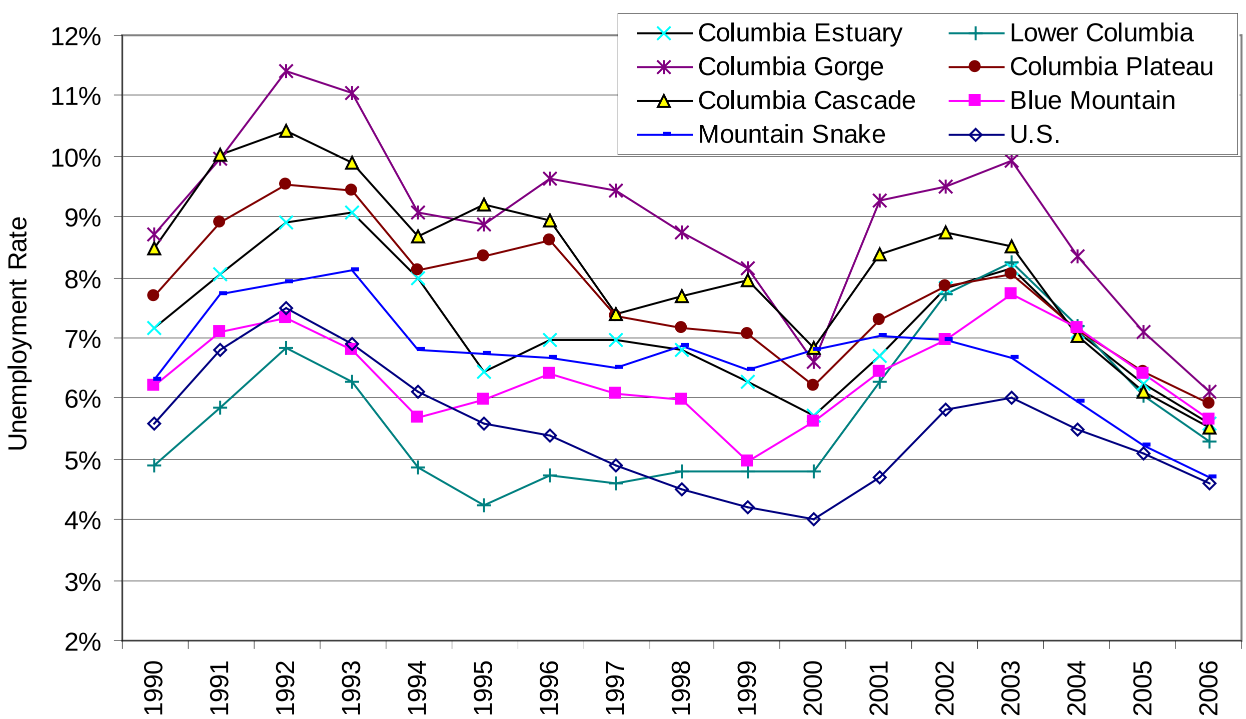
For example, an analysis of high tech employment in Oregon found several of the counties in the mid-Columbia area with no employment related to high tech. Due to the strength of the high tech sectors and the forecasts of continued growth, the impacts from changed policies toward MA funding would be hard to identify. Impacts that should be considered are more focused. Two impact possibilities have been identified. The first is the possibility that downriver commercial and recreational fisheries would be affected. There are no substitute gillnet or tribal commercial fisheries, so effects are probably a linear increase or decrease, depending on the MA policies towards production levels. Within the study area, the Columbia River Gorge is a major recreation destination for the urbanites in the region. Any lost recreational fishing opportunities may be substituted with other types of recreational experiences in the Gorge. The level and extent of these substitutions are conjecture and are not modeled for this EIS. The second effect is that an economy where hatcheries are located and headquarter spending occurs are likely to accrue impacts. The impacts are likely to be proportionately small for headquarter spending that occurs in urban areas and at the state level, but they may affect certain groups or areas disproportionately. Most of the remainder of the discussion will focus on the more direct impacts expected in the downriver locations.

Figure 3.7
Project Province Counties Population Trends in 1969 to 2005



Source: Bureau of Economic Analysis, Regional Economic Information System, Table CA05.

Figure 3.8
Project Provinces and National Unemployment Trends in 1990 to 2006



Source: Bureau of Labor Statistics.

The socioeconomic data for age, gender, race, land density, poverty, income, and employment by province for the study area is presented in Table 3.3.[1] Many of the provinces are sparsely populated. The heavy reliance on agriculture tends to generate higher levels of unemployment, due to the seasonal nature and lower average earnings. Higher poverty rates are seen in these provinces with the highest in the Columbia Plateau (14.5 percent). Large shares of minority groups include blacks in the urban dominated population for the Lower Columbia (2.3 percent) and American Indian (3.9 percent) in the Columbia Cascade Province. Hispanics make up over 22 percent of the population in the Columbia Plateau Province because of their participation in farm worker occupations. The percentage of Asians is shown, but is also low. The share of retirement age population (65 and older) is about the same as the states where the provinces are located.

1. There is a mixture of years for which the data applies. Some of the detailed data is for the most recent decennial census year while employment information is more current.

Table 3.3
Columbia Basin Demographic Profile by Selected Provinces

	By Race												By Hispanic Origin			
	White	Share	Black	Share	Am. Indian/ AK Native	Share	Asian	Share	Hawaiian/ Pac. Islander	Share	Two or more races	Share	Hispanic or Latino Origin	Share	Not Hispanic, White alone	Share
All counties																
Washington	5,420,961	84.8%	227,926	3.6%	104,405	1.6%	422,039	6.6%	29,703	0.5%	190,764	3.0%	581,357	9.1%	4,895,065	76.5%
Oregon	3,348,473	90.5%	68,610	1.9%	51,209	1.4%	133,740	3.6%	10,277	0.3%	88,449	2.4%	379,038	10.2%	2,996,271	81.0%
Idaho	1,396,543	95.2%	9,534	0.7%	20,897	1.4%	15,918	1.1%	1,841	0.1%	21,732	1.5%	138,870	9.5%	1,266,216	86.3%
Total	10,165,977	87.9%	306,070	2.6%	176,511	1.5%	571,697	4.9%	41,821	0.4%	300,945	2.6%	1,099,265	9.5%	9,157,552	79.2%
U.S.	239,746,254	80.1%	38,342,549	12.8%	2,902,851	1.0%	13,159,343	4.4%	528,818	0.2%	4,718,669	1.6%	44,321,038	14.8%	198,744,494	66.4%
Project area counties																
Washington	1,402,035	92.1%	20,225	1.3%	30,132	2.0%	35,028	2.3%	3,668	0.2%	30,433	2.0%	269,772	17.7%	1,145,804	75.3%
Oregon	2,717,867	89.7%	65,303	2.2%	38,444	1.3%	126,825	4.2%	9,223	0.3%	72,174	2.4%	329,747	10.9%	2,411,357	79.6%
Idaho	114,371	93.6%	526	0.4%	3,496	2.9%	1,615	1.3%	105	0.1%	2,028	1.7%	3,215	2.6%	111,529	91.3%
Total	4,234,273	90.6%	86,054	1.8%	72,072	1.5%	163,468	3.5%	12,996	0.3%	104,635	2.2%	602,734	12.9%	3,668,690	78.5%
Washington	1,402,035	92.1%	20,225	1.3%	30,132	2.0%	35,028	2.3%	3,668	0.2%	30,433	2.0%	269,772	17.7%	1,145,804	75.3%
Columbia Estuary	23,858	92.6%	78	0.3%	626	2.4%	478	1.9%	41	0.2%	680	2.6%	1,420	5.5%	22,551	87.5%
Lower Columbia	536,525	91.5%	9,511	1.6%	6,447	1.1%	18,151	3.1%	1,892	0.3%	13,902	2.4%	35,910	6.1%	503,567	85.9%
Columbia Gorge	29,224	93.8%	104	0.3%	939	3.0%	193	0.6%	80	0.3%	628	2.0%	2,311	7.4%	27,064	86.8%
Columbia Plateau	655,753	92.4%	9,792	1.4%	16,102	2.3%	14,796	2.1%	1,441	0.2%	12,187	1.7%	200,437	28.2%	463,973	65.3%
Columbia Cascade	136,338	92.8%	676	0.5%	5,737	3.9%	1,250	0.9%	209	0.1%	2,636	1.8%	29,173	19.9%	108,776	74.1%
Blue Mountain	20,337	95.7%	64	0.3%	281	1.3%	160	0.8%	5	0.0%	400	1.9%	521	2.5%	19,873	93.5%
Oregon	2,717,867	89.7%	65,303	2.2%	38,444	1.3%	126,825	4.2%	9,223	0.3%	72,174	2.4%	329,747	10.9%	2,411,357	79.6%
Columbia Estuary	35,241	94.4%	300	0.8%	460	1.2%	539	1.4%	85	0.2%	690	1.8%	2,287	6.1%	33,163	88.9%
Lower Columbia	2,338,762	89.0%	62,981	2.4%	28,627	1.1%	122,908	4.7%	8,349	0.3%	65,187	2.5%	287,538	10.9%	2,071,874	78.9%
Columbia Gorge	42,235	93.3%	276	0.6%	1,228	2.7%	594	1.3%	196	0.4%	716	1.6%	8,319	18.4%	34,300	75.8%
Columbia Plateau	271,941	94.0%	1,588	0.5%	7,825	2.7%	2,449	0.8%	349	0.1%	5,090	1.8%	30,664	10.6%	243,190	84.1%
Blue Mountain	29,688	95.1%	158	0.5%	304	1.0%	335	1.1%	244	0.8%	491	1.6%	939	3.0%	28,830	92.3%
Idaho	114,371	93.6%	526	0.4%	3,496	2.9%	1,615	1.3%	105	0.1%	2,028	1.7%	3,215	2.6%	111,529	91.3%
Columbia Plateau	32,717	93.4%	311	0.9%	328	0.9%	995	2.8%	55	0.2%	623	1.8%	1,053	3.0%	31,758	90.7%
Mountain Snake	81,654	93.7%	215	0.2%	3,168	3.6%	620	0.7%	50	0.1%	1,405	1.6%	2,162	2.5%	79,771	91.6%
Total	4,234,273	90.6%	86,054	1.8%	72,072	1.5%	163,468	3.5%	12,996	0.3%	104,635	2.2%	602,734	12.9%	3,668,690	78.5%
Columbia Estuary	59,099	93.7%	378	0.6%	1,086	1.7%	1,017	1.6%	126	0.2%	1,370	2.2%	3,707	5.9%	55,714	88.3%
Lower Columbia	2,875,287	89.5%	72,492	2.3%	35,074	1.1%	141,059	4.4%	10,241	0.3%	79,089	2.5%	323,448	10.1%	2,575,441	80.2%
Columbia Gorge	71,459	93.5%	380	0.5%	2,167	2.8%	787	1.0%	276	0.4%	1,344	1.8%	10,630	13.9%	61,364	80.3%
Columbia Plateau	960,411	92.9%	11,691	1.1%	24,255	2.3%	18,240	1.8%	1,845	0.2%	17,900	1.7%	232,154	22.4%	738,921	71.4%
Columbia Cascade	136,338	92.8%	676	0.5%	5,737	3.9%	1,250	0.9%	209	0.1%	2,636	1.8%	29,173	19.9%	108,776	74.1%
Blue Mountain	50,025	95.3%	222	0.4%	585	1.1%	495	0.9%	249	0.5%	891	1.7%	1,460	2.8%	48,703	92.8%
Mountain Snake	81,654	93.7%	215	0.2%	3,168	3.6%	620	0.7%	50	0.1%	1,405	1.6%	2,162	2.5%	79,771	91.6%

Table 3.3 (cont.)

	Resident Population	Share	By Age: Under 18 Years	Share	18 to 64	Share	65 and Over	Share	By Gender: Female	Share	Male	Share
All counties												
Washington	6,395,798	100%	1,526,267	23.9%	4,131,162	64.6%	738,369	11.5%	3,204,295	50.1%	3,191,503	49.9%
Oregon	3,700,758	100%	856,259	23.1%	2,366,319	63.9%	478,180	12.9%	1,861,481	50.3%	1,839,277	49.7%
Idaho	1,466,465	100%	394,280	26.9%	903,012	61.6%	169,173	11.5%	727,367	49.6%	739,098	50.4%
Total	11,563,021	100%	2,776,806	24.0%	7,400,493	64.0%	1,385,722	12.0%	5,793,143	50.1%	5,769,878	49.9%
U.S.	299,398,484	100%	73,735,562	24.6%	188,402,570	62.9%	37,260,352	12.4%	151,795,031	50.7%	147,603,453	49.3%
Project area counties												
Washington	1,521,521	100%	399,169	26.2%	941,094	61.9%	181,258	11.9%	761,000	50.0%	760,521	50.0%
Oregon	3,029,836	100%	713,728	23.6%	1,960,157	64.7%	355,951	11.7%	1,519,481	50.2%	1,510,355	49.8%
Idaho	122,141	100%	25,439	20.8%	77,825	63.7%	18,877	15.5%	59,656	48.8%	62,485	51.2%
Total	4,673,498	100%	1,138,336	24.4%	2,979,076	63.7%	556,086	11.9%	2,340,137	50.1%	2,333,361	49.9%
Washington	1,521,521	100%	399,169	26.2%	941,094	61.9%	181,258	11.9%	761,000	50.0%	760,521	50.0%
Columbia Estuary	25,761	100%	4,933	19.1%	15,069	58.5%	5,759	22.4%	13,049	50.7%	12,712	49.3%
Lower Columbia	586,428	100%	149,156	25.4%	370,564	63.2%	66,708	11.4%	294,660	50.2%	291,768	49.8%
Columbia Gorge	31,168	100%	7,097	22.8%	19,741	63.3%	4,330	13.9%	15,571	50.0%	15,597	50.0%
Columbia Plateau	710,071	100%	196,170	27.6%	434,761	61.2%	79,140	11.1%	352,772	49.7%	357,299	50.3%
Columbia Cascade	146,846	100%	36,886	25.1%	88,425	60.2%	21,535	14.7%	73,900	50.3%	72,946	49.7%
Blue Mountain	21,247	100%	4,927	23.2%	12,534	59.0%	3,786	17.8%	11,048	52.0%	10,199	48.0%
Oregon	3,029,836	100%	713,728	23.6%	1,960,157	64.7%	355,951	11.7%	1,519,481	50.2%	1,510,355	49.8%
Columbia Estuary	37,315	100%	7,915	21.2%	23,369	62.6%	6,031	16.2%	18,919	50.7%	18,396	49.3%
Lower Columbia	2,626,814	100%	618,955	23.6%	1,708,704	65.0%	299,155	11.4%	1,317,276	50.1%	1,309,538	49.9%
Columbia Gorge	45,245	100%	11,165	24.7%	27,361	60.5%	6,719	14.9%	22,920	50.7%	22,325	49.3%
Columbia Plateau	289,242	100%	68,952	23.8%	181,456	62.7%	38,834	13.4%	144,534	50.0%	144,708	50.0%
Blue Mountain	31,220	100%	6,741	21.6%	19,267	61.7%	5,212	16.7%	15,833	50.7%	15,387	49.3%
Idaho	122,141	100%	25,439	20.8%	77,825	63.7%	18,877	15.5%	59,656	48.8%	62,485	51.2%
Columbia Plateau	35,029	100%	6,774	19.3%	24,783	70.7%	3,472	9.9%	16,709	47.7%	18,320	52.3%
Mountain Snake	87,112	100%	18,665	21.4%	53,042	60.9%	15,405	17.7%	42,947	49.3%	44,165	50.7%
Total	4,673,498	100%	1,138,336	24.4%	2,979,076	63.7%	556,086	11.9%	2,340,137	50.1%	2,333,361	49.9%
Columbia Estuary	63,076	100%	12,848	20.4%	38,438	60.9%	11,790	18.7%	31,967	50.7%	31,109	49.3%
Lower Columbia	3,213,242	100%	768,111	23.9%	2,079,268	64.7%	365,863	11.4%	1,611,936	50.2%	1,601,306	49.8%
Columbia Gorge	76,413	100%	18,262	23.9%	47,102	61.6%	11,049	14.5%	38,490	50.4%	37,923	49.6%
Columbia Plateau	1,034,342	100%	271,896	26.3%	641,000	62.0%	121,446	11.7%	514,015	49.7%	520,327	50.3%
Columbia Cascade	146,846	100%	36,886	25.1%	88,425	60.2%	21,535	14.7%	73,900	50.3%	72,946	49.7%
Blue Mountain	52,467	100%	11,668	22.2%	31,801	60.6%	8,998	17.1%	26,881	51.2%	25,586	48.8%
Mountain Snake	87,112	100%	18,665	21.4%	53,042	60.9%	15,405	17.7%	42,947	49.3%	44,165	50.7%

Table 3.3 (cont.)

	Land Area (Sq. Miles)	Share	Pop. Per Sq. Mile	Land in Farms in 2002 (acres)	Land in Farms in 2002 (percent)	Education 2000 >25 HS Graduate (percent)	Education 2000 >25 College Graduate (percent)	Commute Time in 2000 (minutes)	Median Household Income in 2004	Population in Poverty in 2004 (percent)	Percent of Housing Occupants Per Room >1.00	Percent of Housing Lacking Complete Plumbing
All counties												
Washington	66,544	27%	96.1	15,318,008	36.0%	87.1%	27.7%	25.5	48,438	11.6%	5.1%	0.5%
Oregon	95,997	39%	38.6	17,080,422	27.8%	85.1%	25.1%	22.2	42,568	12.9%	4.8%	0.5%
Idaho	82,747	34%	17.7	11,767,294	22.2%	84.7%	21.7%	20.0	40,509	11.5%	4.9%	0.6%
Total	245,288	100%	47.1	44,165,724	28.1%	86.2%	26.1%	23.7	45,554	12.0%	5.0%	0.5%
U.S.	3,537,438		84.6	938,279,056	41.4%	80.4%	24.4%	25.5	44,334	12.7%	5.7%	0.6%
Project area counties												
Washington	41,011	37%	37.1	12,623,522	48.1%	80.4%	19.6%	21.3	43,205	14.0%	7.3%	0.6%
Oregon	44,056	39%	68.8	11,048,212	39.2%	85.8%	27.0%	22.8	45,392	12.4%	5.0%	0.5%
Idaho	26,518	24%	4.6	1,980,153	11.7%	86.4%	24.6%	18.0	36,373	12.5%	2.8%	0.6%
Total	111,586	100%	41.9	25,651,887	35.9%	84.1%	24.5%	22.2	44,444	12.9%	5.6%	0.5%
Washington	41,011	100%	37.1	12,623,522	48.1%	80.4%	19.6%	21.3	43,205	14.0%	7.3%	0.6%
Columbia Estuary	1,197	3%	21.5	64,210	8.4%	79.7%	15.1%	21.9	34,376	13.8%	3.9%	0.8%
Lower Columbia	4,175	10%	140.5	241,226	9.0%	86.1%	19.4%	24.2	48,650	12.2%	4.4%	0.4%
Columbia Gorge	3,529	9%	8.8	612,506	27.1%	83.2%	16.5%	24.4	39,277	13.8%	5.4%	1.2%
Columbia Plateau	21,465	52%	33.1	9,192,981	66.9%	75.9%	20.3%	19.4	40,491	15.4%	9.9%	0.6%
Columbia Cascade	10,010	24%	14.7	2,232,206	34.8%	78.2%	18.9%	18.6	38,051	14.4%	8.0%	1.4%
Blue Mountain	635	2%	33.4	280,393	69.0%	85.8%	18.0%	16.8	35,672	15.4%	2.8%	0.5%
Oregon	44,056	100%	68.8	11,048,212	39.2%	85.8%	27.0%	22.8	45,392	12.4%	5.0%	0.5%
Columbia Estuary	827	2%	45.1	22,234	4.2%	85.6%	19.1%	19.5	37,703	13.0%	2.9%	0.9%
Lower Columbia	13,847	31%	189.7	1,899,449	21.4%	86.2%	28.1%	23.5	46,081	12.3%	5.0%	0.5%
Columbia Gorge	2,903	7%	15.6	1,115,881	60.1%	80.2%	19.2%	18.8	37,639	13.6%	6.0%	0.8%
Columbia Plateau	21,297	48%	13.6	7,014,127	51.5%	83.5%	20.0%	18.7	42,292	12.4%	5.0%	0.6%
Blue Mountain	5,182	12%	6.0	996,521	30.0%	86.0%	21.5%	16.6	36,563	13.5%	2.5%	0.6%
Idaho	26,518	100%	4.6	1,980,153	11.7%	86.4%	24.6%	18.0	36,373	12.5%	2.8%	0.6%
Columbia Plateau	1,077	4%	32.5	340,115	49.4%	91.0%	41.0%	17.9	36,346	13.5%	3.1%	0.7%
Mountain Snake	25,442	96%	3.4	1,640,038	10.1%	84.5%	18.0%	18.1	36,384	12.2%	2.6%	0.6%
Total	111,586	100%	41.9	25,651,887	35.9%	84.1%	24.5%	22.2	44,444	12.9%	5.6%	0.5%
Columbia Estuary	2,024	2%	31.2	86,444	6.7%	83.2%	17.5%	20.5	36,344	13.3%	3.3%	0.9%
Lower Columbia	18,022	16%	178.3	2,140,675	18.6%	86.2%	26.5%	23.6	46,550	12.3%	4.9%	0.4%
Columbia Gorge	6,432	6%	11.9	1,728,387	42.0%	81.4%	18.1%	21.1	38,308	13.7%	5.8%	0.9%
Columbia Plateau	43,839	39%	23.6	16,547,223	59.0%	78.5%	20.9%	19.1	40,855	14.5%	8.3%	0.6%
Columbia Cascade	10,010	9%	14.7	2,232,206	34.8%	78.2%	18.9%	18.6	38,051	14.4%	8.0%	1.4%
Blue Mountain	5,817	5%	9.0	1,276,914	34.3%	85.9%	20.1%	16.7	36,202	14.3%	2.6%	0.6%
Mountain Snake	25,442	23%	3.4	1,640,038	10.1%	84.5%	18.0%	18.1	36,384	12.2%	2.6%	0.6%

Table 3.3 (cont.)

									Employment			
			Per Capita	Personal Income (thousands)						Wage and		Unemployment
	Population	Share	Income	Total	Share	Net Earnings	Dividends	Transfers	Total	Salary	Proprietors	Rate
All counties												
Washington	6,291,899	55%	35,479	223,232,089	59%	156,808,269	36,560,323	29,863,497	3,733,429	3,027,812	705,617	4.9%
Oregon	3,638,871	32%	32,289	117,497,280	31%	78,533,266	21,415,219	17,548,795	2,232,693	1,770,547	462,146	5.4%
Idaho	1,429,367	13%	28,478	40,706,031	11%	27,333,884	7,346,099	6,026,048	868,365	665,650	202,715	3.2%
Total	11,360,137	100%	33,577	381,435,400	100%	262,675,419	65,321,641	53,438,340	6,834,487	5,464,009	1,370,478	4.8%
U.S.	296,507,061		34,471	10,220,942,000		7,103,199,000	1,591,151,000	1,526,592,000	174,249,600	140,967,000	33,282,600	4.6%
Project area counties												
Washington	1,496,113	33%	27,292	40,832,000	29%	26,951,148	6,235,066	7,645,786	753,793	599,573	154,220	6.1%
Oregon	2,973,318	65%	33,349	99,156,248	69%	68,057,384	17,621,811	13,477,053	1,863,372	1,497,343	366,029	5.2%
Idaho	121,009	3%	26,766	3,238,903	2%	1,921,622	685,801	631,480	77,640	57,930	19,710	4.2%
Total	4,590,440	100%	31,201	143,227,151	100%	96,930,154	24,542,678	21,754,319	2,694,805	2,154,846	539,959	5.5%
Washington	1,496,113	100%	27,292	40,832,000	100%	26,951,148	6,235,066	7,645,786	753,793	599,573	154,220	6.1%
Columbia Estuary	25,453	2%	24,543	624,703	2%	306,774	131,605	186,324	11,594	8,141	3,453	6.6%
Lower Columbia	573,641	38%	29,519	16,933,396	41%	11,635,297	2,529,762	2,768,337	260,695	203,353	57,342	6.1%
Columbia Gorge	30,453	2%	25,777	784,997	2%	469,434	146,396	169,167	12,417	8,578	3,839	7.1%
Columbia Plateau	700,883	47%	25,637	17,968,593	44%	11,721,293	2,678,028	3,569,272	371,759	304,013	67,746	6.2%
Columbia Cascade	144,633	10%	27,256	3,942,094	10%	2,483,059	648,535	810,500	89,008	69,520	19,488	5.5%
Blue Mountain	21,050	1%	27,469	578,217	1%	335,291	100,740	142,186	8,320	5,968	2,352	4.8%
Oregon	2,973,318	100%	33,349	99,156,248	100%	68,057,384	17,621,811	13,477,053	1,863,372	1,497,343	366,029	5.2%
Columbia Estuary	36,842	1%	28,854	1,063,057	1%	671,755	195,173	196,129	23,307	17,614	5,693	5.0%
Lower Columbia	2,580,192	87%	34,116	88,024,903	89%	61,108,350	15,399,031	11,517,522	1,626,777	1,321,444	305,333	5.1%
Columbia Gorge	44,876	2%	26,839	1,204,423	1%	722,442	254,926	227,055	27,981	21,643	6,338	5.5%
Columbia Plateau	280,045	9%	28,550	7,995,278	8%	5,046,767	1,596,924	1,351,587	165,195	122,854	42,341	5.5%
Blue Mountain	31,363	1%	27,695	868,587	1%	508,070	175,757	184,760	20,112	13,788	6,324	6.2%
Idaho	121,009	100%	26,766	3,238,903	100%	1,921,622	685,801	631,480	77,640	57,930	19,710	4.2%
Columbia Plateau	34,990	29%	26,458	925,764	29%	615,537	182,108	128,119	21,537	16,519	5,018	3.0%
Mountain Snake	86,019	71%	26,891	2,313,139	71%	1,306,085	503,693	503,361	56,103	41,411	14,692	4.7%
Total	4,590,440	100%	31,201	143,227,151	100%	96,930,154	24,542,678	21,754,319	2,694,805	2,154,846	539,959	5.5%
Columbia Estuary	62,295	1%	27,093	1,687,760	1%	978,529	326,778	382,453	34,901	25,755	9,146	5.6%
Lower Columbia	3,153,833	69%	33,280	104,958,299	73%	72,743,647	17,928,793	14,285,859	1,887,472	1,524,797	362,675	5.3%
Columbia Gorge	75,329	2%	26,410	1,989,420	1%	1,191,876	401,322	396,222	40,398	30,221	10,177	6.1%
Columbia Plateau	1,015,918	22%	26,468	26,889,635	19%	17,383,597	4,457,060	5,048,978	558,491	443,386	115,105	5.9%
Columbia Cascade	144,633	3%	27,256	3,942,094	3%	2,483,059	648,535	810,500	89,008	69,520	19,488	5.5%
Blue Mountain	52,413	1%	27,604	1,446,804	1%	843,361	276,497	326,946	28,432	19,756	8,676	5.6%
Mountain Snake	86,019	2%	26,891	2,313,139	2%	1,306,085	503,693	503,361	56,103	41,411	14,692	4.7%

Sources: U.S. Bureau of Census (data year 2006); U.S. Bureau of Economic Analysis, Regional Economic Information System, Table CA05 and CA25 (data year 2005); and Bureau of Labor Statistics (data year 2006).

3.3.4 Fisheries

3.3.4.1 Harvesting

As previously noted in this section, MA supported production contributes to ocean fisheries from Oregon north to southeast Alaska, as well as Columbia River inland fisheries. This is consistent with the migration patterns of Columbia River Basin produced salmon: north turning fish (fall Chinook), south turning fish (coho), and some that tend to migrate in either direction (some of the above). Steelhead tend to scatter and migrate as far as Russian waters. Harvest amounts by geographic area depend on migration patterns and on governance intended to allocate benefits aligned with production origin.

Because salmon range over a large geographic area both in the ocean and in inland waters, production and harvest management is very complex. As previously discussed, there are five general governance items that give direction to production and harvest management. These five are the principles in international agreements on salmon interceptions, the PST, MSA leading to the PFMC Salmon Management Plan, Columbia River ESA listed recovery stocks' harvest impact constraints, and user group allocation agreements.[1] The ESA restricts the amount of wild salmon that may be harvested directly or indirectly once a species or sub-species has been placed on the threatened or endangered species list. Any plans or management that might affect production or harvests from Columbia River hatcheries have to address some or all of these governance requirements.

The harvest modeling for the commercial and recreational fisheries developed for the EIS were based on early 2000's production and exploitation rates. Table 3.4 shows harvests of MA production for the status quo alternative and percent contribution of MA production adults to total harvests.[2]

The main fisheries in which MA funded hatchery operations contribute are the U.S. West Coast ocean commercial and recreational fall Chinook north of Cape Falcon (22 percent), the ocean recreational coho north of Cape Falcon (23 percent), the ocean commercial and recreational coho south of Cape Falcon (18 percent), and of course river fisheries. The MA funded contribution is about 52 percent of all commercial harvests and 27 percent of all recreational harvests across all species in the Columbia River salmon fisheries. There is some contribution to the ocean tribal commercial and C&S fishery north of Cape Falcon (34 percent fall Chinook and three percent coho). The overall contribution to fisheries masks the importance of certain MA funded hatchery individual population production. Some of the production is solely for recovery objectives. Other production where harvest augmentation is an objective is tied to the implementation of the PST, such as the ODFW Big Creek tule fall Chinook population. This

---

1. User groups in this sense are regional commercial, tribal, and recreational participants that have homogeneous interests and compete for access to salmon and steelhead in regional fisheries. For example, the southeast Alaska commercial salmon fishery is one user group. The lower Columbia River recreational fishery is another user group.
2. The status quo alternative is not a snapshot of a certain time, but a representation of recent conditions. The harvests are itemized by fisheries and by species.

Table 3.4
Harvests From MA Funded Production and Share of Total by Fisheries and by Species for Status Quo Alternative

	Fall Ch.		Spr./Sum. Ch.		Coho		Winter St.		Summer St.		Total	
Fishery	Count	Share	Count	Share	Count	Share	Count	Share	Count	Share	Count	Share
West Coast Ocean												
Alaska	6,971	8%	360	2%	1	0.0001%					7,333	0%
a) Commercial	6,676	8%	346	2%	1	0.0001%					7,023	0%
b) Sport	295	6%	14	2%							309	6%
British Columbia	24,715	2%	1,337	1%	1,243	0.2%	104	43%	80	5%	27,479	1%
a) Commercial	22,833	3%	1,298	1%	1,232	0.2%	104	43%	80	5%	25,547	2%
b) Sport	1,883	1%	39	0%	11	0.3%					1,933	1%
Subtotal Alaska/B.C. harvest	31,687	3%	1,697	1%	1,244	0.1%	104	43%	80	5%	34,812	1%
North of Cape Falcon	24,199	22%	616	8%	32,045	2%					56,860	4%
a) Commercial	16,971	19%	429	8%	9,242	1%					26,642	2%
- Non-tribal	9,522	14%	238	8%	6,869	1%					16,629	1%
- Tribal	7,449	34%	192	8%	2,372	3%					10,013	11%
b) Sport	7,229	34%	186	8%	22,804	23%					30,218	24%
Washington Puget Sound	4,482	1%	83	3%							4,565	1%
a) Commercial	1,630	0%	3	5%							1,633	0%
b) Sport	2,852	4%	80	3%							2,932	4%
South of Cape Falcon					8,970	18%					8,970	18%
a) Commercial					1,249	7%					1,249	7%
b) Sport					7,721	24%					7,721	24%
Columbia Basin Inland	18,768	27%	10,517	16%	99,365	76%	9,745	60%	7,567	8%	145,962	39%
a) Commercial	13,938	28%	4,825	15%	77,463	81%	60	42%	1,212	12%	97,497	52%
- Lower mainstem gillnet	4,193	27%	718	9%	48,623	74%					53,534	60%
- Tribal	9,744	28%	4,108	17%	28,840	98%	60	42%	1,212	12%	43,963	44%
b) Sport	4,830	27%	5,692	17%	21,903	62%	9,686	60%	6,355	8%	48,465	27%
- Mainstem	2,646	27%	2,480	16%	8,439	76%	363	36%	354	12%	14,282	35%
- Lower	2,042	27%	2,373	16%	768	76%	363	36%	354	12%	5,900	22%
- Buoy 10	537	27%			7,573	76%					8,110	68%
- Upper	66	27%	107	16%	99	76%					272	26%
- Terminal	2,184	26%	3,212	18%	13,463	56%	9,323	62%	6,001	8%	34,183	24%
Total Harvest	79,136	4%	12,913	5%	141,625	4%	9,849	60%	7,647	8%	251,169	4%
Hatchery returns	67,012		9,068		66,010		3,679		1,410		147,178	
a) Hatchery market	16,753		2,267		16,502		920		353		36,795	
- Food fish	8,376		1,133		8,251		460		176		18,397	
- Carcass	8,376		1,133		8,251		460		176		18,397	
b) Other	50,259		6,801		49,507		2,759		1,058		110,384	

Notes: 1. North of Falcon catch area includes mouth-of-Columbia, coastal Washington to U.S.-Canada border, and Strait of Juan de Fuca. Landing ports include Astoria, Ilwaco/Chinook, Westport, Neah Bay, and La Push. South of Falcon catch area includes Oregon ports south of Astoria, and all California ports.

2. All steelhead marine harvest is assumed to be British Columbia commercial. All steelhead tribal is from above Bonneville Dam catch areas. Non-Columbia R. origin are not shown in ocean region harvests.

3. Sport terminal catch areas can be above Bonneville mainstem or tributaries.

4. Hatchery returns include broodstock collection and hatchery surplus. Carcass sales include broodstock fish. Hatchery surplus fish assume 25% enter the market, half edible and half inedible carcass. "Other" surplus are not marketed, so have no dollar value. Egg sales are not included as a hatchery surplus revenue source.

Source: Mobrand (Larry Lestelle) April 2008 data version for Chinook and coho harvest. Mobrand (Greg Blair) August 2008 data version for steelhead harvests, all species hatchery returns, and all species hatchery production.

population is an index of abundance for which regional fisheries catch sharing plans are benchmarked.

The federal government must protect tribal fishing rights guaranteed to Columbia River Indian tribes in treaties as reaffirmed in court decisions (see Section 3.3.1). The federal government must also fulfill federal tribal trust responsibilities to all tribal entities. Table 3.5 is provided to summarize the existing harvest situation using the status quo alternative for tribal and other river fisheries. Across all species in Columbia River fisheries, tribal catch is about 44 percent from MA funded production, ranging from 17 percent of spring Chinook to 98 percent of coho. Harvest management to fulfill the tribal treaty and trust responsibilities has been predicated on these relative MA funded hatchery contributions. If the MA hatchery production strategies change, then management regimes will have to be adjusted so that the relative harvest shares are brought back into governance requirements. The consequences chapter shows similar tables for EIS alternatives and shows how the MA hatchery production changes impact regional economies.

Table 3.5
Columbia Basin Inland Harvests by Species Population Origins and by Fishery for Status Quo Alternative

		Commercial			Sport					
		Mainstem			Mainstem			Extreme		
		Gillnet	Tribal	Subtotal	Lower	Buoy 10	Upper	Terminal	Subtotal	Total
Fall Chinook										
	MA only	4,193	9,744	13,938	2,042	537	66	2,184	4,830	18,768
	All CR origin	15,669	34,807	50,477	7,476	1,967	243	8,536	18,221	68,698
Spring/summer Chinook										
	MA only	718	4,108	4,825	2,373	0	107	3,212	5,692	10,517
	All CR origin	7,898	24,322	32,220	14,768	0	664	17,795	33,227	65,447
Coho										
	MA only	48,623	28,840	77,463	768	7,573	99	13,463	21,903	99,365
	All CR origin	66,043	29,406	95,449	1,009	9,953	130	24,054	35,146	130,595
Summer steelhead										
	MA only	0	1,212	1,212	354	0	0	6,001	6,355	7,567
	All CR origin	0	10,414	10,414	3,030	0	0	76,584	79,614	90,027
Winter steelhead										
	MA only	0	60	60	363	0	0	9,323	9,686	9,745
	All CR origin	0	143	143	1,013	0	0	15,143	16,156	16,298
Total										
	MA only	53,534	43,963	97,497	5,900	8,110	272	34,183	48,465	145,962
	All CR origin	89,611	99,091	188,702	27,295	11,920	1,037	142,112	182,364	371,066
	Notes: 1.	All Columbia River origin includes natural and hatchery production.								

3.3.4.2 Processing and Markets

3.3.4.2.1 Processing

There were 61 different processor businesses that purchased Columbia River commercial gillnet and tribal caught salmon in 2007. Table 3.6 shows processor counts by purchase categories. There are four types of fish receiver/processors aligned with their operational characteristics are:

1. Fish receiver that buys for their own marketing purposes. These may be a retail market in Seattle or Portland, or a farmer's market in the Portland or Seattle area.

2. Buyer that purchases mainly for their own value added purposes. Product forms may include smoking and/or canning.

3. Tender and buyer that purchases mostly for resale to other larger processors.

4. Medium and large processor. Receives fish and sells them to distributors or hauls them to Seattle for further processing and marketing. Much of the lower Columbia River gillnet harvests involve tendering. The seasons are very short and the harvesters do not want to leave their fishing grounds to make deliveries. The tender/receiver weighs them, ices the fish, and grades them out. The tender also makes out the fish tickets. The fish tickets are made out in the fish processor name or in their name. The fish processor supplies ice, the transportation, and pays the harvester. They receive from $0.15 to $0.25 per pound, depending on the species. Tribal set net fisheries can be left to soak, but must be tended at least once per day. Tribal harvesters will make individual arrangement for selling to a processor.

Table 3.6
Processor Types for Columbia River Commercial and Tribal Salmon Purchases in 2007

	Counts			
Category	<$10,000	<$100,000	$100,000+	Total
Tribal purchases	8	6	7	21
Gillnet purchases	26	15	5	46
Total	30	20	11	61
Notes: 1.	Itemized counts will not sum to totals, because processors may purchase from both gillnet and tribal harvesters.			
2.	The counts may be an over estimate of actual processing businesses, because one business can hold more than one license under which fish tickets are issued.			
3.	Harvesters that have direct sales to the public are included in the counts.			
4.	Purchase categories are only salmon and steelhead with area-of-catch from Columbia River locations.			

Source: PacFIN annual vessel summary, March 2008 extraction.

There are five larger processors in the Astoria area that receive, process, and market fish harvested from the lower Columbia River gillnet fishery. The larger processors will have total sales over $5 million. Their operation generally receives the fish from the tender. The processor guts the fish, and in some cases removes the head, re-ices, and sells the fish to a distributor or sends the fish to be put into cold storage. Very little is processed into fillets etc. in the Astoria area. Purchases are hauled to cold storage and processing facilities in the Seattle/Bellingham area. There are seven large processors with similar sales and manufacturing characteristics that purchase commercial tribal fisheries.

CRITFC sponsored a feasibility study to develop a tribal owned and operated processing center at East White Salmon, Washington on an in-lien fishing access site. The Corps of Engineers provided project management for its construction in 2006. A new tribal entity will be formed to operate the center.

Hatchery escapements that are surplus fish (over and above needed for propagation) may be sold to processors or rendering businesses on a bid basis. For those that are food fish quality, there will be no difference in manufacturing product forms between ocean and river capture, and hatchery surplus salmon. Other surplus fish are donated to low-income food banks or used for biological stream revitalization.

Table 3.7 shows typical seafood product forms and distribution for river capture salmon. Much of the salmon harvested and processed to a product for freezing (graded, headed/gutted, boxed) is sent to the Seattle/Bellingham area. This is an area that handles fish from Alaska, as well as from the Pacific Northwest. The area is also a central place from which to market fish throughout the world. Fish may be cut fresh there or put into cold storage. Fish are stored in the name of the Astoria area processor until they are sold, either in their frozen whole form or further processed for sale to the buyer's specifications. The processing in the Seattle/Bellingham area of Columbia River fish is part of a larger base. Labor is experienced, and the storage and marketing infrastructure is adequate. These plants also process farmed fish. There is not enough volume on the Columbia River to compete with the Bellingham area processing.

Table 3.7
Typical River Harvest Seafood Product Forms

	Spring Chinook	Coho	Fall Chinook	
			Tule	Bright
Destination market				
U.S.	Fresh	Fresh	West Coast	Fresh, Frozen
Europe		Frozen		
Product Form				
Head-on fresh	100%			
Head-off fresh		45%		75%
Head-off frozen		45%		25%
Fillets fresh		5%		
Fillets frozen		5%		
Canned				
Smoked				
Jerky			100%	
Eggs				

Local processors utilizing Columbia River Basin salmon harvests supply seafood salmon products to a growing market demand for wild caught fish. A carcass byproduct from the processing also serves as an additional added-value manufacturing input. An Astoria business uses the carcasses for the manufacture of fish meal and oil. This analog salmon product has been used at Columbia River hatcheries to rear a new generation of salmon smolts. There is also a worldwide poultry and cattle livestock market for this protein form.

In addition to buyer and processor businesses/handling harvest distribution to consumers, there are a number of harvesters that make direct sales to the public. There is a greater proportion of tribal commercial catch handled with this type of distribution than in the lower Columbia River gillnet fishery.

Purchase price offered to harvesters by processors is usually negotiated preseason with understandings that adjustments can occur when triggered by management constraints in troll or river fisheries, and/or actual seafood retail price changes. Salmon prices vary for fish size, species, and condition. Lower river caught fish typically fetch higher prices than catch in upriver tribal fisheries (Table 3.8). CRITFC sponsors programs in tribal marketing and education programs about the care and custody of fish to improve quality of deliveries or what is sold through direct sales to the public. The new marketing and product quality strategies are to increase the price balance between lower and upriver harvest locations.

The overall trend for river salmon commercial fishery landings has been downward since 1938 (Figure 3.9). There was a spike in the late 1980's and the bump-up during the period 2001 to 2004 was encouraging that harvest levels might have bottomed to the five million pound and ten million dollar level. While this level provides a modest fishery, it is but a fraction of historical Columbia River production landed at river locations.

Commercial salmon largely enter a global market with many substitutes. This includes readily available products from farmed salmon production and other wild capture sources. The lower Columbia River gillnet fishery supplied about seven percent of West Coast fishery harvests and West Coast fishery harvests are about 18 percent of all Pacific Ocean landed revenue in 2004 (Table 3.9).

The trend is for increasing shares of farmed salmon production to provide for domestic and world salmon demand. Farmed salmon production costs have allowed significantly lower prices to be passed on to consumers. However, consumers' familiarity with the differences between farmed salmon and wild capture quality is also growing, so opportunities exist to divert gillnet fishery harvests to higher value market channels. The following section explores salmon market trends and the growth of higher value niche markets.

3.3.4.2.2 Markets

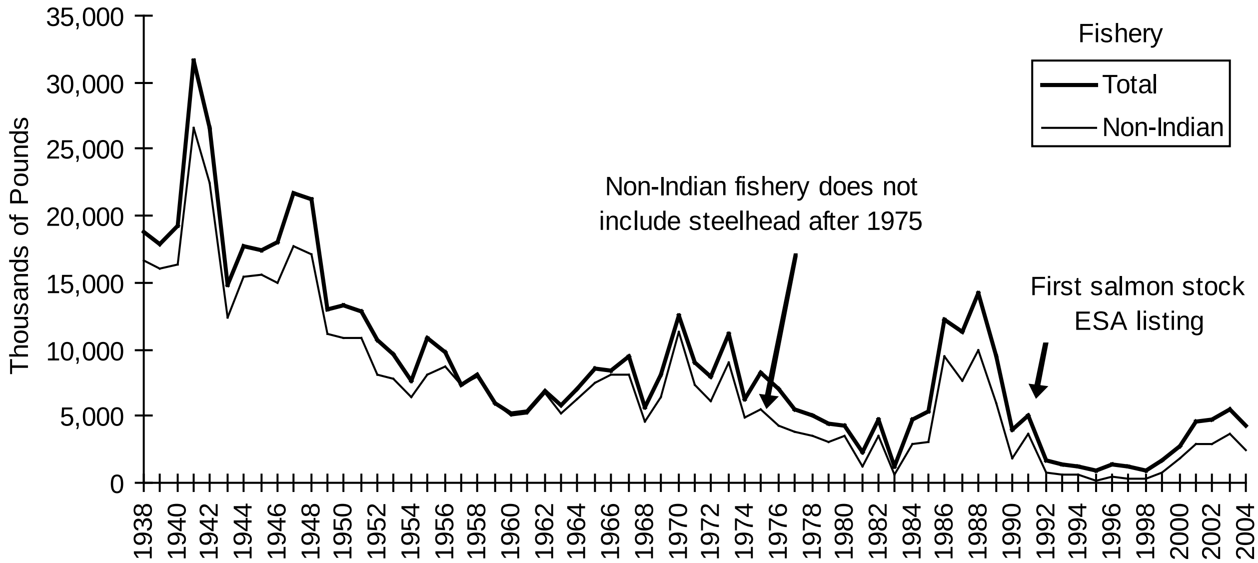
Since the early 1980's, improved captive salmon propagation procedures and transportation systems have allowed salmon aquaculture to supply the needs of the world market with a consistent supply of salmon. Salmon aquaculture is setting standards that have to be addressed by any other producers of salmon. U.S. market consumption for seafood is up, but supplies from

Table 3.8
Columbia River Salmon Commercial Harvest Real Ex-Vessel Price, Value, and Pounds in 2000 to 2007

	Average Price Per Landed Pound (2007 dollars)								Ex-Vessel Value (thousands of 2007 dollars)								Pounds (thousands)							
	2000	2001	2002	2003	2004	2005	2006	2007	2000	2001	2002	2003	2004	2005	2006	2007	2000	2001	2002	2003	2004	2005	2006	2007
Non-Indian Gillnet																								
Chinook																								
Spring/summer	3.32	3.27	3.66	3.06	4.11	3.61	4.16	4.87	293	841	1,402	519	1,418	589	1,048	824	88	257	383	170	345	163	252	169
Fall	1.14	0.58	0.44	0.64	1.18	1.31	1.85	2.21	281	229	363	765	1,145	825	1,018	559	247	395	819	1,198	972	628	551	253
Coho	0.62	0.32	0.37	0.59	1.00	1.13	1.36	1.63	975	715	629	1,397	1,123	1,091	919	559	1,563	2,258	1,683	2,354	1,124	969	678	343
Chum	0.36	0.25	0.22	0.17	0.27	0.55	0.23	0.46	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Pink		0.12	0.11	0.08		0.22				0	0	0		0				0	0	0		0		
Sockeye	2.27	1.09			1.74				3	6			3				1	6			2			
Unspecified		0.29								0								0						
Subtotal									1,552	1,792	2,394	2,681	3,689	2,504	2,986	1,941	1,899	2,917	2,885	3,722	2,443	1,761	1,481	766
Treaty Indian, All Gears																								
Chinook																								
Spring/summer	2.32	1.50	1.36	1.38	1.84	1.82	2.25	3.27	63	368	270	218	342	122	436	264	27	245	199	159	186	67	194	81
Fall	0.71	0.29	0.21	0.20	0.70	0.59	1.43	1.90	486	385	339	327	1,110	989	1,692	1,402	689	1,315	1,594	1,602	1,582	1,668	1,185	738
Coho	0.54	0.13	0.14	0.12	0.40	0.47	0.68	0.83	27	9	3	3	29	26	75	66	49	68	22	23	72	56	110	80
Chum					1.09	0.32							0	0							0	0		
Pink				0.56								0								0				
Sockeye	1.08	0.73	1.00		1.12	1.83			0	5	1		2	4			0	7	1		2	2		
Steelhead	0.33	0.15	0.10	0.10	0.25	0.27	0.51	0.65	25	20	11	9	14	19	83	90	76	132	112	89	56	70	165	140
Unspecified	3.57	5.74							1	16							0	3						
Subtotal									603	802	623	558	1,497	1,160	2,285	1,823	842	1,769	1,927	1,872	1,898	1,864	1,653	1,038
Columbia River Total									2,155	2,594	3,017	3,239	5,187	3,665	5,271	3,764	2,741	4,687	4,812	5,594	4,341	3,624	3,134	1,804

Source: PacFIN fish ticket data, March 2008 extraction.

Figure 3.9
Columbia River Commercial Landings, Total and Non-Indian Fisheries in 1938 to 2004



Source: Washington Department of Fish and Wildlife (WDFW) and Oregon Department of Fish and Wildlife (ODFW) (August 2004), Table 14 and Table 19; and Pacific Fishery Management Council (PFMC) (February 2005), Table IV-9.

Table 3.9
Pacific Ocean and Lower Columbia River Salmon Landings Volume and Value in 2004

	Volume		Value	
	Amount	Percent	Amount	Percent
Alaska	697.8	94.2%	225.3	82.2%
Washington (except LCR gillnet)				
Non-Indian	12.2	1.7%	5.7	2.1%
Treaty	17.0	2.3%	11.1	4.0%
Oregon (except LCR gillnet)				
Non-Indian	3.4	0.5%	10.0	3.6%
Treaty	0.9	0.1%	0.7	0.3%
California				
Ocean	7.1	1.0%	18.0	6.6%
LCR gillnet	2.4	0.3%	3.4	1.2%
Total	740.9	100.0%	274.2	100.0%

Notes. 1. Volume and value amounts are in millions.
2. There is a small California Klamath River treaty commercial fishery in some years that is not reported in this table.

Source: NMFS (November 2005) and PacFIN.

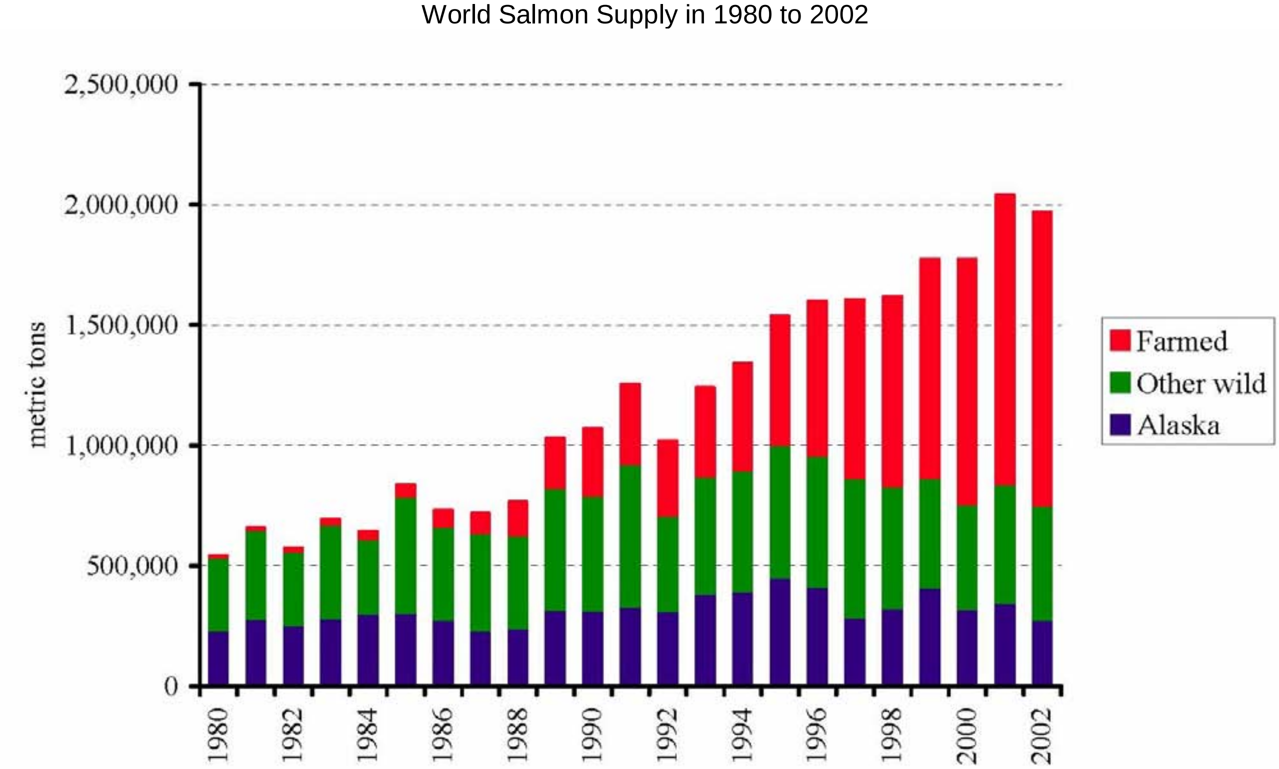
imports are more than filling increases in demand. Most of the supply increase is from foreign farmed salmon origin, which can be produced year around, in consumer desired size, with volumes needed by large retail and food service companies, and at a lower cost.

The "squeeze" between Alaska's production of canned and frozen salmon and aquaculture's production of fresh salmon puts Pacific Northwest salmon production into a price and market niche position. To realize improved prices, it is necessary to distinguish unique qualities of the production so customers will seek out and pay for its advantages.

The world supply of salmon has gone through dramatic changes. Captured salmon production increased from about 520 thousand metric tons (mt) in 1980 to about 720 thousand mt in 2002 (about 40 percent of that from Alaska). At the same time that captured salmon production increased, farmed salmon increased from no production in 1980 to over 1,230 thousand mt in 2002 (Figure 3.10). Salmon supplies that were traditionally dependent on captured harvests have changed toward farmed salmon production.

Today's global salmon markets are characterized by strong competition and rapidly growing supplies of an aquaculture product. Farmed salmon production is expected to continue to be the dominant force in product and price determination.

Figure 3.10
World Salmon Supply in 1980 to 2002



Source: Knapp (2005).

Farmed salmon has significant competitive advantages over wild salmon with respect to production factors (Knapp 2005):

Production Factors	Wild Salmon	Farmed Salmon
Volume	Production volume is inconsistent from year to year and difficult to predict.	Farmers can accurately forecast production and guarantee supply commitments.
Timing	Wild harvests must occur during a short summer run.	Farmed production can occur over many months or year-round
Consistency	There is wide variation in the size and quality of individual wild fish.	Farmed fish can be produced of consistent sizes and quality.

Other factors affecting the marketing of captured salmon:

- Increasing consolidation of retail trade by large multinational companies (Wal-Mart, Costco, etc.) competing on price and efficiencies of scale and seeking suppliers who can offer consistent supply of high volumes at low cost.
- Changing consumer demand as incomes rise, lifestyles change, demographics change, and the range of products available to consumers change.
- Seafood reprocessing migrating to low-cost countries, such as Chinese canning of Bumblebee Russian pink salmon, and Chicken of the Sea shift of boneless/skinless salmon canning operations from U.S. to Thailand.

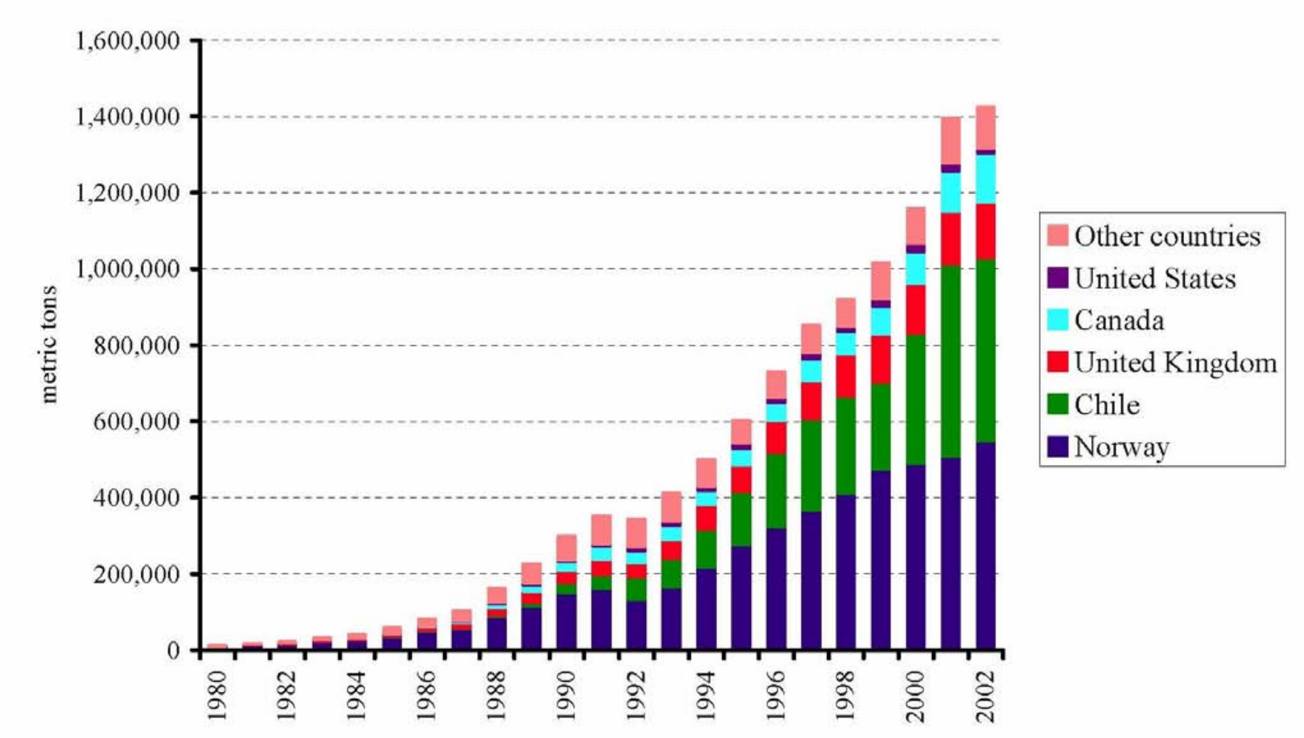
Salmon farming or aquaculture has been part of western civilization for some time. German biologists began hatching salmon eggs as far back as 1763. Chilean biologists began experiments with establishing non-native salmonid species in 1905. Efforts to raise salmonids as food fish began in earnest during the mid 1950's when Norwegian biologists began experimenting with Atlantic salmon smolts (Folsom et al. 1992).

Production of salmon grown in net pens began in earnest in the 1980's. In 1980, pen raised salmon accounted for one percent of the world's total salmon production; in 1991 this increased to 27 percent; the estimated 2001 percentage of farmed salmon is 65 percent.

Historically Norway has been the largest salmon farming production. But in recent years, the Norway-EU salmon agreement has slowed Norwegian growth, while Chilean production has grown very rapidly (Figure 3.11).

One of the main reasons for Chilean farmed salmon producer competitiveness is low labor costs. An abundant supply of cheap fish meal, for use in farmed salmon feed, has also helped the Chilean producers' competitive edge. In Chile, about 1.5 to 1.8 kg of food is needed to produce one kg of mature farmed salmon. This is the equivalent of a cost of $0.68 to $0.82 per produced pound.

Figure 3.11
World Farmed Salmon Supply by Country



Source: Knapp (2005).

The farmed salmon industry is consolidating into large, vertically integrated multinational companies with operations in many countries. This results in:

- Increasing market power;
- Increasing economies of scale in production, processing, distribution, and marketing;
- Diversified production opportunities into other species, not just salmon.

In recent years, consolidation has decreased overhead costs as well as transportation costs to the level where fillets are delivered to the West Coast at between $2.05 and $2.50 per pound. Salmon farmers are expanding production into new markets, including frozen salmon, canned salmon, and roe.

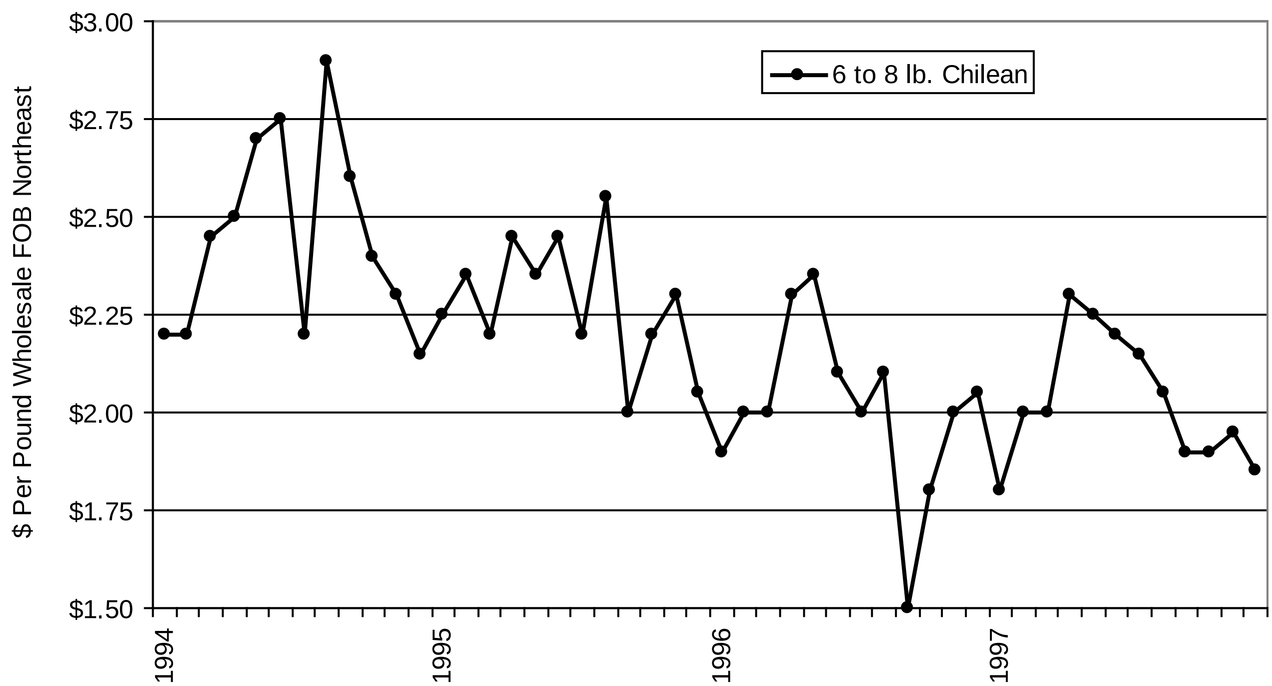
The result of the increase in world salmon supply is to decrease total revenue received by harvesters, even though total landed fish has increased. Alaska for example has increased total harvests to about 800 million pounds, from less than 400 million pounds in the 1970's. Despite increasing harvests to record levels, total revenue from salmon fishing (adjusted for inflation) steadily decreased in the 1990's from about $500 million in the early 1990's to about $200 million in the early 2000's (Knapp 2005).

In Alaska an increasing amount of salmon is being marketed as fresh. Specialty stores and restaurants represent a growing market for consumers whose needs are not met by the large chains. This is a relatively small share of the total market.

The 1990's U.S. domestic salmon market was composed of 68 percent food service consumption and 32 percent retail consumption, but the retail market segment is increasing. Two-thirds of the retail segment is purchased through supermarkets (62 percent), followed by fish markets (23 percent) and specialty outlets (15 percent). The trend in both food service and retail sectors is toward a preference for fresh salmon over frozen salmon and a declining market share for canned salmon (Knapp et al. 2007). Fresh salmon comprised 65 percent of food service sales and comprised 35 percent of retail sales. Four out of five salmon consumers use fresh salmon. This preference was reflected by the fact that 84 percent of fresh/frozen seafood sales of salmon was in fresh form and only 16 percent frozen.

The Pacific Northwest salmon fisheries are competing in the same markets as Alaska, the major producer of wild salmon in the world. Many in the industry agree that to compete on a global market, the Pacific Northwest and Alaska salmon will have to move outside the traditional forms of frozen and canned in order to receive higher revenues for their fisheries. Much food consumption has moved to eating away from home or to cooking quick, ready to eat food. This results in greater preparation at the processing sector. This involves more labor and capital input into processing.

Figure 3.12
Wholesale Prices For Fresh Atlantic Salmon in the U.S.



Source: International Salmon Farmers Association (1998).

3.3.4.3 Economic Contributions

Fisheries generate personal income in regional economies by their products being exports to outside economies. That is, commercial landings in a regional economy are sold directly or after processing to individuals or businesses located outside the regional economy. That transfer of money makes its way as payments to labor and those payments are re-spent regionally (multiplier effect). Similarly, recreational anglers from outside the economy will spend money on guide services, lodging, etc. that will also wind up as household income. A third personal income generation is from the spending that takes place for hatchery operations and hatchery management and administration. From a regional economies perspective, the money for this type of spending comes from an outside economy, i.e. the federal government. Regional total income can be estimated using input/output (I/O) models.

The I/O models used in this analysis have been constructed for Alaska and the Pacific Northwest states with the use of IMPLAN.[1] On the commercial side, representative budgets from the fish harvesting sector and the fish processing sector, as well as a price and cost structure for processing, are used to estimate the impacts of changes. On the recreational side, a charter operator budget and recreational fishermen destination expenditures provide the basic data. Hatchery and hatchery management and administration costs were determined from reviewing funding agency budgets. Then the individual expenditure categories from all of these sources are used as I/O model inputs to estimate the regional total personal income. For convenience in applying the results to the various alternatives, the regional economic impacts were reduced to a per unit basis. The units were landed pounds for commercial fishing, angler day for recreational fishing, and smolts for hatchery production. While these units provide convenient ratios and have accuracy at a regional economy level for large and diverse fisheries, they can misrepresent income generation for individual stocks or local area fisheries.

The regional income generation is called regional economic impacts (REI) and is personal income accruing to households. It is a measurement of economic contribution under current or changed conditions and is not a valid measure of the long-term effects on the economy of changes in fish abundance or policy. It provides a measure of the short-term dislocations and adjustments that might be caused by collapse of a fishery. The REI is not a measure of economic value. Economic value might be additive of consumer surpluses of recreational fishermen, certain non-use values such as tribal subsistence harvests, certain industry profits or cost savings, and a variety of other economic considerations. Economic value is a more appropriate measure to show the long term effects from changes in the fishery. Appendix A provides detailed explanations for the differences between the REI and economic value measurements and discusses non-use values.

REI commercial and recreational economic factors rely on vessel prices and catch per unit effort (CPUE) information from the Alaska Department of Fish and Game, Fisheries and Oceans Canada, the Pacific Salmon Commission, several agencies for U.S. West Coast ocean fisheries

1. The commercial fisheries regional economic impact analysis used methods from Hans Radtke and William Jensen, who developed a fisheries economic assessment model (FEAM) for Alaska and U.S. West Coast. The analysis of regional economic impacts for recreational fishing is based on modeling by Steinback et al. (2004). See Appendix A for detailed explanation of data and methods.

(Pacific States Marine Fisheries Commission PacFIN and RecFIN databases, PFMC annual reviews of salmon fisheries, and NOAA Fisheries Marine Recreational Fisheries Statistics Survey information), and several agencies for inland fisheries (Columbia River Compact status reports, Oregon Department of Fish and Wildlife and Washington Department of Fish and Wildlife special reports, and Columbia River Inter-Tribal Fish Commission information). For commercially caught fish, average weights by region are used. For recreationally caught fish, average success rates measured by angling days per retained fish are used. Appendix A contains tables showing the assumed factors.

Tribal fisheries also generate income in regions. Present treaty fisheries consist primarily of set gillnets, but dip net fishing still occurs at several locations. Tribal fisheries generally take place above Bonneville Dam, but other locations are sometimes used to fulfill treaty and trust responsibilities. Catch is accounted first to ceremonial, next to subsistence (both are sometimes referred to as C&S), and last to commercial purposes. No fish of any run are sold for commercial purposes until ceremonial and subsistence needs are met. As recently as 1995, spring Chinook were only available for ceremonial purposes. Fall Chinook are routinely harvested for commercial sale. Fish are taken from the mainstem Columbia and a number of tributaries. Total tribal commercial harvest of spring and fall run salmon has averaged about 25,000 and 110,000 fish, respectively, in recent years (Mann 2004). For the calculation of REI for tribal fisheries, only commercial component is given value when commercial harvests can be modeled. In some cases, exploitation rates had to be used to forecast harvests which would include commercial and C&S. This can be interpreted as saying that subsistence harvests would have a substitute value. It is not always possible to differentiate ceremonial from subsistence landings because they are not tracked in traditional data programs. While it can be argued that subsistence harvests may be a substitute for a foodstuff and be equivalent to a market price for the fish, their actual economic effects are purely speculative. Ceremonial harvests should not be valued because that would be tantamount to determining a value for tribal spiritual beliefs.

Table 3.10 shows the summation of total personal income by fishery over all species and provides a measurement of jobs for the status quo alternative. The share of total personal income by fisheries and species is shown in Figure 3.13. For the fisheries groupings shown in Table 3.10, the highest REI estimate is $7.9 million for the inriver sport extreme terminal area fishery. The tribal commercial fishery generates $4.4 million. The REI from hatchery operations and headquarter spending is shown in Table 3.11. Notice that this table's REI is related to production costs for MA funded agency release strategies in 2007 rather than the EIS status quo alternative production levels that are used in Chapter 4 to compare alternatives. The fisheries related personal income generated is about 52 percent of total fisheries, hatchery operation, and headquarter activity REI.

The REI effects from MA hatchery funding is considerable. For every one dollar of MA funding, approximately $4.50 of personal income is generated. Most of this income is in rural economies, that if reduced or lost, would be a significant impact.[1] Figure 3.14 shows the share

1. Some of the recreational fishery related impacts could possibly have substitutions in other recreational activities, but there would be little substitutes to commercial fisheries, especially for inriver harvesting. It would be conjecture to imagine hatcheries being used for commercial or educational activities other than for the

of REI from MA funded production harvests and marketable hatchery returns for regional economies by fisheries.

Table 3.10
REI for MA Harvests and Marketable Hatchery Returns by Fisheries for Status Quo Alternative

Fisheries	Personal Income ($000's)	Jobs
Ocean commercial, Alaska and British Columbia	1,881	52
Ocean commercial, West Coast	824	23
Ocean sport	3,167	88
Inriver commercial	1,390	39
Inriver sport mainstem	4,002	111
Inriver sport extreme terminal area	7,928	220
Tribal ocean and inriver	4,356	121
Marketable hatchery returns	255	7
Total	23,803	662

Notes: 1. REI measurement is total personal income in thousands of 2007 dollars and full-time equivalent (FTE) jobs. The calculation of FTE is assumed to be average annual earnings for the study area economy.

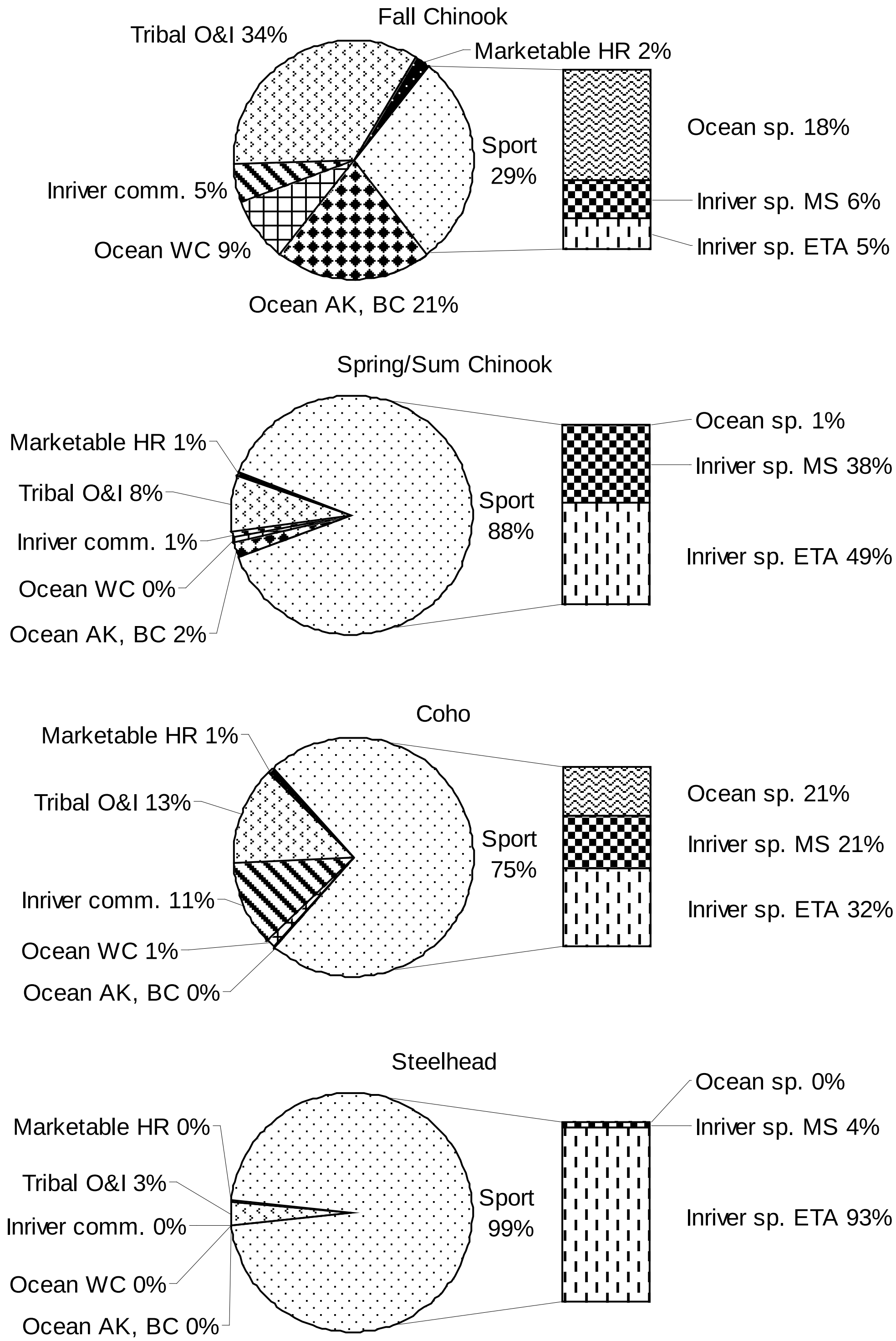
Table 3.11
REI for Hatchery Operations and Headquarter Activity for MA Funded Agency Release Strategies

Agency	Personal Income ($000's)	Jobs
ODFW	7,478	205
USFWS	5,157	143
WDFW	8,280	232
Yakama Nation	1,015	33
Total	21,928	612

Notes: 1. REI measurement is total personal income in thousands of 2007 dollars and full-time equivalent (FTE) jobs. The calculation of FTE is assumed to be average annual earnings for the study area economy. Yakama Nation uses average annual earnings for the Columbia Plateau Province.
2. Accounting stance for regions are state level economies.
3. Hatchery operation and headquarters activity are related to agencies cost analysis for their release strategies in 2007. This differs from the status quo alternative's release levels.

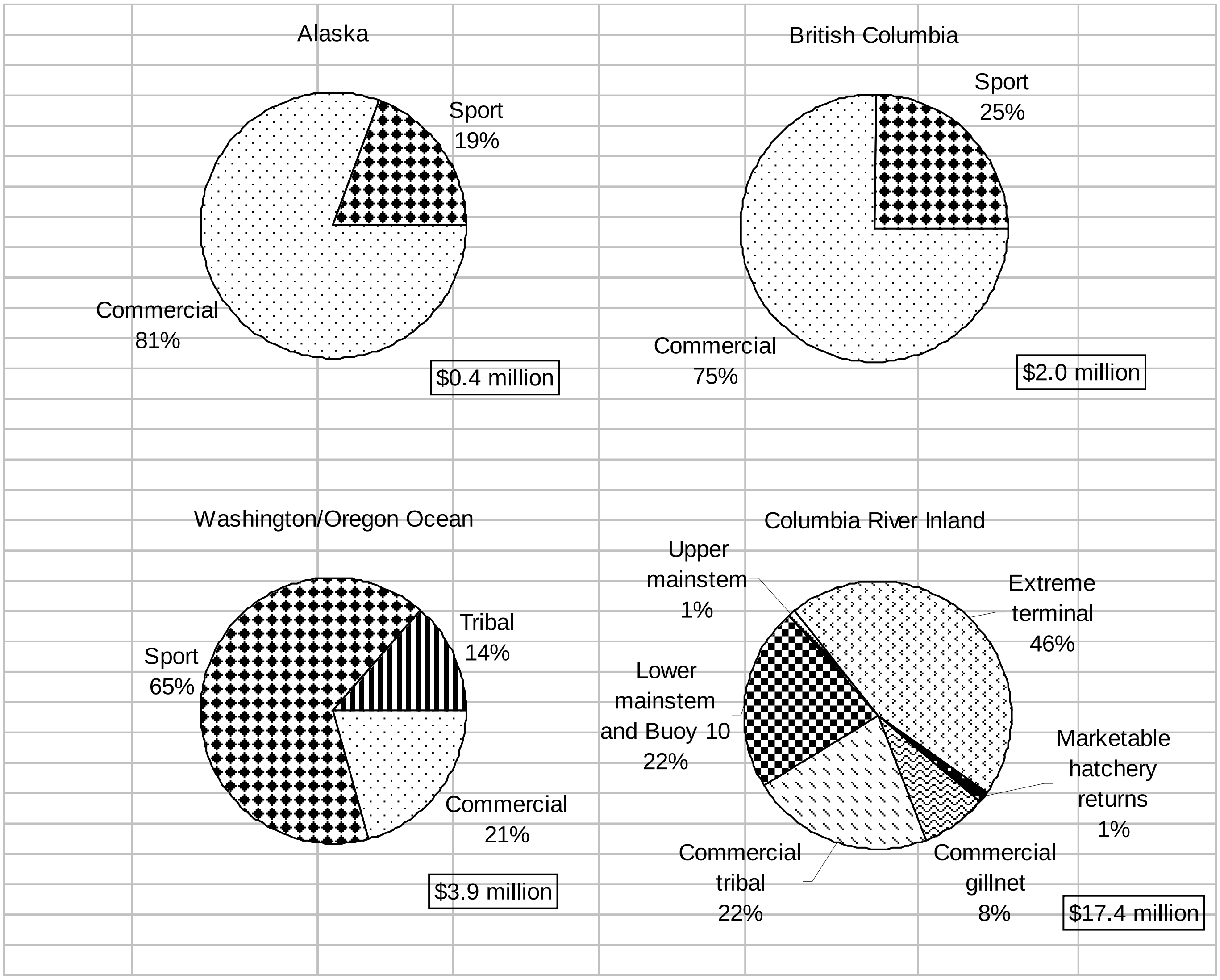
purposes for which they were built. So the effects from hatchery operation and headquarter activity could also be assumed to be without a mitigating substitute.

Figure 3.13
REI Shares for MA Funded Production Harvests and Marketable Hatchery Returns by Species and Fisheries for Status Quo Alternative



Notes: 1.	Abbreviations for pie slice labels:	
	Ocean AK, BC	Ocean commercial, Alaska and British Columbia
	Ocean WC	Ocean commercial, West Coast
	Ocean sp.	Ocean sport
	Inriver comm.	Inriver commercial
	Inriver sp. MS	Inriver sport mainstem
	Inriver sp. ETA	Inriver sport extreme terminal area
	Tribal O&I	Tribal ocean and inriver
	Marketable HR	Marketable hatchery returns

Figure 3.14
REI Shares for MA Funded Production and Marketable Hatchery Returns
by Regional Economies and Fisheries for the Status Quo Alternative



Notes: 1. The Washington and Oregon ocean region includes minor effects from Chinook harvested in California and Puget Sound.

3.4 Environmental Justice

Information about federal actions must identify and address the effects on minorities and low-income populations and communities. The information requirements are spelled out in Executive Order 12898. This section will expand on the socioeconomic descriptions previously presented to discern the presence of the minority and low-income populations in a study area. There will also be a short discussion on possible ways the populations of concern could be affected by the EIS alternatives. The forecasted consequences of the actions on the subject populations are described in Chapter 4.

The actions being evaluated are to change hatchery production (EIS Alternatives 3 through 5) and to zero-out hatchery funding (Alternative 2). This means those that benefit or that will potentially enjoy fishing opportunities afforded from the hatchery production will be affected. Fishery user groups include commercial gillnetters, tribal harvesters and processing businesses that participate in treaty commercial fisheries, tribal personal use harvesters who participate in ceremonial and subsistence fisheries, and recreational anglers. There was no special survey undertaken to determine socioeconomic status aligned with the minority and income indicators for the user groups. The USFWS (2007) recreational angler survey does include demographic statistics, but it is only applicable at the state level. Instead, existing socioeconomic information for residency of likely user group participants was analyzed. Low-income and minority status for tribe reservations are available, but Indians participating in tribal fisheries are not required to live on reservations nor are tribal fisheries located on reservations. The residency area resolution was the selected study area provinces shown on Figure 3.6.[1]

The EIS scoping process was directed to notify potentially affected target populations and specifically tribal interest groups. It was recognized that the possible policy directions for MA spending were are sensitive issue for tribes.[2]

American Indian is a minority group, and therefore, is of particular concern for providing information about the EIS alternatives' effects. Indians can participate in both treaty and non-treaty fisheries, so it can be difficult to accurately show total impacts. Mostly they are user group participants in the treaty fisheries, so quantitative modeling will only be shown for the treaty fisheries. The treaty tribes whose usual and accustomed fishing grounds are the mainstem Columbia River and the immediate tributaries are: Nez Perce Tribe, Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes of the Warm Springs Reservation of Oregon, and Confederated Tribes and Bands of the Yakama Indian Nation. The Shoshone-Bannock Tribes also have treaty fishing rights, but their usual and accustomed fishing grounds are the upper Snake River watershed. These are the only tribes in the Columbia Basin to have reserved

1. For purposes of environmental justice analysis, the provinces are called target areas and the area units are the selected provinces. The reference areas are the Pacific Northwest states and the U.S.
2. Mitchell Act funding for artificial propagation facilities has embittered tribal interests. This is because original funding for these facilities was to transfer production from upriver populations to lower river hatcheries. The usual and accustomed fishing grounds for tribes is above Bonneville Dam. There has been movement in recent years to ameliorate for the original funding effects both by the funded agencies and through the use of other funding programming such as the NPCC F&W Program. Examples are the conveyance of the Klickitat Hatchery to the Yakama Nation and the use of USFWS facility resources to re-establish and supplement upriver Columbia River and Snake River salmon and steelhead populations.

rights to anadromous fish in the 1855 treaties with the United States. These four tribes have treaty-guaranteed fishing rights and management authority in their traditional fishing areas. However, in addition to respecting treaty reserved rights, the federal government must honor its Trust Responsibilities to Indian Tribes.

There are many other tribes that may receive benefits from MA funding in the Columbia River watershed besides the treaty tribes. The resulting treaties, laws, court interpretations, and harvest management agreements means all tribes in this minority group will be affected by the changes. Other documents aptly describe (Meyer Resources 1999 and Corps 1995 are two examples) the cultural importance of river fishing opportunities to this minority group. It is only necessary to determine whether the different alternatives will have disproportionate impact or will have different equity distribution for benefits and risks. The harvest modeling results presented in Chapter 4 itemize the expected changes to the fisheries in which Indians participate.

In regards to impacts on low-income populations and communities, province level assessments are used. Again, this is because a comprehensive survey of participants in fisheries in which MA hatchery production contributes was not available. It was assumed that these multi-county blocks were adequate to encompass most of the residency for participants and business owners in the Columbia River commercial and recreational fisheries.

The comparison of low-income indicators for poverty levels, unemployment, and housing over-crowding were presented in the Section 3.3.3 Study Area Regional Overview. The Columbia Plateau, Columbia Cascade, and Columbia Gorge all have higher low-income indicator rates than the general comparative base of the three Pacific Northwest states or the U.S. However, none exceed the EPA (1998) guidance rate of 20 percent for significance determination based the Year 2000 Decennial Census data. These provinces also have a high Hispanic minority population. This minority group has high participation in farm worker occupations and there is a large agriculture industry base in these provinces. The additive minority group rates mean these provinces exceed the guidance rate of 15.72 percent for significance determination. All of these provinces are located above Bonneville Dam, therefore the telling itemizations for proportional impacts to tribes will also apply to communities of low-income and minority status.

Chapter 4: ENVIRONMENTAL CONSEQUENCES

4.3 Economic Consequences

4.3.1 Background

Impacts from the alternatives need to be addressed in several dimensions. The dimensions pertaining to the purpose of this EIS are:

- Direct effects are caused by the action and occur at the same time and place. An example is economic benefits from fisheries where there are contributions to harvests from MA funded production. These direct effects are dealt with extensively in this section.
- Indirect effects are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. An example is effects to other wildlife from shoreline and water pollution caused by fishing activity. Public health might be affected for groups that depend on production for subsistence and substitutes for changes are not available. There are other sections in this chapter address these types of dimensions.
- Cumulative impacts result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. An example would be any expected changes to ESA listed species recovery plans that would cause fishery governance to compound harvest restrictions brought about by changes to MA funded production. No similar cumulative actions are envisioned for the proposed EIS alternative actions.
- Irreversible and irretrievable impacts can occur if there is no reasonable and practicable alternative that would avoid, mitigate, and eliminate the impacts. A preferred EIS alternative is not proposed for the EIS, so an example does not apply. It is expected, given the range of alternatives, that there will be differential impacts to fisheries. There may not be options to adjust other production nor fisheries management to compensate for the effects to particular user groups.

There are also time dimensions to consider for what may happen in the short term and long term. This section uses these classifications where applicable to describe the alternative action's consequences. The predicted effects are quantified where possible, but there are also qualitative assessments and best professional judgment descriptions.

In order to explain the consequences of alternatives, there needs to be a point of reference. NEPA interpretations generally suggest using current environmental conditions. The status quo alternative was developed to closely approximate current conditions, and therefore it is used as the baseline for comparison. That does not preclude some comparative descriptions being made to historic affected conditions. This would especially be of interest to tribes who will relate current conditions to conditions in times of pre-European settlement in order to gain a point of reference for evaluating the alternatives' impacts. A rich impact description would both use a baseline and historic conditions for a point of reference, but research, investigation, and interpretation budget resources have limited these descriptions.

The harvest forecasts that accompany the changed hatchery production alternatives are the basis for the quantitative modeling of social and economic impacts. A stochastic model was used predicated on early 2000's smolt survival and catch rates. Uncertainty due to environmental conditions or changes in management regimes were not used to place bounds on the point estimates. It is known that smolt survival has in recent years varied by a factor of 10 and that management has reacted to abundance estimates to reduce or increase harvest opportunities. The lack of using forecast bounds to show this variability should not detract from using the quantitative descriptions as they are intended. The estimates are to provide some understanding of magnitude and direction. Significantly more research and analysis would be required to reduce predictor variance sufficiently to make it more than just an ordinal impact measure.

A time horizon harvest forecast was also not available that might show trends in gains or losses in impacts to natural stocks due to the interactions with hatchery production. The forecast that was used anticipated that interactions would occur, but there was no progression of successive generational changes. Therefore, it was not necessary to discount future social and economic impacts to a present year. The predicted changes are as if they were occurring during the time of the baseline conditions. This is of special applicability to social and economic analysis because economic theory suggests that profit motive adjustments will always be made for the changed conditions. It also is of heightened interest because economic impact modeling is highly dependent on fishing opportunity conditions. For example, a decision to have a recreational fishing experience is related to many environmental variables, not the least is expected catch success rates. The modeling assumes early 2000's success rates while the alternative actions may be predicting changed abundances that generate different success rates. Some interpretive descriptions about long-term effects are made, but the quantitative descriptions are as if the natural and hatchery interactions have occurred and that the impacts are immediate.

4.3.2 Methods

The purpose of the federal actions is to change how a selected number of Columbia River Basin hatcheries operate. The selection list is MA funded hatcheries. The current number of hatcheries is 18 and they are owned and operated by states, USFWS, and tribes. They are involved in various stages of capturing and raising salmonid species such as spring Chinook, cutthroat trout, winter steelhead, chum salmon, and others. MA funding is their primary source of revenues, but they also receive support from state general funds and other federal funding programs. There are many production strategies when the hatcheries are viewed at the individual level, but an overall common feature is they produce fish to sustain fisheries and to conserve species populations in a manner that does not impair natural production. The alternatives, with the exception of Alternative 2, were crafted for analysis in the EIS to focus production strategies one way or another and preserve their common features. Alternative 2 would zero-out MA funding for hatcheries, and it is assumed for analysis purposes this is a red light/green light decision to eliminate all production of the populations now supported at the selected hatcheries.

The consequences for eliminating funding or focusing production will have economic effects in two major ways. First, the fisheries in which MA funded hatcheries contribute will be affected. Second, the hatcheries themselves require employment and they make purchases in regions for their operations. A third effect will be minor, and while omitted from quantitative analysis, deserves mention. That is the focusing of hatchery operations may require construction. There are no new hatcheries proposed for construction, but carrying out the alternatives will require capture weirs, raceway improvements, liberation ponds, and a number of other physical improvements. It is not known at this time what might be the costs or time to complete the construction, so they are acknowledged as a potential effect, but they are not quantified.

In regards to the first way that hatcheries have economic effects, the portion of their production to be used for sustaining fisheries can be considered a manufactured product. The public pays for the manufacturing and it is given away as an opportunity for commercial fishing interests to generate a profit, tribes to use fish for C&S purposes, or recreational anglers to enjoy a fishing experience. A measurement for this type of effect is to find the change in social welfare or the value to consumers and producers. Finding the change in social welfare is the basis for doing a benefit-cost analysis (BCA). It is generally applied as change in the social welfare of the nation. That makes sense for the proposed alternative actions because federal dollars are being provided for the production.

The value to consumers can be measured in terms of their willingness-to-pay (WTP) for a change in resource allocation, whereas value to producers can be approximated by the change in net income or profits. For commercial fishing benefits, consumer surplus is the difference in WTP for seafood minus what is actually being paid. Economic theory says that prices will rise if the resource supply is constrained, and therefore consumer surplus would decrease. It is suggested that there are many salmon substitutes, and depending on how discriminating the consumer might be towards the resource, the amount of harvested fish being changed as a result of the alternative actions in this EIS will probably not change the price. For recreational fishing benefits, consumer surplus is the difference in WTP for a heightened experience minus the cost for the existing level of enjoyment. Usually the vehicle to extract that dollar value information in an angler survey is catching additional fish. For commercial fishing, the producer surpluses are the profits realized by businesses. This would include commercial fishing harvesters and processors, and recreational angling guide services, lodging businesses, etc.

Other values to include in a BCA are associated with non-consumptive uses of the resource. An example of a use that does not consume the resource is viewing migrating salmon at fish ladder interpretative centers. Some people derive value from certain resources without ever using them. These can be described as option, existence, and bequest values which are additive over and above the use consumer surplus because these people are not included in the seafood market or angling experience demand for the resource.

Lastly, there are opportunity costs for a resource. Potential benefits foregone by the choice to use a resource in one way rather than another are referred to as opportunity costs. Sometimes it is difficult to determine on which side of the equation an opportunity cost is placed, let alone determining its size. For example, a fish not harvested has minus benefits from a fishing activity and may have positive benefits from its non-use. However, in the case of hatchery production for sustaining fisheries, that fish may return to the hatchery and not be needed for even broodstock to maintain future populations. Generally, opportunity costs are on a tier not included in quantitative analysis because they are indefinable and they will cancel their influence on an equation's results.

When consumer and producer surplus and other non-consumptive use values are difficult to measure, then cost-effectiveness analysis can be applied. It simply relates costs to an analytical objective to determine the least cost way to achieve the objective. Costs can be direct costs or opportunity costs and objectives can be whatever is the purpose or purposes of the proposed action. For example, an objective can be the harvest provided by a hatchery produced fish. In this case the measure is production cost divided by the harvest number. For the other objective to operate MA funded hatcheries in a way that does not impair natural stocks, the measure might be cost per impacted salmon and steelhead populations of concern.

The public and decision makers sometimes just want to know what level of economic activity is being stirred-up within a specified geographic region stemming from changes being made to expenditures within that region. This type of analysis is called regional economic impact (REI). It is a way to show how the direct change in expenditures is multiplied throughout the regional economy. The measurement unit for REI with most bearing is personal income and jobs.

All three measurements are offered for this analysis. A CEA is shown to provide comparative statistics between alternatives (which have the same objective) and to allow comparisons with other programs that might be developed to accomplish the same objective. A limited BCA with an accounting stance for the nation is shown. An REI analysis is provided to show significance of impacts to a regional economy.

The BCA is referenced as limited because a complete analysis would not be possible. There are important components of the equation where values cannot be obtained. This would include, for example, the value that the public places on changes in the status of depressed populations. Second, for those effects that can be quantified, the level of uncertainty associated with the estimates is believed to be relatively large. Last, there is considerable uncertainty about the scientific basis for predicting biological and economic effects in a short or long term. Therefore, the offered BCA should be considered a comparative tool that shows changes in some key economic measures. This type of analysis is intended to provide decision-makers with insight into the relative magnitude and direction of some of the predicted economic changes associated with the different alternatives. Because the analysis adopts a single-time approach of potential effects that are near term in nature, it does not take into account adjustments that would be made over time by affected interests (e.g., to harvesters, anglers, and communities).

Key assumptions used in the BCA are:

- Producer (commercial harvester and processor, and charter boat operator) opportunity costs are undefinable,
- Producer surplus from charter boats, guide services, marinas, lodges, and other recreational related businesses is comparatively negligible,
- Consumer willingness to pay and existing seafood prices would be unaffected by the EIS alternative actions,
- The effects from other user groups such as C&S harvests, etc. are relatively small,
- Non-consumptive use and non-use values are inconsequential to the analysis, and
- Interactions with other fisheries are not economically significant.

The REI is offered despite its limitation for only having meaning in the immediate sense. It is realized that any changes made in an economy are going to have offsetting adjustments that may be unpredictable in the long term. The measures for income changes and jobs have some comparative usefulness for showing distributional effects across economies. The REI from fishing and hatchery operations are separately calculated.

Key assumptions used in the REI are:

- The period of analysis is indeterminate, with quantitative changes in resource costs and benefits and regional economic activity being near-term. For benefits from actions to conserve depressed species, long-term effects from the recovery species should be made.
- The accounting stance (i.e. geographic region of study) is at the state level. The state level measurements are summed to totals which may under or over estimate impacts because of interactions between state level economies.
- Economic effects that are quantified are presented as annual impacts.
- The analysis of changes in resource costs and benefits assumes a full employment economy in which all resources have alternative uses (i.e. opportunity costs).

The analytical framework in which the CEA, BCA, REI, and measures are calculated are described in detail in Appendix A.

4.3.3 Cost Analysis

4.3.3.1 Analytical Approach

Harvesting and canning salmon played a key role in the economic development of the Pacific Northwest. As salmon stocks began to decline due to a variety of factors, salmon hatcheries were built to replace and/or increase natural production.

Oregon and Washington have funded hatchery salmon production for more than 100 years. This activity has been continually viewed as a relatively simple solution to persistent problems of habitat loss and overfishing. From the earliest efforts well into the 1960's, most production relied primarily on release of salmon fry with a gradual shift toward holding fish to fingerling size for stocking. Since then, hatchery programs began holding fish for release as full term smolts. As release sizes became larger, costs per smolt became a crucial part in hatchery production decisions.

The region's hatchery operations are receiving close study because of their potential impacts to wild salmon stocks. Once thought to be straightforward, using hatchery production for mitigating lost habitat due to dam construction, has given way to scientific findings about their adverse impacts (National Research Council 1996).

Several hatchery review projects have been completed or are underway in the Pacific Northwest.[1] Recommendations and guidelines for technical and policy reform of hatcheries were made by Integrated Hatchery Operations Team (IHOT 1995). The National Marine Fisheries Service (NMFS) completed consultations covering all hatchery production in the Columbia Basin. As a result, hatchery management practices have been substantially revised (NMFS 2000). NOAA Fisheries requires submittal and approval of Hatchery and Genetic Management Plans (HGMP's) under the ESA salmon and steelhead 4(d) rule as a mechanism for addressing "take" of ESA-listed species that may occur as a result of artificial propagation activities. Hatchery operators have recognized the benefits of their development for regional fish production and management planning even if the 4(d) rule does not apply. NPCC established the Artificial Production Review and Evaluation (APRE) process guided by the Artificial Production Advisory Committee (APAC) and the Council's Independent Scientific Advisory Board (ISAB) in 1999. A series of reports have since been issued that have included the review of individual basins' hatcheries (APRE 1999 and 2004). The database described in APRE (2004) provides a wealth of information on purpose, general funding, overall smolt production, and estimated survival rates (when available) of all artificial propagation programs (sites) in the Columbia Basin. APRE hatchery performance standards are used in the development and updates of HGMP's. The successful approach used in the State of Washington Hatchery Reform Project started in 1999 was directed by Congress in 2005 to NOAA Fisheries for application to the entire Columbia River Basin. This review is called the Columbia River Basin Hatchery Reform Project (HRP). The HRP is working in collaboration with a separate review process ongoing for the

1. APRE hatchery and genetic management plans are available at: http://www.apre.info/APRE/home.jsp. Data and information from the APRE will soon be moved to a new website, http://www.managingforsuccess.us. This new site has updated information taken from recently developed HGMP's, CWT analysis, facilities and operations reports, NPCC subbasin plans, BiOp's, and other sources of information.

USFWS National Fish Hatcheries in the Basin (USFWS June 2005). States and tribes also have ongoing review or master planning processes that complement the region wide initiatives. The MA Hatchery Decision EIS was started in 2004. Each successive hatchery review project has recommended integrated hatchery operations or restrictive segregated operations so as to not impair natural production while still fulfilling their objectives for sustaining fisheries.

The NPCC also requested the IEAB provide a CEA of hatcheries in 2001. Only the first phase of that study was completed (IEAB 2002). The study concluded that "[the] cost analysis has given us a basis for optimism that more extensive cost-effectiveness study of specific project proposals for the Council cost will provide useful information." The study also noted some data gaps and needs and recommended "that the Council consider funding a Phase II Economics Analysis of Artificial Production to more fully investigate a wide range of hatchery objectives and cost configurations.[1] This would involve developing a larger data base of cost and production information, to support evaluation of separable costs for rearing individual stocks and species at hatcheries having multiple stocks and purposes. The study could be broadened to involve some collaboration between the economists and biological analysts in order to broaden the assessment of costs associated with augmentation, mitigation, restoration, and other ESA-related objectives." The findings and recommendations from the IEAB (2002) report were useful in determining an approach to compile total production costs for the MA hatcheries.

In light of the new hatchery review process being undertaken since the IEAB Phase I report, the Council requested in February 2008 a new study be completed. There are several objectives, including determining whether progress has been made on consistent and revealing cost accounting. Another objective is to suggest how economic analysis can be used as a decision making criteria in hatchery reforms.

---

1. The IEAB (2002) and CBFWA (2003) have strongly recommended that cost tracking data systems be instituted. A cost tracking data system would include, among other data elements, consistent cost information for:

    - Operating costs listed separately for labor, overhead, utilities, fish feed, and other itemizations applicable to production groups. Normal maintenance and upkeep directly associated with each specific location; and joint costs shared across a number of operating locations (e.g. head office and hatchery facility) and planning expenses, research and tag recapture/analysis applicable to production groups.
    - Capital costs listed separately to include construction expenses, design and planning, and land acquisition. These costs are to be sub-divided into buildings, equipment, raceways, water supply facilities, and land. Useful life expectancy should be estimated.

    It should include survival rates that approximate returns to fisheries, hatcheries, and spawning grounds for any specific production. Table templates in this report's appendix may be useful for beginning discussions about such a cost accounting system.

    A robust data system would provide the parameters for making comparisons among hatcheries with the same objectives for fish production. For example, hatchery production for the purpose of fishery augmentation should not be compared to hatchery production with the purpose of research or supplementation. At a policy level, the information can be important for ranking and allocating salmon recovery and habitat mitigation funds.

    A major problem for production cost accounting is that it takes three to five years from the time of smolt release to when an adult Chinook returns. It will take another two years to gather and evaluate the survival rate and catch history of the brood year. It would be important to establish a tracking cost data system linked to the life cycle of the hatchery production.

The SAFE Project had completed an evaluation phase started in 1993 and was ready to proceed to an implementation phase.[1] The BPA funds about two-thirds of Project costs in recent years. Since the funding is from the NPCC F&W Program, the Council recommended the IEAB and ISAB provide an evaluation. The two entities relied on two separate analyses (North et al. 2006 and TRG 2006) to make their recommended action. In consideration of the evaluations, the NPCC decided to keep the SAFE Project in the F&W Program for two years at approximately the same level of funding support as provided in recent years.

4.3.3.2 Cost Categories

The cost analysis drew upon the above mentioned studies to determine common cost categories. Four production categories were selected for the cost analysis:

1. Hatchery production costs. This category includes the primary hatchery plus other hatcheries where the fish might be taken for rearing.
2. State agency headquarters and management costs. These costs are calculated as an indirect accounting rate on some hatchery costs.
3. Capital or fixed costs. These costs were not typically included in annual budgets showing hatchery operation costs. It was necessary to use other studies to estimate construction and upgrade costs.
4. Acclimation and liberation costs. Final grow-out, acclimation, and liberation costs of non-MA funded entities. An example is the SAFE Project.

4.3.3.3 Production Costs

Data used in the cost analysis came from the four agencies receiving MA funds. They were recently required to submit detailed cost accounting statements and production results by NOAA Fisheries (White 2008). The results were interpreted for the cost analysis using common cost categories. The costs include other funding sources used at hatcheries where MA funding occurs. External costs for fish that have final rearing, acclimation, and/or liberation costs that are non-MA funded were also investigated. Calculated fixed costs were added to the analysis (see following section for estimating methods). The production costs for each MA hatchery are shown in Table 4.1. The costs-per-smolt results are from the four agencies' own analysis using recent years actual budgets and five year adult return averages.

---

1. The SAFE, among all the categorizing definitions that might be found in hatchery review documents, is an extension of an augmentation hatchery project whose purpose is fishery enhancement. Its operation is unique in how smolt releases are accomplished. Releases are at harvest sites tested to have low intercepts of upriver destined depressed stocks. Released stocks have been tested to have low stray rates. Many species, stocks, and release sites have been reviewed before settling on current operations. There are extra costs associated with transporting and acclimating the smolt so they return to the sites. Taken alone, the extra costs for the SAFE process are a small amount of total hatchery production costs.

Table 4.1
Summary Cost Per Smolt for Agency Release Strategy by Hatchery

Agency	Species	Hatchery	Release Strategy /2	Pounds	Operation Costs /1	Head-quarters /3	Total Oper-ational and Indirect	Capital or Fixed Costs /4	Internal Total Costs	Fish Transported With External Costs /5 Acclimation	Rearing	External Total Costs	Internal and External Total Costs
ODFW	Coho	Big Creek	535,000	44,583	0.635	0.178	0.813	0.386	1.199				1.199
ODFW	Fall Ch.	Big Creek	5,700,000	71,250	0.095	0.027	0.122	0.058	0.180				0.180
ODFW	Wint. St.	Big Creek	140,000	17,619	0.969	0.271	1.240	0.583	1.823				1.823
ODFW	Coho	Bonneville complex	4,810,000	289,274	0.336	0.094	0.430	0.279	0.708	3,585,000		0.332	1.040
ODFW	Sum. St.	Bonneville complex	215,000	43,000	1.592	0.446	2.038	0.926	2.964				2.964
ODFW	Wint. St.	Bonneville complex	260,000	43,333	1.328	0.372	1.699	0.772	2.471				2.471
ODFW	Spr. Ch.	Clackamas	361,120	36,830	0.651	0.182	0.833	0.472	1.305				1.305
ODFW	Coho	Sandy	1,000,000	66,667	0.514	0.144	0.657	0.309	0.966	300,000		0.332	1.298
USFWS	Spr. Ch.	Carson	1,420,000	88,750	0.698	0.187	0.885	0.290	1.174				1.174
USFWS	Coho	Eagle Creek	2,250,000	90,722	0.348	0.093	0.442	0.187	0.628	700,000	600,000	0.571	1.199
USFWS	Wint. St.	Eagle Creek	100,000	20,000	1.841	0.492	2.333	0.926	3.260				3.260
USFWS	Coho	LWS/Willard	650,000	32,500	0.896	0.239	1.135	0.232	1.367				1.367
USFWS	Fall Ch.	LWS/Willard	8,200,000	27,079	0.061	0.016	0.078	0.015	0.093				0.093
USFWS	Spr. Ch.	LWS/Willard	1,000,000	66,667	0.682	0.182	0.864	0.309	1.173				1.173
USFWS	Fall Ch.	Spring Creek	6,493,000	80,151	0.174	0.047	0.221	0.057	0.278				0.278
WDFW	Coho	Elochoman complex	915,000	53,824	0.336	0.090	0.426	0.272	0.698				0.698
WDFW	Fall Ch.	Elochoman complex	2,000,000	28,571	0.110	0.029	0.140	0.066	0.206				0.206
WDFW	Sum. St.	Elochoman complex	30,000	6,000	1.044	0.279	1.323	0.926	2.250				2.250
WDFW	Wint. St.	Elochoman complex	105,000	20,818	1.035	0.277	1.312	0.918	2.230				2.230
WDFW	Coho	Fallert Creek	350,000	20,588	0.309	0.083	0.391	0.272	0.664				0.664
WDFW	Fall Ch.	Fallert Creek	2,500,000	35,714	0.104	0.028	0.131	0.066	0.198				0.198
WDFW	Spr. Ch.	Fallert Creek	125,000	12,500	0.499	0.133	0.632	0.463	1.095				1.095
WDFW	Sum. St.	Fallert Creek	30,000	5,455	2.354	0.629	2.983	0.842	3.825				3.825
WDFW	Spr. Ch.	Kalama Falls complex	375,000	37,500	0.499	0.133	0.632	0.463	1.095				1.095
WDFW	Sum. St.	Kalama Falls complex	60,000	10,909	2.354	0.629	2.983	0.842	3.825				3.825
WDFW	Coho	Kalama Falls complex	350,000	20,588	0.309	0.083	0.391	0.272	0.664				0.664
WDFW	Fall Ch.	Kalama Falls complex	2,500,000	35,714	0.104	0.028	0.131	0.066	0.198				0.198
WDFW	Wint. St.	Kalama Falls complex	100,000	16,370	2.123	0.567	2.690	0.758	3.448				3.448
WDFW	Coho	North Fork Toutle	800,000	53,333	0.430	0.115	0.544	0.309	0.853				0.853
WDFW	Fall Ch.	North Fork Toutle	2,500,000	35,714	0.122	0.033	0.154	0.066	0.221				0.221
WDFW	Sum. St.	North Fork Toutle	25,000	4,545	1.099	0.293	1.392	0.842	2.234				2.234
WDFW	Fall Ch.	Ringold Springs	3,450,000	57,500	0.092	0.025	0.117	0.077	0.194				0.194
WDFW	Sum. St.	Ringold Springs	180,000	36,000	0.680	0.182	0.862	0.926	1.789				1.789

Table 4.1 (cont.)

Agency	Species	Hatchery	Release Strategy /2	Pounds	Operation Costs /1	Head-quarters /3	Total Oper-ational and Indirect	Capital or Fixed Costs /4	Internal Total Costs	Fish Transported With External Costs /5: Acclimation	Fish Transported With External Costs /5: Rearing	External Total Costs	Internal and External Total Costs
WDFW	Sum. St.	Skamania complex	254,000	50,800	1.170	0.312	1.482	0.926	2.409				2.409
WDFW	Wint. St.	Skamania complex	190,000	38,000	1.170	0.312	1.482	0.926	2.409				2.409
WDFW	Coho	Washougal	3,150,000	163,235	0.232	0.062	0.293	0.240	0.534				0.534
WDFW	Fall Ch.	Washougal	4,000,000	61,538	0.089	0.024	0.113	0.071	0.185				0.185
Yakama	Coho	Klickitat	1,000,000	66,667	0.134	0.016	0.149	0.309	0.458				0.458
Yakama	Fall Ch.	Klickitat	4,000,000	53,333	0.044	0.005	0.049	0.062	0.111				0.111
Yakama	Spr. Ch.	Klickitat	600,000	40,000	0.261	0.031	0.292	0.309	0.600				0.600
Yakama	Fall Ch.	Prosser	1,700,000	28,333	0.036	0.004	0.040	0.077	0.117				0.117
Yakama	Coho	Yakama Nation ACC	500,000	25,000	0.209	0.025	0.234	0.232	0.465				0.465
	Total Smolt Production		64,923,120	2,036,977						4,585,000	600,000		

Notes:

1. Operation costs include fish production, maintenance, marking, onsite monitoring and evaluation, and other costs for hatchery operations in a particular budget year. Fish production costs include labor, feed, materials and services, fish health, fish feed quality control program, annual maintenance, transportation, and administration costs not covered by agency indirect. The particular year may have different production than used in the evaluation of MA EIS alternatives, but the costs per smolt are assumed to apply to the MA EIS alternatives' production.
2. Smolt releases and operation costs per pound are from data generated for Erik White, NOAA Fisheries in May 2008; and by the two states, USFWS, and the Yakama Nation. Chum, cutthroat, and sockeye costs for the MA hatcheries are not shown because they are not used to compare MA EIS alternatives
3. Hatchery production indirect cost charged by states' central management (i.e. Olympia and Salem headquarters' costs) is 26.7% for WDFW, 28.0% for ODFW, 26.7% for USFWS, and 11.8% for the Yakama Nation.
4. Fixed costs are estimated using the Berry formula for $50 (1995 dollars) per pound release weight adjusted to 2007 using the ENR Construction Cost Index and annualized using the BPA amortization method. BPA capitalization and annualization methods are used to determine annual per smolt fixed costs.
5. Smolts described as external are those reared or partially reared at one or more MA funded hatcheries and transported and released at a non-MA hatchery. There may be other situations where smolts are transported to other hatcheries for final grow-out or to other remote sites for liberation, but costs are included in MA funded operations. When transfers are eggs or parrs, external costs include rearing. The per smolt release weight when fish are exported to a non-MA hatchery is assumed to be similar to the on-station weight of releases at the origin hatchery.
6. External acclimation costs use estimates from the SAFE Program for Youngs Bay and Deep River as applicable to other external situations.

The following are some general observations about smolt size, time in hatchery, and production costs.

- Most of the smolts released range from 10 to 15 per pound for CHS and COH and 20 to 25 for CHF. The CHS and COH will spend about 18 months in the system, and the CHF about nine months. Costs will reflect that time.
- Feed costs will range from $0.40 to $0.80 per pound of feed, depending on size and quality. Feed conversion rates range from 0.8 to 1.2, therefore a smolt that is 10 to the pound will cost about from $0.06 to $0.12 per smolt.
- Marking and CWT insert costs are a federal directive and have partial federal funding from other programs, such as the PCSRF. Tribal hatcheries do not use marking except for research purposes. Marking costs are about $0.05 per smolt, depending on the share of smolts to receive a CWT insert.
- Labor costs are the largest component of total variable costs, usually around 50 percent, not including labor overhead for fringe benefits, insurance, etc.
- Central office overhead, management and evaluation, and other indirect costs (sometimes referred to as headquarter costs) are significant. They are from about $0.03 to $0.40 per smolt.
- Capitalized construction and upgrade costs were estimated, assuming the fixed costs required debt financing. Annual debt servicing costs plus straight-line depreciation over the assumed useful life are included in the accounting of per-smolt costs.

Overall, the costs of hatchery operations for a particular species and release size do not vary significantly for individual hatcheries when all segments of the operation from collecting adults for capturing, eyeing, ponding, release, etc. are included.

At private salmon aquaculture as a comparison, the cost of a smolt may average $1.60 to $2.00 for a 100 gram (3.5 oz or 4.5 smolts per pound) fish (Radtke and Davis 1997, and Forster 1995). Salmon aquaculture's objective is to produce desired protein at least cost. As salmon ranching hatcheries released larger sized smolts, they realized that the costs of returns were getting larger, especially as the percentage of adults harvested do not increase proportionally enough to cover the extra costs. At $2.00 per smolt with a 10 percent return, the cost is $20 per fish; at two percent (most likely) the cost is $100. This is about five to seven times the actual selling price of the harvested fish. Salmon ranchers quickly realized their returns could be increased by building fences (net pens for full term aquaculture) and thereby increasing the survival rates to about 90 percent.

4.3.3.4 Hatchery Fixed Costs

In any economic analysis, facility costs present a special problem. In day to day operations, they will likely be considered "sunk costs." However, in an evaluation of expanding programs or decision making over long terms that will include heavy maintenance and replacement costs, facility costs need to be included.[1]

There are several studies available that can be referenced for making fixed cost estimates. A study by Rich Berry provided such estimates (Radtke and Davis 1997).[2] The estimates do not reflect the considerable pre-project and design costs in today's findings about the effects of hatchery production on native stocks. Carter (ODFW 1999) accumulated 10 years (1989-1999) of hatchery capital cost data for Oregon state-funded hatcheries and annualized the costs to determine a ratio of capital costs to operation costs. He assumed no new funds would be available for capital improvement of state-funded hatcheries in the 10 years following 1989-1999. The ratio was used as an average for the set of studied hatcheries. A recent update to his calculation shows per-smolt cost estimates are about $0.04 (personal communication October 2006).

Carter concluded his estimates are conservative because ODFW funded only essential construction projects during the study's 10 year time frame, and therefore, should be considered maintenance and upgrade capital costs. An engineering approach such as Berry's estimates most likely provides better estimates of capital costs when new construction or expansion is being considered. It may be appropriate to use Carter (1999) estimates in the short term, assuming only the minimum level of capital improvement expenditures will be made to keep the production hatcheries operating. For a longer term or expansionary period, the estimates quoted by Berry should be used. For any special application such as research, neither of these mentioned studies would apply.

It is necessary to reduce Berry's estimate to an annual cost. Capitalization policies for the states or other federal agencies contributing smolts for the project were not consulted in determining a method to use for amortizing the adopted fixed costs. It was simply assumed that the Berry estimate for capital costs would require debt financing (20 year borrowing term and current discount rate) and the useful life for computing straight-line depreciation would be 30 years (no salvage value after 30 years). The Office of Management and Budget (OMB) mandates using a discount rate set in January of each year for federal economic analysis, which is 4.9 percent in 2007.[3] Using a 30 year life cycle period includes longer lasting structures as well as shorter life

---

1. Facility costs are referred to as fixed costs in this study to differentiate them from hatchery operation variable costs. Fixed costs in this context would include pre-project, design, construction, and financing costs. Capital costs is a term used interchangeably with fixed costs.
2. Radtke and Davis (1997) reiterated personal communication with Rich Berry at ODFW (March 1995). Mr. Berry was responding to the question "If you were asked to construct a hatchery that produces salmon smolts for commercial and recreational harvests, what is your estimate of the total construction costs?" His estimate for a state operated hatchery's construction costs would be about $50 per pound of smolt produced in the early 1990's. Using the ENR construction cost index, this is about $100 per pound in 2007 dollars.
3. The Office of Management and Budget (OMB) released OMB Circular A-94 "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs," dated October 29, 1992. This Circular no longer prescribes a discount rate, but instead advises that an appropriate discount rate should be used to discount costs and benefits. The discount rate mandated for cost-effectiveness analyses (CEA) is the treasury borrowing rate taken from the Presidential Administration's economic assumptions, published at the beginning of each year, with maturity comparable to the period of analysis. This provides a more stable discount rate to reduce the need for revisions to the economic analysis. The current discount rates (released every January/February) are at http://www.whitehouse.gov/omb/circulars/a094/a94_appx-c.html.

cycle items (like concrete raceways). This period would be considered an economic life rather than a structural life.

The resulting amortized fixed costs include the annual depreciation allowance plus average annual financing interest costs. This is translated to a per-smolt cost simply by dividing by the smolt production. The calculated per-smolt costs are $0.14 across all species and size at liberation.

The adopted fixed costs are influenced for being on the high end of a range because not all of a hatchery's fixed cost would necessarily have to use debt financing. Also, the useful life could be longer than 30 years or there would be an end-of-life salvage value. The adopted costs are tempered to being on the lower end of a range by the costs not including today's pre-project and design costs.

There have been no hatcheries built in the last decade comparable to those that are similar to MA funded facilities. One new research facility has been built in the Oregon Coast Range. The cost was $7.8 million for reconstructing an existing augmentation hatchery (ODFW October 2005). There are no plans to use this facility for augmentation or supplementation purposes. A new Yakama Nation supplementation and research facility was constructed during the late 1990's at Cle Elum, Washington. Production capacity is 810,000 CHS or 54,000 pounds at 15 smolts per pound. Construction costs were $35.1 million that included a $15.9 million central hatchery, $6.1 million for three acclimation sites, $3.4 million water cooling facility, and $1.6 million capture trap. The costs are $650 per pound. The planning and permitting costs were $3.3 million. A hatchery complex is being improved for the purpose of "supplementation" in the Grande Ronde River watershed (tributary to the Snake River) at a cost of $19 million (Kirkman 2005). Improvements to two existing hatcheries and the construction of a new Lostine River Hatchery will allow production for about 1.39 million juvenile CHS. This is about $14 per smolt released, or about $165 per pound produced - about 1.5 times higher than the Berry method estimate for a "standard" hatchery capital cost. Permit costs may be a significant part of the expense of developing new sites. Construction in environmentally sensitive areas, difficult site conditions, expensive land, complex water supply development, long piping distances, and distant utilities are other factors that can drive up capital costs. The Berry method estimates may be appropriate for the original costs of the existing augmentation hatcheries, but do not reflect current hatchery pre-project and construction costs.

Fixed costs are estimated by using the Berry formula based on smolt production weight. Including fixed costs (such as ponds, roads, buildings, etc.) in an economic analysis is an important component of any long term public infrastructure decision making process. If initial construction costs can be considered sunk costs, then at least the fixed costs should account for heavy maintenance and replacement type construction. Sometimes sunk costs are resurrected into current costs to show past sponsor participation in projects. A typical example is utilities who want power generating facilities included in customer rate determining calculations. In the case of MA funding, the four agencies might argue their hatcheries' initial construction costs should be used for MA cost sharing. For public policy decisions, all costs including fixed costs should be considered, even as each entity may only be focused on their actual cash outlay for specific programs.

4.3.3.5 Cost Ratios

MA smolt production costs are only one component of the unit cost of a returning adult. The smolt unit cost of production allows an evaluation of a hatchery to control costs and reflect one part of the efficiency of an operation. However, smolts are not sold or caught. The cost to produce a returning harvestable adult gives a better evaluation of individual hatcheries and of the hatchery program in general. Table 4.2 shows the cost-per-harvestable adult (CHA) by using the four agencies' submitted cost accounting and production results information. Because the definition for the MA alternative's status quo did not exactly match the agencies cost accounting basis, the same cost-per-smolt from the four agencies were applied to a different production schedule and adult return estimates for the status quo alternative (Table 4.3).

The CHA can be a useful indicator for making MA operational decisions based on internal program considerations. (A later chapter will discuss cost considerations for comparison to external programs.) For example, because CHF's are released at smaller sizes, production costs-per-smolt are one-third COH costs. However, the CHA indicator for MA harvest shows they are about equal. This is because CHF has a lower survival rate and is a heavily harvested species in ocean and mainstem fisheries. The same mathematical procedures using weighted average production costs and representative SAR's can be applied to a more detailed individual contributing hatchery stocks for internal least cost planning.

Another cost indicator given hatchery augmentation objectives might be a ratio for harvest value. A measure of harvest revenue and recreational fishing expenditures would show dollar flows arising from fishing activity, but these values are not particularly good indicators for effects to the local economy. A harvest revenue ratio should not be judged for being less than one. The ratio is a simple relationship between one realized value and production costs. It would not be a benefit-cost ratio, because not all benefits nor costs are included in the equation. A following chapter uses modeling procedures to estimate how these dollar flows lead to personal income contributions. A cost ratio related to efficiencies might be smolt releases per production costs.

Table 4.2
Cost Per Harvestable Adult for Agency Release Strategy

Species	Smolt Production	Cost Per Smolt: Operation	Cost Per Smolt: Headquarters	Cost Per Smolt: Fixed	External Smolt Production	External Cost Per Smolt: Operation	External Cost Per Smolt: Fixed	Average SAR	Total Adults	Cost Per Total Adult Return
Fall Chinook	43,043,000	0.096	0.025	0.055				0.340%	146,233	52
Spring Chinook	3,881,120	0.596	0.154	0.337				0.559%	21,687	195
Coho	16,310,000	0.348	0.093	0.263	5,185,000	0.106	0.286	1.238%	201,880	67
Summer steelhead	794,000	1.301	0.353	0.914				0.498%	3,950	516
Winter steelhead	895,000	1.350	0.367	0.808				0.320%	2,864	789
Total	64,923,120				5,185,000				376,614	79

Notes:
1. Average production costs are weighted averages based on release strategies from Table 4.1.
2. Smolt production is from the release strategies shown in Table 4.1.
3. Average SAR's are means from broodyears 1992 through 2001 and hatchery surplus calculated using most recent 10 year (years 1998 - 2007) adult returns, except Prosser Chinook use LWS as a proxy SAR, Gobar Pond spring Chinook uses Fallert Creek, and Yakama and LWS coho uses Klickitat. Summer and winter steelhead SAR's were proxied using early 1990's returns for Skamania and Eagle Creek hatchery programs. Where SAR estimates were not provided by the agencies, CWT production groups from http://www.cbr.washington.edu/cwtSAR/ were used. Surplus is adult returns minus production program broodstock needs.
4. External costs for agencies not funded with MA funds that receive fish for rearing and acclimation from MA hatcheries include estimated headquarter costs. External smolt production is the internal production transferred to other hatcheries for final rearing and liberation. An example is Bonneville Hatchery complex coho transferred to the SAFE program for acclimation to sustain a terminal fishery.
5. The operation costs include maintenance costs, but do not include estimated hatchery facility construction fixed costs. The annualized estimated construction fixed costs use the Berry formula ($50 per pound in 1995 dollars) adjusted by the ENR Construction Cost Index to 2007 and the BPA amortization method.
6. The basis for the harvestable adult cost ratio are harvests in commercial, recreational, and treaty fisheries as well as escapements to hatcheries.

Table 4.3
Cost Per Harvestable Adult for Status Quo Alternative

Species	Smolt Production: Internal	Smolt Production: External	Average SAR	Total Adults	Cost Per Total Adult Return
Fall Chinook	50,297,592		0.29%	146,148	61
Spring Chinook	4,781,831		0.46%	21,980	237
Coho	13,223,556	5,750,700	1.57%	207,635	56
Summer steelhead	778,276		1.16%	9,057	221
Winter steelhead	1,225,247		1.10%	13,528	229
Total	70,306,501	5,750,700		398,348	77

Notes:
1. Average production costs per smolt are weighted averages based on release strategies from Table 4.2. Average SAR's are across brood years representative of the early 2000's from harvest models.

4.3.4 Economic Analysis

4.3.4.1 Analytical Approach

This section provides economic effects analysis results for determining cost effectiveness (CEA), net economic value (NEV), and regional economic impact (REI) for the status quo (Alternative 1) and the four other EIS alternatives. The EIS Alternative 2 is for all MA support to go away and hatchery production with non-MA support would continue as traditional hatchery releases. The other alternatives are for different support levels and changed production practices. The Appendix A, Chapter 2 discusses the economic analysis context, methods, and factors and explained the geographic boundaries and accounting stances to be used in the analysis. The economic effects from fishing opportunities are derived from harvests in ocean and river locations (Figure 4.1). Benefits from commercial and recreational fishing and the proportion of hatchery escapements that reach a market are based on per fish unit values using these harvests.

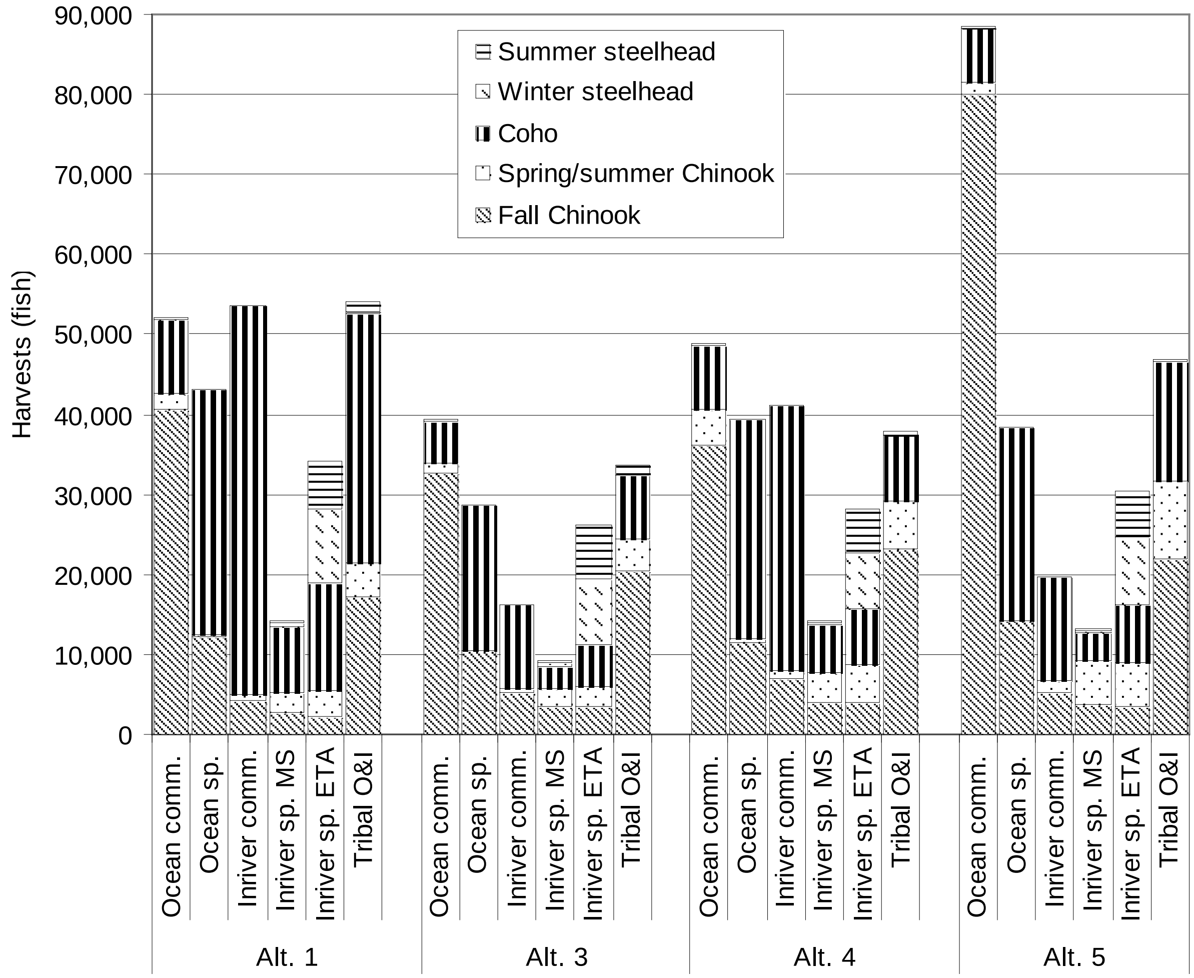
The CEA provides for a cost comparison based on an internal objective for providing harvestable fish and based on an external objective that allows comparison to other non-MA programs. A previous section on cost analysis described how internal program cost comparisons might be helpful in decision making for least cost approaches to accomplishing MA Program goals. The MA Program has multiple objectives which makes any external comparisons difficult. The comparison basis selected was cost per one percent saved juveniles associated with impacted returns of upriver CHS, upriver bright CHF, and summer steelhead (SSL). This was an indicator suggested by the IEAB (2004) as useful when programs have objectives for improving smolt passage survival. Appendix A, Chapter 3 describes other programs where similar measurements have been studied.

The NEV is calculated for economies wherever the Columbia River MA funded production salmon and steelhead are harvested and receive primary processing. The NEV accounting stance is intended to be the U.S. national economy. Including British Columbia in the accounting stance overestimates benefits by six to eight percent, depending on the alternative. However, the PST has negotiated equivalents in salmon species origins. (An equivalent example is the ratio of economic welfare arising from a pink salmon as compared to a sockeye salmon.) Theoretically, if the Columbia River MA hatchery production was not caught in British Columbia, then equivalents would be caught in other West Coast or Alaska fisheries. Therefore, the NEV would have the same reference basis, even though it was being generated in an equivalent species.

Subtracted from these benefits are the costs for the MA system production, external, and calculated annualized fixed costs. These costs are from the cost analysis rather than actual budget tabulations. This is because all of the alternatives represent hypothetical conditions. While the status quo alternative nearly patterns the existing situation in 2006 and 2007, there were sufficient differences in the agencies' submitted cost accounting and production results that use of cost indicators was required rather than using snapshot actual costs.

It is acknowledged there could be other benefits and costs brought into the equation. Hatchery production is to replace lost habitat due to hydropower development, so hydropower benefits and dam construction costs could be included. Dams have multiple benefits like transportation, but

Figure 4.1
Hatchery Harvests by Fisheries and by Species for Alternatives



Notes: 1.	Abbreviations for *x*-axis labels:	
	Ocean comm.	Ocean commercial
	Ocean sp.	Ocean sport
	Inriver comm.	Inriver commercial
	Inriver sp. MS	Inriver sport mainstem
	Inriver sp. ETA	Inriver sport extreme terminal area
	Tribal O&I	Tribal ocean and inriver
2.	The Alternative 2 is not depicted because there is no Mitchell Act supported production, and therefore harvests are zero.	
3.	Tribal C&S harvests are not included in the shown fisheries. Table 4.14 shows recent years C&S harvests.	

they also have multiple and cumulative costs. Benefits promote industrial and urban development which in-turn can have adverse consequences. Opportunity costs for land and water could be brought into the equation. There are also non-market benefits that could be considered, like the benefits from non-consumptive fish resource recreational experiences and passive use values. Despite the simplifying assumptions of only using harvest values and production cost elements, results should be revealing for showing the incremental effect of policy alternatives.

REI's are calculated for commercial and recreational fishing activity, the proportion of hatchery escapements that reach a market using per fish unit values, and for hatchery operation and headquarter activity. The accounting stance is for state and British Columbia province level economies. These particular regional economies are itemized for the REI measure in the consideration a different aggregation or separation of geography will be of interest. Because angler residency information was not known for all fisheries participation, and the accounting stance was for large regional economies, economic local substitution effects for resident anglers were not considered. Similarly, the estimates do not include effects from substitution fisheries that may offset downturns in what MA production contributes to the fisheries. REI's from hatchery production and headquarters costs are itemized to show relative contributors to MA alternatives' total impacts. The hatchery calculated fixed costs are included in the BCA determinations, but are not used to determine REI.

4.3.4.2 Cost-Effectiveness Analysis

The CHA ratio previously explained for being useful for internal (same objective) comparisons was extended to each MA EIS alternative (Table 4.4). There is a mix of results for the different production populations among alternatives. The important CHS production ratio has the least cost in Alternative 5 and the highest ratio in the Status Quo Alternative.

In regards to comparisons with external programs that have objectives for salmon recovery, the annual costs per one percent juvenile "savings" were developed. There were several existing analysis results using this indicator, so it was convenient to calculate the same indicator for the MA EIS alternatives. The comparison required translation to outmigrating juveniles associated with the harvest brood years (Table 4.5). The selected impacted stocks were upriver CHS, upriver bright CHF (URB), and summer steelhead (SSL). Table 4.5 shows the costs per one percent juveniles saved for upriver CHS to be about \$8, for URB to be about \$1, and for SSL to be about \$7 across alternatives.

4.3.4.3 Net Economic Value

The NEV analysis does not attempt to measure the MA Program's total benefits over time in relation to its costs. It only provides simple one-time estimates of benefits from commercial and recreational harvests and hatchery surplus sales and costs for the MA production system. The NEV from fisheries and hatchery returns are estimated for the status quo alternative to be \$19.2 million (Table 4.6). The estimated BCA for the status quo alternative when MA hatchery system

Table 4.4
Cost Per Harvestable Adult for Alternatives

Species	Smolt Production	Production Costs	Average SAR	Total Adults	Cost Per Total Adult Return
Alternative 1					
Fall Chinook	50,297,592	8,871,989	0.29%	146,148	61
Spring Chinook	4,781,831	5,199,144	0.46%	21,980	237
Coho	13,223,556	11,554,490	1.57%	207,635	56
Summer steelhead	778,276	1,998,373	1.16%	9,057	221
Winter steelhead	1,225,247	3,094,592	1.10%	13,528	229
Total	70,306,501	30,718,588		398,348	77
Alternative 3					
Fall Chinook	37,948,009	6,693,647	0.34%	130,312	51
Spring Chinook	3,188,378	3,466,630	0.55%	17,551	198
Coho	5,790,783	5,059,876	1.75%	101,050	50
Summer steelhead	804,779	2,066,424	1.24%	10,017	206
Winter steelhead	1,109,634	2,802,590	1.14%	12,617	222
Total	48,841,584	20,089,166		271,546	74
Alternative 4					
Fall Chinook	45,223,644	7,976,996	0.32%	146,821	54
Spring Chinook	7,403,713	8,049,840	0.47%	34,961	230
Coho	8,426,183	7,362,637	2.02%	169,871	43
Summer steelhead	752,219	1,931,465	1.09%	8,191	236
Winter steelhead	1,625,794	4,106,249	0.81%	13,204	311
Total	63,431,552	29,427,186		373,049	79
Alternative 5					
Fall Chinook	44,733,040	7,890,458	0.45%	199,323	40
Spring Chinook	5,053,255	5,494,256	0.69%	35,087	157
Coho	7,749,840	6,771,662	1.59%	123,321	55
Summer steelhead	1,218,440	3,128,577	0.83%	10,134	309
Winter steelhead	1,109,634	2,802,590	1.14%	12,617	222
Total	59,864,209	26,087,542		380,482	69
Summary					
Alternative 1	70,306,501	30,718,588		398,348	77
Alternative 3	48,841,584	20,089,166		271,546	74
Alternative 4	63,431,552	29,427,186		373,049	79
Alternative 5	59,864,209	26,087,542		380,482	69

Notes: 1. Production costs include MA funding, other funding sources used at hatcheries where MA funding occurs, estimated fixed costs, and external costs.

Table 4.5
CEA for MA Production Cost Per Impacted Recovery Populations for Alternatives

Species	Run Size (Year 2003-2007 Avg.)	SAR (Year 2003-2007 Avg.)	Outmigrating Juveniles (000,000) (Year 2003-2007 Avg.)	Harvest	SAR	Juveniles (000)	MA Cost ($000)		
Alternative 1									
Upriver CHS	157,909	0.46%	34.4	239	0.46%	52.0	$ 1,228		
URB	270,060	0.29%	92.9	1,956	0.29%	673.2	$ 966		
Sum. steelhead	325,460	1.16%	28.0	34	1.16%	2.9	$ 98		
Alternative 2									
Upriver CHS				0	n/a		$ -		
URB				0	n/a		$ -		
Sum. steelhead				0	n/a		$ -		
Alternative 3									
Upriver CHS				219	0.55%	39.8	$ 923		
URB				2,758	0.34%	803.3	$ 1,125		
Sum. steelhead				35	1.24%	2.8	$ 101		
Alternative 4									
Upriver CHS				357	0.47%	75.7	$ 1,749		
URB				3,211	0.32%	989.0	$ 1,412		
Sum. steelhead				39	1.09%	3.6	$ 110		
Alternative 5									
Upriver CHS				580	0.69%	83.6	$ 1,887		
URB				2,875	0.45%	645.2	$ 901		
Sum. steelhead				40	0.83%	4.8	$ 149		
Saved Impacts						Juveniles (000)	MA Cost ($000)	Cost Per Saved Juvenile	Cost Per 1% Saved Juvenile ($000,000)
Status quo minus Alternative 2									
Upriver CHS						52.0	$ 1,228	$ 24	$ 8
URB						673.2	$ 966	$ 1	$ 1
Sum. steelhead						2.9	$ 98	$ 34	$ 10
Status quo minus Alternative 3									
Upriver CHS						12.1	$ 305	$ 25	$ 9
URB						-130.1	$ (159)	$ 1	$ 1
Sum. steelhead						-	-	-	-
Status quo minus Alternative 4									
Upriver CHS						-23.7	$ (521)	$ 22	$ 8
URB						-315.8	$ (446)	$ 1	$ 1
Sum. steelhead						-0.7	$ (12)	$ 17	$ 5
Status quo minus Alternative 5									
Upriver CHS						-31.6	$ (660)	$ 21	$ 7
URB						28.0	$ 65	$ 2	$ 2
Sum. steelhead						-2.0	$ (51)	$ 26	$ 7

Notes:
1. Upriver CHS and URB fall Chinook are run size at the mouth of the Columbia River. Summer steelhead run size is indexed to Bonneville Dam.
2. SAR's used in this table are smolt survival to run size. The MA EIS status quo alternative SAR's are used as a proxy for brood year conditions that generated the run size.
3. The impact rate basis is from mainstem fishing (non-treaty, treaty) for the shown recovery species: CHS (1.24%, 10.00%), URB (7.44%, 15.95%), SSL (4.47%, 19.51%)
4. The impact harvest is the mainstem fishing harvest from MA produced fish times the impact rate.
5. Impact juveniles represent the number of outmigrating juveniles associated with impact harvests. This assumes zero adult passage mortality.
6. Total MA costs are segmented for upriver CHS, URB, and SSL using total MA spring Chinook, fall Chinook, and summer steelhead production costs, respectively.
7. MA costs include operation, headquarters, external, and capital/fixed costs for internal and external operations.
8. Cost per saved juvenile assumes that the saved impact harvest would not be made up in other fisheries if the MA alternatives' production did not occur.
9. Summer steelhead impacts for Alternative 3 are statistically insignificant.

Source: Run size and impact rates are from Joint Columbia River Management Staff (July 14, 2008) and (January 31, 2008

Table 4.6
NEV From Fisheries and Marketable Hatchery Returns for
Alternatives and Comparison With the Status Quo Alternative

Alternatives	Fall Chinook	Spring/Sum Chinook	Coho	Winter Steelhead	Summer Steelhead	Total
Alternative 1	4,400	4,413	7,045	2,025	1,337	19,219
Alternative 2	0	0	0	0	0	0
Alternative 3	4,438	3,635	2,964	1,813	1,474	14,324
Alternative 4	5,038	6,481	4,750	1,511	1,232	19,012
Alternative 5	6,261	8,476	3,961	1,813	1,294	21,803
Differences						
Alternative 2	-4,400	-4,413	-7,045	-2,025	-1,337	-19,219
Alternative 3	38	-778	-4,081	-212	138	-4,895
Alternative 4	638	2,068	-2,296	-514	-104	-207
Alternative 5	1,861	4,063	-3,085	-212	-43	2,584
Notes: 1.	NEV is in thousands.					
2.	Differences are alternatives minus status quo alternative.					
3.	The NEV includes effects from all Columbia River inland, U.S. West Coast,					
	Alaska, and British Columbia harvesting and processing regions.					

costs are included is negative $11.5 million (Table 4.7). The incremental BCA for Alternatives 3 through 5 ranges from an algebraically positive $7.2 million to $1.1 million (Table 4.8). This means each of the Alternatives 3 through 5 are less negative than the status quo.

NEV analysis can also be useful for showing operation efficiencies. For example, the NEV analysis shows the influence of CHS production. Harvesters receive a high price per pound for this species, and while the production costs are also high, the benefit-cost calculation is positive for Alternatives 3 and 5 (Table 4.7).

4.3.4.4 Regional Economic Impacts

The REI from MA production fisheries for the status quo alternative is estimated to be $23.8 million personal income of which about two-thirds is from ocean and inriver recreational fishing (Table 4.9). The REI for hatchery production and headquarters cost are $31.7 million (Table 4.10). As previously described, calculated rather than annual actual budgets are used for the latter analysis. Actual program administration expenditures vary from year-to-year, so the choice for using the shown budgets should be viewed as providing a representative REI for these types of expenditures. The expenditures are made at hatchery and state management headquarter locations, so the effects are regional. The total incremental REI for Alternatives 3 through 5 ranges from a negative $14.2 million to a positive $667 thousand (Table 4.8) in personal income and negative 394 to positive 19 in full-time equivalent jobs. These measurements are to regional

Table 4.7
Benefits and Costs for Alternatives

	Smolt Releases	Production Cost ($000's)	Harvest and Hatchery Returns NEV ($000's): Commercial	Treaty Commercial	Recreational	Hatchery Returns	Total	Net Benefits ($000's)
Species								
Alternative 1								
Fall Chinook	50,297,592	$8,872	$839	$357	$3,148	$56	$4,400	-$4,472
Spring Chinook	4,781,831	$5,199	$62	$130	$4,213	$8	$4,413	-$786
Coho	13,223,556	$11,554	$384	$151	$6,487	$23	$7,045	-$4,509
Summer steelhead	778,276	$1,998	$0	$9	$1,327	$1	$1,337	-$662
Winter steelhead	1,225,247	$3,095	$0	$0	$2,023	$1	$2,025	-$1,070
Total	70,306,501	$30,719	$1,286	$647	$17,198	$88	$19,219	-$11,499
Alternative 2								
Fall Chinook	0	$0	$0	$0	$0	$0	$0	$0
Spring Chinook	0	$0	$0	$0	$0	$0	$0	$0
Coho	0	$0	$0	$0	$0	$0	$0	$0
Summer steelhead	0	$0	$0	$0	$0	$0	$0	$0
Winter steelhead	0	$0	$0	$0	$0	$0	$0	$0
Total	0	$0	$0	$0	$0	$0	$0	$0
Alternative 3								
Fall Chinook	37,948,009	$6,694	$710	$417	$3,265	$46	$4,438	-$2,256
Spring Chinook	3,188,378	$3,467	$49	$118	$3,463	$6	$3,635	$168
Coho	5,790,783	$5,060	$95	$38	$2,813	$17	$2,964	-$2,096
Summer steelhead	804,779	$2,066	$0	$9	$1,465	$1	$1,474	-$592
Winter steelhead	1,109,634	$2,803	$0	$0	$1,811	$1	$1,813	-$990
Total	48,841,584	$20,089	$854	$582	$12,817	$71	$14,324	-$5,765
Alternative 4								
Fall Chinook	45,223,644	$7,977	$814	$469	$3,704	$51	$5,038	-$2,939
Spring Chinook	7,403,713	$8,050	$118	$187	$6,163	$12	$6,481	-$1,569
Coho	8,426,183	$7,363	$269	$38	$4,415	$27	$4,750	-$2,613
Summer steelhead	752,219	$1,931	$0	$3	$1,228	$1	$1,232	-$699
Winter steelhead	1,625,794	$4,106	$0	$0	$1,508	$2	$1,511	-$2,595
Total	63,431,552	$29,427	$1,202	$697	$17,019	$94	$19,012	-$10,415
Alternative 5								
Fall Chinook	44,733,040	$7,890	$1,513	$447	$4,242	$59	$6,261	-$1,630
Spring Chinook	5,053,255	$5,494	$89	$300	$8,078	$9	$8,476	$2,982
Coho	7,749,840	$6,772	$119	$71	$3,752	$19	$3,961	-$2,811
Summer steelhead	1,218,440	$3,129	$0	$3	$1,289	$1	$1,294	-$1,835
Winter steelhead	1,109,634	$2,803	$0	$0	$1,811	$1	$1,813	-$990
Total	59,864,209	$26,088	$1,720	$821	$19,172	$90	$21,803	-$4,284

Notes:
1. Production costs include MA funding, other funding sources used at hatcheries where MA funding occurs, estimated fixed costs, and external costs.
2. The NEV includes effects from all Columbia River inland, U.S. West Coast, Alaska, and British Columbia harvesting and processing regions.

Table 4.8
NEV and REI Alternatives Comparison

				REI	
				Personal	
	Alternative		BCA ($000)	Income ($000)	FTE
Alternative 1 (status quo)			-11,499	+51,805	+1,440
Differences					
	Alternative 2		+11,499	-51,805	-1,440
	Alternative 3		+5,734	-14,171	-394
	Alternative 4		+1,084	+229	+6
	Alternative 5		+7,215	+667	+19

Notes: 1. Differences are each alternative minus status quo.
2. REI measurement is total personal income and full-time equivalent (FTE) jobs. The calculation of FTE is assumed to be average annual earnings for the study area economy.
3. The BCA and REI include effects from all Columbia River inland, U.S. West Coast, Alaska, and British Columbia harvesting and processing regions.

economies wherever MA production is harvested, hatchery escapements reach a market, or hatchery and headquarter expenditures occur.

4.3.4.5 Model Parameter Sensitivity

MA funded hatchery system outcomes, such as harvest benefits, are derived from production conditions for which agencies have no control. One factor affecting smolt survival is the concentration of predators in the estuary and ocean. Seals and sea lions have been targeted for over a century for preying on Columbia River salmon (Reed 1890). More recently bird populations in the lower Columbia River have been identified as effective predators of salmon smolts. The world's largest colony of Caspian terns and the two largest colonies of double-crested cormorants on the West Coast have recently become established in the Columbia estuary (NMFS 2000).

While not yet fully understood on an ecosystem basis, ocean conditions appear to strongly influence smolt survival. Correlations with numbers of adult salmon returning to spawning streams and hatchery release sites have received considerable study (Mantua 1997). Important changes in Northeast Pacific marine ecosystems have been correlated with the Pacific Decadal Oscillation (PDO) index (Anderson 1997 and Francis et al. 1998). Warm PDO phases have favored high salmon production in Alaska and low salmon production off the west coast of California, Oregon, and Washington states. Conversely, cool PDO eras have favored low salmon production in Alaska and relatively high salmon production for California, Oregon, and Washington (Hare 1996, Hare et al. 1999, Peterson et al. 2006). North et al. (2006) shows CHS MA production related to the 12 month PDO index for recent brood years (Figure 4.2).

Table 4.9
REI From Fisheries and Marketable Hatchery Returns for Alternatives

Species	Smolt Releases	Harvest and Hatchery Returns REI ($000's) Commercial	Treaty Commercial	Recreational	Hatchery Returns	Total
Alternative 1						
Fall Chinook	50,297,592	$2,912	$2,860	$2,393	$164	$8,329
Spring Chinook	4,781,831	$156	$328	$3,853	$22	$4,359
Coho	13,223,556	$1,025	$1,077	$5,860	$63	$8,025
Summer steelhead	778,276	$1	$87	$1,185	$2	$1,275
Winter steelhead	1,225,247	$1	$4	$1,806	$4	$1,816
Total	70,306,501	$4,095	$4,356	$15,097	$255	$23,803
Alternative 2						
Fall Chinook	0	$0	$0	$0	$0	$0
Spring Chinook	0	$0	$0	$0	$0	$0
Coho	0	$0	$0	$0	$0	$0
Summer steelhead	0	$0	$0	$0	$0	$0
Winter steelhead	0	$0	$0	$0	$0	$0
Total	0	$0	$0	$0	$0	$0
Alternative 3						
Fall Chinook	37,948,009	$2,517	$3,941	$2,573	$134	$9,165
Spring Chinook	3,188,378	$117	$295	$3,171	$17	$3,600
Coho	5,790,783	$256	$260	$2,555	$49	$3,119
Summer steelhead	804,779	$1	$87	$1,308	$2	$1,398
Winter steelhead	1,109,634	$1	$4	$1,617	$4	$1,626
Total	48,841,584	$2,892	$4,588	$11,224	$206	$18,910
Alternative 4						
Fall Chinook	45,223,644	$2,921	$4,477	$2,932	$149	$10,479
Spring Chinook	7,403,713	$327	$469	$5,637	$36	$6,468
Coho	8,426,183	$719	$246	$4,032	$76	$5,073
Summer steelhead	752,219	$1	$35	$1,097	$2	$1,134
Winter steelhead	1,625,794	$1	$4	$1,347	$7	$1,359
Total	63,431,552	$3,969	$5,231	$15,044	$270	$24,513
Alternative 5						
Fall Chinook	44,733,040	$5,247	$4,143	$3,287	$173	$12,850
Spring Chinook	5,053,255	$180	$751	$7,405	$27	$8,363
Coho	7,749,840	$318	$498	$3,314	$52	$4,182
Summer steelhead	1,218,440	$1	$31	$1,151	$4	$1,187
Winter steelhead	1,109,634	$1	$4	$1,617	$4	$1,626
Total	59,864,209	$5,747	$5,427	$16,774	$260	$28,208

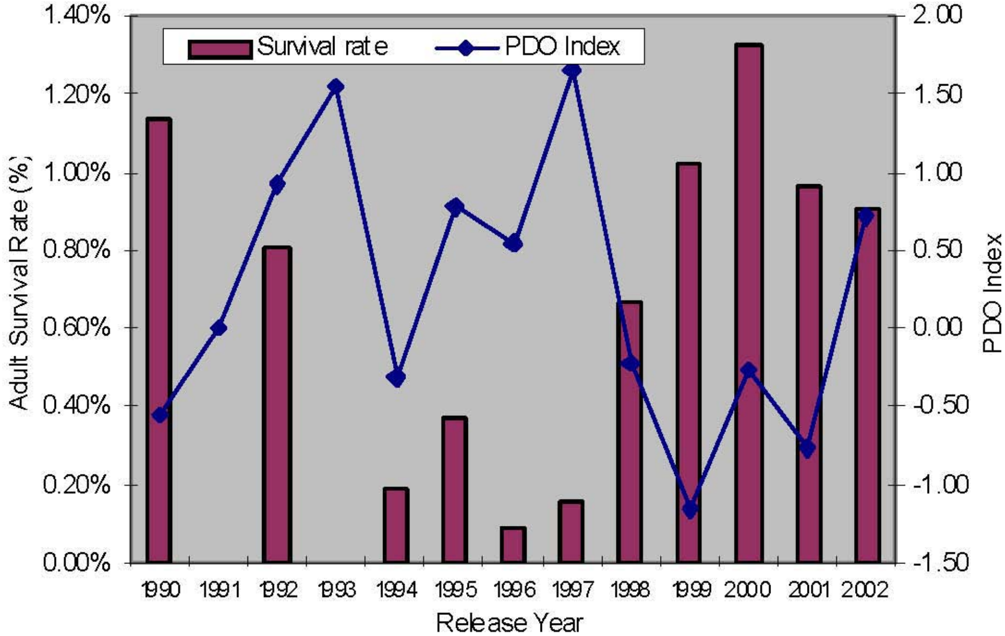
Notes: 1. REI measurement is total personal income in thousands.
2. The REI includes effects from all Columbia River inland, U.S. West Coast, Alaska, and British Columbia harvesting and processing regions.

Table 4.10
REI From Fisheries, Marketable Hatchery Returns, Hatchery Operations, and Headquarter Activity for Alternatives and Comparisons With the Status Quo Alternative

	REI		Differences	
	Personal		Personal	
Alternatives	Income ($000's)	FTE	Income ($000's)	FTE
Alternative 1				
Fisheries	23,549	655		
Hatchery returns	255	7		
Hatchery operation	22,339	621		
Hatchery headquarters	5,663	157		
Total REI	51,805	1,440		
Alternative 2				
Fisheries	0	0	-23,549	-655
Hatchery returns	0	0	-255	-7
Hatchery operation	0	0	-22,339	-621
Hatchery headquarters	0	0	-5,663	-157
Total REI	0	0	-51,805	-1,440
Alternative 3				
Fisheries	18,704	520	-4,844	-135
Hatchery returns	206	6	-49	-1
Hatchery operation	14,893	414	-7,445	-207
Hatchery headquarters	3,831	107	-1,832	-51
Total REI	37,634	1,046	-14,171	-394
Alternative 4				
Fisheries	24,243	674	695	19
Hatchery returns	270	7	15	0
Hatchery operation	21,900	609	-439	-12
Hatchery headquarters	5,622	156	-42	-1
Total REI	52,034	1,447	229	6
Alternative 5				
Fisheries	27,948	777	4,399	122
Hatchery returns	260	7	5	0
Hatchery operation	19,306	537	-3,032	-84
Hatchery headquarters	4,958	138	-706	-20
Total REI	52,472	1,459	667	19

Notes:
1. REI measurement is total personal income in thousands and full-time equivalent (FTE) jobs. The calculation of FTE is assumed to be average annual earnings for the study area economy.
2. REI does not include fixed costs expenditures.
3. Differences are each alternative minus status quo alternative.
4. The REI includes effects from all Columbia River inland, U.S. West Coast, Alaska, and British Columbia harvesting and processing regions.

Figure 4.2
Relationship Between SAR and Pacific Decadal
Oscillation Index SAFE System Spring Chinook Releases



Notes: 1. CHS brood years are 1988-2000. PDO is 12 month index.
Source: North et al. (2006) and Mantua (1997).

It is of interest to show the sensitivity of MA funded hatchery system economic measurements related to a range of SAR's. Such information can be useful for evaluations over a longer planning horizon than what might be shown in the snapshot conditions used in the economic analysis. For example, MA funding agencies could decide if economic outcomes during high risk years (positive PDO index years) are sufficient to justify waiting for the benefits during low risk years (negative PDO index years). While sufficient and reliable information is not yet available, future operational planning could even ramp-up or ramp-down production in anticipation of ocean survival.

An example economic results sensitivity analysis is shown in Table 4.11. The example SAR range for low SAR's is half of the SAR's used in the harvest model and the high SAR's are double. The incremental change in NEV shows that the BCA has moved to a positive value of $7.7 million for the status quo alternative for the example high SAR's. Instead of REI being $51.8 million for fishery benefits and hatchery operation and headquarter activity, the range would be $39.9 million to $75.6 million for the example SAR range.

Risk in a production system is the probability of an undesirable outcome. MA funding agencies have investigated and experimented with a number of remedies to improve smolt survival during rearing and acclimation and provide best conditions for out-migration. However, this sensitivity analysis shows a very high variability for production factors is also related to environmental conditions.

Table 4.11
Economic Result Sensitivity to SAR Range

Measure	Indicator	From Alternative	SAR Range Average	Low	High
Incremental NEV and REI	BCA change ($000)	2	$11,499	$21,109	-$7,720
		3	$5,734	$8,182	$839
		4	$1,084	$1,188	$877
		5	$7,215	$5,923	$9,800
	REI change ($000)	2	-$51,805	-$39,904	-$75,608
		3	-$14,171	-$11,724	-$19,064
		4	$229	-$126	$939
		5	$667	-$1,535	$5,071
Cost per "harvestable" adult across all stocks	Total production		$77	$154	$39

Notes: 1. SAR range example is half and double assumed smolt survival-to-fisheries and hatchery escapements used in harvest model.
2. Change is alternative minus status quo. Total production used in cost per harvestable adult is the status quo alternative.

4.4 Social Consequences

4.4.1 Background

There are a variety of social impacts that may arise as a result of changes in MA funded hatcheries. All alternatives will change hatchery production levels. The changed production are expected to have impacts to natural fish runs to varying extents, although the full impact might take as long as fifty years for some species. The changed hatchery and natural runs will change harvest opportunities, and therefore, change the the potential to generate income and employment in commercial fishing and processing throughout West Coast, British Columbia, and Alaska. Income and employment generated from recreational fishing opportunities will also be impacted. The net impact is uncertain both due to scientific information and policy information. The changed fish runs might be predictable, but there would also be adjustments to harvest management measures to compensate for the changed fish runs. Outguessing the compensating management measures is problematic, so social impact descriptions on a regional or community level are challenging.

Social impacts are often discussed in terms of the overall impact on income, employment and other economic indicators; but it is important to remember that the aggregate totals conceal many important details. First, aggregate totals are often long-run effects, but there are likely to be important distinctions between the short run and the long run and the transition periods.[1] Second, aggregate effects often mask interpersonal or geographic differences in impact.[2] Thus, a net increase in jobs may not mean much to someone without the appropriate skills for the jobs created while a net decrease in jobs may mask a substantial increase in employment opportunities for some. While it is often much more difficult to determine the detail of social impacts, some discussion of likely trends may help to focus on the distribution of the impacts

1. Related impacts occur through the process of capitalization of various economic values into land prices. Through the process of capitalization, the person owning the land at the time of an economic change actually bears much of the burden or receives much of the benefit of the changes even though the impact is spread over many years. Capitalization occurs with both positive and negative impacts. For example, increased recreational opportunities may cause the value of land near the recreation site to increase by some multiple of the expected annual value of increased recreation opportunities. While capitalization is seldom as efficient or complete as this discussion implies, it is important to take it into account when trying to determine the distribution of benefits and costs. So, the person owning the land at the time of the change receives most of the impact whether that person continues to own the land or not. This reduction may also be viewed as a decrease in allowable spending by households who receive current or future rents from these assets.
2. Social impacts are subject to great uncertainty, especially where the issue of financing is not resolved. From the regional perspective, income is income, whether it comes from the sale of agricultural commodities or from federal payments for construction activity. Hence, the regional social impact analysis does not focus on the net benefits or costs of activities. Rather, it focuses on whether the local communities are made better or worse off. However, some activities may be financed from a variety of sources, including local ones. Then the source of the funds becomes an important issue. From the local perspective, federal funds generate only benefits while local funds generate benefits and costs. This is true whether the local funds are raised through local governments, e.g., taxes paid for an improved municipal water system, or through private sources, e.g., higher irrigation costs. A variety of such issues are unresolved and will have a substantial effect on the ultimate impacts. Further, where there are likely to be negative local impacts, some form of mitigation might be possible. From an economic perspective, such issues often have little impact on the net economic outcome, but from a social perspective, they may be decisive in determining the impact. Where differences in the source of funding are clearly defined, they will be noted, but there are many areas where future decisions may substantially alter the impacts.

might be helpful. Social impact discussion categories for regional and communty impacts, fiscal condition of local governments, and quality of life.

4.4.2 Regional and Community Impacts

4.4.2.1 Income Distribution

The net impact of changed hatchery operations is likely to have some effects on income distribution. In the short run, the jobs generated from commercial harvesting and hatchery operation jobs will favor skilled workers over unskilled workers. This may have an adverse effect on the distribution of income with losses in these impact sectors. Alternatively, if the displaced workers can get employment elsewhere, it is likely to improve the income distribution due to the higher average wages. Jobs from commercial fish processing and the tourism jobs that accompany recreational fishing will favor less skilled workers. Replacement jobs may not be available in local communities unless there is a shift to other recreational opportunities.

Significant recreation opportunities regionally and at Columbia River Basin locations come from MA funded production. If fish abundances are reduced, such as in Alternative 2, other that consumptive recreational fishing use will also be diminished, such as viewing migrating fish. Fishing activity may shift and cause congestion in other fisheries or activities. The switch to other water oriented recreation may be for boat touring, skiing, and windsurfing. The alternatives may cause fishing for some species of fish like spring Chinook to improve, while fishing for other anadromous and resident fish to decline. It could be that such changes will affect the proportion of visitors attracted to affected regions from outside the local area. This has the effect of increasing the impacts on the local economy through gains in household income and jobs even though total visitors will be fewer.

Where the change in angler days in Columbia River recreational fishing (Table 4.13) is negative for alternatives, employment losses are expected in the short run due to loss in recreation opportunities. These may be offset in the long run as alternative recreation activities are developed and if increases in fish populations from other origins like from natural populations provide additional opportunities. Small businesses that rely on users of the recreation facilities may face reduced patronage. Some may go out of business if the recreation users are a prime source of customers. While these may be offset by employment gains in the long run, there is likely to be a transition period that creates difficulties for existing businesses. In general, the job losses are likely to be in the service sector, and the anticipated growth in service sector employment should mitigate any adverse effects on employment. The most likely negative impacts would be on specific businesses.

Recreation changes will have direct employment impacts in the area affected but many of the people who will either benefit from new recreation opportunities or lose from the loss of old ones are located in other parts of the state and even the country. Many people argue that the recreation opportunities available in the Pacific Northwest are an important amenity, but it would be difficult to quantify the value of such changes or their distribution among the population.

There will be some construction necessary associated with implementing the alternatives. When viewed from the regional perspective, the short-run impacts from construction are likely to be negligible due to the size of the economies. Whether such jobs are filled by local residents or by "commuters" the effect is likely to be an increase in average income. The increased purchases of construction materials and other construction related expenses would impact favorably on many local businesses.

It is important to keep the time trend in mind when evaluating job changes. A concentration of job losses in the short run would have a much more negative impact than similar losses spread over a long period of time, especially when the time trend is for employment gains. Over time, the region may have a lower level of employment after the changes in hatchery operation than would have occurred without such changes, but this may not result in an actual reduction in employment if the changes take place over a long enough time period.

4.4.2.2 Employment Distribution

In the short run, the employment changes are likely to favor skilled over unskilled workers for commercial fishing and hatchery operation employment and the reverse for recreational fishing. The share of minorities in the affected communities is in the Columbia River Basin above Bonneville Dam is greatest for Hispanics and above average for American Indians. Hispanics are most likely to be negatively affected by the loss of agricultural jobs and their relatively low representation in the skilled trade categories. For American Indians in this area, fishing is a way of life. Replacement jobs afforded by fishing opportunities are unthinkable.

American Indians could only be positively impacted in the long run if overall fish runs improve. The long run benefits of the improved fish runs would be cultural, subsistence, and commercial for this group. Salmon fishing has an important cultural benefit for many Indian tribes. In addition it provides direct food benefits and part of the catch may be sold commercially, providing income. There would not be offsetting short-run or long-term effects from employment or income opportunities for this group.

4.4.2.3 Population Distribution and Composition

The changes associated with changed hatchery operations that decrease commercial and recreational fishing opportunities are likely to affect location patterns by making dispersed employment opportunities less available. Moreover, reductions in operations or closing hatcheries may have concentrated employment impacts in specific areas. The loss in dispersed areas would depend on the overall effect on fishing. To the extent that fishing activity is not disrupted, the changes will be associated with a gain for growing areas but not necessarily at the expense of other areas in the region. Rather the gain is likely to be associated with net migration into the region in response to employment opportunities.

Changes in economic factors will create incentives for migration in response to employment and business opportunities. Sudden changes tend to affect demographic composition. For example, younger workers are likely to be more mobile than older workers. This affects the demographic composition of growing and declining areas. Loss of economic opportunity tends to result in young people moving out of an area, and this could be a particular issue for families. On the other hand, growing areas, with good employment opportunities are particularly attractive to such workers. The likely effect would be neutral for small communities and positive for the areas of concentrated economic activity. However, if there is a substantial loss in skilled worker income and employment, then the demographic effects would also be negative. Younger, more mobile workers would tend to leave first, with a resulting concentration of older, less mobile population seen in other declining areas.

4.4.3 Fiscal Condition of State and Local Governments

The respective federal, state, and tribal agencies that operate the hatcheries could be noticeably affected by the EIS alternatives. Around one-third of the MA funds cover headquarters management and administrative costs. However, the secondary effects from income and property taxes arising from hatchery operations will be comparatively small. Also, the impact on state economic activity is likely to be quite small relative to the overall state economies. Hatcheries are a public asset and not subject to property taxes except in certain cases of in-lieu of agreements.

Traditionally, local governments relied on property taxes for most of their locally generated revenue, and changes in property taxes were an important fiscal issue. This has been changed in Oregon for two reasons. First, local schools, the largest user of property tax revenue for most local governments, are no longer reliant on property taxes in Oregon. While local school districts do collect property taxes, the State determines the level of school expenditure and adjusts state contributions to offset changes in property tax revenue. Hence, an important source of local fiscal impact is drastically curtailed by the financing mechanism in Oregon. Second, the Oregon property tax system is based on an assessed value that is considerably below market value for most property in Oregon. While assessed value can not increase beyond market value, it can grow by three percent per year so long as it is below market value. Hence, even for general government in Oregon, a decrease in property values may not result in any loss of tax revenue, so long as the market value does not decline below the assessed value. On the other hand, since the drawdown would not occur for some time, market values may be above assessed values or other changes in the financing system may have occurred.

In Washington, changes in assessed value would have a more direct impact on local government finance, but these impacts would not be large unless there were substantial changes in economic activity. Most of the projected impacts appear to be either neutral or positive in the short-run for most local governments. The exception would be largely rural areas where the decline in value for agricultural land might have a noticeable impact.

Local impacts can be expected to be varied. Some communities, especially those near hatcheries, fish processing, or recreational sites, could see changes in activity. This would be expected to generate changes in local government revenue and also create changes in demand for services. If population growth is occurring in the area, then increased activity could add to costly infrastructure improvements and personnel expansions. However, if population growth is stagnate or decreasing, then net local government impacts would not be as noticeable.

Communities that are more oriented to commercial fishing and recreation are likely to see changed impacts. If there are decreases in economic activity, disruptions tend to drive down real estate prices. Since local governments rely on property taxes, the reductions in real estate values could have a negative impact. This issue is problematic for Oregon because assessed value is well below market value for most properties. Hence, market value would have to fall significantly to affect local tax collections. The tax revenue and property values should be more closely correlated in Washington. In both states, there are likely to be changes in business taxes, but these go primarily to the state governments, where they would have a small impact.

4.4.4 Quality of Community Life

Drastic changes in economic conditions typically have negative effects on the quality of community life in the short run. If the change is negative, then the disruptions caused by reduced business and income and loss of employment create the negative effects. However, even if the impact is an increase in employment and business activity, there is often a negative effect on the quality of community life due to overcrowding of infrastructure and the demand for more services than the local governments are prepared to provide. In the long run, these effects tend to be mitigated by adaptation to the new level of economic activity. While most communities prefer adapting to growth rather than decline, there is no definitive evidence that growth is necessary to generate a high quality of community life in the long run. Nevertheless, the transition to lower levels of economic activity can create negative effects for long periods of time, and some communities may find that they are no longer economically viable.

There is a potential that the combined effects would be substantial from the loss of changed commercial and recreational fishing opportunities and the closure of hatcheries. The transition would be difficult and many businesses could be pushed into insolvency. This would be particular troublesome if the changes occurred at a time of low economic growth that provide alternative employment opportunities, like the present.

While the potential for major impacts on various social measures exists, it is problematic as to whether any large-scale effects would occur. Even within the affected region, the expected employment changes are a relatively small percentage of total employment. These changes are likely to take place over a period of time in which the region is on a growth trend. Hence, the negative effects could be offset by natural growth. While potential negative effects have been identified for various fishing user groups, the most likely outcome is that negative effects would be geographically concentrated. These effects would be oriented around areas with major changes in activity, such as where recreation is an important determinate of the local economy or where hatcheries are located. A geographic specific analysis might be warranted once a preferred alternative is adopted in order to show how mitigation of fisheries and hatchery closures might occur. It could be that hatcheries have alternative uses when left intact, such as for education. Or their water use and physical structures could have alternative uses. Water use might be diverted to agriculture, industrial, municipal uses. Physical structures might be useful for water or wastewater treatment facilities. Operator housing could be converted to low-income housing programs. Hatchery remoteness and limited access will dictate the feasibility for alternative uses at some facilities. It could also be that changed fishing opportunities may be geographically concentrated, in which case there would be secondary effects on supporting businesses and communities. Quality of life effects deserve mention, but the effects are not all "average." Deleterious effects to one individual may be an improvement to another. The discussion and suggested effects are worthwhile to raise issues, but its difficult to predict the impact levels and distribution of the expected changes from the alternatives.

4.5 Environmental Justice Consequences

4.5.1 Methods and Assumptions

The alternative actions would affect those that have an opportunity to harvest Columbia River salmon and steelhead populations wherever they migrate. The alternatives would most directly affect those that are living near the Columbia River. Their residency choice would be associated with the River providing work opportunities, such as commercial fishing or working at MA funded hatcheries; or recreational opportunities, such as sport fishing. To the extent these are minority and/or low-income populations, there is potential for disproportionate impacts from the actions. Disproportionate impacts could be from ecological risks or human health risks.

The indicators used to show impacts are harvested fish numbers and the commercial value of fish. While numbers are needed for comparisons, they mask the total value that society in general and the American Indian place on salmon and steelhead. Many economic and opinion surveys have determined that these anadromous fish are icons for the public's well being. (See description of passive use values in Appendix A.) The fish have cultural and spiritual value to tribes that numbers and even subjective descriptions fail to adequately portray. Changes to harvest opportunities due to changed hatchery practices can have written cultural context descriptions, but tribal representatives need to be able to offer their own words about the effects of those changes. There was opportunity for comment during the scoping phase of the EIS process and release of the EIS is intended to draw comments. This process might be especially applicable to the tribal perspective about hatchery produced anadromous fish. Artificial propagation is a man-made technology based on how nature might be manipulated and consumed. This is in contrast to tribal views about the importance of complete physical and spiritual interactions with the natural world. The indicators offered to show disproportionate effects would not be an adequate anthropologic description from a tribal perspective.

4.5.2 Disproportionate Impact Analysis

The target area chosen to evaluate whether disproportionate harvest and employment opportunity impacts were occurring was described in Chapter 3. The area was in general the ecological provinces downriver from the Snake River confluence with the Columbia River. Other regions with MA funded hatchery production could have been chosen, but the REI effects from harvests are about 75 percent for Columbia River inland fisheries. It is recognized that MA funded hatchery production does contribute to ocean tribal commercial and C&S fisheries in north of Cape Falcon harvest area. The salmon fishery management plan is for tribal allocations to be satisfied first. Therefore, the disproportionate impacts would be to benefit the tribal fishers as abundances from Columbia River origin rise and fall. This harvest area is considered in the management of Columbia River inland fisheries that are designed to provide harvest opportunities for 50 percent of the harvestable returns.

Environmental justice evaluation for the actions is concerned with the changed use of the fish resources or changed employment opportunities. In addition, the evaluation needs to address whether the resources being changed affect subsistence living. It was identified in Chapter 3 that there were significant minority and low-income populations in provinces upriver from Bonneville Dam. American Indians are a minority population and there are treaty and federal trust responsibilities for ensuring access to the fish resources for commercial as well as C&S fisheries. The usual and accustomed fishing grounds are also above Bonneville Dam. So analyzing for minority and low-income also provides information about treaty and trust responsibilities.

There is also high representation of the Hispanic minority group in the upriver provinces and there may be effects to them in sport fishery opportunities. There is no recognizable right to subsistence fishing for other than the American Indian group, but subsistence fishing may be occurring for other minority groups. Information about subsistence fishing for other than tribal fisheries was not quantified. It is admitted that province level angler demographics are unknown, and therefore, a quantifiable impact analysis from effects to minority participation in sportfishing is not completed. The analysis described below does show that the alternative actions effects are expected to change upriver and extreme terminal area recreational harvests. Without more information about angler demographic characteristics and effort, it is not known whether minority fishers will disproportionately benefit in the increases and decreases.

The status quo alternative is the basis by which impacts are compared. This alternative is projected to leave present circumstance essentially unchanged. This would mean any comparison would have a positive or adverse consequence from a base that in itself may have unacceptable cultural, material, or health impacts. The indicators presented in this section should be viewed in relation to absolute measures presented in other sections, such as changed harvest numbers or changes in expected natural population production.

An analysis was done to determine the change between the status quo and other alternatives for Columbia River inland fisheries aligned with the province boundaries. Results are expressed as percent changes to fish harvests in Table 4.12 and Figure 4.3. Results are expressed as ex-vessel revenue for commercial fisheries and angler days for recreational fisheries in Table 4.13 and Figure 4.4.

These analysis tables do not include the C&S fishery. The prosecution of tribal fisheries is for the following sequence to occur: amounts allocated for subsistence fishing are to be counted first, then amounts of fish to be used for ceremonial purposes are counted, then commercial fishing is counted. Recent years C&S harvest amounts are shown in Table 4.14. It was assumed for the analysis that the C&S harvest levels could be attained from other than MA funded hatcheries. It has been necessary to use downriver harvest opportunities in the past to provide for C&S fisheries. The assumption means that either upriver or downriver locations would be used to satisfy C&S fishery purposes despite the importance of MA funded hatchery production for all River production.

The analysis tables show tribal commercial fisheries across all species are less affected than below Bonneville commercial fisheries for all alternatives except Alternative 4 when measuring by fish numbers. Tribal commercial fisheries are down by 33 percent and non-Indian commercial fisheries are down by 23 percent. However, when measured by harvest value, there is a 28 percent increase in tribal fisheries and a decrease of six percent in non-Indian fisheries.

Table 4.12
Columbia Basin Inland Harvests by Species and Fishery for Alternative Comparisons

Species and Origin	Commercial Mainstem Gillnet	Commercial Mainstem Tribal	Commercial Mainstem Subtotal	Sport Mainstem Lower	Sport Mainstem Buoy 10	Sport Mainstem Upper	Sport Extreme Terminal	Sport Subtotal	Total
MA Funded Hatchery Production									
Fall Chinook									
Alt. 2	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%
Alt. 3	23%	50%	42%	32%	32%	46%	56%	43%	42%
Alt. 4	65%	72%	70%	54%	54%	65%	84%	67%	69%
Alt. 5	26%	57%	47%	37%	37%	53%	62%	48%	48%
Spring/summer Chinook									
Alt. 2	-100%	-100%	-100%	-100%	0%	-100%	-100%	-100%	-100%
Alt. 3	-12%	-8%	-8%	-12%	0%	-6%	-22%	-17%	-13%
Alt. 4	43%	46%	45%	43%	0%	54%	48%	46%	46%
Alt. 5	122%	137%	135%	122%	0%	157%	70%	94%	112%
Coho									
Alt. 2	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%
Alt. 3	-79%	-77%	-78%	-68%	-66%	-58%	-61%	-63%	-75%
Alt. 4	-32%	-78%	-49%	-25%	-29%	-33%	-48%	-40%	-47%
Alt. 5	-74%	-54%	-66%	-58%	-59%	-28%	-47%	-51%	-63%
Summer steelhead									
Alt. 2	0%	-100%	-100%	-100%	0%	0%	-100%	-100%	-100%
Alt. 3	0%	0%	0%	12%	0%	0%	10%	10%	9%
Alt. 4	0%	-60%	-60%	-2%	0%	0%	-8%	-7%	-16%
Alt. 5	0%	-64%	-64%	1%	0%	0%	-3%	-3%	-13%
Winter steelhead									
Alt. 2	0%	-100%	-100%	-100%	0%	0%	-100%	-100%	-100%
Alt. 3	0%	0%	0%	-17%	0%	0%	-10%	-10%	-10%
Alt. 4	0%	0%	0%	-27%	0%	0%	-25%	-25%	-25%
Alt. 5	0%	0%	0%	-17%	0%	0%	-10%	-10%	-10%
Total									
Alt. 2	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%
Alt. 3	-70%	-40%	-56%	-3%	-59%	-12%	-23%	-27%	-47%
Alt. 4	-23%	-33%	-28%	31%	-23%	25%	-17%	-12%	-22%
Alt. 5	-63%	-12%	-40%	53%	-53%	64%	-11%	-10%	-30%
All CR Origin Production									
Total									
Alt. 2	-79%	-59%	-68%	-60%	-76%	-69%	-60%	-61%	-65%
Alt. 3	-43%	-25%	-34%	-17%	-38%	-14%	-27%	-26%	-30%
Alt. 4	-26%	-18%	-22%	-2%	-23%	2%	-21%	-18%	-20%
Alt. 5	-41%	-8%	-23%	-1%	-37%	15%	-24%	-21%	-22%

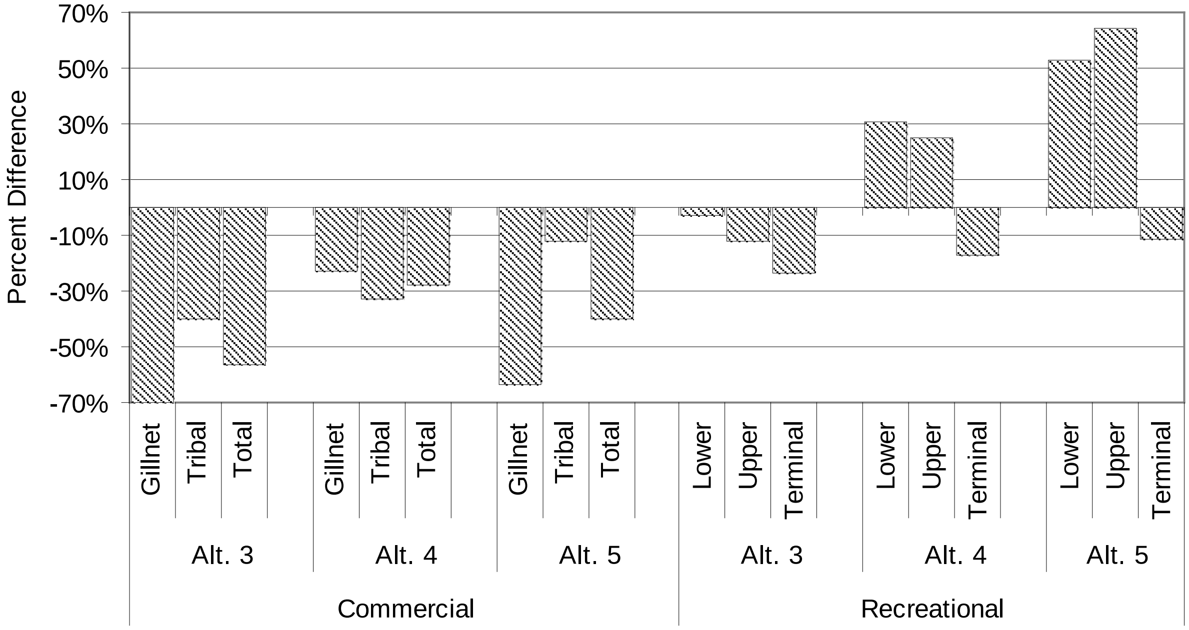
Notes: 1. Comparisons are percent differences from status quo alternative.
2. All Columbia River origin includes natural, non-MA hatchery, and MA hatchery production.

Table 4.13
Columbia Basin Inland Commercial Harvest Value and Angler Days by Species and Fishery from MA Funded Hatchery Production for Alternative Comparisons

	Commercial			Sport				
Species and	Mainstem			Mainstem			Extreme	
Origin	Gillnet	Tribal	Subtotal	Lower	Buoy 10	Upper	Terminal	Subtotal
Fall Chinook								
Alt. 2	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%
Alt. 3	23%	50%	41%	32%	32%	46%	56%	43%
Alt. 4	65%	72%	69%	54%	54%	65%	84%	67%
Alt. 5	26%	57%	46%	37%	37%	53%	62%	48%
Spring/summer Chinook								
Alt. 2	-100%	-100%	-100%	-100%	0%	-100%	-100%	-100%
Alt. 3	-12%	-8%	-8%	-12%	0%	-6%	-22%	-17%
Alt. 4	43%	46%	45%	43%	0%	54%	48%	46%
Alt. 5	122%	137%	134%	122%	0%	157%	70%	94%
Coho								
Alt. 2	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%
Alt. 3	-79%	-77%	-78%	-68%	-66%	-58%	-61%	-63%
Alt. 4	-32%	-78%	-43%	-25%	-29%	-33%	-48%	-40%
Alt. 5	-74%	-54%	-69%	-58%	-59%	-28%	-47%	-52%
Summer steelhead								
Alt. 2	0%	-100%	-100%	-100%	0%	0%	-100%	-100%
Alt. 3	0%	0%	0%	12%	0%	0%	10%	10%
Alt. 4	0%	-60%	-60%	-2%	0%	0%	-8%	-7%
Alt. 5	0%	-64%	-64%	1%	0%	0%	-3%	-3%
Winter steelhead								
Alt. 2	0%	-100%	-100%	-100%	0%	0%	-100%	-100%
Alt. 3	0%	0%	0%	-17%	0%	0%	-10%	-10%
Alt. 4	0%	0%	0%	-27%	0%	0%	-25%	-25%
Alt. 5	0%	0%	0%	-17%	0%	0%	-10%	-10%
Total								
Alt. 2	-100%	-100%	-100%	-100%	-100%	-100%	-100%	-100%
Alt. 3	-52%	2%	-25%	-7%	-59%	-9%	-23%	-25%
Alt. 4	-6%	28%	11%	37%	-23%	39%	-4%	1%
Alt. 5	-38%	57%	9%	88%	-53%	111%	5%	14%

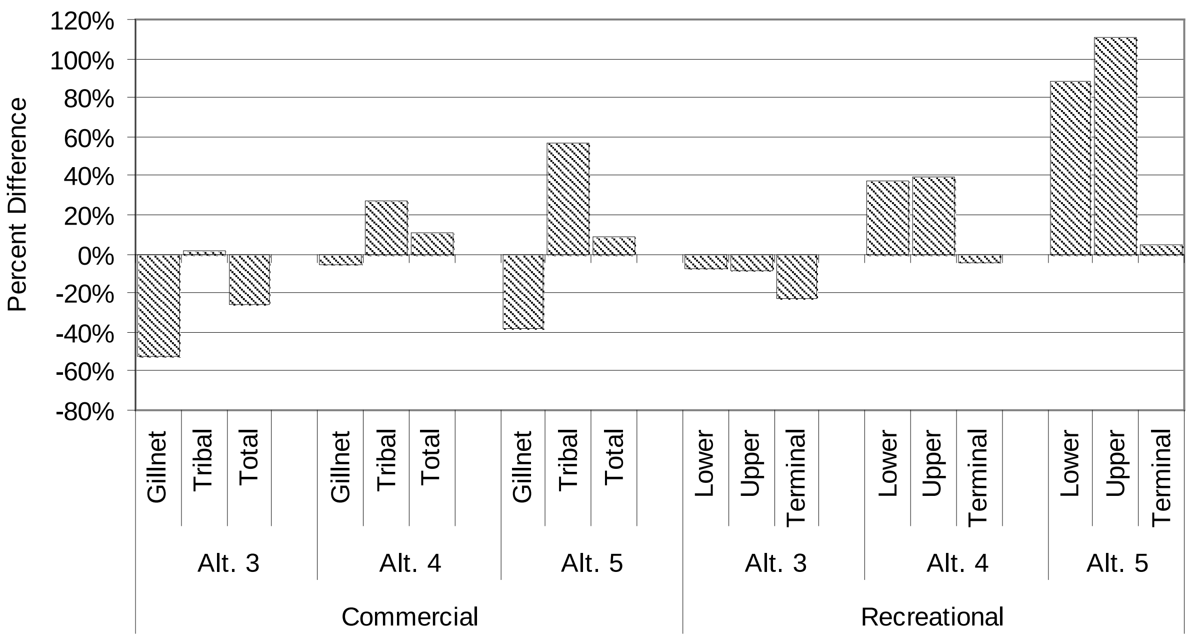
Notes: 1. Comparisons are percent differences from status quo alternative.

Figure 4.3
Columbia Basin Inland Harvests by Commercial and Recreational
Fishery From MA Funded Hatcheries for Alternative Comparisons



Notes: 1. Comparisons are percent differences in numbers of fish harvested from status quo alternative.
2. The Alternative 2 percent difference is not depicted because it is -100% for all fisheries.

Figure 4.4
Columbia Basin Inland Harvest Value and Angler Days by Commercial and
Recreational Fishery From MA Funded Hatcheries for Alternative Comparisons



Notes: 1. Commercial fisheries base measurement is harvest value, and recreational fisheries base measurement is angler days.
2. Comparisons are percent differences from status quo alternative.
3. The Alternative 2 percent difference is not depicted because it is -100% for all fisheries.

Table 4.14
Ceremonial and Subsistence Harvests on the Columbia River Above Bonneville Dam

	High		Low			
	Amount	Year	Amount	Year	Mean	Median
Last 10 Years						
Coho	22	2006	22	2006	22	22
Spring/Summer Chinook	11,527	2001	2,394	1999	8,048	9,227
Fall Chinook	1,310	1999	0	1998	473	404
Steelhead	1,596	2006	1,596	2006	1,596	1,596
Last 5 Years						
Coho	22	2006	22	2006	22	22
Spring/Summer Chinook	9,800	2003	6,952	2007	8,519	8,949
Fall Chinook	683	2003	270	2007	466	416
Steelhead	1,596	2006	1,596	2006	1,596	1,596

Notes: 1. The 10 year period is 1998 to 2007 and the five year period is 2003 to 2007.
2. Sometimes Willamette River surplus hatchery fish are used to augment C&S harvests.
Sources: Chinook from PFMC (2008) and coho and steelhead from ODFW and WDFW (July 2007).

The reason is that there is a shift in production away from steelhead and coho to URB fall Chinook and spring Chinook. These populations realize higher prices than the status quo alternative production for tule fall Chinook and coho.

Recreational fisheries in extreme terminal areas decrease in numbers (Figure 4.3) and mostly decrease when measured by angler days (Figure 4.4) for all alternatives. All of the actions' productions and release strategies are to avoid impacts to naturally occurring production in tributaries. The angler day forecast has more of a decrease (nine percent) across all fisheries for upriver mainstem locations than downriver locations (seven percent) for Alternative 3. This is because this alternative has a Willamette and Lower Columbia River focus to support commercial fisheries. Alternative 4 increases are about the same for lower and upriver angler days. The forecast for Alternative 5 is higher for upriver fisheries because the focus is production at interior Columbia River hatcheries.

Hatchery employment impacts to minority and low-income groups are a concern for Alternative 2. The other alternatives will have modified employment needs and it is expected there will be some temporary construction employment to respond to the recommended changes in operations. However, Alternative 2 is to zero-out hatchery funding which without other program funding will cause the hatcheries to close. The exposed impact is to an estimated 150 direct jobs at WDFW, ODFW, and USFWS. There may also be jobs exposed at the Yakama Nation, SAFE Program, and other hatcheries which depend on the integration of MA funded hatcheries for capture, rearing, and liberation services. There are also operation scales afforded by the MA funded hatcheries that would likely increase impacts to other hatcheries. For example, centralized smolt hauling, marking, feed purchasing, etc. are sometimes at lower unit costs for high volume operations. The higher unit prices would have to be made-up with decreased operation and possibly manpower at other facilities. There was not an employment residency and race survey available for all hatcheries, so the disproportionate impact assessment was not directly calculable. If employment race status is of higher proportion in a minority group, then perceptibly there will be a disproportionate impact. Hatchery permanent position employment wages for skilled occupations are relatively high paying jobs, especially in rural eastern and western Oregon communities. There may also be indirect impacts from the hatchery closures from the multiplier effect that the direct jobs and hatchery purposes bring to regions. By hatchery count and location, it appears, given assumptions about labor force commuting distances, that hatchery employment would be about evenly split in provinces above and below Bonneville Dam. The headquarter employment and other support service employment are largely in the urban areas of Salem, Portland-Vancouver Metropolitan Area, and Olympia. It would not appear that hatchery closures, headquarter cutbacks, demands for service and contracts would be considered a disproportionate impact.

4.5.3 Connected, Cumulative, and Mitigation Effects

The EO 12898 implementation requires consideration of connected and cumulative effects, and when necessary, mitigation measures for the impacts. The alternative actions are for changed MA funded hatchery productions and there is a connectedness to natural and other hatchery production. For example, the USFWS Eagle Creek Hatchery is being used to rear coho populations for liberation by the Yakama Nation and the Nez Perce Tribe in upriver locations. Loss of the Eagle Creek production would not only cause lost fishing opportunities, but impair the re-introduction of the coho population at sustaining levels in upriver locations. The Yakama Nation also receives URB fall Chinook raised at the USFWS Little White Salmon Hatchery which receives MA funding. These and other MA funded hatcheries productions are not being changed away from that support, and moreover, the alternative actions are to increase the collaborative efforts to re-establish and sustain upriver populations. Hatchery production can have cumulative impacts by impairing naturally producing populations. (See Chapter 1 for the potential ecological adverse effect descriptions.) One of the purposes for developing this EIS was to describe and assess the changed hatchery practices that would decrease the adverse interactions with natural production. The outcomes for how the actions are achieving the reduction in impacts is described in other Chapter 4 sections. Since they are described as a purpose rather than a mitigation action, it is not necessary to assess disproportionate impacts in this section.

The environmental justice analysis, through assumptions about the target area definitions, satisfying C&S fishery levels, and modeled economic effects for commercial fisheries, is intended to show possible disproportionate effects within the target area. Numerical indicators are offered, but they are not adequate measures for determining impacts to tribes. Tribes must offer their perspective in their own words. For example, the shown measurements for Alternative 2 to zero-out MA funded production will have substantial impacts to tribal commercial fisheries and possibly severe long-term repercussions to restoring depressed and extirpated populations. However, it may have the effects of trending Columbia River production to be more naturally occurring. To the degree which the collective views of tribes prefer that production would mean Alternative 2 would be more acceptable to continuing the MA funded hatchery program. Until a sense of acceptability for all of the alternatives is reached between all user groups, the need for mitigating effects through tradeoffs and/or user group subsidies are proposed.

BIBLIOGRAPHY

Environmental Protection Agency (EPA). Final Guidance For Incorporating Environmental Justice Concerns in EPA's NEPA Compliance Analyses. April 1998.

Folsom, William, et al. World Salmon Culture. Silver Spring, Maryland, The Office of International Affairs, National Marine Fisheries Service, National Oceanic and Atmospheric Administration. September 1992.

Idaho Department of Fish and Game (IDFG) et al. A Proposal for a Multi-Year Regional Approach to Management and Funding of Actions Authorized Under PL75-502 Mitchell Act. June 20, 2005.

Independent Scientific Advisory Board (ISAB). Report on Harvest Management of Columbia Basin Salmon and Steelhead. ISAB 2005-4. June 2005.

International Salmon Farmers Association. World Farmed Salmon Supply/Demand Review. May 1998.

Joint Columbia River Management Staff (ODFW and WDFW). 2007 Joint Staff Report: Stock Status and Fisheries for Fall Chinook Salmon, Coho Salmon, Chum Salmon, Summer Steelhead, and White Sturgeon. July 13, 2007.

Knapp, Gunnar, Cathy A. Roheim, and James L. Anderson. The Great Salmon Run: Competition Between Wild and Farmed Salmon. TRAFFIC North America, World Wildlife Fund. January 2007.

Knapp, Gunnar. "Implications of Aquaculture for Wild Fisheries: The Case of Alaska Wild Salmon." Presented for the Bevan Sustainable Fisheries Lecture Series, University of Washington, Seattle. February 10, 2005.

Mann, Roger. The Yakima Basin Regional Economy and the Contribution of Fish and Wildlife. Yakima County Public Services. November 2004.

Meyer Resources, Inc. Tribal Circumstances and Impacts of the Lower Snake River Project on the Nez Perce, Yakama, Umatilla, Warm Springs and Shoshone Bannock Tribes. Prepared for the Columbia River Intertribal Fish Commission. October 1999.

National Marine Fisheries Service (NMFS). Final Programmatic Environmental Impact Statement for Pacific Salmon Fisheries Management off the Coasts of Southeast Alaska, Washington, Oregon, and California and in the Columbia River Basin. November 2003.

National Marine Fisheries Service (NMFS). Salmon and Steelhead Advisory Commission. A New Management Structure for Anadromous Salmon and Steelhead Resources and Fisheries of the Washington and Columbia River Conservation Areas. 1984.

National Marine Fisheries Service (NMFS). Fisheries of the United States 2004. November 2005.

National Research Council (NRC). Sharing the Fish: Toward a National Policy on Individual Fishing Quotas. Washington, D.C., National Academy Press. 1999.

Northwest Power and Conservation Council (NPCC). Columbia River History Project. Interactive website: http://www.nwcouncil.org/history/MitchellAct.asp. Undated.

Pacific Fishery Management Council (PFMC). Preseason Report III Analysis of Council Adopted Management Measures for 2008 Ocean Salmon Fisheries. Published annually in April. April 2008.

Pacific Fishery Management Council (PFMC). Review of 2004 Ocean Salmon Fisheries. February 2005.

Pacific Fishery Management Council (PFMC). Review of 2007 Ocean Salmon Fisheries. Pacific Fishery Management Council. February 2008.

Steinback, Scott, Brad Gentner, and Jeremy Castle. The Economic Importance of Marine Angler Expenditures in the United States. Via Internet: http://spo.nwr.noaa.gov/pp2.pdf. NOAA Professional Paper NMFS 2. January 2004.

U.S. Army Corps of Engineers (Corps). Columbia River System Operation Review, Final Environmental Impact Statement. Appendix D, Cultural Resources. DOE/EIS-0170. November 1995.

U.S. Fish and Wildlife Service (USFWS). 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. May 2007.

Washington Department of Fish and Wildlife (WDFW) and Oregon Department of Fish and Wildlife (ODFW). Status Report-Columbia River Fish Runs and Fisheries, 1938-2002. Tables only. August 2004.

Appendix A
Economics Technical Report

Table of Contents

Page

List of Tables and Figures

Table of Contents (Cont.)

Glossary

APRE	Artificial Production Review and Evaluation
BCA	benefit-cost analysis
C&S	ceremonial and subsistence
CEA	cost effectiveness analysis
CHA	cost-per-harvestable adult
CHF	fall Chinook
CHS	spring Chinook
EIS	Environmental Impact Statement
ESA	Endangered Species Act
FEAM	Fisheries Economic Assessment Model
FTE	full time equivalent
I/O	input-output
IEAB	Independent Economic Analysis Board
IFQ	individual fishing quota
IMPLAN	IMpact Analysis for PLANning
MA	Mitchell Act
MSA	Magnuson Stevens Act
NEV	net economic value
NMFS	National Marine Fisheries Service
ODFW	Oregon Department of Fish and Wildlife
PFMC	Pacific Fishery Management Council
REI	regional economic impact
SAFE	Select Area Fisheries Enhancement Project
SSL	summer steelhead
TRG	The Research Group
URB	upriver bright
USFWS	U.S. Fish and Wildlife Service
WTP	willingness-to-pay

Appendix A
Economics Technical Report

Chapter 1. BACKGROUND

This technical appendix provides a description of analytical methods used to compare alternatives for the Mitchell Act (MA) Environmental Impact Statement (EIS). The economics discussion in the EIS reflects a summary of the information presented in this technical appendix.

The hatchery production and subsequent harvests in fisheries of that production specifically applies to fish raised wholly or partly using MA funds as described in the EIS Chapter 1. Changes in harvests caused by the way hatcheries operate under the alternatives will include differences from natural as well as hatchery produced fish. The association between hatchery and natural run production and the modeling of harvest levels from that production is more fully explained in Chapter 2. Table A.1 shows the differences for estimated harvests for ocean, mainstem, and terminal area fisheries across all species for fish from all origins, and Columbia River origins. Columbia River origins are itemized for MA funded hatcheries. Fisheries are wherever Columbia River origin salmon and steelhead are harvested.

The harvest model did not provide sufficient information for all fisheries to use all Columbia River origin harvests in the economic analysis. Table A.1 shows that the interactions with other Columbia River hatchery and natural production will occur, but the effects were not sufficiently detailed to use in the economic analysis.

Chapter 2. METHODS AND FACTORS

A. Analytical Approach

The EIS includes an analysis to evaluate MA funding polices using economic considerations. There are three analytical approaches used: determining net economic value (NEV), calculating regional economic impact (REI), and undertaking a cost-effectiveness analysis (CEA). There are even other economic analysis approaches that could be used, but these three will provide sufficient descriptions for the evaluation. The approaches use a static model applicable to depicting short range effects of the EIS alternatives.[1] For this technical appendix, the term economic effects encompasses all three approaches.

---

1. Most economic analysis will be incomplete because not all changes in long range values and external costs are addressed. Long range value changes are those that can be expected to occur after a plan's actions are absorbed. (When these future changes are included, the revenue or costs streams are reduced to annual net present values in order for them to be used in the analysis. The choice of the discount rate to use in calculating net present value is controversial [Hanley and Spash 1993].) Because of the uncertainty in knowing these adjustments, analysts generally assume the change in the short term will approximate what happens over the course of the

The economic analysis approaches address use and non-use values. Use values are associated with consumption of the fish (e.g., fish that are harvested). Use values can also be non-consumptive and include such activities as taking trips to view fish at fish ladder visitor centers. Non-use values are associated with the value that society places on a resource even though an individual may not actually use the resource. The promulgation of the ESA through listings of Columbia River anadromous fish means that society does place a value on all fish. The problem is figuring out what that value might be. A section below discusses this measurement problem and offers how qualitative discussions might be useful in lieu of modeling with numbers.[1]

The NEV use value is the sum of benefits minus actual and opportunity costs.[2] NEV for the commercial fishery varies by area and time wherever MA produced fish are caught. Economic models specific to regions are used in the accounting of the commercial NEV use values. NEV for recreational angling assumes willingness-to-pay (WTP) estimates less actual costs for the

---

long term. Short term value changes are the immediate gains or losses to be expected to occur if the status quo is changed.

External costs are also not usually evaluated. Prices of products or services sold in the open market often do not reflect all the costs of making the product or providing the service. External costs are passed on to others in society, often in the form of dirty air, polluted water, or less biodiversity. External costs are difficult to identify and hard to quantify, but they can significantly decrease the value to society of commodity production. Although it would not be easy to allocate these costs to resource management plan strategies, they could make up a significant part of the costs of producing commodity outputs and should be evaluated along with market and nonmarket values.

1. Economic values can be nonfinancial (no market information exists), as well as financial (prices exist from markets where traded goods are for well-defined property rights that are exclusive, transferable, and enforceable [Panayotou 1992]). For example, some people (termed non-users) who do not actually fish for salmonids may still place a value on the existence of the resource. Deriving this value must rely on expressed preference information (either real or hypothetical) gathered through surveys that address the particular setting and policy issues needing decisions. Because of lack of budget resources to do a more comprehensive analysis, the values of the non-users are generally either not included or are imputed from other studies. Such values can play a significant role in determining future programs related to the management of a natural resource and should be a criteria in any policymaking, but should be used carefully in the decision-making because of the difficulties in measuring such values.

   The nonmarket values include livability considerations, and livability is becoming more important as Pacific Northwest economies mature. Economies are becoming more dependent upon high-technology industries, which require a highly educated, highly skilled workforce. High technology firms do not have the usual locational requirements for being near markets or near manufacturing inputs, and as such, can decide to make capital investments based on other criteria. One of the competitive advantages in the Pacific Northwest is livability relative to other areas that makes it unnecessary to pay premium compensation for a degraded environment or for overcrowding. Scenic and productive river basins will play an important role in drawing the major components of economic growth: capital and a highly skilled work force.

2. Opportunity costs may be such items as wages forgone by skippers and crew members who elect to work in the fishing industry rather than other industries. Opportunity costs for a recreational angler might be foregone wages if an employed person was fishing rather than being compensated for working. Opportunity costs may also include the loss of benefits associated with growth and reproduction if the fish were allowed to escape. Some financial expenditures such as taxes are not resource costs because they are a redistribution of income for fishers to society as a whole.

fishing experience. The net WTP estimates are garnered from other studies on a per unit basis and applied to the MA affected use levels.[1] A benefit-cost analysis (BCA) is developed using total NEV less MA funded hatchery system production expenditures.[2]

NEV estimates utilized in this report should be viewed as general indicators for comparing alternatives. Specific application of the models for certain program effects or in selective geographic areas may not be appropriate. Some would argue that because MA hatcheries are to offset dam construction impacts hydropower values and costs should also be in the NEV equation. Similarly, it could be argued that other opportunity costs for land and water use should be used in the NEV equation. A discussion of the appropriateness for benefits and costs in introduced later in this technical appendix.

REI is calculated to show perspective in the economic analysis. The public is generally concerned how policy conditions will affect income and employment in a region rather than how national benefits and costs might play out.[3] The REI analysis has two components: (1) the economic activity from commercial harvests and recreational angling attributable to MA production; and (2) the economic activity from administrating and operating the MA hatchery programs. The REI calculations are made for regional economies where the components cause dollar flows to occur. The regional economies are defined to be states, and in the case of Canada, provinces.

The CEA provides itemizations sufficient for choosing among different policy strategies to achieve least cost operations. It also provides a measurement to compare the MA funding to several other Columbia River salmon recovery projects designed to achieve similar objectives.

A discussion of substitution effects for commercial and recreational user groups is offered. Degrees of likelihood for substitution are used to help describe magnitude of these effects. For the recreational fisheries, it could be that a proportion of anglers would fish for other target species if salmon was not available. The discussion also addresses whether the anglers were resident within the economies being analyzed. Fishing expenditures can be considered as coming from disposable income, which would be spent on other local recreational opportunities if not spent on fishing. It can also be argued that if the angling opportunity was not available, residents might travel elsewhere in recreational pursuits, thereby taking money out of the economy.

Sportfishing direct value measurement needs additional interpretation. Fishing trip expenditures do not represent all angler spending. There is also capital spending for fishing equipment, boats,

---

1. The studies use a variety of indirect methods to estimate WTP such as from contingent valuation surveys, travel cost models, or other hedonic analysis.
2. Benefit-cost analysis is a method to compare gross benefits of the project or policy (e.g., gains) with the actual and opportunity costs (e.g., losses). It can give insights into the economic efficiency of management and regulatory actions. It is a surrogate measure of the public's willingness to pay for a gain or to avoid a loss, or as the willingness to accept compensation to tolerate a loss or to go without a benefit.
3. REI analysis differs from NEV in that it does not account for social benefits or values; that is, it does not account for opportunity costs. For instance, an REI of sportfishing does not analyze what individuals would do with their time and money if, as a result of a fishery closure or moratorium, they couldn't go fishing. REI also does not take into account non-use values.

etc. This type of spending is generally not associated with a direct value measurement for a fish resource for several reasons: 1) it could be spent in an economy elsewhere from the fishing location; such would be the case of non-residents; 2) it is usually for a capital item that could be used to pursue other fish resources; and 3) the purchase may be unrelated to the decision to take a fishing trip for the fish resource being studied. Capital spending is not included in the REI calculations.

Fishery resources produced in the Columbia River provide all types of values to society. This includes values that can be measured by those that consumptively use the resources as well as values for those that do not use the resources. Measuring values for the non-consumptive users and non-users is much more difficult because there are no traditional market exchanges. For the purpose of this review, values derived from the act of fishing (by both recreational and commercial interests) are assessed quantitatively and non-consumptive users and non-user values are only qualitatively discussed. Following economic value categorization literature (Leeworthy and Bowker 1997), the non-consumptive use and non-use values are discussed in a section titled passive use values.

Estimates of NEV and REI from commercial and recreational fishing are made using factors and procedures developed by management agencies, such as Oregon Department of Fish and Wildlife (ODFW) (Carter 1999), Pacific Fishery Management Council (PFMC) (2004), and NOAA Fisheries (2000). The economic analysis relies heavily on the parameters and models developed by Radtke et al. (1999). Estimates for CEA use procedures developed by the NPCC Independent Economic Analysis Board (IEAB) (2004).

B. Net Economic Value

The following sections discuss how NEV may be calculated when related to economic effects from the MA funded fish production. There are sections for commercial and recreational fishing, and a third section about cost estimates for the MA hatchery production. Another section below discusses passive use values associated with fish resources produced with MA funding.

The EIS's alternatives are for the operational changes at hatcheries. It is assumed that the changes are in effect both in the short term and long term, i.e. it is not necessary to account for benefits and costs that may be different at various dates throughout a study period. It would be necessary to use such present value analysis if MA funds were typically used for capital construction projects. However, it is typical that MA funds are only used for annual operations (including some maintenance and replacement) at hatcheries and reducing benefits and costs to a common time period is not necessary. Therefore the NEV and its ratios are expressed as an annual present value term.

There is a misalignment in the immediacy of realizing benefits when spending money for the production of anadromous fish. Depending on the species, smolts take one or two years to raise in freshwater and do not generate fishing benefits as adults for another one to three years. A strict refinement in the analysis would be to convert the operational costs to a future value and discount the benefits to a present value for the alignment. However, such a refinement would be very minor compared to the other uncertainties associated with the benefit and costs and the discounting effects between broodyear costs and adult benefits were assumed to be negligible.

1. Commercial Fishing

The calculation of NEV from commercial fishing includes what changes occur in consumer and producer surplus. Surplus in this sense is the difference between the benefits and costs arising from the consumer and the harvester/processor.

Generally, any valuation of salmon species involves a geographic area and a salmon species for which there are many substitutes. In such cases, the demand curve is relatively flat. That is, if consumers are faced with a rise in the price of one type of salmon in one area, consumers may shift their consumption to an alternative salmon or some other protein product. In such cases, there are no extra benefits (or consumer surpluses) that could be counted resulting from consumers' willingness to pay different prices for a specific salmon product. Therefore, most economic valuations involving salmon will center on the benefits that a producer receives (or producer surpluses) from the harvesting and processing of salmon.

The calculation of producer surplus for harvesting means the costs of harvest (fuel, repairs, labor, etc.) should be subtracted from the gross revenues.[1] Because fishing seasons are of short duration, most fishing boats are not limited to salmon fishing. The investment in boat and gear is also used for other fisheries. Also, at low levels of total salmon harvest and with small incremental changes in salmon production, it is often argued that any increased harvest could be taken with almost the same amount of labor, fuel, ice, etc. as before. Since the current fisheries (both the harvesting sector and processing sector) are greatly overcapitalized, in use of fixed and operating capital as well as labor, this is a plausible assumption. This assumption implies that almost no additional costs are involved and gross benefits are close to net benefits.

The assumption of full employment is implicit in most benefit and cost analysis. But unemployment and excess fishing capacity, both transitory and chronic, seem to prevail in many Pacific coastal communities dependent on commercial fishing. Changes in markets or fishing opportunities may make it necessary for people and capital to change occupations and/or locations. Various factors make it difficult for this to happen quickly enough to prevent a period of unemployment and idle capacity. The Water Resources Council (1979) suggests that when "idle boats" are available, the only NEV will be the operating costs.

Because it is difficult to collect data on the commercial salmon fishing industry for specific areas and specific gears, a general guidance may be to present information for harvesters and first level primary processing basis on a regional basis. Because primary processing is an integral part of producing salmon, a portion of the primary processor margins should also be used to calculate the NEV of commercial fishing. It is argued that the only processing benefit be is included is the

1. Using ex-vessel value as a basis to estimate "net value" for tribal harvest may not apply. Chronic underemployment of human and capital resources in rural areas on tribal lands may result in very low incremental costs resulting from increased harvest opportunity. Other studies have suggested that the average cost increase with increased harvest opportunities may be two to nine percent (Barclay and Morley 1977). A two percent cost was utilized by Meyer in the Elwha Study (Meyer et al. 1995).

minimal amount of processing required to move the fish out of the region - dressing, icing, packing, etc. The first level processor basis should be used because in many areas tendering and other costs and incentives (such as year-end bonuses) may not reflect the actual ex-vessel prices. It may also be argued that the first level processing in any area is inseparable from the harvesting component.

A calculation of producer surplus is an accounting of the profitability of the fleet and the profitability of the primary processor sector. There are subsequent indirect producer surpluses to other industries, but these two sectors are illustrative of the main NEV generators. A more thorough examination of this accounting is described in TRG (2003). The applications of this modeling approach to Alaska has to address an emerging financial consideration in the prosecution of Alaska fisheries. That is the permit lease payments being made for prosecuting limited entry fisheries where IFQ's are privately held. Those payments are an added profitability to the calculation. The proportion of fixed expenses to include in NEV has a theoretical treatment in NMFS (1996). The accounting in algebraic notation of per unit NEV becomes:

Harvest Sector

$$TPSh = \sum [\mathrm{NEVP} * \mathrm{HP}]_{i,s,j}$$

Where:

ExV - L = VE + FE + NI for a representative harvester's pro forma statement in vessel category *i*
NEVh% = (dFE + NI + L) / ExV
NEVP = NEV% * P

And:

ExV:	ex-vessel revenue	dFE:	proportion of fixed expenses attributable to NEV
HP:	harvest pounds		
P:	ex-vessel price = ExV / HP	NI:	net income
L:	net lease payments	NEVh%:	net economic value as a percent of ex-vessel revenue
VE:	variable expenses		
i:	vessel categories that harvest the species	NEVPh:	net economic value per harvest pound for harvesting sector
s:	species released	*TPSh:*	total producer surplus for harvesting sector
j:	MA alternative		

Processor Sector

$$TPSp = \sum [\mathrm{NEVp} * \mathrm{HP}]_{k,s,j}$$

Where:

NEVp% = (dFE + NI) / ExP
NEVp = NEVp% * Y * P

And:

ExP	ex-processor revenue
NEVp%:	net economic value as a percent of ex-processor revenue
NEVp:	net economic value per harvest pound for processor sector
NI:	net income per finish pound
k:	processor categories that use species as a manufacturing input
dFE:	share of fixed expenses counted for net economic value, i.e. a financial interpretation using industry pro forma statements
Y:	yield or finish pound ÷ round pound
TPSp:	total producer surplus for processing sector

Various vessel categories whose annual revenues are from salmon fisheries and a processor category are used to approximate the profitability for the harvester and processor producer surplus for this example.

Two studies were used to determine the profitability for the commercial salmon fishing industry. For West Coast harvests, Davis (2003) presented vessel and processor pro forma operating costs for all fisheries (Table A.2). It was assumed that all of the ocean and Puget Sound salmon fisheries were prosecuted by the salmon troller type vessel in this table and the river salmon fisheries (non-Indian below Bonneville Dam fisheries and tribal above Bonneville Dam fisheries) were prosecuted by the gillnetter type vessel. The Davis (2003) study found that many product forms including salmon products manufactured by processors have a 40 cents per finish pound cost margin. This margin was used for the producer component in calculating the NEV. For Alaska and British Columbia fisheries, TRG (2007) provides similar estimates for five vessel types and three processor types. For these geographic regions, the salmon netter vessel type and shoreside processor type were selected to represent the benefits and cost margins.

The resulting commercial fishing NEV per fish units are shown on Table A.3. The geographically defined fisheries on Table A.3 include an ocean and river tribal category. However, tribal ceremonial and subsistence (C&S) harvests are not itemized. These harvests receive special treatment because their value is related to tribal spiritual beliefs. It can be argued that subsistence harvests may be a substitute for a foodstuff and be equivalent to a market price for the fish. Differentiating ceremonial from subsistence landings are not tracked in traditional data programs. Therefore, if total C&S is included and per unit ceremonial values are different than commercial values, then the summed tribal NEV may be too high or too low.

2. Recreational Fishing

The recreational fishing net economic values are related to the act of fishing. A fishing act is generally defined as an activity carried out on a per trip or per day basis. The values adopted for this analyses are from literature. A fairly recent comprehensive study on West Coast ocean fishing values by Haab et al. (2006) was used. The ISER (1999) and Mills (1994) studies were used for Alaska and British Columbia. The extensive literature search on Columbia River NEV per trip values made by Radtke et al. (1999) was relied on for those fisheries. The various studies were brought together to establish comparable levels for what people would be willing to pay less costs for the fishing experience. Researchers refer to the method of relating values in one fishery and setting to another as a benefit transfer approach. Each recreational fishing experience may create its own value based on the species, geographic area fished, and other variables. There has been some discussion by behavior economists that there may be a different economic value when a trip purpose is to catch a hatchery or natural origin fish. The literature review did not provide numbers for this trip purpose, so it is assumed there are no differences. The adopted values may or may not be similar to another anglers experience, so some caution is expressed on relying on the per units estimates as definitive representations of use values.

It was necessary to translate per trip unit estimates to per fish unit estimates. Success rates for ocean and lower river salmon trips are closely counted or estimated by the management agencies. Table A.4 shows total trips and the source of the information. Table A.5 uses harvests in order to calculate success rates (angler days per retained fish). Notice that because above Bonneville Dam pressure counts are not compiled by management agencies and that that catch is estimated, success rates from below Bonneville Dam are assumed to apply.

An error is introduced into success rates when fisheries are managed for mark selective fishing. That is, fishing trips could be happening without catch being retained. If the geographic area or season is large and long to encompass both non-retention and retention fisheries, then the statistic average would incorporate such affects. In that case, it would be inaccurate to apply the success rates to unselective fishery. The economic modeling does not use such isolated fisheries, so it is thought that the error will be minor.

3. Other Costs

There are many types of benefits and costs that can be associated with MA funded hatcheries. A quantitative analysis of NEV is an attempt to choose and make estimates for the major parameters of benefits and costs. Generally those parameters should include what can be controlled such as fish production levels which will generate benefits and the production costs. Other parameters, such as those associated with Columbia River hydropower operations which was the impetus for providing MA funds, would be of interest. However, there would have to be connectedness arguments, and in the end, may not provide a difference in change from the alternatives. One "other cost" that does deserve to be in the benefits and costs is the cost of producing the smolt releases. A significant effort was expended to determine these costs for the four agencies that receive the MA funds. The effort was needed for a couple of reasons. First, treating MA funds themselves as costs in a summary NEV equation is not justified because there the funds are mixed with other state and federal monies to produce or acclimate the fish. An example is a significant contribution of MA smolt production that goes to the Select Area Fisheries Enhancement Project (SAFE). The SAFE is largely funded by the BPA and local fishing industry assessments. Another reason that hatchery production costs needed to be estimated is that the EIS alternatives include reprogramming hatcheries. The reprogramming will have differential cost impacts, but fisheries may be disproportionately affected. It was necessary to have costs per smolt for the species and populations that contributed to the different ocean and river fisheries. These cost details were also necessary to generate the REI and CEA estimates.

4. Passive Use Values

Economic value represents what people would be willing to give up (pay) in exchange for a good or service. This definition describes an anthropocentric view of value, that is, value to people (Goulder and Kennedy 1997). For a fishery resource to have economic value, people must be willing to give up other valuable resources (which can be represented by money) in order to utilize the fishery resource. Clearly this makes economic value a function of people's preferences and their ability to pay.

When measuring economic value, it is not necessary to know why people value a resource (e.g., for nutritional, biological, or recreation reasons), but rather how much they value it relative to other things (Tietenberg 1996). This makes it clear that economics is an appropriate tool when the objective is to allocate scarce resources. For example, if something of value must be given up to save native fish populations, society needs to know whether the native fish are worth more than what must be given up. Information about the biological, nutritional, or recreational value of fish will certainly affect people's WTP for the resource, but the economist does not need to know the motives behind people's WTP in order to make economically efficient resource allocations. The calculation for economic efficiency requires information on the total value of resources, that value being the result of many different motives. While recognizing that total value is the goal, there are methodological issues related to the measurement of economic value that have led to distinctions among different types of economic value.

People may value a particular resource such as the fishery because they either use the resource currently, or they intend to use it at some time in the future. Current and future use value can be either direct or indirect. An example of direct use value would be the willingness of anglers to pay for access to the salmon in ocean fisheries. This may be actual price paid, which may be market price or any price that may not signal a "market clearing" price; an angler may be willing to pay more than he is being charged on the market.[1] An example of indirect use value would be the willingness of a reader to pay for a magazine account of a fishing trip to the Pacific Northwest. In both cases, someone had to actually use the site or resource in order for something of value to be produced.

There are some people who are willing to pay for a resource, even though they never intend to use it. This type of non-use value is called existence value, because people are willing to pay to ensure that a resource exists, without knowing that they will ever actually use the resource. The motive for existence value may be that people want to ensure that a resource exists for future generations to enjoy. Some economists have described these values as a kind of insurance premium, to guarantee that the resource will be available when, and if, future use is desired by them or for others.

Economists have defined and occasionally measured values associated with the simple presence of a fish population. The value is reckoned as the amount that people (defined appropriately) would be willing to pay to assure the existence of a fish stock, or to pay for a specified increase

---

1. Panayotou (1992) showed that for ecosystem goods and services, commercial markets fail to adequately capture the true value. Their common property nature prevents formation of efficient markets. The markets that do exist are fraught with imperfections that lead to undervaluation and/or over estimation.

in the fish stock. For example, Olsen, Richards, and Scott (1991) found that people who claimed no intention to catch or eat salmon from the Columbia River were still willing to pay on average $26.52 per year per household ($39.87 in 2007 dollars) to obtain a doubling of the salmon run size. Non-use values of this sort are non-exclusive, meaning that everyone who values the fish run obtains this value simultaneously (as contrasted with consumptive user values which accrue only to those catching fish in competition with others). Hence, assuming (1) that all households enjoy this non-use value, (2) that a doubling of the fish run means 2.5 million fish per year, and (3) that there are roughly 2.0 million households in the relevant region, that value of doubling the run would be $70.24 million per year.[1]

More recently, Layton, Brown and Plummer (1999) have estimated an individual value function for a variety of fish categories (including Columbia basin migratory fish) among Washington residents. Completed for the Washington Department of Ecology, that study developed a means of estimating WTP for any given increase in fish population from an assumed current level, and for two different "without program" fish population projections. For example, for a current fish population of two million and a projected stable future population of two million in the Columbia Basin, Layton et al. find that the typical Washington household would be WTP $119.04 per year ($143.66 in 2007 dollars) for a 50 percent increase in the migratory fish population. This represents the total (use plus non-use) value for the fish population increase. With a total of two million households holding such values, the overall value per fish is a remarkable $268.08 ($323.51 in 2007 dollars). This particular estimate pertains to a rather broad class of fish, including all the salmon and steelhead stocks in the Columbia Basin.

It is likely that the fishery resources including salmonids provide all of the above described use and non-use values to society. The decision about which ones to focus on for measurement is a function of the resource allocation question being asked. For example, if a particular fishery resource is not threatened with extinction, there is no need to measure the existence value of that resource. Since society would not be deciding whether to allocate scarce resources to save the fishery, the existence value is not relevant. If the policy decision under consideration is whether to invest resources to increase the fish populations, then the values which are measured must correspond to only the increase in fish numbers. In other words, total use value would not be the appropriate value to compare with the value of the resources necessary to increase the population by some incremental amount. Given the different types of policy decisions which might be relevant, as well as the fact that the existence of some Pacific Northwest fish populations may be in question, measurements of both total and marginal values are likely to be useful to decision makers.

5. Modeling Assumptions

While our suggested modeling has some complexity, it was still necessary to use a number of assumptions: 1) producer (commercial harvester and processor, and charter boat operator) opportunity costs are undefinable, 2) producer surplus from charter boats, guide services, marinas, lodges, and other recreational related businesses is comparatively negligible, 3) consumer willingness to pay and existing seafood prices would be unaffected by the EIS alternative actions, 4) the effects from other user groups such as C&S harvests, etc. are relatively

1. Olsen et al. take this as roughly the number of households in the Washington, Oregon, Idaho region in 1989.

small, 5) non-consumptive use and non-use values are inconsequential to the analysis, and 6) interactions with other fisheries are not economically significant.[1] Incorporating methods that make estimates for these simplifying assumptions would add involvedness to the analysis, but should not materially change the results. Having to use simplifying assumptions should not be an excuse to not perform a quantitative analysis (NMFS March 2007). Because of these assumptions, we refer to the BCA as a "limited" model. Results are an indicator of changes in social welfare rather than a complete estimate of social welfare.

C. Regional Economic Impacts

REI are generated from fishing activities and from the expenditures to produce the fish. Two sections below explain the two generators and provide a short primer about how REI's are a different economic measurement than NEV's.

1. Fishing

The NEV of the fishery resource has been defined as people's willingness to give up money to have the resource. A common mistake that is often made in economic analysis is to not include the costs associated with using the fishery resource (e.g. travel costs, lodging costs, equipment) as part of the NEV from the resource. These associated costs, or expenditures, are instead the source of local or REI's associated with use of the fishery.

The NEV must represent the value of the fishery resource itself, and not the value of the related travel and equipment items. For example, suppose the fishery was threatened by a hydropower development and policy makers wanted to know whether the anglers could "buy out" the hydropower interests. All of the money spent on travel and equipment is no longer available to be used to buy out the competing hydropower interests. However, the money that is left over, after all the costs of angling have been paid, is the net WTP (consumer surplus) for the fishery resource (or fishing at the particular site). If extracted, this surplus could, in principle, be used to buy out the hydropower interests.

Another way to view the difference between NEV and REI is to consider NEV as the net loss to society if the resource were no longer available. Suppose that a specific river fishery were no longer available to anglers, and they had to either fish somewhere else or engage in some other activity. The money spent on travel and equipment would not be lost to the financial economy - in fact it could be spent on travel and equipment or some other commodities in some other location. But the value anglers received from fishing that specific river would be lost. It must be assumed that one river's fishing was preferred over (had greater value than) those of the other rivers or activities, or the anglers wouldn't have chosen the original site in the first place. Their net WTP for the chosen fishery versus other fisheries or activities would be a loss to society. Their expenditures or associated impacts on income or jobs would be a loss to the economy in the vicinity of the preferred river, but would be a gain to some other local economy. REI,

1. The non-interactions assumption in the sense used in this list includes the effects of substitution fisheries for both commercial and recreational harvesters. A dynamic bioeconomic model would undoubtedly predict that there is not a unity relationship with fish abundance and harvest demand.

therefore, describes the local or regional effects on jobs and income associated with any specific area chosen as the point of interest.

The above example should make it clear why local economies are often more concerned about REI than NEV, especially when the economic values are in the form of consumer surplus. If anglers are willing to pay some amount of money over and above their costs, but don't actually have to pay, the consumers get to take that surplus or value home with them in the form of "unextracted" income. It is not immediately obvious to local businesses that the consumer surplus generated from any specific fishery has any impact on the local economy. On the other hand, money spent on lodging, food, supplies, guides, etc., has a direct impact on local businesses and on personal income in the local area.

It is clear that NEV and REI are two distinct measures, and each is useful for different purposes. NEV's are important if the goal is to allocate society's resources efficiently. REI's are important in assessing the distributional impacts of the different allocation possibilities on the financial economies of areas. It may often be the case that society will want to invest in a less valuable resource because the local area or economy that holds the resource is in need of economic development. Nevertheless, having the information on economic value will tell society how much they are giving up in order to achieve the redistribution of economic activity or development.

Some of the REI may be new to an area, some of these may be considered a transfer from one region or industry to another. For example, the expenditures on the MA program may be a transfer from electricity paying consumers in Portland or California to anglers and businesses in the coastal area. These are allocation and equity issues and are not addressed in this analysis.

The calculations for REI in this report are in personal income impacts. Corresponding measures for full time equivalent (FTE) jobs may be developed by assuming the personal income is a person's average wage and salary or proprietors net income. Many fishing related jobs are part-time and seasonal, as are jobs in other industries. However, to generate a comparable statistic, usually the FTE indicator is used. Even other economic activity measurements can be made. Gross business output and gross value added (gross output less intermediate goods used up in production) is an often used measure.

Economic input/output (I/O) models are used to estimate the REI from fish production changes or to calculate the contributions of an industry to a regional economy. The basic premise of the I/O framework is that each industry sells its output to other industries and final consumers and in turn purchases goods and services from other industries and primary factors of production. Therefore, the economic performance of each industry can be determined by changes in both final demand and the specific inter-industry relationships.

The models selected for this project all utilize one of the best known secondary I/O models available. The U.S. Forest Service has developed a computer system called IMpact Analysis for PLANning (IMPLAN) which can be used to construct county or multi-county I/O models for any region in the U.S.[1] The regional I/O models used by the Forest Service are derived from technical coefficients of a national I/O model and localized estimates of total gross outputs by sectors.[2] IMPLAN adjusts the national level data to fit the economic composition and estimated trade balance of a chosen region. Areas that are any combination of single counties can be constructed using IMPLAN.

Because adult salmon are harvested in ocean fisheries, any increased smolt survival will benefit economies at ocean communities from Alaska to California as well as inland communities of the Columbia Basin. All of these economies are included in the analysis. The studies selected to represent commercial fishery REI for Alaska and British Columbia are TRG (2007) and Davis (2003), which both rely on the FEAM.[3] The four studies selected to show recreational fishing REI in the economy are ISER (1999) and Mills (1994) for Alaska fisheries, Steinback et al. (2004) for West Coast and Columbia River entrance fisheries, and Radtke et al. (1999) for Columbia River interior fisheries. Estimates of REI from composite stocks are determined by the information made available on contributions of Columbia River stocks to the ocean and river fisheries. Unit values used to generate ocean and river harvest REI's are shown in Table 2.

2. Hatchery Production

Expenditures for operating hatcheries and headquarter costs also contribute to regional economies. Costs were aggregated for wages and salaries and non-labor expenditures. Wage and salary expenditures were reduced by 30 percent to account for taxes, insurance and other deductions. Separate I/O response coefficients were used to estimate the impacts of regional spending in the two categories.

D. <u>Cost Effectiveness Analysis</u>

CEA differs from NEV and REI economic analysis approaches. CEA instead asks the question: given a particular objective, which is the least cost way of achieving it? Thus, it facilitates choice among options, but cannot answer whether or not any or all of the options are worth doing. CEA is used instead of NEV and REI analysis when there are difficulties in associating monetary values with outcomes, but where the outcomes can be defined or quantified in non-monetary fashion (Pearce 1992).

---

1. The IMpact Analysis for PLANning (IMPLAN) model is now being offered for general use by the Minnesota IMPLAN Group (Olson et al. 1993).
2. The available IMPLAN models are generally three to four years behind calendar years. This is due to data availability and the time it takes to prepare the models. Unless very dramatic changes take place in a regional economy, the sector coefficients will not change dramatically from year to year.
3. The Fisheries Economic Assessment Model (FEAM) uses the IMPLAN response coefficients to generate the REI from ocean and river commercial salmon harvests. The FEAM was originally developed for the West Coast Fisheries Development Foundation by Hans Radtke and William Jensen in 1986. There was a separate Alaska FEAM developed about the same year. Both the West Coast and Alaska FEAM's have been updated many times to make them current with new fleet dynamics and IMPLAN response coefficients.

The Northwest Power Act requires CEA for projects and approaches considered by the NPCC for funding.[1] For example, some interests in the region are considering if it is possible to achieve targeted levels of juvenile salmonid survival with reduced spill offset by other techniques for reducing mortality (IEAB 2004).

Cost-effectiveness can be used for judging internal program decisions about how to operate in a least cost manner. For example, a cost per harvestable adults for species and release strategies could be used in operational decision making. The MA programs can also be compared to external programs based on its objectives. The trick is to find a comparable statistic. This is made even more difficult because MA funded hatcheries have multiple objectives. If the objective to be used is providing lower costs for harvest access at lower Columbia River fisheries, then Equation 1 will apply and tend towards negative values as MA hatchery costs go down. If the objective to be used is showing lower costs per impacted depressed stocks, then Equation 2 will apply. It will tend toward positive values as impact rates improve (decrease).

Equation 1:

$$\sum\left[\text{Smolt Releases} * \text{SAR} * \text{Cost Per Smolt}\right]_{s,MAj} - \left[\text{Smolt Releases} * \text{SAR} * \text{Cost Per Smolt}\right]_{s,StatusQuo}$$

Equation 2:

$$\sum\left[\frac{\text{Smolt Releases} * \text{SAR} * \text{Cost Per Smolt}}{\text{Harvest} * \text{Impact Rate}}\right]_{s,i,MAj} - \left[\frac{\text{Smolt Releases} * \text{SAR} * \text{Cost Per Smolt}}{\text{Harvest} * \text{Impact Rate}}\right]_{s,i,StatusQuo}$$

where *s = species released*
i = species protected
j = MA alternative
MA = MA smolt production
StatusQuo = smolts raised and released for base case

The IEAB (2004) has chosen annual costs per one percent juvenile "savings" as a measure for salmon recovery CEA. This measurement is used in the application of Equation 2.

Chapter 3. ECONOMIC ANALYSIS

A. Introduction

This chapter provides economic effects analysis results for determining net economic value (NEV), regional economic impact (REI), and results from CEA. Chapter 2 discussed the economic analysis context, methods, and factors and explained the boundaries to be used in the

1. The Northwest Power Act is an alias for the Pacific Northwest Electric Power Planning and Conservation Act passed by Congress in 1980. It is the authorizing legislation for the NPCC.

analysis. The economic effects from fishing opportunities are derived from harvests in ocean and river locations wherever MA funded production contributes.

NEV is calculated for status quo (Alternative 1) and four other MA EIS alternatives. The MA EIS Alternative 2 is for all MA support to go away and hatchery production with non-MA support would continue as traditional hatchery releases. The other alternatives are for different support levels and changed production practices.

Benefits from commercial and recreational fishing NEV's and the proportion of hatchery escapements that reach a market are based on per fish unit values (Table A.3). Subtracted from these benefits are the costs for the MA system production, external, and calculated annualized fixed costs. These costs are from the cost analysis rather than actual budget tabulations. This is because all of the alternatives represent hypothetical conditions. While the status quo alternative nearly patterns the existing situation in 2006 and 2007, there were sufficient differences in the agencies' submitted cost accounting and production results that use of cost indicators was required rather than using snapshot actual costs.

It is acknowledged there could be other benefits and costs brought into the equation. Hatchery production is to replace lost habitat due to hydropower development, so hydropower benefits and dam construction costs could be included. Dams have multiple benefits like transportation, but they also have multiple and cumulative costs. Benefits promote industrial and urban development which in-turn can have adverse consequences. Opportunity costs for land and water could be brought into the equation. There are also non-market benefits that could be considered, like the benefits from non-consumptive fish resource recreational experiences and passive use values. Despite the simplifying assumptions of only using harvest values and production cost elements, results should be revealing for showing the incremental effect of policy alternatives.

The NEV is calculated for economies wherever the Columbia River MA funded production salmon and steelhead are harvested and receive primary processing. The NEV accounting stance is intended to be the U.S. national economy. Including British Columbia in the accounting stance overestimates benefits by six to eight percent, depending on the alternative. However, the PST has negotiated equivalents in salmon species origins. (An equivalent example is the ratio of economic welfare arising from a pink salmon as compared to a sockeye salmon.) Theoretically, if the Columbia River MA hatchery production was not caught in British Columbia, then equivalents would be caught in other West Coast or Alaska fisheries. Therefore, the NEV would have the same reference basis, even though it was being generated in an equivalent species.

This basic approach for determining NEV also sets the stage for conducting further research for effects from changed economic and environmental conditions or sensitivity to policy considerations. For example, how would harvest price increases or decreases change benefit-cost results? What would be the effect of salmon recovery successes which now severely limit below Bonneville inriver fisheries? What are the effects from changed SAR's? Are there distributional changes to fishery user groups (commercial, recreational, and tribal)? What are the long-term, indirect ecological effects from the concentrated MA area fishing? These research questions were beyond the scope and such questions must be left to other analysis.

REI's are calculated for commercial and recreational fishing and for a proportion of hatchery escapements that reach a market using per fish unit values (Table A.3). The accounting stance is for state and province level economies. The particular regional economies are itemized for the REI measure in the consideration a different aggregation or separation of geography that might be of interest. Because angler residency information was not known for all fisheries participation, and the accounting stance was for large regional economies, economic local substitution effects for resident anglers were not considered. Similarly, the estimates do not include effects from substitution fisheries that may offset downturns in what MA production contributes to the fisheries. REI's from hatchery production and headquarters costs are itemized to show relative contributors to MA alternatives' totals. The hatchery calculated fixed costs are included in the BCA determinations, but are not used to determine REI.

The CEA in this chapter is a cost comparison for alternatives and a comparison to several external (non-MA related) programs. Internal program cost comparisons might be helpful in decision making for least cost approaches to accomplishing MA Program goals. The MA Program has multiple objectives which makes any external comparisons difficult. The external program cost comparison used the objective to maximize harvest access to hatchery production while minimizing impacts to depressed stocks. The comparison basis was cost per one percent saved juveniles associated with impacted returns of upriver CHS, upriver bright CHF, and summer steelhead (SSL). The external program examples included forgone hydropower benefits from spilling, smolt passage improvements, and the smolt predation reductions from the Northern Pikeminnow Sport Fishing Reward Program.

B. Net Economic Value

The NEV analysis does not attempt to measure the MA Program's total benefits over time in relation to its costs. It only provides simple one-time estimates of benefits from commercial and recreational harvests and hatchery surplus sales and costs for the MA production system. The NEV from fisheries and hatchery returns are estimated for the status quo alternative to be $19.2 million (Table A.6). The estimated BCA for the status quo alternative when MA hatchery system costs are included is negative $11.5 million.[1]

BCA analysis can also be useful for showing operation efficiencies. For example, the BCA analysis shows the influence of CHS production. Harvesters receive a high price per pound for this species, and while the production costs are also high, the benefit-cost calculation is mostly positive for Alternatives 3 and 5 (Table A.6). The CEA discussion later in this chapter shows how only harvest numbers and the cost side of production can similarly be useful for showing operation efficiencies.

---

1. The negative NEV calculation for the hatchery production is not unusual. Carter (1999) found, for example, that coastal Oregon COH hatchery production SAR's of at least 1.7 percent coupled with selective retention management would be needed to generate positive NEV. The Salmon River Hatchery located on the northern Oregon Coast has not attained this SAR level in any of the brood years 1995 to 2000. The Bandon Hatchery located along the southern Oregon Coast has fallen below the level in three out of six years for the same brood years. An extension of results using the analysis performed by Caudill (2002) also shows negative BCA for four mid-Columbia River USFWS hatcheries.

C. Regional Economic Impacts

The REI from MA production fisheries for the status quo alternative is estimated to be $23.8 million personal income of which about two-thirds is from ocean and inriver recreational fishing (Table A.7). The REI for hatchery production and headquarters cost are $31.7 million (Table A.8). As previously described, calculated rather than annual actual budgets are used for the latter analysis. Actual program administration expenditures vary from year-to-year, so the choice for using the shown budgets should be viewed as providing a representative REI for these types of expenditures. The expenditures are made at hatchery and state management headquarter locations, so the effects are regional.

D. Cost-Effectiveness Analysis

The CHA ratio previously explained for being useful for internal (same objective) comparisons was extended to each MA EIS alternative (Table A.9). There is a mix of results for the different production populations among alternatives. The important CHS production has the least cost ratio in Alternative 5 and the highest cost ratio in the status quo alternative.

In regards to comparisons with external programs that have objectives for salmon recovery, the indicator chosen by the IEAB (2004) for annual costs per one percent juvenile "savings" can be developed. There were several existing analysis results using this indicator, so it was convenient to calculate the same indicator for the MA EIS alternatives. The comparison required translation to outmigrating juveniles associated with the harvest brood years. The selected impacted stocks were upriver CHS, upriver bright CHF (URB), and summer steelhead (SSL). Table A.10 shows the costs per one percent juveniles saved for upriver CHS to be about $8, for URB to be about $1, and for SSL to be about $7 across alternatives.

The annual costs of a one percent savings of juvenile salmonids compared to other programs are shown in Table A.11. The comparison program indicators are foregone benefits, some are additional costs, and others are cost savings. All of the indicators relate to dollars per one percent increased survival in depressed stock's downstream migrating smolts. Some of the programs are direct calculations of saved smolts and others are smolt equivalents calculated from adult natural run mortalities. The selected objective used to generate a statistic shows the MA programs to be a very favorable comparison to the other programs. However, there is some interpretation of the provided statistic necessary to judge the project cost-effective according to IEAB (2004) definitions.

The IEAB (2004) defined a project as representing a cost-effective scenario when it reduces net costs and increases the objective relative to the status quo scenario. It is a "win-win" situation that should be acceptable to the program sponsors as well as fisheries interests. The MA Program supports four agencies' hatcheries and each hatchery has an involved strategy for carrying out production objectives. For example, some of the present smolt production costs are shifted toward operations funded by states and other stakeholder interests. In this case, smolt production levels to meet augmentation hatchery goals are maintained and the number of adults reaching accessible fisheries is increased. Net costs stay the same, but harvest benefits are increased. Another example is that some production is being used to re-establish and or supplement salmon and steelhead recovery populations. There are economic and social benefits in this case that go beyond using CEA for a performance and evaluation measure. In other cases, the hatcheries are providing fisheries augmentation production and the CEA becomes useful to comparisons with other programs that accomplish the same objective, i.e. habitat improvements, reduced passage mortality, etc. In regards to comparing the MA EIS alternatives, moving from the status quo to any of the alternatives must consider the changed benefits and costs (Table A.6) in light of decreased salmon recovery impacts (Table A.10) to determine if it is a winning or losing CEA situation.

BIBLIOGRAPHY

Anderson, J.J. "Decadal Climate Cycles and Declining Columbia River Salmon." University of Washington. Published in Sustainable Fisheries Conference Proceedings (1998). September 26, 1997.

Artificial Production Review and Evaluation (APRE). Final Basin-Level Report. Northwest Power and Conservation Council. Council Document 2004-17. Available online at: http://www.nwcouncil.org/library/2004/2004-17.htm. November 30, 2004.

Artificial Production Review and Evaluation (APRE). Report and Recommendations of the Northwest Power Planning Council. Council Document 99-15. October 13, 1999.

Barclay, J.C. and R.W. Morley. Estimation of Commercial Fishery Benefits and Associated Costs For the National Income Account. Department of Fisheries and Oceans, Vancouver, B.C. 1977.

Carter, Chris. Coastal Salmonid and Willamette Trout Hatchery Program Review. Appendix C - Economic Considerations. Oregon Department of Fish and Wildlife. Draft. March 15, 1999.

Caudill, James. The Economic Effects of Pacific Northwest National Fish Hatchery Salmon Production: Four Mid-Columbia River Hatcheries. Draft. U.S. Fish and Wildlife Service, Division of Economics. July 12, 2002.

Columbia Basin Fish and Wildlife Authority (CBFWA). Correspondence from Rod Sando, Executive Director to Mark Walker, Northwest Power and Conservation Council. December 8, 2003.

Davis, S. West Coast Groundfish Fishery Economic Assessment Model: Final Report for Cooperative Agreement No. NEPA-0402. Portland, PFMC. September 28, 2003.

Forster, John. Cost Trends in Farmed Salmon. Prepared for Alaska Department of Commerce and Economic Development, Division of Economic Development. June 1995.

Francis, R.C., S.R. Hare, A.B. Hollowed, and W.S. Wooster. "Effects of Interdecadal Climate Variability on the Oceanic Ecosystems of the Northeast Pacific." *Fisheries Oceanography,* 7, 1-21. 1998.

Goulder, L.H. and D. Kennedy. "Valuing Ecosystem Services: Philosophical Bases and Empirical Methods." Pages 23-47 *in* G.C. Daily ed. Nature's Services: Societal Dependence on Natural Ecosystems. Island Press, Washington, D.C. 1997.

Haab, Timothy C., Robert L. Hicks, John C. Whitehead. The Economic Value of Marine Recreational Fishing: Analysis of the MRFSS 1998 Pacific Add-on. February 10, 2006.

Hanley, N. and C.L. Spash. Cost-Benefit Analysis and the Environment. Edward Elgar, Hants, England, 278 pp. 1993.

Hare, S.R. Low Frequency Climate Variability and Salmon Production. Ph.D. dissertation, School of Fisheries, University of Washington, Seattle. 1996.

Hare, S.R, N.J. Mantua, and R.C. Francis. "Inverse Production Regimes: Alaska and West Coast Pacific Salmon." *Fisheries,* 24, 6-14. 1999.

Independent Economic Analysis Board (IEAB). Artificial Production Review - Economics Analysis Phase I. Council document IEAB 2002-1. July 2002.

Independent Economic Analysis Board (IEAB). Juvenile Passage Cost Effectiveness Analysis for the Columbia River Basin: Description and Preliminary Analysis. Northwest Power and Conservation Council. Document IEAB 2004-01. January 2004.

Institute of Social and Economic Research (ISER), University of Alaska Anchorage. Economics of Sport Fishing In Alaska. Prepared for the Alaska Department of Fish and Game. December 1999.

Integrated Hatchery Operations Team (IHOT). Policies and Procedures for Columbia Basin Anadromous Salmonid Hatcheries, Annual Report 1995. Bonneville Power Administration, DOE/BP-60629 Project No. 92-043. January 1995.

Joint Columbia River Management Staff (ODFW and WDFW). 2008 Joint Staff Report: Stock Status and Fisheries for Spring Chinook, Summer Chinook, Sockeye, Steelhead, and Other Species, and Miscellaneous Regulations. January 31, 2008.

Joint Columbia River Management Staff (ODFW and WDFW). 2008 Joint Staff Report: Stock Status and Fisheries for Fall Chinook Salmon, Coho Salmon, Chum Salmon, Summer Steelhead, and White Sturgeon. July 14, 2008.

Joint Columbia River Management Staff (ODFW and WDFW). 2007 Joint Staff Report: Stock Status and Fisheries for Fall Chinook Salmon, Coho Salmon, Chum Salmon, Summer Steelhead, and White Sturgeon. July 13, 2007.

Kirkman, Ken. "The Northeast Oregon Hatchery Project Profile." BPA Integrated Fish and Wildlife Program Project Factsheets. 2005.

Layton, David F., Gardner M. Brown, Jr., and Mark L. Plummer. Valuing Multiple Programs to improve Fish Populations. Unpublished manuscript, prepared for the Washington Department of Ecology, Olympia, Washington. Available from Cathy Caruthers at WDOE. 1999.

Leeworthy, V.R. and J.M. Bowker. Nonmarket Economic User Values of the Florida Keys/Key West. U.S. Dept. Commerce/NOAA/National Ocean Service/Office of Ocean Resources Conservation and Assessment/Strategic Environmental Assessments Division. 1997.

Mantua, N.J., S.R. Hare, Y. Zhang, J.M. Wallace, and R.C. Francis. "A Pacific Decadal Climate Oscillation With Impacts on Salmon." *Bulletin of the American Meteorological Society,* Vol. 78, pp 1069-1079. 1997.

Meyer, Philip A. et al. Elwha River Restoration Project: Economic Analysis, Final Technical Report. A report to the U.S. Bureau of Reclamation, the National Park Service, and the Lower Elwha S'Klallam Tribe. April 1995.

Mills, Michael J. Harvest, Catch, and Participation in Alaska Sport Fisheries During 1993. ADFG, Division of Sport Fish. September 1994.

National Marine Fisheries Service (NMFS). Biological Opinion on Impacts of Treaty Indian and non-Indian Year 2000 Winter, Spring, and Summer Season Fisheries in the Columbia River Basin, on Salmon and Steelhead Listed Under the Endangered Species Act. NOAA/NMFS, Portland, Oregon. February 29, 2000.

National Marine Fisheries Service (NMFS). Guidelines For Economic Reviews of National Marine Fisheries Service Regulatory Actions. March 2007.

National Marine Fisheries Service (NOAA Fisheries), Office of Sustainable Fisheries. Guidelines for Economic Analysis of Fishery Management Actions. Silver Spring, Maryland. Revised August 16, 2000.

National Research Council. Upstream: Salmon and Society in the Pacific Northwest. National Academy Press. Washington, D.C. 1996.

National Marine Fisheries Service (NMFS). Fixed Costs and Joint Cost Allocation in the Management of Pacific Whiting - A Workshop Report. NOAA-TM-NMFS-SWFSC-234. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center. September 1996.

North, John ODFW; Marc Miller and John Sewall, WDFW; and, Tod Jones, Alan Dietrichs, and Toni Miethe, CEDC. Select Area Fisheries Evaluation Project Final Project Completion Report October 1993 – October 2005. Prepared for the Bonneville Power Administration, Portland, Oregon. April 2006.

Olsen, Darryll, Jack Richards, and R. Douglas Scott. "Existence and Sport Values for Doubling the Size of Columbia River Basin Salmon and Steelhead Runs." *Rivers* 2(1):44-56. 1991.

Olson, D., et al. Micro IMPLAN User's Guide: Version 91-F. Minnesota IMPLAN Group Inc., St. Paul, Minnesota. 1993.

Oregon Department of Fish and Wildlife (ODFW). "Hatchery Research Center Opens." News Release. October 14, 2005.

Oregon Department of Fish and Wildlife (ODFW). Coastal Salmonid and Willamette Trout Hatchery Program Review. Appendix C – Economic Considerations. Draft March 15, 1999.

Pacific Fishery Management Council (PFMC). Review of 2003 Ocean Salmon Fisheries. Pacific Fishery Management Council. February 2004.

Pacific Fishery Management Council (PFMC). Review of 2007 Ocean Salmon Fisheries. Pacific Fishery Management Council. February 2008.

Panayotou, T. Green Markets: The Economics of Sustainable Development. ICS Press for the International Center for Economic Growth, San Francisco, CA. 169 pp. 1992.

Pearce, D.W. The MIT Dictionary of Modern Economics, Fourth Edition. The MIT Press. Cambridge, MA. 1992.

Peterson, William T., Rian C. Hooff, Cheryl A. Morgan, Karen L. Hunter, Edmundo Casillas, and John W. Ferguson. Ocean Conditions and Salmon Survival in the Northern California Current. Fish Ecology Division, Northwest Fisheries Science Center, National Marine Fisheries Service, Newport, Oregon. August 2006.

Radtke, Hans D. and Shannon W. Davis. The Economics of Hatchery Salmon Production in Oregon. Prepared for Oregon Trout. August 1997.

Radtke, Hans D., Shannon W. Davis, and Rebecca L. Johnson. Lower Snake River Juvenile Salmon Migration Feasibility Study: Anadromous Fish Economic Analysis. Prepared for Foster Wheeler Environmental Corporation and U.S. Army Corps of Engineers. October 1999.

Reed, F.C., E.P. Thompson, and R.C. Campbell. Fourth Annual Report of the State Board of Fish Commissioners for 1890. Oregon. 1890.

The Research Group (TRG). Select Area Fishery Evaluation Project, Economic Analysis Study, Final Report. Prepared for Bonneville Power Administration, Washington Department of Fish and Wildlife, and Oregon Department of Fish and Wildlife. November 2006.

The Research Group (TRG). Draft Review of the West Coast Commercial Fishing Industry in 2004. Prepared for Pacific States Marine Fisheries Commission. May 2006.

The Research Group (TRG). "West Coast Groundfish Fishery Economic Assessment Model." Letter to Jim Seger, Pacific Fishery Management Council transmitting Final Report for Cooperative Agreement No. NEPA-0402. PFMC, Portland. September 28, 2003.

The Research Group (TRG). Estimating Economic Impacts of Alaska Fisheries Using a Computable General Equilibrium Model, Data Acquisition and Reduction Task Documentation. Draft. Prepared for National Marine Fisheries Service and Alaska Fisheries Science Center. November 2007.

Skidmore, John, Resource Manager, Bonneville Power Administration. Personal communication. September 7, 2006.

Steinback, Scott, Brad Gentner, and Jeremy Castle. The Economic Importance of Marine Angler Expenditures in the United States. Via Internet: http://spo.nwr.noaa.gov/pp2.pdf. NOAA Professional Paper NMFS 2. January 2004.

Tietenberg, T. Environmental and Natural Resource Economics. Harper Collins, New York, 614 pp. 1996.

U.S. Fish and Wildlife Service (USFWS). Proposed Process for U.S. Fish and Wildlife Service Review of National Fish Hatcheries in the Columbia River Basin, Co-manager Report. Fishery Resources Pacific Region. June 2005.

University of Alaska, ISER. The Economics of Sportfishing in Alaska. Prepared for the Department of Fish and Game. December 1999.

Water Resources Council. Procedures for Evaluation of National Economic Benefits and Costs in Water Resources Planning. Final Rule Benefits and Costs Published in the FEDERAL REGISTER on December 4, 1979.

Watts, James W. and Howard K. Takata. The 2005 Lower Columbia River and Buoy 10 Recreational Fisheries. Oregon Department of Fish and Wildlife, Columbia River Management. December 2006.

White, Erik. Personal communication. 2008.

Table A.1
Harvest Model Results for Fisheries by Population Origin Categories for Alternatives

	Harvests	Origin						
	From	Not	All Columbia River			MA Columbia River		
Alternative	All Origins	Col. R.	Amount	Difference	% Diff	Amount	Difference	% Diff
Ocean Fisheries								
A1	5,770,026	5,538,627	231,399			105,208		
A2	5,628,593	5,532,584	96,009	(135,390)	-59%	-	(105,208)	-100%
A3	5,731,076	5,540,663	190,413	(40,986)	-18%	75,260	(29,948)	-28%
A4	5,759,008	5,541,867	217,140	(14,259)	-6%	96,556	(8,652)	-8%
A5	5,742,224	5,541,977	200,247	(31,152)	-13%	135,095	29,887	28%
Extreme Terminal Area Columbia River Fisheries								
A1	210,771	-	210,771			83,132		
A2	57,507	-	57,507	(153,264)	-73%	-	(83,132)	-100%
A3	129,488	-	129,488	(81,283)	-39%	36,203	(46,929)	-56%
A4	149,090	-	149,090	(61,681)	-29%	50,132	(33,000)	-40%
A5	144,893	-	144,893	(65,878)	-31%	48,204	(34,928)	-42%
Mainstem Columbia River Fisheries								
A1	160,295	-	160,295			n/a		
A2	72,403	-	72,403	(87,892)	-55%	n/a	n/a	n/a
A3	130,104	-	130,104	(30,191)	-19%	n/a	n/a	n/a
A4	148,086	-	148,086	(12,209)	-8%	n/a	n/a	n/a
A5	144,053	-	144,053	(16,241)	-10%	n/a	n/a	n/a
All Fisheries								
A1	6,141,092	5,538,627	602,465			n/a		
A2	5,758,502	5,532,584	225,918	(376,547)	-63%	n/a	n/a	n/a
A3	5,990,668	5,540,663	450,005	(152,460)	-25%	n/a	n/a	n/a
A4	6,056,184	5,541,867	514,317	(88,148)	-15%	n/a	n/a	n/a
A5	6,031,170	5,541,977	489,193	(113,272)	-19%	n/a	n/a	n/a

Notes: 1. Fisheries are wherever Columbia River origin salmon and steelhead are harvested.

2. All Columbia River production includes MA funded hatchery, other hatchery, and natural populations.

3. Harvests include all modeled species, including fall Chinook, spring/summer Chinook, coho, and summer/winter steelhead.

4. Not available (n/a) means the harvest model did not distinguish production origin for all species and fisheries. Where n/a is shown in the table, assumptions had to be made for the economic analysis to estimate MA funded production contributions to fisheries. Summer/winter steelhead was provided for the shown n/a fisheries and origin, so no assumptions had to be used to estimate the proportion of MA funded production. Chinook and coho populations in extreme terminal area fisheries were provided for total Columbia River and MA funded production, but only total Columbia River production was provided for mainstem fisheries. So the same proportion of extreme terminal area harvests between total Columbia River production and MA funded production was applied to mainstem total Columbia River harvests to get harvests from MA funded production.

Source: Mobrand (Larry Lestelle) April 2008 data version for Chinook and coho harvest. Mobrand (Greg Blair) August 2008 data version for steelhead harvests, all species hatchery returns, and all species hatchery production.

Table A.2
Vessel and Primary Processor Pro Forma Statements

Vessel Type	Vessels: Variable Costs: Labor	Other	Total	Fixed Costs	Net Income
Salmon troller, Washington	39.0%	24.8%	63.8%	23.6%	12.6%
Salmon netter, Puget Sound	39.0%	33.0%	72.0%	21.5%	6.4%
Salmon troller, Oregon	39.0%	20.4%	59.4%	18.6%	22.0%
Salmon netter, Columbia River	39.0%	35.8%	74.8%	17.0%	8.3%
Salmon netter, Alaska	53.3%	22.2%	75.5%	9.5%	15.0%

Processor Type	Processors: Yield	Contribution Margin
Shoreside, Alaska	73%	$0.21
Columbia River	80%	$0.40
Oregon ocean	87%	$0.40
Puget Sound	80%	$0.40
Washington ocean	87%	$0.40

Notes: 1. Operating costs are expressed as a share of revenue. Fixed costs are not a function of operating revenue, but are depicted as such for demonstrating the proportion in this cost category.
2. Contribution margin includes profit and a portion of fixed costs per finish pound.

Source: Davis (2003) and TRG (2007).

Table A.3
NEV and REI Per Unit Economic Assumptions

	Commercial				Recreational: Chinook Only Ocean Season				Recreational: All-Salmon Ocean Season				Recreational	
	Ex-Vessel Price Per Pound	Pounds Per Fish	REI Per Fish	NEV Per Fish	Days Per Fish	REI Per Fish	NEV Per Fish	NEV Per Day	Days Per Fish	REI Per Fish	NEV Per Fish	NEV Per Day	REI Per Day
Species: Spring/Summer Chinook													
Ocean													
Alaska	2.68	17.5	48.11	15.13					0.88	261.54	351.97	--	--
British Columbia	3.22	17.7	63.34	17.77					0.88	261.54	351.97	--	--
Washington ocean	3.28	12.2	67.53	22.42	6.72	334.69	464.37	69.12	0.88	43.85	75.31	85.56	49.82
Washington Puget Sound	1.92	16.5	42.89	17.60	6.72	334.69	464.37	69.12	0.88	43.85	75.31	85.56	49.82
Oregon	4.92	11.2	81.66	32.27	6.07	355.51	220.06	36.24	1.42	83.26	22.40	15.75	58.55
Columbia Basin inland													
Recreational													
Mainstem	--	--	--	--	11.45	670.28	730.48	63.80				63.80	58.55
Commercial													
Gillnet	4.97	18.4	57.24	39.72	--	--	--	--				--	--
Tribal	3.61	18.4	76.67	30.67	--	--	--	--				--	--
C&S	3.61	18.4	--	66.35	--	--	--	--				--	--
Hatchery surplus market	1.81	18.4	17.98	6.61	--	--	--	--				--	--
Hatchery carcass	0.11	18.4	1.58	0.10	--	--	--	--				--	--
Species: Fall Chinook													
Ocean													
Alaska	2.68	17.5	48.11	15.13					0.88	261.54	351.97	--	--
British Columbia	3.22	17.7	63.34	17.77					0.88	261.54	351.97	--	--
Washington ocean	3.28	12.2	67.53	22.42	6.72	334.69	464.37	69.12	0.88	43.85	75.31	85.56	49.82
Washington Puget Sound	1.92	16.5	42.89	17.60	6.72	334.69	464.37	69.12	0.88	43.85	75.31	85.56	49.82
Oregon	4.92	11.2	81.66	32.27	6.07	355.51	220.06	36.24	1.42	83.26	22.40	15.75	58.55
Columbia Basin inland													
Recreational													
Mainstem	--	--	--	--					3.19	186.48	203.23	63.80	58.55
Buoy 10	--	--	--	--					3.48	203.65	221.94	63.80	58.55
Commercial													
Gillnet	2.23	18.4	103.06	21.46	--	--	--	--				--	--
Tribal	1.93	18.4	241.85	19.47	--	--	--	--				--	--
C&S	1.93	18.4	--	35.48	--	--	--	--				--	--
Hatchery surplus market	0.97	18.4	17.98	6.61	--	--	--	--				--	--
Hatchery carcass	0.11	18.4	1.58	0.10	--	--	--	--				--	--

Table A.3 (cont.)

	Commercial				Recreational								
					Chinook Only Ocean Season				All-Salmon Ocean Season				
	Ex-Vessel Price Per Pound	Pounds Per Fish	REI Per Fish	NEV Per Fish	Days Per Fish	REI Per Fish	NEV Per Fish	NEV Per Day	Days Per Fish	REI Per Fish	NEV Per Fish	NEV Per Day	REI Per Day
Species: Coho													
Ocean													
Alaska	0.83	6.5	14.53	2.50					0.88	261.54	351.97	--	--
British Columbia	1.35	5.5	10.13	2.88					0.88	261.54	351.97	--	--
Washington ocean	1.40	3.8	10.78	3.85					0.88	43.85	75.31	85.56	49.82
Washington Puget Sound	1.62	6.8	20.60	6.46					0.88	43.85	75.31	85.56	49.82
Oregon	1.66	5.8	16.90	7.20					1.42	83.26	22.40	15.75	58.55
Columbia Basin inland													
Recreational													
Mainstem	--	--	--	--	3.19	186.48	203.23	63.80				63.80	58.55
Buoy 10	--	--	--	--	3.48	203.65	221.94	63.80				63.80	58.55
Commercial													
Gillnet	1.63	7.5	18.86	7.10	--	--	--	--				--	--
Tribal	0.83	7.5	36.45	4.93	--	--	--	--				--	--
C&S	0.83	7.5	--	6.18	--	--	--	--				--	--
Hatchery surplus market	0.41	7.5	6.97	2.69	--	--	--	--				--	--
Hatchery carcass	0.11	7.5	0.64	0.04	--	--	--	--				--	--
Species: Summer/Winter Steelhead													
Ocean													
Alaska	--	7.0	--	1.19									
British Columbia	0.42	7.0	10.59	1.96									
Washington ocean	1.77	--	--	--									
Washington Puget Sound	1.73	--	--	--									
Oregon	--	--	--	--									
Columbia Basin inland													
Recreational													
Mainstem	--	--	--	--	3.19	186.48	208.84	65.56				65.56	58.55
Commercial													
Gillnet	--	--	--	--	--	--	--	--				--	--
Tribal	0.65	18.4	71.97	7.11	--	--	--	--				--	--
C&S	0.65	18.4	--	11.88	--	--	--	--				--	--
Hatchery surplus market	0.32	18.4	7.37	2.81	--	--	--	--				--	--
Hatchery carcass	0.11	18.4	1.58	0.10	--	--	--	--				--	--

Notes and sources: See next page.

Table A.3 (cont.)

Notes

1. Pounds per fish shown in this table should be considered as representative for early 2000's broodyear returns. Ex-vessel prices for the shown regions are for 2007 landings.
2. When the per unit assumptions are borrowed from other studies (i.e. economic modeling is not used to generate Year 2007 results), then the assumptions have been adjusted to 2007 dollars using the GDP implicit price deflator.
3. Listed REI per unit are for state and province level economies. A portion of Alaska impacts accrue to West Coast economies.
4. Recreational days per fish use five year success rate average of years 2003 to 2007 for Alaska and West Coast ocean and Columbia River salmon fisheries. Fall Chinook, coho, and steelhead use a combined success rate for Columbia River mainstem fisheries.
5. Commercial NEV per pound is from processor contribution margin per pound times yield, plus the harvester profit share per pound. Harvester profit share is the percent of net income plus other contributions to producer surplus times ex-vessel price.
6. Recreational ocean salmon is assumed to be Chinook only outside of the months of July and August and all-salmon for those months.
7. Recreational Columbia Basin inland steelhead is shown under column title "Chinook Only Ocean Salmon Season" for table layout convenience.
8. Alaska recreational non-resident REI apportioned to salmon fishing using same ratio as resident fishing. This method was used despite the source study suggesting that there is a weak statistical significance.
9. Hatchery sales include food fish, carcass and egg sales. It is assumed that food fish sales are about half of the river tribal fishery ex-vessel price. Carcass sale value estimated to be $0.11 per pound for whole body fish less eggs. The REI and NEV calculations are then similar to what is generated by the fishing industry processor sector.
10. The C&S fishery is fish harvested for tribal ceremonial and subsistence purposes. A subsistence economic value is assumed to have a substitute retail purchase value for a similar fish. There is no itemization for fish harvested for ceremonial purposes, so the counts used for the C&S value are high. However, the per unit substitute value is probably a low assumption. The per unit value is shown in the NEV column for table layout convenience. The value should not be interpreted as a NEV value because that would be tantamount to placing a dollar value on tribal spiritual beliefs.
11. See text for other assumptions and modeling explanations.

Sources:

West Coast FEAM is used for Washington and Oregon ocean and Columbia River commercial NEV.
The Research Group (2003) is used for Washington and Oregon ocean and Columbia River commercial REI.
Steinback et al. (2004) is used for Washington and Oregon ocean, Columbia River mainstem, and Buoy 10 recreational REI.
Haab et al. (2006) is used for Washington and Oregon ocean recreational NEV.
Radtke et al. (1999) is used for Columbia River recreational NEV.
The Research Group (2007) is used for Alaska and British Columbia ocean commercial NEV and REI.
University of Alaska, ISER (1999) and Mills (1994) are used for Alaska and British Columbia recreational REI and NEV.
IMPLAN for generation of state level economic response coefficients.
PacFIN March 2008 extraction for West Coast prices, ADFG for Alaska prices, and Canada DFO for British Columbia prices.
Board of Governors of the Federal Reserve System for U.S.-Canada exchange rate.
U.S. Bureau of Economic Analysis for GDP implicit price deflator.

Table A.4
Recreational Salmon Fishing Angler Trips

	High		Low			
	Amount	Year	Amount	Year	Mean	Median
Last 10 Years						
Ocean						
North of Cape Falcon	128.3	2001	14.8	1998	74.9	74.5
Oregon, south of Falcon	106.2	2003	6.8	1998	57.1	55.6
California	178.9	2004	86.3	2007	132.7	126.5
Columbia Basin inland						
Freshwater sport						
Buoy 10	125.9	2001	30.0	1998	65.2	62.0
Below Bonneville	345.8	2002	91.1	1998	226.0	234.9
Above Bonneville						
Last 5 Years						
Ocean						
North of Cape Falcon	119.3	2003	56.0	2006	84.9	80.5
Oregon, south of Falcon	106.2	2003	37.9	2006	72.1	62.3
California	178.9	2004	86.3	2007	123.7	109.6
Columbia Basin inland						
Freshwater sport						
Buoy 10	88.8	2003	36.1	2007	57.9	55.2
Below Bonneville	326.9	2003	202.6	2007	258.1	249.8
Above Bonneville						

Notes:
1. Trips are in thousands, and ocean trips include May to September.
2. The 10 year period is 1998 to 2007 and the five year period is 2003 to 2007.
3. Angler trips have been adjusted to be synonymous with angler days.
4. Oregon coho south of Cape Falcon was not allowed to be retained in 1998. Retention of coho off California has been prohibited since 1996. Spring Chinook fishing has only been allowed on the Columbia River since 2001, so only five year summary is included. Steelhead is a prohibited species in ocean fisheries.
5. Oregon south of Falcon trips are represented by trip origins from Tillamook, Newport, and Coos Bay, and North of Falcon trips are represented by trip origins from Westport, Ilwaco, and Astoria.

Sources: Ocean from PFMC (2008) and Columbia Basin from Watts and Takata (2006).

Table A.5
Recreational Salmon Fishing Success Rates

	Low		High			
	Amount	Year	Amount	Year	Mean	Median
Last 10 Years						
Ocean						
Chinook only						
North of Cape Falcon	14.6	2007	1.3	2002	6.7	5.9
Oregon, south of Falcon	15.5	2007	1.8	2002	5.1	4.3
California	2.0	2007	1.0	2004	1.4	1.2
Chinook and coho						
North of Cape Falcon	1.3	2006	0.6	2000	0.8	0.8
Oregon, south of Falcon	4.0	1998	0.8	2003	1.7	1.3
Columbia Basin inland						
Buoy 10 (Chinook and coho)	7.5	2006	0.9	2001	3.0	2.8
Mainstem						
Spring/summer Chinook	--		--		--	--
Fall fisheries	4.0	2001	1.9	2000	2.9	3.0
Last 5 Years						
Ocean						
Chinook only						
North of Cape Falcon	14.6	2007	2.5	2005	6.7	5.0
Oregon, south of Falcon	15.5	2007	2.7	2005	6.1	2.9
California	2.0	2007	1.0	2004	1.3	1.2
Chinook and coho						
North of Cape Falcon	1.3	2006	0.7	2003	0.9	0.8
Oregon, south of Falcon	2.3	2005	0.8	2003	1.4	1.3
Columbia Basin inland						
Buoy 10 (Chinook and coho)	7.5	2006	1.3	2003	3.5	3.0
Mainstem						
Spring/summer Chinook	14.2	2007	7.6	2004	11.4	12.0
Fall fisheries	3.4	2004	3.0	2003	3.2	3.2

Notes:
1. Success rates are in trips per retained fish, so higher trips per fish is a lower success rate.
2. Chinook success rates are from seasons when regulations are Chinook only or all-salmon. Success rates are calculated from trips and catch occurring in May, June, and September for Chinook only. Coho success rates are from seasons when management regulations allow all-salmon catch. The months of July and August are used to estimate success rates for Chinook and coho together. In some years there are seasonal species Chinook/coho ratio restrictions. Columbia Basin mainstem success rates were calculated using the source information for below Bonneville Dam and it is assume that the rates apply to fishing in the mainstem above Bonneville Dam. Success rates for fall fisheries include fall Chinook, coho, and steelhead.
3. Angler trips have been adjusted to be synonymous with angler days.
4. The 10 year period is 1998 to 2007 and the five year period is 2003 to 2007.
5. Oregon coho south of Cape Falcon was not allowed to be retained in 1998, so that year is excluded. Retention of coho off California has been prohibited since 1996. Spring Chinook fishing has only been allowed on the Columbia River since 2001, so only five year summary is included. Steelhead is a prohibited species in ocean fisheries.
6. Oregon south of Falcon success rates are represented by trip origins from Tillamook, Newport, and Coos Bay, and North of Falcon success rates are represented by trip origins from Westport, Ilwaco, and Astoria.

Sources: Ocean from PFMC (2008) and Columbia Basin from Watts and Takata (2006).

Table A.6
Benefits and Costs for Alternatives

Species	Smolt Releases	Production Cost ($000's)	Harvest and Hatchery Returns NEV ($000's): Commercial	Treaty Commercial	Recreational	Hatchery Returns	Total	Net Benefits ($000's)
Alternative 1								
Fall Chinook	50,297,592	$8,872	$839	$357	$3,148	$56	$4,400	-$4,472
Spring Chinook	4,781,831	$5,199	$62	$130	$4,213	$8	$4,413	-$786
Coho	13,223,556	$11,554	$384	$151	$6,487	$23	$7,045	-$4,509
Summer steelhead	778,276	$1,998	$0	$9	$1,327	$1	$1,337	-$662
Winter steelhead	1,225,247	$3,095	$0	$0	$2,023	$1	$2,025	-$1,070
Total	70,306,501	$30,719	$1,286	$647	$17,198	$88	$19,219	-$11,499
Alternative 2								
Fall Chinook	0	$0	$0	$0	$0	$0	$0	$0
Spring Chinook	0	$0	$0	$0	$0	$0	$0	$0
Coho	0	$0	$0	$0	$0	$0	$0	$0
Summer steelhead	0	$0	$0	$0	$0	$0	$0	$0
Winter steelhead	0	$0	$0	$0	$0	$0	$0	$0
Total	0	$0	$0	$0	$0	$0	$0	$0
Alternative 3								
Fall Chinook	37,948,009	$6,694	$710	$417	$3,265	$46	$4,438	-$2,256
Spring Chinook	3,188,378	$3,467	$49	$118	$3,463	$6	$3,635	$168
Coho	5,790,783	$5,060	$95	$38	$2,813	$17	$2,964	-$2,096
Summer steelhead	804,779	$2,066	$0	$9	$1,465	$1	$1,474	-$592
Winter steelhead	1,109,634	$2,803	$0	$0	$1,811	$1	$1,813	-$990
Total	48,841,584	$20,089	$854	$582	$12,817	$71	$14,324	-$5,765
Alternative 4								
Fall Chinook	45,223,644	$7,977	$814	$469	$3,704	$51	$5,038	-$2,939
Spring Chinook	7,403,713	$8,050	$118	$187	$6,163	$12	$6,481	-$1,569
Coho	8,426,183	$7,363	$269	$38	$4,415	$27	$4,750	-$2,613
Summer steelhead	752,219	$1,931	$0	$3	$1,228	$1	$1,232	-$699
Winter steelhead	1,625,794	$4,106	$0	$0	$1,508	$2	$1,511	-$2,595
Total	63,431,552	$29,427	$1,202	$697	$17,019	$94	$19,012	-$10,415
Alternative 5								
Fall Chinook	44,733,040	$7,890	$1,513	$447	$4,242	$59	$6,261	-$1,630
Spring Chinook	5,053,255	$5,494	$89	$300	$8,078	$9	$8,476	$2,982
Coho	7,749,840	$6,772	$119	$71	$3,752	$19	$3,961	-$2,811
Summer steelhead	1,218,440	$3,129	$0	$3	$1,289	$1	$1,294	-$1,835
Winter steelhead	1,109,634	$2,803	$0	$0	$1,811	$1	$1,813	-$990
Total	59,864,209	$26,088	$1,720	$821	$19,172	$90	$21,803	-$4,284

Notes: 1. Production costs include MA funding, other funding sources used at hatcheries where MA funding occurs, estimated fixed costs, and external costs.

2. The NEV includes effects from all Columbia River inland, U.S. West Coast, Alaska, and British Columbia harvesting and processing regions.

Table A.7
REI From Fisheries and Marketable Hatchery Returns for Alternatives

Species	Smolt Releases	Harvest and Hatchery Returns REI ($000's) Commercial	Treaty Commercial	Recreational	Hatchery Returns	Total
Alternative 1						
Fall Chinook	50,297,592	$2,912	$2,860	$2,393	$164	$8,329
Spring Chinook	4,781,831	$156	$328	$3,853	$22	$4,359
Coho	13,223,556	$1,025	$1,077	$5,860	$63	$8,025
Summer steelhead	778,276	$1	$87	$1,185	$2	$1,275
Winter steelhead	1,225,247	$1	$4	$1,806	$4	$1,816
Total	70,306,501	$4,095	$4,356	$15,097	$255	$23,803
Alternative 2						
Fall Chinook	0	$0	$0	$0	$0	$0
Spring Chinook	0	$0	$0	$0	$0	$0
Coho	0	$0	$0	$0	$0	$0
Summer steelhead	0	$0	$0	$0	$0	$0
Winter steelhead	0	$0	$0	$0	$0	$0
Total	0	$0	$0	$0	$0	$0
Alternative 3						
Fall Chinook	37,948,009	$2,517	$3,941	$2,573	$134	$9,165
Spring Chinook	3,188,378	$117	$295	$3,171	$17	$3,600
Coho	5,790,783	$256	$260	$2,555	$49	$3,119
Summer steelhead	804,779	$1	$87	$1,308	$2	$1,398
Winter steelhead	1,109,634	$1	$4	$1,617	$4	$1,626
Total	48,841,584	$2,892	$4,588	$11,224	$206	$18,910
Alternative 4						
Fall Chinook	45,223,644	$2,921	$4,477	$2,932	$149	$10,479
Spring Chinook	7,403,713	$327	$469	$5,637	$36	$6,468
Coho	8,426,183	$719	$246	$4,032	$76	$5,073
Summer steelhead	752,219	$1	$35	$1,097	$2	$1,134
Winter steelhead	1,625,794	$1	$4	$1,347	$7	$1,359
Total	63,431,552	$3,969	$5,231	$15,044	$270	$24,513
Alternative 5						
Fall Chinook	44,733,040	$5,247	$4,143	$3,287	$173	$12,850
Spring Chinook	5,053,255	$180	$751	$7,405	$27	$8,363
Coho	7,749,840	$318	$498	$3,314	$52	$4,182
Summer steelhead	1,218,440	$1	$31	$1,151	$4	$1,187
Winter steelhead	1,109,634	$1	$4	$1,617	$4	$1,626
Total	59,864,209	$5,747	$5,427	$16,774	$260	$28,208

Notes: 1. REI measurement is total personal income in thousands.
2. The REI includes effects from all Columbia River inland, U.S. West Coast, Alaska, and British Columbia harvesting and processing regions.

Table A.8
REI From Fisheries, Marketable Hatchery Returns, Hatchery Operations, and Headquarter Activity for Alternatives and Comparisons With the Status Quo Alternative

Alternatives	REI Personal Income ($000's)	REI FTE	Differences Personal Income ($000's)	Differences FTE
Alternative 1				
Fisheries	23,549	655		
Hatchery returns	255	7		
Hatchery operation	22,339	621		
Hatchery headquarters	5,663	157		
Total REI	51,805	1,440		
Alternative 2				
Fisheries	0	0	-23,549	-655
Hatchery returns	0	0	-255	-7
Hatchery operation	0	0	-22,339	-621
Hatchery headquarters	0	0	-5,663	-157
Total REI	0	0	-51,805	-1,440
Alternative 3				
Fisheries	18,704	520	-4,844	-135
Hatchery returns	206	6	-49	-1
Hatchery operation	14,893	414	-7,445	-207
Hatchery headquarters	3,831	107	-1,832	-51
Total REI	37,634	1,046	-14,171	-394
Alternative 4				
Fisheries	24,243	674	695	19
Hatchery returns	270	7	15	0
Hatchery operation	21,900	609	-439	-12
Hatchery headquarters	5,622	156	-42	-1
Total REI	52,034	1,447	229	6
Alternative 5				
Fisheries	27,948	777	4,399	122
Hatchery returns	260	7	5	0
Hatchery operation	19,306	537	-3,032	-84
Hatchery headquarters	4,958	138	-706	-20
Total REI	52,472	1,459	667	19

Notes:
1. REI measurement is total personal income in thousands and full-time equivalent (FTE) jobs. The calculation of FTE is assumed to be average annual earnings for the study area economy.
2. REI does not include fixed costs expenditures.
3. Differences are each alternative minus status quo alternative.
4. The REI includes effects from all Columbia River inland, U.S. West Coast, Alaska, and British Columbia harvesting and processing regions.

Table A.9
Cost Per Harvestable Adult for Alternatives

Species	Smolt Production	Production Costs	Average SAR	Total Adults	Cost Per Total Adult Return
Alternative 1					
Fall Chinook	50,297,592	8,871,989	0.29%	146,148	61
Spring Chinook	4,781,831	5,199,144	0.46%	21,980	237
Coho	13,223,556	11,554,490	1.57%	207,635	56
Summer steelhead	778,276	1,998,373	1.16%	9,057	221
Winter steelhead	1,225,247	3,094,592	1.10%	13,528	229
Total	70,306,501	30,718,588		398,348	77
Alternative 3					
Fall Chinook	37,948,009	6,693,647	0.34%	130,312	51
Spring Chinook	3,188,378	3,466,630	0.55%	17,551	198
Coho	5,790,783	5,059,876	1.75%	101,050	50
Summer steelhead	804,779	2,066,424	1.24%	10,017	206
Winter steelhead	1,109,634	2,802,590	1.14%	12,617	222
Total	48,841,584	20,089,166		271,546	74
Alternative 4					
Fall Chinook	45,223,644	7,976,996	0.32%	146,821	54
Spring Chinook	7,403,713	8,049,840	0.47%	34,961	230
Coho	8,426,183	7,362,637	2.02%	169,871	43
Summer steelhead	752,219	1,931,465	1.09%	8,191	236
Winter steelhead	1,625,794	4,106,249	0.81%	13,204	311
Total	63,431,552	29,427,186		373,049	79
Alternative 5					
Fall Chinook	44,733,040	7,890,458	0.45%	199,323	40
Spring Chinook	5,053,255	5,494,256	0.69%	35,087	157
Coho	7,749,840	6,771,662	1.59%	123,321	55
Summer steelhead	1,218,440	3,128,577	0.83%	10,134	309
Winter steelhead	1,109,634	2,802,590	1.14%	12,617	222
Total	59,864,209	26,087,542		380,482	69
Summary					
Alternative 1	70,306,501	30,718,588		398,348	77
Alternative 3	48,841,584	20,089,166		271,546	74
Alternative 4	63,431,552	29,427,186		373,049	79
Alternative 5	59,864,209	26,087,542		380,482	69

Notes: 1. Production costs include MA funding, other funding sources used at hatcheries where MA funding occurs, estimated fixed costs, and external costs.

Table A.10

CEA for MA Production Cost Per Impacted Recovery Populations for Alternatives

	Year 2003-2007 Avg.						
Species	Run Size	SAR	Outmigrating Juveniles (000,000)	Harvest	SAR	Juveniles (000)	MA Cost ($000)
Alternative 1							
Upriver CHS	157,909	0.46%	34.4	239	0.46%	52.0	$ 1,228
URB	270,060	0.29%	92.9	1,956	0.29%	673.2	$ 966
Sum. steelhead	325,460	1.16%	28.0	34	1.16%	2.9	$ 98
Alternative 2							
Upriver CHS				0	n/a		$ -
URB				0	n/a		$ -
Sum. steelhead				0	n/a		$ -
Alternative 3							
Upriver CHS				219	0.55%	39.8	$ 923
URB				2,758	0.34%	803.3	$ 1,125
Sum. steelhead				35	1.24%	2.8	$ 101
Alternative 4							
Upriver CHS				357	0.47%	75.7	$ 1,749
URB				3,211	0.32%	989.0	$ 1,412
Sum. steelhead				39	1.09%	3.6	$ 110
Alternative 5							
Upriver CHS				580	0.69%	83.6	$ 1,887
URB				2,875	0.45%	645.2	$ 901
Sum. steelhead				40	0.83%	4.8	$ 149

Saved Impacts	Juveniles (000)	MA Cost ($000)	Cost Per Saved Juvenile	Cost Per 1% Saved Juvenile ($000,000)
Status quo minus Alternative 2				
Upriver CHS	52.0	$ 1,228	$ 24	$ 8
URB	673.2	$ 966	$ 1	$ 1
Sum. steelhead	2.9	$ 98	$ 34	$ 10
Status quo minus Alternative 3				
Upriver CHS	12.1	$ 305	$ 25	$ 9
URB	-130.1	$ (159)	$ 1	$ 1
Sum. steelhead	-	-	-	-
Status quo minus Alternative 4				
Upriver CHS	-23.7	$ (521)	$ 22	$ 8
URB	-315.8	$ (446)	$ 1	$ 1
Sum. steelhead	-0.7	$ (12)	$ 17	$ 5
Status quo minus Alternative 5				
Upriver CHS	-31.6	$ (660)	$ 21	$ 7
URB	28.0	$ 65	$ 2	$ 2
Sum. steelhead	-2.0	$ (51)	$ 26	$ 7

Notes:
1. Upriver CHS and URB fall Chinook are run size at the mouth of the Columbia River. Summer steelhead run size is indexed to Bonneville Dam.
2. SAR's used in this table are smolt survival to run size. The MA EIS status quo alternative SAR's are used as a proxy for brood year conditions that generated the run size.
3. The impact rate basis is from mainstem fishing (non-treaty, treaty) for the shown recovery species: CHS (1.24%, 10.00%), URB (7.44%, 15.95%), SSL (4.47%, 19.51%)
4. The impact harvest is the mainstem fishing harvest from MA produced fish times the impact rate.
5. Impact juveniles represent the number of outmigrating juveniles associated with impact harvests. This assumes zero adult passage mortality.
6. Total MA costs are segmented for upriver CHS, URB, and SSL using total MA spring Chinook, fall Chinook, and summer steelhead production costs, respectively.
7. MA costs include operation, headquarters, external, and capital/fixed costs for internal and external operations.
8. Cost per saved juvenile assumes that the saved impact harvest would not be made up in other fisheries if the MA alternatives' production did not occur.
9. Summer steelhead impacts for Alternative 3 are statistically insignificant.

Source: Run size and impact rates are from Joint Columbia River Management Staff (July 14, 2008) and (January 31, 200

Table A.11
CEA External Programs Comparison

	Species		
Selected Programs	CHF	CHS	Steelhead
August spill at Ice Harbor	$600	No effect	No effect
Extended length screens at Lower Granite	$12	$3	$6
Extended length screens at Little Goose	$23	$7	$14
Corner collector at Bonneville	$95	$95	$158
Sport Fishing Reward Program	$2.91 (all stocks combined)		
SAFE	$0.84	$0.51	n/a
MA EIS Alternative 3 saved impacts	$1	$9	-
MA EIS Alternative 4 saved impacts	$1	$8	$5
MA EIS Alternative 5 saved impacts	$2	$7	$7

Notes: 1. Table values are foregone benefits (spill program), capital costs (screens and collectors), program costs (predation reduction and select fisheries), or cost savings (hatchery practices) per one percent increase in salmonid downstream migration survival.

2. SAFE costs include operation, headquarter, and annualized fixed costs.

3. MA EIS alternatives are cost savings, i.e. the alternatives are the saved impacts and reduced costs from changing hatchery practices and production levels.

Source: IEAB (2004) for other actions, The Research Group (November 2006) for SAFE, and EIS for alternatives.

Appendix J

Mitchell Act Hatchery EIS

Socioeconomics Impact Methods Appendix

Prepared by:

TCW Economics
Sacramento, CA

Contact: Thomas Wegge

Prepared for:

NOAA Fisheries
Northwest Regional Office
Salmon Recovery Division
Portland, Oregon

Contact: Allyson Purcell

March 2010

Appendix – Socioeconomics Impact Methods

This appendix describes the methods and data used to conduct the analysis of socioeconomic effects described in Section 4.6. The analysis of socioeconomic impacts considers predicted harvest-related effects both within the Columbia River Basin and in other regions where Columbia River stocks contribute, and hatchery operations-related effects, including hatchery production costs, associated with affected salmon and steelhead hatcheries in the Columbia River Basin.

1.0 Harvest- Related Effects of Hatchery Production

An excel workbook with linked worksheets, referred to as the Hatchery Impact Model, was developed by TCW Economics to assess harvest-related and hatchery operations-related effects of the Mitchell Act EIS alternatives. Data and values in the worksheets are organized by economic regions. The analytical purpose of these regions is to measure the economic impacts (i.e., generation of jobs and personal income) of fishing activity (and, in the case of the Columbia River Basin, hatchery operations as well) that occurs in nearby fisheries. The Columbia River Basin is comprised of four economic regions: Lower Columbia River, Mid Columbia River, Upper Columbia River, and Lower Snake River. The Ocean and Puget Sound area includes six regions: Oregon Coast, California Coast, Washington Coast, Puget Sound/Strait of Juan de Fuca (Puget Sound), British Columbia, and Southeast Alaska (SEAK).

Each economic region in the Columbia River Basin includes a set of counties in which affected fisheries are located. The counties that comprise each economic region are as follows:

- **Lower Columbia River economic region**: Columbia (OR), Multnomah (OR), Washington (OR), Clackamas (OR), Yamhill (OR), Polk (OR), Marion (OR), Benton (OR), Linn (OR), Lane (OR), Clatsop (OR), Clark (WA), Wahkiakum (WA), Cowlitz (WA), Lewis (WA), Pacific (OR)

- **Mid Columbia River economic region**: Hood River (OR), Wasco (OR), Sherman (OR), Gilliam (OR), Morrow (OR), Umatilla (OR), Grant (OR), Wheeler (OR), Crook (OR), Jefferson (OR), Deschutes (OR), Skamania (WA), Klickitat (WA), Bento (WA), Franklin (WA), Walla Walla (WA), Adams (WA)

- **Upper Columbia River economic region**: Okanogan (WA), Chelan (WA), Douglas (WA), Kittatas (WA), Yakima (WA)

- **Lower Snake River economic region**: Lemhi (ID), Custer (ID), Valley (ID), Adams (ID), Idaho (ID), Clearwater (ID), Lewis (ID), Nez Perce (ID), Latah (ID), Shasone (ID), Wallowa (OR), Union (OR), Asotin (WA), Columbia (WA), Garfield (WA), Whitman (WA)

Commercial (tribal and non-tribal) and recreational fishing activity in affected fisheries (including the mainstem Columbia River and its tributaries) were assigned to the economic region where the fishing activity occurs. The correspondence between fishing areas (both mainstem Columbia River and terminal areas) and economic regions in the Columbia River Basin is shown in Figure A-1.

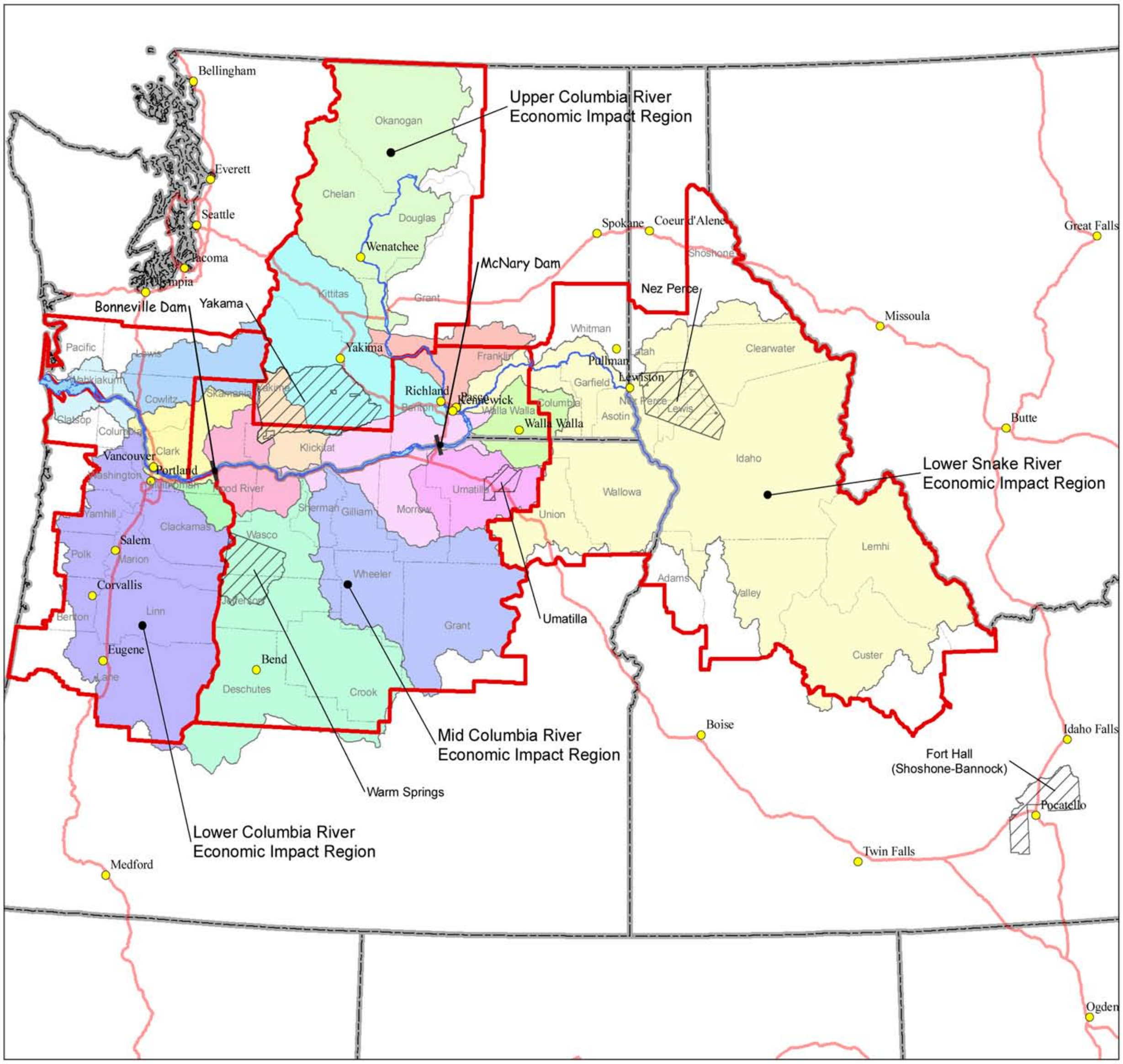


Figure A-1. Terminal Fishing Areas and Economic Impact Regions in the Columbia River Basin

C:\04GISData\ProjectData\MitchellActEIS\MapProjects\SocioEconRegions.mxd Published 6 / 25 / 2009

The six economic regions in the Ocean and Puget Sound Area were defined for purposes of assigning tribal, commercial and recreational fisheries to geographic areas where affected fisheries are located. Because fishing activity associated with the catch of Columbia River stocks occurs almost exclusively in marine waters of these areas, the economic regions are associated with most fishing-related commerce that is generated by fishing activity in these areas. The Oregon, Washington, and California coast economic regions are comprised of the coastal counties in those areas, whereas the Puget Sound, British Columbia, and Southeast Alaska regions are less well defined but intended to capture fishing-related economic activity in nearby affected marine waters.

It should be noted that the Lower Columbia River economic region includes some counties that also are included in the Oregon and Washington Coast economic regions. This is because salmon fishing activity that occurs in the Lower Columbia River directly contributes fishing-related economic activity to Clatsop County in Oregon and Pacific County in Washington, as does fishing activity along the coastal areas. The Lower Columbia River economic region and the Oregon and Washington Coast economic regions, however, are the only regions that have counties common to more than one region (i.e., they geographically overlap).

1.1 Catch Estimates

The Mitchell Act Fishery Modeling Team estimated salmon (coho, Chinook, and sockeye) and steelhead harvest in tribal, non-tribal commercial and recreational fisheries throughout the study area. Catch estimates were provided for each of the EIS alternatives. The modeling methods and data used to develop these harvest estimates are described by Lestelle and Morishima (2009). Because the estimates of catch under the alternatives are based on different exploitation rates under the alternatives, fishing activity associated with catch include consideration of changes in both hatchery production and exploitation rates. However, because it is assumed that the underlying dynamics of the fisheries do not appreciably change between the alternatives, the resulting allocation of effort also does not appreciably change as a result of different exploitation rates.

Harvest estimates for fisheries in the Columbia River Basin were based on production and exploitation rates from the early 2000's. The predicted number of fish (both wild and hatchery fish) caught in tribal, non-tribal commercial, and recreational fisheries was estimated for areas of the mainstem Columbia River and for different terminal areas within the Columbia River Basin (see Figure A-1). The catch estimates were then assigned to the four economic regions in the Columbia River Basin based on the county (and region) corresponding to the location of the fisheries.

For regions in the Ocean and Puget Sound Area, species-specific catch estimates were provided by the Mitchell Act Fishery Modeling Team for treaty troll, non-treaty troll, and sport fishing fisheries north and south of Cape Falcon. For the marine fisheries off of Oregon, California, and Washington, catch was assigned to port areas based on the average proportion of catch in each port between 2001 and 2005 (see Lestelle and Morishima 2009). For the SEAK, British Columbia, and Puget Sound regions, modeled estimates of total treaty, non-tribal commercial, and sport catch (including contributions from the Columbia River and all other river systems) had to be allocated among the different user groups. For alternatives other than Alternative 1, the percentage distribution of catch among each user group over the 2002-2006 period was used for this allocation, supplemented by other information generated by the EIS fishery assessment. The resulting distribution for coho and Chinook catch in these more distant fisheries was as follows:

Coho
- Northwest and southwest Vancouver Island troll: 100% non-tribal commercial
- West coast Vancouver Island: 100% sport
- Puget Sound/Strait of Juan de Fuca: 82% commercial (split 81.6% tribal and 18.4% non-tribal), 18% sport

Chinook
- SEAK: 82% non-tribal commercial, 18% sport
- North and central coasts of British Columbia: 70% non-tribal commercial, 30% sport
- West coast Vancouver Island: 73% non-tribal commercial, 27% sport
- Puget Sound/Strait of Juan de Fuca: 74% commercial (split 88.5% tribal and 11.5% non-tribal), 26% sport

For Alternative 1, which serves as the baseline for analyzing socioeconomic impacts, historical catch (2002-2006 averages) rather than modeled catch estimates were used to characterize catch conditions in the Puget Sound, British Columbia and SEAK regions. Historical averages were used in order to more accurately establish baseline conditions for evaluating the relative effects of changes in harvest conditions compared to the baseline.

It should be noted that the historical harvest of the First Nations tribes was used to estimate the tribal harvest in British Columbia under all alternatives.

1.2 Gross and Net Economic Values

1.2.1 Commercial Fisheries

Estimates of tribal and non-tribal commercial catch provided by the Mitchell Act Fishery Modeling Team were converted to gross and net economic values using different factors. For estimating gross economic values (ex-vessel values), the number of fish caught was first converted to pounds. The pounds-per-fish factors by species and region used in the conversion are presented in Table A-1. The data sources for these conversion factors include the following:

- Commercial weights (dressed weight per fish) for Washington and Oregon coastal regions: PFMC 2008 SAFE Report, Appendix D, Tables D-2 and D-3 (average weights over the 2004-2008 period)

- Commercial weights (round weight per fish) for SEAK, British Columbia, and Columbia River Basin regions: The Research Group, draft Mitchell Act DEIS socioeconomic section, Appendix B, Table B.2

- Commercial weights (dressed weight per fish) for Puget Sound: Washington Department of Fish and Wildlife (in an excel file provided to the EIS economics team)

Once commercial catch was converted to pounds, the share of catch assumed for ceremonial and subsistence (C&S) purposes was estimated and subtracted from the total tribal harvest in the Mid Columbia River, Upper Columbia River, and Lower Snake River regions. Estimates of the C&S harvest were derived by TCW Economics using information on average tribal harvest in the Columbia River Basin provided by the Mitchell Act Fishery Modeling Team (personal communication with Larry Lestelle, Biostream Environmental, Senior Biologist, April 8, 2009). This information included 5-year averages of C&S harvest in the Columbia River Basin for summer Chinook, fall Chinook, and coho, and 3-year averages for spring Chinook. These average percentages, which were applied to average tribal harvest under the alternatives, were as follows: summer Chinook, 64.3%; spring Chinook, 65.9%; fall Chinook, 0.5%; and coho, 7.1%.

Per pound ex-vessel prices for each species and region were then applied to the resulting tribal harvest and the non-tribal commercial harvest to estimate the total regional ex-vessel value of commercial salmon landings in each region. For all regions, prices (in 2007 dollars) generated by The Research Group (draft Mitchell Act DEIS socioeconomic section, Appendix B, Table B.2) were used to convert estimated landings to total ex-vessel harvest values. These prices are shown in Table A-2.

Lastly, net economic values (net income) associated with the commercial harvest were estimated. Per-fish factors (Table A-3) derived from The Research Group's draft analysis for the Mitchell Act EIS (Appendix B, Table B.2) were used to estimate net economic values.

1.2.2 Recreational Fisheries

Table A-4 shows the angler-trip conversion factors used to convert catch to angler trips for each species and region. The data sources for these conversion factors include the following:

- Sport catch per trip for all regions other than California: The Research Group, draft Mitchell Act DEIS socioeconomic section, Appendix B, Table B.3 (inverted days per fish),

- Sport catch per trip for California regions: PFMC 2008 SAFE Report, Table IV-11.

Once catch was converted to sport angler trips, per trip expenditure factors for each species and region were applied to the estimated number of sport trips to estimate the total trip-related expenditures in each region. For all regions other than California, trip expenditures (in 2007 dollars) developed by The Research Group (draft Mitchell Act DEIS socioeconomic section, Appendix B, Table B.2) were used to convert estimated sport trips to total trip expenditures. Expenditure factors for the California region were derived by adjusting Oregon trip expenditures by the relative percentage difference in regional personal income factors (see below) for Oregon and California. The resulting per trip expenditure factors are shown in Table A-5.

Net economic values (willingness to pay for fishing over and above expenditures) associated with the recreational catch were estimated using per angler day values derived from a review of past studies of anglers' net willingness to pay for salmon fishing in the Pacific Region and Alaska (Boyle et. al 1998). These factors, which were adjusted to 2007 dollars using the consumer price index, are $39.71 per angler day for fishing in Alaska and $59.12 for salmon fishing in all other areas. For the analysis, it was assumed that an angler trip is equivalent to an angler day.

1.3 Harvest-Related Regional and Local Economic Impacts

Harvest-related regional economic impacts are generated by three fishery components: 1) economic activity from tribal commercial harvests, 2) economic activity from non-tribal commercial harvests, and 3) economic activity generated by sport fishing. Estimates of regional economic impacts from these activities are expressed in terms of personal income and jobs generated in each of the 10 regions in the Columbia River Basin and the Ocean and Puget Sound Area.

1.3.1 Personal Income

To estimate total (direct, indirect, and induced) personal income generated by estimated commercial and recreational catch under each alternative, local regional income impact factors for each species and region were applied to the converted catch (i.e., pounds of commercial landings and sport trips). Table A-6 shows the regional income impact factors (in 2007 dollars) used to convert catch (in pounds) and angler trips for each user group, species, and region to personal income impacts. The sources for the regional income impact factors include the following:

- Regional income impact factors (per pound) for commercial catch in the Puget Sound region and the Washington and Oregon coastal regions: Fishery Economic Assessment Model (FEAM) impact factors for 2007 provided by the PFMC in file “Tables CH IV Econ Sup.” (These factors were those used to produce the regional economic impacts presented in the PFMC 2008 SAFE Report.)

- Regional income impact factors (per pound) for commercial catch in SEAK, British Columbia, and Columbia River Basin regions: The Research Group, draft Mitchell Act DEIS socioeconomic section, Appendix B, Table B.2.

- Sport income impact factors (per angler trip) for Puget Sound region and the Washington, Oregon, and California coastal regions: FEAM charter and private boat trip impact factors for 2007 provided by the PFMC in file “Tables CH IV Econ Sup” (factors for charter and private boats were weighted based on boat-type trip distributions over the 2004-08 period for each region, as reported in the PFMC 2008 SAFE Report).

- Sport income impact factors (per angler trip) for SEAK, British Columbia, and Columbia River Basin regions: The Research Group, draft Mitchell Act DEIS socioeconomic section, Appendix B, Table B.2.

It should be noted that regional income is measured as personal income accruing to households. It measures the contribution to personal income under current (or changed) conditions. Because dynamic changes in the economy over time are not considered, the assessment is not considered a valid measure of effects on the economy over the long term from changes in fish abundance or policy.

1.3.2 Jobs

Jobs (full- and part-time; direct, indirect, and induced) generated by the commercial and recreational catch in each region under each alternative were estimated by applying an earnings-per-job factor to the estimated total income generated by catch in each region described above. The earnings-per-job factors for each region were calculated by dividing total earnings in each region in 2007 by total jobs, as reported by the Bureau of Economic Analysis (BEA) (BEA Table CA05N: Personal Income by Major Source and Earnings by NAICS Industry; BEA Table CA25N: Total Full- and Part-Time Employment by NAICS Industry). For California, Oregon and Washington Coast economic regions, factors were developed for individual counties that comprise the regions. The resulting earnings-per-job factors are presented in Table A-7. (Note that the earnings-per-job factor for the Puget Sound region was also used for SEAK and British Columbia.) The personal income totals for each region were then divided by the earnings-per-jobs factors to estimate jobs for each region and alternative.

2.0 Hatchery-Operations Related Effects

Although the analysis of socioeconomic effects focused on harvest-related effects from expected changes in Columbia River Basin hatchery production, operational effects, including effects on production costs, hatchery jobs and personal income generated by production changes, also were evaluated. This section describes the methods and data used to conduct these analyses.

2.1 Cost Analysis

Smolt production at salmon and steelhead hatcheries in the Columbia River Basin varies under the EIS alternatives; consequently, hatchery production costs also vary by alternative. The assessment of hatchery operations costs considers baseline costs associated with Alternative 1 (No Action) and changes in these baseline costs associated with changes in smolt production (and release), implementation of best management practices (BMPs), and construction of new weirs. Baseline costs include smolt production costs, indirect or overhead (i.e.,"headquarters") costs, and amortized capital costs associated with hatchery facility improvements. Changes in hatchery operations costs under the project alternatives considers only variable costs (i.e., those costs that change in response to smolt production changes), and additional (incremental) costs for implementing BMPs and constructing new weirs.

Smolt production costs were estimated separately for facilities funded by the Mitchell Act and for other hatchery facilities in the Columbia River Basin that produce salmon and steelhead. Budget data compiled by NOAA Fisheries (personal communication with Allyson Purcell, National Marine Fisheries Service, June 22, 2009) for hatcheries funded by the Mitchell Act were used to estimate smolt production costs for both Mitchell Act and non-Mitchell Act hatchery facilities. Facility-specific and average smolt production costs from Mitchell Act hatcheries are presented in Table A-8. Average smolt production costs by entity and species in Table A-8 were primarily used to estimate costs for non-Mitchell Act hatchery facilities in the Columbia River Basin that would be affected.

Smolt production costs were estimated by multiplying the estimated number of smolts produced at each hatchery by a unit cost factor (cost per smolt) developed for each hatchery and species, for both Mitchell Act and non-Mitchell Act hatcheries. The unit cost factors are composed of variable operating costs and fixed costs. Fixed costs include the unit costs attributable to administration of the hatchery programs at the agency headquarters level and short-term hatchery capital costs (facility replacement). For Alternative 1 (the baseline condition), hatchery production costs were estimated based on variable operating and fixed costs associated with production levels for each hatchery and species under Alternative 1. For Alternatives 2 through

5, smolt production costs were estimated by applying the variable operating costs to the smolt production levels specific to each hatchery under each alternative, then adding in the fixed costs associated with Alternative 1. (This assumes that fixed costs associated with baseline conditions would not change in response to changes in smolt production levels under each alternative.) For a small number of hatcheries, no smolts are predicted to be produced under baseline conditions (Alternative 1), suggesting that fixed costs for these hatcheries would be zero. For these hatcheries, the fixed-cost component of the unit cost factor was assumed to be the same as the fixed cost for the alternative with the highest smolt production levels across the four action alternatives. (The excel spreadsheet used to calculate costs by region is available upon request.)

Costs for implementing BMPs and constructing new weirs were developed by the Mitchell Act EIS team. The purpose of the cost estimating was to develop capital costs at a pre-conceptual level for BMPs identified in the region. Where available, HGMPs were reviewed and information was used to obtain production levels and estimated water needs to help identify the general scope of specific BMPs. A pre-conceptual cost estimation process was conducted to identify probable ranges of costs for capital needs identified for the BMPs. This was done by applying probable costs from similar projects. The analysis was completed without review of facility drawings or review of specific facilities. No sites were visited to specifically verify costs applied to each BMP.

Key considerations of the estimates of BMP costs include:

- All costs for adherence to BMPs are included. In some cases, BMPs do not have any capital costs associated with them. Fish passage, however, might be an exception.

- The cost to provide fish passage at hatcheries that currently block migration was not estimated. Fish passage costs were not developed because it was determined that they would vary greatly depending on the specific site constraints, total flow requirements, facility size and location and related unforeseeable implementation issues.

- The cost of any additional staffing associated with meeting BMPs (with the exception of staff to provide security) was not included.

- The annual cost of staffing weirs was not included.

For the analysis, it was assumed that BMP costs would be as follows:

- A water supply alarm would cost an estimated $10,000.

- A back-up power generator is estimated to cost between $30,000 and $50,000.

- An updated water intake screen is estimated to cost between $200,000 to $500,000, depending on the specific site constraints, total flow requirements, facility size, location and related unforeseeable implementation issues.

- Around-the-clock staffing for security reasons would cost $100,000 per year.

- Installing a water treatment system to ensure pathogen-free water is estimated to cost between $100,000 to $1,000,000, depending on the specific site constraints, total flow requirements, facility size and location, and related unforeseeable implementation issues.

- Fixing water intake structures is estimated to cost between $50,000 and $1,000,000 depending on facility size and location, specific site constraints, total flow requirements, location and related unforeseeable implementation issues.

It should be noted that actual costs for these BMPs would depend on specific site constraints, total flow requirements, site location, and related unforeseeable implementation issues.

The estimates of BMP costs provide a very general benchmark for future planning, and broad assumptions for overall costs in a region. To develop actual implementation costs for a specific BMP, preliminary and final design processes would be needed, and associated annual operations and maintenance costs should be considered. Other cost considerations, such as sequencing, economy of scale, and inflation and escalation, also would need to be considered. The costs estimated through this exercise should not be utilized for obtaining funding for implementing a specific BMP. This would require the review of specific facility drawings and documents, and investigating the specific items by an engineer.

The full costs of implementing hatchery reform were not included in the analysis. The cost estimates only allow for a relative comparison of costs across alternatives. As decisions are made on priorities for implementation of hatchery reform, the probable ranges of costs provided would be refined through standard planning and design processes. Estimates of the full cost of hatchery reform are not currently available.

Lastly, one-time costs for BMPs and new weirs by alternative were annualized using a 4 percent annual amortization rate, which was the current discount rate recommended by the Office and Management Budget, over a 25-year amortization period.

2.2 Effects on Regional Economic Activity

Hatcheries support jobs in the Columbia River Basin economy by directly employing workers and from economic activity generated by procuring goods and services needed for hatchery operations from regional businesses. Expenditures on hatchery labor and the procurement of goods and services produce indirect and induced effects on employment and personal income in regional economies.

The analysis of hatchery operations-related effects was based on the estimates of annual hatchery costs for each alternative. Estimates of hatchery production costs (including annualized costs for implementing BMPs and constructing new weirs) were as follows:

- Alternative 1: $79.5 million
- Alternative 2: $51.9 million
- Alternative 3: $76.9 million
- Alternative 4: $79.4 million
- Alternative 5: $81.5 million

To assess hatchery operations-related effects at the regional level, hatchery facility operation costs within the four Columbia River Basin economic regions were developed. The operating costs, including smolt production costs, BMP costs and new weir construction costs, were assigned to the appropriate regions based on the location of hatchery facilities within each region. (As stated above for the calculation of smolt production costs, the excel spreadsheet used to calculate costs by region is available upon request.)

The number of jobs directly supported by hatchery operations under each alternative was estimated by applying a factor of 8 jobs per million dollars of costs to the estimates of regional hatchery costs. This factor was derived based on a review of budget/jobs relationships from budget information on salmon and steelhead hatcheries operated by WDFW, ODFW, and the Yakama Nation. The total number of jobs (direct, indirect, and induced) generated in each region as a result of direct hatchery employment was estimated using a multiplier of 1.5, which was based on an employment multiplier for Washington State generated by the IMPLAN input-output model (Minnesota IMPLAN Group 2008) for the industrial sector that includes fish hatcheries (Animal Production except for Cattle, Poultry, and Eggs).

Employment generated by hatchery-related procurement expenditures was estimated by assuming that 40 percent of hatchery production costs under each alternative are attributable to procurement expenditures, and that half of procurement expenditures are made locally (i.e., within regional economies). These assumptions were developed based on the professional judgment of TCW Economics' personnel following a review of available hatchery budget information. Jobs directly generated by procurement expenditures in each region were estimated using a factor of 10 jobs per million dollars of procurement expenditures. This factor was derived based on employment coefficients (jobs per million dollars of output) for wholesale and retail trade sectors produced by the IMPLAN model for Washington State. The total number of jobs (direct, indirect, and induced) generated in each region by procurement spending was estimated using a multiplier of 1.7, which was derived based on IMPLAN employment multipliers for retail trade sectors.

Personal income attributable to direct, indirect and induced jobs was estimated based on an estimated factor of $50,000 per job. This personal income factor was developed based on two sources. For direct hatchery jobs, a review of salary and benefits data for hatchery jobs provided by hatchery budgets suggested that average employee compensation, including benefits, per direct hatchery job was about $50,000. For procurement-related jobs and indirect and induced jobs generated by both direct hatchery employment and procurement spending, the IMPLAN model 2007 database for Washington State suggested average personal income, including employee compensation and proprietor income, of about $50,000 per job across all jobs in the state. This factor was applied to estimated jobs to produce estimates of total personal income in each region for each alternative.

References

Blair, Greg. Mobrand Jones & Stokes. Vashon, WA. June 12, 2009. Personal communication with Dan Warren, D.J. Warren and Associates, regarding weir and BMP costs. E-MAIL

Boyle, K., R. Bishop, J. Caudill, J. Charbonneau, D. Larson, M. Markowski, R. Unsworth and R. Paterson. A database of sport fishing values. Prepared for Economics Division, U.S. Fish and Wildlife Service. Cambridge, MA: Industrial Economics, Inc. 1998. http://www.indecon.com/fish/Sprtfish.pdf

Lestelle, Larry and Gary Morishima. 2009. Chinook and coho salmon fishery modeling approach for application to the Mitchell Act EIS. Submitted to ICF Jones & Stokes. July 2009.

Minnesota IMPLAN Group, Inc. 2008. IMPLAN Professional model software (version 2.0.1025) and 2007 IMPLAN data file for Washington. Stillwater, MN.

Mobrand, Lars. Mobrand Jones & Stokes. Vashon, WA. June 22, 2009. Personal communication with Thomas Wegge, TCW Economics, regarding Mitchell Act smolt production by hatchery and alternative. E-MAIL with attachment (Excel file)

Purcell, Allyson. National Marine Fisheries Service. Portland, OR. June 22, 2009. Personal communication with Thomas Wegge, TCW Economics - excel file attachments, with data on hatchery budgets for agencies and tribal entities operating salmon and steelhead hatcheries in the Columbia River Basin. E-MAIL with attachment (Excel file)

The Research Group. 2009. Preliminary 2.1 economic and social analysis sections prepared for the Mitchell Act EIS. Prepared for NOAA Fisheries, Northwest Regional Office Salmon Recovery Division. Corvallis, OR.

Table A-1. Average pounds per fish (commercial)

	Tribal				Non-Tribal Commercial	
REGION	Coho	Chinook	Steelhead	Sockeye	Coho	Chinook
COLUMBIA RIVER BASIN						
Lower Snake River	7.5	18.4	18.4	na	7.5	18.4
Upper Columbia River	7.5	18.4	18.4	na	7.5	18.4
Mid Columbia River	7.5	18.4	18.4	7.5	7.5	18.4
Lower Columbia River	7.5	18.4	18.4	na	7.5	18.4
OCEAN AND PUGET SOUND REGION						
Oregon Coast						
Astoria (Clatsop)	7.7	11.9	na	na	7.7	11.9
Tillamook (Tillamook)	7.7	11.9	na	na	7.7	11.9
Newport (Lincoln)	7.7	11.9	na	na	7.7	11.9
Coos Bay (Coos)	7.7	11.9	na	na	7.7	11.9
Brookings (Curry	7.7	11.9	na	na	7.7	11.9
California Coast						
Crescent City (Del Norte)	na	na	na	na	na	na
Eureka (Humboldt)	na	na	na	na	na	na
Fort Bragg (Mendocino)	na	na	na	na	na	na
San Francisco (San Francisco)	na	na	na	na	na	na
Monterey (Monterey)	na	na	na	na	na	na
Washington Coast						
Neah Bay (Clallam)	6.5	10.1	na	na	7.1	13.1
LaPush (Jefferson)	6.5	10.1	na	na	7.1	13.1
Westport (Grays Harbor)	6.5	10.1	na	na	7.1	13.1
Ilwaco (Pacific)	6.5	10.1	na	na	7.1	13.1
Puget Sound/SJDF	6.4	10.8	na	na	6.4	10.8
British Columbia	5.5	17.7	7.0	na	5.5	17.7
Southeast Alaska	6.5	17.5	7.0	na	6.5	17.5

Notes:
na = not applicable
Sources:
Commercial weights (round weight) for SEA, BC, and Columbia River Basin regions: The Research Group Mitchell Act DEIS Appendix Table B.2
Puget Sound commercial Chinook and coho weight (dressed weight): WDFW (Excel File="PS Salmon_average weight per fish.xlsx")
Commercial Chinook and coho weights (dressed weight) for Washington and Oregon coastal regions: 2008 SAFE Report, Tables D-2 and D-3, 2004-2008 (in Excel file: "Master App D")

Table A-2. Ex-vessel price per pound (2007 dollars)

	Tribal				Non-Tribal Commercial	
REGION	Coho	Chinook	Steelhead	Sockeye	Coho	Chinook
COLUMBIA RIVER BASIN						
Lower Snake River	$0.83	$3.61	$0.65	na	$1.63	$4.97
Upper Columbia River	$0.83	$3.61	$0.65	na	$1.63	$4.97
Mid Columbia River	$0.83	$3.61	$0.65	$0.83	$1.63	$4.97
Lower Columbia River	$0.83	$3.61	$0.65	na	$1.63	$4.97
OCEAN AND PUGET SOUND REGION						
Oregon Coast						
Astoria (Clatsop)	$1.66	$4.92	na	na	$1.66	$4.92
Tillamook (Tillamook)	$1.66	$4.92	na	na	$1.66	$4.92
Newport (Lincoln)	$1.66	$4.92	na	na	$1.66	$4.92
Coos Bay (Coos)	$1.66	$4.92	na	na	$1.66	$4.92
Brookings (Curry	$1.66	$4.92	na	na	$1.66	$4.92
California Coast						
Crescent City (Del Norte)	na	na	na	na	na	na
Eureka (Humboldt)	na	na	na	na	na	na
Fort Bragg (Mendocino)	na	na	na	na	na	na
San Francisco (San Francisco)	na	na	na	na	na	na
Monterey (Monterey)	na	na	na	na	na	na
Washington Coast						
Neah Bay (Clallam)	$1.40	$3.28	$1.77	na	$1.40	$3.28
LaPush (Jefferson)	$1.40	$3.28	$1.77	na	$1.40	$3.28
Westport (Grays Harbor)	$1.40	$3.28	$1.77	na	$1.40	$3.28
Ilwaco (Pacific)	$1.40	$3.28	$1.77	na	$1.40	$3.28
Puget Sound/SJDF						
British Columbia	$1.35	$3.22	$0.42	na	$1.35	$3.22
Southeast Alaska	$0.83	$2.68	na	na	$0.83	$2.68

Notes:
na = not applicable
Source:
The Research Group Mitchell Act DEIS Appendix Table B.2.

Table A-3. Net economic value (net income) factors for commercial fishing (value per fish)

REGION	Coho	Chinook	Steelhead	Sockeye
COLUMBIA RIVER BASIN				
Lower Snake River	$6.41	$21.83	$7.11	$6.41
Upper Columbia River	$6.41	$21.83	$7.11	$6.41
Mid Columbia River	$6.41	$21.83	$7.11	$6.41
Lower Columbia River	$6.41	$21.83	$7.11	$6.41
OCEAN AND PUGET SOUND REGION				
Oregon Coast	$7.20	$32.27	na	na
California Coast	na	na	na	na
Washington Coast	$3.85	$22.42	na	na
Puget Sound/SJDF	$6.46	$17.60	na	na
British Columbia	$2.69	$16.45	na	na
Southeast Alaska	$2.69	$16.45	na	na

Notes:

1. Columbia River Basin Chinook and coho are weighted averages, with weights derived from the relative share of fall and spring/summer chinook harvest and also the relative share of harvest in tribal and non-tribal commercial fisheries.
2. For sockeye, the coho NEV factor was used.
3. na = not applicable

Source:

The Research Group Mitchell Act DEIS Appendix Table B.2 (NEV per fish)

Table A-4. Average catch per recreational fishing trip, by species and region

REGION	Coho	Chinook	Steelhead
COLUMBIA RIVER BASIN			
Lower Snake River	0.31	0.31	0.31
Upper Columbia River	0.31	0.31	0.31
Mid Columbia River	0.31	0.31	0.31
Lower Columbia River	0.29	0.29	0.31
OCEAN AND PUGET SOUND REGION			
Oregon Coast			
Astoria (Clatsop)	0.70	0.70	na
Tillamook (Tillamook)	0.70	0.70	na
Newport (Lincoln)	0.70	0.70	na
Coos Bay (Coos)	0.70	0.70	na
Brookings (Curry	0.70	0.70	na
California Coast			
Crescent City (Del Norte)	1.41	na	na
Eureka (Humboldt)	1.41	na	na
Fort Bragg (Mendocino)	1.41	na	na
San Francisco (San Francisco)	1.41	na	na
Monterey (Monterey)	1.41	na	na
Washington Coast			
Neah Bay (Clallam)	1.14	1.14	na
LaPush (Jefferson)	1.14	1.14	na
Westport (Grays Harbor)	1.14	1.14	na
Ilwaco (Pacific)	1.14	1.14	na
Puget Sound/SJDF	1.14	1.14	na
British Columbia	1.14	1.14	na
Southeast Alaska	1.14	1.14	na

Notes:
na = not applicable
Sources:
Sport catch per trip for all regions other than California: The Research Group Mitchell Act DEIS Appendix Table B.2 (inverted days per fish)
Sport catch per trip for California: 2008 SAFE Report, Table IV-11 (2003-2008) (in Excel file: "Tables Ch IV")

Table A-5. Expenditures per sport trip (2007 dollars)

REGION	Coho	Chinook	Steelhead
COLUMBIA RIVER BASIN			
Lower Snake River	$78.42	$78.42	$78.42
Upper Columbia River	$78.42	$78.42	$78.42
Mid Columbia River	$78.42	$78.42	$78.42
Lower Columbia River	$78.42	$78.42	$78.42
OCEAN AND PUGET SOUND REGION			
Oregon Coast			
Astoria (Clatsop)	$78.42	$78.42	na
Tillamook (Tillamook)	$78.42	$78.42	na
Newport (Lincoln)	$78.42	$78.42	na
Coos Bay (Coos)	$78.42	$78.42	na
Brookings (Curry	$78.42	$78.42	na
California Coast			
Crescent City (Del Norte)	$108.13	na	na
Eureka (Humboldt)	$108.13	na	na
Fort Bragg (Mendocino)	$108.13	na	na
San Francisco (San Francisco)	$108.13	na	na
Monterey (Monterey)	$108.13	na	na
Washington Coast			
Neah Bay (Clallam)	$70.43	$70.43	na
LaPush (Jefferson)	$70.43	$70.43	na
Westport (Grays Harbor)	$70.43	$70.43	na
Ilwaco (Pacific)	$70.43	$70.43	na
Puget Sound/SJDF	$70.43	$70.43	na
British Columbia	$224.27	$224.27	na
Southeast Alaska	$224.27	$224.27	na

Notes:
na = not applicable
Source:
The Research Group Mitchell Act DEIS Appendix Table B.2 (Spending for California derived by adjusting Oregon factors based on the relative percentage difference in personal income factors for California and Oregon.)

Table A-6. Personal income factors, per pound of commercially landed salmon and per sport trip (2007 dollars)

	Tribal				Non-Tribal Commercial		Sport		
REGION	Coho	Chinook	Steelhead	Sockeye	Coho	Chinook	Coho	Chinook	Steelhead
COLUMBIA RIVER BASIN									
Lower Snake River	$4.86	$4.17	$3.91	na	$2.51	$3.11	$58.54	$58.54	$58.54
Upper Columbia River	$4.86	$4.17	$3.91	na	$2.51	$3.11	$58.54	$58.54	$58.54
Mid Columbia River	$4.86	$4.17	$3.91	$4.86	$2.51	$3.11	$58.54	$58.54	$58.54
Lower Columbia River	$4.86	$4.17	$3.91	na	$2.51	$3.11	$58.54	$58.54	$58.54
OCEAN AND PUGET SOUND REGION									
Oregon Coast									
Astoria (Clatsop)	$2.71	$7.68	na	na	$2.71	$7.68	$56.43	$56.43	na
Tillamook (Tillamook)	$2.79	$7.71	na	na	$2.79	$7.71	$40.26	$40.26	na
Newport (Lincoln)	$3.08	$7.55	na	na	$3.08	$7.55	$60.66	$60.66	na
Coos Bay (Coos)	$3.03	$7.53	na	na	$3.03	$7.53	$44.19	$44.19	na
Brookings (Curry	$3.05	$7.17	na	na	$3.05	$7.17	$37.02	$37.02	na
Regionwide Total	$3.04	$8.03	na	na	$3.04	$8.03	$58.65	$58.65	na
California Coast									
Crescent City (Del Norte)	na	na	na	na	na	na	$38.78	na	na
Eureka (Humboldt)	na	na	na	na	na	na	$43.83	na	na
Fort Bragg (Mendocino)	na	na	na	na	na	na	$64.91	na	na
San Francisco (San Francisco)	na	na	na	na	na	na	$91.92	na	na
Monterey (Monterey)	na	na	na	na	na	na	$65.96	na	na
Regionwide Total	na	na	na	na	na	na	$80.87	na	na
Washington Coast									
Neah Bay (Clallam)	$2.03	$5.48	na	na	$2.03	$5.48	$38.50	$38.50	na
LaPush (Jefferson)	$2.35	$6.83	na	na	$2.35	$6.83	$47.22	$47.22	na
Westport (Grays Harbor)	$2.03	$8.33	na	na	$2.03	$8.33	$120.67	$120.67	na
Ilwaco (Pacific)	$2.71	$7.90	na	na	$2.71	$7.90	$79.83	$79.83	na
Regionwide Total	$2.46	$6.92	na	na	$2.46	$6.92	$84.79	$84.79	na
Puget Sound/SJDF	$2.36	$7.69	na	na	$2.36	$7.69	$86.85	$86.85	na
British Columbia	$1.84	$3.57	$1.51	na	$1.84	$3.57	$297.13	$297.13	na
Southeast Alaska	$2.24	$2.75	na	na	$2.24	$2.75	$297.13	$297.13	na

Notes:
na = not applicable
Source:
The Research Group Mitchell Act DEIS Appendix Table B.2.

Table A-7 Earnings per Job (2007 dollars)

REGION	
COLUMBIA RIVER BASIN	
Lower Snake River	$25,382
Upper Columbia River	$29,196
Mid Columbia River	$32,402
Lower Columbia River	$38,200
OCEAN AND PUGET SOUND REGION	
Oregon Coast	
Astoria (Clatsop)	$33,815
Tillamook (Tillamook)	$31,219
Newport (Lincoln)	$30,913
Coos Bay (Coos)	$32,411
Brookings (Curry	$27,138
Regionwide Total	$31,649
California Coast	
Crescent City (Del Norte)	$36,964
Eureka (Humboldt)	$34,288
Fort Bragg (Mendocino)	$32,867
San Francisco (San Francisco)	$82,847
Monterey (Monterey)	$50,658
Regionwide Total	$69,978
Washington Coast	
Neah Bay (Clallam)	$33,019
LaPush (Jefferson)	$29,328
Westport (Grays Harbor)	$36,072
Ilwaco (Pacific)	$29,101
Regionwide Total	$33,101
Puget Sound/SJDF	$55,923
British Columbia	$55,923
Southeast Alaska	$55,923

Notes:
For Southeast Alaska and British Columbia, earnings-per-job for Puget Sound are used.
Sources:
Bureau of Economic Analysis. April 2009. Table CA05N Personal Income by Major Source and Earnings by NAICS Industry;Table CA25N Total Full-Time and Part-Time Employment by NAICS Industry.

Table A-8. Production Unit Costs (Facility Specific and Average) per Smolt for Agency Release Strategy at Mitchell Act Hatchery Facilities, by Operating Entity

Agency	Species	Hatchery	Release Strategy /2	Pounds	Operations Costs /1	Headquarters /3	Capital Costs /4
ODFW	Coho	Big Creek	535,000	44,583	0.635	0.178	0.040
ODFW	Coho	Bonneville complex	4,810,000	289,274	0.336	0.094	0.040
ODFW	Coho	Sandy	1,000,000	66,667	0.514	0.144	0.040
	COHO (average)				0.495	0.138	0.040
ODFW	Fall Ch.	Big Creek	5,700,000	71,250	0.095	0.027	0.040
ODFW	Spr. Ch.	Clackamas	361,120	36,830	0.651	0.182	0.040
ODFW	Sum. St.	Bonneville complex	215,000	43,000	1.592	0.446	0.040
ODFW	Wint. St.	Big Creek	140,000	17,619	0.969	0.271	0.040
ODFW	Wint. St.	Bonneville complex	260,000	43,333	1.328	0.372	0.040
	WINTER STEELHEAD (average)				1.148	0.321	0.040
USFWS	Coho	Eagle Creek	2,250,000	90,722	0.348	0.093	0.040
USFWS	Coho	LWS/Willard	650,000	32,500	0.896	0.239	0.040
	COHO (average)				0.622	0.166	0.040
USFWS	Fall Ch.	LWS/Willard	8,200,000	27,079	0.061	0.016	0.040
USFWS	Fall Ch.	Spring Creek	6,493,000	80,151	0.174	0.047	0.040
	FALL CHINOOK (average)				0.118	0.031	0.040
USFWS	Spr. Ch.	Carson	1,420,000	88,750	0.698	0.187	0.040
USFWS	Spr. Ch.	LWS/Willard	1,000,000	66,667	0.682	0.182	0.040
	SPRING CHINOOK (average)				0.690	0.184	0.040
USFWS	Wint. St.	Eagle Creek	100,000	20,000	1.841	0.492	0.040
WDFW	Coho	Elochoman complex	915,000	53,824	0.336	0.090	0.040
WDFW	Coho	Fallert Creek	350,000	20,588	0.309	0.083	0.040
WDFW	Coho	Kalama Falls complex	350,000	20,588	0.309	0.083	0.040
WDFW	Coho	North Fork Toutle	800,000	53,333	0.430	0.115	0.040
WDFW	Coho	Washougal	3,150,000	163,235	0.232	0.062	0.040
	COHO (average)				0.323	0.086	0.040
WDFW	Fall Ch.	Elochoman complex	2,000,000	28,571	0.110	0.029	0.040
WDFW	Fall Ch.	Fallert Creek	2,500,000	35,714	0.104	0.028	0.040
WDFW	Fall Ch.	Kalama Falls complex	2,500,000	35,714	0.104	0.028	0.040
WDFW	Fall Ch.	North Fork Toutle	2,500,000	35,714	0.122	0.033	0.040
WDFW	Fall Ch.	Ringold Springs	3,450,000	57,500	0.092	0.025	0.040
WDFW	Fall Ch.	Washougal	4,000,000	61,538	0.089	0.024	0.040
	FALL CHINOOK (average)				0.104	0.028	0.040
WDFW	Spr. Ch.	Fallert Creek	125,000	12,500	0.499	0.133	0.040
WDFW	Spr. Ch.	Kalama Falls complex	375,000	37,500	0.499	0.133	0.040
	SPRING CHINOOK (average)				0.499	0.133	0.040
WDFW	Sum. St.	Elochoman complex	30,000	6,000	1.044	0.279	0.040
WDFW	Sum. St.	Fallert Creek	30,000	5,455	2.354	0.629	0.040
WDFW	Sum. St.	Kalama Falls complex	60,000	10,909	2.354	0.629	0.040
WDFW	Sum. St.	North Fork Toutle	25,000	4,545	1.099	0.293	0.040
WDFW	Sum. St.	Ringold Springs	180,000	36,000	0.680	0.182	0.040
WDFW	Sum. St.	Skamania complex	254,000	50,800	1.170	0.312	0.040
	SUMMER STEELHEAD (average)				1.450	0.387	0.040
WDFW	Wint. St.	Elochoman complex	105,000	20,818	1.035	0.277	0.040
WDFW	Wint. St.	Kalama Falls complex	100,000	16,370	2.123	0.567	0.040
WDFW	Wint. St.	Skamania complex	190,000	38,000	1.170	0.312	0.040
	WINTER STEELHEAD (average)				1.443	0.385	0.040
Yakama	Coho	Klickitat	1,000,000	66,667	0.134	0.016	0.040
Yakama	Coho	Yakama Nation ACC	500,000	25,000	0.209	0.025	0.040
	COHO (average)				0.171	0.020	0.040
Yakama	Fall Ch.	Klickitat	4,000,000	53,333	0.044	0.005	0.040
Yakama	Fall Ch.	Prosser	1,700,000	28,333	0.036	0.004	0.040
	FALL CHINOOK (average)				0.040	0.005	0.040
Yakama	Spr. Ch.	Klickitat	600,000	40,000	0.261	0.031	0.040
TOTAL SMOLT PRODUCTION			64,923,120	2,036,977			

Table A-8 (con't). Smolt Production Unit Costs (Facility Specific and Average) per Smolt for Agency Release Strategy at Mitchell Act Hatchery Facilities, by Operating Entity

COMPUTED VALUES FOR OTHER OPERATING ENTITIES								
Agency	**Species**	**Hatchery**	**Release Strategy /2**	**Pounds**	**Operations Costs /1**	**Headquarters /3**	**Capital Costs /4**	**External Costs/5**
IDFG, CTUIR (Spring Chinook)								
ODFW					0.651	0.182	0.040	
USFWS					0.690	0.184	0.040	
WDFW					0.499	0.133	0.040	
YAKAMA					0.261	0.031	0.040	
AVERAGE					0.525	0.133	0.040	
IDFG (Summer Steelhead)								
ODFW					1.592	0.446	0.040	
WDFW					1.450	0.387	0.040	
AVERAGE					1.521	0.416	0.040	
ALL CHUM (from WDFW cost sheets for Washougal Hat. provided by Andy Appleb					0.055	0.002	0.040	
(Notes: Operations costs include rearing, marking, and administrative costs; capital costs estimated based on ratio [1.03] of capital costs to operating costs for coho at Washougal)								
ALL SOCKEYE (from ODFW cost sheets for Redfish Lake Hat. provided by Allyson					1.425	0.008	0.040	
(Note: Operations costs include program costs minus headquarter costs; capital costs estimated based on ratio [0.65] of capital costs to operating costs for average ODFW coho costs.								

Notes: 1. Operation costs include fish production, maintenance, marking, onsite monitoring and evaluation, and other costs for hatchery operations in a particular budget year. Fish production costs include labor, feed, materials and services, fish health, fish feed quality control program, annual maintenance, transportation, and administration costs not covered by agency indirect. The particular year may have different production than used in the evaluation of MA EIS alternatives, but the costs per smolt are assumed to apply to the MA EIS alternatives' production.

2. Smolt releases and operation costs per pound are from data generated for Erik White, NOAA Fisheries in May 2008; and by the two states, USFWS, and the Yakama Nation. Chum, cutthroat, and sockeye costs for the MA hatcheries are not shown because they are not used to compare MA EIS alternatives.

3. Hatchery production indirect cost charged by states' central management (i.e. Olympia and Salem headquarters' costs) is 26.7% for WDFW, 28.0% for ODFW, 26.7% for USFWS, and 11.8% for the Yakama Nation.

4. Capital costs are estimated based on research by Carter on the average annualized capital cost for facility replacement at Oregon state-funded hatcheries.

5. Smolts described as external are those reared or partially reared at one or more MA funded hatcheries and transported and released at a non-MA hatchery. There may be other situations where smolts are transported to other hatcheries for final grow-out or to other remote sites for liberation, but costs are included in MA funded operations. When transfers are eggs or parts, external costs include rearing. The per smolt release weight when fish are exported to a non-MA hatchery is assumed to be similar to the on-station weight of releases at the origin hatchery. External acclimation costs use estimates from the SAFE Program for Youngs Bay and Deep River as applicable to other external situations.

Source of Facility Cost Data and Notes: The Research Group. 2009. Mitchell Act Hatchery EIS. Preliminary 2.1, Economic and Social Analysis Sections. January 2009.

Appendix K

Chinook and Coho Salmon Fishery Modeling Approach for Application to the Mitchell Act EIS

July 2009

Submitted to

ICF Jones & Stokes
Vashon Island, WA

Prepared by

Larry Lestelle[1]
Gary Morishima[2]

1/ Biostream Environmental
17791 Fjord Drive NE STE AA
Poulsbo, WA 98370

2/ MORI-ko, L.L.C.
P.O. Box 1563
Mercer Island, WA 98040

Table of Contents

List of Figures

List of Tables

Chinook and Coho Salmon Fishery Modeling Approach for Application to the Mitchell Act EIS

1.0 Introduction

Chinook and coho salmon produced by Mitchell Act hatcheries are harvested by fisheries in the Columbia River and in ocean areas over a geographic area extending from California to Alaska. This document describes the modeling approach used to assess fishery impacts of hatchery production alternatives in the Mitchell Act Environmental Impact Statement (EIS). One aspect of the EIS is to evaluate how possible changes to the Mitchell Act hatchery program would affect fisheries within the Columbia River system and in coastal waters.

Changes in production levels or other production characteristics in Mitchell Act hatcheries are being considered as part of the Columbia River Hatchery Reform process or in response to funding changes. The modeling approach described herein was used to evaluate how the range of alternatives being analyzed within the Mitchell Act EIS would be expected to impact fishery harvests. Model output consisting of summarized projections of catches for commercial, recreational, and tribal fishery sectors of relevance to the EIS were provided to other members of the project team for analysis and incorporation into the EIS.

Relatively simple, steady-state models were employed to project marine fishery catch levels and run sizes to the mouth of the Columbia River for chinook and coho. These models were based on more complex models used to support annual fishery planning processes of the Pacific Fisheries Management Council (PFMC) and Pacific Salmon Commission (PSC). Steady state models were developed in part to simplify evaluation and comparison of EIS alternatives, and in part due to the budget and time limitations to complete the analysis.

Impacts of EIS alternatives on both marine and Columbia River fisheries were modeled within the context of exploitation rate constraints established to protect comingled naturally-produced stocks listed under the Endangered Species Act (ESA) under guidance given by NOAA Fisheries in recent years (NMFS 2005, PFMC 2006, and ODFW/WDFW 2006a and 2006b). These ESA exploitation rate limits have remained generally consistent since 2005.

This document is organized into four sections:

1. Introduction;
2. General approach;
3. EIS Chinook Model; and
4. EIS Coho Model.

2.0 General Approach

For some purposes, it may be desirable to attempt to produce projections of catches under the proposed EIS alternatives in a manner suitable for direct comparison with catches observed during some selected period in order to facilitate interpretation. However, it must be recognized that observed fishery catches are an outcome of the cumulative effects of a multitude of choices made in response to the status of the particular set of stocks, biological requirements for conservation, and agency and individual decisions. Managers choose when, where, and how to provide opportunity to harvest fish. Individuals decide to avail themselves of those opportunities according to their own interests and priorities, relying upon personal assessments of the costs and benefits that suit their needs.

Any multi-year historical period would reflect the outcomes of several years of these types of decisions in response to annual variability in stock-age cohort abundances. The EIS analysis involves "what if" scenarios under production alternatives described in the EIS. No historical time period would be expected to result in the same relative abundances of all stocks under each EIS alternative. Nor is there any reason to expect that any set of historical regulations or fishing pattern observed as a response to a particular stock-abundance mix, conservation requirements, and management objectives would be well suited to simulate the expected response of managers and fishermen to different conditions envisioned under the variety of EIS production alternatives.

Both the U.S. and Canada adopted a substantial variety of regulations designed to respond to domestic conservation concerns for chinook and coho stocks over time. For chinook, fishing patterns developed in response to forecasts of stock-age specific abundance and estimates of projected impacts on individual populations, many of which originate from outside the Columbia River. For example, fisheries in Puget Sound must comply with requirements of 4(d) rules and annual guidance provided during the PFMC planning process. These requirements established exploitation rate constraints on impacts on individual chinook stocks originating in Puget Sound; since concerns for individual stocks can vary from year to year due to the relative abundance in contributing cohorts, fishing patterns and catches can vary substantially from year to year. Chinook fisheries off the West Coast of Vancouver are another example. During the early 2000s, actual regulations of Canadian fisheries under PST regimes included changes in size limits, time-area closures to reduce impacts on Interior Fraser coho and WCVI, early run Fraser, and Strait of Georgia chinook stocks, and reductions in harvests below levels allowed under the PST Agreement to obtain information on stock presence/absence to help address domestic conservation concerns. In Puget Sound and Washington coastal areas, fisheries operated under annually negotiated plans, taking into account expectations for terminal abundance of hatchery and natural stocks of chinook, coho, pink, sockeye, chum, steelhead, and sturgeon.

For coho, due to Canadian conservation concerns for the status of the Interior Fraser Management Unit, cumulative annual exploitation rates imparted by all Canadian fisheries on this unit have been capped at 3% (substantially below the maximum allowable impact allowable under recent PST Agreements). A variety of measures have been implemented since the mid-1990s, including elimination of coho-directed commercial fishing, non-retention restrictions for unmarked coho encountered in commercial fisheries, mark-selective fisheries (MSF) in recreational fishing with a variety of time-area restrictions on bag limits.

Each year in the area south of the Canadian-Washington border, annual abundances of individual stocks, conservation requirements, and societal fishery management objectives are considered within an intensive three-month planning process that concludes in April. During this period, complex negotiations are employed to constrain impacts on critical stocks in ocean fisheries regulated through the PFMC and by state and tribal managers for fisheries in inside waters. Each year, the combination of stocks, constraints, and management objectives results in different pre-season regulatory packages. Pre-season regulations are frequently revised in-season as fishery information becomes available.

It may be possible to produce an analysis of harvest impacts for the limited set of fisheries when catches are dominated by contributions from Columbia River stocks using abundance estimates associated with some historic time period. But, while catch levels for Columbia River and PFMC fisheries might be expected to be similar to observed levels during this time period, catch levels observed for other areas would be driven principally by the abundance of stocks originating outside the Columbia River and fishing patterns.

The selection of any particular historic period or set of regulations would be arbitrary. There is no assurance that the package of regulations would be selected or appropriate in response to changes in relative abundance of individual stock-age cohorts in specific fisheries or management objectives under any of the EIS alternative production scenarios. And, there would be no assurance that individual behavior in response to those regulations would mirror what was observed.

It is neither feasible nor practicable to attempt to produce an EIS harvest analysis that would generate catch projections that would be directly comparable to observed historical catch levels. Such an effort would involve an extremely complex modeling approach. There is an immense potential for a wide variety of stock conditions, fishing patterns, and regulations that could potentially occur in response to changes in production of Columbia River stocks under various EIS alternative scenarios. Justification would be required for myriad decisions that affect the distribution of harvest opportunity and assumptions regarding fisherman behavior. And, the results that would be produced would confound effects of fishing patterns and stock-age cohort abundance, greatly increasing the complexity of reporting and interpreting potential impacts of EIS alternatives.

A simple steady-state analysis was employed to provide information on how fishery impacts would be expected to change under EIS alternatives. Simulation models were developed separately for chinook and coho using Microsoft Excel software. The models incorporate three major elements:

(a) Variation in abundance only for Columbia River stocks under the EIS alternatives. The abundance of all stocks originating outside the Columbia River are fixed at levels associated with base periods used in fishery planning models employed by the PSC and PFMC;

(b) Exploitation rates, patterns, and regulations characterized by base period data for the PSC and PFMC planning models; and

(c) Prescriptive rules to govern conduct of fisheries. These prescriptive rules include: (1) Pacific Salmon Treaty agreements for chinook and coho in effect through 2008; (2) annual guidance for fishery management planning provided by the NMFS for ESA-listed chinook and coho stocks; (3) the Columbia River Interim Management Agreement in effect through 2007; (4) the PFMC Framework Management Plan; and (5) MSF for coho only in PFMC ocean and Columbia River in-river fisheries; MSF only for spring chinook fisheries in the Columbia River below Bonneville Dam.

Models based on this approach provide catch projections that can be readily employed to compare potential fishery impacts of EIS alternative production levels for stocks originating in the Columbia River.

The EIS harvest models were designed to be integrated with the All-H Analyzer Model (AHA). The AHA Model uses Beverton-Holt stock-production parameters to estimate population abundance levels at different life stages over the full life cycle for the species. The stock-production parameters are derived by integrating habitat, hydro, hatchery, and harvest effects on population performance (Mobrand-Jones & Stokes Associates 2005). AHA Model data sets have been created for virtually all Columbia River populations of chinook and coho, whether they are entirely natural, entirely hatchery (segregated), or an integrated composite of natural and hatchery fish.

In its original form, the AHA Model incorporates simple assumptions about overall harvest impacts, and includes that mortality into the derivation of the stock-production parameters. The model estimates the parameters for steady state conditions incorporating the effects of all of the H's.

The harvest models developed for the EIS replace the AHA assumptions. The EIS Models rely on the same datasets that are employed by the PFMC and PSC Models to characterize stock-specific fishery exploitation patterns. Compared to the PFMC and PSC Models, the representation of fishing processes is simpler in the ocean components of the EIS Models, while providing for more complex population structure for salmon produced in the Columbia River. Fishery exploitation patterns from the PFMC and PSC Models were assigned to natural and hatchery production components of chinook and coho from the Columbia River. This approach provided consistency with the PFMC and PSC Models necessary to incorporate abundance-based management regimes adopted by the Pacific Salmon Commission, evaluate impacts of Mitchell Act production changes within the context of ESA exploitation rate constraints on natural stocks, and estimate mortalities in the various fisheries of interest for the EIS analysis.

Elements of the PSC chinook and coho FRAM models were simplified and adapted for use in the EIS Models, as described under species-specific sections that follow. For both species, the abundances of populations produced outside the Columbia River were set to be equal to levels associated with base periods (1979-1982 and 1986-1991 for chinook and coho, respectively). Thus, the EIS Models isolate production changes for Columbia River populations associated with the five EIS alternatives for purposes of the fishery impact analysis.

The AHA and EIS harvest models were linked with output from each providing input to the other. Population-specific estimates of juvenile production served as the input to the harvest model, and harvest impacts output from the harvest model then became the final input needed to complete the life cycle in the AHA Model. Both models assumed steady state conditions, requiring that several iterations be modeled to achieve output approaching equilibriums. Three iterations through AHA were found to be sufficient for this purpose.

ICF Jones & Stokes (J&S) used the AHA Model to produce estimates of juvenile chinook and coho for all natural, hatchery segregated, and hatchery-natural integrated populations in the Columbia River basin under each of the five alternatives being evaluated. The estimates represented the number of juveniles arriving to the mainstem Columbia River downstream of Bonneville Dam for each EIS alternative. The combined total for all populations modeled represented the total number of juveniles for each species produced in the Columbia River basin to arrive to the head of the river's estuarine zone.[1]

Each of the EIS harvest models, one for chinook and one for coho, consists of two components: (1) an ocean fishery component employing an annual time step with associated exploitation rates; and (2) a gauntlet-type impact component for Columbia River fisheries that includes dam losses. The conceptual differences between how harvest impacts were modeled in the ocean and river are illustrated in Figures 1 and 2. Besides estimating total mortality (landed catch and incidental loss due to drop off and release mortality), exploitation rates, and landed catches for all fisheries of interest (freshwater and marine), the harvest models estimate the number of adult salmon escaping mainstem Columbia River fisheries to return to terminal areas. Terminal areas are defined as starting at the mouths of the various subbasins or the Columbia River upstream of McNary Dam. Terminal area harvest rates on hatchery fish were estimated using AHA so that final escapements achieved production targets or escapement goals.

The EIS models were formulated in Microsoft Excel with separate applications for each species. Each model is configured with rules as described herein. The models have not been structured for readily exploring changes to the rules—to perform that type of investigation would require revisions to the models. As currently structured, the models can be used to analyze variations in alternatives representing different production scenarios following the instructions given in the README sections of the model files.

The EIS Chinook Model consists of two separate files, one for the ocean component and another for the in-river component. Output from the ocean component is used as input for in-river component. The file names at the time of the preparation of this report are (1) CRHMchin_OcnModule - Apr6_09.xls and (2) CRHMchin_CRModule - Apr6_09.xls. The model does not require any macros to be run—all inputs entered into the model by copying ranges from smolt input files generated by J&S. The README sections for each modeling component are provided in Appendix A.

The EIS Coho Model consists of one file, which is structured to assess catches in both the ocean and in-river fisheries. The file name for the model at the time of the preparation of this report CRHMcoho - Apr3_09.xls. The model does not require any macros to be run—all inputs are

[1] / The estuarine zone of the Columbia River begins a short distance downstream of Bonneville Dam.

entered by copying ranges from smolt input files generated by J&S. The README section of the model is provided in Appendix B.

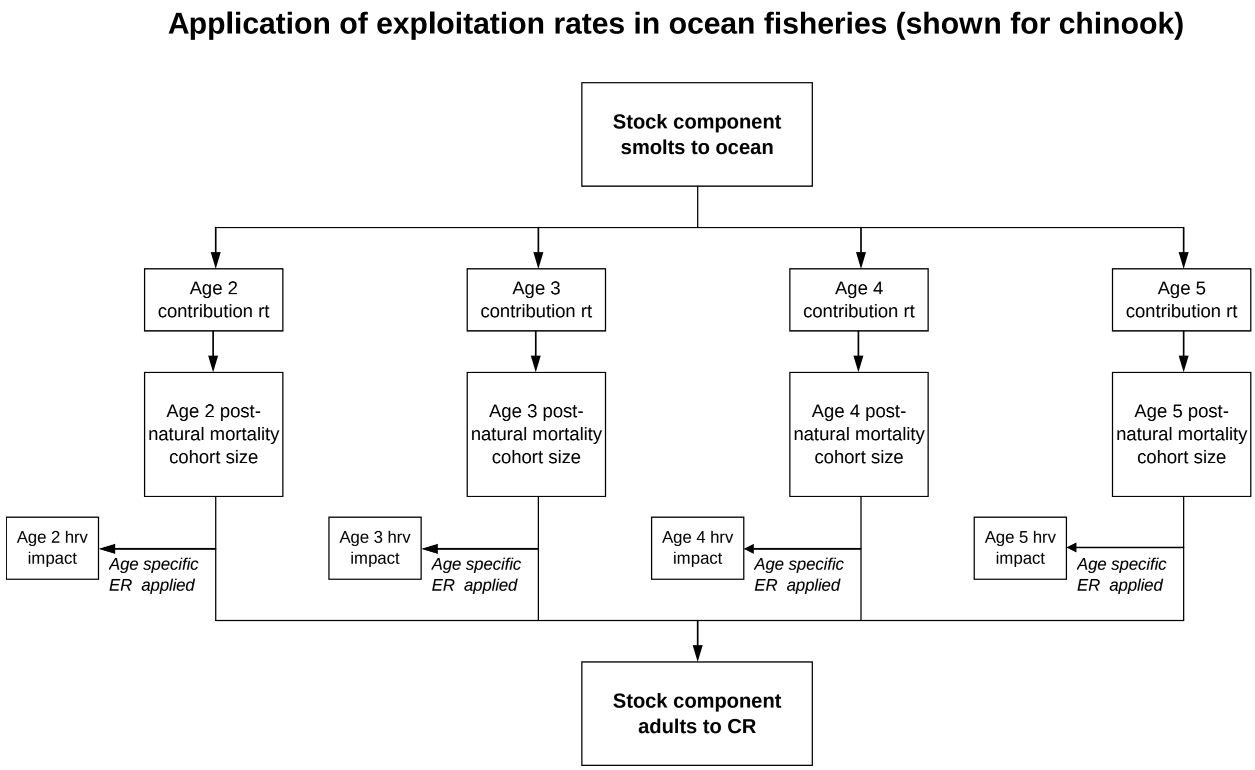


Figure 1. Application of exploitation rates (ERs) applied in an annual time step for simulating ocean fishery impacts in the EIS harvest models. Application for chinook is illustrated. Age specific contribution rates (rt) are used to estimate the post-natural mortality cohort sizes by age in the chinook model.

Application of gauntlet type impacts in Columbia River fisheries

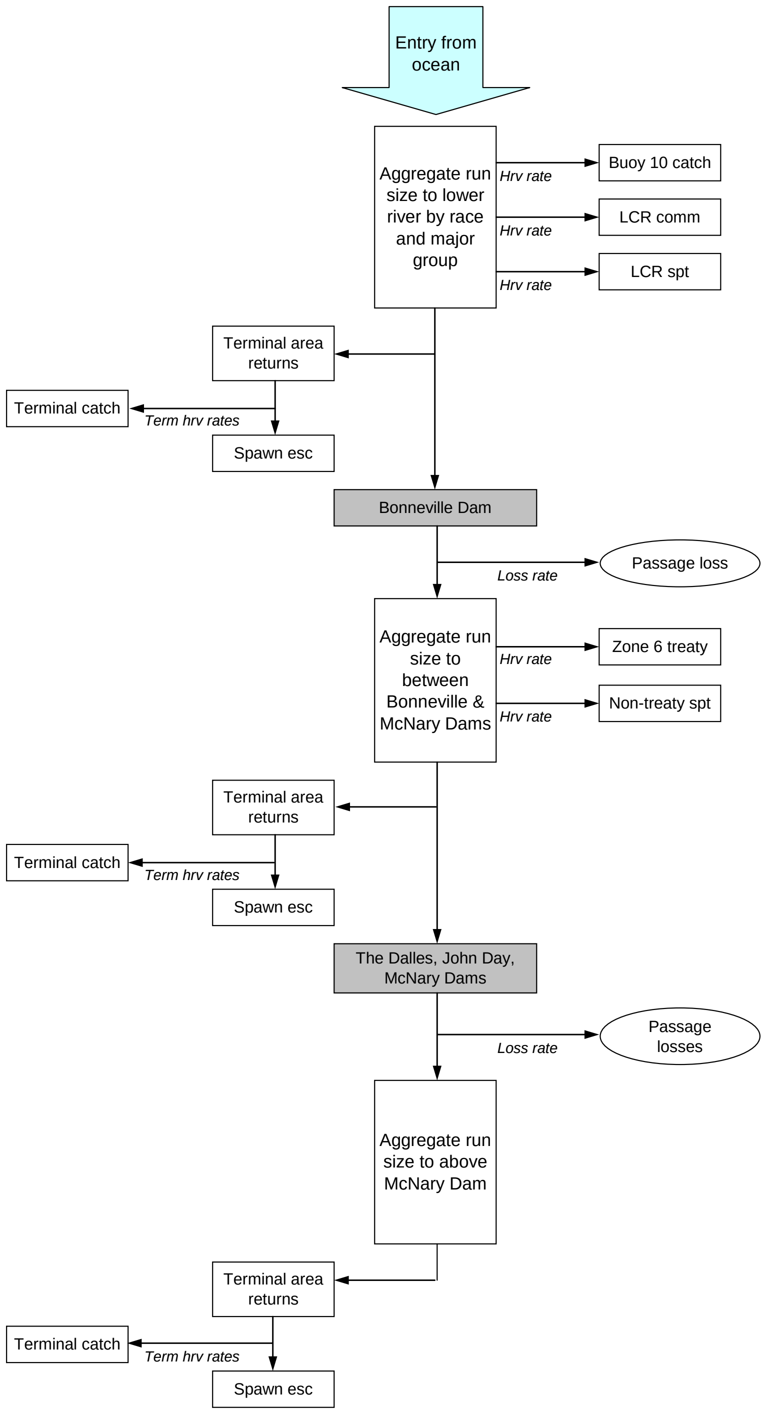


Figure 2. Application of gauntlet type impacts for simulating in-river catches and dam losses in the EIS harvest models.

3.0 EIS Chinook Model

This section describes the EIS Chinook Model. The model's formulation is presented, followed by a short summary of modeling results for the five EIS alternatives.

3.1 Model Formulation

Model formulation is described in three sections: overview, marine fisheries formulation, and Columbia River fisheries formulation. The overview describes the approach conceptually, the next two sections provide the primary mathematical formulations.

3.1.1 Overview

The EIS chinook harvest model relied heavily on the PSC Chinook Model. The PSC model provided the analytical basis for implementing abundance-based management under the 1999 PSC Chinook Agreement. A key feature of that model is the interaction between the annual abundance of all stocks that contribute to fisheries north of the Washington-British Columbia border and annual catch ceilings. Consequently, allowable harvest rates in marine fisheries that impact Columbia River chinook are affected by the relative changes in the abundance of contributing stocks. Since the population sizes for stocks originating outside the Columbia River were fixed in the EIS analysis, this feature provided the means to change ocean fishery impacts in response to the different population abundance levels of Columbia River populations by EIS alternative.

The PSC Chinook Model focuses primarily on ocean troll and sport fisheries between Cape Falcon off northern Oregon and Southeast Alaska at a scale suitable for the EIS analysis. Columbia River chinook populations migrate predominantly northward from the Columbia River (Snake River fall chinook are also encountered to some degree southward to central California). Ocean fisheries south of Cape Falcon were not modeled as part of this analysis. Fisheries south of Cape Falcon are managed to protect ESA-listed Sacramento River winter and California coastal chinook and to achieve fall chinook spawning escapement goals for the Klamath, Sacramento, and Oregon coastal rivers (PFMC 2004, 2005, 2007). Since the abundance of those stocks was fixed in this analysis, and since the migration pattern of Columbia River chinook is predominantly northward, the potential impact of EIS alternatives on chinook fisheries south of Cape Falcon would be negligible.

Elements of the PSC Chinook Model were simplified and adjusted to accommodate the steady state assumptions applied here. The PSC Model evaluates stock and fishery impacts over a multi-year period using an annual time step. Initial stock-age abundances are specified through input data and annual stock-age abundances are determined through a calibration process that incorporates observed levels of fishery catches and escapements. The initial seed values for stock-age abundance do not represent expectations under steady state conditions. Therefore, a method to estimate initial stock-age abundances for each production unit was formulated, as described below.

The principal modeling steps are illustrated in Figure 3 (steps are identified in parentheses in flow chart boxes).

A. Juvenile population levels passing Bonneville Dam: The estimated number of juveniles by population to survive downstream passage at Bonneville Dam (or entering the mainstem downstream of Bonneville) provides the input to the harvest model. The AHA Model was used to produce juvenile estimates for each of 145 chinook populations defined for the analysis. The total across all populations is intended to represent the total chinook production from the Columbia River under each of the alternatives. The number of juveniles in each population are also identified as to production type, i.e., whether they are natural or hatchery produced. Appendix C lists the populations, together with number of juveniles (final iteration input) under each alternative, and other relevant population-specific information.

B. Estimation of estuarine survival: Estimates of estuarine survival are derived for each population and production type, then applied to the number of juveniles corresponding to each population and type arriving at the head of the Columbia River estuary. This step is done in conjunction with the following step because it requires that the populations also be classified by their representative PSC stock component. The PSC Chinook Model uses marine survival estimates that are applied to the number of juveniles departing the estuary. In combination, the estuarine and PSC ocean survivals (not including harvest mortality) comprise the total smolt to adult survival rate (SAR).

J&S formulated recent year averages of SAR for each of the populations being modeled. The information used in deriving the rates was obtained through the course of numerous Hatchery Scientific Review Group (HSRG) workshops held with biologists from each subbasin. The rates were intended to be approximations of recent year average survival of a cohort from the point of entering the estuary (i.e., arriving below Bonneville Dam) and back to the same point as mature fish in the absence of all fishing. We assumed that these rates were reasonable approximations and applied them in the EIS harvest model. The PSC Chinook Model uses stock-specific maturity rates and a global set of marine survival rates applied to the cohort as it enters the ocean (i.e., departs the river estuary).

The J&S SAR rates divided by the marine survival rates used in the PSC Chinook Model (by stock component) produce the estimates of estuarine survival by population and production type. The number of juveniles that depart the estuary is the Age 1 cohort size.

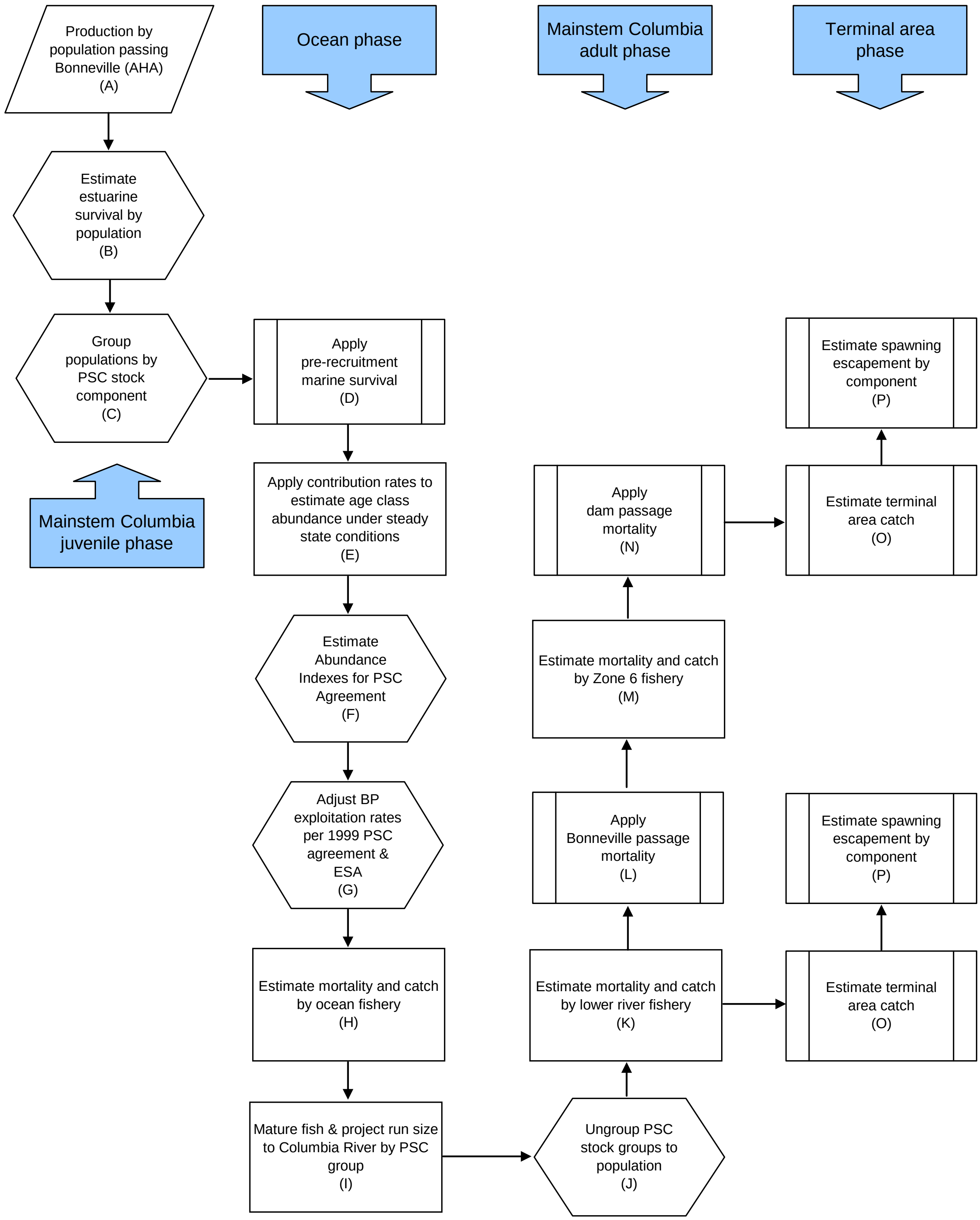


Figure 3. EIS Chinook Model flow chart.

C. Populations grouped by PSC stock component: This step assigns each Columbia River population (with exception as noted below) to a particular stock group or component represented in the PSC Chinook Model. These stocks have specific exploitation patterns during the base period, maturation rates, and relationships between initial specifications of stock size by age. A total of 30 stock groups are used in the PSC Chinook Model (Appendix D), of which 10 originate in the Columbia River. All Columbia River populations are assigned to one of these stock groups, with the exception of upriver spring chinook and Snake River summer chinook, which are assumed to behave like upriver springs. This group is assumed to have only negligible impacts by ocean fisheries due to a different ocean migration pattern that largely keeps it from being harvested in coastal waters. All modeling in the ocean from this point on uses the PSC stock components.

D. Application of pre-fishing marine survival: For each age, a fixed survival rate is applied to the cohort sizes producing the number of fish alive prior to fishing.

E. Application of contribution rates to estimate age class abundance: In the PSC model, initial abundance of stock-age complexes are specified through input data. The initial population sizes for the base period represent estimates of abundance in one year, that being 1979; since the fish in any given year come from several different broods with different initial abundances and survival rates, the PSC input data do not reflect steady state conditions.

In this step, contribution rates are estimated, then applied, presuming base period exploitation rates and steady state conditions. The contribution rates are applied to cohort sizes that exist at the beginning of the year following entry into the ocean. The rates estimate the initial number of fish in each stock group recruited to the beginning of fishing for each age class. Since all marine fisheries operate on a single pool of fish, only the pre-fishing recruitment size needs to be computed.

Under steady-state conditions, the initial abundance of each stock group could be determined by simply multiplying production component projections by these contribution rates. However, because the rates computed using base period data do not directly reflect steady state conditions, an adjustment is necessary. Therefore, the rates derived for the base period with PSC Model inputs were adjusted to mimic the relative age-specific abundances represented in the PSC Model input data. The resulting rates applied to cohort sizes give the number of pre-fishing recruits for each age class under steady state conditions.

F. Estimation of Abundance Indices under PSC Agreement: Under the 1999 PSC Chinook Agreement, the total allowable catches in certain highly mixed stock fisheries are regulated with aggregate abundance management regimes. Exploitation rates under these regimes are determined through the use of abundance indices. Abundance indices of relevance here are for Southeast Alaska (SEAK), Northern British Columbia (NBC), and the West Coast of Vancouver Island (WCVI).

The indices for these areas are affected by the abundance of populations produced in the Columbia River, in addition to the abundances of stocks produced in other regions. All non-Columbia River stock abundances were fixed at base period levels for purposes of our modeling.

This step estimates the index values for SEAK, NBC, and WCVI fisheries under each of the five EIS alternatives.

G. <u>Adjustment of base period exploitation rates per PSC Agreement and ESA requirements:</u> In this step, the base period exploitation rates for specific marine fisheries are adjusted as called for under the 1999 PSC Chinook Agreement and to meet ESA requirements for U.S. fisheries.

For Alaskan and Canadian fisheries of interest here (SEAK, NBC, WCVI), the abundance index is tied to a harvest impact index (HRI) to indicate the change in allowable fishery impact relative to the levels observed during the PSC Model base period (average of 1979-1982). The HRI acts as a scalar on exploitation rate (Figure 4). Some simplification was necessary for our model because the index in our case could only be compared to one year during that four year period. Nonetheless, the relative change in a single year's abundance index is informative as a means to indicate the potential magnitude of change anticipated under the EIS alternatives.

For PMFC fisheries north of Cape Falcon, a HRI was computed based on ESA jeopardy standards for the Snake River fall and Lower Columbia River (LCR) tule (i.e., Coweeman) fall chinook stocks. The maximum allowable HRI for each stock would be the smaller of the limit derived for each stock. For Snake River falls, the combined ocean fisheries are required to achieve a 30% reduction from the average 1988-93 exploitation rate for this population (NMFS 2005). Fisheries impacts have been lower than allowable limits in recent years. For LCR tules, the total exploitation rate for all fisheries combined is required to be below a 49% limit (NMFS 2005). Accounting for both of these limits, we determined that the LCR tule impact limit would be the more restrictive limit for our modeling.

The HRIs as described above were used to adjust the base period exploitation rates (base period exploitation rate * HRI).

H. <u>Estimation of ocean fishery mortality and catch:</u> Results from the previous step yield the total allowable exploitation rate by age for each stock in each fishery. These rates are for total impact, including drop-off and sub-legal release mortalities. Appendix E lists the complete set of fisheries modeled. Appendix F provides the incidental mortality rates applied for each fishery.

Landed catches were estimated by applying these impact rates and subtracting off incidental mortalities.

For PFMC fisheries, the combined total impact rate was allocated between the treaty and non-treaty troll and sport fisheries using the average division of catch over a five year period (2001-2005).Resulting catches for each of these three fishery groups was then considered to be allocated between ports (north of Cape Falcon) based on the average proportion of catch in each port between 2001-2005. Estimates of catch levels by fishery sector and port are needed for economic impact analysis for EIS alternatives.

I. <u>Projection of mature fish returning to Columbia River:</u> The numbers of fish in each age group and each stock component surviving ocean fisheries represents the run sizes returning to the Columbia River mouth under steady state conditions. The sum across age groups is the total run size for each PSC stock component.

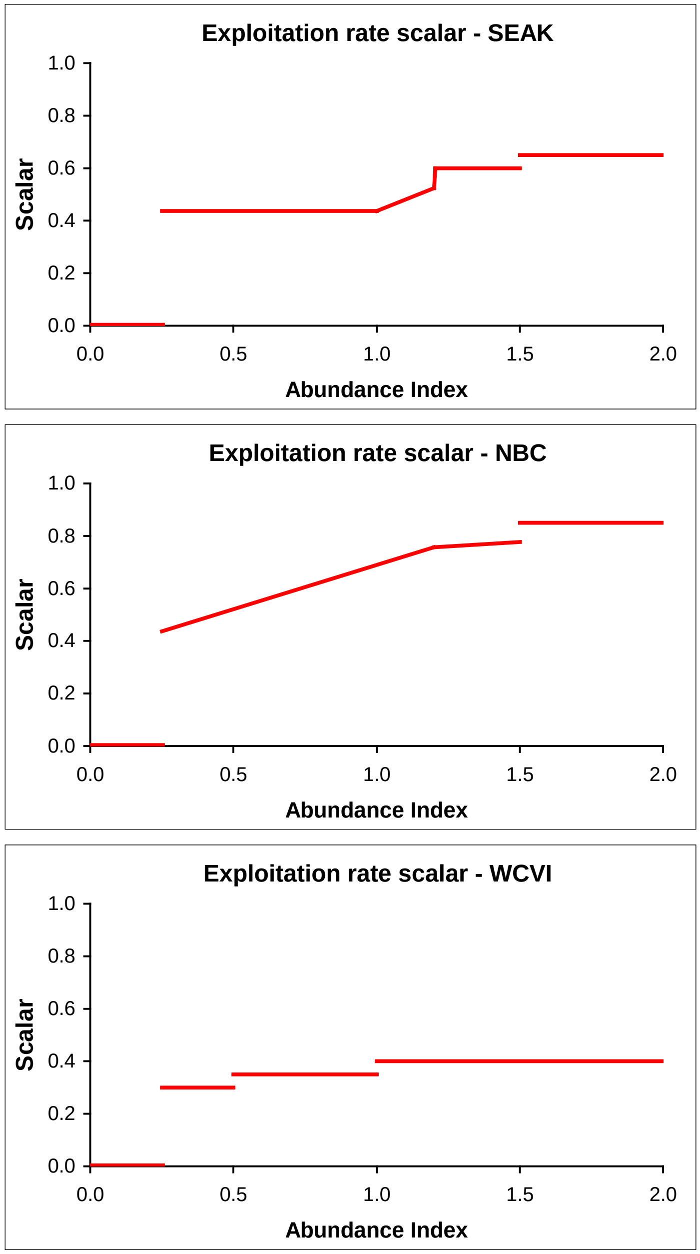


Figure 4. Harvest rate scalars in SEAK, NBC, WCVI fisheries.

J. <u>Ungroup PSC stock components into populations:</u> Ocean fishery impacts are evaluated using groups of individual populations as described in step (C). This step ungroups the PSC stock components into the 145 populations that comprise them. The relative abundance of populations within each group is assumed to be identical to the proportions that existed as juveniles departing the river.

Run sizes of those populations that were assumed to not be harvested in coastal waters, i.e., upriver spring chinook and Snake River summer chinook, were estimated by applying the SARs reported by J&S.

At this point in the modeling procedure, all populations are accounted for and run sizes back to the river mouth have been estimated. Steps that follow determine the impacts and catches made by the various in-river fisheries.

K. Estimation of lower mainstem river (below Bonneville Dam) fishery mortality and catch:
In-river fishery impacts were simulated as a sequential gauntlet of mortalities: lower river fisheries → Bonneville Dam passage → Zone 6 fisheries → upper river dam passage mortalities → terminal area tributary fisheries → escapement. Specific fisheries modeled were:

Downstream of Bonneville Dam	*Upstream of Bonneville Dam*
Buoy 10 sport	Zone 6 treaty Indian
Lower river commercial	Zone 6 sport
Lower river sport	

Terminal fisheries were defined as those in Select Area Fisheries Enhancement (SAFE) areas, all tributaries (including within the lower Willamette River), and the mainstem Columbia upstream of McNary Dam.

Fishery regimes were driven principally by the projected in-river run sizes of the production components that constrain harvest impacts in accordance with the provisions of the Columbia River Interim Management Agreement[2] (in effect through 2007) and ESA requirements for fall chinook. Additional details for modeling fisheries were based on information contained in the Joint Staffs reports for spring-summer (ODFW/WDFW 2006a) and fall fisheries (ODFW/WDFW 2006b), and through communications with agency biologists.

Spring and summer chinook fishery impacts in the mainstem Columbia River were modeled using sliding scales based on the abundances of upriver runs, as specified in the Interim Management Agreement. Modeling rules for these runs are detailed in Appendix G.

Spring chinook fisheries downstream of Bonneville Dam are MSFs, requiring the release of all non-adipose clipped fish. This requirement applies both to the lower river commercial and sport fisheries. A mortality rate of 10% was applied to the release of sport caught unmarked fish. The lower river commercial fishery uses both tanglenet and 8-9 inch mesh gillnet, having expected mortality rates on released fish of 18.5% and 40% respectively (Guy Norman, WDFW, *personal communications*). We applied an average rate of 25% due to a mixed composition of nets that are apparently used.

---

[2] / 2005-2007 Columbia River Interim Management Agreement for Upriver Chinook, Sockeye, Steelhead, Coho and White Sturgeon.

Harvest rates in these fisheries, while governed by the sliding scale on upriver spring chinook in Appendix G, were also applied to Willamette and other lower river spring chinook. However, those rates were increased slightly to account for differences in run timing (impact rates average 2-4%, Guy Norman, WDFW, *personal communications*). The Interim Management Agreement allocates the non-treaty impact to areas above and below Bonneville Dam as follows:

Downstream of Bonneville Dam	*Upstream of Bonneville Dam*
85%	15%

The allocation of the downriver impact between sport and commercial fisheries occurs as follows (Guy Norman, WDFW, *personal communications*):

Sport	*Commercial*
57%	43%

Upper Columbia River summer chinook (originating upstream of Priest Rapids) are managed in a manner to allocate most of the fishery impact to fisheries upstream of Priest Rapids. These populations are not listed by the ESA. For combined run sizes of upriver summer chinook returning to the Columbia less than 50,000 in size, non-treaty impacts were allocated as follows (based on Bartlett and Tweit 2006):

Below Priest Rapids	*Above Priest Rapids*
10%	90%

Larger run sizes provide a somewhat higher relative impact to non-treaty fisheries downstream of Priest Rapids.

It should be noted from Appendix G, listing the sliding scale that governs overall impacts, that harvest rates on summer chinook are very small (~5%) on run sizes of less than 29,000. Rates rise as run sizes increase, jumping significantly at runs larger than 50,000.

Allowable impacts in the mainstem Columbia River on fall chinook are determined by ESA requirements for Snake River wild falls and Lower River falls (Coweeman or LRH tule stock). Attention was primarily given to Snake River or Upriver Brights (URBs) in the Joint Staffs planning report for 2006, while it shifted to LRHs in their planning report for 2007. We applied the rates detailed for URBs as outlined in the Interim Management Agreement to simplify the modeling procedure. It turns out that the resulting rates on LRHs are very close to what they would have been had we modeled around that stock, and are in the lower end of the expected range reported by NMFS (2005) for LRHs.

The Interim Management Agreement called for a 30% reduction from base period harvest rates on Snake River wild falls in combined non-Indian and treaty Indian mainstem fisheries. The corresponding impact rate is 31.29% of the aggregate URB run. This impact rate is allocated as 23.04% to treaty Indian fisheries (Zone 6) and 8.25% for all non-Indian fisheries.

The allocation of the non-Indian impact on URBs, as specified in ODFW/WDFW (2007), was modeled as follows:[3]

Sport	*Commercial*
51%	49%

The allocated rate for sport fisheries was further divided between the Buoy 10, Lower River sport, and the sport fishery between Bonneville and McNary dams. The sport fishery upstream of McNary Dam is primarily located in the Hanford Reach, which does not impact Snake River falls. Therefore, impacts upstream of McNary Dam were not included in the 8.25% impact rate assigned to non-Indian fisheries. We allocated the impact assigned to sport fisheries to achieve the pattern seen in recent years, as shown below:

Buoy 10	*Lower River sport*	*Above Bonneville*
20%	76%	4%

The harvest rates that result from using these allocations were applied to all fall chinook populations passing through the lower river with the exception of Lower River Wild (LRW) populations. The largest component of LRW populations is North Fork Lewis River wild falls. LRW fall chinook are somewhat later timed than LRHs and observed mainstem harvest rates since 2002 have been higher than on LRH fish (NMFS 2005). For LRW populations, we applied the average observed harvest rate between 2002-2006 to the Lower River commercial fishery.

L. Application of Bonneville Dam passage survival: A 97% passage rate was applied to populations destined for subbasins upstream of Bonneville Dam after all mortalities associated with downstream fisheries were subtracted.

M. Estimation of Zone 6 fishery mortality and catch: Harvest impacts by treaty Indian fisheries on spring and summer chinook were modeled according to sliding scales based on population abundance as described in Step K. The impact rate on upriver fall chinook, as specified in the Interim Management Agreement, was modeled as 23.04%. These harvest impact rates were applied to the number of fish passing Bonneville Dam.

The allowable harvest rates by treaty Indians include commercial as well as ceremonial and subsistence (C&S) catches. The percentages of the catches used for C&S purposes, based on averaging data for 2002-2006, are as follows (from PFMC database):

Chinook race	*% C&S*
Spring	65.9%
Summer	64.3%
Fall	0.5%

Small non-Indian sport fisheries between Bonneville and McNary dams were assumed, as described in Joint Staff (2006a and 2006b). Allocations to these fisheries were described in Step K.

---

[3] / We applied the allocation shown although the Interim Agreement called for a 50:50 split.

N. Application of dam passage survivals: Fish surviving the Zone 6 fisheries in each population were then subjected to the fish passage rate specified by J&S as part of their data input to the harvest model. The rate accounted for all dams passed upstream of Bonneville Dam prior to arriving to terminal areas. Fish that pass dams associated with these rates are assumed to represent escapement to the subbasins (or to the mainstem upstream of McNary Dam).

O. Estimation of terminal area run sizes and terminal area catches: Terminal area catches for each population were estimated by applying the terminal areas harvest rates provided by J&S as part of their data input to the harvest model. These rates include MSFs on hatchery fish where appropriate.

P. Estimation of spawning escapements: Fish surviving terminal area fisheries were assumed to represent spawning escapements.

3.1.2 Marine Fisheries Formulation

The primary formulas for understanding the modeling procedure are presented.

The EIS Chinook Model utilizes the following types of input data: (1) stock-age-fishery specific exploitation rates; (2) stock-age specific maturation rates; (3) assumed age-specific survival rates; (4) fishery-age-specific release and drop off mortality rates; and (5) initial stock-age specific cohort sizes.

Notation used is defined below. For clarification, individual populations within the Columbia River are denoted by the *i* subscript. These combine into the PSC stock groups (or components) denoted by the subscript *c*.

AER_c	Allowable Exploitation Rate for component *c*
AI_f	Abundance Index for fishery f
$AR_{c,a}$	Adjusted Contribution rate for component *c* at age *a*
$BP_{c,a}$	Estimated average production level for component *c* age *a* during the PSC Model Base Period
$BPER_{c,f,a-1}$	Base Period Exploitation Rate as it would be applied to the entire cohort size in fishery *f* for component *c* age *a-1*. Note: the BPER described here differs from that used in the PSC Model. In that model, the BPER represents the proportion of the vulnerable cohort that was harvested during the base period, i.e., not the proportion harvested of the entire cohort size. The BPERs as applied here are simply the PSC Chinook Model BPERS multiplied by age-specific proportions vulnerable to exploitation.
$COH_{c,a}$	Cohort size of component *c* at age *a*
$CRRUN_{c,a}$	Run size back to the Columbia River of mature fish for component *c* and age *a*

$DO_{f,a-1}$	Drop Off mortality rate for fishery *f* age *a-1* fish
ESA_c	ESA jeopardy standard for component *c*
HRI_f	Harvest Rate Index for fishery *f*
$J_{i,k,c}$	Juvenile estuarine survival rate for population *i* of production type *k* (natural or hatchery) associated with PSC stock component *c*
$M_{i,k,c}$	Number of migrants reaching the ocean in population *i* of production type *k* (natural or hatchery) associated with PSC stock component *c*
$MR_{c,a-1}$	Maturation rate for component *c* at age *a*
$N_{c,a}$	Initial population size of component *c* age a fish input into the PSC Chinook Model during the base period
$p_{i,k,c}$	Juveniles for population *i* of production type *k* (natural or hatchery) associated with PSC stock component *c*
$R_{c,a}$	Contribution rate for component *c* at age *a*
$RM_{f,a-1}$	Release mortality rate for fishery *f* age *a-1* fish
$s_{c,a}$	Pre-fishery survival rate for component *c* age *a*
$SAR_{i,k,c}$	Smolt (number entering estuary) to adult (number arriving to head of estuary) survival rate for population *i* of production type *k* associated with component *c*
$SN_{c,a}$	Initial population size of age *a* fish estimated from production component *c*

The formulation is presented in the same steps used in the overview.

A. <u>Juvenile population levels passing Bonneville Dam:</u> The juvenile production level for each population *i* (p_i) by production type *k* (natural or hatchery) is the number to arrive to the lower Columbia River downstream of Bonneville Dam. This is the point considered the upstream end of the estuarine zone. Each Columbia River population is classified as belonging to one of 10 PSC model stocks.

B. <u>Estimation of estuarine survival:</u> Estimates of estuarine survival are derived for each population by production type (natural or hatchery) and applied to the number of juveniles arriving at the head of the Columbia River estuary to produce the number of migrants reaching the ocean by

$$M_{i,k,c} = p_{i,k,c} * J_{i,k,c} \qquad \text{(eq.1)}$$

Juvenile estuarine survival for each *i*, *k*, and *c* is derived by first estimating total marine survival (MS_c) of the Age 1 cohort (number departing the estuary) in the absence of fishing for each PSC stock component. This is the base period adult equivalent stock size (*BPAEQ*) divided by its Age 1 cohort size (COH_1) for each component *c* as follows:

$$MS_c = \frac{BPAEQ_c}{COH_{c,1}} \quad \text{(eq.2)}$$

Where *BPAEQ* is calculated as

$$BPAEQ_c = \sum_a (COH_{c,a} * s_{c,a} * MR_{c,a}) \quad \text{(eq.3)}$$

Then juvenile estuarine survival for each *i*, *k*, and *c* is simply

$$J_{i,k,c} = \frac{MS_c}{SAR_{i,k,c}} \quad \text{(eq.4)}$$

C. <u>Populations grouped by PSC stock component:</u> All populations except upriver springs and Snake River summers are grouped according to their representative PSC stock component *c*; the Age 1 cohort size for each stock component is then

$$COH_{c,1} = \sum_i \sum_k M_{i,k,c} \quad \text{(eq.5)}$$

E. <u>Application of contribution rates to estimate age class abundance:</u> Age specific contribution rates, presuming base period exploitation rates ($BPER_{c,f,a}$) and steady state conditions, are calculated as

$$R_{c,2} = s_{c,2} \quad \text{(eq.6)}$$

for age 2 and by the following for older ages

$$R_{c,a} = R_{c,a-1} * (1 - \sum_f BPER_{c,f,a-1}) * (1 - MR_{c,a-1}) * s_{c,a} \quad \text{(eq.7)}$$

Under steady-state conditions, the initial abundance of each stock group could be determined by simply multiplying production component projections by these contribution rates. However, because the rates computed using base period data do not directly reflect steady state conditions, an adjustment is necessary. Therefore, the rates derived for the base period with PSC Model inputs were adjusted to mimic the relative age-specific abundances represented in the PSC Model input data. The resulting rates applied to cohort sizes give the number of pre-fishing recruits for each age class under steady state conditions after accounting for pre-fishing natural mortality.

It should be noted that the version of equation 7 shown above is actually a simplification of what was used in the model. We derived the contribution rates that were applied by taking into account release mortality of sub-legals and drop-off mortalities, which requires several more steps than shown in equation 7. The derivation of contribution rates taking these incidental mortality rates into account is given in Appendix H.

The adjusted contribution rates ($AR_{c,a}$) are approximated by multiplying contribution rates by the ratios between the initial population sizes specified by the input data for the base period in the PSC Model:

$$AR_{c,a} = R_{c,2} * \frac{N_{c,a}}{N_{c,2}} \quad \text{(eq.8)}$$

Note that $N_{c,a}$ means the same thing as $COH_{c,a}$ but it refers to base period initial population sizes.

Since all ocean fisheries operate on a single pool, only the pre-fishing recruitment size needs to be computed. The initial population sizes resulting for each component are established by

$$SN_{c,a} = AR_{c,a} * COH_{c,1} \quad \text{(eq.9)}$$

F. Estimation of Abundance Indices under PSC Agreement: Abundance indices of relevance here are for Southeast Alaska (SEAK), Northern British Columbia (NBC), and the West Coast of Vancouver Island (WCVI). The abundance index is tied to an HRI to indicate the change in fishery impacts relative to the levels observed during the PSC Model base period. An analogue to the abundance index used in the PSC model can be generated using the following formula:

$$AI_f = \frac{\sum_{c,a} SN_{c,a} * BPER_{c,f,a}}{\sum_{c,a} BP_{c,a} * BPER_{c,f,a}} \quad \text{(eq.10)}$$

G. Adjustment of base period exploitation rates per PSC Agreement and ESA requirements: The base period exploitation rates for the SEAK, NBC, and WCVI troll and sport fisheries are adjusted with harvest rate scalars tied to the abundance indices described in the previous step. In the model, these scalars are taken from lookup tables, which are illustrated in Figure 2.

For PMFC fisheries north of Cape Falcon, a HRI was derived based on ESA jeopardy standards for the Snake River fall and Lower Columbia River (LCR) tule (i.e., Coweeman) fall chinook stocks, as described in the Overview section. Considering information for the limits on both populations, we calculated that the more restrictive limit was for LCR tules for our modeling.

The allowable exploitation rate is then computed as follows:

$$AER_c = ESA_c - \sum_{f \in SEAK,NBC,WCVI} BPER_{c,f} * HRI_f - \sum_{f \notin SEAK,NBC,WCVI,WA-OR} BPER_{c,f} \quad \text{(eq.11)}$$

H. Estimation of ocean fishery mortality and catch: In this step, the allowable exploitation rates (ER) have been determined for each Columbia River production component. Marine catches and total ocean exploitation rates can then be calculated from the following:

$$C_{c,f,a} = ER_{c,f,a} * SN_{c,a} \quad \text{(eq.12)}$$

$$TotER_{c,a} = \sum_{f} ER_{c,f,a} \quad \text{(eq.13)}$$

I. Projection of mature fish returning to the Columbia River: Run sizes back to the Columbia River were projected from the following:

$$CRRUN_{c,a} = SN_{c,a} * (1 - TotER_{c,a}) * MR_{c,a} \quad \text{(eq.14)}$$

3.1.3 Columbia River Fisheries

The calculation of harvest impact rates and catches in the Columbia River is a straightforward process following the description given in the Overview section.

3.2 Modeling Results

Rolled-up summary tables of modeling results for all stocks under each alternative are presented in Tables 1 (ocean) and 2 (mainstem Columbia River). In each table model results are presented in two sections. The top section contains “normalized” values, that is, proportional total catch values relative to those projected for NEPA Alt 1A. A value of 1 indicates that the catch is equal to that for NEPA Alt 1A. The bottom section presents the differences in catches projected as a result of the EIS production alternatives, that is, projected values under each EIS alternative subtracted from NEPA Alt 1A; consequently, differences in fishery catches resulting from the EIS NEPA alternatives can be most directly seen in the values presented in the bottom section.

The results presented in Tables 1 and 2 reflect stock-specific differences in ocean exploitation patterns. Table 1 summarizes impacts in ocean fishery catches for all stocks combined; it is important to recall that these catches reflect a combination of base period abundances for stocks originating outside the Columbia River and projections for production for Columbia River stocks under the EIS alternatives. Stocks harvested in northern fisheries, like fall brights, would be impacted principally by ocean fisheries off the WCVI, NBC, and SEAK. Stocks harvested by more southerly fisheries, like tules, would affect north of Cape Falcon and WCVI fisheries. Some stocks that are not harvested significantly by ocean fisheries, like upriver spring chinook, would not be expected to impact ocean fishery catches. Changes in production under EIS NEPA alternatives for Columbia River stocks would have small impacts on some fisheries, such as Other BC, WA SJDF & PS, and WA Coastal net because exploitation rates for Columbia River stocks are very small in these fisheries.

Table 2 presents modeled results for Columbia River stocks by fisheries in the Columbia River. Stock-specific differences are apparent here as well, reflecting impacts of differences in both production levels under the NEPA EIS alternatives and impacts of ocean fisheries. Since ocean fisheries have relatively small impacts on spring and summer chinook, differences between EIS NEPA alternatives are principally due to differences in production. Differences for fall chinook are due to a combination of production differences and impacts of ocean fisheries.

Detailed catches by population for ocean and Columbia River fisheries were produced and have been submitted for economic analysis.

Table 1. Modeling results for chinook in ocean fisheries for five scenarios using the EIS Chinook Model (based on inputs applied in February 2009). Results are shown as values normalized to Scenario 1 (raw output for scenario divided by output for Scenario 1) and as differences from Scenario 1.

Normalized

Scenario	Summary of all areas							North of Falcon allocation		
	SEAK	North & Central BC	WCVI	Other BC	WA SJDF & PS	WA coast net	NF troll/spt	TTr	NTTr	NTSpt
NEPA Alt 1A	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
NEPA Alt 2A	0.936	0.966	0.891	0.998	0.993	0.993	0.673	0.673	0.673	0.673
NEPA Alt 3A	1.028	1.001	0.969	1.000	0.999	0.999	0.885	0.885	0.885	0.885
NEPA Alt 4A	1.062	1.011	0.980	1.000	1.000	1.000	0.910	0.910	0.910	0.910
NEPA Alt 5A	1.035	1.003	0.970	1.000	0.999	0.999	0.884	0.884	0.884	0.884

Differences from Scenario 1

Scenario	Summary of all areas							North of Falcon allocation		
	SEAK	North & Central BC	WCVI	Other BC	WA SJDF & PS	WA coast net	NF troll/spt	TTr	NTTr	NTSpt
NEPA Alt1	0	0	0	0	0	0	0	0	0	0
NEPA Alt2	-6,847	-8,229	-16,127	-1,763	-4,366	-296	-26,290	-8,194	-10,146	-7,951
NEPA Alt3	2,940	277	-4,626	140	-365	-25	-9,249	-2,883	-3,569	-2,797
NEPA Alt4	6,592	2,636	-2,988	322	-61	-15	-7,268	-2,265	-2,805	-2,198
NEPA Alt 5	3,732	813	-4,415	241	-372	-25	-9,306	-2,900	-3,591	-2,815

Table 2. Modeling results for chinook in Columbia River fisheries for five scenarios using the EIS Chinook Model (based on inputs applied in February 2009). Results are shown as values normalized to Scenario 1 (raw output for scenario divided by output for Scenario 1) and as differences from Scenario 1.

Normalized

Run	Scenario	Fishery					
		Low river comm	B10 spt	Low river spt	Bon-McN spt	Z6 treaty	Term area
Spr chinook	NEPA Alt 1A	1.000	1.000	1.000	1.000	1.000	1.000
	NEPA Alt 2A	0.762	1.000	0.762	0.783	0.718	0.772
	NEPA Alt 3A	0.909	1.000	0.909	0.912	0.788	0.898
	NEPA Alt 4A	0.888	1.000	0.888	0.914	0.791	0.903
	NEPA Alt 5A	0.981	1.000	0.981	1.025	0.984	0.991
Sum chinook	NEPA Alt 1A	1.000	1.000	1.000	1.000	1.000	1.000
	NEPA Alt 2A	1.005	1.000	1.005	1.000	1.005	1.006
	NEPA Alt 3A	0.999	1.000	0.999	1.000	0.999	0.999
	NEPA Alt 4A	1.009	1.000	1.009	1.000	1.009	0.683
	NEPA Alt 5A	1.092	1.000	1.092	1.000	1.092	1.033
Fall chinook	NEPA Alt 1A	1.000	1.000	1.000	1.000	1.000	1.000
	NEPA Alt 2A	0.698	0.656	0.656	0.732	0.732	0.632
	NEPA Alt 3A	0.920	0.909	0.909	1.003	1.003	1.003
	NEPA Alt 4A	0.977	0.974	0.974	1.000	1.000	1.452
	NEPA Alt 5A	0.917	0.906	0.906	0.999	0.999	1.002

Differences from Scenario 1

Run	Scenario	Fishery					
		Low river comm	B10 spt	Low river spt	Bon-McN spt	Z6 treaty	Term area
Spr chinook	NEPA Alt 1A	0	0	0	0	0	0
	NEPA Alt 2A	-897	0	-2,972	-114	-2,257	-6,224
	NEPA Alt 3A	-343	0	-1,138	-46	-1,699	-2,777
	NEPA Alt 4A	-423	0	-1,402	-45	-1,677	-2,653
	NEPA Alt 5A	-71	0	-237	13	-127	-257
Sum chinook	NEPA Alt 1A	0	0	0	0	0	0
	NEPA Alt 2A	0	0	0	0	7	12
	NEPA Alt 3A	0	0	0	0	-2	-2
	NEPA Alt 4A	0	0	0	0	11	-634
	NEPA Alt 5A	1	0	1	0	116	66
Fall chinook	NEPA Alt 1A	0	0	0	0	0	0
	NEPA Alt 2A	-3,276	-689	-2,620	-69	-9,437	-5,569
	NEPA Alt 3A	-869	-183	-697	1	108	44
	NEPA Alt 4A	-245	-52	-198	0	15	6,842
	NEPA Alt 5A	-895	-189	-717	0	-21	33

4.0 EIS Coho Model

This section describes the EIS Coho Model, followed by a short summary of modeling results for the five EIS alternatives.

4.1 Model Formulation

The EIS Coho Model is described in three sections: overview, marine fisheries, and Columbia River fisheries. The overview provides a conceptual description; the next two sections provide the computational formulas.

4.1.1 Overview

The coho harvest model relied heavily on the Fishery Regulation Assessment Model (FRAM) (Model Evaluation Workgroup 2007). FRAM serves as the planning tool for implementing abundance-based management under the 2002 PSC Southern Coho Agreement and for domestic fishery planning in the annual planning processes undertaken by PFMC. Because coho are harvested predominantly as a single brood, there is no need to consider multiple age-year effects unlike chinook. FRAM simulates fishery impacts on a complex of fisheries over multiple time steps during a single fishing year covering the period from January through December. We consolidated these multiple time steps into single annual steps to simplify the modeling procedure.

FRAM accounts for ocean fishery impacts on coho, using fishery exploitation rates and projections of stock abundance so it is readily adaptable for evaluating changes in production levels from the Columbia River under the EIS NEPA alternatives. Like the PSC Chinook Model, FRAM relies on fishery-specific exploitation rates observed during a base period for a comprehensive set of indicator stocks originating from Central California to Southeast Alaska, representing total West Coast production.

The principal modeling steps are illustrated in Figure 5. Since many of the modeling steps are virtually identical to those described in the overview for chinook, step descriptions are shortened, where appropriate.

A. Production components passing Bonneville Dam: A total of 54 coho populations were defined to represent the total coho production from the Columbia River under each of the EIS alternatives. The estimated number of juveniles by population to survive downstream passage at Bonneville Dam provides the input to the coho harvest model. Appendix I lists the populations, together with number of juveniles (final iteration input) under each alternative, and other relevant population-specific information.

B. Production components grouped by FRAM stock group: This step assigns each Columbia River production component to one of five Columbia River FRAM model stock groups. A total of 123 stock groups are used in FRAM (Appendix J), of which five originate in the Columbia River (excluding Clakamas Late Wild which were not assigned in this analysis).

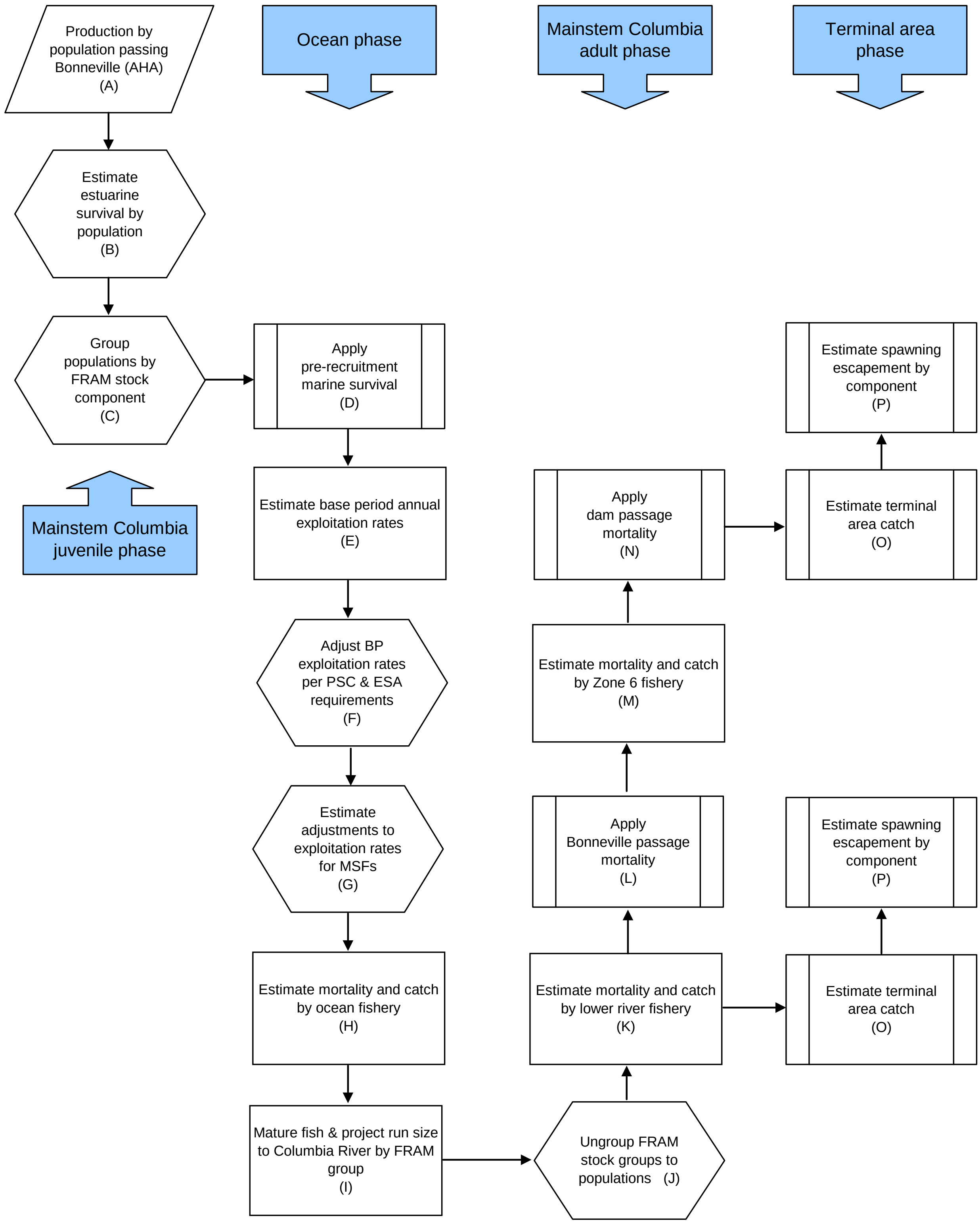


Figure 5. EIS Coho Model flow chart.

C. Estimation of estuarine survival: The same procedure is used for estimating estuarine survival as described for the EIS chinook model. FRAM utilizes marine survival estimates that are applied to the number of juveniles departing the estuary. In combination, the estuarine and ocean survivals (not including harvest mortality) comprise the total smolt to adult survival rate (SAR). J&S formulated recent year averages of SARs for each of the modeled populations. We assumed that these rates were reasonable approximations and applied them in the harvest model. The J&S SAR rates divided by the marine survival rates used in FRAM produce the estimates of estuarine survival by population component.

D. Application of pre-recruitment marine survival: A fixed survival rate is applied to the cohort sizes leaving the Columbia River estuary, producing the number of fish at the start of their third year of life (Age 3 cohort size).

E. Estimation of base period annual exploitation rates: This step produces the base period (1986-1991) annual marine exploitation rates used to assess the harvest impacts of marine fisheries on each FRAM stock. FRAM simulates fishery impacts on a complex of fisheries over multiple time steps covering the period from January through December on a single calendar year. We consolidated these multiple time steps into a single annual step; a more complex monthly time step was unnecessary for evaluation of EIS alternatives. The FRAM base period monthly fishery harvest rates were converted to monthly annual exploitation rates and summed to generate a total annual fishery exploitation rate for each stock.

Appendix K lists the complete set of coho fisheries modeled.

F. Adjustment of base period exploitation rates per PSC Agreement and ESA requirements: This step adjusts the base period exploitation rates to obtain rates that would be consistent with the 2002 PSC Southern Coho Agreement and with those used in domestic fisheries to meet ESA requirements. The adjustments were made only to ocean fisheries in the area from Oregon through WCVI, since these are the only ones with significant impacts on Columbia River coho.

The PSC Coho Agreement is designed to establish exploitation rate constraints on a specified set of naturally spawning coho management units, none of which originate in the Columbia River. Consequently, alternative production for Columbia River coho per se would not directly constrain fisheries under PSC coho management regimes. However, the impacts of WCVI fisheries on Columbia River coho can be expected to be reduced as a consequence of constraints placed on exploitation rates on Southern British Columbia, Puget Sound, and Washington Coastal coho management units. For purposes of the coho model component, an analog to the harvest rate index incorporated into the PSC Chinook Agreement was employed. The HRI for WCVI fisheries was derived using key natural populations in Puget Sound and from the Washington Coast. The HRIs act as scalars on the base period exploitation rates. The formulation is given in the next section.

For Washington and Oregon ocean fisheries, harvest rate indices were developed to be consistent with the ESA jeopardy standard established for listed Lower Columbia River (LCR) naturally-produced coho. The impact limit on LCR natural coho in PFMC area marine fisheries and mainstem Columbia River commercial and sport fisheries was limited in 2006 to 15%, which was applied here. Of this amount, a maximum of 9.9% was to be taken in PFMC marine waters (PFMC 2006b). This impact limit was then allocated between ocean fisheries north and south of Cape Falcon, Oregon in proportion to the ratios reflected in the FRAM base period data.

For fisheries south of Cape Falcon, we assumed that the troll fishery would continue to operate under coho non-retention restrictions. The troll fishery in this area, however, would still impact Columbia River coho due to incidental mortality incurred while harvesting chinook. The HRI for both marked and unmarked fish from the Columbia River was set at the ratio between the recent average troll exploitation rate and the base period exploitation rate.

We assumed that the sport fishery south of Cape Falcon would operate under mark-selective retention restrictions. The HRI for the unmarked component would be estimated as the minimum of constraints that would be created by any individual Columbia River stock component.

For PFMC fisheries north of Cape Falcon, we assumed that the non-treaty fisheries (both troll and sport) would continue to operate under mark-selective retention restrictions. The treaty troll fishery would continue to operate without such restrictions. The HRIs were calculated by aggregating exploitation rates for non-treaty troll and sport fisheries on Columbia River coho, and for the treaty troll fishery separately. The allowable impact north of Cape Falcon was allocated between the treaty troll and non-treaty troll/sport aggregates in proportion to the proportional distribution indicated in the final 2006-2008 pre-season FRAM runs, as reported in corresponding PFMC final pre-season reports.

G. Estimation of adjustments to exploitation rates for MSFs: The HRIs computed in the previous step provide the means of determining the allowable impact rate on unmarked fish. The HRIs on marked fish are then computed by simply dividing by the release mortality and drop-off rates (Appendix L).

H. Estimation of ocean fishery mortality and catch: Results from the two previous steps yield the total allowable exploitation rates for each stock and fishery, including the impact rates on unmarked and marked fish in PFMC fisheries. These rates are for total impact, including drop-off and sub-legal release mortalities.

For PFMC fisheries, resulting catches both south and north of Cape Falcon were treated as being allocated between ports based on the average proportion of catch in each port between 2001-2005. This takes into account the provisions of the PFMC's Salmon Framework Plan (PFMC 2003). As with chinook, information on the distribution of catches among commercial and recreational fisheries by port is essential for economic impact analysis of EIS alternatives.

Landed catches were estimated by applying these impact rates and subtracting off incidental mortalities.

I. Projection of mature fish returning to Columbia River: The numbers of fish in each stock group surviving ocean fisheries represents the run sizes returning to the Columbia River mouth under steady state conditions.

J. Ungroup FRAM stock groups into production components: This step ungroups the FRAM stock groups into the populations that comprise them (step B). Within each group, it was assumed that that they ungroup in the same proportions that existed as juveniles departing the river.

At this point in the modeling procedure, all populations are accounted for and run sizes back to the river mouth have been estimated. Steps that follow determine the impacts and catches made by the various in-river fisheries.

K. Estimation of lower mainstem river (below Bonneville Dam) fishery mortality and catch: In-river fishery impacts were simulated as a sequential gauntlet of mortalities: lower river fisheries → Bonneville Dam passage → Zone 6 fisheries → upper river dam passage mortalities → terminal area tributary fisheries → escapement. Specific fisheries modeled were:

Downstream of Bonneville Dam	*Upstream of Bonneville Dam*
Buoy 10 sport	Zone 6 treaty Indian
Lower river commercial	Zone 6 sport
Lower river sport	

Terminal fisheries were defined as those in SAFE areas, all tributaries (including within the lower Willamette River), and the mainstem Columbia upstream of McNary Dam.

The total allowable impact on LCR natural coho was treated as the 15% minus the impact that resulted in the aggregate of PFMC ocean fisheries. That rate would be at least 5.1%, given that the limit to the total allowable rate in PFMC marine fisheries was 9.9%. The mainstem river impact rates were computed separately for early and late run coho components, with the corresponding rate applied to each component.

The in-river impact rate was allocated between the three fishery groups downstream of Bonneville Dam by using the recent year average harvest rates for Buoy 10 and Lower River sport (each expanded appropriately for incidental mortalities), then assigning the remaining allowable impact to the Lower River commercial fishery. This procedure resulted in an impact rate for the commercial fishery comparable to recent years.

We assumed that all mainstem sport fisheries would operate under mark-selective retention restrictions, as has occurred in recent years. No mark-selective retention restrictions were applied to the Lower River commercial fishery.

Landed catches were then computed using the impact rates and subtracting off release and drop-off mortalities.

L. Application of Bonneville Dam passage survival: A 97% passage rate was applied to populations destined for subbasins upstream of Bonneville Dam after all mortalities associated with downstream fisheries were subtracted.

M. Estimation of Zone 6 fishery mortality and catch: Harvest impacts by treaty Indian fisheries in the Zone 6 fishery were assumed to at the average harvest rate (the proportion of the population reaching Zone 6 that is killed by the fishery) for years 2004-2006. Harvest rates increased somewhat in these years compared to earlier years and are assumed to be representative of how fisheries would operate in the foreseeable future. Landed catch was estimated by subtracting off incidental net mortalities. This fishery would not operate as a MSF.

A very small non-Indian sport fishery between Bonneville and McNary dams was assumed to be operative.

N. Application of dam passage survivals: Fish surviving the Zone 6 fisheries in each population were then subjected to the fish passage rate specified by J&S as part of their data input to the harvest model. The rate accounted for all dams passed upstream of Bonneville Dam prior to arriving to terminal areas. Fish that pass dams associated with these rates are assumed to represent escapement to the subbasins (or to the mainstem upstream of McNary Dam).

O. Estimation of terminal area run sizes and terminal area catches: Terminal area catches for each population were estimated by applying the terminal areas harvest rates provided by J&S as part of their data input to the harvest model. These rates include MSFs on hatchery fish were appropriate.

P. Estimation of spawning escapements: Fish surviving terminal area fisheries were assumed to represent spawning escapements.

4.1.2 Marine Fisheries Formulation

The primary formulas for understanding the modeling procedure are presented.

The coho model component utilizes the following types of input data: (1) stock-age-fishery specific exploitation rates; (2) fishery-age-specific release and drop off mortality rates; (3) initial stock-age specific cohort sizes.

Only steps that differ from what were described for chinook are presented below.

Notation used is defined below. For clarification, individual populations within the Columbia River are denoted by the *i* subscript. These combine into the FRAM stock groups (or components) denoted by the subscript *c*.

AER_c	Allowable Exploitation Rate for component *c*
$COH_{c,a}$	Cohort size of component *c* at age *a*
$CRRUN_{c,a}$	Run size back to the Columbia River of mature fish for component *c* and age *a*
DO	Drop Off mortality rate
ER_m	Exploitation rate expressed as the monthly annual (the rate that would be achieved if attained for the entire season)
ESA_c	ESA jeopardy standard for component *c*
HRI_f	Harvest Rate Index for fishery *f*

HR_m	Harvest rate by FRAM period
$J_{i,k,c}$	Juvenile estuarine survival rate for population *i* of production type *k* (natural or hatchery) associated with PSC stock component *c*
$M_{i,k,c}$	Number of migrants reaching the ocean in population *i* of production type *k* (natural or hatchery) associated with PSC stock component *c*
$p_{i,k,c}$	Juveniles for population *i* of production type *k* (natural or hatchery) associated with PSC stock component *c*
RM	Release mortality rate in MSF
s_t	Survival rate in the *t* time step
$SAR_{i,k,c}$	Smolt (number entering estuary) to adult (number arriving to head of estuary) survival rate for population *i* of production type *k* associated with component *c*

B. Estimation of estuarine survival: The same basic procedure is used for estimating estuarine survival as described for chinook, though simplified since there is no need to address multiple ages. The total natural marine survival rate is specified in FRAM through time steps for both Age 2 and Age fish; hence the product of these rates is MS_c. The juvenile estuarine survival rate is then calculated as in equation 4.

E. Estimation of base period annual exploitation rates: This step produces the base period (1986-1991) annual marine exploitation rates used to assess the harvest impacts of marine fisheries on each FRAM stock. FRAM simulates fishery impacts on a complex of fisheries over multiple time steps covering the period from January through December on a single calendar year. These time steps were consolidated into single annual steps for purposes of the simplified model. FRAM base period harvest rates (*HR*) by period can be converted to monthly annual exploitation rates (*ER*) using the following iterative equation (starting with the first time period, $ER_1 = 0$):

$$ER_{s,f,m} = \prod_{t=1}^{m} s_t * \prod_{t=1}^{m-1} (1 - ER_t) * HR_m \qquad \text{(eq.15)}$$

The total annual exploitation rate (*AER*) is just the sum of the monthly exploitation rates:

$$AER_{s,f} = \sum_{m=1}^{M} ER_{s,f,m} \qquad \text{(eq.16)}$$

These base period annual exploitation rates are modified only for ocean fisheries in the area from Oregon through WCVI, since these are the only ocean fisheries with significant impacts on Columbia River coho.

F. Adjustment of base period exploitation rates per PSC Agreement and ESA requirements: The PSC Coho Agreement is designed to establish exploitation rate constraints on a specified set of naturally spawning coho management units, none of which originate in the Columbia River. Consequently, alternative production for Columbia River coho per se would not affect PSC coho management regimes. However, the impacts of WCVI fisheries on Columbia River coho can be expected to be reduced as a consequence of constraints placed on exploitation rates on Southern British Columbia, Puget Sound, and Washington Coastal coho management units. For purposes of the coho model component, an analog to the harvest rate index incorporated into the PSC Chinook Agreement was employed. The HRI for WCVI fisheries was derived using key natural populations in Puget Sound and from the Washington Coast. The HRI for WCVI fisheries would represent the minimum of these ratios:

$$HRI_s = \min\left[\frac{Limit_s * \dfrac{AER_{s,WCVI}}{\sum_f AER_{s,f}}}{AER_{s,WCVI}}\right] \qquad \text{(eq.17)}$$

Where the values of *Limit* would be 0.17 and 0.15 for Puget Sound and Washington Coastal Coho Management Units, respectively. These values correspond to the mid-point of the exploitation rate ceilings specified under the PSC Coho Agreement for *moderate* abundance levels.

For Washington and Oregon ocean fisheries, harvest rate indices were developed to be consistent with the ESA jeopardy standard established for listed Lower Columbia River coho.

For fisheries south of Cape Falcon, the HRI for both marked and unmarked fish from the Columbia River would be set at the ratio between the recent average troll exploitation rate and the base period exploitation rate.

We assumed that the sport fishery south of Cape Falcon would operate under mark-selective retention restrictions. The HRI for the unmarked component would be estimated as the minimum of the ratios for Columbia River production components represented in FRAM:

$$HRI_{USF} = \min\left[\frac{ESA_{s,SF}}{AER_{s,SF}}\right] \qquad \text{(eq.18)}$$

The HRI for marked stocks would be computed as:

$$HRI_{MSF} = \frac{HRI_{USF}}{(RM + DO)} \qquad \text{(eq.19)}$$

For PFMC fisheries north of Cape Falcon, HRIs were be determined in accordance with the following procedure:

(1) Aggregate exploitation rates for non-treaty troll and sport fisheries on Columbia River coho, and for the treaty troll fishery separately.

(2) Allocate the allowable north of Cape Falcon ESA impact between the treaty troll and non-treaty troll/sport aggregates in proportion to the distribution indicated in the final pre-season FRAM runs.

For the treaty troll fishery, the HRI was computed assuming that no mark retention restrictions would be employed:

$$HRI_{TTNF} = \min\left[\frac{ESA_{s,TTNF}}{AER_{s,TTNF}}\right] \qquad \text{(eq.20)}$$

For the non-treaty fishery aggregate, we assumed that mark retention restrictions would be in effect. The HRI was then computed in an analogous way, giving the allowable exploitation rates for unmarked fish.

G. Estimation of adjustments to exploitation rates for MSFs: The formulation for MSFs was shown in the step above as part of presenting the HRIs.

H. Estimation of ocean fishery mortality and catch: Total mortality of unmarked and marked coho, along with catch, are then calculated as follows:

$$Mort_{U,NTNF} = HRI_{U,NTNF} * \left[\sum_{c \in U} AER_{c,NTNF} * COH_{c,1}\right] \qquad \text{(eq.21)}$$

$$Catch_{M,NTNF} = \frac{HRI_{U,NTNF}}{(RM + DO)} * \left[\sum_{c \in M} AER_{c,NTNF} * COH_{c,1}\right] \qquad \text{(eq.22)}$$

4.1.3 Columbia River Fisheries

The calculation of harvest impact rates and catches in the Columbia River is a straightforward process following the description given in the Overview section.

4.2 Modeling Results

Rolled-up summary tables of modeling results under each alternative are presented in Tables 3 (ocean) and 4 (mainstem Columbia River). The format for these tables is described in section 3.2 for chinook. As indicated in Table 3, some ocean fishery catches would be relatively insensitive to differences in Columbia River coho production under EIS NEPA alternatives (e.g., Canadian and WA non PFMC fisheries) because catches would be dominated by contributions of other stocks originating outside the Columbia River. The impact of EIS NEPA alternatives on ocean fisheries is most readily apparent in the bottom section of Table 3. As with chinook, differences between EIS NEPA alternatives are more readily apparent in Columbia River fisheries (Table 4). Detailed catches by population were produced and have been submitted for analysis.

Table 3. Modeling results for coho in ocean fisheries for five scenarios using the EIS Coho Model (based on inputs applied in March 2009). Results are shown as values normalized to Scenario 1 (raw output for scenario divided by output for Scenario 1) and as differences from Scenario 1.

Normalized

Scenario	SEAK	Canadian				WA non PFMC		North of Falcon			South of Falcon		
		NW VI Trl	SW VI Trl	WC VI Spt	Other	Non term	Term	TTr	NTTr	NTSpt	Troll	Sport	CA-OR term
NEPA Alt1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.000	1.000	1.000
NEPA Alt2	1.000	0.997	0.993	0.997	0.999	0.999	0.999	0.957	0.643	0.604	0.000	0.633	1.000
NEPA Alt3	1.000	0.998	0.996	0.999	1.000	0.999	0.999	0.972	0.790	0.754	0.000	0.826	1.000
NEPA Alt4	1.000	0.999	0.997	0.999	1.000	0.999	1.000	0.980	0.860	0.830	0.000	0.910	1.000
NEPA Alt5	1.000	0.998	0.996	0.999	1.000	0.999	0.999	0.972	0.790	0.754	0.000	0.826	1.000

Differences from Scenario 1

Scenario	SEAK	Canadian				WA non PFMC		North of Falcon			South of Falcon		
		NW VI Trl	SW VI Trl	WC VI Spt	Other	Non term	Term	TTr	NTTr	NTSpt	Troll	Sport	CA-OR term
NEPA Alt1	1.000	0	0	0	0	0	0	0	0	0	0	0	0
NEPA Alt2	1.000	-255	-1,140	-12	-155	-1,244	-207	-2,860	-9,405	-30,712	0	-8,825	0
NEPA Alt3	1.000	-163	-729	-6	-103	-854	-132	-1,887	-5,516	-19,050	0	-4,173	0
NEPA Alt4	1.000	-116	-513	-4	-75	-632	-94	-1,372	-3,684	-13,146	0	-2,169	0
NEPA Alt5	1.000	-163	-729	-6	-103	-854	-132	-1,887	-5,516	-19,050	0	-4,173	0

Table 4. Modeling results for coho in Columbia River fisheries for five scenarios using the EIS Coho Model (based on inputs applied in March 2009). Results are shown as values normalized to Scenario 1 (raw output for scenario divided by output for Scenario 1) and as differences from Scenario 1.

Normalized

Scenario	Fishery					
	Buoy 10	LCR sport	LCR comm	Z6 T comm	Ab Bon spt	Term area
NEPA Alt1	1.000	1.000	1.000	1.000	1.000	1.000
NEPA Alt2	0.252	0.270	0.257	0.171	0.166	0.096
NEPA Alt3	0.602	0.554	0.577	0.627	0.674	0.574
NEPA Alt4	0.761	0.698	0.729	0.665	0.728	0.765
NEPA Alt5	0.602	0.554	0.577	0.627	0.674	0.574

Differences from Scenario 1

Scenario	Fishery					
	Buoy 10	LCR sport	LCR comm	Z6 T comm	Ab Bon spt	Term area
NEPA Alt1	0	0	0	0	0	0
NEPA Alt2	-6,492	-688	-27,469	-4,081	-109	-63,340
NEPA Alt3	-3,457	-420	-15,653	-1,836	-43	-29,848
NEPA Alt4	-2,073	-285	-10,026	-1,649	-35	-16,489
NEPA Alt5	-3,457	-420	-15,653	-1,836	-43	-29,848

Literature Cited

Bartlett, H., and B. Tweit. 2006. Harvest framework for non-treaty fisheries directed at salmonids originating above Priest Rapids Dam. Draft. WDFW, Olympia, WA.

Mobrand – Jones & Stokes Associates. 2005. All H Analyzer (AHA) user guide – draft. Unpublished report. Mobrand – Jones & Stokes Associates, Vashon Island, WA. Available at http://www.managingforsuccess.us/Portals/_default/Documents/AHA%20User%20Guide.doc

Model Evaluation Workgroup. 2007. Fishery Regulation Assessment Model (FRAM) – Technical Documentation for Chinook and Coho (Document prepared for the Council and its advisory entities). Pacific Fishery Management Council, Portland, OR.

NMFS 2005. Biological Opinion on Impacts of Treaty Indian and Non-Indian Fisheries in the Columbia River Basin in the years 2005-2007, on Salmon and Steelhead listed Under the Endangered Species Act, Conference on Lower Columbia Coho, and Magnuson Stevens Act Essential Fish Habitat Consultation. May 9, 2005.

ODFW/WDFW. January 2006a. Joint Staff Report concerning commercial seasons for spring chinook, steelhead, sturgeon, shad, smelt, and other species and miscellaneous regulations for 2006. Joint Columbia River Management Staff. Clackamas, OR/Vancouver, WA.

ODFW/WDFW. July 2006b. Joint Staff Report concerning the 2006 fall in-river commercial harvest of Columbia River fall chinook salmon, summer steelhead, coho salmon, chum salmon, and sturgeon. Joint Columbia River Management Staff. Clackamas, OR/Vancouver, WA.

ODFW/WDFW. July 2007. Joint Staff Report concerning the 2007 fall in-river commercial harvest of Columbia River fall chinook salmon, summer steelhead, coho salmon, chum salmon, and sturgeon. Joint Columbia River Management Staff. Clackamas, OR/Vancouver, WA.

PFMC. 2003. Pacific Coast Salmon Plan Fishery Management Plan For Commercial And Recreational Salmon Fisheries Off The Coasts Of Washington, Oregon And California As Revised Through Amendment 14. September 2003, Portland, OR.

PFMC. 2004. Preseason Report III Analysis of Council Adopted Management Measures for 2004 Ocean Salmon Fisheries. April 2004, Portland, OR.

PFMC. 2005. Preseason Report III Analysis of Council Adopted Management Measures for 2005 Ocean Salmon Fisheries. April 2005, Portland, OR.

PFMC. 2006. Preseason Report III Analysis of Council Adopted Management Measures for 2006 Ocean Salmon Fisheries. April 2006, Portland, OR.

PFMC. 2007. Preseason Report III Analysis of Council Adopted Management Measures for 2007 Ocean Salmon Fisheries. April 2007, Portland, OR.

Appendices

Appendix A – README Sections of the EIS Chinook Model

Mitchell Act EIS Chinook Harvest Model

Ocean Impacts and Catch Module (CRHMchin_OcnModule - Apr6_09.xls)

4/3/2009

For documentation to model, see report entitled
"Chinook and Coho Salmon Fishery Modeling Approach for Application to the Mitchell Act EIS"

The model is formulated in this spreadsheet file.
A brief description of the purpose of each spreadsheet is given below

Tab	Description
README	Brief description of model structure, purpose of individual spreadsheets, and instructions for model use.
SmoltInputs	Raw smolt inputs from J&S using AHA model. Formulas exist in columns A, E, F, and X through AG. Care is needed to ensure inputs go into appropriate columns.
SmoltInputGrouped	Columbia River populations are grouped in this sheet into PSC Model stocks. If population names are changed in the input material coming from AHA, then care is needed to ensure names are changed on this sheet accordingly and that populations are grouped properly. Nothing needs to be done to this sheet unless population names are changed or new ones added. Keep structure of sheet intact.
AllStockInput	Age 1 cohort sizes (number of juveniles departing estuary) are listed for all PSC stocks used in the model for the Base Period and for the specific alternative being modeled. Nothing is to be done on this sheet; keep structure of
BasePeriodProduction	Base Period initial population sizes by age are given. Nothing is to be done on this sheet; keep structure of sheet
OcnChinModel_impacts	This sheet performs all the vital computations for getting the total impact rate on each stock group, as well as the ocean escapements. The alternative is entered as a label into cell "HW4". Relevant output is seen in the nearby visible cells. Output for each alternative is to be copied as values into the Columbia River Catch Module. Note that the model is also configured to compute impacts with MSFs operative in PFMC fisheries. A toggle switch is shown for turning on MSFs in PFMC fisheries.
OcnChinModel_landed	This sheet performs all the vital computations for getting obtaining ocean catches for each PSC stock group. Nothing is to be done on this sheet to generate computations. The overall total catches across all stock groups are reported in row 42. This row is then to be copied as values into a separate file for summarizing catches by alternative. Output from this sheet are also used to generate Columbia River population specific catches on the sheet "CRPopCatchTable". The model would need to be run separately with MSFs turned on.
CRPopCatchTable	Output table of Columbia River population specific catches is formulated. The table is then copied as values into the next sheet for storing each alternative's output.
CRPopCatchStorage	Values from the previous tab "CRPopCatchTable" are pasted as values here for storage.
PSC Model Stocks	Lookup tables for PSC stocks. Keep sheet intact.
MatRate PSC stks	Lookup table reformatted here. Keep sheet intact.
MarSurv PSC stks	Lookup table reformatted here. Keep sheet intact.
PSC Fisheries	Lookup tables related to PSC fisheries. Keep sheet intact.
BPERs PSC stks	Lookup tables for PSC fisheries and stocks related to the Base Period. Keep sheet intact.
BPERs PSC stks 2	Base Period exploitation rates in conjunction with PNVs for grouping by different combinations used in the model. This sheet used for calculating catch without MSFs turned on in PFMC fisheries.
BPERs PSC stks 2A	Base Period exploitation rates in conjunction with PNVs for grouping by different combinations used in the model. This sheet used for calculating TOTAL IMPACTS without MSFs turned on in PFMC fisheries.
AK-BC rules	Sheet contains a lookup table for obtaining the harvest rate scalars for SEAK, NBC, and WCVI troll and sport fisheries. Rules are for Aggregate Abundance Based Management regimes (AABM)
SRF-Cow Indices	Sheet computes the limits for WA and OR PMFC fisheries based on Snake River falls and Coweeman falls. See report documentation for details. All calculations have been performed on the sheet and nothing is to be done.
MiscLkups	Miscellaneous Lookup tables used in the model are given. Two of the tables are used for associating CR populations with PSC stocks and identifying whether they are originate above or below Bonneville Dam. One table lists the post estuary marine survival for each CR stock group as computed in a separate file using the standard PSC model marine survival rates and the stock specific maturation rates.
SRFs base mort dist	Reference table stored here containing information for Snake River falls used in obtaining the PFMC modeling limits on this population.

Instructions for use:

1. Copy and paste input blocks from J&S input file into appropriate columns in the sheet "SmoltInputs."
2. If populations have been added or names changed, manual name changes and grouping will be required on the sheets "SmoltInputGrouped" and "MiscLkups".
3. On the sheet "OcnChinModel_impacts", enter the alternative name to be run into cell "HW4". Copy select output as identified above as values into the storage table and other separate summary files as desired.
4. All aspects of the model are operated through embedded formulas and lookup tables. No macros need to be run.

Appendix A –EIS Chinook Model continued

Columbia River Impacts and Catch Module CRHMchin_CRModule - Apr6_09.xls)

4/3/2009

For documentation to model, see report entitled
"Chinook and Coho Salmon Fishery Modeling Approach for Application to the Mitchell Act EIS"

The model is formulated in this spreadsheet file.
A brief description of the purpose of each spreadsheet is given below

Tab	Description
README	Brief description of model structure, purpose of individual spreadsheets, and instructions for model use.
OcnModel output	Output summaries for each alternative from "OcnChinModel_impacts" in the Ocean Module are pasted in as values into the appropriate locations in the table. These serve as inputs into the Columbia River catch module. Keep structure of sheet intact.
More spring output	Smolt input data from the sheet "SmoltInputs" in the Ocean Module are pasted into this sheet in the appropriate columns. These data are then used in the sheet to generate run sizes back to the Columbia River for upriver spring chinook and Snake River summers. Calculations of run sizes are generated automatically. Keep structure
OcnOutput Lkup	Data from the appropriate cells in "OcnModel output" (cells from columns B-N) are pasted into this sheet, which is automatically structured into a Lookup table for use in this module. Keep structure of sheet intact.
MiscLkups	Lookups used in this module. Keep structure of sheet intact.
DetailedInput	Smolt input data from the sheet "SmoltInputs" in the Ocean Module are pasted into this sheet in the appropriate columns. Columns X through the end of the table contain formulas for generating run sizes of marked and unmarked fish for each population back to the Columbia River. Keep structure of sheet intact.
InRiver rules1	Sheet contains the rules for generating in-river impacts and catches. Some of the rules are also derived from Lookup tables in the sheet "InRiver rules2." Nothing needs to be done on this sheet. All rules are formulated for the model. See documentation in the reported cited above for details.
InRiver rules2	Lookup tables for obtaining harvest rate rules for upriver springs and Snake River summers.
CRCompuations1	Computations for obtaining population specific impacts and catches within the Columbia River are made on this sheet. All alternatives are processed simultaneously.
CatchRollup1	Catches are rolled up on this sheet by race and major fishery. All alternatives are processed simultaneously.
RollupSummary	The rollup summary of catches is displayed on a separate sheet for easy retrieval. All alternatives are shown
TermAreaSummary	Terminal area catches are summarized on this sheet. Values from columns BP through BU from the sheet "CRCompuations1" are pasted as values into columns H through M.

Instructions for use:

1. Copy and paste input blocks from J&S input file into appropriate columns in the sheets "More spring output" and "DetailedInput" as described above. Also copy and paste output from "OcnChinModel_impacts" into the sheet "OcnModel output."
2. If populations have been added or names changed, manual name changes and grouping will be required on the sheets "More spring output", "DetailedInput, "CRCompuations1", and "CatchRollup1".
3. Copy as values terminal area catches into the sheet "TermAreaSummary" as specified above.
4. All aspects of the model are operated through embedded formulas and lookup tables. No macros need to be run.

Appendix B – README Section of the EIS Coho Model

Mitchell Act EIS Coho Harvest Model

Ocean and In-River Impacts and Catch Model (CRHMcoho - Apr3_09.xls)

4/3/2009

For documentation to model, see report entitled
"Chinook and Coho Salmon Fishery Modeling Approach for Application to the Mitchell Act EIS"

The model is formulated in this spreadsheet file.
A brief description of the purpose of each spreadsheet is given below

Tab	Description
README	Brief description of model structure, purpose of individual spreadsheets, and instructions for model use.
SmoltInputs	Raw smolt inputs from J&S using AHA model. Formulas exist in columns A, X, and Y. Care is needed to ensure inputs go into appropriate columns.
SmoltInputGrouped	Columbia River populations are grouped in this sheet into FRAM stocks. If population names are changed in the input material coming from AHA, then care is needed to ensure names are changed on this sheet accordingly and that populations are grouped properly. Nothing needs to be done to this sheet unless population names are changed or new ones added.
CohoModel	This sheet performs all the vital computations. The alternative is input as a label into cell "B1390". Output is created in the adjacent cells. Output for each alternative can be copied as values into the adjacent highlighted cells for storage. If new pops are added or combined, check cells F1279 AND F1280 to ensure that they equal zero, otherwise see note in the cell that says "Apply Solver here" for updating the Columbia River harvest rates.
OcnCatchSummaryByPopOutput	This sheet summarizes ocean catches for each Columbia River population. The cells highlighted in blue contain formulas - do not disturb. Copy the highlighted cells in blue in columns AJ to AZ to the cells below AS VALUES -- as can be readily seen for each alternative. This is the procedure for storing the output for each alternative.
TermAreaCatchesOutput	This sheet summarizes terminal area catches for each Columbia River population. The cells highlighted in blue contain formulas - do not disturb. Copy the highlighted cells in blue in columns B to V to the cells below AS VALUES -- as can be readily seen for each alternative. This is the procedure for storing the output for each
Harvest scalars	Sheet contains Lookup tables for retrieving harvest rate scalars for PFMC fisheries - do not disturb. Nothing needs to be done to this sheet.
MarineSurv	Sheet contains marine survival rate information for post estuarine survival - do not disturb.
NonColumbia mark rates	Mark rates for all non-Columbia River FRAM stocks are contained in Lookup table. Values seen are for 2006.
FRAMStkLkup	Lookup table that classifies Columbia River populations into FRAM stocks and identifies whether they originate above or below Bonneville Dam. If new populations are added, this table is to be manually updated.
RM and DO	Reference table for release mortality and drop-off mortality rates used in computations.
Control	Control sheet used to run macros that perform the initial computations for assembling the Base Period AERs. All macros have been run to completion and are not required to be run henceforth. Sheets are left configured here for documentation and future use if needed.
AERCompute	Base Period summarization sheet used in conjunction with macros run through the Control sheet. Do not disturb.
BPERLkups	Base Period summarization sheet used in conjunction with macros run through the Control sheet. Do not disturb.
BPEscOutput	Base Period summarization sheet used in conjunction with macros run through the Control sheet. Do not disturb.
AEROutput0	Base Period summarization sheet used in conjunction with macros run through the Control sheet. Do not disturb.
AEROutput1	Base Period summarization sheet used in conjunction with macros run through the Control sheet. Do not disturb.
AEROutput2	Base Period summarization sheet used in conjunction with macros run through the Control sheet. Do not disturb.
AEROutput3	Base Period summarization sheet used in conjunction with macros run through the Control sheet. Do not disturb.
AEROutput4	Base Period summarization sheet used in conjunction with macros run through the Control sheet. Do not disturb.
AEROutput5	Base Period summarization sheet used in conjunction with macros run through the Control sheet. Do not disturb.
TempStorage	Temporary storage sheet used in the Base Period summarization used with macros run through the Control
MiscLookups	Miscellaneous Lookups used in the file. Do not disturb.
ObservedColRHarv	Observed Columbia River catch data, used to summarize certain average harvest rates used for mainstem Columbia fisheries.

Instructions for use:

1. Copy and paste input blocks from J&S input file into appropriate columns in the sheet "SmoltInputs."
2. If populations have been added or names changed, manual name changes and grouping will be required on the sheets "SmoltInputGrouped" and "FRAMStkLkup".
3. On the sheet "CohoModel", enter the alternative name to be run into cell "B1390" - model output is shown to the right. Copy output as values into the storage area to right and into other summarization files as desired.
4. All aspects of the model are operated through embedded formulas and lookup tables. No macros need to be run.

Appendix C - Chinook Populations Modeled and Number of Juveniles Arriving to Below Bonneville Dam

Population Name	Pop ID	PSC stock	PSC Stk	Number of juveniles to below Bonneville Dam										SAR	
				NEPA Alt1		NEPA Alt2		NEPA Alt3		NEPA Alt4		NEPA Alt5			
				Hat	Nat	Hat	Nat	Hat	Nat	Hat	Nat	Hat	Nat	Hat	Nat
Columbia Lower Middle Hanford Fall Chinook (Priest Rapids Upriver	286	Col Riv Upriver Bright	19	3,492,790	3,312,961	3,497,918	5,348,767	3,497,918	5,306,595	3,497,918	5,300,341	3,497,918	5,303,478	0.0107	0.0205
Deschutes Fall Chinook	288	Col Riv Upriver Bright	19	0	588,375	0	665,808	0	580,655	0	578,959	0	579,629	0.0059	0.0285
Yakima_Marion Drain Fall Chinook	311	Col Riv Upriver Bright	19	10,697	3,131	10,697	2,451	10,697	2,889	10,697	2,885	10,697	2,887	0.0148	0.0690
Yakima Fall Chinook	313	Col Riv Upriver Bright	19	180,911	266,076	0	72,312	180,911	179,453	180,911	177,495	180,911	178,464	0.0073	0.0159
Yakima Fall Chinook (Little White Salmon-Hatchery)	794	Col Riv Upriver Bright	19	887,908	0	0	0	0	0	0	0	0	0	0.0058	0.0159
Klickitat Fall Chinook	635	Col Riv Upriver Bright	19	0	160,445	0	108,731	0	160,400	0	160,312	0	160,394	0.0049	0.0196
Columbia Lower Middle Columbia Fall Chinook (URB-Ringold-Hatch	692	Col Riv Upriver Bright	19	1,826,722	0	0	0	1,826,722	0	1,826,722	0	1,826,722	0	0.0049	0.0205
Columbia Gorge_Spring Creek Fall Chinook (Tules-Hatchery)	257	Spring Creek Hatchery	20	12,788,123	1	0	0	12,788,123	1	12,788,123	1	12,788,123	1	0.0062	0.0112
White Salmon Fall Chinook (Tule)	253	Spring Creek Hatchery	20	0	30,103	0	29,690	0	30,101	0	30,105	0	30,109	0.0048	0.0224
Hood Fall Chinook	260	Spring Creek Hatchery	20	0	6,491	0	0	0	6,484	0	6,478	0	6,491	0.0057	0.0317
Wind Fall Chinook (Tule)	281	Spring Creek Hatchery	20	0	110,300	0	82,401	0	110,292	0	110,300	0	110,315	0.0048	0.0037
Little White Salmon Fall Chinook (Tule)	646	Spring Creek Hatchery	20	0	15,013	0	0	0	15,011	0	15,011	0	15,014	0.0049	0.0196
Columbia Gorge_Tributaries Fall Chinook (Tules- Oregon)	659	Spring Creek Hatchery	20	0	5,943	0	5,544	0	5,939	0	5,939	0	5,945	0.0062	0.0112
Columbia Estuary_ Big Creek Fall Chinook (Tules-Hatchery)	322	Lower Bonneville Hatchery	21	5,826,626	1	0	0	5,826,626	1	5,826,626	1	5,826,626	1	0.0018	0.0093
Columbia Estuary_Chinook River Fall Chinook	321	Lower Bonneville Hatchery	21	0	5,566	0	0	0	2,151	0	6,211	0	2,154	0.0127	0.0093
Willamette_Clackamas Fall Chinook	413	Lower Bonneville Hatchery	21	0	8,346	0	3,165	0	5,620	0	6,999	0	5,627	0.0040	0.0121
Columbia Estuary_Clatskanie Fall Chinook	601	Lower Bonneville Hatchery	21	0	7,329	0	8,952	0	8,212	0	9,754	0	8,215	0.0029	0.0261
Columbia Estuary_Scapoose Fall Chinook	602	Lower Bonneville Hatchery	21	0	77,811	0	29,622	0	52,472	0	63,222	0	52,577	0.0029	0.0009
Columbia Estuary_Big Creek Fall Chinook (Tules)	662	Lower Bonneville Hatchery	21	0	19,326	0	512	0	19,182	0	19,419	0	19,187	0.0018	0.0093
Columbia Estuary_Youngs Bay Tribs Fall Chinook	727	Lower Bonneville Hatchery	21	0	97,982	0	2,956	0	27,700	0	124,799	0	27,746	0.0029	0.0009
Cowlitz_Lower Cowlitz Fall Chinook	354	Fall Cowlitz Hatchery	22	4,807,421	570,924	2,185,189	865,111	2,185,189	858,351	4,807,421	692,626	2,185,189	858,345	0.0016	0.0084
Cowlitz_Toutle Fall Chinook	356	Fall Cowlitz Hatchery	22	0	87,684	0	172,882	0	83,299	0	86,398	0	83,300	0.0017	0.0131
Elochoman Fall Chinook	339	Fall Cowlitz Hatchery	22	2,072,070	125,870	0	138,969	0	89,540	0	101,875	0	89,398	0.0037	0.0065
Grays Fall Chinook	347	Fall Cowlitz Hatchery	22	0	33,359	0	45,342	0	19,180	94,185	40,678	0	19,168	0.0037	0.0065
Cowlitz_Coweeman Fall Chinook	353	Fall Cowlitz Hatchery	22	0	120,566	0	145,021	0	141,216	0	128,020	0	141,212	0.0011	0.0088
Kalama Fall Chinook	366	Fall Cowlitz Hatchery	22	0	154,714	0	149,103	0	69,416	0	90,054	0	69,416	0.0023	0.0065
Sandy Fall Chinook (Early)	400	Fall Cowlitz Hatchery	22	0	494,765	0	612,667	0	577,224	0	548,356	0	577,224	0.0040	0.0077
Washougal Fall Chinook	407	Fall Cowlitz Hatchery	22	0	147,645	0	171,682	0	70,982	0	112,205	0	70,982	0.0030	0.0065
Lewis_EF Lewis Fall Chinook (Tule)	561	Fall Cowlitz Hatchery	22	0	55,893	0	45,908	0	16,532	0	125,931	0	16,532	0.0006	0.0075
Kalama Fall Chinook (Hatchery)	578	Fall Cowlitz Hatchery	22	5,040,033	1	0	0	199,310	1	1,603,648	1	199,310	1	0.0023	0.0065
Washougal Fall Chinook (Hatchery)	581	Fall Cowlitz Hatchery	22	4,002,563	1	0	0	175,623	1	2,001,281	1	175,623	1	0.0030	0.0065
Columbia Estuary_Mill-Aber-Germ Fall Chinook	664	Fall Cowlitz Hatchery	22	0	49,894	0	104,390	0	98,871	0	103,336	0	98,861	0.0127	0.0093
Lower Columbia_LC Tribs Fall Chinook (Tules-Oregon)	669	Fall Cowlitz Hatchery	22	0	83,037	0	118,297	0	79,297	0	81,005	0	79,297	0.0029	0.0009
Cowlitz_Toutle Fall Chinook (Hatchery)	722	Fall Cowlitz Hatchery	22	2,500,399	1	0	0	2,500,399	1	2,500,399	1	2,500,399	1	0.0017	0.0131
Lewis_NF Lewis Fall Chinook (Lower River Brights)	376	Lewis River Wild	23	0	923,111	0	939,845	0	932,935	0	928,150	0	932,935	0.0011	0.0199
Sandy Fall Chinook (Late)	401	Lewis River Wild	23	0	572,787	0	597,309	0	572,409	0	572,085	0	572,409	0.0040	0.0080
Willamette_Clackamas Spring Chinook(Hatchery)	415	Willamette River Hatchery	24	1,077,846	0	0	0	1,077,846	0	1,077,846	0	1,077,846	0	0.0026	0.0569
Willamette_McKenzie Spring Chinook	416	Willamette River Hatchery	24	1,265,568	202,286	1,265,568	202,747	1,265,568	202,286	1,265,568	202,134	1,265,568	202,134	0.0034	0.0247
Willamette_North Santiam Spring Chinook	419	Willamette River Hatchery	24	752,168	11,878	752,168	11,808	752,168	11,867	752,168	11,861	752,168	11,861	0.0054	0.0373
Willamette_South Santiam Spring Chinook	420	Willamette River Hatchery	24	1,123,163	16,241	1,007,544	22,563	1,007,544	22,269	1,007,544	22,163	1,007,544	22,163	0.0039	0.0373
Sandy Spring Chinook	402	Willamette River Hatchery	24	300,548	115,657	0	109,534	300,548	115,779	300,548	115,503	300,548	115,689	0.0058	0.0150
Willamette_MF Willamette Spring Chinook	417	Willamette River Hatchery	24	1,256,592	16,032	1,256,592	16,067	1,256,592	16,032	1,256,592	16,021	1,256,592	16,021	0.0062	0.0373
Willamette_Molalla Spring Chinook	418	Willamette River Hatchery	24	99,111	1,196	99,111	1,177	99,111	1,195	99,111	1,194	99,111	1,194	0.0042	0.0373
Columbia Estuary_Youngs Bay Spring Chinook (CEDC SAFE-Willa	566	Willamette River Hatchery	24	850,096	1	850,096	1	850,096	1	850,096	1	850,096	1	0.0053	0.0093
Willamette_Coast Fork Spring Chinook	730	Willamette River Hatchery	24	0	235	0	236	0	235	0	235	0	235	0.0042	0.0373
Willamette_Clackamas Spring Chinook	733	Willamette River Hatchery	24	0	26,524	0	30,228	0	26,558	0	26,528	0	26,528	0.0026	0.0599
Willamette_Callappoia Spring Chinook	736	Willamette River Hatchery	24	0	259	0	260	0	259	0	258	0	258	0.0042	0.0373
Cowlitz_Upper Cowlitz Spring Chinook	609	Cowlitz Spring Hatchery	25	1,263,553	18,428	833,112	27,177	833,112	27,677	624,833	34,940	833,112	27,677	0.0029	0.0513

Population Name	Pop ID	PSC stock	PSC Stk	Number of juveniles to below Bonneville Dam										SAR	
				NEPA Alt1		NEPA Alt2		NEPA Alt3		NEPA Alt4		NEPA Alt5			
				Hat	Nat	Hat	Nat	Hat	Nat	Hat	Nat	Hat	Nat	Hat	Nat
Lewis_NF Lewis Spring Chinook (Hatchery)	724	Cowlitz Spring Hatchery	25	1,351,351	0	297,000	0	500,444	0	0	0	500,444	0	0.0031	0.0280
Columbia Estuary_Deep River Spring Chinook (Cowlitz-Merwin-Gra	323	Cowlitz Spring Hatchery	25	362,250	1	362,250	1	362,250	1	362,250	1	362,250	1	0.0066	0.0093
Kalama Spring Chinook	367	Cowlitz Spring Hatchery	25	501,336	4,851	501,336	4,423	501,336	4,445	75,033	5,419	501,336	4,445	0.0053	0.0467
Lewis_NF Lewis Spring Chinook	378	Cowlitz Spring Hatchery	25	0	29,098	0	26,656	0	26,342	500,148	41,867	0	26,343	0.0031	0.0280
Columbia Lower Middle_Mainstem Columbia Spring Chinook (Ringo	693	Upriver Spring	999	327,825	0	327,825	0	327,825	0	327,825	0	327,627	0	0.0027	0.0476
Upper Middle Columbia Summer Chinook (Wells Hatchery)	694	Col Riv Summer	26	253,756	0	253,756	0	253,756	0	253,756	0	253,756	0	0.0175	0.0233
Upper Middle Columbia Mainstem Summer Chinook	819	Col Riv Summer	26	0	127,842	0	128,223	0	127,746	0	127,553	0	124,035	0.0149	0.0233
Upper Middle Columbia_Mainstem Summer Chinook (Turtle Rock-H	245	Col Riv Summer	26	403,829	0	403,829	0	403,829	0	403,829	0	403,829	0	0.0072	0.0233
Wenatchee Summer Chinook	249	Col Riv Summer	26	269,041	537,127	269,041	538,461	269,041	536,757	269,041	536,056	269,041	521,334	0.0176	0.0248
Methow Summer Chinook	236	Col Riv Summer	26	0	23,032	0	23,004	0	22,884	0	22,784	0	22,319	0.0103	0.0233
Methow Summer Chinook (Wells Hatchery)	826	Col Riv Summer	26	92,018	0	92,018	0	92,018	0	92,018	0	92,018	0	0.0103	0.0233
Okanogan-Similkimeen Summer Chinook	240	Col Riv Summer	26	155,004	430,365	155,004	431,332	155,004	430,199	155,004	452,618	270,642	434,755	0.0416	0.0246
Entiat Summer-Fall Chinook (Late Run)	678	Col Riv Summer	26	0	5,661	0	5,668	0	5,646	0	5,633	0	5,500	0.0687	0.0233
Snake Hells Canyon Fall Chinook	224	Lyons Ferry (Snake Fall)	29	1,566,741	95,179	89,121	60,451	89,121	61,777	89,121	61,754	29,677	73,484	0.0203	0.0439
Lower Columbia_Bonneville Fall Chinook (Hatchery)	390	Mid Col Brights	30	4,493,088	8	0	0	4,493,088	8	4,493,088	8	4,493,088	8	0.0029	0.0009
Klickitat Fall Chinook (URB-Hatchery)	270	Mid Col Brights	30	3,248,483	0	0	0	3,248,483	0	3,248,483	0	3,248,483	0	0.0066	0.0178
Little White Salmon Fall Chinook (URB-Hatchery)	277	Mid Col Brights	30	1,706,159	1	0	0	1,706,159	1	1,706,159	1	1,706,159	1	0.0058	0.0093
Umatilla Fall Chinook	300	Mid Col Brights	30	243,492	86,373	243,389	117,822	243,389	120,848	243,389	120,516	243,389	120,834	0.0202	0.0177
Umatilla Fall Chinook (Stepping Stone HAtchery)	809	Mid Col Brights	30	395,280	0	251,003	0	251,003	0	251,003	0	251,003	0	0.0034	0.0177
Columbia Estuary_Youngs Bay Fall Chinook (Rogue Brights-CEDC	320	Mid Col Brights	30	1,174,050	1	0	0	0	0	2,168,815	1	0	0	0.0069	0.0093
Grande Ronde_Lookingglass Creek Spring Chinook	213	Upriver Spring	999	84,823	3,622	84,823	3,562	84,823	3,562	84,823	3,562	110,527	3,744	0.0214	0.0271
Grande Ronde_Catherine Creek Spring Chinook	214	Upriver Spring	999	44,211	8,974	44,117	10,294	44,117	10,293	44,117	10,293	25,704	10,219	0.0142	0.0271
7-Grande Ronde_Lostine Spring Chinook	215	Upriver Spring	999	84,823	33,261	84,823	33,233	84,823	33,234	84,823	33,234	84,823	32,962	0.0261	0.0279
Grande Ronde_Upper Grande RondeSpring Chinook	216	Upriver Spring	999	85,337	4,327	85,337	4,299	85,337	4,299	85,337	4,299	85,337	4,265	0.0119	0.0271
9-Imnaha Spring-Summer Chinook	222	Upriver Spring	999	122,120	36,825	55,080	37,570	110,160	36,510	110,160	36,510	38,556	42,418	0.0244	0.0272
9a-Imnaha Spring-Summer Chinook (Stepping Stone Hatchery)	982	Upriver Spring	999	0	0	0	0	0	0	0	0	83,722	0	0.0244	0.0290
Snake Hells Canyon Spring Chinook (Oxbow Hatchery)	228	Upriver Spring	999	101,842	0	101,842	0	101,842	0	101,842	0	101,842	0	0.0085	0.0271
Entiat Spring Chinook	231	Upriver Spring	999	0	5,712	0	4,389	0	6,872	0	6,872	0	13,870	0.0042	0.0112
Entiat Spring Chinook (NFH)- Hatchery	232	Upriver Spring	999	0	0	0	0	0	0	0	0	0	0	0.0042	0.0120
Methow (Methow-Chewuch) Spring Chinook	234	Upriver Spring	999	174,523	42,515	73,212	43,622	73,212	43,622	73,212	43,622	43,631	33,994	0.0083	0.0121
Methow Spring Chinook (Winthrop Hatchery)	235	Upriver Spring	999	292,325	1	292,325	1	292,325	1	292,325	1	292,325	1	0.0062	0.0121
Methow (Twisp) Spring Chinook	821	Upriver Spring	999	88,950	10,884	61,324	9,692	61,324	9,692	61,324	9,692	24,346	9,432	0.0035	0.0121
Wenatchee (Chiwawa) Spring Chinook	247	Upriver Spring	999	192,999	37,196	192,999	34,094	192,999	34,095	192,999	34,095	136,708	37,605	0.0092	0.0112
Wenatchee Spring Chinook (Leavenworth NFH)- Hatchery	248	Upriver Spring	999	905,955	1	905,955	1	905,955	1	905,955	1	905,955	1	0.0035	0.0112
Wenatchee (Nason) Spring Chinook	822	Upriver Spring	999	0	10,811	0	15,725	0	15,725	0	15,725	0	16,400	0.0092	0.0112
Wenatchee (White) Spring Chinook	823	Upriver Spring	999	36,187	13,189	36,187	16,552	36,187	16,552	36,187	16,552	36,187	16,461	0.0039	0.0112
Hood Spring Chinook	261	Upriver Spring	999	119,615	2,821	119,510	6,481	119,536	6,545	57,400	6,156	119,485	6,436	0.0053	0.0728
Klickitat Spring Chinook	271	Upriver Spring	999	789,606	10,651	0	10,177	460,128	12,679	760,745	15,081	760,745	14,244	0.0021	0.0532
Little White Salmon Spring Chinook (Hatchery)	278	Upriver Spring	999	904,674	0	0	0	904,674	0	904,674	0	904,674	0	0.0038	0.0187
Wind Spring Chinook (Hatchery)	283	Upriver Spring	999	1,030,522	0	0	0	1,030,522	0	1,030,522	0	1,030,522	0	0.0036	0.0205
Deschutes Spring Chinook (RoundButte-Hatchery)	289	Upriver Spring	999	262,854	0	262,854	0	262,854	0	262,854	0	262,854	0	0.0041	0.0672
Deschutes Spring Chinook	290	Upriver Spring	999	612,481	14,210	612,481	14,310	612,481	14,180	612,481	14,263	612,481	14,077	0.0041	0.0710
John Day_Upper Mainstem John Day Spring Chinook	292	Upriver Spring	999	0	13,853	0	13,915	0	13,853	0	13,889	0	13,789	0.0101	0.0799
John Day_MF John Day Spring Chinook	802	Upriver Spring	999	0	13,013	0	13,083	0	13,012	0	13,054	0	12,940	0.0101	0.0799
John Day_NF John Day Spring Chinook	803	Upriver Spring	999	0	30,503	0	30,538	0	30,502	0	30,523	0	30,404	0.0101	0.0800
1-Tucannon Spring Chinook	296	Upriver Spring	999	58,324	9,552	58,324	9,266	58,324	9,258	58,324	9,258	33,323	9,679	0.0053	0.0278
Umatilla Spring Chinook	301	Upriver Spring	999	684,740	11,341	205,437	11,089	205,437	11,058	205,437	11,058	205,437	10,999	0.0091	0.0563
Walla Walla Spring Chinook	304	Upriver Spring	999	167,900	5,104	167,900	5,082	67,160	4,848	67,160	4,848	67,160	4,857	0.0051	0.0560

Appendix C – page 3 of 3

Population Name	Pop ID	PSC stock	PSC Stk	Number of juveniles to below Bonneville Dam										SAR	
				NEPA Alt1		NEPA Alt2		NEPA Alt3		NEPA Alt4		NEPA Alt5			
				Hat	Nat	Hat	Nat	Hat	Nat	Hat	Nat	Hat	Nat	Hat	Nat
Yakima_American Spring Chinook	308	Upriver Spring	999	0	4,299	0	4,332	0	4,339	0	4,339	0	4,311	0.0000	0.0684
Yakima_Naches Spring Chinook	309	Upriver Spring	999	0	15,373	0	15,609	0	15,622	0	15,622	0	15,395	0.0000	0.0681
Yakima_Upper Yakima Spring Chinook	312	Upriver Spring	999	545,614	80,120	545,614	80,115	545,614	80,115	545,614	80,115	545,614	79,730	0.0084	0.0505
5-Clearwater_Lolo Creek Spring Chinook	439	Upriver Spring	999	50,605	2,931	34,156	15,523	34,156	15,523	34,156	15,523	34,156	15,142	0.0024	0.0271
4-Clearwater_South Fork Clearwater Spring Chinook	442	Upriver Spring	999	0	8,533	0	8,557	0	8,557	0	8,557	0	8,432	0.0027	0.0271
6B-NF Clearwater_Spring Chinook (Dworshak-Hatchery)	443	Upriver Spring	999	357,389	0	357,389	0	357,389	0	357,389	0	357,389	0	0.0167	0.0271
6A-Clearwater_Middle Fork Clearwater Spring Chinook (Kooskia-Ha	444	Upriver Spring	999	204,222	0	204,222	0	204,222	0	204,222	0	204,222	0	0.0167	0.0271
25-Salmon_Lemhi River Spring Chinook	453	Upriver Spring	999	0	18,976	0	21,531	0	21,531	0	21,531	0	19,916	0.0000	0.0289
28-Salmon_East Fork Salmon River Spring-Summer Chinook	454	Upriver Spring	999	0	10,297	0	12,994	0	12,994	0	12,994	0	4,744	0.0000	0.0286
10A-Salmon_Little Salmon Spring Chinook (Rapid River-Hatchery)	455	Upriver Spring	999	930,443	0	930,443	0	930,443	0	930,443	0	930,443	0	0.0137	0.0246
31-Salmon_Upper Salmon Mainstem Spring Chinook	456	Upriver Spring	999	0	7,991	0	9,952	0	9,952	0	9,952	67,131	23,805	0.0076	0.0271
29-Salmon_Yankee Fork Spring Chinook	457	Upriver Spring	999	0	1,096	0	825	0	825	0	825	0	1,321	0.0101	0.0271
13-Salmon_EF-SF Johnson Creek Summer Chinook	458	Upriver Spring	999	34,615	23,554	34,615	23,523	34,615	23,523	34,615	23,523	34,615	23,183	0.0131	0.0286
11-Salmon_SF Salmon Summer Chinook	459	Upriver Spring	999	0	30,207	0	25,646	0	25,646	0	25,646	86,292	46,123	0.0127	0.0271
26-Salmon_Pahsimeroi Summer Chinook	460	Upriver Spring	999	0	6,421	0	12,262	0	12,262	0	12,262	96,900	27,698	0.0113	0.0271
1a-Clearwater_Lochsa Spring Chinook (Hatchery)	508	Upriver Spring	999	238,276	0	238,276	0	238,276	0	238,276	0	238,276	0	0.0127	0.0271
2-Asotin Spring-Summer Chinook	509	Upriver Spring	999	0	3,866	0	5,643	0	6,042	0	6,042	0	6,105	0.0253	0.0271
3-Grande Ronde_Wenaha Spring Chinook	510	Upriver Spring	999	0	12,863	0	14,488	0	14,510	0	14,510	0	14,648	0.0253	0.0278
2a-Clearwater_Lower Selway Spring Chinook (Hatchery)	518	Upriver Spring	999	102,111	0	102,111	0	102,111	0	102,111	0	102,111	0	0.0076	0.0271
4A-Clearwater_South Fork Clearwater Spring Chinook (Hatchery)	519	Upriver Spring	999	373,994	0	373,994	0	373,994	0	373,994	0	373,994	0	0.0127	0.0271
10-Salmon_Little Salmon Spring-Summer Chinook	522	Upriver Spring	999	0	7,629	0	7,602	0	7,602	0	7,602	0	7,554	0.0000	0.0271
11A-Salmon_SF Salmon Summer Chinook (McCall-Hatchery)	523	Upriver Spring	999	360,700	0	75,937	0	75,937	0	75,937	0	256,000	0	0.0193	0.0246
19+23-Salmon_Middle Fork_Upper Mainstem Spring-Summer Chin	524	Upriver Spring	999	0	10,421	0	10,451	0	10,451	0	10,451	0	10,061	0.0000	0.0290
12-Salmon_Secesh Spring Chinook	525	Upriver Spring	999	0	15,746	0	16,431	0	16,431	0	16,431	0	14,369	0.0000	0.0289
14-Salmon_Chamberlain Creek Spring Chinook	526	Upriver Spring	999	0	17,160	0	17,517	0	17,517	0	17,517	0	16,682	0.0000	0.0289
15-Salmon_Big Creek Spring Chinook	527	Upriver Spring	999	0	19,718	0	20,332	0	20,332	0	20,332	0	18,356	0.0000	0.0289
16-Salmon_Middle Fork_Lower Mainstem Spring-Summer Chinook	528	Upriver Spring	999	0	2,565	0	6,103	0	6,103	0	6,103	0	1,229	0.0000	0.0271
17-Salmon_Camas Creek Spring Chinook	529	Upriver Spring	999	0	2,813	0	3,080	0	3,080	0	3,080	0	1,705	0.0000	0.0290
18-Salmon_Loon Creek Spring Chinook	530	Upriver Spring	999	0	4,433	0	4,553	0	4,553	0	4,553	0	3,913	0.0000	0.0290
20-Salmon_Sulphur Creek Spring Chinook	531	Upriver Spring	999	0	5,497	0	5,519	0	5,519	0	5,519	0	5,375	0.0253	0.0290
21-Salmon_Bear Valley Spring Chinook	532	Upriver Spring	999	0	31,439	0	31,445	0	31,445	0	31,445	0	31,149	0.0000	0.0290
22-Salmon_Marsh Creek Spring Chinook	533	Upriver Spring	999	0	3,523	0	3,663	0	3,663	0	3,663	0	3,012	0.0000	0.0290
24-Salmon_NF Salmon River Spring Chinook	534	Upriver Spring	999	0	2,603	0	5,335	0	5,335	0	5,335	0	1,366	0.0000	0.0271
26A-Salmon_Pahsimeroi Summer Chinook (Pahsimeroi Hatchery)	535	Upriver Spring	999	339,796	0	129,200	0	129,200	0	129,200	0	355,300	0	0.0113	0.0271
27-Salmon_Lower Salmon Mainstem Spring Chinook	536	Upriver Spring	999	0	7,579	0	12,647	0	12,647	0	12,647	0	2,737	0.0000	0.0271
30-Salmon_Valley Spring Chinook	537	Upriver Spring	999	0	4,588	0	7,560	0	7,560	0	7,560	0	1,903	0.0000	0.0271
32-Salmon_Panther Creek Spring Chinook (Extirpated)	538	Upriver Spring	999	0	7	0	4	0	4	0	4	0	9	0.0076	0.0271
6-Grande Ronde_Minam Spring Chinook)	551	Upriver Spring	999	0	8,144	0	9,739	0	9,761	0	9,761	0	9,931	0.0253	0.0271
Okanogan Spring Chinook	597	Upriver Spring	999	0	1	0	1	0	1	0	1	0	0	0.0062	0.0130
White Salmon Spring Chinook	649	Upriver Spring	999	0	2	0	2	0	2	0	2	0	2	0.0043	0.0019
Wind Spring Chinook	652	Upriver Spring	999	0	5,430	0	2,694	0	5,441	0	5,430	0	5,428	0.0076	0.0205
1-Clearwater_Lochsa Spring Chinook	695	Upriver Spring	999	0	8,966	0	8,979	0	8,979	0	8,979	0	8,891	0.0077	0.0271
6-Clearwater_Lower Clearwater Spring Chinook	698	Upriver Spring	999	0	4,861	0	4,864	0	4,864	0	4,864	0	4,842	0.0000	0.0271
3-Clearwater_Upper Selway Spring Chinook	700	Upriver Spring	999	0	4,913	0	4,911	0	4,911	0	4,911	0	4,856	0.0016	0.0271
2-Clearwater_Lower Selway Spring Chinook	785	Upriver Spring	999	146,122	7,452	146,122	7,371	146,122	7,371	146,122	7,371	146,122	7,335	0.0016	0.0271
3a-Clearwater_Upper Selway Spring Chinook (Hatchery)	786	Upriver Spring	999	102,111	0	102,111	0	102,111	0	102,111	0	102,111	0	0.0021	0.0271
31A-Salmon_Upper Salmon Mainstem Spring Chinook (Sawtooth H	788	Upriver Spring	999	351,859	0	351,859	0	351,859	0	351,859	0	415,834	0	0.0038	0.0246
6C-Clearwater_Lower Mainstem_Spring Chinook (NPTH-Hatchery)	820	Upriver Spring	999	42,376	0	42,376	0	42,376	0	42,376	0	42,376	0	0.0100	0.0271
4-Clearwater_South Fork Clearwater_Newsome Creek Spring Chin	828	Upriver Spring	999	25,640	1,894	25,595	7,800	25,595	7,800	25,595	7,800	25,595	7,655	0.0027	0.0271

Appendix D - PSC Chinook Model Stock Groups

Stock No.	PSC Stock Name	Stock Code
1	Alaska Southeast	AKS
2	North/Central BC	NTH
3	Fraser Early	FRE
4	Fraser Late	FRL
5	WCVI Hatchery	RBH
6	WCVI Natural	RBT
7	Upper Georgia Strait	GSQ
8	Lower Georgia Strait Natural	GST
9	Lower Georgia Strait Hatchery	GSH
10	Nooksack Fall Fingerling	NKF
11	Puget Sound Hatchery Fingerling	PSF
12	Puget Sound Natural Fingerling	PSN
13	Puget Sound Hatchery Yearling	PSY
14	Nooksack Spring Yearling	NKS
15	Skagit Wild	SKG
16	Stillaguamish Wild	STL
17	Snohomish Wild	SNO
18	WA Coastal Hatchery	WCH
19	Col Riv Upriver Bright	URB
20	Spring Creek Hatchery	SPR
21	Lower Bonneville Hatchery	BON
22	Fall Cowlitz Hatchery	CWF
23	Lewis River Wild	LRW
24	Willamette River Hatchery	WSH
25	Cowlitz Spring Hatchery	CWS
26	Col Riv Summer	SUM
27	Oregon Coastal Fall	ORC
28	WA Coastal Wild	WCN
29	Lyons Ferry (Snake Fall)	LYF
30	Mid Col Brights	MCB

Appendix E - PSC Chinook Model Fisheries
(Columbia River fisheries excluded from list)

Fishery no.	Fishery name
1	Alaska troll
2	North troll
3	Central troll
4	WCVI troll
5	WA/OR troll
6	Strait of Georgia troll
7	Alaska net
8	Noth net
9	Central net
10	WCVI net
11	Juan de Fuca net
12	Puget Sound North net
13	Puget Sound South net
14	Washington Coast net
15	Columbia River net
16	Johnstone Strait net
17	Fraser net
18	Alaska sport
19	North/Central sport
20	WCVI sport
21	Washington ocean sport
22	Puget Sound North sport
23	Puget Sound South sport
24	Strait of Georgia sport

Appendix F - PSC Chinook Model Incidental Mortality Rates

Fishery no.	Sub-legal release mortality	Drop-off mortality
1	0.211	0.008
2	0.211	0.017
3	0.211	0.017
4	0.211	0.017
5	0.211	0.017
6	0.211	0.017
7	0.9	0
8	0.9	0
9	0.9	0
10	0.9	0
11	0.9	0
12	0.9	0
13	0.9	0
14	0.9	0
15	0.9	0
16	0.9	0
17	0.9	0
18	0.123	0.036
19	0.123	0.036
20	0.123	0.069
21	0.123	0.069
22	0.123	0.145
23	0.123	0.145
24	0.322	0.069
25	0.123	0.069

Appendix G - Sliding Scale Harvest Rate Regimes for Upriver Spring Chinook and Upper Columbia Summer Chinook in the Columbia River

Spring Management Period Chinook Harvest Rate Schedule

Tot upriver spr & Snk R. sum [1/]	Snk R. nat spr/sum [2/]	Treaty Z-6 harv rate	NT nat harv rate [3/]	Tot nat harv rate	NT nat limited harv rate
<27,000	<2,700	5.0%	<0.5%	<5.5%	0.5%
27,000	2,700	5.0%	0.5%	5.5%	0.5%
33,000	3,300	5.0%	1.0%	6.0%	0.5%
44,000	4,400	6.0%	1.0%	7.0%	0.5%
55,000	5,500	7.0%	1.5%	8.5%	1.0%
82,000	8,200	7.0%	2.0%	9.0%	1.5%
109,000	10,900	8.0%	2.0%	10.0%	
141,000	14,100	9.0%	2.0%	11.0%	
217,000	21,700	10.0%	2.0%	12.0%	
271,000	27,100	11.0%	2.0%	13.0%	
326,000	32,600	12.0%	2.0%	14.0%	
380,000	38,000	13.0%	2.0%	15.0%	
434,000	43,400	14.0%	2.0%	16.0%	
488,000	48,800	15.0%	2.0%	17.0%	

1/ Total upriver runsize of spring chinook plus Snake River summer chinook.
2/ If the Snake River spring/summer chinook run size is <10% of the total upriver run size, the harvest rate is to based on the Snake River natural spring/summer run size.
3/ Non-treaty harvest rate on natural populations.

Appendix G - continued
Sliding Scale Harvest Rate Regimes for Upriver Spring Chinook and Upper Columbia Summer Chinook in the Columbia River

Upper Columbia Summer Chinook Harvest Rate Schedule (Adapted from table on page 39 in ODFW/WDFW 2006a)

Tot upriver sum run (wo Snk sum)	Treaty rate	NT rate	Treaty factor to apply (reduces rate)1/	NT factor to apply (reduces rate)1/	Adj Treaty rate	Adj NT rate	Total
0	0.000	0.000	1.000	1.000	0.000	0.000	0.000
5,000	0.050	0.020	1.000	1.000	0.050	0.020	0.070
16,000	0.050	0.013	1.000	1.000	0.050	0.013	0.063
29,000	0.100	0.050	1.000	1.000	0.100	0.050	0.150
32,000	0.100	0.060	1.000	1.000	0.100	0.060	0.160
36,250	0.100	0.070	1.000	1.000	0.100	0.070	0.170
38,250	0.121	0.121	1.000	0.750	0.121	0.091	0.212
40,250	0.140	0.140	1.000	0.750	0.140	0.105	0.245
42,250	0.157	0.157	0.940	0.750	0.147	0.118	0.265
44,250	0.172	0.172	0.940	0.750	0.162	0.129	0.291
46,250	0.186	0.186	0.940	0.750	0.175	0.140	0.315
48,250	0.199	0.199	0.940	0.750	0.188	0.150	0.337
50,000	0.368	0.368	0.650	0.450	0.239	0.165	0.404
55,000	0.368	0.368	0.650	0.450	0.239	0.166	0.405
60,000	0.369	0.369	0.650	0.450	0.240	0.166	0.406
65,000	0.369	0.369	0.650	0.450	0.240	0.166	0.406
70,000	0.370	0.370	0.650	0.450	0.240	0.166	0.407
75,000	0.370	0.370	0.650	0.450	0.241	0.167	0.407
80,000	0.370	0.370	0.650	0.450	0.241	0.167	0.407
85,000	0.371	0.371	0.650	0.450	0.241	0.167	0.408
90,000	0.371	0.371	0.650	0.450	0.241	0.167	0.408

1/Applied a reduction factor to reduce harvest rates at high run sizes because fishery is developing and it is not clear that the full rate can be applied.

Note: The adjustments defined above did not come into play because of the relatively small summer chinook run sizes modeled.

Appendix H - Derivation of Chinook Contribution Rates Taking into Account Incidental Mortality Rates

The total marine exploitation rate, including incidental mortalities, is computed using the procedure described below. This is then used to compute contribution rates (equation 7 in the main body of text) that take into account incidental mortalities

The CTC Model base period data represents the proportion of the vulnerable cohort that is landed by the fishery:

$$BPER_{c,f,a} = \frac{C_{c,f,a}}{N_{c,a} * PV_{f,a}} = \frac{C_{c,f,a}}{N_{c,a} * (1 - PNV_{f,a})} \quad \text{(a)}$$

The Landed Catch Exploitation Rate (ER) on the entire cohort is:

$$ER_{c,f,a} = \frac{C_{c,f,a}}{N_{c,a}} = BPER_{c,f,a} * PV_{f,a} \quad \text{(b)}$$

During the CTC Model Base Period, incidental mortality consisted of two components: (1) Release Mortality of Sub-Legals; and (2) Drop-Off Mortality.

Release Mortality of Sub-Legals:

For ocean fisheries, fish that are landed, but below minimum size limits are released. Some of these fish die as a result. The CTC Model basically computes these mortalities assuming that the encounter rate for legals and sub-legal-size fish is the same:

$$RMER_{c,f,a} = ER_{c,f,a} * (PNV_{f,a} * RM_{f,SL}) \quad \text{(c)}$$

Define

$$RM_{f} = PNV_{f,a} * RM_{f,SL} \quad \text{(d)}$$

Drop-Off Mortality:

Drop-Off Mortality is the proportion of fish encountered by the fishery which is killed as a result, but which does not accounted for by landed catch (e.g., predation loss, hooked in a location that would cause lethal injury but manage to escape). Drop-off mortality should be applied to all fish encountered in the fishery. Assuming that both legal and sub-legal sized fish are encountered at the same rate(DO). The exploitation rate associated with Drop Off Mortality is:

$$DOER_{c,f,a} = DO_{f} * ER_{c,f,a} \quad \text{(e)}$$

Therefore, the total exploitation rate for a fishery is:

$$TER_{c,f,a} = ER_{c,f,a} + RMER_{c,f,a} + DOER_{c,f,a} = ER_{c,f,a} * (1 + RM_{f,} + DO_{f}) \qquad \text{(f)}$$

To consider total mortalities in equation 7 in the main body of text, replace the BPERs with the TERs as shown above.

Appendix I - Coho Populations Modeled and Number of Juveniles Arriving to Below Bonneville Dam

Population Name	Pop ID	FRAM stock	FRAM NO.	Number of juveniles to below Bonneville Dam										SAR	
				NEPA Alt1		NEPA Alt2		NEPA Alt3		NEPA Alt4		NEPA Alt5			
				Hat	Nat	Hat	Nat	Hat	Nat	Hat	Nat	Hat	Nat	Hat	Nat
Columbia Estuary_Big Creek Coho (Hatchery)	329	Columbia River Early Hatchery	165	582,120	0	0	0	0	0	0	0	0	0	0.0108	0.0373
Elochoman Coho (Early- Type S Hatchery)	341	Columbia River Early Hatchery	165	415,012	0	0	0	0	0	415,012	0	0	0	0.0205	0.0485
Kalama Coho (Early- Type S)	371	Columbia River Early Hatchery	165	353,144	0	0	0	0	0	202,624	0	0	0	0.0111	0.1651
Lower Columbia_Bonneville Coho (Hatchery)	396	Columbia River Early Hatchery	165	1,247,734	1	0	0	1,247,734	1	500,032	1	1,247,734	1	0.0177	0.0093
Sandy Coho (Hatchery)	404	Columbia River Early Hatchery	165	700,081	0	0	0	700,081	0	700,081	0	700,081	0	0.0139	0.0327
Willamette_Clackamas-Eagle Creek Coho (Hatchery)	423	Columbia River Early Hatchery	165	349,067	1	0	0	349,067	1	349,067	1	349,067	1	0.0252	0.0093
Columbia Estuary_Big Creek Coho	603	Columbia River Early Hatchery	165	0	6,093	0	9,051	0	6,943	138,600	7,345	0	6,943	0.0108	0.0373
Grays Coho (Early-Type S-Hatchery)	685	Columbia River Early Hatchery	165	150,381	0	0	0	0	0	150,381	0	0	0	0.0051	0.0485
Willamette_Lower Willamette Tribs Coho	731	Columbia River Early Hatchery	165	0	326	0	2,539	0	326	0	326	0	326	0.0254	0.0504
Willamett_Upper Willamette Tribs coho	732	Columbia River Early Hatchery	165	0	120	0	309	0	120	0	120	0	120	0.0254	0.0504
Lewis_NF Lewis Coho (Early-Type S Hatchery)	781	Columbia River Early Hatchery	165	879,967	0	439,984	0	115,785	0	115,785	0	115,785	0	0.0295	0.0448
Cowlitz_Toutle Coho (Early-Type S Hatchery)	796	Columbia River Early Hatchery	165	801,287	0	0	0	56,034	0	0	0	56,034	0	0.0381	0.1278
Cowlitz_Toutle Coho (Early-Type S Natural)	797	Columbia River Early Hatchery	165	0	22,053	0	20,965	0	7,527	560,340	18,712	0	7,527	0.0381	0.1278
Methow Coho	237	Columbia River Early Hatchery	165	240,754	12,847	240,754	12,847	240,754	12,847	240,754	12,847	240,754	12,847	0.0063	0.0112
Wenatchee Coho	250	Columbia River Early Hatchery	165	575,374	101,033	575,374	101,033	575,374	101,033	575,374	101,033	575,374	101,033	0.0175	0.0112
Litte White Coho (Hatchery)	279	Columbia River Early Hatchery	165	0	0	0	0	0	0	0	0	0	0	0.0384	0.0100
Umatilla Coho	302	Columbia River Early Hatchery	165	0	11,791	0	0	0	11,791	0	11,791	0	11,791	0.0085	0.0550
Yakima_Coho (Hatchery)	314	Columbia River Early Hatchery	165	286,712	0	0	0	286,712	0	286,712	0	286,712	0	0.0192	0.0336
Yakima_Upper Yakima-Naches Coho	315	Columbia River Early Hatchery	165	302,885	51,775	0	4,973	302,885	51,775	302,885	51,775	302,885	51,775	0.0192	0.0336
Columbia Gorge_Columbia Gorge Tributaries Coho (Oregon)	394	Columbia River Early Hatchery	165	0	1,293	0	879	0	975	0	693	0	975	0.0291	0.0467
Hood Coho	395	Columbia River Early Hatchery	165	0	710	0	312	0	228	0	172	0	228	0.0000	0.0467
Clearwater Coho	446	Columbia River Early Hatchery	165	429,469	18,095	0	5,340	429,469	18,095	429,469	18,095	429,469	18,095	0.0061	0.0224
Fifteenmile Creek Coho	648	Columbia River Early Hatchery	165	0	627	0	312	0	385	0	238	0	385	0.0000	0.0467
White Salmon Coho (Early- Type S)	651	Columbia River Early Hatchery	165	0	2,909	0	9,214	0	7,793	0	8,475	0	7,793	0.0000	0.0429
Columbia Gorge_Columbia Gorge Tributaries Coho (WA)	653	Columbia River Early Hatchery	165	0	1,142	0	1,924	0	880	0	677	0	880	0.0000	0.0426
Umatilla Coho (Bonneville-Cascade-Oxbow-Hatchery)	686	Columbia River Early Hatchery	165	1,132,200	0	0	0	1,132,200	0	1,132,200	0	1,132,200	0	0.0085	0.0550
Columbia Estuary_Youngs Bay Tribs Coho	328	Youngs Bay Hatchery	167	0	4,052	0	6,749	0	4,024	0	4,339	0	4,024	0.0000	0.0373
Columbia Estuary_Youngs Bay Coho (Bonneville-Sandy-Hat	331	Youngs Bay Hatchery	167	1,726,186	0	0	0	1,726,186	0	2,701,857	0	1,726,186	0	0.0128	0.0373
Columbia Estuary_Chinook River Coho	333	Youngs Bay Hatchery	167	0	1,406	0	1,171	0	1,388	0	1,499	0	1,388	0.0181	0.0373
Columbia Estuary_Deep River Coho (Early-Type S-Grays-Ha	334	Youngs Bay Hatchery	167	401,310	0	203,962	0	401,310	0	401,310	0	401,310	0	0.0181	0.0373

Appendix I – page 2 of 2

Population Name	Pop ID	PSC stock	PSC Stk	Number of juveniles to below Bonneville Dam										SAR	
				NEPA Alt1		NEPA Alt2		NEPA Alt3		NEPA Alt4		NEPA Alt5			
				Hat	Nat	Hat	Nat	Hat	Nat	Hat	Nat	Hat	Nat	Hat	Nat
Columbia Estuary_Gnat Creek Coho	393	Youngs Bay Hatchery	167	0	1,056	0	373	0	371	0	527	0	371	0.0108	0.0373
Sandy Coho	403	Sandy Early Wild	169	0	211,931	0	303,795	0	225,870	0	242,532	0	225,870	0.0139	0.0327
Willamette_Upper Clackamas Coho	421	Clakamas Early Wild	171	0	29,280	0	29,285	0	29,280	0	29,280	0	29,280	0.0254	0.0540
Willamette_Lower Clackamas Coho	422	Clakamas Early Wild	171	0	5,883	0	3,888	0	5,883	0	5,883	0	5,883	0.0254	0.0504
Columbia Estuary_Clatskanie Coho (Late-Type N)	327	Columbia River Late Hatchery	175	0	4,035	0	6,779	0	6,004	0	4,465	0	6,004	0.0000	0.0373
Columbia Estuary_Bernie Creek Coho (Late-Type N-FFA)	335	Columbia River Late Hatchery	175	16,538	0	0	0	16,538	0	16,538	0	16,538	0	0.0181	0.0373
Elochoman Coho (Late- Type N)	342	Columbia River Late Hatchery	175	496,062	14,614	0	16,047	200,182	13,228	146,475	15,050	200,182	13,228	0.0205	0.0485
Cowlitz_Lower Cowlitz Coho (Type N)	358	Columbia River Late Hatchery	175	0	21,070	596,924	19,988	1,432,622	20,422	850,021	22,107	1,432,622	20,422	0.0240	0.1278
Kalama Coho (Late- Type N)	370	Columbia River Late Hatchery	175	350,828	0	0	0	0	0	202,624	0	0	0	0.0111	0.1651
Lewis_NF Lewis Coho (Late-Type N)	381	Columbia River Late Hatchery	175	40,023	47,622	40,023	46,525	40,023	45,607	231,012	39,449	40,023	45,607	0.0430	0.0467
Washougal Coho	409	Columbia River Late Hatchery	175	497,876	13,120	0	12,698	202,624	12,977	225,781	14,260	202,624	12,977	0.0277	0.0532
Kalama Coho (Natural)	580	Columbia River Late Hatchery	175	0	2,019	0	1,342	0	1,727	0	1,420	0	1,727	0.0279	0.1651
Washougal Coho (Stepping Stone Hatchery)	582	Columbia River Late Hatchery	175	0	0	0	0	0	0	272,095	0	0	0	0.0277	0.0570
Cowlitz Upper Cowlitz Coho	612	Columbia River Late Hatchery	175	95,508	72,040	95,508	56,010	95,508	56,010	95,508	56,010	95,508	56,010	0.0662	0.0560
Cowlitz_Coweeman Coho (Type N)	619	Columbia River Late Hatchery	175	0	9,383	0	11,793	0	11,646	0	11,716	0	11,646	0.0240	0.1322
Lewis_EF Lewis Coho	626	Columbia River Late Hatchery	175	0	38,725	0	45,857	0	46,293	0	45,929	0	46,293	0.0361	0.0463
Grays Coho (Late-Type N)	667	Columbia River Late Hatchery	175	0	10,665	0	10,930	0	10,665	155,925	17,809	0	10,665	0.0048	0.0532
Columbia Estuary_Mill-Aber-Germ Coho (Type N)	681	Columbia River Late Hatchery	175	0	31,201	0	44,797	0	35,592	0	32,722	0	35,592	0.0000	0.0373
Columbia Estuary_Scappoose Coho	714	Columbia River Late Hatchery	175	0	4,450	0	4,643	0	4,413	0	6,636	0	4,413	0.0000	0.0373
Lewis_NF Lewis Coho (Late-Type N Hatchery)	777	Columbia River Late Hatchery	175	815,127	0	301,041	0	75,260	0	0	0	75,260	0	0.0295	0.0448
Cowlitz_Lower Cowlitz Coho (Type N Hatchery)	795	Columbia River Late Hatchery	175	3,223,393	0	0	0	0	0	850,021	0	0	0	0.0240	0.1278
Klickitat Coho (Lewis-Hatchery)	272	Columbia River Late Hatchery	175	1,114,707	0	0	0	1,114,707	0	1,114,707	0	1,114,707	0	0.0086	0.0569
Klickitat Coho (Washougal-Hatchery)	273	Columbia River Late Hatchery	175	2,215,675	0	0	0	0	0	0	0	0	0	0.0029	0.0518
Klickitat Coho	643	Columbia River Late Hatchery	175	0	8,689	0	38	0	1,863	0	1,677	0	1,863	0.0069	0.0569

Appendix J - FRAM Coho Model Stock Groups

FRAM Stk No.	Stock Name	Code
1	Nooksack River Wild	nkskrw
3	Kendall Creek Hatchery	kendlh
5	Skookum Creek Hatchery	skokmh
7	Lummi Ponds Hatchery	lumpdh
9	Bellingham Bay Net Pens	bhambh
11	Samish River Wild	samshw
13	Area 7/7A Independent Wild	ar77aw
15	Whatcom Creek Hatchery	whatch
17	Skagit River Wild	skagtw
19	Skagit River Hatchery	skagth
21	Baker (Skagit) Hatchery	skgbkh
23	Baker (Skagit) Wild	skgbkw
25	Swinomish Channel Hatchery	swinch
27	Oak Harbor Net Pens	oakhbh
29	Stillaguamish River Wild	stillw
31	Stillaguamish River Hatchery	stillh
33	Tulalip Hatchery	tuliph
35	Snohomish River Wild	snohow
37	Snohomish River Hatchery	snohoh
39	Area 8A Net Pens	ar8anh
41	Port Gamble Net Pens	ptgamh
43	Port Gamble Bay Wild	ptgamw
45	Area 12/12B Wild	ar12bw
47	Quilcene Hatchery	qlcnbh
49	Quilcene Bay Net Pens	qlcenh
51	Area 12A Wild	ar12aw
53	Hoodsport Hatchery	hoodsh
55	Area 12C/12D Wild	ar12dw
57	George Adams Hatchery	gadamh
59	Skokomish River Wild	skokrw
61	Area 13B Misc. Wild	ar13bw
63	Deschutes R. (WA) Wild	deschw
65	South Puget Sound Net Pens	ssdnph
67	Nisqually River Hatchery	nisqlh
69	Nisqually River Wild	nisqlw
71	Fox Island Net Pens	foxish
73	Minter Creek Hatchery	mintch
75	Area 13 Miscellaneous Wild	ar13mw
77	Chambers Creek Hatchery	chambh
79	Area 13 Misc. Hatchery	ar13mh
81	Area 13A Miscellaneous Wild	ar13aw
83	Puyallup River Hatchery	puyalh
85	Puyallup River Wild	puyalw
87	Area 11 Hatchery	are11h
89	Area 11 Miscellaneous Wild	ar11mw
91	Area 10E Hatchery	ar10eh
93	Area 10E Miscellaneous Wild	ar10ew
95	Green River Hatchery	greenh
97	Green River Wild	greenw
99	Lake Washington Hatchery	lakwah

Appendix J – page 2 of 3

FRAM Stk No.	Stock Name	Code
101	Lake Washington Wild	lakwaw
103	Area 10 H inc. Ebay,SeaAq NP	are10h
105	Area 10 Miscellaneous Wild	ar10mw
107	Dungeness River Wild	dungew
109	Dungeness Hatchery	dungeh
111	Elwha River Wild	elwhaw
113	Elwha Hatchery	elwhah
115	East JDF Miscellaneous Wild	ejdfmw
117	West JDF Miscellaneous Wild	wjdfmw
119	Port Angeles Net Pens	ptangh
121	Area 9 Miscellaneous Wild	area9w
123	Makah Coastal Wild	makahw
125	Makah Coastal Hatchery	makahh
127	Quillayute R Summer Natural	quilsw
129	Quillayute R Summer Hatchery	quilsh
131	Quillayute River Fall Natural	quilfw
133	Quillayute River Fall Hatchery	quilfh
135	Hoh River Wild	hohrvw
137	Hoh River Hatchery	hohrvh
139	Queets River Fall Natural	quetfw
141	Queets River Fall Hatchery	quetfh
143	Queets R Supplemental Hat.	quetph
145	Quinault River Fall Natural	quinfw
147	Quinault River Fall Hatchery	quinfh
149	Chehalis River Wild	chehlw
151	Chehalis River (Bingham) Hat.	chehlh
153	Humptulips River Wild	humptw
155	Humptulips River Hatchery	humpth
157	Grays Harbor Misc. Wild	gryhmw
159	Grays Harbor Net Pens	gryhbh
161	Willapa Bay Natural	willaw
163	Willapa Bay Hatchery	willah
165	Columbia River Early Hatchery	colreh
167	Youngs Bay Hatchery	youngh
169	Sandy Early Wild	sandew
171	Clakamas Early Wild	clakew
173	Clakamas Late Wild	claklw
175	Columbia River Late Hatchery	colrlh
177	Oregon North Coastal Hat.	orenoh
179	Oregon North Coastal Wild	orenow
181	Oregon No. Mid Coastal Hat.	orenmh
183	Oregon No. Mid Coastal Wild	orenmw
185	Oregon So. Mid Coastal Hat.	oresmh
187	Oregon So. Mid Coastal Wild	oresmw
189	Oregon Anadromous Hatchery	oranah
191	Oregon Aqua-Foods Hatchery	oraqah
193	Oregon South Coastal Hat.	oresoh
195	Oregon South Coastal Wild	oresow
197	California North Coastal Hatch	calnoh
199	California North Coastal Wild	calnow

Appendix J – page 3 of 3

FRAM Stk No.	Stock Name	Code
201	California Central Coastal Hat.	calcnh
203	California Central Coastal Wild	calcnw
205	Georgia Strait Mainland Hat.	gsmndh
207	Georgia Strait Mainland Wild	gsmndw
209	Georgia Strait Vanc. Is. Hat.	gsvcih
211	Georgia Strait Vanc. Is. Wild	gsvciw
213	Johnstone Strait Hatchery	jnstrh
215	Johnstone Strait Wild	jnstrw
217	SW Vancouver Island Hat.	swvcih
219	SW Vancouver Island Wild	swvciw
221	NW Vancouver Island Hatchery	nwvcih
223	NW Vancouver Island Wild	nwvciw
225	Lower Fraser River Hatchery	frslwh
227	Lower Fraser River Wild	frslww
229	Upper Fraser River Hatchery	frsuph
231	Upper Fraser River Wild	frsupw
233	BC Central Coast Hat./Wild	bccnhw
235	BC North Coast Hatchery/Wild	bcnchw
237	Trans Boundary Hatchery/Wild	tranhw
239	Alaska No. Inside Hat./Wild	niakhw
241	Alaska No. Outside Hat./Wild	noakhw
243	Alaska So. Inside Hat./Wild	siakhw
245	Alaska So. Outside Hat./Wild	soakhw

Appendix K - FRAM Coho Model Fisheries

Fishery number	Coho FRAM Fishery Name	Abbrev Name
1	North California Coast Terminal Catch	No Cal Trm
2	Central California Coast Terminal Catch	Cn Cal Trm
3	Fort Bragg Sport	Ft Brg Spt
4	Fort Bragg Troll	Ft Brg Trl
5	KMZ Sport (Klamath Management Zone)	Ca KMZ Spt
6	KMZ Troll (Klamath Management Zone)	Ca KMZ Trl
7	Southern California Sport	So Cal Spt
8	Southern California Troll	So Cal Trl
9	South Oregon Coast Terminal Catch	So Ore Trm
10	Oregon Private Hatchery Terminal Catch	Or Prv Trm
11	South-Mid Oregon Coast Terminal Catch	SMi Or Trm
12	North-Mid Oregon Coast Terminal Catch	NMi Or Trm
13	North Oregon Coast Terminal Catch	No Ore Trm
14	Mid-North Oregon Coast Terminal Catch	Or Cst Trm
15	Brookings Sport	Brkngs Spt
16	Brookings Troll	Brkngs Trl
17	Newport Sport	Newprt Spt
18	Newport Troll	Newprt Trl
19	Coos Bay Sport	Coos B Spt
20	Coos Bay Troll	Coos B Trl
21	Tillamook Sport	Tillmk Spt
22	Tillamook Troll	Tillmk Trl
23	Buoy 10 Sport (Columbia River Estuary)	Buoy10 Spt
24	Lower Columbia River Mainstem Sport	L ColR Spt
25	Lower Columbia River Net (Excl Youngs Bay)	L ColR Net
26	Youngs Bay Net	Yngs B Net
27	Below Bonneville Oregon Tributary Sport	LCROrT Spt
28	Clackamas River Sport	Clackm Spt
29	Sandy River Sport	SandyR Spt
30	Below Bonneville Washington Tributary Sport	LCRWaT Spt
31	Above Bonneville Sport	UpColR Spt
32	Above Bonneville Net	UpColR Net
33	Area 1 (Illwaco) & Astoria Sport	A1-Ast Spt
34	Area 1 (Illwaco) & Astoria Troll	A1-Ast Trl
35	Area 2 Troll Non-treaty (Westport)	Area2TrlNT
36	Area 2 Troll Treaty (Westport)	Area2TrlTR
37	Area 2 Sport (Westport)	Area 2 Spt
38	Area 3 Troll Non-treaty (LaPush)	Area3TrlNT
39	Area 3 Troll Treaty (LaPush)	Area3TrlTR
40	Area 3 Sport (LaPush)	Area 3 Spt
41	Area 4 Sport (Neah Bay)	Area 4 Spt
42	Area 4/4B (Neah Bay PFMC Regs) Troll Non-treaty	A4/4BTrlNT
43	Area 4/4B (Neah Bay PFMC Regs) Troll Treaty	A4/4BTrlTR
44	Area 5, 6, 6C Troll (Strait of Juan de Fuca)	A 5-6C Trl
45	Willapa Bay (Area 2.1) Sport	Willpa Spt
46	Willapa Tributary Sport	Wlp Tb Spt
47	Willapa Bay & FW Trib Net	WlpaBT Net
48	Grays Harbor (Area 2.2) Sport	GryHbr Spt
49	South Grays Harbor Sport (Westport Boat Basin)	SGryHb Spt
50	Grays Harbor Estuary Net	GryHbr Net

Fishery number	Coho FRAM Fishery Name	Abbrev Name
51	Humptulips River Sport	Hump R Spt
52	Lower Chehalis River Net	LwCheh Net
53	Humptulips River Ceremonial & Subsistence	Hump R C&S
54	Chehalis River Sport	Chehal Spt
55	Humptulips River Net	Hump R Net
56	Upper Chehalis River Net	UpCheh Net
57	Chehalis River Ceremonial & Subsistence	Chehal C&S
58	Wynochee River Sport	Wynoch Spt
59	Hoquiam River Sport	Hoquam Spt
60	Wishkah River Sport	Wishkh Spt
61	Satsop River Sport	Satsop Spt
62	Quinault River Sport	Quin R Spt
63	Quinault River Net	Quin R Net
64	Quinault River Ceremonial & Subsistence	Quin R C&S
65	Queets River Sport	Queets Spt
66	Clearwater River Sport	Clrwtr Spt
67	Salmon River (Queets) Sport	Salm R Spt
68	Queets River Net	Queets Net
69	Queets River Ceremonial & Subsistence	Queets C&S
70	Quillayute River Sport	Quilly Spt
71	Quillayute River Net	Quilly Net
72	Quillayute River Ceremonial & Subsistence	Quilly C&S
73	Hoh River Sport	Hoh R Spt
74	Hoh River Net	Hoh R Net
75	Hoh River Ceremonial & Subsistence	Hoh R C&S
76	Makah Tributary Sport	Mak FW Spt
77	Makah Freshwater Net	Mak FW Net
78	Makah Ceremonial & Subsistence	Makah C&S
79	Area 4, 4A Net (Neah Bay)	A 4-4A Net
80	Area 4B, 5, 6C Net Nontreaty (Strait of JDF)	A4B6CNetNT
81	Area 4B, 5, 6C Net Treaty (Strait of JDF)	A4B6CNetTR
82	Area 6D Dungeness Bay/River Net Nontreaty	Ar6D NetNT
83	Area 6D Dungeness Bay/River Net Treaty	Ar6D NetTR
84	Elwha River Net	Elwha Net
85	West JDF Straits Tributary Net	WJDF T Net
86	East JDF Straits Tributary Net	EJDF T Net
87	Area 7, 7A Net Nontreaty (San Juan Islands)	A6-7ANetNT
88	Area 7, 7A Net Treaty (San Juan Islands)	A6-7ANetTR
89	East JDF Straits Tributary Sport	EJDF FWSpt
90	West JDF Straits Tributary Sport	WJDF FWSpt
91	Area 5 Marine Sport (Sekiu)	Area 5 Spt
92	Area 6 Marine Sport (Port Angeles)	Area 6 Spt
93	Area 7 Marine Sport (San Juan Islands)	Area 7 Spt
94	Dungeness River Sport	Dung R Spt
95	Elwha River Sport	ElwhaR Spt
96	Area 7B-7C-7D Net Nontreaty (Bellingham Bay)	A7BCDNetNT
97	Area 7B-7C-7D Net Treaty (Bellingham Bay)	A7BCDNetTR
98	Nooksack River Net	Nook R Net
99	Nooksack River Sport	Nook R Spt
100	Samish River Sport	Samh R Spt

Appendix K – page 3 of 4

Fishery number	Coho FRAM Fishery Name	Abbrev Name
101	Area 8 Skagit Marine Net Nontreaty	Ar 8 NetNT
102	Area 8 Skagit Marine Net Treaty	Ar 8 NetTR
103	Skagit River Net	Skag R Net
104	Skagit River Test Net	SkgR TsNet
105	Swinomish Channel Net	SwinCh Net
106	Area 8.1 Marine Sport	Ar 8-1 Spt
107	Area 9 Marine Sport (Admiralty Inlet)	Area 9 Spt
108	Skagit River Sport	Skag R Spt
109	Area 8A Stillaguamish/Snohomish Net Nontreaty	Ar8A NetNT
110	Area 8A Stillaguamish/Snohomish Net Treaty	Ar8A NetTR
111	Area 8D Tulalip Bay Net Nontreaty	Ar8D NetNT
112	Area 8D Tulalip Bay Net Treaty	Ar8D NetTR
113	Stillaguamish River Net	Stil R Net
114	Snohomish River Net	Snoh R Net
115	Area 8.2 Marine Sport	Ar 8-2 Spt
116	Stillaguamish River Sport	Stil R Spt
117	Snohomish River Sport	Snoh R Spt
118	Area 10 Marine Sport (Seattle)	Ar 10 Spt
119	Area 10 Net Nontreaty (Seattle)	Ar10 NetNT
120	Area 10 Net Treaty (Seattle)	Ar10 NetTR
121	Area 10A Net Nontreaty (Elliott Bay)	Ar10ANetNT
122	Area 10A Net Treaty (Elliott Bay)	Ar10ANetTR
123	Area 10E Net Nontreaty (East Kitsap)	Ar10ENetNT
124	Area 10E Net Treaty (East Kitsap)	Ar10EnetTR
125	Area 10F-G Ship Canal/Lake Washington Net Treaty	10F-G Net
126	Green/Duwamish River Net	Duwm R Net
127	Green/Duwamish River Sport	Duwm R Spt
128	Lake Washington-Lake Sammamish Tributary Sport	L WaSm Spt
129	Area 11 Marine Sport (Tacoma)	Ar 11 Spt
130	Area 11 Net Nontreaty (Tacoma)	Ar11 NetNT
131	Area 11 Net Treaty (Tacoma)	Ar11 NetTR
132	Area 11A Net Nontreaty (Commencement Bay)	Ar11ANetNT
133	Area 11A Net Treaty (Commencement Bay)	Ar11ANetTR
134	Puyallup River Net	Puyl R Net
135	Puyallup River Sport	Puyl R Spt
136	Area 13 Marine Sport (South Puget Sound)	Ar 13 Spt
137	Area 13 Net Nontreaty (South Puget Sound)	Ar13 NetNT
138	Area 13 Net Treaty (South Puget Sound)	Ar13 NetTR
139	Area 13C Net Nontreaty (Chambers Bay)	Ar13CNetNT
140	Area 13C Net Treaty (Chambers Bay)	Ar13CNetTR
141	Area 13A Net Nontreaty (Carr Inlet)	Ar13ANetNT
142	Area 13A Net Treaty (Carr Inlet)	Ar13ANetTR
143	Area 13D Net Nontreaty (South Puget Sound)	Ar13DNetNT
144	Area 13D Net Treaty (South Puget Sound)	Ar13DNetTR
145	Area 13F-13K Net Nontreaty (South PS Inlets)	A13FKNetNT
146	Area 13F-13K Net Treaty (South PS Inlets)	A13FKNetTR
147	Nisqually River Net	Nisq R Net
148	McAllister Creek Net	McAlls Net
149	13D-13K Tributary Sport (South PS Inlets)	13D-K TSpt
150	Nisqually River Sport	Nisq R Spt

Appendix K – page 4 of 4

Fishery number	Coho FRAM Fishery Name	Abbrev Name
151	Deschutes River Sport (Olympia)	Desc R Spt
152	Area 12 Marine Sport (Hood Canal)	Ar 12 Spt
153	Area 12-12B Net Nontreaty (Upper Hood Canal)	1212BNetNT
154	Area 12-12B Net Treaty (Upper Hood Canal)	1212BNetTR
155	Area 9A Net Nontreaty (Port Gamble)	Ar9A NetNT
156	Area 9-9A Net Treaty (Port Gamble/On Reservation)	Ar9A NetTR
157	12A Net Nontreaty (Quilcene Bay)	Ar12ANetNT
158	12A Net Treaty (Quilcene Bay)	Ar12ANetTR
159	12C-12D Net Nontreaty (Lower Hood Canal)	A12CDNetNT
160	12C-12D Net Treaty (Lower Hood Canal)	A12CDNetTR
161	Skokomish River Net	Skok R Net
162	Quilcene River Net	Quilcn Net
163	12-12B Tributary FW Sport	1212B TSpt
164	12A Tributary FW Sport (Quilcene River)	Quilcn Spt
165	12C-12D Tributary FW Sport	12C-D TSpt
166	Skokomish River Sport	Skok R Spt
167	Lower Fraser River Stock Terminal Catch	FRSLOW Trm
168	Upper Fraser River Stock Terminal Catch	FRSUPP Trm
169	Fraser River/Estuary Sport	Fraser Spt
170	Johnstone Straits Troll	JStrBC Trl
171	Northern British Columbia Troll	No BC Trl
172	North Central British Columbia Troll	NoC BC Trl
173	South Central British Columbia Troll	SoC BC Trl
174	NW Vancouver Island Troll	NW VI Trl
175	SW Vancouver Island Troll	SW VI Trl
176	Georgia Straits Troll	GeoStr Trl
177	British Columbia Juan de Fuca Troll	BC JDF Trl
178	Northern British Columbia Net	No BC Net
179	Central British Columbia Net	Cen BC Net
180	NW Vancouver Island Net	NW VI Net
181	SW Vancouver Island Net	SW VI Net
182	Johnstone Straits Net	Johnst Net
183	Georgia Straits Net	GeoStr Net
184	Fraser River Gill Net	Fraser Net
185	British Columbia Juan de Fuca Net	BC JDF Net
186	Johstone Strait Sport	JStrBC Spt
187	Northern British Columbia Sport	No BC Spt
188	Central British Columbia Sport	Cen BC Spt
189	British Columbia Juan de Fuca Sport	BC JDF Spt
190	West Coast Vancouver Island Sport	WC VI Spt
191	North Georgia Straits Sport	NGaStr Spt
192	South Georgia Straits Sport	SGaStr Spt
193	Alberni Canal Sport	Albern Spt
194	Southwest Alaska Troll	SW AK Trl
195	Southeast Alaska Troll	SE AK Trl
196	Northwest Alaska Troll	NW AK Trl
197	Northeast Alaska Troll	NE AK Trl
198	Alaska Net (Areas 182:183:185:192)	Alaska Net

Appendix L - FRAM Coho Model Incidental Mortality Rates (from FRAM documentation)

Fishery	Fishery type	Comments	Release mortality	"Other" mortality a/
PFMC Ocean Recreational[d]	MSF	barbless	14%	5%
	Non-Retention	N. Pt. Arena	14% b	5% b
	Non-Retention	S. Pt. Arena	23% b	5% b
PFMC Ocean T-Troll	Retention		na c	5%
	Non-Retention		26% b	5% b
PFMC Ocean NT-Troll	MSF	barbless	26%	5%
Area 5, 6C Troll	Retention		na	5%
Puget Sound Recreational[e]	Retention		na	5%
	MSF	barbless	7%	5%
WA Coastal Recreational	Retention		na	5%
Buoy 10 Recreational	MSF	barbed	16%	5%
Gillnet and Setnet			na	2%
PS Purse Seine			26% b	2%
PS Reef Net, Beach Seine, Round Haul			na	2%
Freshwater Net			na	2%
Freshwater Recreational	Retention		na	5%
	Non-Retention		10% b	5% b

a The "other" mortality rates (which include drop-out and drop-off) are applied to landed fish (retention fisheries), thus FRAM does not assess "drop-off" in non-retention fisheries. For mark-selective fisheries (MSF), "other" mortality rates are applied to encounters of marked and unmarked fish.

b Rate assessed externally to FRAM.

c None assessed.

d Source: Salmon Technical Team (2000).

e Source: WDF et al. (1993).

Appendix L

Mitchell Act Hatchery EIS

Supporting Demographic and Socioeconomic Data for the Analysis of Environmental Justice Impacts

Submitted by:

TCW Economics
Sacramento, CA

Contact: Thomas Wegge

In Conjunction with:

ENTRIX, Inc.
Sacramento, CA

Contact: Steve Pavich

Prepared for:

NOAA Fisheries
Northwest Regional Office
Salmon Recovery Division
Portland, Oregon

Contact: Allyson Purcell

March 2010

Table EJ-1: County-Level Census Data														
County (State)	**State**	**Econ Impact Region**	**Port**	**Population (2008)**	**Population (2000)**	**Population-Race (2000)**	**White (2000)**	**B/AA (2000)**	**AI/AN (2000)**	**Asian (2000)**	**H/PI (2000)**	**Other (2000)**	**2+ (2000)**
British Columbia (multiple)	BC	British Columbia	N/A		--	--	--	--	--	--	--	--	--
Del Norte (CA)	CA	California Coast	Crescent City (P)	29,100	27,507	27,507	21,693	1,184	1,770	637	23	1,079	1,121
Humboldt (CA)	CA	California Coast	Eureka (P)	129,000	126,518	126,518	107,179	1,111	7,241	2,091	241	3,099	5,556
Mendocino (CA)	CA	California Coast	Fort Bragg (P)	86,221	86,265	86,265	69,671	536	4,103	1,038	126	7,427	3,364
Monterey (CA)	CA	California Coast	Monterey (P)	408,238	401,762	401,762	224,682	15,050	4,202	24,245	1,789	111,782	20,012
San Francisco (CA)	CA	California Coast	San Francisco (P)	808,976	776,733	776,733	385,728	60,515	3,458	239,565	3,844	50,368	33,255
Benton (OR)	OR	Lower Columbia	N/A	81,859	78,153	78,153	69,678	658	619	3,506	188	1,503	2,001
Clackamas (OR)	OR	Lower Columbia	N/A	380,576	338,391	338,391	308,852	2,233	2,416	8,292	569	7,699	8,330
Columbia (OR)	OR	Lower Columbia	N/A	49,408	43,560	43,560	41,130	105	580	255	43	344	1,103
Lane (OR)	OR	Lower Columbia	N/A	346,560	322,959	322,959	292,728	2,506	3,642	6,470	599	6,292	10,722
Linn (OR)	OR	Lower Columbia	N/A	115,348	103,069	103,069	96,059	327	1,313	799	151	1,855	2,565
Marion (OR)	OR	Lower Columbia	N/A	314,606	284,834	284,834	232,469	2,539	4,111	4,997	1,022	30,148	9,548
Multnomah (OR)	OR	Lower Columbia	N/A	714,567	660,486	660,486	522,825	37,434	6,785	37,638	2,320	26,620	26,864
Polk (OR)	OR	Lower Columbia	N/A	77,074	62,380	62,380	55,639	263	1,151	683	153	2,792	1,699
Washington (OR)	OR	Lower Columbia	N/A	529,216	445,342	445,342	366,007	5,119	2,913	29,752	1,325	26,100	14,126
Yamhill (OR)	OR	Lower Columbia	N/A	98,168	84,992	84,992	75,628	721	1,253	908	104	4,321	2,057
Clark (WA)	WA	Lower Columbia	N/A	424,733	345,238	345,238	306,648	5,813	2,910	11,095	1,274	6,857	10,641
Cowlitz (WA)	WA	Lower Columbia	N/A	101,254	92,948	92,948	85,326	482	1,417	1,206	124	1,958	2,435
Lewis (WA)	WA	Lower Columbia	N/A	74,132	68,600	68,600	63,772	259	840	475	122	1,751	1,381
Wahkiakum (WA)	WA	Lower Columbia	N/A	4,133	3,824	3,824	3,574	10	60	18	3	63	96
Adams (ID)	ID	Lower Snake River	N/A	3,499	3,476	3,476	3,347	2	49	5	1	32	40
Clearwater (ID)	ID	Lower Snake River	N/A	8,176	8,930	8,930	8,467	13	181	33	5	56	175
Custer (ID)	ID	Lower Snake River	N/A	4,254	4,342	4,342	4,224		24	1	1	51	41
Idaho (ID)	ID	Lower Snake River	N/A	15,448	15,511	15,511	14,599	13	448	40	3	141	267
Latah (ID)	ID	Lower Snake River	N/A	35,906	34,935	34,935	32,817	206	262	732	33	269	616
Lemhi (ID)	ID	Lower Snake River	N/A	7,808	7,806	7,806	7,543	8	47	14	3	60	131
Lewis (ID)	ID	Lower Snake River	N/A	3,594	3,747	3,747	3,455	13	144	16	3	35	81
Nez Perce (ID)	ID	Lower Snake River	N/A	38,975	37,410	37,410	34,260	105	1,988	245	27	188	597
Shoshone (ID)	ID	Lower Snake River	N/A	12,913	13,771	13,771	13,198	15	209	32	10	68	239
Valley (ID)	ID	Lower Snake River	N/A	8,862	7,651	7,651	7,378	3	53	23	3	84	107
Union (OR)	OR	Lower Snake River	N/A	24,961	24,530	24,530	23,129	124	208	209	151	299	410
Wallowa (OR)	OR	Lower Snake River	N/A	6,760	7,226	7,226	6,973	2	51	17	3	69	111
Asotin (WA)	WA	Lower Snake River	N/A	21,420	20,551	20,551	19,650	39	260	105	5	129	363
Columbia (WA)	WA	Lower Snake River	N/A	3,990	4,064	4,064	3,809	9	39	17	2	111	77
Garfield (WA)	WA	Lower Snake River	N/A	2,060	2,397	2,397	2,312		9	16	1	33	26
Whitman (WA)	WA	Lower Snake River	N/A	41,664	40,740	40,740	35,880	623	298	2,260	109	498	1,072
Crook (OR)	OR	Mid Columbia	N/A	23,023	19,182	19,182	17,830	8	250	82	6	731	275
Deschutes (OR)	OR	Mid Columbia	N/A	158,456	115,367	115,367	109,423	222	956	849	85	1,574	2,258
Gilliam (OR)	OR	Mid Columbia	N/A	1,747	1,915	1,915	1,853	3	16	3		22	18
Grant (OR)	OR	Mid Columbia	N/A	6,916	7,935	7,935	7,593	8	127	15	3	54	135
Hood River (OR)	OR	Mid Columbia	N/A	21,536	20,411	20,411	16,099	117	229	301	25	3,137	503
Jefferson (OR)	OR	Mid Columbia	N/A	20,512	19,009	19,009	13,113	50	2,981	57	42	2,152	614
Morrow (OR)	OR	Mid Columbia	N/A	11,140	10,995	10,995	8,386	15	156	46	9	2,148	235
Sherman (OR)	OR	Mid Columbia	N/A	1,638	1,934	1,934	1,810	4	27	9		54	30
Umatilla (OR)	OR	Mid Columbia	N/A	73,526	70,548	70,548	57,852	582	2,375	530	124	7,529	1,556
Wasco (OR)	OR	Mid Columbia	N/A	23,775	23,791	23,791	20,599	71	906	191	119	1,344	561
Wheeler (OR)	OR	Mid Columbia	N/A	1,319	1,547	1,547	1,444	1	13	4	1	54	30
Adams (WA)	WA	Mid Columbia	N/A	17,285	16,428	16,428	10,672	46	112	99	6	5,042	451
Benton (WA)	WA	Mid Columbia	N/A	163,058	142,475	142,475	122,879	1,319	1,165	3,134	163	9,986	3,829
Franklin (WA)	WA	Mid Columbia	N/A	72,783	49,347	49,347	30,553	1,230	362	800	57	14,300	2,045
Klickitat (WA)	WA	Mid Columbia	N/A	20,377	19,161	19,161	16,778	51	665	139	41	961	526
Skamania (WA)	WA	Mid Columbia	N/A	10,794	9,872	9,872	9,093	30	217	53	17	240	222
Walla Walla (WA)	WA	Mid Columbia	N/A	57,788	55,180	55,180	47,081	930	465	614	123	4,548	1,419
Clatsop (OR)	OR	Oregon Coast	Astoria (P)	37,404	35,630	35,630	33,185	185	367	430	60	585	818
Coos (OR)	OR	Oregon Coast	Coos Bay (P)	63,453	62,779	62,779	57,740	194	1,515	568	107	664	1,991
Curry (OR)	OR	Oregon Coast	Brookings (P)	21,523	21,137	21,137	19,634	32	452	147	24	234	614
Lincoln (OR)	OR	Oregon Coast	Newport (P)	45,946	44,479	44,479	40,292	132	1,397	413	70	737	1,438
Tillamook (OR)	OR	Oregon Coast	Tillamook (P)	24,927	24,262	24,262	22,772	54	289	157	50	459	481
Southeast Alaska (multiple)	AK	Southeast Alaska	N/A		--	--	--	--	--	--	--	--	--
Chelan (WA)	WA	Upper Columbia	N/A	71,540	66,616	66,616	55,711	172	661	451	77	8,121	1,423
Douglas (WA)	WA	Upper Columbia	N/A	36,653	32,603	32,603	27,599	101	355	178	31	3,530	809
Grant (WA)	WA	Upper Columbia	N/A	84,697	74,698	74,698	57,174	742	863	652	53	12,967	2,247
Kittitas (WA)	WA	Upper Columbia	N/A	38,951	33,362	33,362	30,617	236	303	731	49	768	658
Okanogan (WA)	WA	Upper Columbia	N/A	40,033	39,564	39,564	29,799	109	4,537	176	28	3,791	1,124
Yakima (WA)	WA	Upper Columbia	N/A	234,564	222,581	222,581	146,005	2,157	9,966	2,124	203	54,375	7,751
Clallam (WA)	WA	Washington Coast	Neah Bay (P)	71,021	64,525	64,525	57,505	545	3,303	731	104	761	1,576
Grays Harbor (WA)	WA	Washington Coast	Westport (P)	71,342	67,194	67,194	59,335	226	3,132	818	73	1,527	2,083
Jefferson (WA)	WA	Washington Coast	LaPush (P)	29,542	25,953	25,953	23,920	110	599	309	34	197	784
Pacific (WA)	WA	Washington Coast	Ilwaco (P)	21,271	20,984	20,984	18,998	42	513	436	19	384	592

Table EJ-1: County-Level Census Data (con't)							
County (State)	**Hispanic (2000)**	**Population-Poverty (2000*)**	**# Below Poverty (2000)**	**% Below Poverty (2000)**	**Median HH Income (2000)**	**Per-Capita Income (2000)**	**Unemploymen t Rate (2008)**
British Columbia (multiple)	--	--	--	--	--	--	--
Del Norte (CA)	3,829	23,626	4,765	20.2%	$29,642	$14,573	8.8%
Humboldt (CA)	8,210	123,167	24,059	19.5%	$31,226	$17,203	7.2%
Mendocino (CA)	14,213	84,736	13,505	15.9%	$35,996	$19,443	6.9%
Monterey (CA)	187,969	382,680	51,692	13.5%	$48,305	$20,165	8.5%
San Francisco (CA)	109,504	765,356	86,585	11.3%	$55,221	$34,556	5.3%
Benton (OR)	3,645	73,237	10,665	14.6%	$41,897	$21,868	4.5%
Clackamas (OR)	16,744	335,122	21,969	6.6%	$52,080	$25,973	5.5%
Columbia (OR)	1,093	43,202	3,910	9.1%	$45,797	$20,078	6.9%
Lane (OR)	14,874	316,016	45,423	14.4%	$36,942	$19,681	6.6%
Linn (OR)	4,514	101,855	11,618	11.4%	$37,518	$17,633	7.6%
Marion (OR)	48,714	274,908	37,104	13.5%	$40,314	$18,408	6.5%
Multnomah (OR)	49,607	645,584	81,711	12.7%	$41,278	$22,606	5.7%
Polk (OR)	5,480	60,526	6,943	11.5%	$42,311	$19,282	5.5%
Washington (OR)	49,735	441,331	32,575	7.4%	$52,122	$24,969	5.1%
Yamhill (OR)	9,017	79,920	7,336	9.2%	$44,111	$18,951	6.3%
Clark (WA)	16,248	341,464	31,027	9.1%	$48,376	$21,448	6.9%
Cowlitz (WA)	4,231	91,364	12,765	14.0%	$39,797	$18,583	8.2%
Lewis (WA)	3,684	67,520	9,460	14.0%	$35,511	$17,082	8.2%
Wahkiakum (WA)	98	3,735	301	8.1%	$39,444	$19,063	7.2%
Adams (ID)	54	3,426	518	15.1%	$28,423	$14,908	10.1%
Clearwater (ID)	165	8,326	1,128	13.5%	$32,071	$15,463	10.4%
Custer (ID)	183	4,330	619	14.3%	$32,174	$15,783	4.2%
Idaho (ID)	243	15,027	2,445	16.3%	$29,515	$14,411	7.3%
Latah (ID)	740	31,008	5,186	16.7%	$32,524	$16,690	4.0%
Lemhi (ID)	170	7,736	1,185	15.3%	$30,185	$16,037	6.4%
Lewis (ID)	71	3,728	447	12.0%	$31,413	$15,942	3.7%
Nez Perce (ID)	721	36,697	4,468	12.2%	$36,282	$18,544	4.2%
Shoshone (ID)	266	13,548	2,220	16.4%	$28,535	$15,934	8.0%
Valley (ID)	150	7,571	701	9.3%	$36,927	$19,246	8.5%
Union (OR)	600	23,795	3,281	13.8%	$33,738	$16,907	8.0%
Wallowa (OR)	125	7,161	1,002	14.0%	$32,129	$17,276	7.5%
Asotin (WA)	401	20,293	3,132	15.4%	$33,524	$17,748	6.1%
Columbia (WA)	258	4,008	507	12.6%	$33,500	$17,374	7.0%
Garfield (WA)	47	2,348	334	14.2%	$33,398	$16,992	4.6%
Whitman (WA)	1,219	35,280	9,027	25.6%	$28,584	$15,298	4.1%
Crook (OR)	1,082	18,851	2,128	11.3%	$35,186	$16,899	9.6%
Deschutes (OR)	4,304	114,226	10,613	9.3%	$41,847	$21,767	8.0%
Gilliam (OR)	35	1,910	173	9.1%	$33,611	$17,659	4.3%
Grant (OR)	163	7,812	1,069	13.7%	$32,560	$16,794	10.3%
Hood River (OR)	5,107	19,986	2,845	14.2%	$38,326	$17,877	5.3%
Jefferson (OR)	3,372	18,753	2,747	14.6%	$35,853	$15,675	9.9%
Morrow (OR)	2,686	10,919	1,617	14.8%	$37,521	$15,802	6.2%
Sherman (OR)	94	1,922	280	14.6%	$35,142	$17,448	5.8%
Umatilla (OR)	11,366	67,329	8,524	12.7%	$36,249	$16,410	6.4%
Wasco (OR)	2,214	23,369	3,023	12.9%	$35,959	$17,195	5.9%
Wheeler (OR)	79	1,534	239	15.6%	$28,750	$15,884	5.8%
Adams (WA)	7,732	16,217	2,951	18.2%	$33,888	$13,534	6.2%
Benton (WA)	17,806	141,232	14,517	10.3%	$47,044	$21,301	5.1%
Franklin (WA)	23,032	48,307	9,280	19.2%	$38,991	$15,459	6.2%
Klickitat (WA)	1,496	18,983	3,236	17.0%	$34,267	$16,502	7.5%
Skamania (WA)	398	9,763	1,281	13.1%	$39,317	$18,002	8.3%
Walla Walla (WA)	8,654	50,245	7,567	15.1%	$35,900	$16,509	4.9%
Clatsop (OR)	1,597	35,017	4,625	13.2%	$36,301	$19,515	5.1%
Coos (OR)	2,133	61,534	9,257	15.0%	$31,542	$17,547	8.1%
Curry (OR)	761	20,868	2,554	12.2%	$30,117	$18,138	7.8%
Lincoln (OR)	2,119	43,880	6,084	13.9%	$32,769	$18,692	6.5%
Tillamook (OR)	1,244	23,794	2,718	11.4%	$34,269	$19,052	5.4%
Southeast Alaska (multiple)	--	--	--	--	--	--	--
Chelan (WA)	12,831	65,564	8,147	12.4%	$37,316	$19,273	5.5%
Douglas (WA)	6,433	32,179	4,640	14.4%	$38,464	$17,148	5.3%
Grant (WA)	22,476	73,591	12,809	17.4%	$35,276	$15,037	6.4%
Kittitas (WA)	1,668	31,177	6,122	19.6%	$32,546	$18,928	5.8%
Okanogan (WA)	5,688	38,943	8,311	21.3%	$29,726	$14,900	6.4%
Yakima (WA)	79,905	218,966	43,070	19.7%	$34,828	$15,606	6.9%
Clallam (WA)	2,203	62,602	7,825	12.5%	$36,449	$19,517	7.1%
Grays Harbor (WA)	3,258	66,251	10,668	16.1%	$34,160	$16,799	7.7%
Jefferson (WA)	535	25,751	2,899	11.3%	$37,869	$22,211	5.5%
Pacific (WA)	1,052	20,666	2,973	14.4%	$31,209	$17,322	7.6%

Table EJ-2: County-Level Census Data (Percentages)												
County (State)	**State**	**Econ Impact Region**	**Port**	**Population (2008)**	**Population (2000)**	**Population-Race (2000)**	**White (2000)**	**B/AA (2000)**	**AI/AN (2000)**	**Asian (2000)**	**H/PI (2000)**	**Other (2000)**	**2+ (2000)**
British Columbia (multiple)	BC	British Columbia	N/A		--	--	--	--	--	--	--	--	--
Del Norte (CA)	CA	California Coast	Crescent City (P)	29,100	27,507	27,507	78.9%	4.3%	6.4%	2.3%	0.1%	3.9%	4.1%
Humboldt (CA)	CA	California Coast	Eureka (P)	129,000	126,518	126,518	84.7%	0.9%	5.7%	1.7%	0.2%	2.4%	4.4%
Mendocino (CA)	CA	California Coast	Fort Bragg (P)	86,221	86,265	86,265	80.8%	0.6%	4.8%	1.2%	0.1%	8.6%	3.9%
Monterey (CA)	CA	California Coast	Monterey (P)	408,238	401,762	401,762	55.9%	3.7%	1.0%	6.0%	0.4%	27.8%	5.0%
San Francisco (CA)	CA	California Coast	San Francisco (P)	808,976	776,733	776,733	49.7%	7.8%	0.4%	30.8%	0.5%	6.5%	4.3%
Benton (OR)	OR	Lower Columbia	N/A	81,859	78,153	78,153	89.2%	0.8%	0.8%	4.5%	0.2%	1.9%	2.6%
Clackamas (OR)	OR	Lower Columbia	N/A	380,576	338,391	338,391	91.3%	0.7%	0.7%	2.5%	0.2%	2.3%	2.5%
Columbia (OR)	OR	Lower Columbia	N/A	49,408	43,560	43,560	94.4%	0.2%	1.3%	0.6%	0.1%	0.8%	2.5%
Lane (OR)	OR	Lower Columbia	N/A	346,560	322,959	322,959	90.6%	0.8%	1.1%	2.0%	0.2%	1.9%	3.3%
Linn (OR)	OR	Lower Columbia	N/A	115,348	103,069	103,069	93.2%	0.3%	1.3%	0.8%	0.1%	1.8%	2.5%
Marion (OR)	OR	Lower Columbia	N/A	314,606	284,834	284,834	81.6%	0.9%	1.4%	1.8%	0.4%	10.6%	3.4%
Multnomah (OR)	OR	Lower Columbia	N/A	714,567	660,486	660,486	79.2%	5.7%	1.0%	5.7%	0.4%	4.0%	4.1%
Polk (OR)	OR	Lower Columbia	N/A	77,074	62,380	62,380	89.2%	0.4%	1.8%	1.1%	0.2%	4.5%	2.7%
Washington (OR)	OR	Lower Columbia	N/A	529,216	445,342	445,342	82.2%	1.1%	0.7%	6.7%	0.3%	5.9%	3.2%
Yamhill (OR)	OR	Lower Columbia	N/A	98,168	84,992	84,992	89.0%	0.8%	1.5%	1.1%	0.1%	5.1%	2.4%
Clark (WA)	WA	Lower Columbia	N/A	424,733	345,238	345,238	88.8%	1.7%	0.8%	3.2%	0.4%	2.0%	3.1%
Cowlitz (WA)	WA	Lower Columbia	N/A	101,254	92,948	92,948	91.8%	0.5%	1.5%	1.3%	0.1%	2.1%	2.6%
Lewis (WA)	WA	Lower Columbia	N/A	74,132	68,600	68,600	93.0%	0.4%	1.2%	0.7%	0.2%	2.6%	2.0%
Wahkiakum (WA)	WA	Lower Columbia	N/A	4,133	3,824	3,824	93.5%	0.3%	1.6%	0.5%	0.1%	1.6%	2.5%
Adams (ID)	ID	Lower Snake River	N/A	3,499	3,476	3,476	96.3%	0.1%	1.4%	0.1%	0.0%	0.9%	1.2%
Clearwater (ID)	ID	Lower Snake River	N/A	8,176	8,930	8,930	94.8%	0.1%	2.0%	0.4%	0.1%	0.6%	2.0%
Custer (ID)	ID	Lower Snake River	N/A	4,254	4,342	4,342	97.3%	0.0%	0.6%	0.0%	0.0%	1.2%	0.9%
Idaho (ID)	ID	Lower Snake River	N/A	15,448	15,511	15,511	94.1%	0.1%	2.9%	0.3%	0.0%	0.9%	1.7%
Latah (ID)	ID	Lower Snake River	N/A	35,906	34,935	34,935	93.9%	0.6%	0.7%	2.1%	0.1%	0.8%	1.8%
Lemhi (ID)	ID	Lower Snake River	N/A	7,808	7,806	7,806	96.6%	0.1%	0.6%	0.2%	0.0%	0.8%	1.7%
Lewis (ID)	ID	Lower Snake River	N/A	3,594	3,747	3,747	92.2%	0.3%	3.8%	0.4%	0.1%	0.9%	2.2%
Nez Perce (ID)	ID	Lower Snake River	N/A	38,975	37,410	37,410	91.6%	0.3%	5.3%	0.7%	0.1%	0.5%	1.6%
Shoshone (ID)	ID	Lower Snake River	N/A	12,913	13,771	13,771	95.8%	0.1%	1.5%	0.2%	0.1%	0.5%	1.7%
Valley (ID)	ID	Lower Snake River	N/A	8,862	7,651	7,651	96.4%	0.0%	0.7%	0.3%	0.0%	1.1%	1.4%
Union (OR)	OR	Lower Snake River	N/A	24,961	24,530	24,530	94.3%	0.5%	0.8%	0.9%	0.6%	1.2%	1.7%
Wallowa (OR)	OR	Lower Snake River	N/A	6,760	7,226	7,226	96.5%	0.0%	0.7%	0.2%	0.0%	1.0%	1.5%
Asotin (WA)	WA	Lower Snake River	N/A	21,420	20,551	20,551	95.6%	0.2%	1.3%	0.5%	0.0%	0.6%	1.8%
Columbia (WA)	WA	Lower Snake River	N/A	3,990	4,064	4,064	93.7%	0.2%	1.0%	0.4%	0.0%	2.7%	1.9%
Garfield (WA)	WA	Lower Snake River	N/A	2,060	2,397	2,397	96.5%	0.0%	0.4%	0.7%	0.0%	1.4%	1.1%
Whitman (WA)	WA	Lower Snake River	N/A	41,664	40,740	40,740	88.1%	1.5%	0.7%	5.5%	0.3%	1.2%	2.6%
Crook (OR)	OR	Mid Columbia	N/A	23,023	19,182	19,182	93.0%	0.0%	1.3%	0.4%	0.0%	3.8%	1.4%
Deschutes (OR)	OR	Mid Columbia	N/A	158,456	115,367	115,367	94.8%	0.2%	0.8%	0.7%	0.1%	1.4%	2.0%
Gilliam (OR)	OR	Mid Columbia	N/A	1,747	1,915	1,915	96.8%	0.2%	0.8%	0.2%	0.0%	1.1%	0.9%
Grant (OR)	OR	Mid Columbia	N/A	6,916	7,935	7,935	95.7%	0.1%	1.6%	0.2%	0.0%	0.7%	1.7%
Hood River (OR)	OR	Mid Columbia	N/A	21,536	20,411	20,411	78.9%	0.6%	1.1%	1.5%	0.1%	15.4%	2.5%
Jefferson (OR)	OR	Mid Columbia	N/A	20,512	19,009	19,009	69.0%	0.3%	15.7%	0.3%	0.2%	11.3%	3.2%
Morrow (OR)	OR	Mid Columbia	N/A	11,140	10,995	10,995	76.3%	0.1%	1.4%	0.4%	0.1%	19.5%	2.1%
Sherman (OR)	OR	Mid Columbia	N/A	1,638	1,934	1,934	93.6%	0.2%	1.4%	0.5%	0.0%	2.8%	1.6%
Umatilla (OR)	OR	Mid Columbia	N/A	73,526	70,548	70,548	82.0%	0.8%	3.4%	0.8%	0.2%	10.7%	2.2%
Wasco (OR)	OR	Mid Columbia	N/A	23,775	23,791	23,791	86.6%	0.3%	3.8%	0.8%	0.5%	5.6%	2.4%
Wheeler (OR)	OR	Mid Columbia	N/A	1,319	1,547	1,547	93.3%	0.1%	0.8%	0.3%	0.1%	3.5%	1.9%
~~Adams (WA)~~	~~WA~~	~~Mid Columbia~~	~~N/A~~	~~17,285~~	~~16,428~~	~~16,428~~	~~65.0%~~	~~0.3%~~	~~0.7%~~	~~0.6%~~	~~0.0%~~	~~30.7%~~	~~2.7%~~
Benton (WA)	WA	Mid Columbia	N/A	163,058	142,475	142,475	86.2%	0.9%	0.8%	2.2%	0.1%	7.0%	2.7%
Franklin (WA)	WA	Mid Columbia	N/A	72,783	49,347	49,347	61.9%	2.5%	0.7%	1.6%	0.1%	29.0%	4.1%
Klickitat (WA)	WA	Mid Columbia	N/A	20,377	19,161	19,161	87.6%	0.3%	3.5%	0.7%	0.2%	5.0%	2.7%
Skamania (WA)	WA	Mid Columbia	N/A	10,794	9,872	9,872	92.1%	0.3%	2.2%	0.5%	0.2%	2.4%	2.2%
Walla Walla (WA)	WA	Mid Columbia	N/A	57,788	55,180	55,180	85.3%	1.7%	0.8%	1.1%	0.2%	8.2%	2.6%
Clatsop (OR)	OR	Oregon Coast	Astoria (P)	37,404	35,630	35,630	93.1%	0.5%	1.0%	1.2%	0.2%	1.6%	2.3%
Coos (OR)	OR	Oregon Coast	Coos Bay (P)	63,453	62,779	62,779	92.0%	0.3%	2.4%	0.9%	0.2%	1.1%	3.2%
Curry (OR)	OR	Oregon Coast	Brookings (P)	21,523	21,137	21,137	92.9%	0.2%	2.1%	0.7%	0.1%	1.1%	2.9%
Lincoln (OR)	OR	Oregon Coast	Newport (P)	45,946	44,479	44,479	90.6%	0.3%	3.1%	0.9%	0.2%	1.7%	3.2%
Tillamook (OR)	OR	Oregon Coast	Tillamook (P)	24,927	24,262	24,262	93.9%	0.2%	1.2%	0.6%	0.2%	1.9%	2.0%
Southeast Alaska (multiple)	AK	Southeast Alaska	N/A		--	--	--	--	--	--	--	--	--
Chelan (WA)	WA	Upper Columbia	N/A	71,540	66,616	66,616	83.6%	0.3%	1.0%	0.7%	0.1%	12.2%	2.1%
Douglas (WA)	WA	Upper Columbia	N/A	36,653	32,603	32,603	84.7%	0.3%	1.1%	0.5%	0.1%	10.8%	2.5%
Grant (WA)	WA	Mid Columbia	N/A	84,697	74,698	74,698	76.5%	1.0%	1.2%	0.9%	0.1%	17.4%	3.0%
Kittitas (WA)	WA	Upper Columbia	N/A	38,951	33,362	33,362	91.8%	0.7%	0.9%	2.2%	0.1%	2.3%	2.0%
Okanogan (WA)	WA	Upper Columbia	N/A	40,033	39,564	39,564	75.3%	0.3%	11.5%	0.4%	0.1%	9.6%	2.8%
Yakima (WA)	WA	Upper Columbia	N/A	234,564	222,581	222,581	65.6%	1.0%	4.5%	1.0%	0.1%	24.4%	3.5%
Clallam (WA)	WA	Washington Coast	Neah Bay (P)	71,021	64,525	64,525	89.1%	0.8%	5.1%	1.1%	0.2%	1.2%	2.4%
Grays Harbor (WA)	WA	Washington Coast	Westport (P)	71,342	67,194	67,194	88.3%	0.3%	4.7%	1.2%	0.1%	2.3%	3.1%
Jefferson (WA)	WA	Washington Coast	LaPush (P)	29,542	25,953	25,953	92.2%	0.4%	2.3%	1.2%	0.1%	0.8%	3.0%
Pacific (WA)	WA	Washington Coast	Ilwaco (P)	21,271	20,984	20,984	90.5%	0.2%	2.4%	2.1%	0.1%	1.8%	2.8%

Table EJ-2: County-Level Census Data (Percentages) - con't

County (State)	Total MINORITY	Hispanic (2000)	% Below Poverty (2000)	Median HH Income (2000)	Per-Capita Income (2000)
British Columbia (multiple)	--	--	--	--	--
Del Norte (CA)	21.1%	13.9%	20.2%	$29,642	$14,573
Humboldt (CA)	15.3%	6.5%	19.5%	$31,226	$17,203
Mendocino (CA)	19.2%	16.5%	15.9%	$35,996	$19,443
Monterey (CA)	44.1%	46.8%	13.5%	$48,305	$20,165
San Francisco (CA)	50.3%	14.1%	11.3%	$55,221	$34,556
Benton (OR)	10.8%	4.7%	14.6%	$41,897	$21,868
Clackamas (OR)	8.7%	4.9%	6.6%	$52,080	$25,973
Columbia (OR)	5.6%	2.5%	9.1%	$45,797	$20,078
Lane (OR)	9.4%	4.6%	14.4%	$36,942	$19,681
Linn (OR)	6.8%	4.4%	11.4%	$37,518	$17,633
Marion (OR)	18.4%	17.1%	13.5%	$40,314	$18,408
Multnomah (OR)	20.8%	7.5%	12.7%	$41,278	$22,606
Polk (OR)	10.8%	8.8%	11.5%	$42,311	$19,282
Washington (OR)	17.8%	11.2%	7.4%	$52,122	$24,969
Yamhill (OR)	11.0%	10.6%	9.2%	$44,111	$18,951
Clark (WA)	11.2%	4.7%	9.1%	$48,376	$21,448
Cowlitz (WA)	8.2%	4.6%	14.0%	$39,797	$18,583
Lewis (WA)	7.0%	5.4%	14.0%	$35,511	$17,082
Wahkiakum (WA)	6.5%	2.6%	8.1%	$39,444	$19,063
Adams (ID)	3.7%	1.6%	15.1%	$28,423	$14,908
Clearwater (ID)	5.2%	1.8%	13.5%	$32,071	$15,463
Custer (ID)	2.7%	4.2%	14.3%	$32,174	$15,783
Idaho (ID)	5.9%	1.6%	16.3%	$29,515	$14,411
Latah (ID)	6.1%	2.1%	16.7%	$32,524	$16,690
Lemhi (ID)	3.4%	2.2%	15.3%	$30,185	$16,037
Lewis (ID)	7.8%	1.9%	12.0%	$31,413	$15,942
Nez Perce (ID)	8.4%	1.9%	12.2%	$36,282	$18,544
Shoshone (ID)	4.2%	1.9%	16.4%	$28,535	$15,934
Valley (ID)	3.6%	2.0%	9.3%	$36,927	$19,246
Union (OR)	5.7%	2.4%	13.8%	$33,738	$16,907
Wallowa (OR)	3.5%	1.7%	14.0%	$32,129	$17,276
Asotin (WA)	4.4%	2.0%	15.4%	$33,524	$17,748
Columbia (WA)	6.3%	6.3%	12.6%	$33,500	$17,374
Garfield (WA)	3.5%	2.0%	14.2%	$33,398	$16,992
Whitman (WA)	11.9%	3.0%	25.6%	$28,584	$15,298
Crook (OR)	7.0%	5.6%	11.3%	$35,186	$16,899
Deschutes (OR)	5.2%	3.7%	9.3%	$41,847	$21,767
Gilliam (OR)	3.2%	1.8%	9.1%	$33,611	$17,659
Grant (OR)	4.3%	2.1%	13.7%	$32,560	$16,794
Hood River (OR)	21.1%	25.0%	14.2%	$38,326	$17,877
Jefferson (OR)	31.0%	17.7%	14.6%	$35,853	$15,675
Morrow (OR)	23.7%	24.4%	14.8%	$37,521	$15,802
Sherman (OR)	6.4%	4.9%	14.6%	$35,142	$17,448
Umatilla (OR)	18.0%	16.1%	12.7%	$36,249	$16,410
Wasco (OR)	13.4%	9.3%	12.9%	$35,959	$17,195
Wheeler (OR)	6.7%	5.1%	15.6%	$28,750	$15,884
Benton (WA)	13.8%	12.5%	10.3%	$47,044	$21,301
Franklin (WA)	38.1%	46.7%	19.2%	$38,991	$15,459
Klickitat (WA)	12.4%	7.8%	17.0%	$34,267	$16,502
Skamania (WA)	7.9%	4.0%	13.1%	$39,317	$18,002
Walla Walla (WA)	14.7%	15.7%	15.1%	$35,900	$16,509
Clatsop (OR)	6.9%	4.5%	13.2%	$36,301	$19,515
Coos (OR)	8.0%	3.4%	15.0%	$31,542	$17,547
Curry (OR)	7.1%	3.6%	12.2%	$30,117	$18,138
Lincoln (OR)	9.4%	4.8%	13.9%	$32,769	$18,692
Tillamook (OR)	6.1%	5.1%	11.4%	$34,269	$19,052
Southeast Alaska (multiple)	--	--	--	--	--
Chelan (WA)	16.4%	19.3%	12.4%	$37,316	$19,273
Douglas (WA)	15.3%	19.7%	14.4%	$38,464	$17,148
Grant (WA)	23.5%	30.1%	17.4%	$35,276	$15,037
Kittitas (WA)	8.2%	5.0%	19.6%	$32,546	$18,928
Okanogan (WA)	24.7%	14.4%	21.3%	$29,726	$14,900
Yakima (WA)	34.4%	35.9%	19.7%	$34,828	$15,606
Clallam (WA)	10.9%	3.4%	12.5%	$36,449	$19,517
Grays Harbor (WA)	11.7%	4.8%	16.1%	$34,160	$16,799
Jefferson (WA)	7.8%	2.1%	11.3%	$37,869	$22,211
Pacific (WA)	9.5%	5.0%	14.4%	$31,209	$17,322

Table EJ-3: Tribal Demographic Data

Reservation	State	Population (2000)	White (2000)	B/AA (2000)	AI/AN (2000)	Asian (2000)	H/PI (2000)	Other (2000)	2+ (2000)
Colville	WA	7,598	2,471	15	4,479	13	6	284	330
Shoshone / Fort Hall	ID	5,759	1,792		3,609	51	9	147	151
Nez Perce	ID	17,969	15,179	24	2,087	69	18	154	438
Umatilla	OR	2,927	1,384	3	1,373	15		28	124
Warm Springs	OR	3,282	127		3,007	5	5	37	101
Yakama	WA	31,731	10,730	141	6,959	549	12	12,029	1,311

Reservation	Hispanic (2000)	Population-Poverty	# Below Poverty (2000)	% Below Poverty (2000)	Median HH Income (2000)	Per-Capita Income (2000)	Tribal Enrollment	Unemployment Rate (2005)
Colville	471	7,544	2,023	26.8%	$27,826	$12,185	9,171	N/A
Shoshone / Fort Hall	369	5,684	1,339	23.6%	$31,961	$11,309	4,796	81.0%
Nez Perce	379	17,321	2,452	14.2%	$30,710	$14,768	3,338	27.0%
Umatilla	36	2,907	458	15.8%	$37,827	$15,158	2,542	22.0%
Warm Springs	159	3,208	910	28.4%	$31,406	$9,136	4,412	43.0%
Yakama	15,958	31,321	8,783	28.0%	$30,148	$10,618	9,822	50.0%

Table EJ-4: Tribal Demographic Data (Percentages)

Reservation	State	Population (2000)	White (2000)	B/AA (2000)	AI/AN (2000)	Asian (2000)	H/PI (2000)	Other (2000)	2+ (2000)
Colville	WA	**7,598**	32.5%	0.2%	58.9%	0.2%	0.1%	3.7%	4.3%
Shoshone / Fort Hall	ID	**5,759**	31.1%	0.0%	62.7%	0.9%	0.2%	2.6%	2.6%
Nez Perce	ID	**17,969**	84.5%	0.1%	11.6%	0.4%	0.1%	0.9%	2.4%
Umatilla	OR	**2,927**	47.3%	0.1%	46.9%	0.5%	0.0%	1.0%	4.2%
Warm Springs	OR	**3,282**	3.9%	0.0%	91.6%	0.2%	0.2%	1.1%	3.1%
Yakama	WA	**31,731**	33.8%	0.4%	21.9%	1.7%	0.0%	37.9%	4.1%

Reservation	Hispanic (2000)	Total Minority	% Below Poverty	Per-Capita	Unemployment Rate (2005)
Colville	6.2%	**67.5%**	26.8%	$12,185	N/A
Shoshone / Fort Hall	6.4%	**68.9%**	23.6%	$11,309	81.0%
Nez Perce	2.1%	**15.5%**	14.2%	$14,768	27.0%
Umatilla	1.2%	**52.7%**	15.8%	$15,158	22.0%
Warm Springs	4.8%	**96.1%**	28.4%	$9,136	43.0%
Yakama	50.3%	**66.2%**	28.0%	$10,618	50.0%

Table EJ-5: Recreational Sport Fisherman Demographic Data														
	Race				*Ethnicity*	*Annual HH Income*								
Location	**White**	**Black**	**Asian**	**Other**	**Hispanic**	**<10K**	**10-20K**	**20-30K**	**30-40K**	**40-50K**	**50-75K**	**75-100K**	**> 100K**	**Not Reported**
U.S (All)	83.0%	11.0%	4.0%	2.0%	13.0%	5.0%	7.0%	10.0%	10.0%	8.0%	15.0%	9.0%	13.0%	25.0%
U.S. (Fishing)	92.0%	5.0%	1.0%	2.0%	5.0%	2.0%	5.0%	9.0%	10.0%	9.0%	20.0%	14.0%	17.0%	14.0%
Alaska (All)	76.0%	3.0%	--	20.0%	4.0%	5.0%	6.0%	10.0%	9.0%	9.0%	17.0%	13.0%	15.0%	15.0%
Alaska (Fishing)	83.0%	0.0%	--	15.0%	2.0%	0.0%	0.0%	9.0%	8.0%	11.0%	23.0%	12.0%	22.0%	11.0%
California (All)	76.0%	7.0%	--	17.0%	29.0%	4.0%	7.0%	9.0%	8.0%	6.0%	13.0%	10.0%	18.0%	24.0%
California (Fishing)	91.0%	2.0%	--	7.0%	15.0%	0.0%	4.0%	5.0%	6.0%	4.0%	20.0%	22.0%	27.0%	10.0%
Idaho (All)	97.0%	0.0%	--	2.0%	9.0%	4.0%	6.0%	13.0%	12.0%	8.0%	15.0%	7.0%	10.0%	23.0%
Idaho (Fishing)	97.0%	0.0%	--	0.0%	1.0%	0.0%	0.0%	16.0%	7.0%	14.0%	17.0%	14.0%	12.0%	18.0%
Oregon (All)	92.0%	1.0%	--	7.0%	10.0%	4.0%	6.0%	13.0%	11.0%	12.0%	16.0%	11.0%	14.0%	15.0%
Oregon (Fishing)	98.0%	0.0%	--	0.0%	5.0%	0.0%	5.0%	11.0%	9.0%	17.0%	22.0%	8.0%	19.0%	6.0%
Washington (All)	86.0%	3.0%	--	10.0%	7.0%	3.0%	6.0%	9.0%	12.0%	8.0%	18.0%	12.0%	14.0%	19.0%
Washington (Fishing)	96.0%	0.0%	--	4.0%	3.0%	2.0%	3.0%	7.0%	14.0%	6.0%	23.0%	13.0%	24.0%	9.0%

Table EJ-6: Commercial Fishermen Demographic Data													
	White (2000)	**B/AA (2000)**	**AI/AN (2000)**	**Asian (2000)**	**H/PI (2000)**	**Other (2000)**	**2+ (2000)**	**Hispanic (2000)**	**Total Minority**	**Median HH Income**	**Per Capita Income**	**% Below Poverty**	**Unemployment**
Washington	**81.8%**	**3.2%**	**1.6%**	**5.5%**	**0.4%**	**3.9%**	**3.6%**	**7.5%**	**18.2%**	**$45,776**	**$22,973**	**10.6%**	**5.3%**
Ilwaco	92.8%	0.5%	1.4%	0.4%	0.1%	1.8%	2.9%	5.3%	7.1%	$29,632	$16,138	16.3%	3.7%
LaPush	9.3%	0.8%	83.0%	--	--	1.6%	5.2%	5.2%	90.6%	$21,750	$9,589	34.5%	16.1%
Neah Bay	14.1%	0.1%	78.2%	--	--	1.6%	5.9%	5.4%	85.8%	$21,635	$11,338	29.9%	16.0%
Westport	92.7%	0.3%	3.1%	0.9%	--	0.5%	2.4%	3.0%	7.2%	$32,037	$17,362	14.3%	4.1%
Cathlamet	94.2%	0.5%	1.6%	0.9%	0.0%	0.4%	2.5%	0.5%	5.9%	$33,409	$18,588	15.1%	--
Skamokawa	93.4%	0.5%	1.2%	0.5%	0.0%	2.4%	2.1%	2.4%	6.7%	$35,769	$20,920	0.0%	--
Kalama	96.0%	0.7%	0.9%	0.3%	0.1%	0.3%	1.8%	1.5%	4.1%	$38,152	$19,592	13.7%	--
Longview	89.3%	0.7%	1.8%	2.2%	0.1%	3.0%	2.9%	5.8%	10.7%	$35,171	$18,559	16.7%	--
Vancouver	84.8%	2.5%	1.0%	4.5%	0.5%	2.9%	3.8%	6.3%	15.2%	$41,618	$20,192	12.2%	--
Oregon	**86.6%**	**1.6%**	**1.3%**	**3.0%**	**0.2%**	**4.2%**	**3.1%**	**8.0%**	**13.4%**	**$40,916**	**$20,940**	**11.6%**	**6.4%**
Astoria	91.1%	0.5%	1.1%	1.9%	0.2%	2.7%	2.5%	6.0%	8.9%	$33,011	$18,759	15.9%	4.3%
Brookings	90.5%	0.2%	2.4%	1.3%	0.1%	1.4%	4.0%	4.7%	9.4%	$31,656	$17,010	11.5%	3.2%
Coos Bay	90.8%	0.4%	2.3%	1.4%	0.3%	1.3%	3.5%	4.5%	9.2%	$31,212	$18,158	16.5%	5.4%
Newport	88.6%	0.5%	2.2%	1.7%	0.2%	3.9%	3.0%	9.0%	11.5%	$31,996	$20,580	14.4%	5.7%
Tillamook	92.6%	0.2%	1.2%	0.7%	0.2%	3.4%	1.8%	11.1%	7.5%	$29,875	$15,160	15.4%	2.6%
St. Helens	92.7%	0.3%	1.7%	0.6%	0.1%	1.3%	3.1%	4.1%	7.1%	$40,648	$17,237	11.9%	--
Clatskanie	93.9%	0.1%	1.2%	0.7%	0.3%	1.0%	2.8%	3.3%	6.1%	$35,833	$16,717	11.5%	--
Dodson	90.1%	0.2%	3.9%	0.8%	0.0%	2.2%	3.0%	6.2%	10.1%	$37,273	$16,083	16.6%	--
California	**59.5%**	**6.7%**	**1.0%**	**10.9%**	**0.3%**	**16.8%**	**4.7%**	**32.4%**	**40.5%**	**$47,493**	**$22,711**	**14.2%**	**7.2%**
Crescent City	78.3%	0.5%	6.1%	4.6%	0.1%	4.3%	6.0%	11.0%	21.6%	$20,133	$12,833	34.6%	6.5%
Eureka	82.5%	1.6%	4.2%	3.6%	0.3%	2.7%	5.1%	7.8%	17.5%	$25,849	$16,174	23.7%	5.5%
Fort Bragg	79.5%	1.0%	1.9%	0.9%	0.1%	12.1%	4.6%	22.7%	20.6%	$28,539	$15,832	40.9%	5.3%
Monterey	80.8%	2.5%	0.6%	7.4%	0.3%	3.9%	4.4%	10.9%	19.1%	$49,109	$27,133	7.8%	2.2%
San Francisco	49.7%	7.8%	0.4%	30.8%	0.5%	6.5%	4.3%	14.1%	50.3%	$55,221	$34,556	11.3%	3.0%

Science, Service, Stewardship

Agenda Item C.3.b
Supplemental NMFS PowerPoint (Turner)
September 2010

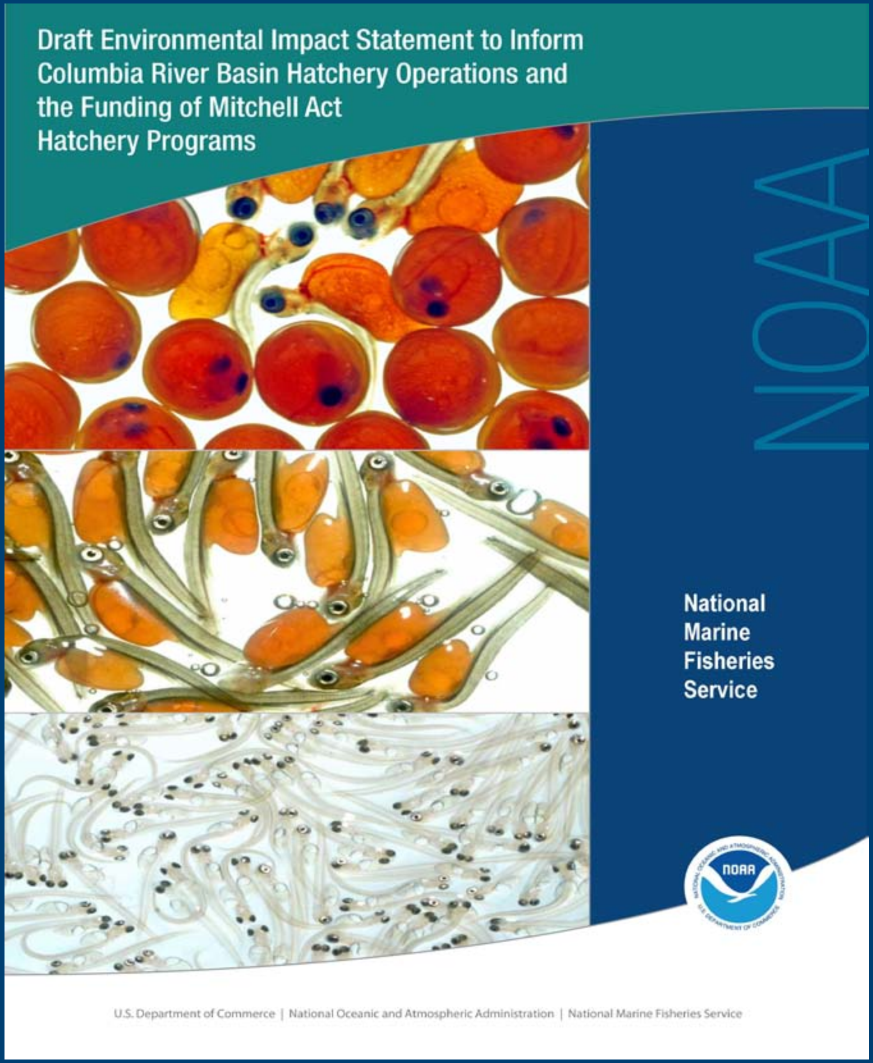
Draft Environmental Impact Statement to Inform Columbia River Basin Hatchery Operations & the Funding of Mitchell Act Hatchery Programs

(AKA: The Mitchell Act EIS)

NOAA FISHERIES SERVICE

Science, Service, Stewardship

For the Skeptics Among You:



Science, Service, Stewardship

The EIS Evolves:

- Initiated in 2004, the EIS purpose was to develop a strategy for the funding and operation of Mitchell Act programs.
- Early scoping quickly led to two challenges:

Science, Service, Stewardship

The EIS Evolves:

Challenge #1: Broad scope of the Mitchell Act:

"To provide for the conservation of the fishery resources of the Columbia River, establishment, operation, and maintenance of one or more stations in Oregon, Washington, and Idaho, and for the conduct of necessary investigations, surveys, stream improvements, and stocking operations for these purposes." 52 Stat. 345:

Science, Service, Stewardship

The EIS Evolves:

Challenge #2: Comprehensive Analysis

Mitchell Act production would best be analyzed when the effects of all other, non-Mitchell Act production are analyzed as well.

Science, Service, Stewardship

Solutions

- Center each alternative around a **policy direction** that would guide NOAA's decisions on hatchery production – not on particular operations. Use a common sense "implementation scenario" to illustrate each alternative.
- Expand scope to include all hatchery production in the Columbia River basin.

Science, Service, Stewardship

Columbia River Basin Hatchery System

- 178 salmon and steelhead programs from 80 hatchery facilities.
- 62 programs funded under the Mitchell Act. In past 10 years, $11-16 million annually for Mitchell Act hatchery operations producing over 71 million fish (49% of the total production in Columbia River basin).

Hatcheries and Facilities in the Columbia and Snake River Basins

Prepared by Parametix, Inc. January 19, 2010 (DEIS_Figure_1-3_20100119.mxd).

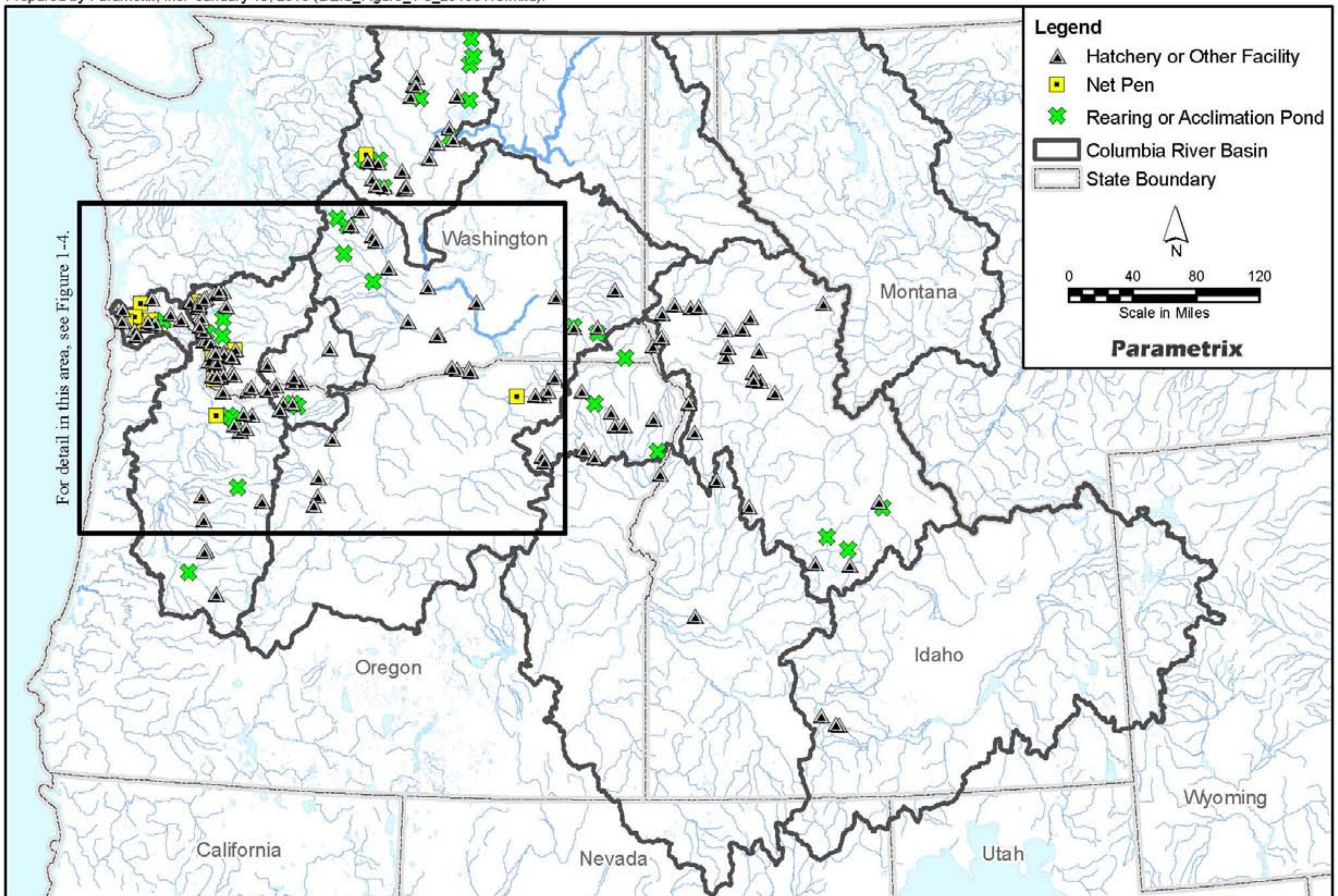


Figure 1-3. Hatcheries and facilities in the Columbia and Snake River basins.

Hatcheries Currently Receiving Mitchell Act Funding

Prepared by Parametrix, Inc. January 19, 2010 (DEIS_Figure_1-2_20100119.mxd).

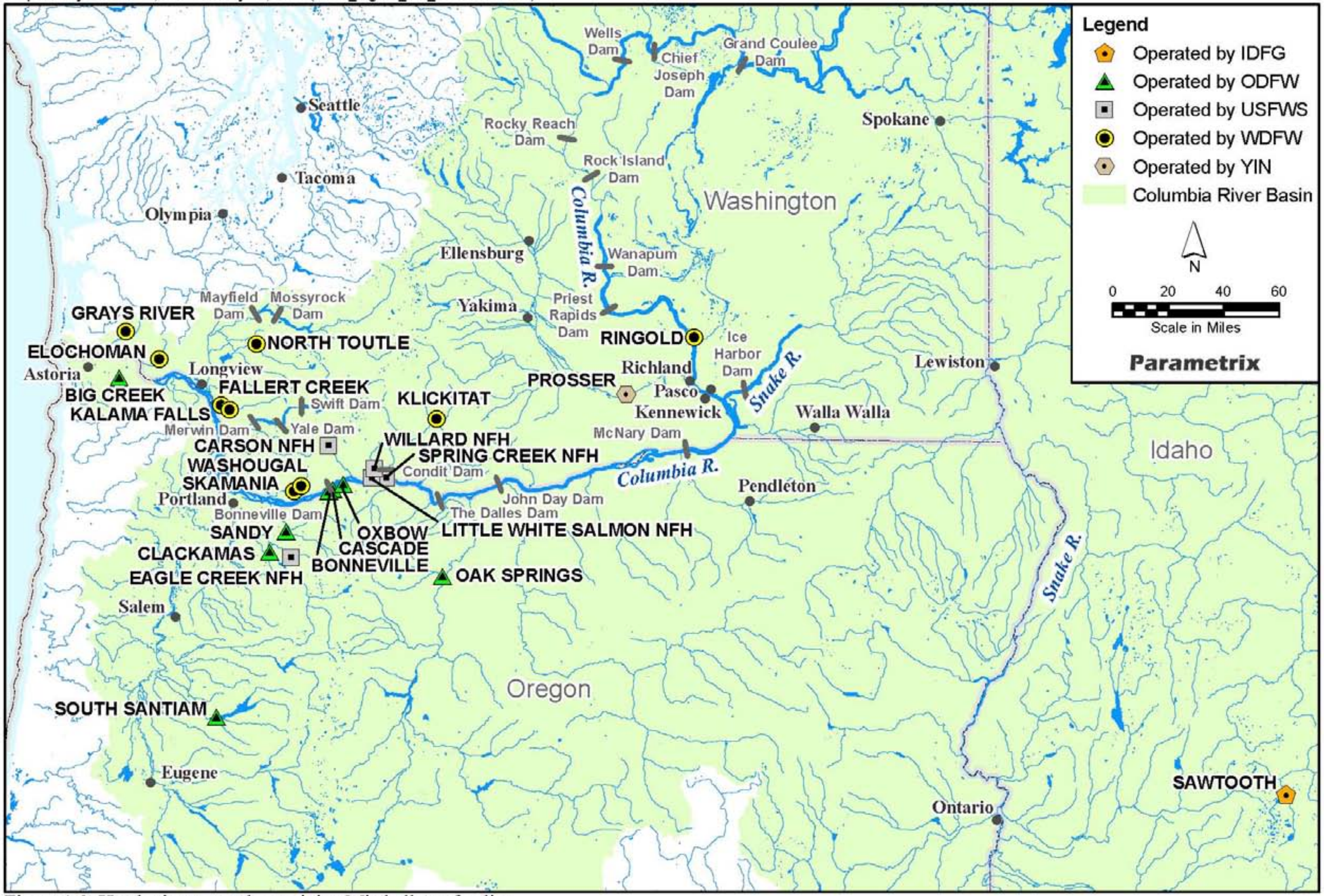


Figure 1-2. Hatcheries currently receiving Mitchell Act funding.

Purpose of EIS

Develop a **policy direction** that will:

- Guide use of Mitchell Act funds.
- Inform NMFS' future decisions under the Endangered Species Act related to Columbia River Basin hatchery programs.

Science, Service, Stewardship

Alternatives

Alternative 1: No-Action (status quo)

Alternative 2: No funding for the Mitchell Act – all Mitchell Act programs terminated. Other programs modified to achieve "intermediate" performance goals.

Science, Service, Stewardship

Alternative 3

Maintain existing goals for Mitchell Act production. Modify all production to achieve “intermediate” performance goals.

Science, Service, Stewardship

Alternative 4

Lower river programs to achieve “stronger” performance standards. Use available hatchery capacity to affirmatively aid 1) recovery (re-introductions) and 2) harvest in ocean and lower river. Upper river programs to achieve “intermediate” performance goals.

Science, Service, Stewardship

Alternative 5

Upper river programs to achieve "stronger" performance goals. Use available hatchery capacity to affirmatively aid 1) recovery (re-introductions) and 2) harvest in upper river. Lower river programs to achieve "intermediate" performance goals.

Alternatives

There is no Preferred Alternative in the draft EIS.

The Policy Direction adopted in the final EIS will likely be a combination of elements from the five alternatives.

Resource	Species/Indicator		Effects Relative to Alternative 1 (No Action)			
			Alt 2	Alt 3	Alt 4	Alt 5
Fish	Salmon and Steelhead		Improved	Improved	Improved	Improved
Socio-economics	Hatchery Program Costs		Improved	Improved	No Change	Adverse
	Harvest and Economic Values for Commercial Fisheries		Adverse	Adverse	Adverse	Adverse
	Harvest and Economic Values for Recreational Fisheries		Adverse	Adverse	Adverse	Adverse
	Regional Economic Conditions Columbia River Basin		Adverse	Adverse	Adverse	Adverse
	Regional Economic Impacts Pacific Ocean and Puget Sound		Adverse	Adverse	Adverse	Adverse
Environmental Justice	Native American Tribes		Adverse	Adverse	Adverse	Adverse
	Non-tribal User Groups and Communities of Concern		Adverse	Adverse	Adverse	Adverse
Wildlife	Southern Resident Killer Whale		Adverse	No Change	No Change	No Change

Science, Service, Stewardship

The EIS Will Not . . .

- Determine whether any particular program is compliant with the ESA. Those decisions come later under provisions of the ESA.
- Specify or make determinations on how individual programs should be operated.

The EIS Will Not . . .

- Determine whether any particular program (or Alternative) is compliant with the Management Agreement under *U.S. v. Oregon*. Those decisions are made by the Parties.
- Determine the maximum acceptable amount of production in the basin.

Schedule

- **Draft EIS Issued** August 6
- Public Review Period Extended to 120-days ending December 3
- **Final EIS:** Spring, 2011

Public Hearings

- Two Public Hearings to be scheduled in Idaho
  - Lewiston either October 6 or 13 (Tentative)
  - Boise (TBD)

Science, Service, Stewardship

Public Hearings

- Sept. 20, 2010; 5:30 to 7:30 p.m.
  Clark Regional Wastewater District, 8000 NE 52nd Crt., Vancouver, WA 98665
- Sept. 24, 2010; 5:30 to 7:30 p.m.
  Kennewick Public Library, 1620 S. Union St., Kennewick, WA 99338
- Sept. 30, 2010; 5:30 to 7:30 p.m.
  Columbia River Maritime Museum, 1792 Marine Dr., Astoria, OR 97103

Science, Service, Stewardship

WWW.NWR.NOAA.GOV

/Salmon-Harvest-Hatcheries/
Hatcheries/MA-EIS.cfm

SALMON ADVISORY SUBPANEL REPORT ON THE MITCHELL ACT DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)

The Salmon Advisory Subpanel of the Pacific Fishery Management Council has considered the Mitchell Act Draft Environmental Impact Statement (DEIS) recently put forward for public review by the National Marine Fisheries Service (NMFS). The value of wild fish is important to society, the fishing community, and to our ecosystem. That is why, at this time, it is our recommendation that NMFS withdraw the document from the public review process until such time as the agency is able to correct the numerous errors and omissions contained in it, and consult with concerned stakeholders, tribes, agencies and groups whose expertise may be helpful in developing a revised draft document.

We have many reasons for making this request. We have a diverse membership, representing ocean and inriver fisheries from California through Washington, and also have concerns regarding S.E. Alaska fisheries, where some of the ocean trollers have licenses and where various Columbia River salmonids migrate. In our view, the document as drafted, particularly Alternatives 4 and 5, pits inland and coastal fisheries against each other, and this is not a scenario we want to endorse. Additionally, in all scenarios, various fisheries are slated for draconian cuts, and again, we do not wish to endorse any alternative that is going to create serious negative impacts for any fishery.

The larger issue is that the DEIS focuses on cuts in production and harvest, with little or no consideration given to maintenance of viable fisheries throughout all sectors. Despite its errors, the overarching conclusion we draw from the Socioeconomics section is that all fisheries will be heavily negatively impacted economically under one or another of the five alternatives put forward. We point out that the Mitchell Act as originally conceived and implemented was for purposes of mitigation for lost habitat, in order to maintain productive fisheries, as NMFS itself notes on p. 1-21. We quote: “Many of the hatchery programs operated at these [Mitchell Act-funded] hatchery facilities are intended to mitigate for lost habitat and other impacts of hydroelectric dams.” From our perspective, the mitigation obligation of the Mitchell Act has not ended.

We suggest that if NMFS wishes to cut Mitchell Act hatchery production in the future, the agency first needs to deal with bringing the naturally spawning populations to harvestable levels, which means dealing with the habitat issues that were the origin of the Mitchell Act in the 1930s. We as a group can testify to the effect that reduced and degraded habitat has had on salmon runs and on our fisheries. Such habitat degradation continues with wetland losses mounting year by year. With the continuing and on-going development of the Columbia Basin, an issue we note has not been addressed in the DEIS in any substantial way, we believe that maintenance of productive salmon runs and fisheries will continue to depend upon hatchery production in the foreseeable future. We applaud the efforts that are going in to improvement of hatchery practices and management, and point out the very real benefits of using hatcheries to preserve species such as the Snake River sockeye salmon. We also note that for a number of listed species, such as Lower Columbia River coho and tule fall Chinook, the broodstock resides largely in the hatcheries, many of which were originally funded for the purpose of conserving and propagating those fish under the Mitchell Act. The Mitchell Act's success in preserving those salmon in the face of continued habitat loss and degradation is undeniable. Conservation and production of salmon are not mutually exclusive goals.

We point out at this time that there are many significant errors, omissions and flaws that our individual groups have been trying to deal with in analyzing the DEIS, and must emphasize that they seriously hamper our efforts as a whole to provide substantive comment. We request that NMFS (NOAA Fisheries) withdraw the document and revise it, at which time we will be happy to re-examine it in the light of the comments made in this letter.

Thank you.

PFMC
09/11/10

Comments re Draft Mitchell Act EIS by Irene Martin, 9/11/2010. P.O. Box 83, Skamokawa, Wa. 98647. 1-360-795-3920; imartin@iinet.com

The comments below relate solely to the Environmental Justice Section 4.4, pp. 4-159 through 4-174 and their attendant reference pages.

This section begins: "This analysis of environmental justice effects is based on evaluating environmental justice communities and groups of concern," p. 4-161.Unfortunately, much of the documentation regarding many of those communities and groups was omitted from this section of the DEIS. I must add that since this portion of the document was not adequately foot-noted and there is no complete final bibliography, tracking sources for data, citations and statements is well-nigh impossible, and certainly doesn't meet acceptable academic or scientific standards. Page numbers are not given; complete citations, including publisher, place and date, are lacking. Titles mentioned in the text are not listed in the references. I also note that some other sections do contain this information, although it may not be consistent. The Wildlife section, for example, sometimes contains page numbers and, generally, has fuller citations. Websites referred to should be accompanied by information that says when the website was accessed. Sources are apparently listed in alphabetical order, but even this needs to be checked, as I found errors even in this task. I strongly urge the agency to upgrade the quality of the document by providing its source material via proper notes and a standard bibliography, in order that the reader can verify the statements made and ascertain the documents that were consulted. It is expecting a lot of the public to comment on a document where the provenance of the information used in it is so difficult to ascertain.

I note, for example, several works regarding tribal fisheries that should have been consulted for the DEIS, but cannot determine whether they were examined or not. These include: Meyer Resources, Inc., Tribal Circumstances and Impacts of the Lower Snake River Project on the Nez Perce, Yakama, Umatilla, Warm Springs and Shoshone Bannock Tribes (Portland, Ore., Columbia River Intertribal Fish Commission, April 1999), 2 vol., and Allan Scholz, et al., Compilation of Information on Salmon and Steelhead Total Run Size, Catch and Hydropower Related Losses in the Upper Columbia River Basin, above Grand Coulee Dam (Cheney, Wa.: Upper Columbia United Tribes Fisheries Center, Eastern Washington University, 1985). Both of these works express the magnitude of cultural dislocation and social issues regarding regarding tribal entities included in the DEIS, as well as human health issues noted on p. 3-97 of the DEIS as being a subject of mandatory concern under the EPA. I note also the absence of material from the Pacific States Marine Fisheries Commission, particularly their EFIN program. Their West Coast Charter Boat Survey Summary, as well as other documents, might have proven useful. In particular, the coastal community document produced by Jennifer Langdon-Pollock, West Coast Marine Fishing Community Descriptions (Portland, Ore., Pacific States Marine Fisheries Commission, 2004) contains baseline data and descriptions of fishing communities along the entire west coast and should have been consulted.

I note on p. 3-98 that the DEIS states, "data are not available to determine the specific user groups and communities of concern that would be affected by EIS alternatives." In fact, such data may exist in PACFIN and/or RECFIN, and could also have been elicited by discussions with tribal and state fisheries agencies and the Pacific Fishery Management Council and North Pacific Fisheries Management Council, as well as various stakeholder groups. I also point out the numerous economic studies conducted in communities along the west coast by The Research Group's Dr. Hans Radtke, none of which are cited in the list of references for this section. However, a preliminary document by The Research Group, Economic and Social Analysis Sections prepared for the Mitchell Act EIS, dated 2009 (p. 6-11), is apparently the basis for the current document, although I have been unable to locate a copy of it on the NMFS website. There are undoubtedly other documents that should have been included, but without proper notes or bibliography, trying to discern the formative documents for this section of the DEIS and verify the statements made in it is virtually impossible.

I have been unable to determine where the data came from to construct Tables 3-26, 3-27 and 3-28. Page 3-102 states that the thresholds were based on 2000 census data, but the U.S. Census is not listed in the References, Chapter Six. Further, upon checking the data with the U.S. Census of 2000, I must point out that the poverty levels given in Table 3-26, p. 3-103, differ considerably from those given in the 2000 Census. The following numbers are the actual numbers from the U.S. Census of 2000: Poverty rate for California 14.2%, not the 19.5% stated; poverty rate for Idaho 11.8%, not the 15.59% stated; poverty rate for Oregon, 11.6%, not the 14.69% stated, and poverty level for Washington, 10.6%, not the 17.69% stated. I also checked the 2006-2008 U.S. Census Bureau American Community Survey 3-Year Estimates, and found similar discrepancies. I also note that the per capita incomes for the respective states as evidenced by the actual U.S. Census data do not match with what is in Table 3-26. The comparison follows: California, actual Census, 22,711, DEIS 15,815; Idaho, actual Census 17,841, DEIS 13,990; Oregon, actual Census 20,940, DEIS 16,410; Washington actual Census 22,973, DEIS 15,829 Without some explanation of the source of the numbers used in the DEIS, or how they were calculated, I am unable to provide much in the way of useful comment on this part of environmental justice issues section.

This is a serious matter, as some communities and entire counties were omitted from table 3-28, p. 3-113, entitled "Summary of Environmental Justice Communities of Concern." These include Clatsop and Columbia Counties in Oregon, and Cowlitz, Wahkiakum and Pacific Counties in Washington. Of these counties, Clatsop, Wahkiakum, and Pacific Counties were analyzed regarding poverty issues in my study, A Social Snapshot of the Columbia River Gillnet Fishery, Astoria, Salmon For All, 2005, and also in "Resilience in Lower Columbia River Salmon Communities," in Ecology and Society, vol. 13, no. 2, 2008, Article 23. www.ecologyandsociety.org/vol13/iss2/art23/. The first-named also addressed human health issues, a requirement of the EPA as noted on p. 3-97. Further, a recent study on Astoria, Oregon, which the DEIS indicates on p. 3-111 has a poverty rate of 15.9%, was omitted. This publication, by Jennifer Langdon-Pollock, A Pilot Study in Two West Coast Marine Fishing Communities, Astoria and Newport, Oregon: Perspectives from Fishing Community Members. Portland, Ore., Pacific States Marine Fisheries Commission, contains useful information on two communities within the purview of the Mitchell Act DEIS and should have been examined.

It is impossible for me to ascertain from Table 3-28 why various counties were included, as the only number which is provided consistently for each of them is per capita income. Poverty rates have been provided for 13 out of the 35 counties listed, fewer than half, although these data are readily available. In 2000, Wahkiakum and Pacific and Clatsop counties all ranked in the lowest per capita income category of the U.S. census but have been omitted from this listing. It is also impossible to know what weight each of the categories in Table 3-28 was given in order to determine a community of concern, since no explanation is given as to how the table was drawn up. I would have assumed that a county or community with a per capita income in the lowest category of the U.S. Census of 2000 and/or a poverty rate above that of its state might be of some concern regarding environmental justice. A more useful table would have included many more counties with the correct rates in each category for each of them, and some idea of how the various categories rank in terms of importance. It would also have been helpful to know whether the categories were left blank because there were no data, or whether there were other reasons for omitting readily available data such as poverty rates. All four states cited have county data derived from the U.S. Census that is easily available via the Internet. I cannot determine whether any of this data was consulted, or, if so, why so much of it was omitted with no reason given.

I would also have assumed that counties where fisheries are a major source of income, and where Mitchell-Act funded hatcheries exist, such as Wahkiakum and Clatsop counties, would have been included and some analysis done as to the effect the Mitchell Act has had on the economies of these areas and what effect the redirection of Mitchell Act funding and policy changes might be expected to have. It seems to me that an Environmental Impact Statement regarding the Mitchell Act should address the community context in which the Mitchell Act has been a factor for over fifty years, particularly in the areas of socioeconomics and environmental justice. Further, the publication "Fishing Communities," available on the Pacific Fishery Management Council website, www.pcouncil.org, states: "As part of the NEPA process, both economic factors…and social factors (population dynamics, social institutions, environmental justice, cultural values, community identity, history, etc.) need to be addressed in environmental assessments and environmental impact statements." To omit these communities' economic and social factors is simply incomprehensible, given that Mitchell Act-funded hatcheries and fisheries dependent upon them are located there.

I note NMFS own website describes criteria for community impact analysis and lists publications by Karma Norman, the agency's Northwest social scientist, who has developed community profiles for the west coast. These publications include Norman, K. C., J. A. Sepez, H. Lazrus, N. Milne, C. Package, S. Russell, K. Grant, R. Petersen Lewis, J. Primo, E. Springer, M. Styles, B. D. Tilt, I. Vaccaro. 2007. Community profiles for West Coast and North Pacific fisheries - Washington, Oregon, California, and other U.S. states. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-85, 602 p. This publication might have been of assistance in identifying communities potentially affected in Alaska by the DEIS. I also recommend the following publication for your reference: Sepez, J. A., K. C. Norman, R. Felthoven. 2007. A Quantitative Model for Ranking and Selecting Communities Most Involved in Commercial Fisheries. National Association for the Practice of Anthropology Bulletin, (28)43-57. I do not understand why NMFS has not used its own documents or methodologies in developing this portion of the DEIS, but they do not appear in the list of references for this section. I did discover mention of the first-named document in the text of the Socio-Economics Section, p. 3-96, but it was not listed in the list of references for that section either, nor can I determine whether it was actually consulted for either section.

On p. 3-97 the DEIS states that "EPA Guidance recommends that the environmental justice analysis also determine whether such populations or communities have been sufficiently involved in the decision-making process (EPA 1998)." While it is quite clear that many of the communities concerned have not been involved, and have actually been omitted, it is particularly noteworthy that the Columbia River Intertribal Fish Commission does not appear to have been consulted, as their name and those of their individual tribal entities do not appear in the list on p. 8-2.

Since a number of the fishing-oriented counties, tribes and stakeholders with substantial economic, historical and cultural ties to fisheries (and fisheries supported by Mitchell Act hatcheries at that), have been ignored in this section of the DEIS, and given the errors and questions listed above, I suggest a complete rewrite of this section of the DEIS with the opportunity for further comment and public input after additional research has been done. I have put nearly 10 hours of research time into what amounts to a 15 page section, and still find myself unable to comment on Environmental Justice issues in the DEIS due to the numerous problems outlined above. I do not believe that this section is ready for public review at this time.

MITCHELL ACT HATCHERY DRAFT ENVIRONMENTAL IMPACT STATEMENT (DEIS)

Council Staff has developed a draft list of potential questions, the answers to which may be useful to the ad hoc Mitchell Act Committee in developing recommendations for Council consideration at the November Council meeting. Recognizing that many agencies represented at the Council may be conducting concurrent reviews of the DEIS, candidates to answer questions are shown with the goal of not assigning questions to Council advisory bodies or Council staff that might be duplicative of that already planned by other entities. The Council should confirm questions and assignment expectations as a guidance and direction under Agenda Item C.3.d.

1. Has the science used in the analysis of impacts been peer reviewed, and is there agreement with the States and Tribes that it represents the best available science? (WA, OR, Tribes, AK)

2. Are the mitigation requirements and responsibilities under the Mitchell Act adequately described in the DEIS? (WA, OR, Tribes, AK)

3. What are the other alternatives that meet the purpose and need of the proposed action that were not included in the DEIS? (USFWS)

4. Can hatchery reform concepts other than proportion hatchery origin spawners (pHOS) and proportion natural origin broodstock (pNOB), such as natural rearing strategies, be used to develop alternatives that meet the purpose and need of the DEIS but maintain more production than Alternatives 3-5? (Tribes, AK, OR, WA)

5. What fisheries are assumed in the analysis to be mark-selective, and at what point in time? (OR, WA, Tribes, AK)

6. Were Native American tribes engaged in government to government consultations in development of the DEIS, including the four Washington coastal treaty tribes and the four Columbia River treaty tribes? (Tribes)

7. Are the impacts to all ocean fisheries in areas under management authority of the Pacific Council, the Pacific Salmon Commission, and the State of Alaska included in the analysis of each alternative in DEIS (harvest impacts to individual fishery strata, socioeconomic impacts, and the environmental justice analyses)? (STT)
    - If not, what is the list of fisheries not included and what is the relationship of Mitchell Act hatchery production with those fisheries? (STT)

8. Are impacts in all Columbia River basin fisheries included in the DEIS, including tributary C&S and recreational fisheries? (Tribes, OR, WA)

9. Is production from all Columbia Basin hatcheries included in the analysis? (USFWS)

10. Is the methodology describing economic impacts complete and proper, including consistent metrics? For example, are there more appropriate indices of fishery value that should be used rather than ex-vessel value? (SSC)

11. Were expected benefits to fisheries from increased wild production included in the economic analyses? (WA, OR, Tribes, AK)

12. Were current fishery and hatchery management agreements used to estimate impacts (e.g., *US v Oregon*, PST Chinook Annex, *US v Washington, Hoh v Baldrige,* etc.)? (WA, OR, Tribes, AK)

13. Were impacts to commitments in the PST, *US v Oregon*, *US v Washington, Hoh v Baldrige* properly described in the DEIS? (WA, OR, Tribes, AK)

14. Are there relevant sources of information omitted from socioeconomic analysis? (SSC)

15. Is the temporal scale of the impact assessment adequate? (WA, OR, Tribes, AK)

16. Are the natural salmon populations targeted for restoration appropriately identified? (Council Staff)

17. Recognizing recent changes in the hatchery practices that have already occurred, what is the period used to decide the status quo alternative? (OR)

18. Are the DEIS alternatives consistent with adopted state recovery plans? (OR, WA, ID)

PFMC
09/14/10

NATIONAL MARINE FISHERIES SERVICE REPORT

National Marine Fisheries Service (NMFS) Southwest Fisheries Science Centers will briefly report on recent developments relevant to salmon fisheries and issues of interest to the Pacific Fishery Management Council (Council).

Council Task:

1. Discussion.

Reference Materials:

1. Agenda Item C.4.a, NMFS Science Centers Report: NMFS Salmon Research Report.

Agenda Order:

a. Fisheries Science Center Activities **Steve Lindley**
b. Reports and Comments of Advisory Bodies and Management Entities
c. Public Comment
d. Council Discussion

PFMC
08/30/10

NMFS Salmon Research Report

NMFS Science Centers research and development of salmon decision support systems

1. The future of the California Chinook salmon fishery: roles of climate variation, habitat restoration, hatchery practices, and biocomplexity. The SWFSC has begun an interagency collaboration to create a tool that allows resource managers to predict how various management actions would contribute to improving the sustainability of California's Chinook salmon fishery. Likely, a combination of actions will be most effective, including habitat restoration, modification of hatchery operations, and consideration of environmental variation in management and hatchery operations. The tool we develop will be a numerical multiple-population, spatially-explicit life-cycle model of Central Valley and Klamath River Chinook salmon stocks incorporating harvest, growth, survival, maturation, and movement. The effects of management actions on salmon vital rates, production, and harvest in a varying environment will be simulated. The multi-population character of the model and its ability to allow for changes in life-history diversity allows us to address questions of resiliency. A critical aspect of the model is the nature of variation of survival in freshwater, the estuary, and the ocean. We will use statistical models to quantify the variance in survival rates for various life stages by analyzing coded-wire-tag recoveries and time series of spawner escapement. We will relate the variation in survival to environmental conditions (e.g., freshwater flow, prey, and oceanographic conditions). The outcomes of these analyses will be used to set parameter values in the simulation model which will be used to evaluate effects of various management scenarios on salmon production and resiliency.

2. Utilizing ecosystem information to improve the decision support system for central California salmon. In collaboration with partners, SWFSC has begun to investigate two new research areas related to Chinook salmon. First, we are developing statistical tools to identify juvenile and adult Chinook salmon dynamic habitat and prey resources in the coastal ocean and to measure the variability of these habitats and resources relative to the environment. These models will be based on SWFSC trawl surveys and long-term environmental data. Secondly, we are developing bio-physically forced forecasting models to estimate future ecosystem state and potential productivity of Chinook salmon along the California Current system. We have developed the methodology to evaluate current and retrospective ecosystem health based on the biological responses to environmental conditions. We have also developed oceanographic models to forecast what the environmental conditions may be as much as nine months out.

3. Population dynamics model for evaluating the effects of removing four dams from the mainstem Klamath River on Klamath River fall Chinook. The Secretary of the Interior will decide, partly on the basis of an economic cost-benefit analysis, whether to commit federal funds to the removal of four dams on the mainstem Klamath River. If removed, Chinook and coho salmon would regain access to historical habitats in the upper basin, and water quality in the lower basin might be improved. The SWFSC is developing a model based on stock-recruitment dynamics to estimate how many fall Chinook might return to the basin and be available to ocean and river fisheries over the next decades should the dams remain in place or be removed. This analysis will include the predicted effects of climate change.

4. Improving stream temperature predictions for river water decision support systems. The SWFSC is developing a river temperature model to couple with a fish bioenergetics model to give water managers a tool to evaluate how flow releases from Shasta and Keswick dams on the Sacramento River impact river temperature and the growth and survival of fish, especially fall and winter Chinook salmon.

5. Columbia River Life-cycle modeling. Building off previous analyses, the NWFSC is embarking on a major new life-cycle modeling effort of salmonid populations in the Interior Columbia River Basin, which covers large portions of Washington, Idaho, and Oregon. The effort is related to the Biological Opinion on the Federal Columbia Hydropower System. The research will update existing stochastic life-cycle models to incorporate most recent population data (abundance of adults and juveniles, stage-specific survival, etc.), expand the number of populations modeled, incorporate climate effects across life stages and develop the ability to incorporate predicted climate conditions in the near term (1-2 years), such as freshwater conditions (e.g., snow pack), mainstem conditions (flow and temperature), and ocean conditions, on survival through the life cycle. The goal is to predict which populations are most sensitive to climate variability and which restoration actions are most resilient to climate change. In addition, we will evaluate the effects of hatchery spawners on the success of wild spawners, the impact of hatchery releases on wild populations, and density-dependent effects of hatchery production on the productivity of wild fish.

6. Columbia Basin hydrological modeling. In collaboration with partners, the NWFSC is developing detailed hydrological models of several watersheds in the Columbia River Basin using the Distributed Hydrology Soil Vegetation Model (DHSVM). DHSVM is a distributed hydrologic model that explicitly represents the effects of topography and vegetation on water fluxes through the landscape. It is typically applied at high spatial resolutions on the order of 100 m for watersheds of up to 10^4 km^2 and at sub-daily timescales for multi-year simulations. The model can predict how stream flows and temperature will respond to future climate scenarios, and we will couple these outputs with biological models of salmon population response to climate. We have currently developed calibrated models for five watersheds in the Wenatchee River Basin in Washington and five watersheds in the Salmon River Basin in Idaho. We will extend this modeling capability to additional watersheds in the future.

Mass Marking Workgroup

Background. Mass marking and mark-selective fisheries have recently been proposed (recently by Cal-Neva AFS 2009a) as a basis for an alternative management system for fall Chinook salmon in California. The National Marine Fisheries Service (NMFS) Southwest Regional Office, the California Department of Fish and Game, and the U.S. Fish and Wildlife Service jointly requested that the NMFS Southwest Fisheries Science Center (SWFSC) lead a scientific workgroup to more thoroughly review the costs, benefits, and risks of the alternative marking/tagging systems, including the current system (NMFS-DFG-USFWS, 16 June 2009). The SWFSC accepted the request and charged the director of the Fisheries Ecology Division with organizing and executing the process.

Workgroup Charge. The Workgroup's overall charge is to provide a technical evaluation of the attributes of various alternative marking/tagging systems and their value for conservation of Central Valley (CV) and Klamath River (KR) fall Chinook salmon, conservation of other salmon stocks, management of salmon fisheries, management of hatcheries, and other operations.

The Workgroup's charge is to provide a technical evaluation of the attributes of several options of marking/tagging systems that will serve to inform policy makers on the subject. The Workgroup charge does not include recommending that one or another of these systems be adopted. The Workgroup charge also does not include conducting a "Hatchery Reform" review as has been recently undertaken in the Pacific Northwest.

Meetings to date, membership, and remaining schedule

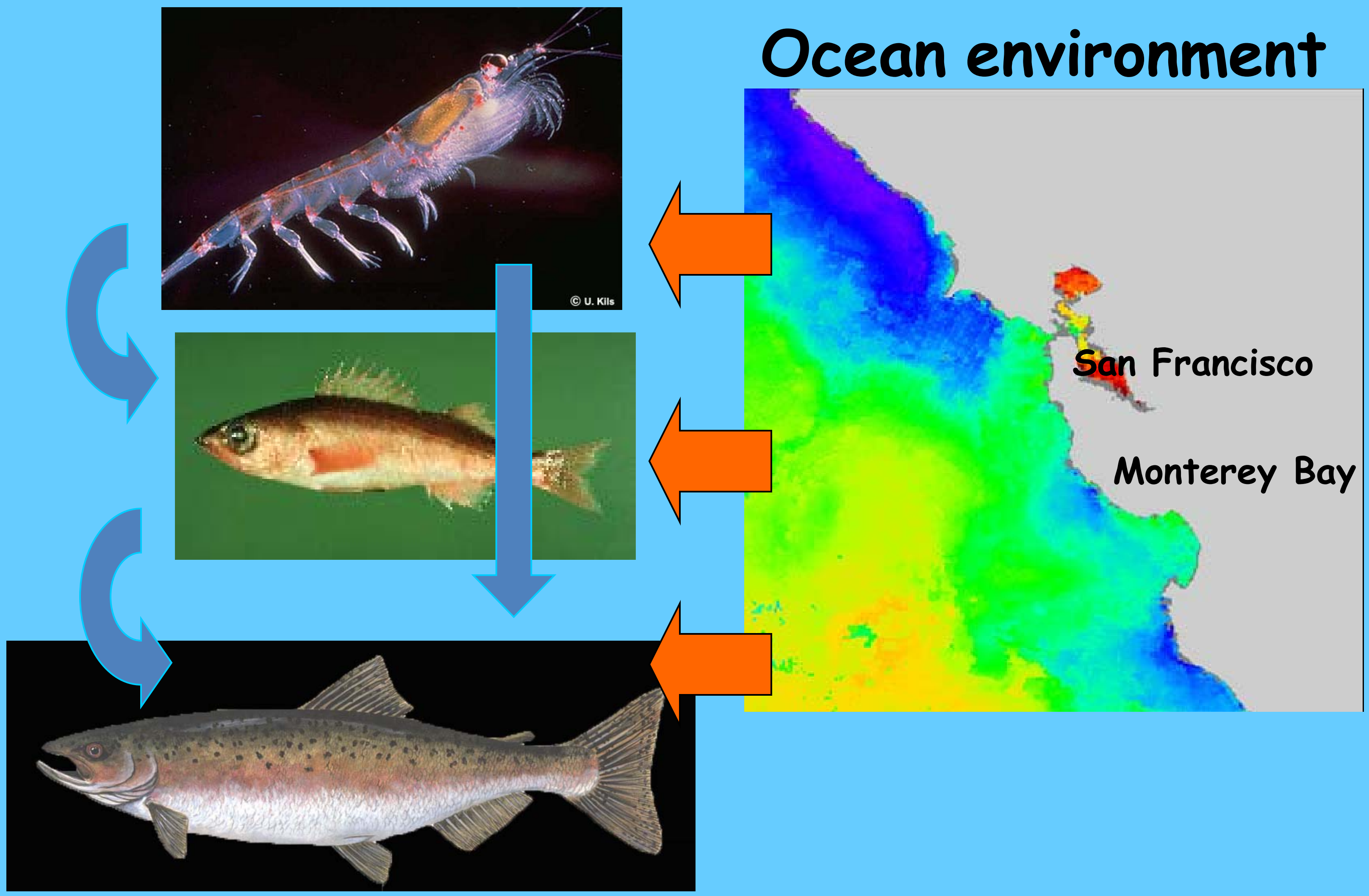
1. Organizing meeting was held 2-3 November 2009 in Santa Cruz.
2. Opportunity for public/interested parties to provide information and data to Workgroup held on 18 November 2009 in Sacramento. Two individuals presented (and provided information) to workgroup: Josh Israel and Dennis Lee. Powerpoint presentations from both presenters and briefing document from Dennis Lee provided to workgroup.
3. Workgroup members: Pete Bisson (USFS), Brad Cavallo (Cramer Fish Sciences), Scott Hamelberg (USFWS), David Hankin (Humboldt State University), Dave Hillemeier (Yurok Tribal Fisheries), Steve Lindley (NMFS-SWFSC), Michael Mohr (NMFS-SWFSC), Melodie Palmer-Zwahlen (CDFG) and Jim Smith (USFWS).
4. Steering committee members: Churchill Grimes (NMFS-SWFSC), Alice Low (CDFG), Jim Smith (USFWS), Thomas Williams (NMFS-SWFSC) and Don Jackson (President, American Fisheries Society)
5. Next meeting date and location TBD
6. Report completion date target May 2010

NMFS salmon management support projects

presented by Steve Lindley and Pete Lawson

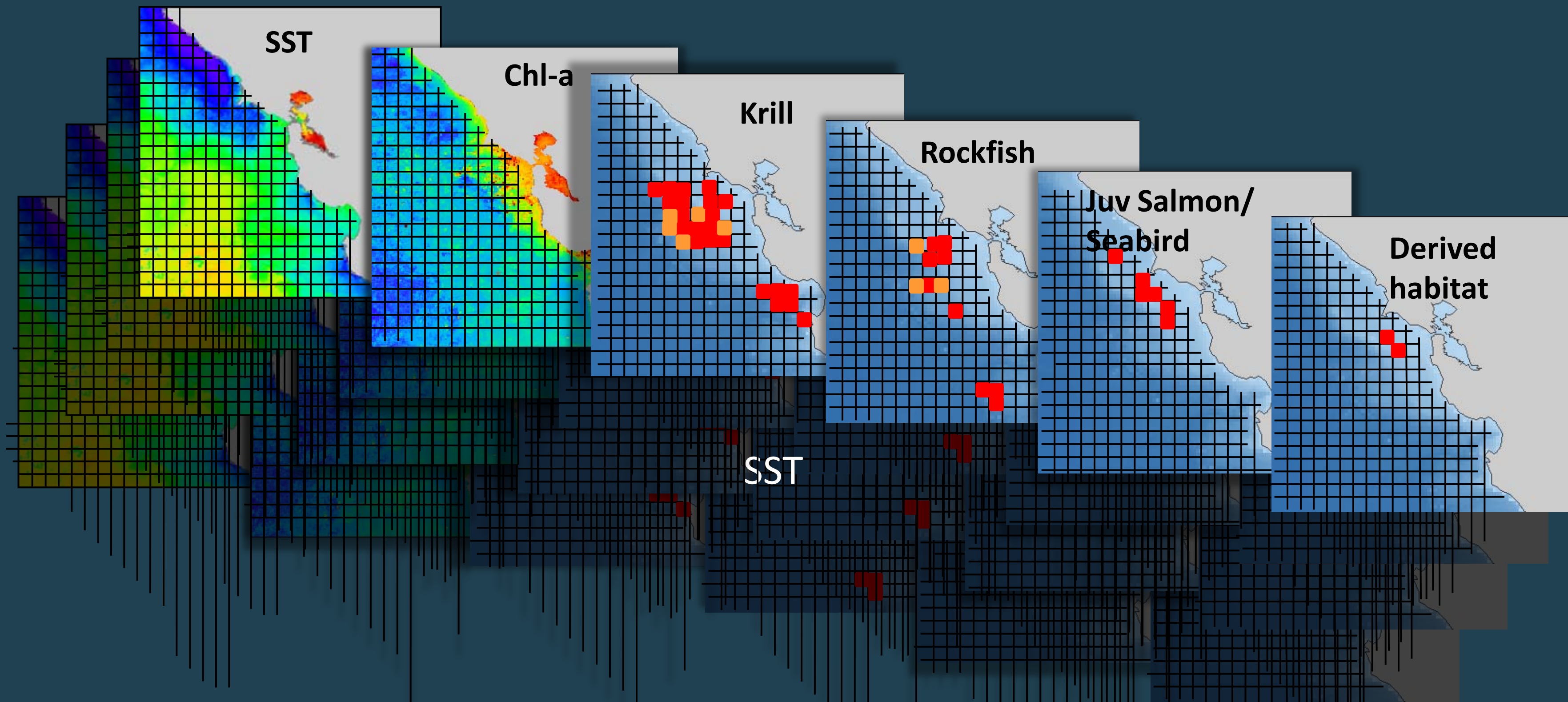
- California Current System ecological modeling
- Sacramento, Klamath, and Columbia River life-cycle modeling
  - Stream temperature modeling
  - Klamath disease modeling
- California Mass Marking Working Group
  - Evaluation of mass marking and mark-selective fisheries
- Ocean sampling
  - Juvenile salmon rope trawl survey
- Use of GSI data in salmon management

Modeling in the California Current System



To date, we have focused on adult reactions to REGIONAL and COASTWIDE conditions.

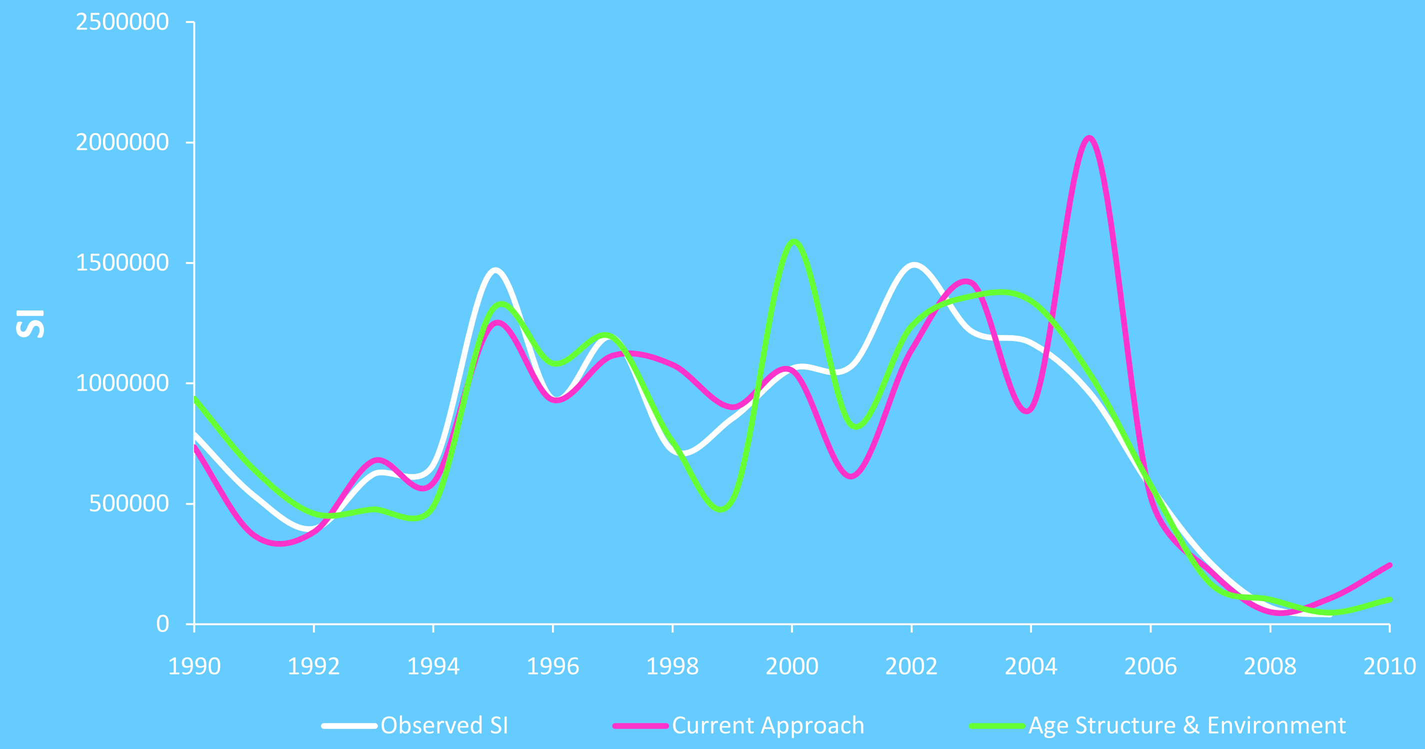
Meso-scale Ocean environment



We are expanding and improving on previous models by examining the role of mesoscale variability (the scale relevant to juveniles) on the productivity of Central Valley Fall run salmon.

Incorporation of environmental data and age structure variability into the assessment models

For Sacramento River fall Chinook, preliminary analyses shows an improvement in estimates of productivity. This is especially true when abundance is drastically reduced.



The future of the California Chinook salmon fishery: roles of climate variation, habitat restoration, hatchery practices, and biocomplexity: A management strategy evaluation

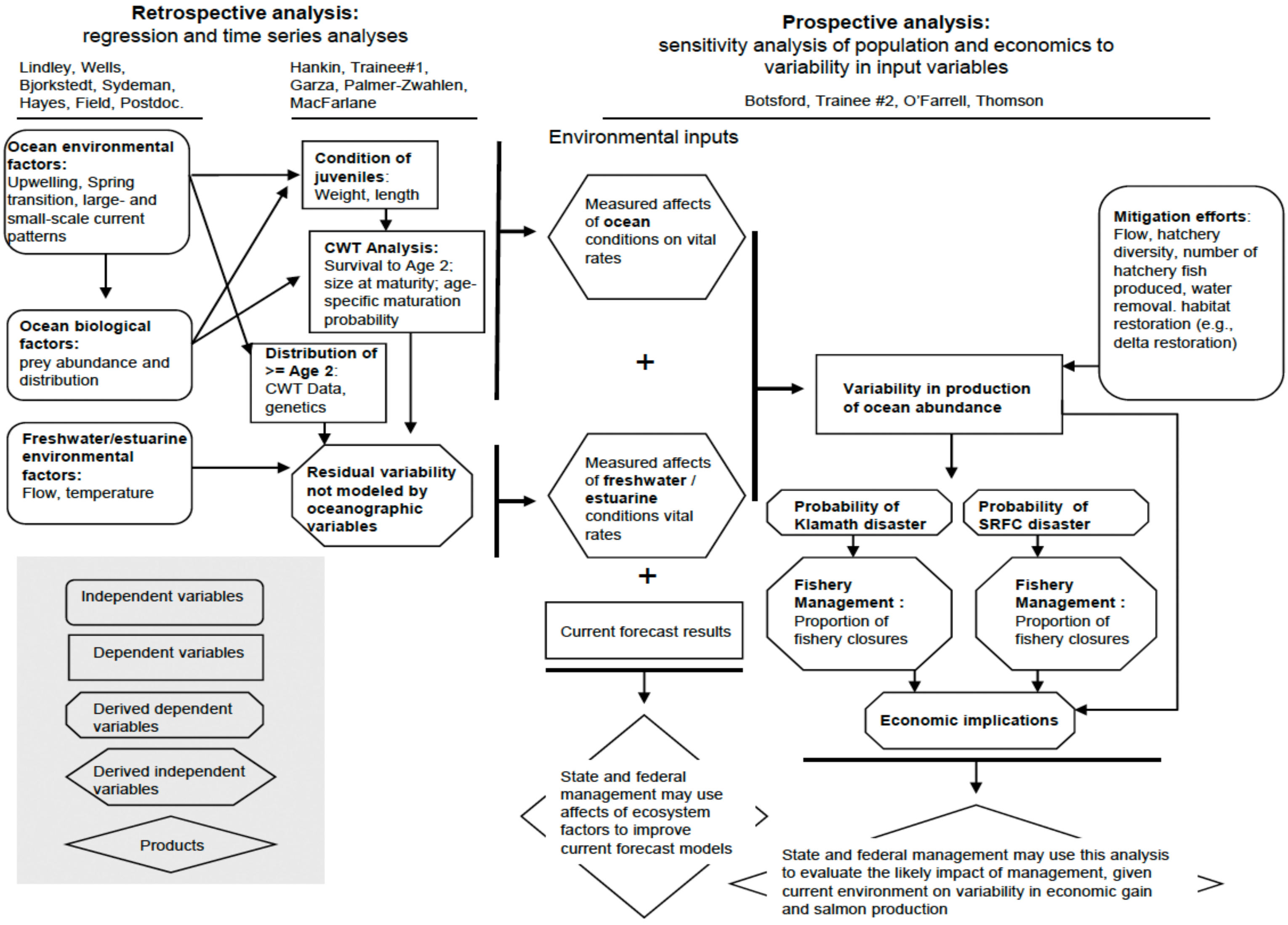
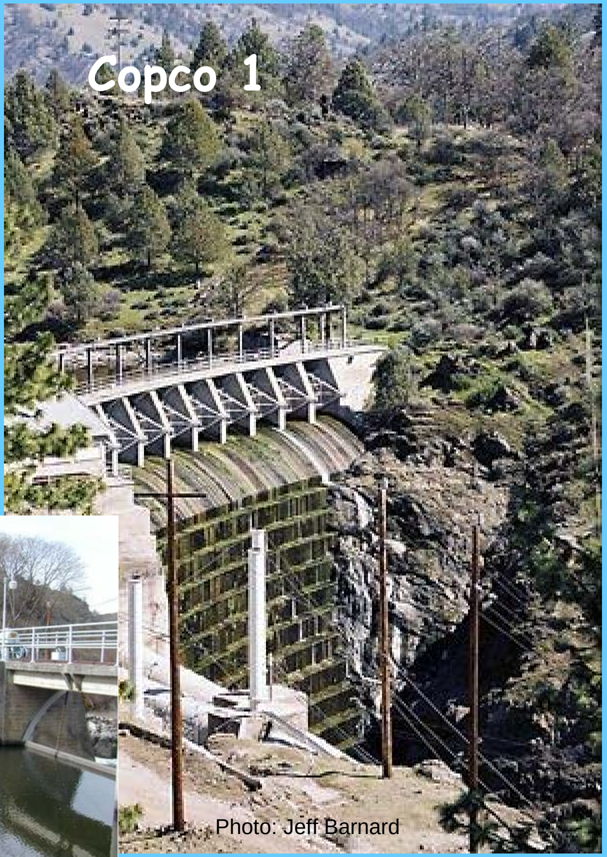
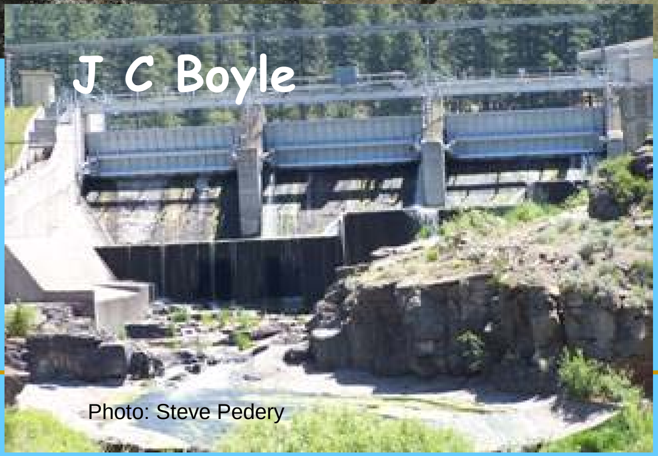


Figure 3: Conceptual diagram of the proposed research models and outputs.

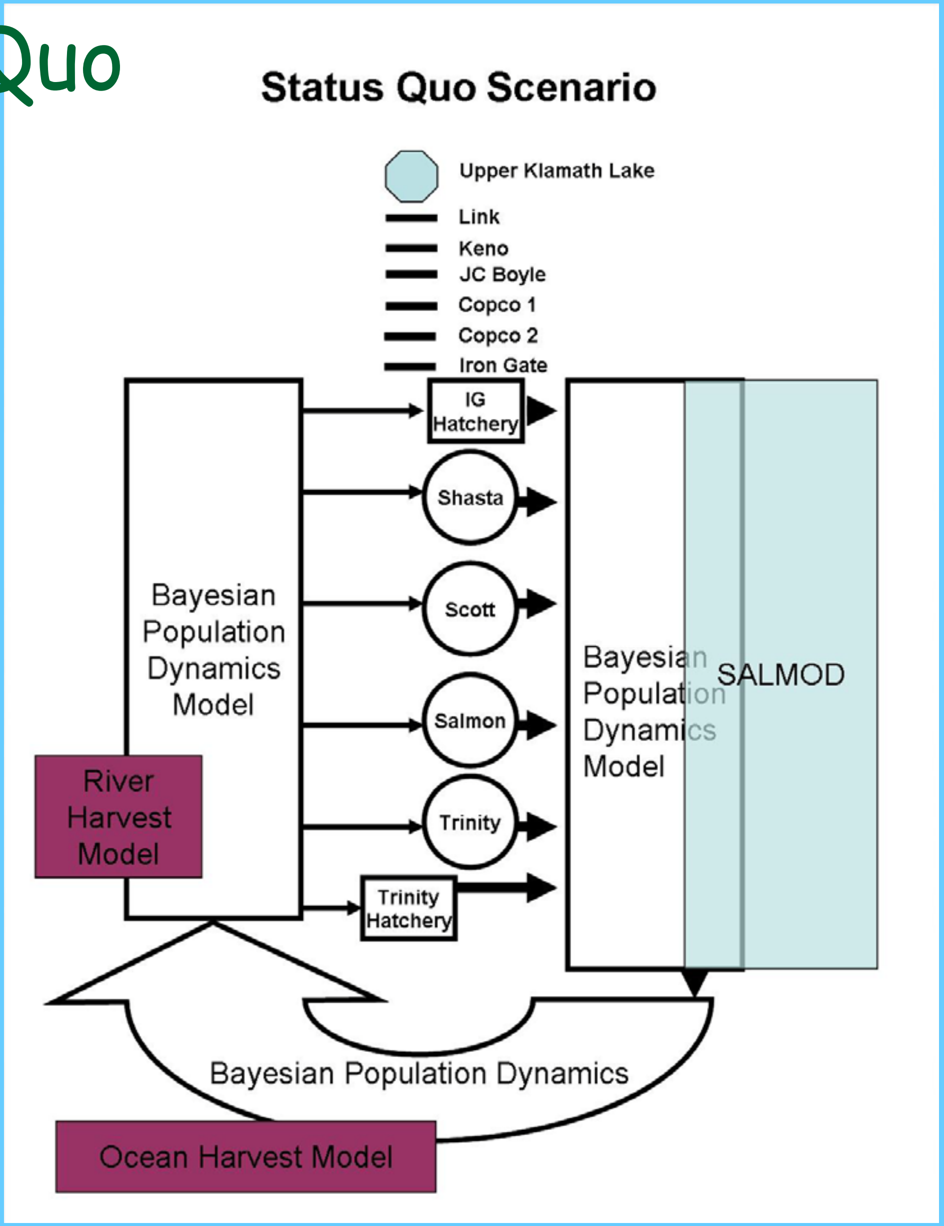
Population dynamics model for evaluating the effects of removing four dams from the mainstem Klamath River on Klamath River fall Chinook.





Alternative: Status Quo

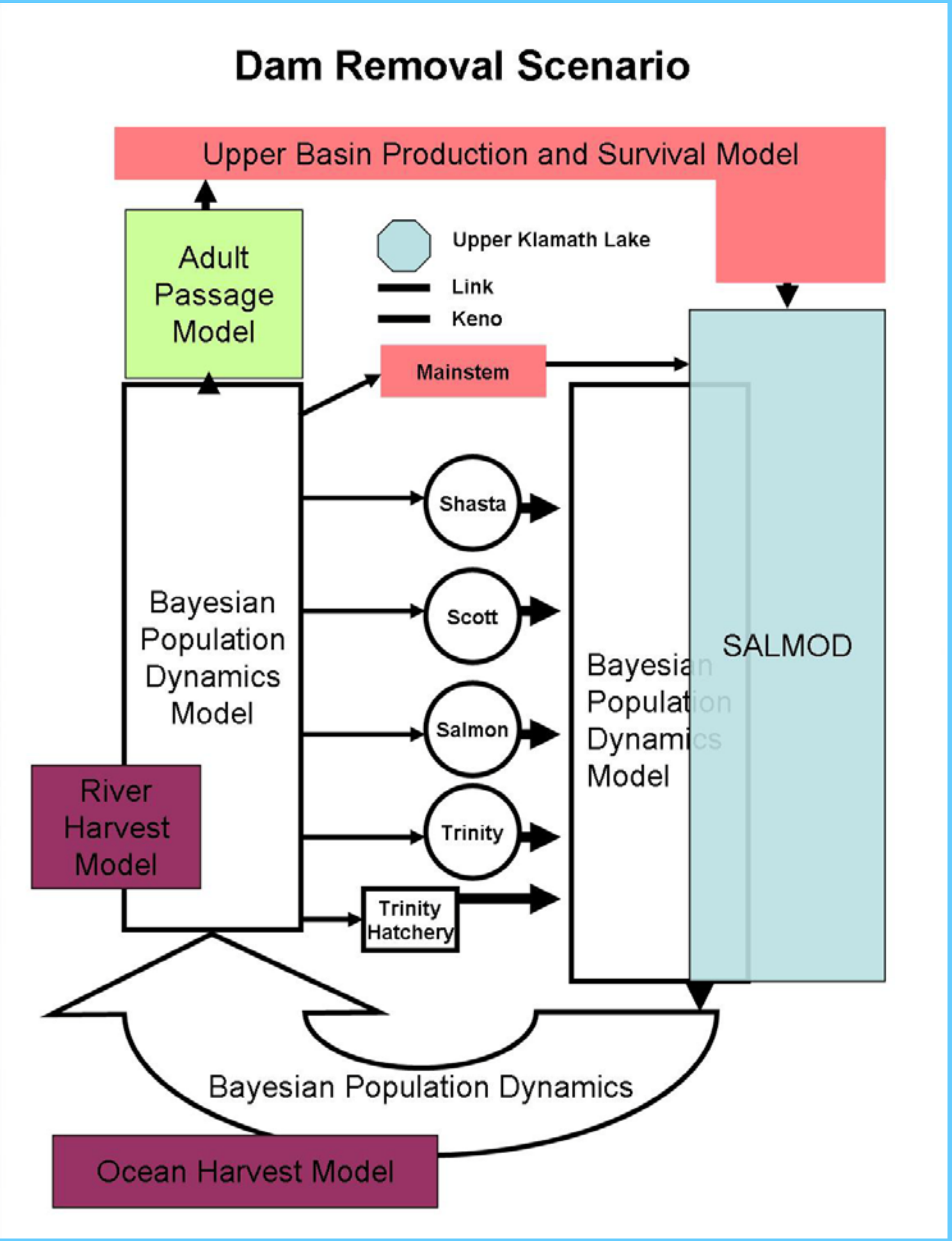
- Bayesian Population Dynamics
  - Lifecycle model for tributaries and IG Hatchery
- SALMOD
  - IG to Ocean survival
- Harvest Model



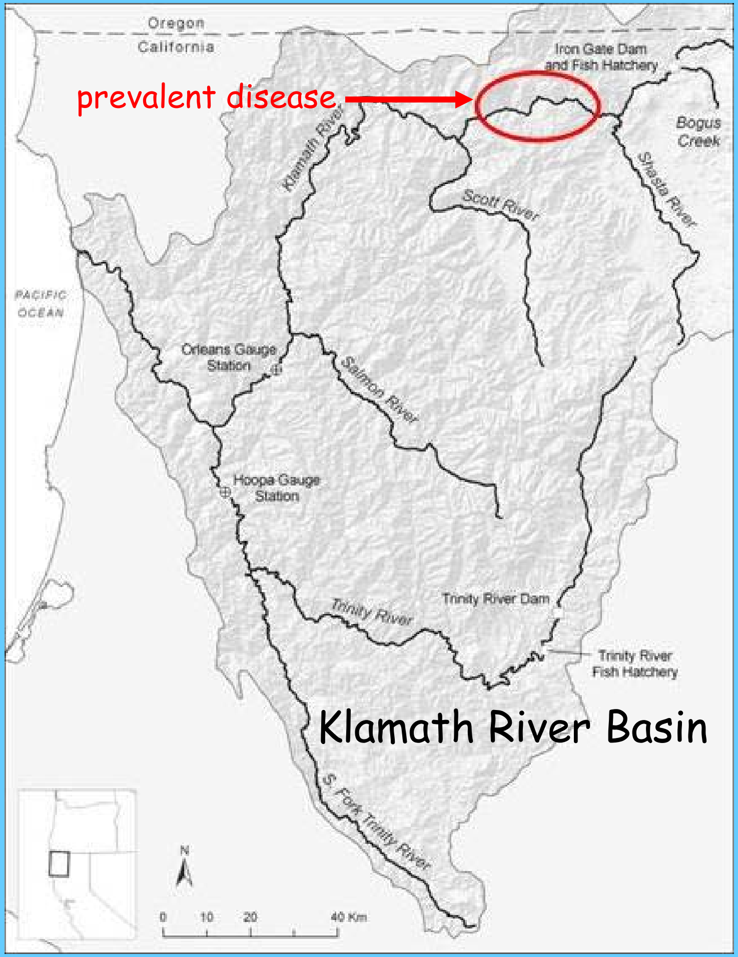
Alternative: Dam Removal

in addition…

- Adult Passage
  - Timing
  - Water quality
- Upper basin and mainstem production
  - Carrying Capacity
  - UKL conditions
- SALMOD
  - Disease
  - Water quality

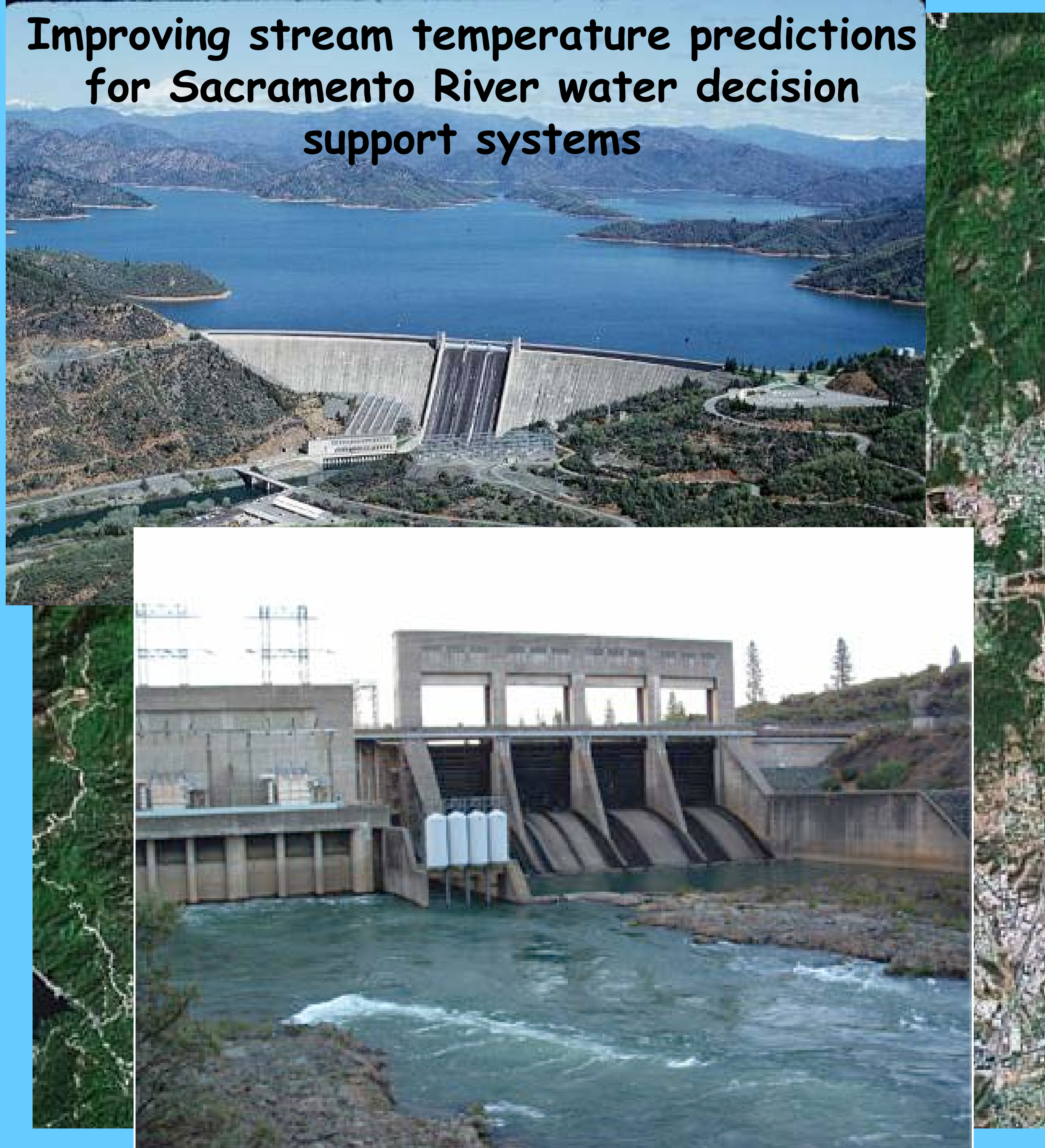


Population level effects of disease on KRFC salmon

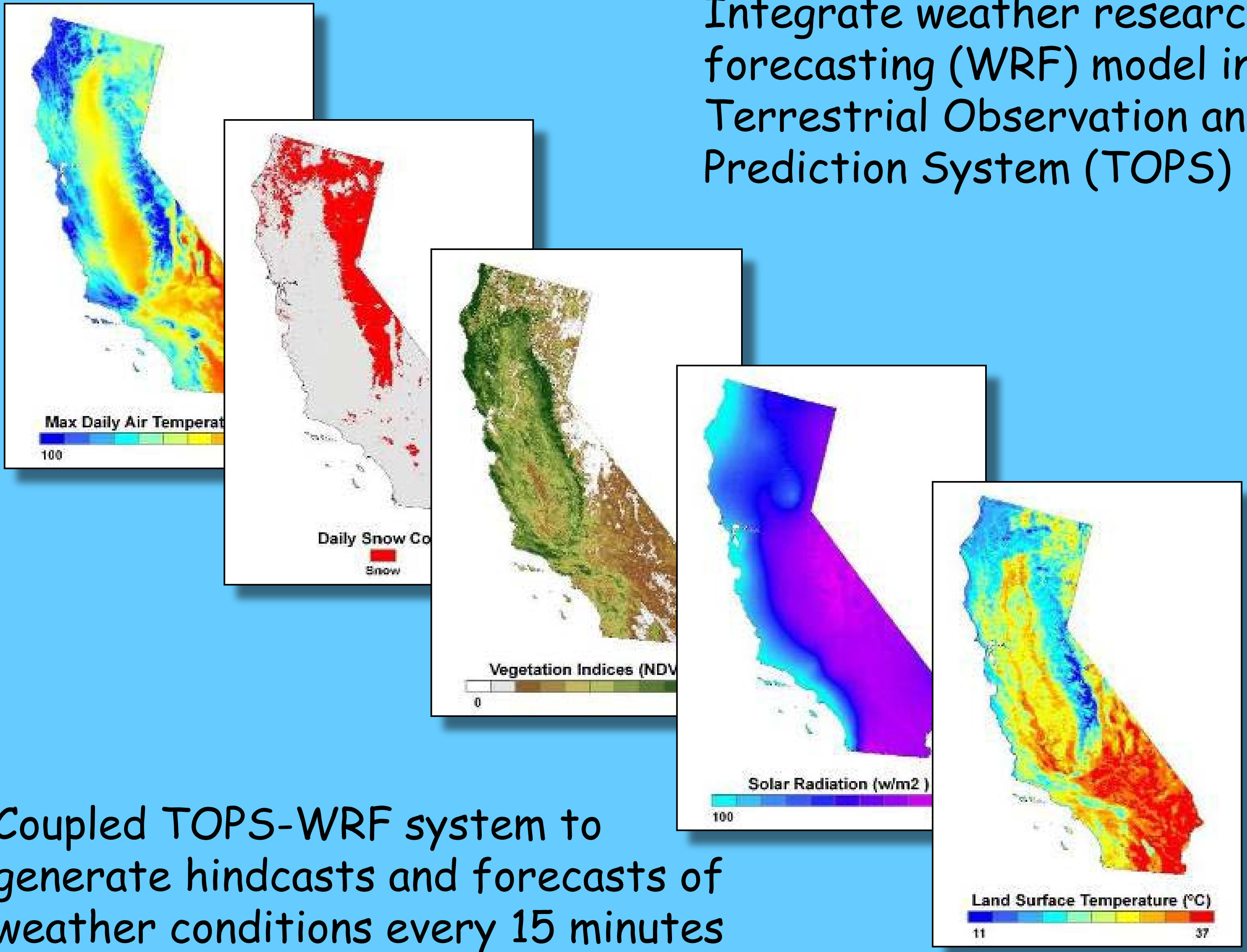


- Evaluate how disease affects KRFC population dynamics, abundance, and harvest
- Construct KRFC life-cycle models with disease incorporated
- Collaboration with fish pathologists

Improving stream temperature predictions for Sacramento River water decision support systems



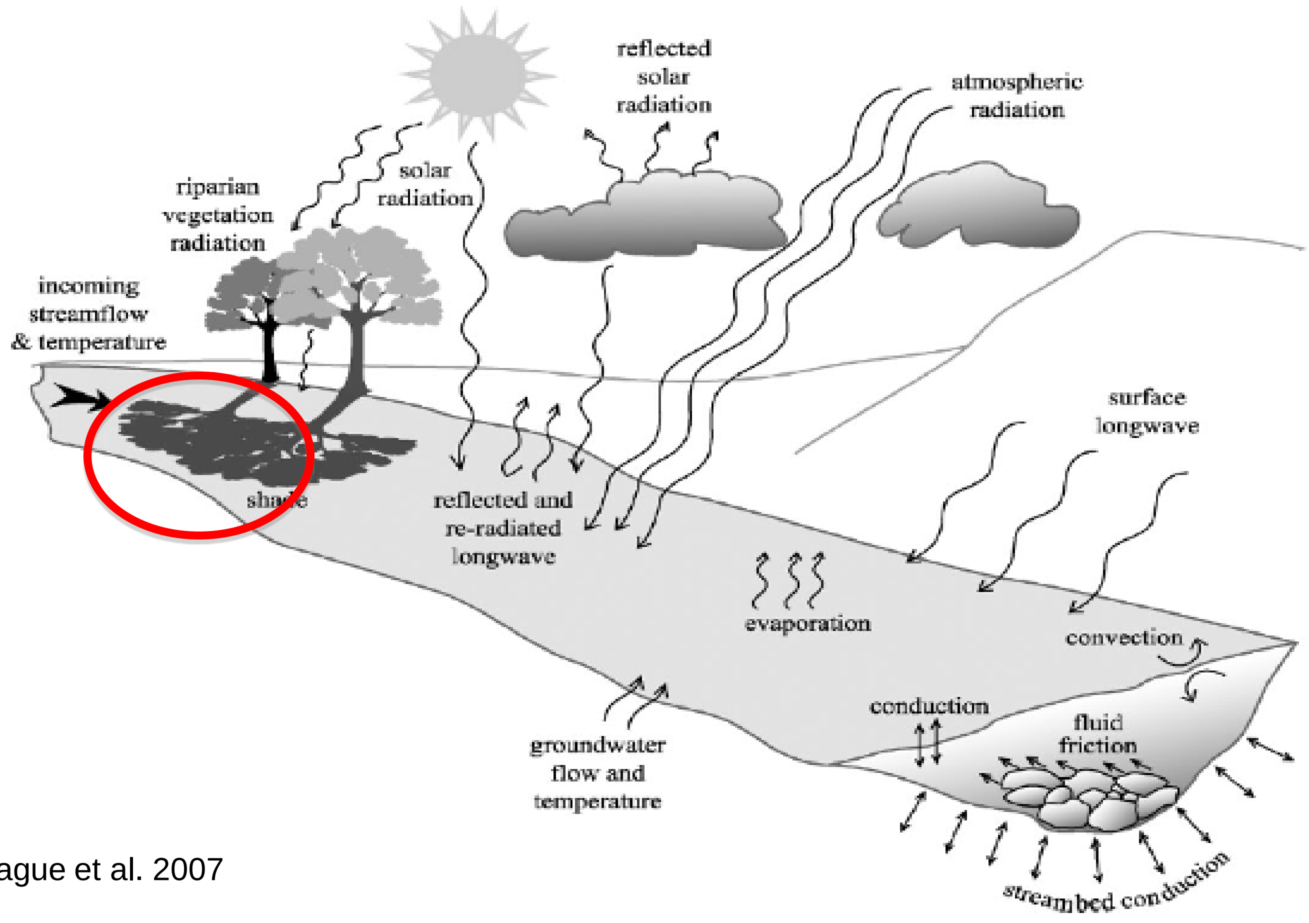
Integrate weather research and forecasting (WRF) model into Terrestrial Observation and Prediction System (TOPS)



Coupled TOPS-WRF system to generate hindcasts and forecasts of weather conditions every 15 minutes at a spatial resolution of $1km^2$

Heat Budget

Based on both atmospheric inputs and water temperature

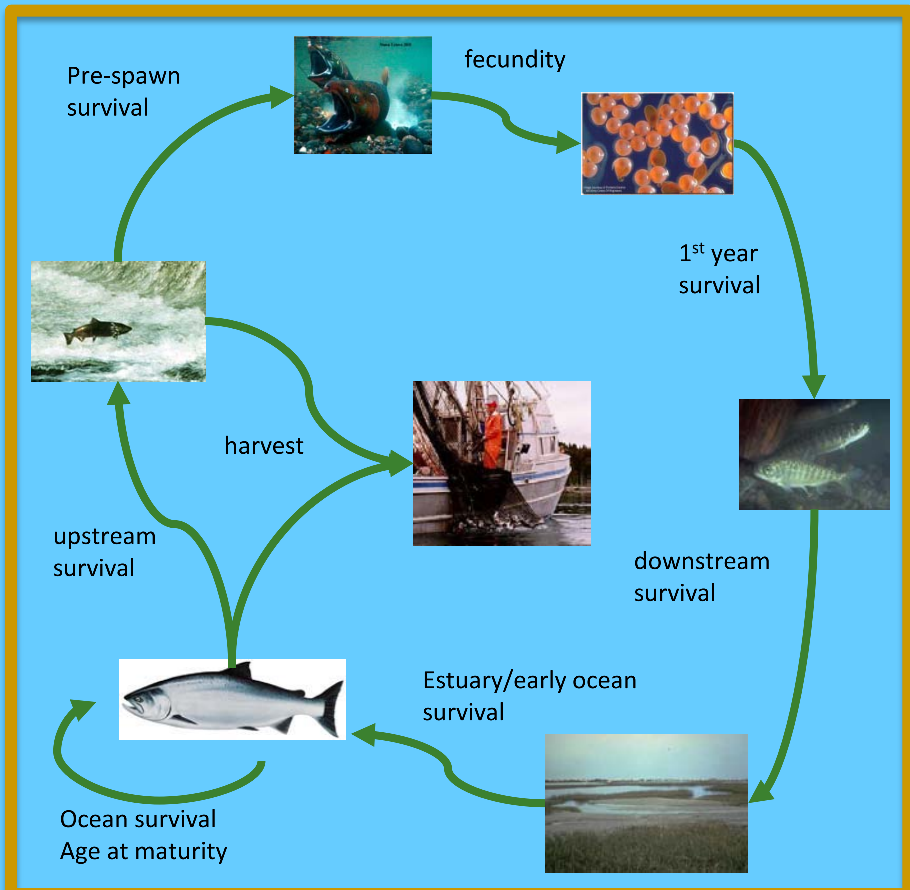


Tague et al. 2007

NWFSC Actions under FCRPS BiOP and AMIP

- Updated status and trends analysis
- Life cycle modeling (see Rich's slides)
- Developing early warning indicators
- Evaluating reintroductions above barriers
- Assessing impacts of non-native species
- Assisting development of rapid response actions if stocks decline

FCRPS BiOP Life-Cycle Model



<u>Data</u>

- Spawner counts and ages
- Smolt-to-Adult survival
- PIT-tag survival
- Chinook and steelhead

•<u>Model Output</u>

•Future trajectories of abundance

•Annual population increase (l)

<u>Questions</u>

•How will populations respond to future environmental conditions in the ocean and freshwater?

•How will alternative hydrosystem conditions affect long-term viability?

Continued Development by NWFSC and the Interior Columbia Technical Recovery Team

Mass Marking Workgroup

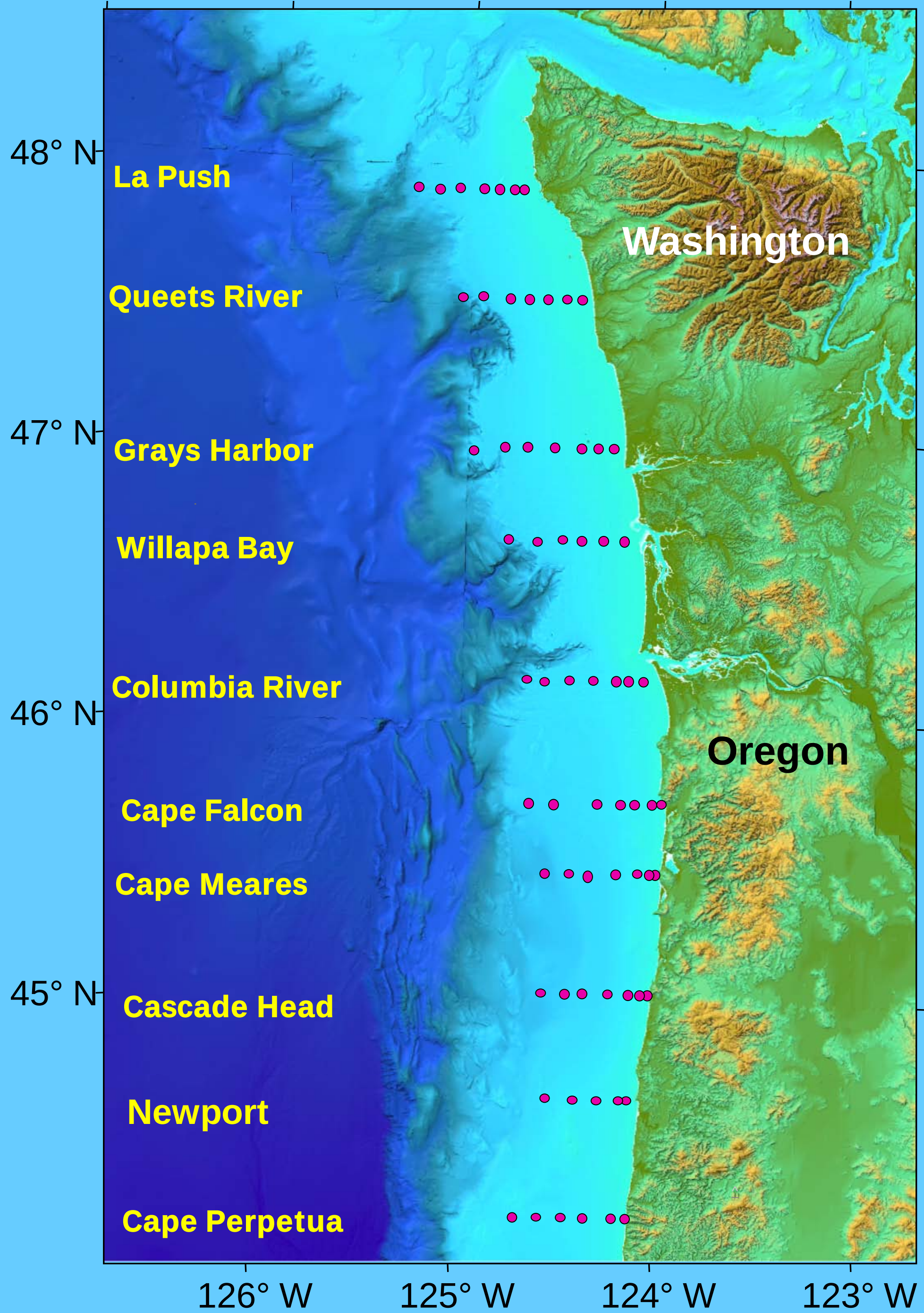
Workgroup Charge

Provide a technical evaluation of the attributes of various alternative marking/tagging systems and their value for conservation of Central Valley (CV) and Klamath River (KR) fall Chinook salmon, conservation of other salmon stocks, management of salmon fisheries, management of hatcheries, and other operations.

The Workgroup charge does not include recommending that one or another of these systems be adopted nor will this effort include a "Hatchery Reform" review.

Background

- Mass marking and mark-selective fisheries have recently been proposed as a basis for an alternative management system for fall Chinook salmon in California.
- Possible benefits that would accrue from the proposal include:
    - improved genetic fitness of hatchery broodstock and natural spawning populations.
    - significantly increased overall harvest and fishing opportunity with decreased fishing mortality on ESA-listed and unmarked stocks.
- However, many questions and concerns have been raised about this proposal regarding the certainty of these benefits accruing, the unintended consequences that could occur with implementation, and the costs of such a program.
- Other marking/tagging system proposals have also been put forward that promise certain benefits over the current system.
- Report target: October 2010

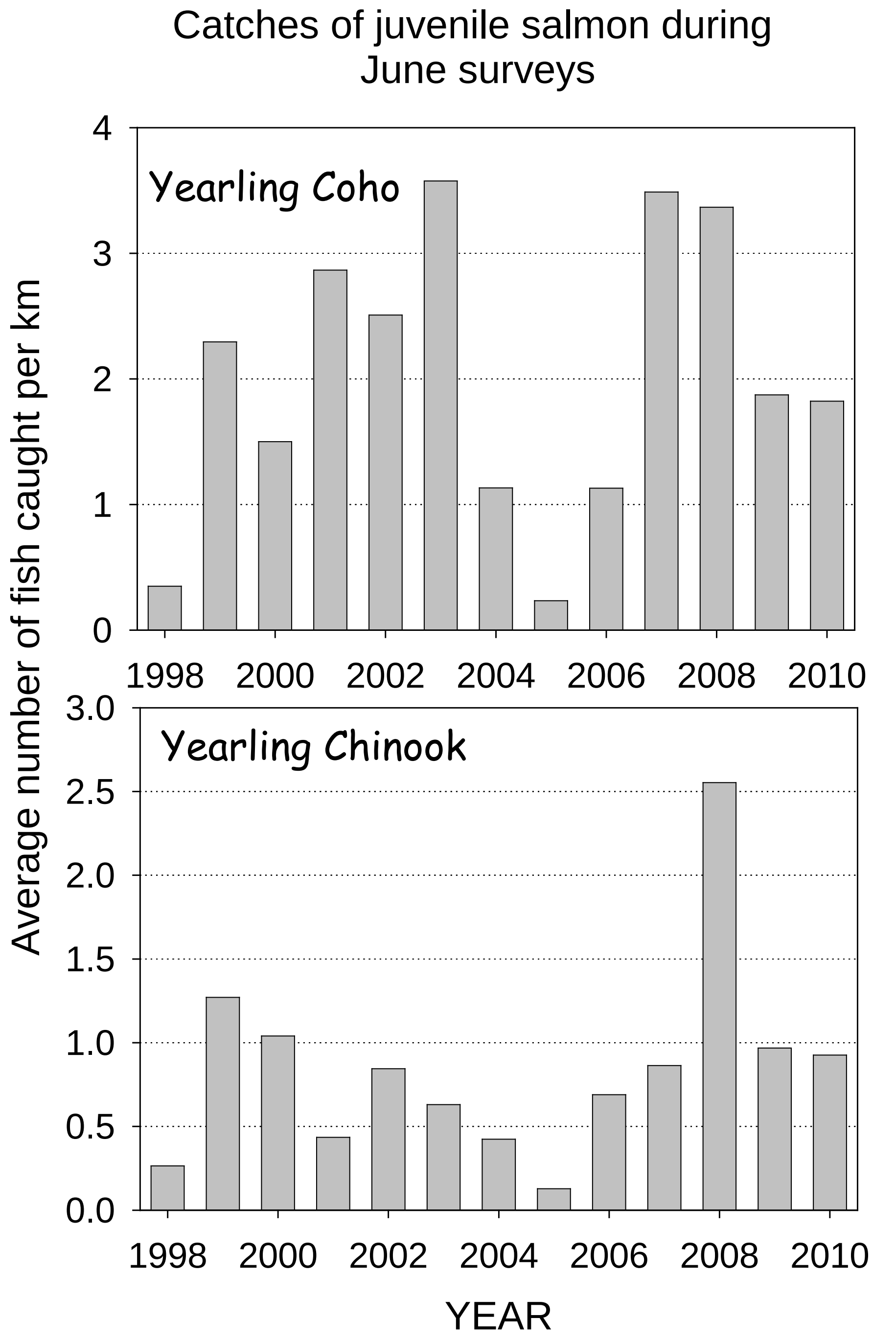


Ocean Sampling of juvenile salmon

- Juvenile salmon sampled in May, June and September since 1998 (13th year) with NORDIC 264 rope trawl, from La Push south to Newport.

- Ocean conditions sampled biweekly off Newport on oceanographic cruises (temperature, salinity, nutrients, phytoplankton, zooplankton, krill, fish larvae)

- Historical data:
  hydrography, 1960s;
  plankton, 1969-1973;
  1983, 1990-1992
  juvenile salmon, 1981-1985



Inter-annual variations in catches of juvenile salmon in rope trawl surveys

- High catches of coho in 1999-2003 and again in 2007 and 2008, but average in 2009 and 2010
- Highest catches of spring Chinook in 2008, but average in 2009 and 2010.
- For other details see salmon forecasting website: http://www.nwfsc.noaa.gov and click on "Ocean Conditions and Salmon Forecasting"

Stoplight Chart showing ocean conditions among years: 1998-2009

1998, 2003-2005 = warm & unproductive; poor salmon returns

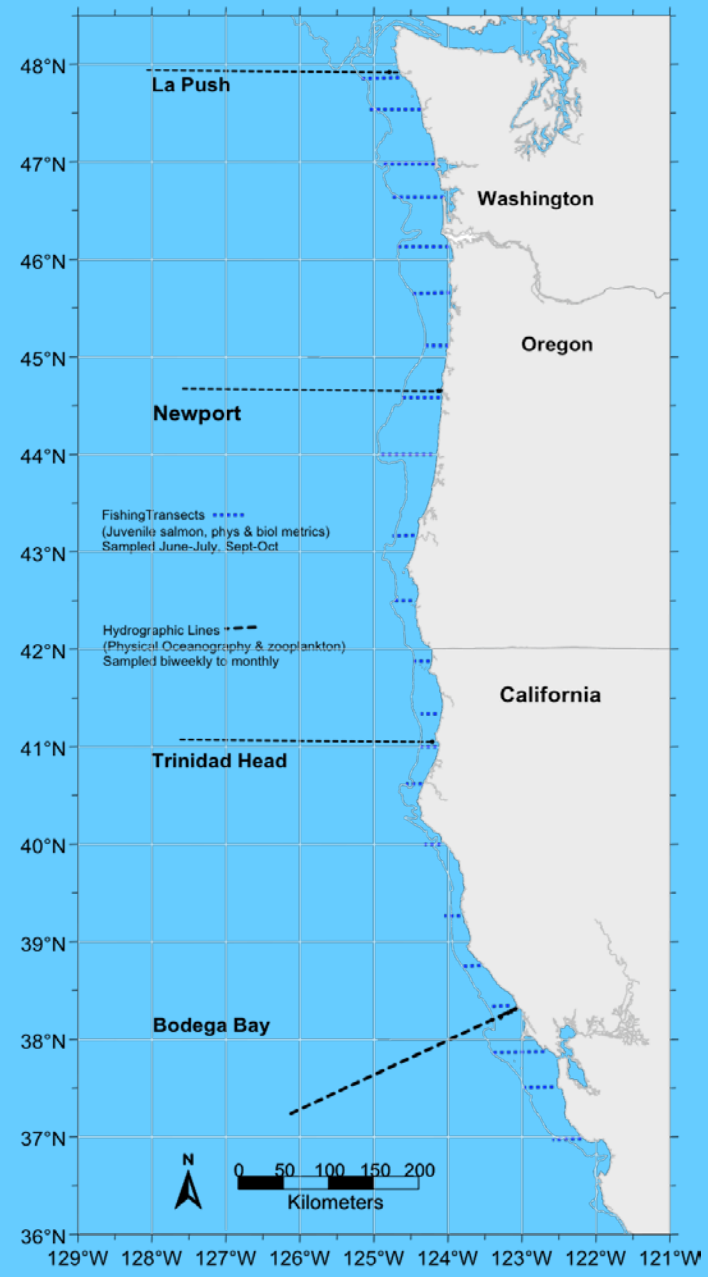
1999-2002 and 2008 = cold & productive; very high returns

Environmental Variables	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
PDO (December-March)	11	5	2	8	4	12	7	10	9	6	3	1
PDO (May-September)	9	2	3	4	6	11	10	12	8	7	1	5
MEI Annual	12	1	3	5	11	10	8	9	6	4	2	7
MEI Jan-June	12	2	3	5	8	10	7	11	4	9	1	6
SST at 46050 (May-Sept)	10	8	4	5	1	6	12	9	2	11	3	7
SST at NH 05 (May-Sept)	8	2	1	4	6	7	12	11	5	9	3	10
SST winter before going to sea	12	7	5	6	4	8	11	10	9	3	1	2
Physical Spring Trans (Logerwell)	8	7	2	1	4	10	9	12	10	3	6	5
Upwelling (Apr-May)	7	1	11	3	6	10	9	12	7	2	4	5
Deep Temperature at NH 05	12	4	5	3	1	7	9	10	11	6	2	8
Deep Salinity at NH05	12	3	6	2	5	9	11	8	7	1	4	10
Length of upwelling season	7	3	2	10	1	11	9	12	6	5	8	4
Copepod richness	12	2	1	5	3	9	8	11	10	6	4	7
N.Copepod Anomaly	12	9	3	6	2	10	7	11	8	5	1	4
Biological Transition	11	5	4	7	6	10	8	12	9	2	1	3
Copepod Community structure	12	3	4	6	1	8	9	11	10	7	2	5
Catches of salmon in surveys												
June-Chinook Catches	11	2	3	9	6	8	10	12	7	5	1	4
Sept-Coho Catches	9	2	1	4	3	5	10	11	7	8	6	12
Mean of Ranks of Environmental Da	10.4	3.8	3.5	5.2	4.3	8.9	9.2	10.8	7.5	5.5	2.9	5.8
RANK of the mean rank	11	3	2	5	4	9	10	12	8	6	1	7

See the NW Center's website: http://www.nwfsc.noaa.gov and click on "Ocean conditions…"

NWFSC and SWFSC coast-wide juvenile salmon survey proposal

- Comprehensive survey of abundance, distribution, condition of juvenile salmon by stream of origin
- Data for annual predictive models of ocean productivity and recruitment
- Intensively monitored hydrographic lines expanded to determine state of ocean productivity and monitor changes due to ocean conditions
- Annual assessment of juvenile salmon in relation to ocean conditions



Use of GSI data in salmon assessment: West Coast Salmon GSI Collaboration

- Closely examine how GSI data can be used in salmon fishery management
- Incorporate GSI data into existing CWT-based models, and construct new models that accommodate GSI
- Develop new statistical methods to estimate stock-specific ocean distributions based on GSI and CWT information
- Sample all fishery times and areas South of Cape Falcon in 2010

West Coast GSI Collaboration

Commercial troll fishermen collect GSI and distribution information at sea.

Sampling in 2010
- open seasons
- non-retention fishing
- NMFS SRP
  - Scientific Research Vessels

Samples through August 2010

8834	Total
4502	Oregon
4332	California

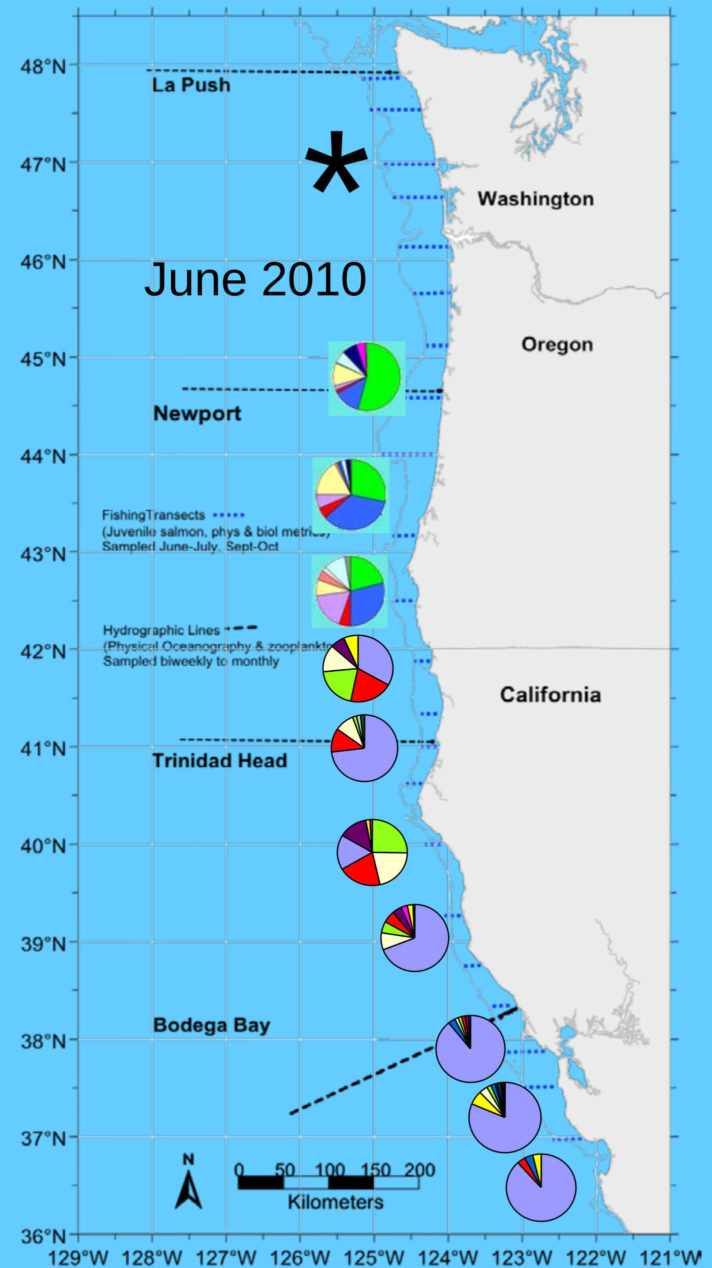
* Washington trollers also collected samples

Columbia River

Klamath

Central Valley

Newport	N = 617
Coos Bay	N = 267
Brookings	N = 38
Crescent City	N=15
Eureka	N=52
Fort Bragg	N=166
Bodega Bay	N=107
San Francisco	N=121
Half Moon Bay	N=156
Santa Cruz	N=26
June Total	**N=1555**



SALMON ESSENTIAL FISH HABITAT (EFH) REVIEW

The Pacific Coast Salmon Essential Fish Habitat (EFH) Review Oversight Panel (Panel) completed initial review of Pacific salmon EFH, which is presented in a draft report to the Pacific Fishery Management Council (Agenda Item C.5.a, Attachment 1). Periodic review of EFH is required under the National Marine Fisheries Service Regulatory Guidance (50 CFR §600.815). Reviews should be conducted at least every five years, and should include evaluation of published and unpublished scientific literature and reports; information for interested parties; and previously unavailable or inaccessible data.

The Panel considered new information and literature, tools to assess habitat suitability, the list of barriers that represent the upstream extent of EFH, the potential to designate Habitat Areas of Particular Concern (HAPC), fishing and non-fishing threats to EFH, and other considerations. The Council contracted with Cramer Fish Science to develop an annotated bibliography (Agenda Item C.5.a, Attachment 2) designed to inform the Panel's review process.

The Panel made several recommendations in the draft report, and will continue developing recommendations and supporting information in anticipation of final Council action at its March 2011 meeting.

The Magnuson-Stevens Reauthorization Act (MSRA) requires fishery management plans (FMPs) to identify EFH for managed species. EFH for Pacific salmon was established by the Council in 1999, in Appendix A of Amendment 14 to the Pacific Coast Salmon Plan. Amendment 14 identified important habitats per life history stage, current and historic distribution, fishing and non-fishing threats to EFH, and identified research needs. Amendment 14 also identified about 50 large dams that lacked adequate fish passage, and interpreted those to the upstream extent of EFH in those watersheds. The Council considered, but did not establish HAPC for salmon at that time.

The Idaho County versus Department of Commerce court decision required NMFS to codify EFH for Pacific salmon, which was issued as a Final Rule in 2008. This rule included some revisions to EFH, mostly to correct errors and clarify information.

Council Action:

1. Approve the salmon EFH report for public review.

Reference Materials:

1. Agenda Item C.5.a, Attachment 1; *Pacific Coast Salmon Essential Fish Habitat Review Draft Report.*

2. Agenda Item C.5.a, Attachment 2; *Appendix A: Annotated Bibliography for 2010 Essential Fish Habitat Update.*

Agenda Order:

a. Agenda Item Overview **Kerry Griffin**
b. Reports and Comments of Advisory Bodies and Management Entities
c. Public Comment
d. **Council Action:** Approve the Salmon EFH Report for Public Review

PFMC
08/27/10

Pacific Coast Salmon
Essential Fish Habitat Review

Report to the Pacific Fishery Management Council

Preliminary Draft for Public Review

13 September, 2010

TABLE OF CONTENTS

1. INTRODUCTION

The Magnuson-Stevens Fisheries Conservation and Management Act of 1996 (MSA)(Public Law 104-297) defines Essential Fish Habitat (EFH) as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity,” and requires fishery management councils to identify (EFH for Federally-managed species. Fishery Management Councils (FMCs) may choose to identify EFH based on current distribution, habitat components, historic presence, or other factors; and must also identify life history habitat requirements, impacts from both fishing and non-fishing activities, and research needs. Councils may choose to identify Habitat Areas of Particular Concern (HAPC) within EFH based on the habitat’s ecological function, sensitivity to human-induced disturbance, rarity, or whether development activities may stress a particular habitat.

Individual fishery management councils may refine the description of EFH to better suit individual species or fishery management Plans (FMPs). The Pacific Fishery Management Council (Council) further defines EFH for Pacific Coast salmon as “all streams, estuaries, marine waters, and other water bodies occupied or historically accessible to salmon in Washington, Oregon, Idaho, and California.” Exceptions include cases in which certain man-made barriers represent the upstream extent of Pacific salmon access. The Council established Pacific salmon EFH in 1999, and made minor revisions in 2008.

This report is intended to describe the general requirements and elements of EFH, including guidance for periodic reviews; summarize the activities of the Pacific Coast salmon EFH Oversight Panel (Panel); summarize existing Pacific Coast Salmon EFH, including activities that affect EFH and research needs; present relevant new information and an updated list of impassible barriers that designate the upstream extent of EFH; and make recommendations for changes as appropriate. The potential changes considered by the Panel included the spatial extent of EFH for freshwater and marine areas; revising the list of impassible barriers; recommending HAPCs; identifying new fishing and non-fishing threats; updating relevant literature on salmonid life history and habitat requirements, and recommending research needs.

How this Document is Organized

This document first provides a general overview of EFH and an explanation of how the periodic review process works. This is followed by a description of existing Pacific salmon EFH, and then expanded information on each Major Objective (refine/revise EFH, consider HAPCs, and describe threats) and the tasks that helped to inform each of those objectives. The Panel’s recommendations are found immediately after each Major Objective and task. Table 1 outlines the three Major Objectives and the tasks associated with those. Note that some tasks helped to inform more than just one objective. For example, the annotated bibliography (Bergman 2010) helped to inform the refine/revise EFH objective as well as the HAPC objective.

Table 1. Overview of major objectives and tasks considered by the Pacific Salmon Essential Fish Habitat oversight Panel.

Major Objective/Task	Description	Outcome
Major Objective: Revise/Revise Pacific Coast Salmon EFH	Review information; determine if changes are warranted for spatial extent, description, or other elements of salmon EFH	Possible changes to the spatial extent of EFH
Task: Pacific salmon distribution	Review and synthesize available information on the distribution and abundance of Pacific Coast salmonids ; develop GIS maps to facilitate decision making	Compares existing EFH to known present and historic distribution
Task: Impassible barriers	1) Review and Synthesize available information on the impassible man-made barriers in each basin that can be used to further refine existing spatial datasets and refine the list of those structures that meet the criteria for designation as the upstream extent of EFH 2) Consider changes to the criteria that define an "impassible barrier."	Possible addition or removal from the list of barriers, and possible addition or reduction of EFH
Task: Habitats important to Pacific salmon life history	Review the available information and develop an annotated bibliography on the importance of specific types of habitats to the life history of Pacific Coast salmon	Update the library of important habitats to Pacific salmon
Task: Alaska EFH	Consider whether to keep the current definition of EFH that includes Alaskan marine waters designated as EFH by the NPFMC	Status quo would mean maintaining the inclusion of Alaskan marine EFH in the PFMC's EFH description
Task: 4th Field vs 6th Field USGS hydrologic units	Consider using smaller/more precise hydrologic unit unit size to depict areas containing EFH.	More refined/precise maps available to help determine spatial extent of EFH
Task: Intrinsic Potential (IP)	Consider whether to use IP as a tool to 1) help define a plausible historical distribution for a species, which could then help achieve a finer resolution in EFH designation; and 2) using IP to guide delineation of HAPCs.	Would provide more refined maps of EFH, especially in California

Task: Qualitative versus spatially-explicit descriptions of EFH	Consider whether to use spatially-explicit descriptions of EFH (e.g., lines on a map), or a qualitative description (e.g., all of a given habitat type, but leave it to the user to determine where that is on a map)	Amendment 14 is based on a comprehensive/ qualitative approach. Changing that approach would result in definitive text and map descriptions of EFH
Major Objective: Habitat Areas of Particular Concern (HAPC)	Consider whether to add HAPCs to existing Pacific Coast salmon EFH. This objective informed by all tasks listed above	HAPCs would highlight certain habitat types as particularly important, but would not add any specific regulatory burden
Major Objective: Existing and emerging threats (fishing and non-fishing)	Review the available information and develop an annotated bibliography on the existing and emerging threats to EFH for Pacific Coast salmon This objective informed by the annotate bibliography on habitats important to salmon life history	Add/amend the list of potential impacts to EFH Develop conservation recommendations for newly-identified threats

Background on Essential Fish Habitat

Federal agencies must consult with the National Marine Fisheries Service (NMFS) on activities that may adversely affect EFH, regardless of whether those activities occur within identified EFH or not. In other words, an activity can adversely affect EFH without occurring within EFH. State and private entities are not required to consult with NMFS unless a proposed action requires a Federal permit or receives Federal funding.

Although there is no formal requirement for state and private collaboration in the consultation process on adverse effects to salmon EFH, there is common interest in reducing threats to managed species, as well as those listed under the Endangered Species Act (ESA). Numerous voluntary and incentive programs encourage habitat conservation, working in concert with Federal and state mandates whenever possible. One example is the habitat restoration program of the NOAA Restoration Center, a nationwide NMFS program that works collaboratively with NMFS regulatory staff and other partners to identify and implement habitat restoration activities.

Although state agencies are not required to consult with NMFS on activities that may adversely affect EFH, NMFS is obligated to provide conservation recommendations to state agencies, if NMFS determines that an activity may adversely affect EFH. Whenever possible, NMFS utilizes existing coordination procedures to transmit EFH conservation recommendations.

Essential Fish Habitat Periodic Reviews

The MSA requires regional FMCs and NMFS to periodically review the EFH provisions of FMPs, and to revise or amend EFH provisions as warranted, based on available information (Public Law 109-479). This review is intended to evaluate published scientific literature and unpublished reports, solicit input from interested parties, and search for previously unavailable information on salmon stocks identified in the FMP. Changes to existing EFH may be made by the Council, if the information warrants changes. The regulatory guidance suggests that reviews should be conducted periodically, and that complete reviews should be conducted at least once every five years. Pacific Coast salmon EFH was established in 1999 as part of Amendment 14 to the Pacific Coast Salmon Plan, and modified in 2008 as a result of the Idaho County versus Commerce court case. The current effort was initiated in 2009.

Methods/Approach

The Panel convened via conference call approximately monthly, from June, 2009 through August, 2010. The agendas varied according to the selected topic at hand. A designated note-taker compiled meeting summaries, with tasks, and distributed to the group.

The Panel included two GIS specialists who provided spatial information and maps to assist in identifying existing EFH and distribution information and determining whether new information warranted changes to the existing EFH maps. One technical issue is that of dataset currentness. This is demonstrated by comparing the boundaries of 4^{th} field hydrologic units used in EFH maps with current hydrologic unit boundaries where the boundaries have had some revisions. A second geospatial issue involved a comparison of the current EFH 4^{th} field hydrologic units with the current fish distribution geospatial data (obtained from Streamnet and Calfish). In both these cases, the NMFS GIS specialists were confident of being able to update maps to make use of the best current geospatial data.

Chronology

- Late 2008 – NMFS and the Council applied for and subsequently received $100k from NMFS Headquarters to provide support for the review. The funding was allocated to the Council
- Early 2009 - Council Staff and NMFS established an Oversight Panel to implement the 5-year review; initiated meetings
- September 2009 – Council Staff provided an informational report at the September Council meeting (Appendix B)
- September 2009 – Council hired contractor (Cramer Fish Sciences) to compile new references and develop an annotated bibliography on the list of barriers, threats to EFH, habitat types/life histories, and to review and synthesize potential actions to avoid, minimize, or otherwise mitigate adverse impacts to EFH associated with the identified threats
- June 2010 – Contract with Cramer Fish Sciences concludes; Oversight Panel begins developing draft report for September 2010 Council meeting

2. REFINE/REVISE ESSENTIAL FISH HABITAT FOR PACIFIC COAST SALMON

Task: Stock Distribution

This section describes existing EFH for Pacific salmon, the approach of Amendment 14, the revisions of the 2008 Final Rule, and makes recommendations for possible changes.

General Approach of Appendix A of Amendment 14 to the Pacific Coast Salmon Plan

In Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999), the Council chose a comprehensive approach to identification of EFH for several reasons: Salmon distribution varies spatially and temporally; there is very limited information regarding ocean distribution and migration; and there is an immense diversity of freshwater habitats. The comprehensive approach is manifested in the text descriptions and the associated maps provided to assist the user. The text descriptions are the legal definition of EFH, and for Pacific salmon are written broadly (see "Description of Existing Essential Fish Habitat"). This means that the species-specific maps of the USGS 4th field hydrologic units across a large geographic area oblige the user to make a more refined determination as to whether a particular activity is in, or may adversely affect, Pacific Coast salmon EFH. EFH identification based on USGS 4th hydrologic units recognizes the diversity of habitats essential to the species in all life stages, considers the variability of environmental conditions, and reinforces linkages between aquatic and adjacent upslope areas (PFMC 1999).

In describing Pacific Coast salmon EFH, the Council chose to include Alaskan marine waters identified by the NPFMC as EFH for salmon. This highlights the importance of habitats around the North Pacific Ocean, and recognizes the fact that many of the salmon stocks spawned in the contiguous West Coast states migrate north past British Columbia and into the waters of Alaska.

Appendix A of Amendment 14 does not specifically identify any HAPCs, although they are discussed in the context of important habitats in salmonid life histories. PFMC (1999) noted the relative lack of sufficient information on which to base HAPC designations in its decision to not identify HAPCs.

Pacific salmon EFH underwent some revisions in 2008 as a result of the Idaho County v DOC lawsuit, which required NMFS to issue the Pacific salmon EFH descriptions as a Final Rule.The 2008 rulemaking exercise addressed some issues (fixed typographical and nomenclature errors; consolidated the marine and freshwater definitions of salmon EFH), but did not constitute a full review.

Description of Existing Essential Fish Habitat

This section presents a summary of existing EFH descriptions for the three Pacific salmonid species managed by the Council. More detailed information can be found in Appendix A of Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999) and the Final Rule that codified Pacific Salmon EFH in 2008 (73 FR 60987). It is important to bear in mind that the text descriptions of EFH are the legal definition. Maps are provided to assist the user in interpreting the spatial extent of salmon EFH, but should not be considered to absolutely depict the extent of EFH. It follows that due to various factors (new information, changes to presence/absence of salmon, etc) the maps will be amended over time.

The 2008 Final Rule merged the marine and freshwater definitions of EFH, to simplify the description. It defines Pacific salmon EFH as "all streams, estuaries, marine waters, and other water bodies occupied or historically accessible to salmon in Washington, Oregon, Idaho, and California" and adds caveats for impassible barriers and for Puget Sound pink salmon (see following sections).

Essential Fish Habitat for Chinook salmon

Chinook salmon EFH includes all streams, estuaries, marine waters, and other water bodies occupied or historically accessible to Chinook salmon in Washington, Oregon, Idaho, and California. Exceptions include cases in which man-made barriers represent the upstream extent of Pacific salmon access. Chinook EFH includes the marine areas off Alaska designated as salmon EFH by the North Pacific Fishery Management Council (NPFMC). Including marine EFH designated by the NPFMC serves to recognize the migratory patterns of Chinook, and the importance of habitat during all life stages. Current marine EFH for Chinook includes the entire EEZ around Alaska. The southern extent of Chinook salmon marine EFH extends to Point Conception, CA, which represents The southern extent of Chinook range.

Although areas upstream of the identified impassible dams are not considered EFH, this does not preclude the possibility of an action taking place upstream of such a barrier that may adversely affect designated EFH. The same logic applies to activities on upslope areas that aren't technically EFH. Any Federal action would still require EFH consultation if that action may adversely affect EFH, regardless of whether it is actually in EFH. Figures 1, 2, and 3 depict the 4th field hydrologic units currently identified as EFH for Chinook salmon, plus Chinook distribution in those 4th field hydrologic units not currently identified as EFH. Note that some 4th field hydrologic units are listed as EFH but do not show distribution. That is probably because Chinook historically occupied that hydrologic unit. Conversely, some hydrologic units show distribution but no EFH. There could be several reasons for this (new information, impassible barrier presence, etc), and will be considered by the Panel in making recommendations to the Council. However, freshwater salmon distribution is not an absolute science. For example, if a particular hydrologic unit has always had relatively poor habitat and scant historic presence, but the occasional salmon strays into that hydrologic unit, that may not be enough to warrant inclusion in EFH. These situations will require further investigation.

Amendment 14 includes descriptions of relevant habitat parameters, including the four major components of Chinook freshwater EFH: 1) spawning and incubation; 2) juvenile rearing; 3) juvenile migration corridors; and 4) adult migration corridors and adult holding habitat. It also includes a life history description and detailed descriptions of habitat requirements per life stage.

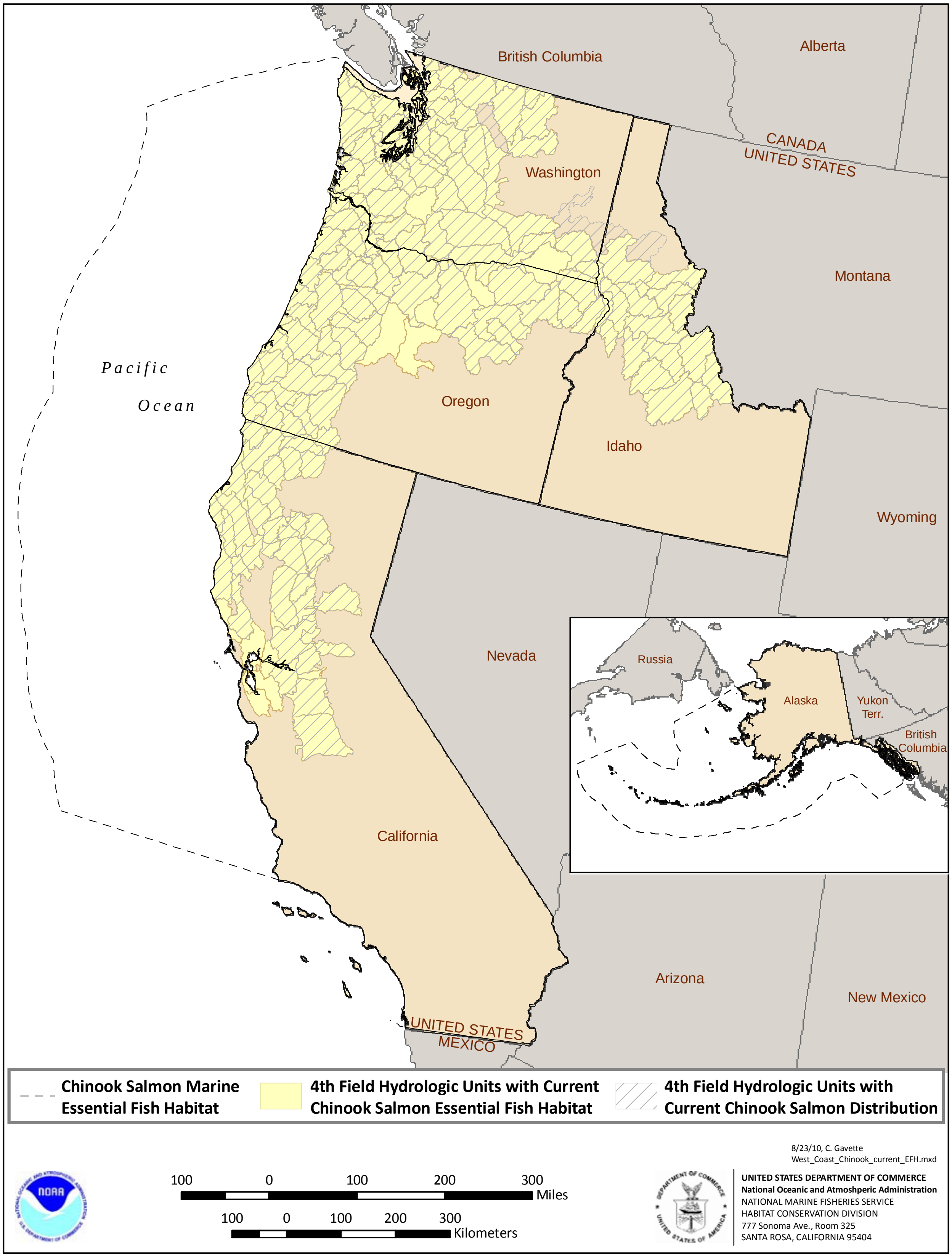


Figure 1. 4th field hydrologic units and marine waters currently identified as EFH for Chinook salmon, and Chinook distribution, U.S. West Coast and Alaska.

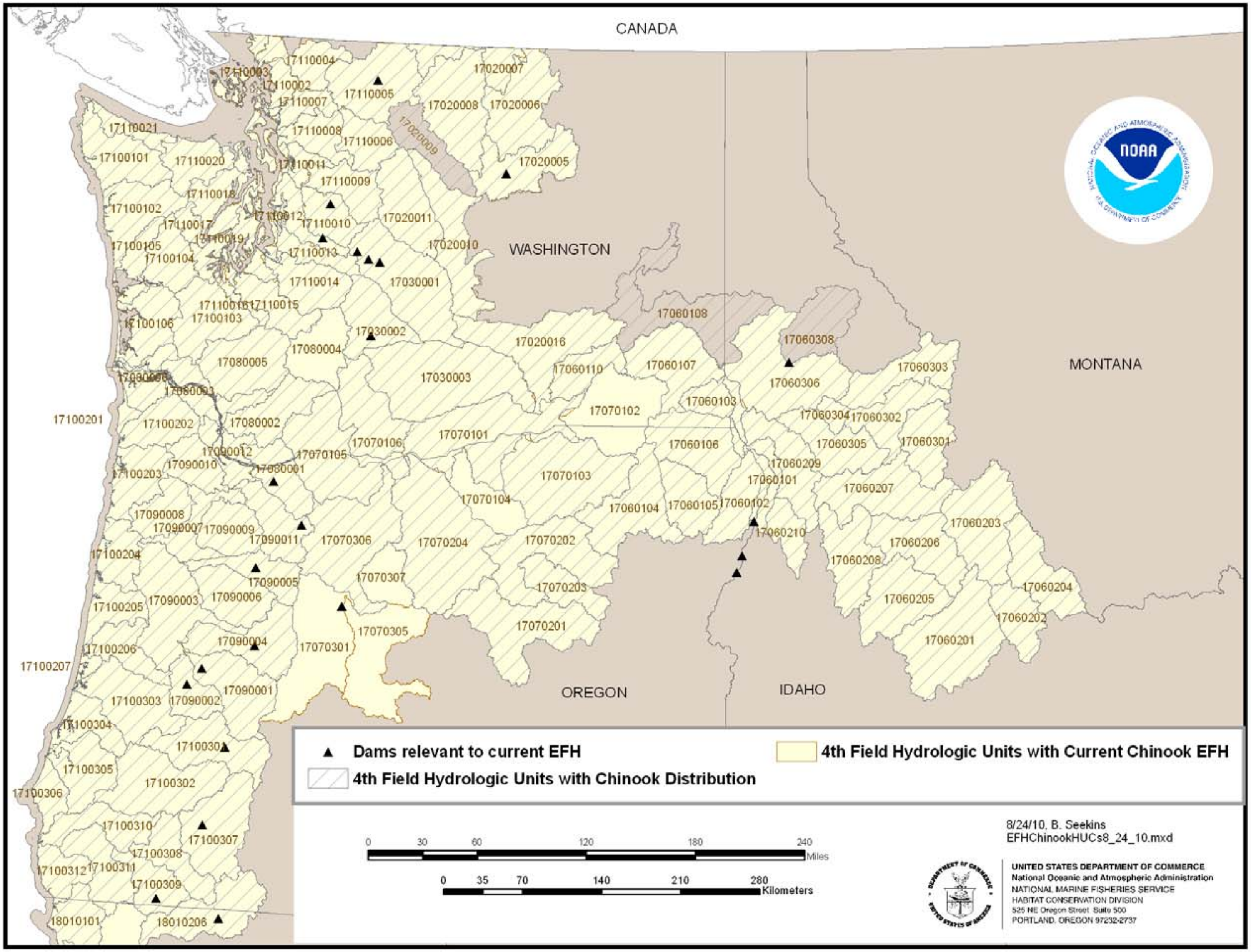


Figure 2. 4th field hydrologic units currently identified as EFH for Chinook salmon, and Chinook distribution in Washington, Oregon, and Idaho.

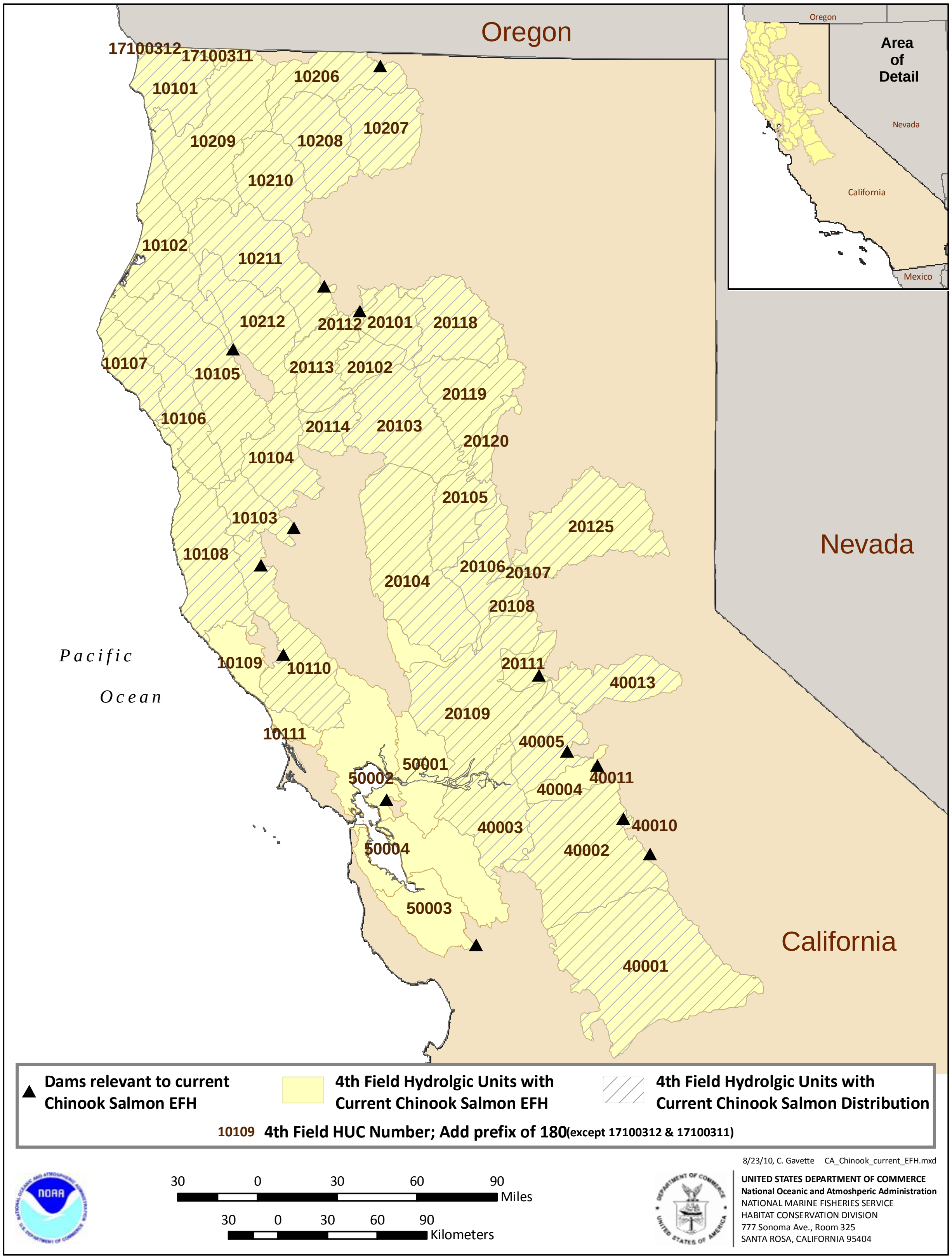


Figure 3. 4th field hydrologic units currently identified as EFH for Chinook salmon, and Chinook distribution in California.

Description of EFH for coho salmon

Coho salmon EFH includes all streams, estuaries, marine waters, and other water bodies occupied or historically accessible to Chinook salmon in Washington, Oregon, Idaho, and California. Exceptions include cases in which man-made barriers represent the upstream extent of Pacific salmon access. Coho EFH includes the marine areas off Alaska designated as salmon EFH by the North Pacific Fishery Management Council (NPFMC). Including marine EFH designated by the NPFMC serves to recognize the migratory patterns of coho, and the importance of habitat during all life stages. Current marine EFH for Coho includes the entire EEZ around Alaska. The southern extent of coho marine EFH is Point Conception, CA, which represents the southern extent of coho range.

Although areas upstream of the identified impassible dams are not considered EFH, this does not preclude the possibility of an action taking place upstream of such a barrier that may adversely affect designated EFH. The same logic applies to activities on upslope areas that aren't technically EFH. Any Federal action woud still require EFH consultation if that action may adversely affect EFH, regardless of whether it is actually in EFH. Figures 4, 5, and 6 depict the 4^{th} field hydrologic units currently identified as EFH for coho salmon, plus Coho distribution in those hydrologic units not currently identified as EFH. Note that some 4^{th} field hydrologic units are listed as EFH but do not show distribution. That is probably because coho historically occupied that hydrologic unit. Conversely, some hydrologic units show distribution but no EFH. There could be several reasons for this (new information, impassible barrier presence, etc), and will be considered by the Panel in making recommendations to the Council. However, freshwater salmon distribution is not an absolute science. For example, if a particular hydrologic unit has always had relatively poor habitat and scant historic presence, but the occasional salmon strays into that hydrologic unit, that may not be enough to warrant inclusion in EFH. These situations will require further investigation.

Amendment 14 includes descriptions of relevant habitat parameters, including the four major components of coho freshwater EFH: 1) spawning and incubation; 2) juvenile rearing; 3) juvenile migration corridors; and 4) adult migration corridors. EFH for coho does not include adult holding habitat. Amendment 14 also includes a life history description and detailed descriptions of habitat requirements per life stage.

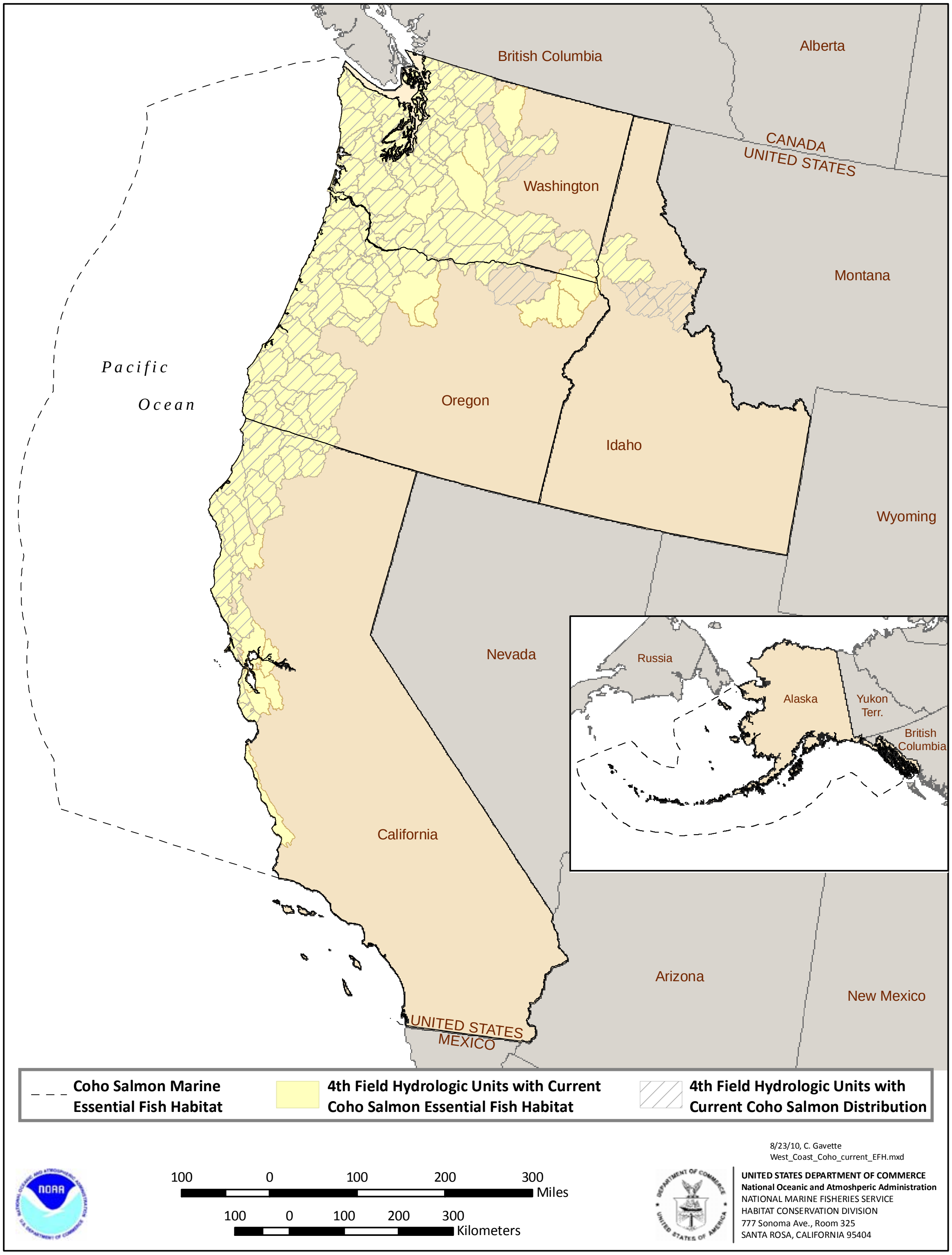


Figure 4. 4th field hydrologic units and marine waters currently identified as EFH for coho salmon, and coho distribution, U.S. West Coast and Alaska.

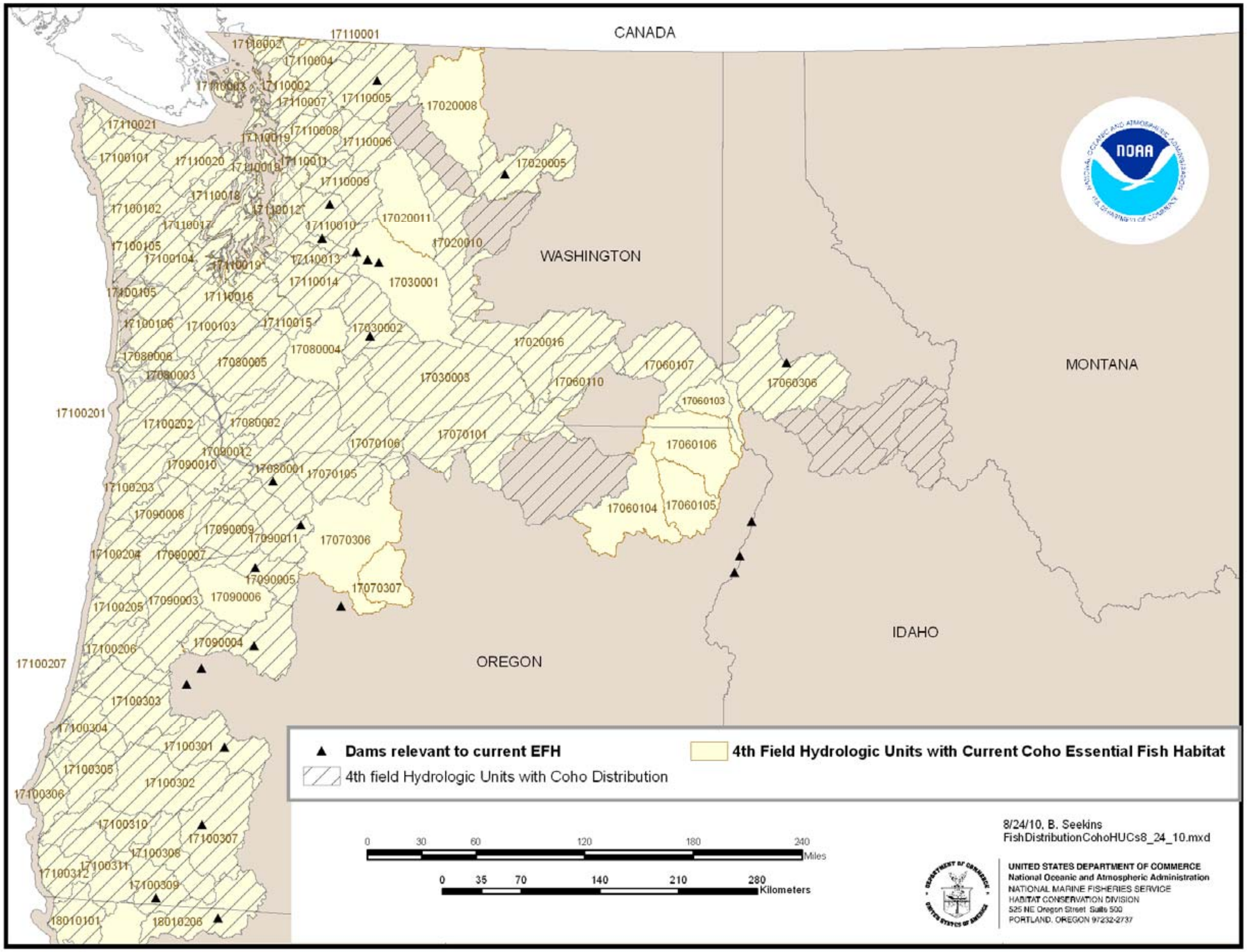


Figure 5. 4th field hydrologic units currently identified as EFH for coho salmon, and coho distribution in Washington, Oregon, and Idaho.

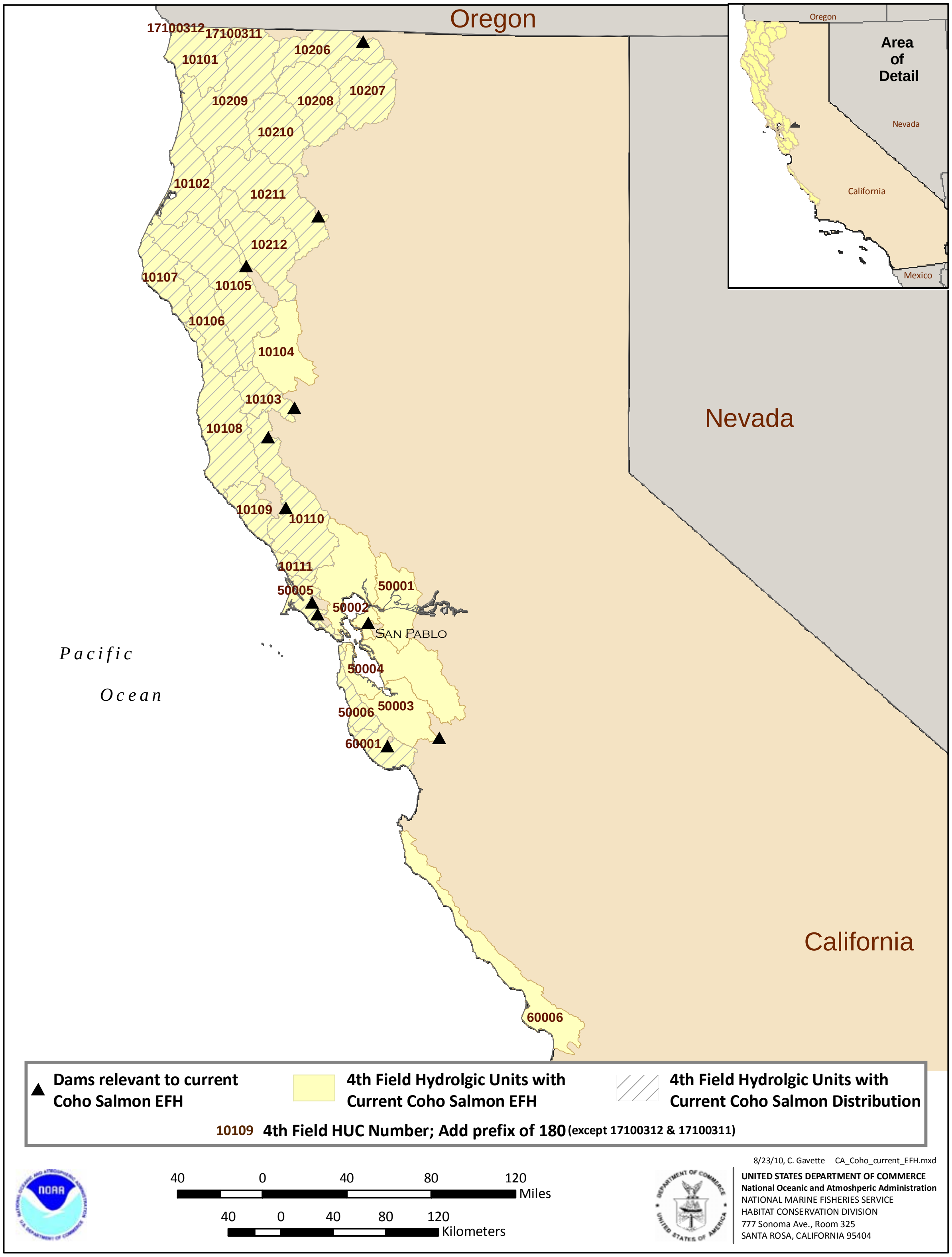


Figure 6. 4th field hydrologic units currently identified as EFH for coho salmon, and coho distribution in California.

Description of EFH for Puget Sound pink salmon

Puget Sound (PS) pink salmon life history and migratory patterns are distinctly different than Chinook and coho salmon, and are described in Amendment 14. Pink salmon EFH is defined as all streams, estuaries, marine waters, and other water bodies occupied or historically accessible to pink salmon within Washington State. EFH for PS pink salmon also includes marine waters north and east of Cape Flattery, Washington, including Puget Sound, the Strait of Juan de Fuca and Strait of Georgia. Exceptions include cases in which man-made barriers represent the upstream extent of Pacific salmon access. Existing PS pink salmon EFH is limited to Puget Sound because Washington State is near the southern extent of pink salmon range and the majority of the commercial and recreational catch (outside of Alaska) occurs in Puget Sound.

Although areas upstream of the identified impassible dams are not considered EFH, this does not preclude the possibility of an action taking place upstream of such a barrier that may adversely affect designated EFH. The same logic applies to activities on upslope areas that aren't technically EFH. Any Federal action would still require EFH consultation if that action may adversely affect EFH, regardless of whether it is actually in EFH. Figure 7 depicts the 4^{th} field hydrologic units currently identified as EFH for PS pink salmon, plus distribution in those hydrologic units not currently identified as EFH. Note that some 4^{th} field hydrologic units are listed as EFH but do not show distribution. That is probably because PS pinks historically occupied that hydrologic unit. Conversely, some hydrologic units show distribution but no EFH. New information appears to indicate pink salmon populations in two hydrologic units not currently identified as EFH: the Hoko-Crescent (17110021) and the Queets-Quinalt (17100102).

It is tempting to assume that because the Hoko-Crescent and Queets-Quinalt hydrologic units show current distribution, they should be included in EFH. However, it is not so simple. First, the pink salmon FMU is not clearly defined in the FMP. The Puget Sound FMUs for coho and Chinook appear to extend from the Elwha River to the east, as do the ESUs. Although NMFS status reviews delineate the pink salmon ESUs (one for even years and one for odd years), the FMP is less clear about defining the western extent of the PS pink salmon FMU. The Panel will continue investigating this issue.

The four major components of freshwater PS pink salmon EFH are: 1) spawning and incubation; 2) juvenile rearing; 3) juvenile migration corridors; and 4) adult migration corridors. EFH for pink does not include adult holding habitat.

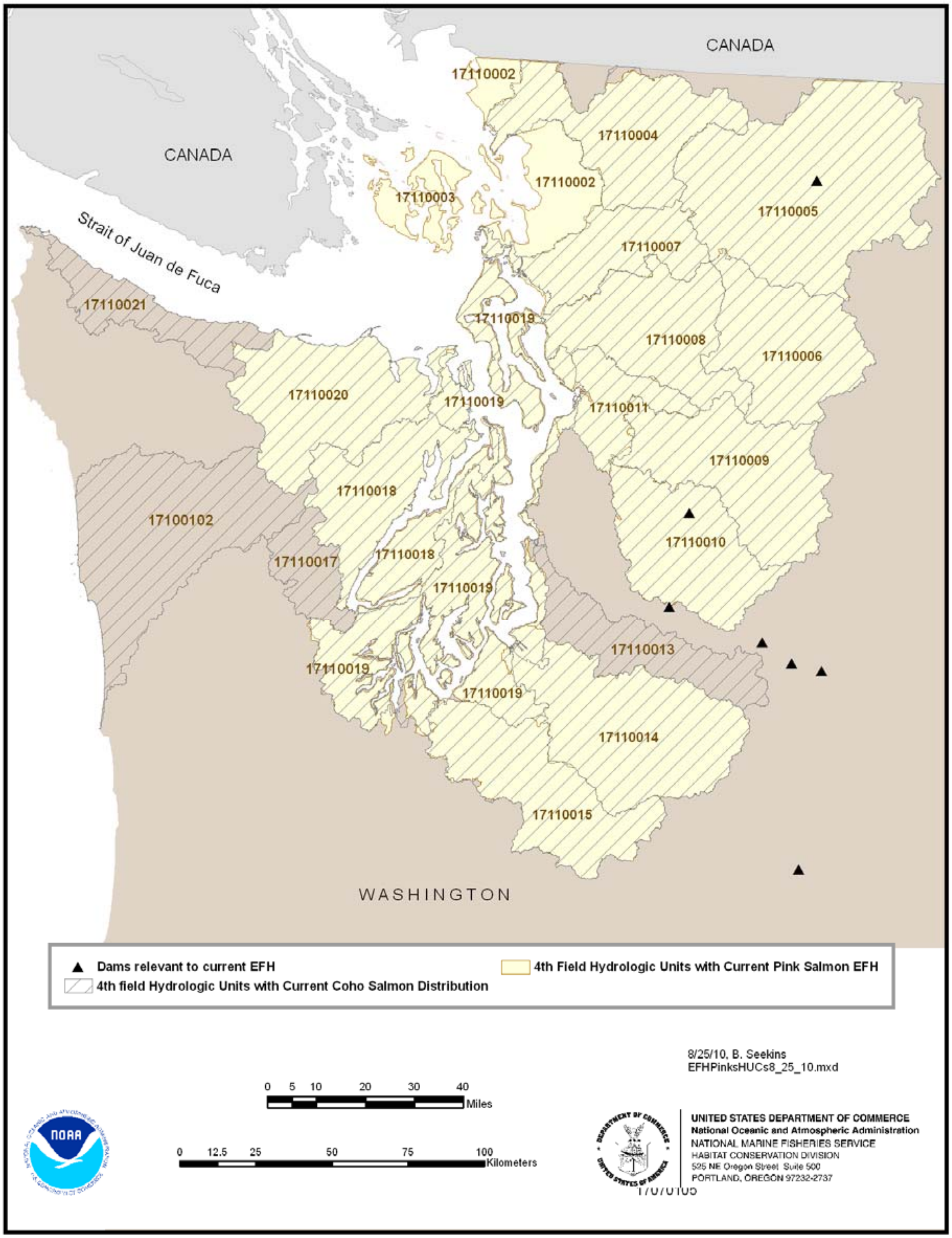


Figure 7. Hydrologic units with Puget Sound pink salmon distribution and EFH.

Preliminary Recommendations

The Panel recommends updating current GIS maps to reflect the most accurate boundaries between hydrologic units.

The Panel recommends modifying the definition of EFH to clarify that Chinook and coho EFH includes the U.S. EEZ from the U.S.-Canada boundary to Point Conception, California:

- *"EFH includes all streams, estuaries, marine waters, and other water bodies occupied or historically accessible to salmon in Washington, Oregon, Idaho, California, and the adjacent U.S. EEZ north of Point Conception, California."*

The Panel recommends adding the Duwamish 4th field hydrologic unit as EFH for PS pink salmon, based on the fact that the abundance of pink salmon in the Duwamish watershed has increased dramatically since Amendment 14 was written, with returns numbering more than one million fish in 2009.

The Panel recommends that the Council and NMFS more clearly define the FMU for Puget Sound pink salmon.

Task: Impassible Barriers

In identifying EFH in Amendment 14, the Council considered dams that effectively blocked fish passage, and used four criteria to determine whether a particular dam should represent the upstream extent of EFH:

1. Is the dam federally owned or operated, licensed by the Federal Energy Regulatory Commission (FERC), state licensed, or subject to state dam safety supervision?
2. Is the dam upstream of any other impassible dam?
3. Is fish passage to upstream areas under consideration, or are fish passage facilities in the design or construction phase?
4. Has NMFS determined that the dam does not block access to habitat that is key for the conservation of the species?

The Panel reviewed the list of barriers, the four criteria outlined in Amendment 14, and the updated information compiled by Bergman (2010) on the list of impassible barriers. The Panel noted some typographical or naming errors that should be corrected (see Table 3), and also reviewed the list of impassible barriers in light of the four considerations from Amendment 14. Possible changes to the list based on those considerations generally fall into two categories.

First, if a dam has been removed (per criterion #3 above), modified to include fish passage, or is under consideration for such action,, it would be a candidate for removal from the list. In some cases this is an obvious decision. For example, the Marmot Dam on the Sandy River, Oregon has been decommissioned and completely removed. Therefore, it should be removed from the list of impassible barriers. However, in some cases, it is not as straightforward.

Second, if NMFS determines, in an official position (e.g., biological opinion, recovery plan, or fish passage prescription under the Federal Power Act) that a dam blocks access to upstream habitat that is "key for the conservation of the species," that dam may be removed from the list (per criterion #4 above). Several dams fitting this category were excluded from the list in Amendment 14 for this reason. Within the past few years, NMFS has completed, or is in the process of completing, several recovery plans, mandated under the ESA. Recovery plans must identify critical habitats and priority actions necessary for population recovery. In some cases, recovery plans specifically identify habitat upstream of existing dams that are on the list of impassible barriers, making those barriers candidates for removal from the list. Consultation under the Endangered Species Act (ESA) typically includes issuance of a Biological Opinion (biop), which includes mandatory terms and conditions to protect the species and/or its designated critical habitat. In the case of dams, these terms and conditions may indicate fish passage actions, again making the barrier a candidate for removal from the list of impassible barriers. Another example is that of fish passage "prescriptions" issued under Section 18 of the Federal Power Act, in which NMFS or the U.S. Fish and Wildlife Service may require fish passage installation and/or upgrades to existing facilities.

There are associated considerations and actions that would have to be undertaken upon removing a dam from the list. The obvious result is that areas upstream of the dam would become EFH, thereby requiring EFH consultation for Federal or state actions that may adversely affect EFH. The other is that the hydrologic unit(s) upstream of the barrier in question would have to be examined to see what, if any, impassible barriers there are further upstream.

Table 3 lists the impassible barriers from the 2008 Final Rule, and explains potential changes. The table does not yet identify those dams that may be candidates for removal from the list based on the four criteria in Amendment 14 and the discussion above. The Panel continues to compile information that will help inform decisions about dams that may be candidates for removal from the list.

Table 3. Preliminary list of impassible barriers and potential changes.

USGS 4th field HUC	State(s)	Hydrologic Unit Name	Impassible Man-made Barrier (from 2008 F.R.)	Possible changes	Notes/Explanation
17110005	WA	Upper Skagit	Gorge Lake Dam		
17110010	WA	Snoqualmie	Tolt Dam (S. Fork Tolt R.)		
17110012	WA	Lake Washington	Cedar Falls (Masonry) Dam (Cedar R.)		
17080001	OR/WA	Lower Columbia-Sandy River	Impassable man-made barrier	City of Portland #2 (Bull Run River)	The Portland General Electric Marmot Dam project (Sandy R.) was decommissioned in 2006. The only remaining impassible barrier is the City of Portland's municipal reservoir dam on the Bull Run River
17090001	OR	Middle Fork Willamette River	Dexter Dam		
17090002	OR	Coast Fork Willamette River	Dorena Dam		
17090004	OR	McKenzie River	Cougar Dam		
17090005	OR	N. Santiam River	Big Cliff Dam		
17090011	OR	Clackamas River	Oak Grove Dam		
17070305	OR	Lower Crooked River	Opal Springs Dam		
17030001	WA	Upper Yakima River	Keechelus Dam Kachess Dam (Kachess R.) Cle Elum Dam (Cle Elum R.)		
17030002	WA	Naches River	Rimrock Dam (Tieton R.)		
17020005	WA	Columbia River	Chief Joseph Dam		
17060101	OR/ID	Hells Canyon	Hells Canyon Complex (Hells Canyon, Oxbow, and Brownlee Dams)	Hells Canyon Dam (Snake R.)	Amendment 14 placed all three of these barriers in HUC 17050201. In reality, only Hells Canyon Dam is in 17060101.

USGS 4th field HUC	State(s)	Hydrologic Unit Name	Impassible Man-made Barrier (from 2008 F.R.)	Possible changes	Notes/Explanation
17050201	OR/ID	Hells Canyon (Snake R.)	None	Oxbow Dam Brownlee Dam	These two dams are in HUC 17050201.
17060306	WA/ID	Clearwater River	Dworshak Dam (at border of HUCs 17060306 and 17060308)		
17100301	OR	N. Umpqua River	Soda Springs Dam		
17100307	OR	Upper Rogue River	Lost Creek Dam		
17100309	CA/OR	Applegate River	Applegate Dam		
18010206	CA/OR	Upper Klamath River	Iron Gate Dam		
18010207	CA	Shasta River	None	Add Shasta/Dwinnell Dam as an impassible barrier	This barrier was listed in Amendment 14, but mistakenly was deleted from the 2008 F.R.
18010211	CA	Trinity River	Lewiston Dam		
18010102	CA	Mad-Redwood	Robert W. Matthews dam		
18010103	CA	Upper Eel River	Scott Dam		
18010110	CA	Russian River	Coyote Valley Dam (E. Fork Russian R.) Warm Springs Dam (Dry Cr.)		
18060001	CA	San Lorenzo-Soquel	Newell Dam (Newell Cr.)		
18050002	CA	San Pablo Bay	San Pablo Dam (San Pablo Cr.)		
18050003	CA	Coyote Creek	LeRoy Anderson Dam		
18050005	CA	Tomales-Drakes Bay	Nicasio Dam (Nicasio Cr.) Peters Dam (Lagunitas Cr.)		
18020106	CA	Feather River	None	Add Feather River Fish Barrier Dam as an impassible	Oroville Dam was listed in Amendment 14, but mistakenly was deleted from the 2008 F.R. NMFS staff recommended at that time

USGS 4th field HUC	State(s)	Hydrologic Unit Name	Impassible Man-made Barrier (from 2008 F.R.)	Possible changes	Notes/Explanation
				barrier	to add the Feather River Fish Barrier Dam because that dam (approx 1.5 miles downstream of Oroville Dam) more logically defines the upstream extent for EFH on the Feather River. No fish pass this barrier, and there is yet another impassible barrier between Oroville and the Fish Barrier Dams.
18020111	CA	Lower American River	Nimbus Dam		
18020112	CA	Sacramento-Upper Clear	Keswick Dam (Sacramento R.) Whiskeytown Dam (Clear Cr.)	Remove Keswick Dam; leave Whiskeytown Dam	This corrects a mistake in Amendment 14
18020115	CA	Stony Creek		Add Black Butte Dam	This dam was mistakenly deleted from the 2008 F.R.
18020126	CA	Bear River		Add Camp Far West Dam	This dam was mistakenly deleted from the 2008 F.R.
18040006	CA	San Joaquin River		Add Friant Dam	This dam was mistakenly deleted from the 2008 F.R.
18040002	CA	Mid. San Joaquin- L. Merced- L. Stanislaus	La Grange Dam (Tuolumne R.)	Add Crocker Diversion Dam (Merced R.) as an impassible barrier	NMFS staff recommended adding this to the 2008 F.R.
18040005	CA	L. Consumnes- L. Mokelumne	Comanche Dam		
18040010	CA	Upper Stanislaus	Goodwin Dam		
18040011	CA	Upper Calveras	New Hogan Dam		

Recommendations

The Panel recommends updating the list of impassible barriers to correct/update typographical and naming errors, and to reflect barriers that have been recently removed or retrofitted with fish passage facilities, as indicated in Table 3. (Note: Table 3 does not yet list those dams that have been or are likely to be removed or receive fish passage).

The Panel further recommends consideration of removing certain barriers from the list that mark the upstream extent of EFH, if considered by NMFS to be necessary for the conservation of the species. (Note: the list of dams fitting that description is pending).

Task: Habitats important to Salmonid Life History

Amendment 14 provides a thorough literature review and synthesis of important habitats per life stage of Pacific salmon. It identifies five levels of data, pertaining to the volume and quality of information available, and presents a matrix for each of the three managed species, indicating residence time, habitat requirements, prey, water quality parameters, and other information. The information and tables are based on the literature review completed at the time. A major part of the periodic review process is aimed at updating the literature and background data that informs EFH identification.

The Council enlisted Cramer Fish Sciences to develop an annotated bibliography of relevant recent information that could inform and update the library of information relative to the habitat requirements of Pacific salmon at several different life stages (Appendix A). Bergman (2010) includes about 100 references in the annotated bibliography, which presents literature for Chinook, coho, and PS pink salmon. Life histories are divided into eggs and spawning, freshwater juveniles, estuarine juveniles, marine juveniles, and adults. For each life stage, the annotated bibliography presents several key or representative references.

Recommendation

The Panel recommends incorporating the annotated bibliography in Bergman (2010) into the literature supporting Pacific salmon EFH.

Task: Alaska Essential Fish Habitat

In Amendment 14, the Council included in the description of Pacific Coast salmon EFH, Alaskan marine waters identified by the NPFMC as EFH for salmon. This was intended to highlight the importance of habitats around the North Pacific Ocean, as well as the far-ranging migrations that many stocks exhibit. The regulatory implications of this designation are not clear. For example, does an action agency have to consult with the NMFS NWR on activities in Alaskan marine waters that may adversely affect salmon of West Coast origin? It is unlikely that this scenario would ever come to fruition because the EFH designations of Alaskan and Pacific salmon overlap. Any conservation recommendations for Alaskan salmon would presumably apply to Pacific salmon managed by the Council. Therefore, the practical effect, as far as EFH consultation is concerned, is negligible. Of note is the fact that the NPFMC is revising marine salmon EFH descriptions, which could result in a significant change in the spatial extent of Alaskan marine EFH.

Recommendation

The Panel recommends retaining Alaskan marine salmon EFH in the description of Pacific Coast salmon EFH, and tracking changes made to marine EFH by the NPFMC.

Task: 4th Field versus 6th Field Hydrologic Units

The seminal EFH descriptions for Pacific salmon are contained in the text of the 2008 Final Rule. Maps are also provided to assist with interpreting EFH more specifically, but it is important bear in mind that the maps are not the final word in the spatial location of EFH. Rather, the text description is the definitive legal description. The maps contain USGS 4th field hydrologic units to depict the current or historic distribution of each of the three managed species of Pacific salmon. To know whether a particular project would possibly adversely affect EFH, the user would first determine whether the project is within one of those 4th field hydrologic units, and then make a second level determination regarding whether the project is actually in (or may adversely affect) EFH. Not every water body within that hydrologic unit would be considered EFH, based on the text description, although activities on land and water that are not EFH could be considered likely to adversely affect EFH. It is up to the user to make that initial determination.

Defining EFH on a 4th field HUC level results in relatively coarse geographic descriptors. Geospatial mapping has improved significantly since the original Amendment 14, and USGS 6th field hydrologic units are commonly used in many geospatial applications. One way to provide a more refined and precise interpretation of the text descriptions for Pacific Coast salmon EFH is to present historic distribution in smaller hydrologic units. The resulting maps would provide a more precise spatial representation of EFH, and allow for a more accurate determination of whether or not a proposed project would occur in, or impact, EFH. However, in many cases, too few data exist to refine EFH to that degree.

Another consideration of switching to the more refined 6th field hydrologic unit maps is the magnitude of staff resources required, which would be significant. For California, there are 59 4th field hydrologic units currently described as EFH, and there are 1294 6th field hydrologic units within those 59 4th field hydrologic units. 547 of those show distribution data while 747 do not.

For Oregon, Washington, and Idaho, there are 115 4th field hydrologic units currently described as EFH, encompassing 4198 6th field hydrologic units. 2443 of those have salmon distribution data, while 1755 do not. These examples illustrate the potential pitfalls, due to a lack of distribution data for many of the 6th field hydrologic units; as well as the staff resources required to manage EFH information for a total of 5492 6th field hydrologic units rather than 174. Figure 8 depicts the difference between 4th field and 6th field hydrologic units.

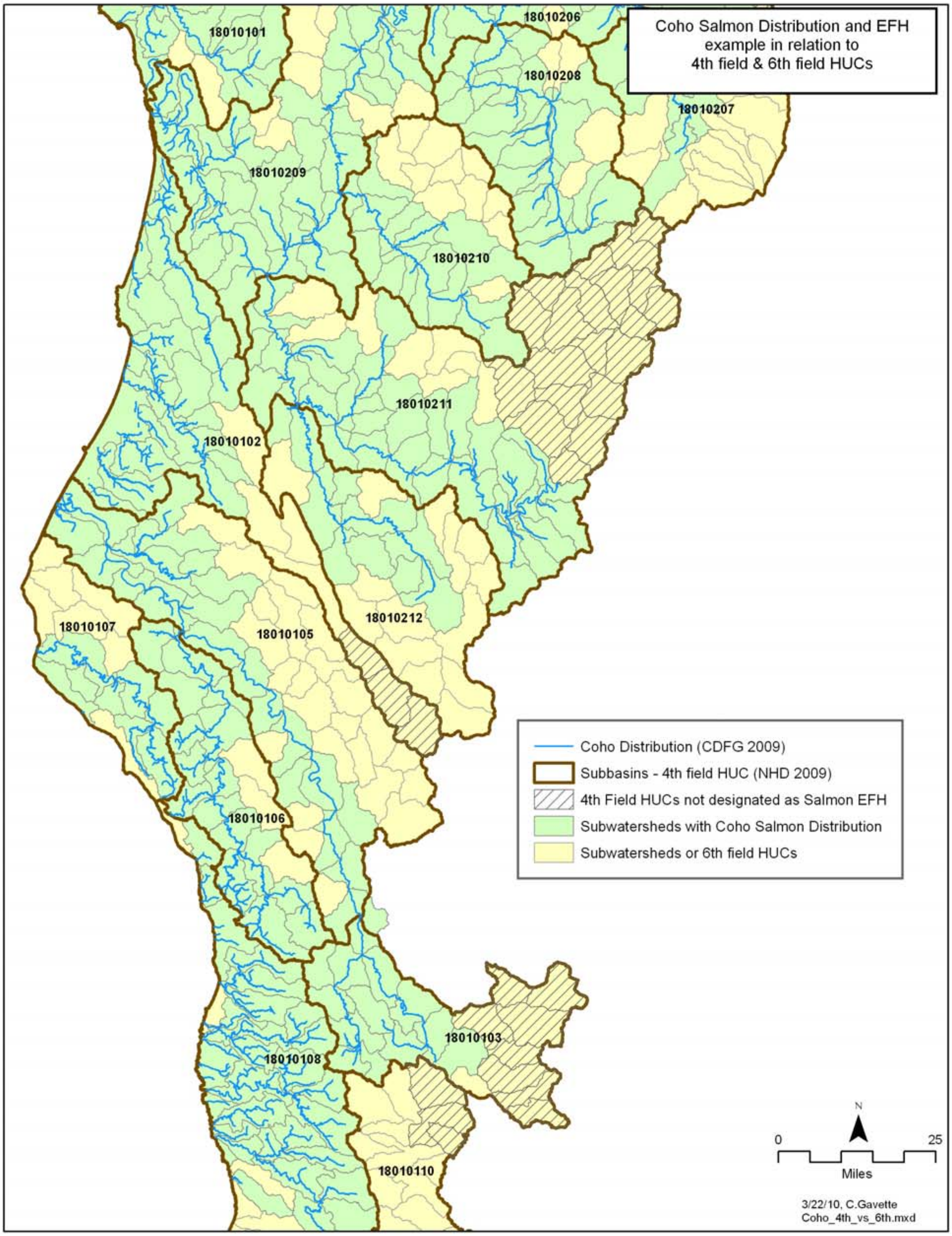


Figure 8. Example of the relative size difference between 4th field and 6th field USGS hydrologic units.

Recommendation

The Panel recommends maintaining the existing 4th field hydrologic unit maps for general use by the public, and providing more detailed maps to users when possible.

The Panel recommends expanding the available data to allow development of maps at the 6th field hydrologic unit level in the future.

Task: Intrinsic Potential

Intrinsic Potential (IP) models are models intended to predict the historical (i.e., pre-anthropogenic disturbance) potential for a given stream reach to develop habitat characteristics suitable for a particular salmonid species and life stage based on a limited set of geomorphic and hydrologic characteristics. Most IP models convert values for stream gradient, valley width index, and mean annual discharge (landform, lithologic, and hydrologic functions that interact to govern movement and deposition of sediment, large wood, and other structural elements along a river network) into separate suitability ratings scaled between 0 and 1. These individual suitability values are combined (typically as the geometric mean of these three suitability values) into the IP value for a particular reach. Additionally, some models may incorporate other environmental factors thought to limit the distribution or abundance of a particular species. For example, models of coho salmon intrinsic potential in California streams incorporate a mean August air temperature threshold as a method of masking out regions where water temperatures are too warm for coho salmon.

Intrinsic Potential (IP) models have potential application both in identifying EFH and in designating HAPCs. Specifically, the Panel explored using IP in areas that lack robust empirical information regarding salmonid presence/absence, either because they have not been surveyed or because populations have been extirpated. If a given hydrologic unit has never been surveyed and the paucity of valid information precludes definitively concluding current or historical presence, IP can be used to infer answers to those questions. IP models also typically include biophysical factors such as gradient that could be used to evaluate the relative suitability of different stream reaches, though such potential uses are confounded by the fact that IP models may be poor predictors of current habitat conditions, as none of the variables reflect habitat changes caused by anthropogenic activities. Figure 9 shows an example of how IP can be used to infer habitat suitability. In this example, stream reaches with suitable IP are highlighted, and then colored to indicate stream reaches above currently impassible barriers. One barrier (Nicasio Dam) is being considered for fish passage while the other (Peters Dam) is not. Both dams, however, show IP above the barrier.

IP models have also been used extensively by salmon technical recovery teams to provide rough estimates of the relative habitat potential among different hydrologic units. In these applications, the sum of all stream segment distances weighted by their IP values is calculated, a value termed IP-km. These estimates were used as proxies for relative habitat capacity in different hydrologic units.

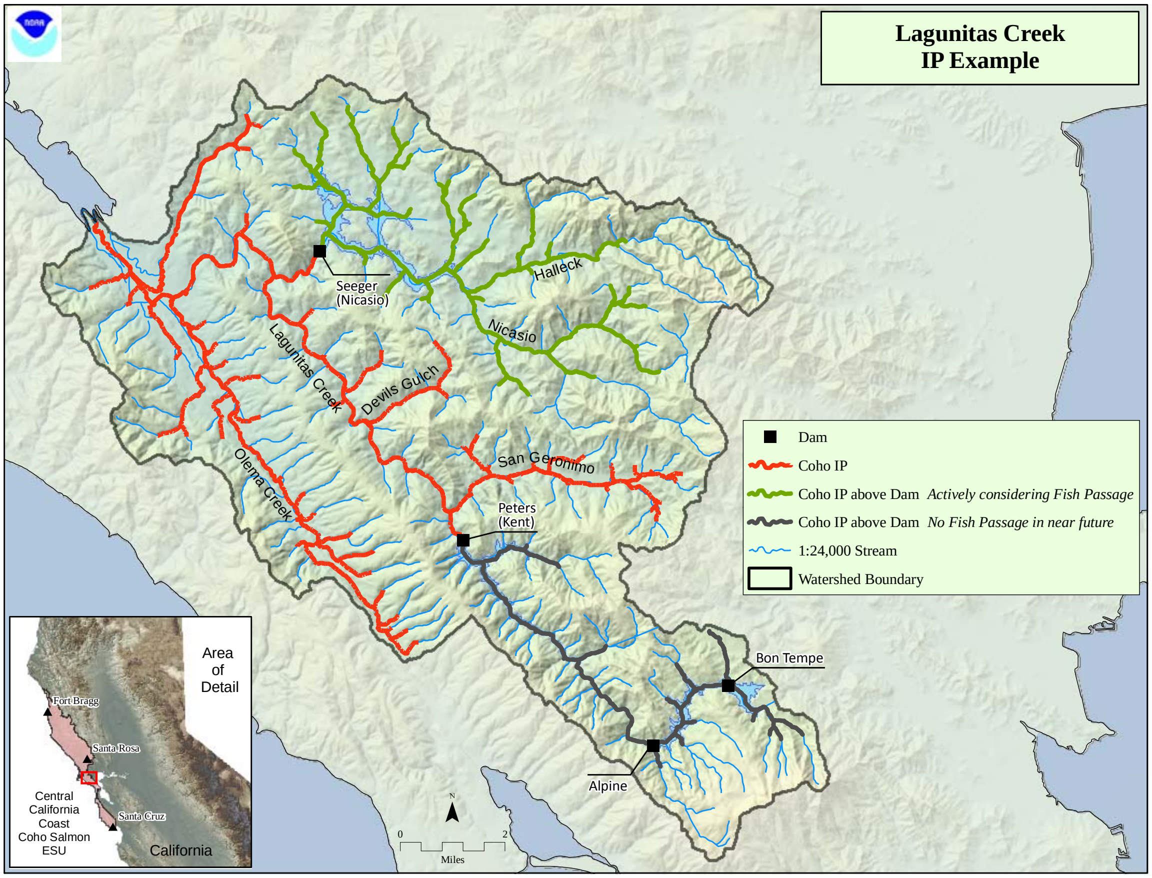


Figure 9. Example of how Intrinsic Potential can help identify potentially suitable habitats for Pacific salmon.

A workshop on Salmon Intrinsic Potential was held in Portland, OR on Nov. 19-20, 2008. A resultant product of that workshop is a paper titled "Development & Management of Fish Intrinsic Potential Data and Methodologies: State of the IP 2008 Summary Report." An excerpt from the report reads "IP models have been developed for some salmon and steelhead groups listed under the Endangered Species Act, and model results have been incorporated into recovery planning activities. However, currently, there is no standard methodology for developing geospatial datasets needed for IP models nor are there peer-reviewed species preference curves for many resident and anadromous species in the Pacific Northwest." (Sheer et al. 2009)

Evolutionarily Significant Units that have IP defined:

- Lower Columbia Coho
- Lower Columbia Chinook
- Oregon Coast Coho (OC-Coho)
- Willamette Chinook
- Puget Sound Chinook
- Snake River spring/ summer Chinook (physical habitat potential, vegetation not considered)
- Upper Columbia River spring-run Chinook (physical habitat potential, vegetation not considered)
- Southern Oregon/Northern California Coast coho salmon (SONCC-Coho)

- Central California Coast coho salmon (CCC-Coho)
- California Coastal Chinook salmon (CC-Chinook)

No GIS data for Snake River fall Chinook is available, and it seems probable that no IP models for pink salmon have been done. The SWR GIS staff currently have resultant GIS data for the IP model work done in that region. However, individual data files exist for each hydrologic unit making any desired analysis fairly time-consuming. The NWR GIS staff do not currently have GIS data for the IP models and would need to obtain it if needed to use IP to infer EFH for particular hydrologic units.

Recommendation

Given the relative uncertainty of using IP to infer salmonid historic presence or habitat suitability, the Panel does not recommend using IP at this time to define EFH. However, the Panel recognizes that in some cases of sparse information, IP can be used as a tool to investigate the likelihood of suitable salmonid habitat.

Task: Qualitative versus Spatially-explicit Descriptions of Essential Fish Habitat

In developing Amendment 14, the Council chose a comprehensive approach toward defining EFH. Inferred in the decision to use 4th field hydrologic units, and to depend on the text description of EFH, is the obligation of the user to make reasonable determinations about whether a particular activity is or is not included in EFH. The same level of responsibility is assigned regarding whether a particular action would adversely affect EFH. As discussed in this document, there are many 4th field hydrologic units shaded to indicate the presence of EFH, but inherent is the fact that not every piece of land or water inside that hydrologic unit should be considered EFH. The user must therefore make a reasonable professional judgment on a case by case basis.

The Panel considered whether it would make sense to pursue spatially-explicit EFH designations, but recognized that because habitats are variable spatially and temporally, it would be impractical to continuously update every portion of EFH, in response to seasonal or Interannual changes in the spatial extent of any particular habitat or in response to natural changes in salmon distribution.

Recommendation

The Panel recommends retaining the existing comprehensive approach to interpreting EFH for Pacific Coast salmon, rather than spatially-explicit designations.

3. HABITAT AREAS OF PARTICULAR CONCERN

The implementing regulations for the EFH provisions of the MSA (50 CFR part 600) encourage the Fishery Management Councils to identify specific types or areas of habitat within EFH as "habitat areas of particular concern" (HAPC), based on one or more of the following considerations: (1) the importance of the ecological function provided by the habitat; (2) the extent to which the habitat is sensitive to human-induced environmental degradation; (3) whether, and to what extent, development activities are, or will be, stressing the habitat type; and (4) the rarity of the habitat type. The intended goal of identifying such habitats as HAPCs is to provide additional focus for conservation efforts. While the HAPC designation does not add any specific regulatory process, it highlights certain habitat types as ecologically very important. This designation is manifested in EFH consultations, in which a consulting NMFS biologist can call attention to a HAPC, and therefore justify protective conservation recommendations to the action agency.

Specific HAPCs have not yet been established for Pacific coast salmon, although Amendment 14 briefly describes several types of habitat that are important to salmon. The Panel considered the following habitat types as possible HAPCs:

Complex channels and floodplain habitats: meandering, island-braided, pool-riffle and forced pool-riffle channels. Complex floodplain habitats, including wetlands, oxbows, side channels, sloughs and beaver ponds, and steeper, more constrained channels with high levels of large woody debris, provide valuable habitat for all Pacific salmon species. The densities of both spawning and rearing salmon are highest in areas of high quality naturally functioning floodplain habitat and in areas with large woody debris than in anthropogenically modified floodplains (Brown and Hartman 1988; Chapman and Knudsen 1980; Brown and Hartman 1988; Montgomery et al. 1999). These important habitats are typically found within complex floodplain channels defined as meandering or island-braided channel patterns and in pool-riffle or forced-pool mountain river systems (see Montgomery and Buffington 1998 and Beechie et al. 2006 for detailed description of these channel types). Complex floodplain habitats are dynamic systems that change over time. As such, the habitat-forming processes that create and maintain these habitats (e.g., erosion and aggradation, channel avulsion, input of large wood from riparian forests) should be considered as integral to the habitat.

An important component of these habitats is large wood, which typically occurs in the form of logjams in floodplains and larger rivers and accumulations of single or multiple logs in smaller mountain channels. Large woody debris helps create complex channels and floodplain habitats and important spawning and rearing habitat by trapping sediment, nutrients, and organic matter, creating pools, sorting gravels, providing cover and hydrologic heterogeneity, and creating important spawning and rearing areas for salmon (Harmon et al. 1986; Abbe and Montgomery 1996; Bilby and Bisson 1998). Complex channels, floodplain habitat, and large woody debris are very sensitive to land, riparian or river management. These areas also provide pools, off-channel areas, shade, cooler temperatures, and thermal refugia during both summer and winter (Crispin et al. 1993).

HAPC criteria met: 4 of 4. (ecologically important, sensitive to disturbance, highly modified, tend to be rare).

Thermal Refugia. Areas to escape high temperatures are critical to salmon survival, especially during hot, dry summers in California and eastern Oregon and Washington. Thermal refugia provide important holding and rearing habitat for adults and juveniles (Goniea et al. 2006, Sutton et al. 2007). Important thermal refugia often exist higher in hydrologic units and are most susceptible to blockage by artificial barriers (Yoshiyama et al. 1998). Reduced flows that are either anthropogenic, natural or climate-change induced can also reduce or eliminate access to refugia (Battin et al. 2007; Riley et al. 2009). Loss of structural elements such as large wood can also influence the formation of thermal refugia. Thermal refugia typically include coolwater tributaries, lateral seeps, side channels, tributary junctions, deep pools, areas of groundwater upwelling and other mainstem river habitats that are cooler than surrounding waters (≥2° C cooler) (Torgersen et al. 1999; Ebersol et al. 2003). As such, refugia can occur at spatial scales ranging from entire tributaries (e.g., spring-fed streams), to stream reaches (e.g., alluvial reaches with high hyporheic flow), to highly localized pockets of water only a few square meters in size embedded within larger rivers.

HAPC criteria met: 4 of 4. Thermal refugia are ecologically important, sensitive to disturbance and face increased potential of stress, and can be rare in interior and southern hydrologic units within the range of Pacific salmon.

Spawning habitat. Spawning habitat has an extremely high ecological importance, and it is especially sensitive to stress and degradation by a number of land- and water-use activities that affect the quality, quantity and stability of spawning habitat (e.g., sediment deposition from land disturbance, streambank armoring, water withdrawals) (Independent Scientific Group 2000; Snake River Salmon Recovery Board 2006). Salmon spawning habitat is typically defined as low gradient stream reaches (<3%), containing clean gravel with low levels of fine sediment and high inter gravel flow. Many spawning areas have been well defined by historical and current spawner surveys and detailed maps exist for some hydrologic units.

HAPC criteria met: 3 of 4. Spawning habitat is ecologically important, sensitive to disturbance and faces increased potential of stress. It is generally not rare.

Estuaries. Estuaries are protected nearshore areas such as bays, sounds, inlets, river mouths, and lagoons influenced by ocean and freshwater. Because of tidal cycles and freshwater runoff, salinity varies within estuaries and results in great diversity, offering freshwater, brackish and marine habitats within close proximity (Haertel and Osterberg 1967). Such areas tend to be shallow, protected, nutrient rich, and are biologically productive, providing important habitat for marine organisms, including salmon.

Estuaries are complex systems that encompass a number of habitat types in a relatively small area, including sand and gravel beaches, mudflats, tidal creeks, shallow nearshore waters, pocket estuaries, and mixing zones, that are vital to the growth and survival of salmon, primarily during their juvenile phase. These systems provide protected habitat for juvenile salmon before entering the marine environment (Macdonald et al. 1988; Miller and Sadro 2003). Juvenile salmon are thought to utilize estuaries for three distinct purposes: (1) as a rich nursery area capable of sustaining increased growth rates; (2) to gain temporary refuge from marine predators; and (3) as a physiological transition zone where juveniles can gradually acclimate to saltwater (Bottom et al. 2005). In the larger, deeper estuaries of the west coast of North America (e.g., Puget Sound, Columbia River, San Francisco Bay), the shallow nearshore habitats of estuaries are especially important to juvenile salmon. For example, in Puget Sound, pink salmon and some ocean-type Chinook salmon enter the estuary at a very small size and rear in the shallow nearshore waters (<3 m deep) until they reach 70 mm in length, when they then move offshore. These shallow waters provide access to benthic prey and protection from predators. Functional estuaries also promote a diversity of life history types in salmon populations, with variation in estuarine use and residence time of juveniles contributing to variations in the timing and size of fish at ocean entry (Bottom et al. 2005). This diversity buffers populations from extreme events in the freshwater or marine environments, and may increase resilience of populations following such disturbances (Bottom et al. 2005). Estuaries also provide rich feeding areas for adult salmon as they return to their natal streams.

Estuaries are highly sensitive, rare and have been stressed by anthropogenic activities for centuries (Johnston 1994). Degradation and loss of these sensitive habitats has been shown to have a detrimental effect on salmon populations (Magnusson and Hilborn 2003) and much estuarine habitat has been lost along the Pacific coast. A number of human activities (e.g., diking, dredging and filling, shoreline armoring, stormwater and wastewater discharge, industrialization, removal of riparian vegetation and large wood), including those that occur upstream in the rivers that flow into an estuary, can reduce both the quality and quantity of estuarine habitat that is available to salmon. In Puget Sound alone, more than one third of the shoreline has been armored, with significant alteration of the shallow nearshore habitat (Shipman 2009).

HAPC criteria met: All 4

Marine and estuarine submerged aquatic vegetation. Submerged aquatic vegetation (SAV) includes the kelps and eelgrass. These habitats have been shown to have some of the highest primary productivity in the marine environment (Foster and Schiel 1985; Herke and Rogers 1993; Hoss and Thayer 1993), and provide a significant contribution to the marine and estuarine food webs (see reviews by Fresh 2006 and Mumford 2007).

The kelps are brown macroalgae, and include those that float to form canopies and those that do not, such as *Laminaria spp*. Canopy-forming kelps of the eastern Pacific coast are dominated by two species, giant kelp (*Macrocystis pyrifera*) and bull kelp (*Nereocystis leutkeana*). Kelp plants, besides requiring moderate to high water movement and energy levels, are most likely limited by the availability of suitable substrate (Mumford 2007). These beds provide nurseries, feeding grounds, and shelter to a variety of fish species, including salmon (Shaffer 2002; Mumford 2007), as well as spawning substrate to Pacific herring (*Clupea pallasii*), an important prey species for all marine life stages of Pacific salmon.

Eelgrasses, of the genus *Zostera,* form dense beds of leafy shoots year-round in the soft sediments of the lower intertidal and shallow subtidal zone, and form a three-dimensional structure in an otherwise two-dimensional (sand or mud) environment (Mumford 2007). Juvenile salmon utilize eelgrass beds as migratory corridors as they transition to the open ocean, and the beds provide both refuge from predators and an abundant food supply (see reviews by Fresh 2006 and Mumford 2007). Pacific herring (*Clupea pallasii*), an important prey species for all marine life stages of Pacific salmon, often spawn on eelgrass.

Both kelp and eelgrass are highly sensitive to human activities. Stressors include those that affect the amount of light available to the plant, and the direct and indirect effects of high or low nutrient levels, toxins, and physical disturbance (Mumford 2007). The location and size of both kelp and seagrass beds vary over time and space, making spatial descriptions and mapping of their distribution difficult. As such, this HAPC should rely on a detailed text description, rather than spatially explicit definitions.

HAPC criteria met: 3 of 4. Marine and estuarine SAV is ecologically important, sensitive to disturbance and faces increased potential of stress.

The Pacific Council issued HAPCS in Groundfish Amendment 19 (seagrasses, kelp canopy, estuaries, rocky reefs), but not in the other three Pacific Council FMPs. The salmon FMP discusses HAPCs for each species but stops short of establishing HAPCs, citing lack of sufficient data on which to base HAPCs.

All other Council FMCs have designated HAPCs, as have several other regional FMCs. Some designated discrete habitat areas as HAPCs, while others broadly designated all areas of a specific habitat type as HAPCs. Some FMCs designated HAPCs for all of the managed species in their jurisdictions, and others only designated HAPCs for particular species or life stages. HAPCs, like EFH generally, are subject to periodic reviews, and are therefore subject to being modified over time.

Recommendations

Although the Panel does not offer a recommendation for adopting specific HAPCs at this time, the Panel agrees that the potential HAPCs listed above merit consideration by the Council.

4. THREATS TO ESSENTIAL FISH HABITAT

Task: Non-fishing Activities that may Affect Pacific Coast Salmon Essential Fish Habitat

The MSRA requires fishery management councils and NMFS to identify non-fishing activities that may adversely affect EFH, and actions to encourage the conservation and enhancement of EFH, including recommended options to avoid, minimize, or compensate for the adverse effects identified in the FMP. Amendment 14 includes 21 such activities and conservation measures, and the Panel identified 10 additional non-fishing threats. Appendix A of Amendment 14 describes impacts and recommended conservation measures of the 21 non-fishing threats identified in 1999, and Appendix A of this report describes the impacts and supporting literature of the 10 newly-identified non-fishing threats. Recommended conservation measures have not yet been identified for all 10 newly-identified threats.

Table 4. Non-fishing threats to Pacific Coast salmon EFH. Newly-identified threats appear in the right column. Detailed information on the threats identified in the first column can be found in Appendix A to Amendment 14. Details information on the threats identified in the second column can be found in Appendix A of this document (Bergmann 2010).

Threats Identified in Amendment 14 (1999)	**New Threats Identified During EFH Review**
Agriculture	Pile driving
Artificial Propagation of Fish and Shellfish	Over-water structures
Bank Stabilization	Alternative energy development
Beaver removal and Habitat Alteration	Liquefied natural gas projects
Construction/Urbanization	Desalination
Dam Construction/Operation	Power plant intakes
Dredging and Dredged Spoil Disposal	Pesticide use
Estuarine Alteration	Flood control maintenance

Forestry	Culvert construction
Grazing	Climate change
Habitat Restoration Projects	
Irrigation/Water Management	
Mineral Mining	
Introduction/Spread of Nonnative Species	
Offshore Oil and Gas Drilling	
Road Building and Maintenance	
Sand and Gravel Mining	
Vessel Operation	
Wastewater/Pollutant Discharge	
Wetland and Floodplain Alteration	
Woody Debris/Structure Removal	

Recommendation

The Panel recommends incorporating the 10 newly-identified non-fishing threats into the Pacific salmon EFH literature, developing conservation measures for those threats still lacking conservation measures, and updating the existing non-fishing threats and conservation recommendations as warranted.

Task: Fishing Activities that may Affect Pacific Coast Salmon Essential Fish Habitat

The MSA requires FMCs to identify fishing activities that may affect EFH, and to minimize adverse effects of those activities to the extent practicable. Fishing activities, harvest of prey species, and the removal of salmon carcasses and their nutrients from streams are identified as fishing-related activities that can affect Pacific Coast salmon EFH. Some of these activities are controlled by the Council and some are not.

Commercial and recreational fishing activities and harvest levels that potentially affect Pacific salmon have not changed significantly since 1999. Although minor changes in location may have occurred, it is unlikely that these would have a significant effect on impacts to EFH for Pacific salmon. Further, it is likely that any changes to overall fishing activities have remained level or have decreased since 1999.

Gear Effects

Amendment 14 does not identify any studies that indicate direct gear effects on Pacific Coast salmon EFH from PFMC-managed fisheries, although some studies indicate that there may be impacts to benthic organisms and their habitats due to bottom trawling and dredging activities. Outmigrating Pacific salmon juveniles feed on various epibenthic invertebrates and zooplankton, including benthic copepods, implying that there could be impacts to prey species. However, Amendment 14 notes that salmon are not known to be dependent on soft ocean bottom habitats. Therefore, it does not conclude that fishing gear effects in the ocean directly affect benthic prey species. Table 5 lists gear types used in PFMC-area fisheries that could impact Pacific Coast salmon EFH. Appendix A of Amendment 14 notes that "detailed management measures have not been developed, because of the lack of information demonstrating an adverse effect on EFH from salmon 'gear.'" It recommends further research on gear effects on EFH of salmon and their prey, especially disturbance to eelgrass beds and rocky habitat.

Table 5. Fisheries and gear potentially adversely affecting Pacific Coast salmon EFH. (PFMC 1999).

Fishery	Gear
Anchovy, sardine, mackerel	purse seine, lampara net
Clam	shovel, hydraulic dredge, clam gun
Crab	pot/trap
Groundfish	bottom/mid-water trawl, longline, hook-and-line, pot/trap, set gill net, spear
Hagfish	pot/trap
Halibut (Pacific)	longline, hook-and-line, troll
Herring	purse seine, gill net, pound net, hook-and-line, weir
Lobster	pot/trap
Salmon	troll, gill net, purse seine, hook-and-line, dip net, weir
Sea urchin, abalone	hand rake, abalone iron
Sea cucumber	hand rake, trawl
Scallop	abalone iron, dredge
Shrimp, prawn	pot/trap, trawl
Smelt	dip net, gill net
Squid	Seine
Sturgeon	hook-and-line, gill net
Swordfish, thresher shark	drift gill net
Tuna (Albacore)	troll, hook-and-line
Tuna (Yellowfin, skipjack tuna)	purse seine, hook-and-line
White croaker, white sea bass, California halibut, et al.	set gill-net, hook-and-line

Conservation measures for gear effects were not presented in Amendment 14, which instead noted the need for research to study the effects of gear on salmon EFH and prey, especially related to disturbance of eelgrass beds and rocky habitat. The 2008 Final Rule did not address fishing effects to Pacific salmon EFH.

Harvest of Prey Species

Commercial and recreational fisheries for many types of prey species potentially decrease the amount of prey available to Pacific salmon. The EFH regulatory guidance defines EFH to include prey. Herring, sardine, anchovy, squid, smelt, groundfish, and crab as possible prey species that are actively fished. Amendment 14 notes that some of these species (e.g., herring and crab) are state managed while others are federally managed, and concluded that both state and federal management already set aside a portion of the biomass as forage reserves for predator species. The initiation of the Council's Ecosystem Fishery Management Plan and statements from the public and from Council advisory bodies demonstrate a growing awareness and interest in managing from an ecosystem perspective.

Removal of Salmon Carcasses

Salmon carcasses provide vital nutrients to stream and lake ecosystems. Carcasses enhance salmonid growth and survival, but fishing activities remove a portion of returning adults that would otherwise supply nutrients to stream systems. This is especially relevant to nutrient-poor streams that depend on the phosphorous, nitrogen, and other nutrients provided by salmon carcasses.

Conservation measures in Amendment 14 center around the need to ensure adequate spawner escapement, which would supply streams with adequate amounts of returning salmon and therefore nutrients.

Recommendation

The Panel recommends retaining the existing list of fishing activities that may affect Pacific salmon EFH.

Task: Information and Research Needs

Amendment 14 identified the need to improve fine-scale mapping of EFH, and the need for accurate GIS data on freshwater and marine distribution and habitat conditions. It recommended that future efforts be focused on developing accurate, seasonal salmon distribution data at a 1:24,000 or finer scale, to aid more in precise and accurate delineation of EFH and in the consultation process.

Amendment 14 noted that by adopting a comprehensive strategy (i.e., using 4^{th} field hydrologic units to present EFH spatial information), it resulted in an entire hydrologic unit being identified as EFH even when portions of it were never utilized by salmon, or was upstream of an impassible barrier. As an example, it highlighted the Snoqualmie (HUC 17110010) that is shown on a map as being EFH, although about half the hydrologic unit is behind an impassible waterfall, above which there was never historic salmonid distribution. It recommends describing EFH in 5^{th} or 6^{th} field hydrologic units when possible.

Recommendation

The Panel recommends updating the list of scientific literature to include the references accumulated during the review process.

Appendix A: Annotated Bibliography for 2010 Essential Fish Habitat Update

Appendix B: Oversight Panel Composition

Chuck Tracy (Council Staff)
Kerry Griffin (Council Staff)
John Stadler (NMFS/NWR)
Eric Chavez (NMFS/SWR
Bryant Chesney (NMFS/SWR)
Phil Roni (NWFSC)
Barbara Seekins (NMFS/NWR)
Charleen Gavette (NMFS/SWR)
Brian Spence (SWFSC)
Nancy Munn (NMFS/NWR)
Matt Dorsey (NMFS/SWR)
Adam Obaza (NMFS/SWR)
Steve Copps (NMFS/NWR)

References

Abbe, T. B. and D. R. Montgomery. 1996. Large woody debris jams, channel hydraulics and habitat formation in large rivers. Regulated Rivers Research and Management **12**: 201- 221.

Battin, J., M.W. Wiley, M.H. Ruckelshaus, R.N. Palmer, E. Korb, K.K. Bartz, and H. Imaki. 2007. Projected impacts of climate change on salmon habitat restoration. Proc Natl Acad Sci, 104(16):6720-6725.

Bauersfeld, Kevin. 1977. Effects of peaking (stranding) of Columbia River dams on juvenile anadromous fishes below the Dalles dam, 1974 and 1975. State of Washington. Department of Fisheries. Technical Report No. 31. Olympia, Washington.

Beechie, T.J., M. Liermann, M.M. Pollock, S. Baker, and J. Davies. 2006. Channel pattern and river-floodplain dynamics in forested mountain river systems. Geomorphology78:124-141.

Bergman, P. S. 2010. Annotated bibliography for 2010 Essential Fish Habitat update. Cramer Fish Sciences.

Bilby, R.E., and P.A. Bisson. 1998. Function and distribution of large woody debris. Pages 324-346 in Naiman R.J. and Bilby R.E. (editors) River ecology and management: lessons from the Pacific Coastal Ecoregion. Springer-Verlag, New York.

Bottom, D.L., C.A. Simenstad, J. Burke, A.M. Baptists, D.A. Jay, K.K. Jones, E. Casillas, and M.H. Schiewe. 2005. Salmon at river's end: the role of the estuary in the decline and recovery of Columbia River salmon. NOAA Technical Memorandum NMFS-NWFSC-68. 228 p + appendices.

Brown, T.G. and G.F. Hartman. 1988. Contribution of seasonally flooded lands and minor tributaries to the production of coho salmon in Carnation Creek, British Columbia. Trans. Am. Fish. Soc., 117: 546-551.

Chapman, D.W. and E. Knudsen. 1980. Channelization and livestock impacts on salmonid habitat and biomass in western Washington. Trans. Am. Fish. Soc., 109: 357-363.

Crispin, V., R. House, and D. Roberts. 1993. Changes in instream habitat, large woody debris, and salmon habitat after the restructuring of a coastal Oregon stream. N. Am. J. of Fish. Manag., 13: 96-102.

Ebersole, J. L., W.J. Liss, and C. A. Frissell, 2003. Cold Water Patches in Warm Streams: Physicochemical Characteristics and the Influence of Shading. J. of the American Water Resources Association (JAWRA) 39(2):355-368.

Foster, M. S. and D. R. Schiel. 1985. The ecology of giant kelp forests in California: A community profile, U. S. Fish Wildl. Serv. Biol. Rep. 85(7.2).

Fresh, K.L. 2006. Juvenile Pacific Salmon in Puget Sound. Puget Sound Nearshore Partnership Report No. 2006-06. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, Washington. 21 p.

Goniea, T.M., Keefer, M.L., Bjornn, T.C., Peery, C.A., Bennett, D.H., Stuehrenberg, L.C., 2006. Behavioral thermoregulation and slowed migration by adult fall chinook salmon in response to high Columbia river water temperatures. Trans. Am. Fish. Soc., 135(2): 408-419.

Haertel, L. and C. Osterberg. 1967. Ecology of Zooplankton, Benthos and Fishers in the Columbia River Estuary. Ecology 48(3):459-472.

Harmon, M.E., J.F. Franklin, F.J. Swanson, P. Sollins, S.V. Gregory, J.D. Lattin, N.H. Anderson, S.P. Cline, N.G. Aumen, J.R. Sedell, G.W. Lienkaemper, K. Cromack, and K.W. Cummins. 1986. Ecology of coarse woody debris in temperate ecosystems. Advances in Ecological Research 15: 133-302.

Herke, W. H. and B. D. Rogers. 1993. Maintenance of the estuarine environment. Pages 263-286 *in* C. C. Kohler and W. A. Hubert, editors. Inland fisheries management in North America. American Fisheries Society, Bethesda, Maryland.

Hoss, D. E. and G. W. Thayer. 1993. The importance of habitat to the early life history of estuarine dependent fishes. American Fisheries Society Symposium 14:147-158.

Independent Scientific Group. 2000. Return to the River 2000: restoration of salmonid fishes in the Columbia River Ecosystem. NPPC 2000-12, Northwest Power Planning Council, Portland, Oregon.

Johnston, C.A. 1994. Cumulative impacts to wetlands. Wetlands, 14(1):49-55.

Macdonald, J.S., C.D. Levings, C.D. McAllister, U.H.M. Fagerlund, and J.R. McBride. 1988. A field experiment to test the importance of estuaries for chinook salmon (*Onchorhynchus tshawytscha*). Canadian Journal of Fisheries and Aquatic Sciences, 45: 1366-1377.

Magnusson, A., R. Hilborn. 2003. Estuarine influence on survival rates of coho (*Oncorhynchus kisutch*) and chinook salmon (*Oncorhynchus tshawytscha*) released from hatcheries on the U.S. Pacific coast. Estuaries, 26(4B): 1094-1103.

McCullough, D. and A. Espinosa Jr. 1996. Columbia River Inter-Tribal Fish Commission. A monitoring strategy for application to salmon watersheds. Portland, Oregon.

Miller, B.A., S. Sadro. 2003. Residence time and seasonal movements of juvenile coho salmon in the ecotone and lower estuary of Winchester Creek, South Slough, Oregon. Trans. Am. Fish. Soc., 132(3): 546-559.

Montgomery, D.R and J.M. Buffington. 1997. Channel-reach morphology in mountain drainage basins. Geological Society of America Bulletin 109: 596-611.

Montgomery, D.R., E.M. Beamer, G. Pess, and T.P. Quinn. 1999. Channel type and salmonid spawning distribution and abundance. Can. J. Fish. and Aquat. Sci. 56: 377-387.

Mumford, T.F. 2007. Kelp and Eelgrass in Puget Sound. Puget Sound Nearshore Partnership Report No. 2007-05. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, Washington. 27 p.

NRC. 1996. Upstream: salmon and society in the Pacific Northwest. Report of the committee on protection and management of Pacific northwest anadromous salmonids, Board on Environmental Studies and Toxicology, and Commission on Life Sciences. National Academy Press. Washington, D.C. (Available from National Academy Press, 1-800-624-6242, Washington, DC 20055).

OCSRI. 1997. OCSRI conservation plan. Draft revision February 24, 1997. State of Oregon, Salem, Oregon

Ralph, S., G. Poole, L.Conquest, and R. Naiman. 1994. Stream channel morphology and woody debris in logged and unlogged basins in western Washington. Canadian Journal of Fisheries and Aquatic Sciences. 51:37-51.

Riley, W.D., D.L. Maxwell, M.G. Pawson, M.J. Ives. 2009. The effects of low summer flow on wild salmon (*Salmo salar*), trout (*Salmo trutta*) and grayling (*Thymallus thymallus*) in a small stream. Freshwater Biology, 54(12): 2581-2599.

Shaffer, J.A., 2002. Nearshore habitat mapping of the central and western strait of Juan de Fuca II. Preferential use of nearshore kelp habitats by juvenile salmon and forage fish. A report to the WDFW and Clallam County Marine Resources Committee, 20 p.

Sheer, M.B., Busch, D.S., Gilbert, E., Bayer, J.M., Lanigan, S., Schei, J.L., Burnett, K.M., and Miller, D., 2009, Development and management of fish intrinsic potential data and methodologies: State of the IP 2008 summary report: Pacific Northwest Aquatic Monitoring Partnership Series 2009-004, 56 p.

Shipman, H. 2009. Shoreline erosion on Puget Sound: Implications for the construction and potential impacts of erosion control structures. Presentation made at Puget Sound Shorelines and the Impacts of Armoring Workshop,May 12-14 2009. Abstract only. http://wa.water.usgs.gov/SAW/abstracts.html#shipman

Snake River Salmon Recovery Board. 2006. Snake River salmon recovery plan for Southeast Washington. Snake River Salmon Recovery Board. Available: http://www.snakeriverboard.org/resources/library.htm. (October 2009)

Spence, B. C., G. A. Lomnicky, R. M. Hughes, and R. P. Novitzki. 1996. An ecosystem approach to salmonid conservation. Prepared by Management Technology for the National Marine Fisheries Service. TR-4501-96-6057. 356p. (Available from the NMFS Habitat Branch, Portland, Oregon).

Torgersen, C.E., D.M. Price, H.W. Li, and B.A. McIntosh. 1999. Multiscale thermal refugia and stream habitat associations of chinook salmon in northeastern Oregon. Ecological Applications 9(1): 301-319.

Yoshiyama, R.M., F.W. Fisher, P.B. Moyle. 1998. Historical abundance and decline of Chinook salmon in the central valley region of California. North American Journal of Fisheries Management, 18: 487-521.

Paul Bergman
126 East Street
Auburn, CA 95603
F: 530.888.7774
pbergman@fishsciences.net

Annotated Bibliography for 2010 Essential Fish Habitat Update

Approach

The following is a compilation of pertinent information from available literature published since 1998 that updates sections of the Pacific Coast Salmon Essential Fish Habitat document (EFH). This document is organized by task, and secondarily by subject (See below), and mimics the organization of the accompanying EFH Reference Database, provided in Microsoft Access format.

Task 2. Impassable man-made barriers

Updated information is organized by 44 subjects (one for each barrier). Information for each passage barrier (in same order as Table A-2 in the 1999 EFH document) is provided in a summary table in the following format:

Category	Data
Barrier	e.g. Gorge Lake Dam
State	WA, OR, ID, CA
USGS HUC	Code
Latitude	Lat in Decimal Degrees
Longitude	Long in Decimal Degrees
Hydrologic Unit, River	USGS HUC Name
River	River Name
Owner/Operator	Agency or Private Operator Name
Authority	Federal License, State License, State Inspected
Upstream From Other Impassable Dams	yes/no
License period	Begin Year - End Year
Fish passage	None, Consideration, Construction
Reference	Citation
Documents	Web Link (Where Available)

Task 3. Threats to salmon EFH

Annotated references are organized by 31 subjects (one for each threat to salmon EFH), 21 previously identified in section 3.2.5 in the 1999 EFH plan, and 10 newly identified by the PFMC:

Threats Identified in 1999 EFH Document	Newly Identified Threats
Agriculture	Pile-driving
Artificial Propagation of Fish and Shellfish	Over-water Structures
Bank Stabilization	Alternative Energy Development
Beaver removal and Habitat Alteration	Liquified Natural Gas Projects
Construction/Urbanization	Desalination
Dam Construction/Operation	Power Plant Intakes
Dredging and Dredged Spoil Disposal	Pesticide Use
Estuarine Alteration	Flood Control Maintenance
Forestry	Culvert Construction
Grazing	Climate Change
Irrigation Water Management	
Mineral Mining	
Introduction/Spread of Nonnative Species	
Offshore Oil and Gas Drilling	
Road Building and Maintenance	
Sand and Gravel Mining	
Vessel Operation	
Wastewater/Pollutant Discharge	
Wetland and Floodplain Alteration	
Woody Debris/Structure Removal	

For each reference, pertinent information relevant to each threat is summarized in brief bullet-point descriptions. Some references provide information for more than one threat, therefore, are repeated in this document to provide easy incorporation of threat-specific information in the revised 2010 EFH document.

Task 4. Salmon life history

Annotated references are organized by 24 subjects, with the same eight subjects for each of the three salmon species (Chinook, Coho, and Pink) and a category for references pertaining generally to Pacific salmon, mimicking the organization of the essential fish habitat descriptions in section 2.0 of the 1999 EFH document:

Salmon Life History Subjects
Eggs and Spawning
Larvae/Alevins
Juveniles (Freshwater)
Juveniles (Estuarine)
Juveniles (Marine)
Adults

For each reference, pertinent information relevant to each subject is summarized in brief bullet-point descriptions. Some references provide information for more than one subject, therefore, are repeated in this document to provide easy incorporation of subject-specific information in the revised 2010 EFH document.

Table of Contents

Task 2. Impassable man-made barriers

Gorge Lake Dam

Category	Data
Barrier	Gorge Lake Dam
State	WA
USGS HUC	17110005
Latitude	48.6978539555272
Longitude	-121.207583128571
Hydrologic Unit	Upper Skagit
River	Skagit River
Owner/Operator	City of Seattle
Authority	Federal License
Upstream From Other Impassable Dams	no
License period	1985-2035
Fish passage	Yes
Reference	NMFS 2007a
Documents	http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/PS-Chinook-Plan.cfm

Masonry Dam (Cedar Falls Dam)

Category	Data
Barrier	Masonry Dam (Cedar Falls Dam)
State	WA
USGS HUC	17110012
Latitude	47.4119402374866
Longitude	-121.752428193575
Hydrologic Unit	Lake Washington
River	Cedar River
Owner/Operator	City of Seattle
Authority	River and reservoir operations on the Cedar River are governed by the Cedar River Watershed Habitat Conservation Plan (HCP)
Upstream From Other Impassable Dams	Yes - natural barrier of Lower Cedar Falls
License period	Begin Year, End Year
Fish passage	None - 1.5 upstream of natural fish barrier, Lower Cedar Falls
Reference	Kerwin 2001, Seattle Public Utilities 1999
Documents	http://www.scc.wa.gov/index.php/239-WRIA-8-Cedar-and-Sammamish-Basin/View-category.html

Tolt Dam

Category	Data
Barrier	Tolt Dam
State	WA
USGS HUC	17110010
Latitude	47.6929455673069
Longitude	-121.689396892902
Hydrologic Unit	Snoqualmie
River	South Fork Tolt River
Owner/Operator	City of Seattle
Authority	Federal License
Upstream From Other Impassable Dams	No
License period	1984-2029
Fish passage	None
Reference	Citation
Documents	http://www.ferc.gov/industries/hydropower/gen-info/licensing/licenses.xls

Keechelus Dam

Category	Data
Barrier	Keechelus Dam
State	WA
USGS HUC	17030001
Latitude	47.3224715200048
Longitude	-121.340129555859
Hydrologic Unit	Upper Yakima
River	Yakima River
Owner/Operator	U.S. Bureau of Reclamation
Authority	U.S. Bureau of Reclamation
Upstream From Other Impassable Dams	No
License period	N/A
Fish passage	None currently, but feasibility study being conducted by USBR
Reference	WSCC 2001b and USBR 2009
Documents	http://www.scc.wa.gov/index.php/287-WRIA-37-38-39-Yakima-River-Watershed/View-category.html http://www.usbr.gov/pn/programs/ucao_misc/fishpassage/activities/pn-ydfp-014.pdf

Kachess Dam

Category	Data
Barrier	Kachess Dam
State	WA
USGS HUC	17030001
Latitude	47.2648511711711
Longitude	-121.206075994562
Hydrologic Unit	Upper Yakima
River	Kachess River
Owner/Operator	U.S. Bureau of Reclamation
Authority	U.S. Bureau of Reclamation
Upstream From Other Impassable Dams	No
License period	N/A
Fish passage	None currently, but feasibility study being conducted by USBR
Reference	WSCC 2001b and USBR 2009
Documents	http://www.scc.wa.gov/index.php/287-WRIA-37-38-39-Yakima-River-Watershed/View-category.html http://www.usbr.gov/pn/programs/ucao_misc/fishpassage/activities/pn-ydfp-014.pdf

Cle Elum Dam

Category	Data
Barrier	Cle Elum Dam
State	WA
USGS HUC	17030001
Latitude	47.2453566833616
Longitude	-121.074381937987
Hydrologic Unit	Upper Yakima
River	Cle Elum River
Owner/Operator	U.S. Bureau of Reclamation
Authority	U.S. Bureau of Reclamation
Upstream From Other Impassable Dams	No
License period	N/A
Fish passage	None currently, but feasibility study being conducted by USBR
Reference	WSCC 2001b and USBR 2009
Documents	http://www.scc.wa.gov/index.php/287-WRIA-37-38-39-Yakima-River-Watershed/View-category.html http://www.usbr.gov/pn/programs/ucao_misc/fishpassage/activities/pn-ydfp-014.pdf

Rimrock Dam

Category	Data
Barrier	Rimrock Dam
State	WA
USGS HUC	17030002
Latitude	46.656329052866
Longitude	-121.130118162351
Hydrologic Unit	Naches
River	Tieton River
Owner/Operator	Tieton Hydropower, L.L.C.
Authority	Federal License
Upstream From Other Impassable Dams	No
License period	1991-2041
Fish passage	None currently, but feasibility study being conducted by USBR
Reference	WSCC 2001b and USBR 2009
Documents	http://www.scc.wa.gov/index.php/287-WRIA-37-38-39-Yakima-River-Watershed/View-category.html http://www.usbr.gov/pn/programs/ucao_misc/fishpassage/activities/pn-ydfp-014.pdf

Chief Joseph Dam

Category	Data
Barrier	Chief Joseph Dam
State	WA
USGS HUC	17020005
Latitude	47.9965599582611
Longitude	-119.627866558278
Hydrologic Unit	Chief Joseph
River	Columbia River
Owner/Operator	Bonneville Power Administration
Authority	U.S. Army Corps of Engineers
Upstream From Other Impassable Dams	No
License period	N/A
Fish passage	None
Reference	UCSRB 2007
Documents	http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Interior-Columbia/Upper-Columbia/upload/UC_Plan.pdf

Dworshak Dam

Category	Data
Barrier	Dworshak Dam
State	ID
USGS HUC	17060306
Latitude	46.5147829690336
Longitude	-116.294882072761
Hydrologic Unit	Clearwater
River	North Fork of the Clearwater River
Owner/Operator	U.S. Army Corps of Engineers
Authority	Federal License
Upstream From Other Impassable Dams	No
License period	1998-2048
Fish passage	None
Reference	NOAA 2008
Documents	http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/final-BOs.cfm

Hells Canyon Complex

Category	Data
Barrier	Hells Canyon Complex (Hells Canyon, Oxbow, and Brownlee Dams)
State	ID
USGS HUC	17060101
Latitude	45.2425876747691
Longitude	-116.701069720247
Hydrologic Unit	Hells Canyon
River	Snake River
Owner/Operator	Idaho Power Company
Authority	Federal License
Upstream From Other Impassable Dams	No
License period	1955-2005 - under review
Fish passage	None
Reference	NOAA 2008
Documents	http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/final-BOs.cfm

Opal Springs Dam

Category	Data
Barrier	Opal Springs Dam
State	OR
USGS HUC	17070305
Latitude	44.4861885030002
Longitude	-121.299073788671
Hydrologic Unit	Lower Crooked River
River	Crooked River
Owner/Operator	Deschutes Valley Water District
Authority	Federal License
Upstream From Other Impassable Dams	No
License period	1982-2032
Fish passage	stakeholders are working collaboratively with the dam operator to construct passage facilities at Opal Springs with an estimated completion date in 2012 (NMFS 2009)
Reference	NMFS 2009a
Documents	http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Interior-Columbia/Mid-Columbia/Mid-Col-Plan.cfm

Big Cliff Dam

Category	Data
Barrier	Big Cliff Dam
State	OR
USGS HUC	17090005
Latitude	44.7508115520359
Longitude	-122.28330406883
Hydrologic Unit	North Santiam
River	N. Santiam River
Owner/Operator	Army Corps of Engineers
Authority	Army Corps of Engineers
Upstream From Other Impassable Dams	No
License period	N/A
Fish passage	Willamette Biological Opinion (NMFS 2008b) proposes feasibility studies to examine fish passage strategies for Big Cliff Dam
Reference	NMFS 2008a, NMFS 2008b
Documents	http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/final-BOs.cfm https://pcts.nmfs.noaa.gov/pls/pcts-pub/pcts_upload.summary_list_biop?p_id=26588

Cougar Dam

Category	Data
Barrier	Cougar Dam
State	OR
USGS HUC	17090004
Latitude	44.127846501927
Longitude	-122.243588911336
Hydrologic Unit	McKenzie
River	McKenzie River
Owner/Operator	Army Corps of Engineers
Authority	Army Corps of Engineers
Upstream From Other Impassable Dams	No
License period	N/A
Fish passage	Construction of trap and haul facilities in 2009
Reference	NMFS 2008a, NMFS 2008b
Documents	http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/final-BOs.cfm https://pcts.nmfs.noaa.gov/pls/pcts-pub/pcts_upload.summary_list_biop?p_id=26588

Dexter Dam

Category	Data
Barrier	Dexter Dam
State	OR
USGS HUC	17090001
Latitude	43.9230683275151
Longitude	-122.805954576491
Hydrologic Unit	Middle Fork Willamette
River	Middle Fork Willamette River
Owner/Operator	Army Corps of Engineers
Authority	Army Corps of Engineers
Upstream From Other Impassable Dams	No
License period	N/A
Fish passage	None
Reference	NMFS 2008b
Documents	https://pcts.nmfs.noaa.gov/pls/pcts-pub/pcts_upload.summary_list_biop?p_id=26588

Dorena Dam

Category	Data
Barrier	Dorena Dam
State	OR
USGS HUC	17090002
Latitude	43.78672518036
Longitude	-122.954833347273
Hydrologic Unit	Coast Fork Willamette
River	Row River
Owner/Operator	Army Corps of Engineers
Authority	Army Corps of Engineers
Upstream From Other Impassable Dams	No
License period	N/A
Fish passage	None
Reference	NMFS 2008b
Documents	https://pcts.nmfs.noaa.gov/pls/pcts-pub/pcts_upload.summary_list_biop?p_id=26588

Soda Springs Dam

Category	Data
Barrier	Soda Springs Dam
State	OR
USGS HUC	17100301
Latitude	43.3025118547971
Longitude	-122.494953643575
Hydrologic Unit	North Umpqua
River	N. Umpqua River
Owner/Operator	PacifiCorp
Authority	Federal License
Upstream From Other Impassable Dams	No
License period	2003-2038
Fish passage	A FERC settlement agreement and U.S. Department of the Interior Section 18 fishway prescriptions require the licensee to construct the Soda Springs fish passage facilities by 2010 and ensure adequate performance by 2012.
Reference	FERC 2009
Documents	

Lost Creek Dam

Category	Data
Barrier	Lost Creek Dam
State	OR
USGS HUC	17100307
Latitude	42.6710371812358
Longitude	-122.675266159417
Hydrologic Unit	Upper Rogue
River	Rogue River
Owner/Operator	Army Corp of Engineers
Authority	Army Corp of Engineers
Upstream From Other Impassable Dams	No
License period	N/A
Fish passage	None
Reference	ODFW 2007
Documents	http://www.dfw.state.or.us/fish/nfcp/rogue_river/docs/Conservation_Plan_Rogue_Spring_Chinook_Salmon_Species_Managment_Unit_final_draft_08_2007.pdf

Applegate Dam

Category	Data
Barrier	Applegate Dam
State	OR
USGS HUC	17100309
Latitude	42.056394499561
Longitude	-123.115171852736
Hydrologic Unit	Applegate
River	Applegate River
Owner/Operator	Symbiotics LLC
Authority	Federal
Upstream From Other Impassable Dams	No
License period	In Review
Fish passage	None. Starting in 2010, ODFW will begin releases of juvenile coho above the dam, with the aim of reintroducing coho to their historical spawning and rearing habitat. Outmigrating juvenile coho would pass through project facilities (NMFS 2009b)
Reference	NMFS 2009b
Documents	

City of Portland #2 (Bull Run River)

Category	Data
Barrier	City of Portland #2 (Bull Run River)
State	OR
USGS HUC	17080001
Latitude	45.4481618443545
Longitude	-122.148376334657
Hydrologic Unit	Lower Columbia-Sandy
River	Bull Run River
Owner/Operator	Portland General Electric
Authority	Federal License
Upstream From Other Impassable Dams	No
License period	Expired in 2004
Fish passage	None
Reference	NMFS 2008
Documents	http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/final-BOs.cfm

Oak Grove Dam

Category	Data
Barrier	Oak Grove Dam
State	OR
USGS HUC	17090011
Latitude	45.1138888904422
Longitude	-121.806111099631
Hydrologic Unit	Clackamas
River	Clackamas River
Owner/Operator	Portland General Electric
Authority	Federal License
Upstream From Other Impassable Dams	Yes - above natural barrier
License period	1957-2006 - under review
Fish passage	None - above waterfalls that act as natural barrier
Reference	NMFS 2008b
Documents	https://pcts.nmfs.noaa.gov/pls/pcts-pub/pcts_upload.summary_list_biop?p_id=26588

Iron Gate Dam

Category	Data
Barrier	Iron Gate Dam
State	CA
USGS HUC	18010206
Latitude	36.9999492513576
Longitude	-119.703978263203
Hydrologic Unit	Upper Klamath
River	Klamath River
Owner/Operator	PacifiCorp
Authority	Federal License
Upstream From Other Impassable Dams	No
License period	1954-2006 - under review
Fish passage	None. A group representing federal, state, and local governments, as well as other non-governmental groups, is currently discussing passage and dam decommissioning options as part of FERC's proposed relicensing of Pacificorp's project (NMFS 2007b).
Reference	NMFS 2007b
Documents	http://swr.nmfs.noaa.gov/salmon/MSRA_RecoveryPlan_FINAL.pdf

Lewiston Dam

Category	Data
Barrier	Lewiston Dam
State	CA
USGS HUC	18010211
Latitude	40.7248683805021
Longitude	-122.796134109552
Hydrologic Unit	Trinity
River	Trinity River
Owner/Operator	U.S. Bureau of Reclamation
Authority	U.S. Bureau of Reclamation
Upstream From Other Impassable Dams	No
License period	N/A
Fish passage	None
Reference	USBR 2008
Documents	

Dwinnell Dam (Shasta River Dam)

Category	Data
Barrier	Dwinnell Dam (Shasta River Dam)
State	CA
USGS HUC	18010207
Latitude	41.5418707610035
Longitude	-122.37612779742
Hydrologic Unit	Shasta
River	Shasta River
Owner/Operator	PacifiCorp
Authority	Federal License
Upstream From Other Impassable Dams	No
License period	1954-2006 - under review
Fish passage	None
Reference	ESA 2009
Documents	http://www.dfg.ca.gov/regions/1/ShastaScott/ShastaRiverEIR/

Robert W. Mathews Dam

Category	Data
Barrier	Robert W. Matthews Dam
State	CA
USGS HUC	18010102
Latitude	40.3678668585629
Longitude	-123.433140370552
Hydrologic Unit	Mad - Redwood
River	Mad River
Owner/Operator	Humboldt Bay Municipal Water District
Authority	State Inspected
Upstream From Other Impassable Dams	No
License period	N/A
Fish passage	None
Reference	MBMWD 2004
Documents	http://www.hbmwd.com/site_documents/hcp.pdf

Coyote Valley Dam

Category	Data
Barrier	Coyote Valley Dam
State	CA
USGS HUC	18010110
Latitude	39.1998913000907
Longitude	-123.184448900252
Hydrologic Unit	Russian River
River	E. Fork Russian River
Owner/Operator	City of Ukiah, CA
Authority	Federal License
Upstream From Other Impassable Dams	No
License period	1982-2032
Fish passage	None
Reference	CDFG 2002
Documents	http://www.krisweb.com/krisrussian/krisdb/html/krisweb/biblio/russian_cdfg_coey_2002_draftrestplan.pdf

Warm Springs Dam

Category	Data
Barrier	Warm Springs Dam
State	CA
USGS HUC	18010110
Latitude	38.7169103378699
Longitude	-123.009111538084
Hydrologic Unit	Russian River
River	Dry Creek
Owner/Operator	Sonoma County Water Agency
Authority	Federal License
Upstream From Other Impassable Dams	No
License period	1984-2034
Fish passage	None
Reference	CDFG 2002
Documents	http://www.krisweb.com/krisrussian/krisdb/html/krisweb/biblio/russian_cdfg_coey_2002_draftrestplan.pdf

Scott Dam

Category	Data
Barrier	Scott Dam
State	CA
USGS HUC	18010103
Latitude	39.4068828587822
Longitude	-122.959111000396
Hydrologic Unit	Upper Eel River
River	Eel River
Owner/Operator	Pacific Gas and Electric Company
Authority	Federal License
Upstream From Other Impassable Dams	No
License period	1983-2033
Fish passage	None
Reference	NMFS 2002b
Documents	http://swr.nmfs.noaa.gov/psd/Final_Potter_Valley_Project_BO.pdf

Keswick Dam

Category	Data
Barrier	Keswick Dam
State	CA
USGS HUC	18020101
Latitude	40.6118723137668
Longitude	-122.444121844213
Hydrologic Unit	Sacramento - L. Cow - L. Clear
River	Sacramento River
Owner/Operator	U.S. Bureau of Reclamation
Authority	U.S. Bureau of Reclamation
Upstream From Other Impassable Dams	No
License period	N/A
Fish passage	None, NMFS outlines the development of a Fish Passage pilot plan for Keswick Dam in the 2009 Biological Opinion (NMFS 2009c).
Reference	USBR 2008, NMFS 2009c
Documents	

Oroville Dam

Category	Data
Barrier	Oroville Dam
State	CA
USGS HUC	18020106
Latitude	39.5448863638888
Longitude	-121.494079266173
Hydrologic Unit	Lower Feather River
River	Feather River
Owner/Operator	California Department of Water Resources
Authority	California Department of Water Resources
Upstream From Other Impassable Dams	No
License period	N/A
Fish passage	None currently, but the draft recovery plan for Central Valley winter-run and spring-run Chinook salmon (NMFS 2009d) states "passage feasibility studies, habitat suitability assessments and other related investigations are underway in separate processes (e.g. FERC relicensing)."
Reference Documents	USBR 2008, NMFS 2009d

Black Butte Dam

Category	Data
Barrier	Black Butte Dam
State	CA
USGS HUC	18020103
Latitude	39.8178789290414
Longitude	-122.338102140431
Hydrologic Unit	Sacramento - Lower Thomes
River	Stoney Creek
Owner/Operator	U.S. Bureau of Reclamation
Authority	U.S. Bureau of Reclamation
Upstream From Other Impassable Dams	No
License period	N/A
Fish passage	None
Reference Documents	NMFS 2002c

Whiskeytown Dam

Category	Data
Barrier	Whiskeytown Dam
State	CA
USGS HUC	18020112
Latitude	40.5978713925959
Longitude	-122.538124985038
Hydrologic Unit	Sacramento - Upper Clear
River	Clear Creek
Owner/Operator	U.S. Bureau of Reclamation
Authority	U.S. Bureau of Reclamation
Upstream From Other Impassable Dams	No
License period	N/A
Fish passage	None
Reference	USBR 2008
Documents	

Camp Far West Dam

Category	Data
Barrier	Camp Far West Dam
State	CA
USGS HUC	18020126
Latitude	39.0498949021269
Longitude	-121.316066728767
Hydrologic Unit	Upper Bear
River	Bear River
Owner/Operator	South Sutter Water District
Authority	Federal License
Upstream From Other Impassable Dams	No
License period	1981-2021
Fish passage	None
Reference	NMFS 1998
Documents	http://www.nwr.noaa.gov/ESA-Salmon-Listings/Salmon-Populations/Reports-and-Publications/upload/chnk-ffd.pdf

Nimbus Dam

Category	Data
Barrier	Nimbus Dam
State	CA
USGS HUC	18020111
Latitude	38.6369046539253
Longitude	-121.224059168077
Hydrologic Unit	Lower American River
River	American River
Owner/Operator	U.S. Bureau of Reclamation
Authority	U.S. Bureau of Reclamation
Upstream From Other Impassable Dams	No
License period	N/A
Fish passage	None, NMFS outlines the development of a Fish Passage pilot plan for Nimbus Dam in the 2009 Biological Opinion (NMFS 2009c).
Reference	USBR 2008, NMFS 2009c
Documents	

Friant Dam

Category	Data
Barrier	Friant Dam
State	CA
USGS HUC	18040006
Latitude	36.9999492513576
Longitude	-119.703978263203
Hydrologic Unit	Upper San Joaquin
River	San Joaquin River
Owner/Operator	U.S. Bureau of Reclamation
Authority	U.S. Bureau of Reclamation
Upstream From Other Impassable Dams	No
License period	N/A
Fish passage	None
Reference	USBR 2008
Documents	

Camanche Dam

Category	Data
Barrier	Camanche Dam
State	CA
USGS HUC	18040005
Latitude	38.2249175167704
Longitude	-121.021053322927
Hydrologic Unit	Lower Consumnes - Lower Mokelumne
River	Mokelumne River
Owner/Operator	East Bay Municipal Utility District
Authority	Federal License
Upstream From Other Impassable Dams	No
License period	1981-2031
Fish passage	None
Reference	Miyamoto and Hartwell 1998
Documents	

New Hogan Dam

Category	Data
Barrier	New Hogan Dam
State	CA
USGS HUC	18040011
Latitude	38.1519203151214
Longitude	-120.813047269629
Hydrologic Unit	Upper Calaveras
River	Calaveras River
Owner/Operator	Calaveras County Water District
Authority	Federal License
Upstream From Other Impassable Dams	No
License period	1982-1932
Fish passage	None
Reference	DWR 2007
Documents	http://www.water.ca.gov/fishpassage/docs/calaveras/calaveras_assess.pdf

Crocker-Huffman Dam

Category	Data
Barrier	Crocker-Huffman Dam
State	CA
USGS HUC	18040002
Latitude	37.5149363332006
Longitude	-120.371023529574
Hydrologic Unit	M. San Joaquin - L. Merced - L. Stanislaus
River	Merced River
Owner/Operator	Merced Irrigation District
Authority	Federal License
Upstream From Other Impassable Dams	No
License period	1964-2014
Fish passage	Passage options are currently being examined by the California Department of Fish and Game (CDGF 2009)
Reference	Vogel 2007, CDFG 2009
Documents	http://www.fws.gov/stockton/AFRP/documents/Final_Crocker_Huffman_Report.pdf

Goodwin Dam

Category	Data
Barrier	Goodwin Dam
State	CA
USGS HUC	18040010
Latitude	37.8629269761722
Longitude	-120.62903738698
Hydrologic Unit	Upper Stanislaus
River	Stanislaus River
Owner/Operator	Oakdale and South San Joaquin Irrigation Districts
Authority	Federal License
Upstream From Other Impassable Dams	No
License period	2006-2046
Fish passage	None
Reference	Yoshiyama et al. 1998
Documents	

La Grange Dam

Category	Data
Barrier	La Grange Dam
State	CA
USGS HUC	18040002
Latitude	37.6719319667837
Longitude	-120.444029047118
Hydrologic Unit	M. San Joaquin - L. Merced - L. Stanislaus
River	Tuolumne River
Owner/Operator	Turlock Irrigation District
Authority	Federal
Upstream From Other Impassable Dams	No
License period	1964-2016
Fish passage	None
Reference	Yoshiyama et al. 1998
Documents	

Nicasio Dam

Category	Data
Barrier	Nicasio Dam (Seeger Dam)
State	CA
USGS HUC	18050005
Latitude	38.0765883995552
Longitude	-122.754433600334
Hydrologic Unit	Tomales - Drakes Bay
River	Nicasio Creek
Owner/Operator	Marin Municipal Water District
Authority	State Inspected
Upstream From Other Impassable Dams	No
License period	N/A
Fish passage	The Central California Coast coho recovery plan (NMFS 2010) lists fish passage at Nicasio Dam as a recovery action for Lagunitas Creek
Reference	NMFS 1998, NMFS 2010
Documents	http://www.nwr.noaa.gov/ESA-Salmon-Listings/Salmon-Populations/Reports-and-Publications/upload/chnk-ffd.pdf

Peters Dam

Category	Data
Barrier	Peters Dam
State	CA
USGS HUC	18050005
Latitude	37.9969236538179
Longitude	-122.704097035198
Hydrologic Unit	Tomales - Drakes Bay
River	Lagunitas Creek
Owner/Operator	Marin Municipal Water District
Authority	State Inspected
Upstream From Other Impassable Dams	No
License period	N/A
Fish passage	None
Reference	NMFS 1998
Documents	http://www.nwr.noaa.gov/ESA-Salmon-Listings/Salmon-Populations/Reports-and-Publications/upload/chnk-ffd.pdf

San Pablo Dam

Category	Data
Barrier	San Pablo Dam
State	CA
USGS HUC	18050002
Latitude	37.9429241306783
Longitude	-122.261080599768
Hydrologic Unit	San Pablo Bay
River	San Pablo Cr.
Owner/Operator	East Bay Municipal Utility District
Authority	State Inspected
Upstream From Other Impassable Dams	No
License period	N/A
Fish passage	None
Reference	Leidy et al. 2005
Documents	

Anderson Dam

Category	Data
Barrier	Anderson Dam
State	CA
USGS HUC	18050003
Latitude	37.1669443542475
Longitude	-121.629056529562
Hydrologic Unit	Coyote Creek
River	Coyote Creek
Owner/Operator	Santa Clara Valley Water District
Authority	State Inspected
Upstream From Other Impassable Dams	No
License period	N/A
Fish passage	None
Reference	Leidy et al. 2005
Documents	

Newell Dam

Category	Data
Barrier	Newell Dam
State	CA
USGS HUC	18060001
Latitude	37.1029470267302
Longitude	-122.073073710986
Hydrologic Unit, River	San Lorenzo - Soquel
River	Newell Creek
Owner/Operator	City of Santa Cruz
Authority	State Inspected
Upstream From Other Impassable Dams	No
License period	N/A
Fish passage	None currently, but the Central California Coast coho recovery plan (NMFS 2010) lists the "removal of all existing summer dams that create a passage impediment to migrating adults or juveniles" as a recovery action for San Lorenzo River
Reference	Alley et al. 2004, NMFS 2010
Documents	http://sccounty01.co.santa-cruz.ca.us/eh/environmental_water_quality/SLR_Salmonid_Enhancement_Final.pdf

Task 3. Threats to Salmon EFH

Agriculture

NMFS. 2007a. Puget Sound Salmon Recovery Plan. NMFS. Available: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/PS-Chinook-Plan.cfm. (October 2009).

- Recent studies of the Skagit River delta have estimated that 72% of intertidal and estuarine marsh habitat has been lost, coinciding with the modification of the basin for agriculture and other land uses.

SRSRB. 2006. Snake River salmon recovery plan for Southeast Washington. Snake River Salmon Recovery Board. Available: http://www.snakeriverboard.org/resources/library.htm. (October 2009)

- Cropping practices in upland areas of the Snake River Basin, the roads, stream crossings, and drainage systems that serve these areas have increased erosion rates and contributed large quantities of fine sediment to spawning riffles. Chemicals and pesticides used to increase crop production can enter the stream as pollutants harmful to fish.
- Conversion of bunch grass prairie to production of annual crops has led to erosion of fine sediments into streams. The sediment is deposited primarily in the lower reaches of streams. Recent changes in agricultural practices, such as no till/direct seed farming,

are aimed at reducing soil erosion and improvement of precipitation filtration into the soil.

WSCC. 2002. Salmonid habitat limiting factors water resource inventory areas 33 (lower) and 35 (middle) Snake watersheds, and lower six miles of the Palouse River. Washington State Conservation Commission. Available: http://www.scc.wa.gov/index.php/288-WRIA-33-34-35-Snake-River-Watershed/View-category.html. (January 2010).

- Best management practices that reduce soil erosion include: no-till/direct seed farming methods (direct seeding into standing wheat stubble for example), installation of terraces, sediment basins, and vegetated filter strips, and enrollment of acreage in the Conservation Reserve Program (CRP, conversion of annual cropland to perennial grass stands for wildlife habitat benefits).
- The Conservation Districts (CDs) and Natural Resources Conservation Service (NRCS) are addressing riparian zone problems with the Conservation Reserve Enhancement Program (CREP). The program is intended to restore riparian forest buffers on agricultural lands adjacent to salmonid bearing streams. The Conservation Reserve Program (CRP) is available through the NRCS to landowners wishing to restore riparian buffers along non-salmonid producing streams. Livestock is fenced out of the buffer and native vegetation is planted. Landowners are compensated at 200% of the agricultural value of the land placed in the buffer over a 10 to 15-year rental agreement. The program pays for all plant materials, fencing, and alternate livestock watering facilities.

Moore, A., C.P. Waring. 2001. The effects of a synthetic pyrethroid pesticide on some aspects of reproduction in Atlantic salmon (Salmo salar L). Aquatic Toxicology 52:1-12.

- The synthetic pesticide cypermethrin, a known contaminant of tributaries supporting spawning salmonid fish, had a significant sublethal impact upon the endocrine system in mature male Atlantic salmon parr, disrupting the reproductive fitness of the population.

Scholz, N.L., N.K. Truelove, B.L. French, B.A. Berejikian, T.P. Quinn, E. Casillas, T.K. Collier. 2000. Diazinon disrupts antipredator and homing behaviors in chinook salmon (Oncorhynchus tshawytscha). Canadian Journal of Fisheries and Aquatic Sciences 57:1911-1918.

- Neurotoxic pesticides are known to contaminate surface waters that provide habitat for salmonids, including some listed for protection under the U.S. Endangered Species Act. Despite their widespread use, the impacts of these pesticides on the neurological health of wild salmon are not well understood.
- Results suggest that olfactory-mediated behaviors are sensitive to neurotoxicity in salmonids and that short-term, sublethal exposures to these insecticides may cause significant behavioral deficits. Such deficits may have negative consequences for survival and reproductive success in these fish.

DeLorenzo, M.E., G.I. Scott, P.E. Ross. 2001. Toxicity of pesticides to aquatic microorganisms: A review. Environmental Toxicology and Chemistry 20(1):84-98.

- "Microorganisms contribute significantly to primary production, nutrient cycling, and decomposition in estuarine ecosystems; therefore, detrimental effects of pesticides on microbial species may have subsequent impacts on higher trophic levels."
- "There is a great deal of variability in the toxicity of even a single pesticide among microbial species. When attempting to predict the toxicity of pesticides in estuarine ecosystems, effects of pesticide mixtures and interactions with nutrients should be considered. The toxicity of pesticides to aquatic microorganisms, especially bacteria and protozoa, is an area of research requiring further study."

Fulton, M. H., D.W. Moore, E.F. Wirth, G.T. Chandler, P.B. Key, J.W. Daugomah, E.D. Strozier, J. Devane, J.R. Clark and others. 1999. Assessment of risk reduction strategies for the management of agricultural nonpoint source pesticide runoff in estuarine ecosystems. Toxicology and Industrial Health 15:200-213.

- Incorporating integrated pest management (IPM) and best management practices as part of the authorization or permitting can help ensure the reduction of pesticide contamination in estuarine ecosystems.

WSCC. 2001b. Habitat limiting factors: Yakima River Watershed. Washington State Conservation Commision. Available: http://www.scc.wa.gov/index.php/287-WRIA-37-38-39-Yakima-River-Watershed/View-category.html. (October 2009).

- "Overall, streams in the Yakima River basin have been profoundly altered to support the development of irrigated agriculture."
- Water quality in the Yakima River watershed becomes progressively impaired as it moves from the headwaters to the mouth, deteriorating as it proceeds through the agricultural area in the lower watershed prior to entry into the Yakima River.
- Use of multimetric community condition indices (such as percent tolerant species for fish or EPT richness and abundance for invertebrates) indicates that the upper Yakima (Cascades and Eastern Cascades ecoregions) is largely unimpaired.
- "In the Columbia Basin, sites were generally impaired or severely impaired as measured by multiple indicators of conditions that were linked to nutrients and pesticides (e.g., agriculture). All lower Yakima mainstem sites were moderately to severely impaired, corresponding with high levels of pesticides in fish tissues and presence of external abnormalities."
- "Recent studies have identified a strong relationship between concentrations of DDT and suspended sediment in the Yakima River and tributaries draining agricultural lands. This finding suggests that DDT transport to the Yakima River can be effectively controlled by measures that reduce erosion of agricultural soils and limit sediment transport."

NMFS. 2008a. Federal Columbia River power system biological opinion. National Marine Fisheries Service. Available: http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/final-BOs.cfm. (October 2009).

- Current environmental conditions in the Columbia River estuary indicate the presence of contaminants in the food chain of juvenile salmonids including DDT, PCBs, and polyaromatic hydrocarbons. This data also indicates that juvenile salmonids in the Columbia River estuary have contaminant body burdens in the range where sublethal effects may occur.
- The sources of exposure are not clear but may be widespread. Several pesticides and heavy metal contaminants have been sampled in Columbia River sediments (ODEQ 2007). In field studies, juvenile salmon from sites in the Pacific Northwest have demonstrated immunosuppression, reduced disease resistance, and reduced growth rates due to contaminant exposure during their period of estuarine residence.

NMFS. 2002. Biological Opinion: Klamath Project Operations. National Marine Fisheries Service.

- "Agricultural practices may adversely impact the aquatic environment. Stream pollution from agriculture runoff is a persistent cause of damage. Animal wastes, fertilizers, pesticides, and herbicides enter the stream as a result of storm runoff and return flows from irrigation. This has resulted in elevated nutrient levels in the Klamath River and some tributaries. "
- "Agricultural practices that reduce riparian vegetation in turn reduce large woody debris recruitment and simplify the stream channel. Removal of riparian vegetation has also resulted in elevated water temperatures in the Klamath Basin. Temperatures periodically reach levels that are lethal to some fish species. This, combined with elevated nutrient levels, results in stimulation of aquatic plant and algae growth."
- "As water temperatures rise and plants and algae decompose, the level of dissolved oxygen decreases. Dissolved oxygen levels in the Klamath River often fall below the state's water quality objective of 7.0 mg/l."

NMFS. 2003. Non-fishing impacts to essential fish habitat and recommended conservation measures. National Marine Fisheries Service.

- "Nutrients are applied to agricultural land in several different forms and come from various sources, including commercial fertilizers, manure from animal production facilities (with bedding and other wastes added to the manure), municipal and industrial treatment plant effluent and sludge, legume and crop residues, irrigation water, and atmospheric deposition of nutrients such as nitrogen and sulfur."
- Animal waste (manure) includes fecal and urinary wastes of livestock and poultry; process water (such as from a milking parlor); and the feed, bedding, litter, and soil with which they become intermixed.
- Pollutants contained in manure and associated bedding materials can be transported into marine environments by runoff and process wastewater from rangelands, pastures,

or confined animal facilities. Theses pollutants may include oxygen-demanding substances such as nitrogen, phosphorus, and organic solids; salts; bacteria, viruses, and other microorganisms, as well as sediments that increase organic decomposition. Runoff of animal wastes can cause fish kills due to ammonia, and solids deposited into the marine environment can reduce productivity over extended periods of time due to the accelerated effects of cultural eutrophication.

NMFS. 2010b. Biological Opinion: Klamath Project Operations. National Marine Fisheries Service, Southwest Region.

- "Agricultural operations have degraded habitat and limited both water quality and quantity, especially for interior population units in the Rogue and Klamath rivers. Channelization and stream straightening associated with flood control or agricultural operations reduces habitat by limiting stream complexity and increases stream velocities, which can be detrimental to both adult and juvenile coho salmon life stages."
- "Summer "pushup" dams are still utilized in agricultural and rural communities in the SONCC coho salmon ESU. These temporary dams can alter the streambed, create migration barriers, change stream temperature profiles, and temporarily increase sedimentation."

Artificial Propogation

NMFS. 2007a. Puget Sound Salmon Recovery Plan. NMFS. Available: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/PS-Chinook-Plan.cfm. (October 2009).

- Natural populations of salmon are negatively affected by "gene flow," the transfer of genes from hatchery populations to natural ones. Recent studies have indicated that the greater the amount of gene flow and the dissimilarity between the hatchery and wild fish populations in a given watershed, the greater the negative genetic effects. Gene flow can cause a loss in unique identity and traits among natural populations of salmon, and within individual populations that receive hatchery fish.
- The loss of genetic diversity may result in a decrease of the viability of a local salmon population in two ways: 1) Loss of adaptation may occur when genes that evolved in a non-local environment replace those that were locally adapted; and 2) hybridization results in recombinations of sets of genes that were favorable to a local population, leading to loss of individual performance and population productivity that may not show up for a generation or more.
- Loss of fitness can occur because of domesticaion, which is the change in the genetic composition of a population as a result of selection for an arti ficial, captive environment

National Marine Fisheries Service Chum Biological Review Team. 2003. Preliminary Conclusions Regarding the Updated Status of Listed ESUs of West Coast Salmon and Steelhead. NMFS Northwest Fisheries Science Center; Seattle, WA.

- Potential threats to Hood Canal summer chum salmon from negative interactions with hatchery fish (late-timed Chinook, coho, pink, and fall chum salmon) through predation, competition, behavior modification or disease transfer were identified by the NMFS Chum Biological Review Team.

Bilby, R. E., B. R. Fransen, P. A. Bisson, and J. K. Walter. 1998. Response of juvenile coho salmon (Oncorhynchus kisutch) and steelhead (Oncorhynchus mykiss) to the addition of salmon carcasses to two streams in southwestern Washington, U.S.A. Canadian Journal of Fisheries and Aquatic Sciences 55:1909-1918.

- Use of hatchery salmon carcasses as a source of marine derived nutrients was found to increase the density of age 0+ coho salmon and age 0+ and l+ steelhead in small southwestern Washington streams.
- In the Northwest, river systems in which salmon spawn and rear are often nutrient poor and the delivery of marine-derived nutrients by returning salmon carcasses is a key component to potential growth and survival of juvenile fish in the system.

McCubbing, D. J. F. and B. R. Ward. 2000. Stream rehabilitation in British Columbia's Watershed Restoration Program: juvenile salmonid response in the Keogh and Waukwaas rivers, 1998.

- Stream fertilization using hatchery carcasses is being tested with promising results, as an interim measure for recovering certain natural salmonid stocks that have been in decline for reasons not related to hatchery practices

Heath, D.H., J. W. Heath, C.A. Bryden, R. A. Johnson, and C.W. Fox. 2003. Rapid evolution of egg size in captive salmon. Science 299:1738-1740.

- Recent studies have confirmed earlier hypotheses that the benign conditions of a hatchery environment may directly select for increased fecundity of females with a correlated reduction in mean egg size
- Two river populations of Chinook salmon subjected to high levels of hatchery supplemented salmon with decreased egg size over a 20 year period resulted in significant declines in egg size of the wild salmon population
- The effect of selection resulting in decreased egg size could be minimized through modified breeding practices

Campton, D.E. 2004. Sperm competition in salmon hatcheries: the need to institutionalize genetically-benign spawning protocols. Transactions of the American Fisheries Society 133: 1277-1289.

- Sperm competition resulting from mixed-milt fertilizations in single containers can result in domestic changes in life history traits if those traits are correlated phenotypically with sperm potency and fertilization success in vitro.
- Salmon hatcheries should discontinue mixed-milt fertilization and institutionalize alternative spawning protocols that preclude or minimize sperm competition in vitro. Three alternative protocols are recommended: pairwise spawning, nested spawning, and factorial or matrix spawning. The underlying premise of these latter protocols is that every adult selected for broodstock should have an equal opportunity, and probability, of producing an equal number of progeny.

Beckman, B.R., W.W. Dickhoff, W.S. Zaugg, C. Sharpe, S. Hirtzel. 1999. Growth, smoltification, and smolt-to-adult return of spring chinook salmon from hatcheries on the Deschutes River, OR. Transactions of the American Fisheries Society 128:1125-1150.

- The lack of seasonal patterns of growth and development in hatchery fish contrast substantially to that seen in wild fish. A more natural seasonal cycle of physiological development and high spring growth may enhance smoltification and survival to the adult stage.

Bugert, R. M. 1998. Mechanics of supplementation in the Columbia River. Fisheries 23: 11-20.

- Limits on the duration of supplementation programs where the goal is to rebuild natural populations may limit the negative effects of hatchery domestication.

Gharrett, A. J., W. W. Smoker, R. R. Reisenbichler, and S. G. Taylor. 1999. Outbreeding depression in hybrids between odd- and even-brood year pink salmon. Aquaculture 73: 117-130.

- Hatchery fish and gamete transfers that have taken place over hundreds of miles and between ecological provinces or regions is expected to have resulted in reductions in fitness of the receiving hatchery stock.

Larsen, D., B. Beckman, K. Cooper, D. Barrett, M. Johnston, P. Swanson and W. Dickhoff. 2004. Assessment of high rates of precocious male maturation in a spring Chinoook salmon supplementation hatchery program.

- High growth rates of fish in the hatchery may alter the age of maturation, producing exceptionally high numbers of precocious males.
- hatchery water supplies or temperature profiles that do not follow natural patterns may result in incomplete or inappropriately timed growth profiles, smoltification, outmigration, and homing.

Hatchery Scientific Review Group (HSRG). 2004. Hatchery Reform: principles and recommendations of the HSRG. HSRG. Available: http://www.lltk.org/pdf/hsrg/HSRG_Princ_Recs_Report_Full_Apr04.pdf. (October 2009).

- Pages 31-45 describe in detail the HSRG system wide recommendations for hatchery reform for the Puget Sound and coastal Washington hatchery system, including the following recommendations:
    - set goals for all stocks and manage hatchery programs on a regional scale
    - manage success in terms of contribution to harvest, conservation and other goals
    - have clear goals for educational programs
    - operate hatchery programs within the context of their ecosystems
    - operate hatchery programs as either genetically integrated or segregated relative to naturally-spawning populations
    - size hatchery programs consistent with stock goals
    - consider both freshwater and marine carrying capacity in sizing hatchery programs
    - ensure productive habitat for hatchery programs
    - emphasize quality, not quantity, in fish releases
    - use in-basin rearing and locally-adapted broodstocks
    - spawn adults randomly throughout the natural period of adult return
    - use genetically benign spawning protocols that maximize effective population size
    - reduce risks associated with outplanting and net pen releases
    - use hatchery salmon carcasses for nitrification of freshwater ecosystems, while reducing associated fish health risks
    - adaptively manage hatchery programs
    - incorporate flexibility into hatchery design and operation
    - evaluate hatchery programs regularly to ensure accountability for success

Flagg, T., B. Berejikian, J. Colt, W. Dickhoff, L. Harrell, D. Maynard, C. Nash, M. 1 Strom, R. Iwamoto, and C. Mahnken. 2001. Ecological and behavioral impacts of artificial production strategies on the abundance of wild salmon populations - a review of practices in the Pacific Northwest. National Marine Fisheries Service, NOAA Tech. Memo. NMFS-NWFSC-XX, Seattle, WA.

- Foraging, social behavior, time of spawning, and predator avoidance can differ for fish reared in the hatchery and in the wild. While resulting differences may primarily reduce survival of hatchery-produced salmon and steelhead, negative effects may carry into a naturally produced population where adults of hatchery origin spawn with naturally produced fish.

Ford, M. J., T. A. Lundrigan, and P. C. Moran. 2004. Population genetics of Entiat River spring Chinook salmon. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-60, Seattle, WA.

- The similarity of DNA (deoxyribonucleic acid) collected from natural Entiat River spring Chinook and Entiat NFH samples indicates that Entiat NFH spring Chinook spawn

- successfully and have introgressed into or may have replaced the natural Entiat River population (Ford et al. 2004).

Upper Columbia Salmon Recovery Board (UCSRB). 2007. Upper Columbia spring Chinook salmon and steelhead recovery plan. Upper Columbia Salmon Recovery Board. Available: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Interior-Columbia/Upper-Columbia/upload/UC_Plan.pdf. (October 2009).

- The primary threat associated with some past and present hatchery programs within the Upper Columbia Basin may be the introgression of out-of-basin stock into local populations, especially within the Entiat and Winthrop subbasins. This threat may have reduced the diversity of spring Chinook and steelhead in the Upper Columbia Basin.

NMFS. 2004a. Interim endangered and threatened species recovery planning guidance. National Marine Fisheries Service, Silver Spring, MD.

- Hatchery supplementation programs may affect the age-at-return of spring Chinook, resulting in more younger-aged hatchery fish spawning in the wild. This could affect reproductive potential and ultimately productivity of naturally produced fish.

NMFS. 2002. Biological Opinion: Klamath Project Operations. National Marine Fisheries Service.

- “Release of large numbers of hatchery chinook into the Klamath Basin has the potential to increase inter-specific competition for resources which could affect survival of young-of-year coho.”
- “CDFG and NMFS have evaluated Iron Gate Hatchery practices and implemented changes to help minimize adverse effects to naturally produced salmon and steelhead.”
- “For example, release of the 4.9 million chinook salmon smolts produced in 2002 was modified from a three-day forced release in early June to a phased approach beginning in mid-May. These fish will be volitionally released in four or five separate lots over a month long period. CDFG and NMFS expects this release schedule to minimize competition between hatchery and naturally produced fish, as well as competition between hatchery fish.”

NMFS. 2008a. Federal Columbia River power system biological opinion. National Marine Fisheries Service. Available: http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/final-BOs.cfm. (October 2009).

- Hatchery actions designed to benefit salmon and steelhead viability sometimes produce only limited positive results. One potential reason for this is that other factors (i.e., limiting factors and threats) can offset or out-weigh the benefits from hatchery actions.
- Hatchery programs can serve an important conservation role when habitat conditions in freshwater depress juvenile survival or when access to spawning and rearing habitat is blocked. Under circumstances like these and in the short-term, the demographic risks

of extinction of such populations likely exceed genetic and ecological risks to natural-origin fish that would result from hatchery supplementation.

- Benefits like this should be considered transitory or short-term and do not contribute to survival rate changes necessary to meet ICTRT abundance and productivity viability criteria. For example, in Puget Sound, eight Chinook
- For example, in Puget Sound, eight Chinook salmon hatchery programs have been specifically implemented to preserve native populations in their natal watersheds. Until, however, the factors limiting Chinook salmon productivity are addressed, the full benefit (i.e., potential contributions to increased viability) of hatchery actions designed to benefit salmon viability may not be realized.

NMFS. 2009. Biological opinion and conference opinion on the long-term operations of the Central Valley Project and State Water Project. National Marine Fisheries Service, Southwest Region.

- "The management of hatcheries, such as Nimbus Fish Hatchery and Feather River Fish Hatchery (FRFH), can directly impact spring-run and steelhead populations by oversaturating the natural carrying capacity of the limited habitat available below dams. In the case of the Feather River, significant redd superimposition occurs in-river due to hatchery overproduction and the inability to physically separate spring-run and fall-run adults. This concurrent spawning has led to hybridization between the spring-run and fall-run in the Feather River. At Nimbus Hatchery, operating Folsom Dam to meet temperature requirements for returning hatchery fall-run often limits the amount if water available for steelhead spawning and rearing the rest of the year."

NMFS. 2009d. Public draft recovery plan for the Evolutionary Significant Units of Sacramento winter-run Chinook salmon and Central Valley spring-run Chinook salmon and the Distinct Population Segment of Central Valley Steelhead. National Marine Fisheries Service, Southwest Regional Office, Sacramento, California. Available: http://swr.nmfs.noaa.gov/recovery/cent_val/Public_Draft_Recovery_Plan.pdf. (December 2009).

- "Hatchery production of spring-run Chinook salmon may threaten the genetic integrity of naturally-spawning populations… Hatchery straying is considered to be an increasing problem due to current practices of offsite releases. Given the large numbers of juveniles released offsite (1,000,000 spring-run), the potential for straying to rivers throughout the Central Valley is high."

SRSRB. 2006. Snake River salmon recovery plan for Southeast Washington. Snake River Salmon Recovery Board. Available: http://www.snakeriverboard.org/resources/library.htm. (October 2009)

- "Release of large numbers of hatchery fish into streams has been shown to have a negative impact on survival of wild fish due to competition for limited resources. Hatchery fish are often larger relative to their wild counterparts at the same age. When

released into a stream with naturally produced fish, the larger hatchery fish can displace wild fish from their territories and decrease survival of the natural component. Hatchery fish can also be more aggressive than wild fish and disrupt normal foraging behavior."

- "From the genetic standpoint, artificial production involves the controlled mating of fish and subsequent rearing of young in a regulated environment and can have significant impacts on the genetic makeup of hatchery-bred fish. These genetic changes can negatively affect the fitness or biological performance of hatchery fish in the natural environment. In addition, because hatchery fish frequently interbreed with naturally produced fish, the fitness of wild populations can be negatively affected, a particular concern for populations listed under the Endangered Species Act. It should be recognized, however, that hatchery managers increasingly recognize the potential negative effects of husbandry practices and are developing techniques to minimize genetic impacts of hatchery production."

NMFS. 2008b. Willamette Project Biological Opinion. National Marine Fisheries Service. Available: https://pcts.nmfs.noaa.gov/pls/pcts pub/pcts_upload.summary_list_biop?p_id=26588. (October 2009).

- "The Willamette Hatchery was built to mitigate lost natural production of spring Chinook in the Middle Fork Willamette due to the construction and operation of Fall Creek, Dexter, Lookout Point, and Hills Creek dams and reservoirs.
- "The current hatchery program is being used to evaluate the potential for the reintroduction of Chinook to their historic habitat above the dams. Due to extremely poor natural reproduction and the dominance of hatchery-produced fish in the run, hatchery fish likely contain the only genetic remnants of the historic run available. These fish are the only remaining source of fish for outplanting efforts."
- "The hatchery program is also being reformed into an integrated broodstock, where the broodstock incorporates natural-origin fish on a regular basis so that the hatchery broodstock is as similar as possible to the natural-origin population. However, due to the extremely low numbers of natural-origin fish observed recently in this population, significant improvements are needed in the key and secondary limiting factors before this broodstock can be fully integrated."
- "Hatchery programs in the Middle Fork Willamette continue to pose risks and some potential benefits to natural-origin Chinook salmon. Having all hatchery fish marked since 2001 has facilitated determining the status of natural-origin fish in this population. Hatchery fish will continue to represent the majority of natural spawners in this population until other limiting factors are addressed that allow natural production to increase."

NMFS. 2005b. Endangered and threatened species; designation of critical habitat for 12 evolutionarily significant units of West Coast salmon and steelhead in Washington, Oregon, and California. Federal Register 70:170(2 September 2005):52630-52858.

- "The majority of studies evaluating the relative fitness of hatchery and natural salmon have been conducted under conditions of mutual competition. Levels of competition in natural streams may vary depending on the number of released fish and status of the natural population, so understanding the role that competition between hatchery and natural fish plays in determining relative fitness is important. Competitive inferiority of hatchery relative to natural spawners has been clearly documented in breeding behavior studies, and the effects of hatchery rearing on competition are generally more pronounced for males than for females."

NMFS. 2004b. Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act consultation interim protection plan for operation of the Priest Rapids Hydroelectric Project FERC Project No. 2114. NOAA Fisheries Northwest Region Hydropower Division NOAA Fisheries Log Number: 1999/01878.

- Risks associated with artificial production programs within the Upper Columbia River Spring-run Chinook ESU are a concern because of the use of non-native Carson stock for fishery enhancement and hydropower mitigation. However, programs have been initiated to develop locally adapted broodstocks to supplement the natural populations in the ESU. The Carson stock is being phased out at those facilities where straying and natural stock interactions are problematic.

National Marine Fisheries Service. 1998b. Factors Contributing to the Decline of Chinook Salmon: An Addendum to the 1996 West Coast Steelhead Factors For Decline Report. Protected Resources Division, National Marine Fisheries Service. Portland, Oregon.

- "Fall-run chinook salmon have been reared at a number of hatcheries in the Central Valley. The state-run Feather River, Nimbus, and Merced Hatcheries, and the Coleman NFH account for the majority of releases into the Central Valley. Exchanges between hatcheries have been commonplace and probably reduced much of the regional variation among stocks. Furthermore, the practice of releasing fish off-station has resulted in a high proportion of returning adults straying into other basins within the Central Valley. The loss of homing fidelity has probably further eroded the distinctiveness of many stocks and inflated the numbers of naturally spawning adults observed. Based on CWT recoveries, the contribution of hatchery strays to naturally spawning populations may exceed 50% in many basins. There are no accurate estimates for the contribution of hatchery strays to natural spawning populations in most Central Valley basins, and, in the absence of such data, the relative health of these stocks may be overestimated."

Bank Stabilization

Schmetterling, D. A., C. G. Clancy, and T. M. Brandt. 2001. Effects of riprap bank reinforcement on stream salmonids in the western United States. Fisheries 26(7): 6-23.

- "Riprap may provide habitat for juvenile salmonids and bolster densities on reaches of streams that have been severely degraded. However, riprap does not provide the intricate habitat requirements for multiple age classes or species provided by natural vegetated banks. Streambanks with riprap have fewer undercut banks, less low-overhead cover and are less likely than natural stream banks to contribute large woody debris to the stream. Lateral streambank erosion."
- "The use of natural materials (i.e., LWD, trees, rootwads, etc.) in bank reinforcement and restoration is a growing practice. These "soft" techniques aim to slow the rate of erosion rather than completely stop lateral erosion."

Garland, R. D., K. F. Tiffan, D. W. Rondorf, and L. O. Clark. 2002. Comparison of subyearling fall Chinook salmon's use of riprap revetments and unaltered habitats in Lake Wallula of the Columbia River. North American Journal of Fisheries Management 22:1283-1289.

- Garland et al. (2002) examined subyearling fall chinook salmon's use of unaltered and riprap habitats in Lake Wallula of the Columbia River using data collected by electrofishing in May 1994 and 1995.
- Based on logistic regression, they found that the probability of fish presence was greater in unaltered shoreline habitats than in riprap habitats. Their model showed that substrate was the most important factor determining subyearling habitat use, but the model did not include other habitat variables known to be important to subyearlings in more diverse systems.
- They suggest that resource managers consider alternative methods of bank stabilization that are compatible with the habitat requirements of the fish that use them.

Williams, G.D., R.M. Thom. 2001. Marine and estuarine shoreline modification issues. White paper submitted to Washington Department of Fish and Wildlife, Washington Department of Ecology, and Washington Department of Transportation. Available: wdfw.wa.gov/hab/ahg/finalsl.pdf. (January 2010).

- Armoring of shorelines to prevent erosion and maintain or create shoreline real estate simplifies habitats, reduces the amount of intertidal habitat, and affects nearshore processes and the ecology of a myriad of species.
- Hydraulic effects to the shoreline include increased energy seaward of the armoring, reflected wave energy, dry beach narrowing, substrate coarsening, beach steepening, changes in sediment storage capacity, loss of organic debris, and downdrift sediment starvation.
- Installation of breakwaters and jetties can result in community changes from burial or removal of resident biota; changes in cover and preferred prey species; and predator attraction. As with armoring, breakwaters and jetties modify hydrology and nearshore sediment transport as well as movement of larval forms of many species.

Toft J.D., J.R. Cordell, C.A. Simenstad, and L.A. Stamatiou. 2007. Fish distribution, abundance, and behavior along city shoreline types in Puget Sound. North American Journal of Fisheries Management 27(2):465-480.

- Goal of study was to compare relative abundance and behavior of juvenile salmonids and other fishes along modified and undeveloped shorelines in Puget Sound
- Five main habitat types:
    - Cobble beach
    - Sand beach
    - Riprap extending into the upper intertidal zone
    - Deep riprap extending into the subtidal zone
    - Edge of overwater structures
- "…substrate type and slope were an important influence on bottom-dwelling fish densities when shoreline modifications only extended into the upper intertidal zone, whereas effects on pelagic fish densities and behavior were more evident when shoreline modifications extended into shallow subtidal waters (i.e., created deep water at the shoreline…found greater fish densities, larger schools of salmon, and fewer terrestrial riparian insects in salmon diets at these sites)."
- "Juvenile salmonids avoided swimming under overwater structures, whereas surfperch, crabs, and sculpins were observed beneath or adjacent to pilings."
- "Overall, our results indicate that shoreline modifications have the greatest effect on nearshore fish assemblages when the alterations extend from the supratidal zone into the subtidal zone. Our data suggest that the differences in fish behavior and usage between modified and unmodified shorelines were caused by physical and biological effects of the modifications, such as changes in water depth, slope, substrate, and shoreline vegetation."

Rice, C.A. 2006. Effects of shoreline modification on a northern Puget Sound beach: microclimate and embryo mortality in surf smelt (*Hypomesus Pretiosus*). Estuaries and Coasts 29(1):63-71.

- Study evaluated differences in microclimate and biological condition between natural and modified beaches in Puget Sound
- "The modified beach had significantly higher daily mean light intensity, air temperature, and substrate temperature, and significantly lower daily mean relative humidity." – substrate temperatures on the modified beach ranged from 14.4-29.4°C, whereas substrate temperatures on the natural beach only ranged from 12.1-18.2°C
- In general, microclimate conditions on the modified beach were more variable – indicating less buffered environment
- When looking at surf smelt egg survival, proportion of eggs containing live embryos at the modified beach was about ½ of the proportion of eggs containing live embryos at the natural beach

Beaver Removal

Pollock, M. M., G. R. Pess and T. J. Beechie. 2004. The importance of beaver ponds to coho salmon production in the Stillaguamish River Basin, Washington, USA. North American Journal of Fisheries Management 24:749-760.

- Pollock et al. (2004) assessed the current and historic distributions of beaver ponds and other coho salmon rearing habitat in the Stillaguamish River, a 1,771-km2 drainage basin in Washington and found that the greatest reduction in coho salmon smolt production capacity originated from the extensive loss of beaver ponds.
- Watershed-scale restoration activities designed to increase coho salmon production should emphasize the creation of ponds and other slow-water environments; increasing beaver populations may be a simple and effective means of creating slow-water habitat.

WSCC. 2002. Salmonid habitat limiting factors water resource inventory areas 33 (lower) and 35 (middle) Snake watersheds, and lower six miles of the Palouse River. Washington State Conservation Commission. Available: http://www.scc.wa.gov/index.php/288-WRIA-33-34-35-Snake-River-Watershed/View-category.html. (October 2009).

- "Beaver ponds, wetlands, oxbow ponds, and side channels connected to the main river channel are all forms of off-channel habitat. Juvenile salmonids (especially coho salmon, rainbow/steelhead trout, and cutthroat trout) seek out this type of habitat for rearing. Off-channel areas provide an abundance of food with fewer predators than would typically be found in the river. These areas also generally have reduced current and large amounts of vegetative and/or woody cover, allowing juvenile salmonids to hide from predators and conserve energy (See Figure 12). Diking, and channelization of rivers, conversion of riparian zones to pasture and cropland, floodplain development, and extermination of beaver all play a roll in destruction of off-channel habitat."

Collen, P., and R.J. Gibson. 2001. The general ecology of beavers (*Castor* spp.), as related to their influence on stream ecosystems and riparian habitats, and the subsequent effects on fish – a review. Reviews in Fish Biology and Fisheries 10(4):439-461.

- "The beaver is a keystone riparian species in that the landscape can be considerably altered by its activities and a new ecosystem created…Although the invertebrates may be fewer per unit area, total number of organisms increases, and diversity increases as the pond ages. In cool, small order streams, the impoundments provide better habitat for large trout, possibly creating angling opportunities. However, at sites where water temperatures rise above their optimum preferenda, salmonids may be replaced by other species, such as cyprinids, catostomids, percids, or centrachids. As the habitat is altered, interactions among co-habiting species may change."
- "Refugia from high or low water flows, low oxygen or high temperatures, may be provided in adverse conditions in winter or summer. However, in some cases dams are

obstructions to upstream migration, and sediment may be deposited in former spawning areas. The practicality and benefits of introducing or restoring beaver populations will vary according to location, and should be considered in conjunction with a management plan to control their densities."

- Beaver dam removal should be done at low flows and after the emergence of salmonid fry to minimize downstream effects
- Article provides a bulleted summary of multiple positive and negative effects of beaver dams and methods for mitigation and removal

Mitchell, S.C., and R.A. Cunjak. 2007. Stream flow, salmon and beaver dams: roles in the structuring of stream fish communities within an anadromous salmon dominated stream. Journal of Animal Ecology 76:1062-1074.

- Calculated Shannon Weiner diversity index and community evenness for sample sites distributed above and below beaver dams preventing upstream migration of Atlantic salmon in Catamaran Brook, New Brunswick, CA over a 15 year period
- Fish community diversity was greatest upstream of beaver dams in reaches that were inaccessible to Atlantic salmon – Atlantic salmon appeared to depress evenness of the fish community, but did not change species richness – the fish community upstream of the beaver dams changes due to replacement of slimy sculpin by Atlantic salmon downstream of the beaver dams
- Locations of beaver dams and autumn flows govern anadromous salmonid spawner distribution, juvenile production, and fish community indices – in streams dominated by anadromous salmonids, community distribution may be a function of obstructions, flows, and the resulting distribution of anadromous salmonids affecting resident species richness, evenness, biomass, and production.

Pollock, M.M., T.J. Beechie, and C.E. Jordan. 2007. Geomorphic changes upstream of beaver dams in Bridge Creek, an incised stream channel in the interior Columbia River basin, eastern Oregon. Earth Surface Processes and Landforms 32:1174-1185.

- Looked at extent of localized aggradation behind beaver dams on an incised stream in the interior Columbia River basin to determine usefulness of using beaver dams to restore the channel and the effects of beaver dams on riparian habitat
- The authors found that vertical aggradation rates were initially rapid (as high as 0.47m/year) as entrenched channels filled, but leveled off (about 0.075m/year) as sediment began to cover adjacent terraces
- New riparian vegetation was about at the 0.5m elevation contour above the stream channel – found 5 times more area within 0.5m elevation contour above the stream channel upstream of beaver dams when compared to areas without beaver dams
- Authors suggest that encouraging recolonization of streams by beaver can expand riparian habitat along incised channels

- Beaver dams studied were from 1-6 years old – indicates that restoration can occur fairly rapidly

Westbrook, C.J., D.J. Cooper, and B.W. Baker. 2006. Beaver dams and overbank floods influence groundwater–surface water interactions of a Rocky Mountain riparian area. Water Resources Research, Vol. 42, W06404.

- Examined influence of two in-channel beaver dams and a 10-year flood event on surface inundation, groundwater levels, and flow patterns in a broad alluvial valley during summers of 2002-2005 – 1.5km reach of 4th order Colorado River in Rocky Mountain National Park
- "The beaver dams and ponds greatly enhanced the depth, extent, and duration of inundation associated with floods; they also elevate the water table during both high and low flows. Unlike previous studies we found the main effects of beaver on hydrologic processes occurred downstream of the dam rather than being confined to the near-pond area."
- "Beaver dams on the Colorado River cause river water to move around them as surface runoff and groundwater seepage during both high- and low-flow periods. The beaver dams attenuated the expected water table decline in the drier summer months for 9 and 12ha of the 58ha study area."
- "…we provide empirical evidence that beaver can influence hydrologic processes during the peak flow and low-flow periods on some streams, suggesting that beaver can create and maintain hydrologic regimes suitable for the formation and persistence of wetlands."
- Authors conclude that beaver can influence floodplain structure and function

Urbanization

NMFS. 2007a. Puget Sound Salmon Recovery Plan. NMFS. Available: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/PS-Chinook-Plan.cfm. (October 2009).

- Much of the urbanized area in Puget Sound is concentrated near the mouths of rivers and along estuarine shorelines, coinciding with important and sensitive habitat required by salmon.
- Streams in heavily urbanized areas have lost much of their complexity and riparian vegetation. For example, Thornton Creek in the Seattle area lost all of its wetlands and 60% of its open channel network during 100 years of development. The remaining stream system is heavily armored with rock and concrete along its banks, has extensive culverts and pipes, and little native vegetation remains. Despite heavy outplants of salmon into the creek for many years, only a handful of returning adults have been observed in recent years.

- The toxic mix of oil, grease, pesticides and other pollutants carried by stormwater runoff alters the chemical processes of urban streams and creates dramatic shifts in their flow patterns. Recent studies by NMFS and the Seattle Public Utilities have also documented high rates of outright mortality to adult salmon still full of eggs and sperm, even in a creek where habitat had been restored.

Scholz, N.L., N.K. Truelove, B.L. French, B.A. Berejikian, T.P. Quinn, E. Casillas, T.K. Collier. 2000. Diazinon disrupts antipredator and homing behaviors in chinook salmon (Oncorhynchus tshawytscha). Canadian Journal of Fisheries and Aquatic Sciences 57:1911-1918.

- Studies examining the impacts of urban run-off on urban creeks suggest that the control of polluted runoff from urban streets, lawns and parks and restoration of chemical balance is imperative to fish productivity.

EPA. 2002. National Water Quality Inventory: 2000 Report to Congress. EPA-841-R-02-001. Washington, D.C.: EPA Office of Water. Available: http://www.epa.gov/305b/2000report/. (January 2010).

- The National Water Quality Inventory (EPA 2002) reports that runoff from urban areas is the leading source of impairment to surveyed estuaries and the third largest source of impairment to surveyed lakes. These include construction sediments, oil from autos, bacteria from failing septic systems, road salts, and heavy metals.
- Urban areas have an insidious pollution potential that one-time events such as oil spills do not. Pollutant increases gradually result in gradual declines in habitat quality.

Arkoosh, M.R., E. Casillas, E. Clemons, P. Huffman, A.N. Kagley, T. Collier, J.E. Stein. 2001. Increased susceptibility of juvenile chinook salmon (Oncorhynchus tshawytscha) to vibriosis after exposure to chlorinated and aromatic compounds found in contaminated urban estuaries. Journal of Aquatic Animal Health 13:257-268.

- The findings of Arkoosh et al. (2001) suggest that a higher predisposition to infection and subsequent disease can occur in salmon exposed to chemical contaminants found in urban estuaries of Puget Sound, Washington.

WSCC. 2001b. Habitat limiting factors: Yakima River Watershed. Washington State Conservation Commision. Available: http://www.scc.wa.gov/index.php/287-WRIA-37-38-39-Yakima-River-Watershed/View-category.html. (October 2009).

- Land use modifications in the Yakima River Watershed, including road construction, floodplain encroachment, and bank revetment associated with conversion to urban/suburban development have adversely impacted the quantity and quality of salmonid habitat, and accessibility to habitat in these streams.

NMFS. 2003. Non-fishing impacts to essential fish habitat and recommended conservation measures. National Marine Fisheries Service.

- “Primary impacts of urbanization include 1) the loss of riparian and shoreline habitat and vegetation and 2) runoff. The removal of upland and shoreline vegetation removal can increase stream water temperatures, reduce supplies of LWD, and reduce sources of prey and nutrients to the water system. An increase in impervious surfaces, such as the addition of new roads, roofs, bridges, and parking facilities, results in a decreased infiltration to groundwater and increased runoff volumes. This also has the potential to adversely affect water quality and water quantity/timing in downstream water bodies (i.e. estuaries and coastal waters).”
- The following are conservation measures to mitigate for urbanization
  1. Implement BMPs (EPA 1993) for sediment control during construction and maintenance operations. These can include avoiding ground disturbing activities during the wet season; minimizing exposure time of disturbed lands; using erosion prevention and sediment control methods; minimizing the spatial extent of vegetation disturbance; maintaining buffers of vegetation around wetlands, streams, and drainage ways; and avoiding building activities in areas of steep slopes and areas prone to mass wasting events with highly erodible soils. Use methods such as sediment ponds, sediment traps, bioswales, or other facilities designed to slow water runoff and trap sediment and nutrients.
  2. Avoid using hard engineering structures for shoreline stabilization and channelization when possible. Use bioengineering approaches (i.e., using vegetation approaches with principles of geomorphology, ecology, and hydrology) to protect shorelines and river banks. Naturally stable shorelines and river banks should not be altered (see Section 4.7).
  3. Encourage comprehensive planning for watershed protection so as to avoid filling and building in floodplain areas affecting EFH. Development sites should be planned to minimize clearing and grading, cut-and-fill, and new impervious surfaces.
  4. Where feasible, remove impervious surfaces such as abandoned parking lots and buildings from riparian and shoreline areas, and reestablish wetlands and native vegetation.
  5. Protect and restore vegetated buffer zones of appropriate width along all streams, lakes, and wetlands that include or influence EFH.
  6. Manage stormwater to duplicate the natural hydrologic cycle, maintaining natural infiltration and runoff rates to the maximum extent practicable.
  7. Where in-stream flows are insufficient to maintain water quality and quantity needed for EFH, establish conservation guidelines for water use permits and encourage the purchase or lease of water rights and the use of water to conserve or augment instream flows in accordance with state and federal water law.
  8. Encourage municipalities to use the best available technologies in upgrading their wastewater systems to avoid combined sewer overflow problems and chlorinated sewage discharges into rivers, estuaries, and the ocean.
  9. On-site disposal systems should be properly designed and installed. They should be located away from open waters, wetlands, and floodplains.

SRSRB. 2006. Snake River salmon recovery plan for Southeast Washington. Snake River Salmon Recovery Board. Available: http://www.snakeriverboard.org/resources/library.htm. (October 2009)

- "Stream areas that attract concentrations of people can lead to harassment of fish and illegal fishing (poaching). Fish on spawning beds are particularly susceptible to intentional harassment as well as to unintentional disturbances from human activities such as boating and swimming. Continued disturbance can cause spawning adults to abandon a good spawning area and to either spawn in poor habitat or to die before spawning."

NMFS. 2010b. Biological Opinion: Klamath Project Operations. National Marine Fisheries Service, Southwest Region.

- "Substantial development and urbanization in the Rogue River Valley, coastal areas, and other parts of the SONCC coho salmon ESU contribute to habitat impairment. Loss of riparian vegetation, loss of tidal wetlands and floodplains, pollution, stream simplification, and consumptive water use are some of the aspects of urbanization that have degraded habitat of coho salmon near urban centers."
- "Straightening and diking of once braided stream channels to facilitate flood control have reduced the amount of available habitat to rearing coho salmon juveniles, which is common throughout the ESU near small towns and cities. This has resulted in the loss of off-channel rearing and habitat areas that were once available to coho salmon."
- "Riparian vegetation, which once helped shade small streams and rivers, has been removed, elevating stream temperatures. Runoff from city streets and urban lawns has increased nutrient loads in several streams and rivers, creating algae blooms that can eventually deplete the oxygen in a waterway."

Dams

Independent Scientific Group. 2000. Return to the River 2000: restoration of salmonid fishes in the Columbia River Ecosystem. NPPC 2000-12, Northwest Power Planning Council, Portland, Oregon.

- Construction of the mainstem dams on the Columbia and Snake rivers profoundly altered the Basin's ecosystem. The dams blocked, to varying extents, both adult fish passage upstream to spawning areas and juvenile fish passage downstream to the estuary and the ocean.

SRSRB. 2006. Snake River salmon recovery plan for Southeast Washington. Snake River Salmon Recovery Board. Available: http://www.snakeriverboard.org/resources/library.htm. (October 2009).

- The USACE devised various passage technologies including screens to collect juvenile fish for transport around the Snake River dams. These technologies have resulted in an increase of juvenile survival, estimated at 50 to 60 percent by the late 1990s in the area extending from Bonneville Dam to above Lower Granite Dam. However, in drought years, juvenile survival for some species may still be as low as 10 to 15 percent.
- Water flowing through fishways usually comes from the surface of reservoirs; thus, water temperatures in adult fishways may be higher than prevailing river temperatures which often exceed 21°C (70°F). Snake River fall Chinook, sockeye, and steelhead migrations are slowed by high temperatures because the fish seek areas of cooler water, such as tributaries, for refuge. These delays may reduce reproductive success of sockeye and fall Chinook salmon. Water temperatures in excess of 13°C can negatively impact fecundity, egg size, and fertility. These conditions are present during a significant portion of the adult migration season for all species.

Dauble, D. 2000. Assessment of the impacts of development and operation of the Columbia River hydroelectric system on mainstem riverine processes and salmon habitats. Report to Bonneville Power Administration. Final Report, Project No. 199800402.

- The four lower Columbia River dams (McNary, John Day, The Dalles, and Bonneville dams) have removed almost all free-flowing riverine habitat down to Bonneville Dam. The dams have eliminated 175 miles of rapids, pools, and riffles that formerly characterized the lower Columbia River, replacing them with wide, deep, slow-moving reservoir habitat.

Williams, J. G., S. G. Smith, W. D. Muir, B. P. Sanford, S. Achord, R. McNatt, D. M. Marsh, R. W. Zabel, and M. D. Scheuerell. 2004. Effects of the federal Columbia River power system on salmon populations. Final draft for Collaboration Group.

- For the period from 1999 to 2003, the mean estimated survival of Snake River spring/summer Chinook yearlings from McNary Dam tailrace to the Bonneville Dam tailrace was 66.7 percent for hatchery and wild Chinook salmon with a range of 50 percent to 72.8 percent. These data indicate significant losses for Snake River fish migrating through the Columbia River hydrosystem.

Ferguson, J. W., G. M. Matthews, R. L. McComas, R. F. Absolon, D. A. Brege, M. H. Gessel, and L. G. Gilbreath. 2004. Passage of adult and juvenile salmon through Federal Columbia River Power System dams. NOAA Technical Memorandum. June 2004.

- Dam operations such as daytime spill, which appears to reduce forebay residence time, may increase smolt survival due to decreased opportunity for smolt predation by northern pikeminnow and smallmouth bass. Studies conducted at McNary Dam in 2001 found that radio-tagged yearling Chinook salmon had prolonged forebay residence.

Williams, J. G., S.G. Smith, R.W. Zabel, W.D. Muir, M.D. Scheuerell, B.P. Sandford, D.M. Marsh, R.A. McNatt, and S. Achord. 2005. Effects of the Federal Columbia River power system on salmonid populations. NOAA Tech. Memo. NMFS-NWFSC-63. Available : http://www.nwfsc.noaa.gov/assets/25/6061_04142005_152601_effectstechmemo63final.pdf. (October 2009).

- Today, median travel times for yearling Chinook from the Snake River to Bonneville Dam range from 14 days to 31 days depending on flow conditions, an increase of 40 to 50% over travel times measured in 1966 when fish encountered only the four mainstem dams.

NMFS. 2008a. Federal Columbia River power system biological opinion. National Marine Fisheries Service. Available: http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/final-BOs.cfm. (October 2009).

- Increased travel time (migration delay) due to man-made impoundments presents an array of potential survival hazards to migrating juvenile salmon and steelhead: increasing their exposure to potential mortality vectors in the reservoirs (e.g. predation, disease, thermals stress), disrupting arrival timing to the estuary (which likely affects predator/prey relationships), depleting energy reserves, potentially causing metabolic problems associated with smoltification, and for some steelhead and all Chinook salmon, contributing to residualism (a loss of migratory behavior).
- Some juvenile mortality and injury is associated with all routes of dam passage, but turbines generally cause the highest direct mortality rates—generally ranging between 8 and 19 percent.
- The migration of Snake River fall Chinook is slowed or stopped when the fish take refuge in cooler areas (e.g. tributary mouths) and resumes when the general river temperature declines. Delayed adult migration, combined with delayed onset of water temperatures conducive to spawning, delays the onset of spawning. By reducing maximum late summer water temperatures, the Federal Columbia River Power System may have allowed the expression of the fall Chinook yearling outmigration strategy.

Perry, R.W., A. Braatz, M. Novick, J. Lucchesi, G. Rutz, R. Koch, J. Schei, N. Adams, and D. Rondorf. 2007. Survival and migration behavior of juvenile salmonids at McNary Dam, 2005. U.S. Geological Survey, Western Fisheries Research Center, Cook, Washington.

- A significant rate of juvenile mortality (approximately 3-5%) can occur in project forebays, just upstream of the dams where fish can be substantially delayed (median of 15-20 hours) before passing through the dam.
- Perry et al. (2007) found that at McNary Dam in 2005, juvenile mortality associated with the bypass system occurred through predation downstream of the tailrace release outfall (where conditions allowed predators to exploit a point-source stream of bypassed migrants).

Ferguson, J.W., G.M. Matthews, R.L. McComas, R.F. Absolon, D.A. Brege, M.H. Gessel, and L.G. Gilbreath. 2005. Passage of adult and juvenile salmonids through federal Columbia River power system dams. NOAA Tech. Memo. NMFS-NWFSC-64. Available:

http://www.nwfsc.noaa.gov/assets/25/6048_04222005_105920_fishpassagetm64final.pdf. (October 2009).

- Contemporary mechanical screen turbine bypass systems typically have low rates of mortality, less than 2 percent.

Perkins, W.A., and M.C. Richmond. 2001. Long-term, one-dimensional simulation of lower Snake River temperatures for current and unimpounded conditions. Pacific Northwest National Laboratory, Richland, Washington.

- Perkins and Richmond (2001) compared water temperatures in the Lower Snake River for current (impounded) and unimpounded conditions using a mathematical model of the river system.
- The long-term analysis showed that the primary difference between the current and unimpounded river scenarios is that the reservoirs decrease the water temperature variability. The reservoirs also create a thermal inertia effect which tends to keep water cooler later into the spring and warmer later into the fall compared to the unimpounded river condition. Given the uncertainties in the simulation model, inflow temperatures, and meteorological conditions the results show only relatively small differences between current and unimpounded absolute river temperatures.

Axel, G.A., E.E. Hockersmith, D.A. Ogden, B.J. Burke, K.E. Frick, and B.P. Sandford. 2007. Passage behavior and survival for radio-tagged yearling Chinook salmon and steelhead at Ice Harbor Dam, 2005. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, Washington.

- Axel et al. (2007) evaluated the behavior and survival of migrating Snake River yearling Chinook salmon to determine the effects of a recently installed spillway weir at Ice Harbor Dam.
- Survival of migrating Chinook salmon was very high (97%), indicating that the spillway weir was effective in passing fish, while using less water.

Budy, P., G.P. Thiede, N. Bouwes, C.E. Petrosky, and H. Schaller. 2002. Evidence linking delayed mortality of Snake River salmon to their earlier hydrosystem experience. North American Journal of Fisheries Management 22(1):35-51.

- Evidence from literature suggests that mortality that takes place in the estuary and early in their ocean residence is related to earlier hydrosystem experience during downstream migration.
- Recent literature suggests that exposure to hydrosystem facilities causes stress for outmigrating juvenile salmonids and can lead to delayed mortality due to: compromised energetic condition, increased susceptibility to predation, increased susceptibility to disease, and incomplete smoltification.

NMFS. 2007. Magnuson-Stevens Reauthorization Act Klamath River Coho Salmon Recovery Plan. Prepared by Rogers, F. R., I. V. Lagomarsino and J. A. Simondet for the National Marine

Fisheries Service, Long Beach, CA. 48 pp. Available: http://swr.nmfs.noaa.gov/salmon/MSRA_RecoveryPlan_FINAL.pdf. (November 2009).

- "Irrigation dams in the lower Shasta River watershed can back up river flow and create impoundments that increase solar input to the river and create habitat supporting non-native fish that prey on juvenile salmonids."
- "Improperly-laddered dams can also impair upstream and downstream dispersal of juvenile coho salmon. To address this issue, restoration funding from CDFG is currently being utilized to remove several irrigation dams (e.g., Aruja and Shasta Valley Water Users Association) along the mainstem Shasta River. Removing these dams should improve water quality conditions while restoring a more natural hydrologic regime."
- "Incentive-based alternatives with willing participants should be investigated as a means of preserving water quality, quantity and coho salmon habitat in the Big Springs area of the upper Shasta River."

Sandford, B.P., and S.G. Smith. 2002. Estimation of smolt-to-adult return percentages for Snake River basin anadromous salmonids, 1990-1997. Journal of Agricultural, Biological, and Environmental Statistics 7(2):243-263.

- Sandford and Smith (2002) found that comparisons of smolt-to-adult return ratio from in-river migrants with different juvenile migration histories showed that, for some stocks in some years, fish entering multiple turbine bypass system channels returned at significantly lower rates than fish that were never detected in a bypass systems.

Tucker, M.E., C.D. Martin and P.D. Gaines. 2003. Spatial and temporal distribution of Sacramento pikeminnow and striped bass at the Red Bluff Diversion Complex, including the Research Pumping Plant, Sacramento River, CA: January 1997 - August 1998. Red Bluff Research Pumping Plant Report Series, Vol. 10. U.S. Fish and Wildlife Service, Red Bluff, California.

- Tucker et al. (2003) found that the temporal distribution of Sacramento pike minnow and striped bass in the Red Bluff Diversion Dam (RBDD) area on the Sacramento River were directly related to RBDD operations. Predators congregated when the dam gates were in, and dispersed when the gates were removed.

Hedgecock, D., M. A. Banks, V. K. Rashbrook, C. A. Dean, and S. M. Blankenship. 2001. Applications of Population Genetics to Conservation of Chinook Salmon Diversity in the Central Valley in Contributions to the Biology of Central Valley Salmonids. Brown, R. L. (ed.), Sacramento, CA: California Department of Fish and Game, pp 45-70.

- Restricted access to historic spawning grounds on the Feather River may be responsible for interbreeding between spring-run and fall-run Chinook salmon in the Lower Feather River.

Fukushima, M., T. P. Quinn, and W. W. Smoker. 1998. Estimation of Eggs Lost from Superimposed Pink Salmon (Oncorhynchus gorbuscha) Redds. Canadian Journal of Fisheries and Aquatic Science 55: 618-625.

- The rate of superimposition is a function of spawning densities and typically occurs in systems where spawning habitat is limited due to passage barriers.

Myers, J. M., R. G. Kope, G. J. Bryant, D. Teel, L. J. Lierheimer, T. C. Wainwright, W. S. Grant, F.W. Waknitz, K. Neely, S. T. Lindley, and R. S. Waples. 1998. Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California. U.S. Department of Commerce, NOAA Tech. Memo. NMFSNWFSC-35.

- Due to impassable barriers upstream, current spawning in the Central Valley is restricted to the mainstem and a few river tributaries in the Sacramento River, where the habitat is severely degraded.

Merz, J. E., J. D. Setka, G. B. Pasternak, and J. M. Wheaton. 2004. Predicting the benefits of spawning habitat rehabilitation to salmonid fry production in a regulated California River. Canadian Journal of Fisheries and Aquatic Sciences 61: 1433-1446.

- Merz et al. (2004) tested the hypothesis that spawning-bed enhancement increases survival and growth of Chinook salmon embryos in a regulated California stream with a gravel deficit.
- Salmon embryos planted in enhanced gravels had higher rates of survival to the swim-up stage than embryos planted in unenhanced spawning gravels. Intergravel temperature and substrate size were strongly correlated with distance downstream from the lowest nonpassable dam.
- “These findings suggest that spawning-bed enhancement can improve embryo survival in degraded habitat.”

NMFS. 2003. Non-fishing impacts to essential fish habitat and recommended conservation measures. National Marine Fisheries Service.

- “The effects of dam construction and operation on EFH can include 1) migratory impediments, 2) water flow and current pattern shifts, 3) thermal impacts, and 4) limits on sediment and woody debris transport.”
- The following are recommended conservation measures to mitigate for Dam effects:
  1. Operate facilities to create flow conditions that provide for passage, water quality, proper timing of life history stages, and properly functioning channel conditions, and to avoid strandings and redd dewatering.
  2. Develop water and energy conservation guidelines for integration into dam operation plans and into regional and watershed-based water resource plans.
  3. Provide mitigation (including monitoring and evaluation) for nonavoidable adverse effects on EFH.

NMFS. 2009. Biological opinion and conference opinion on the long-term operations of the Central Valley Project and State Water Project. National Marine Fisheries Service, Southwest Region.

- "Juvenile downstream migration patterns have been altered by the presence of dams. Juvenile winter-run, and spring-run on the mainstem Sacramento River, arrive at any given location downstream of Keswick Dam earlier than historical, since they are hatched much further downstream and have less distance to travel. Therefore, in order smolt at the same size and time as historical, they must rear longer within the Sacramento River."

NMFS. 2009d. Public draft recovery plan for the Evolutionary Significant Units of Sacramento winter-run Chinook salmon and Central Valley spring-run Chinook salmon and the Distinct Population Segment of Central Valley Steelhead. National Marine Fisheries Service, Southwest Regional Office, Sacramento, California. Available: http://swr.nmfs.noaa.gov/recovery/cent_val/Public_Draft_Recovery_Plan.pdf. (December 2009).

- "In the upper Sacramento River, Lower Feather River, and lower Yuba River, spring-run Chinook salmon spawning may occur a few weeks earlier that fall-spawning, but currently there is no clear distinction between the two because of the disruption of spatial segregation by Shasta and Keswick Dams on the Sacramento River, Oroville Dam on the Feather River, and Englebright Dam on the Yuba River."

Collis, K., S. Adamany, D. Roby, D. Craig, and D. Lyons. 2000. Avian predation on juvenile salmonids in 22 the lower Columbia River. 1998 Annual Report to the Bonneville Power Administration and U.S. Army Corps of Engineers, Portland, OR.

- "Study results in 1997 indicated that there were nine major breeding colonies of fish-eating birds that nest on islands in the lower Columbia River and estuary. The majority of these islands are unnatural, created by either the dumping of dredged material or by mainstem dam impoundments."
- "Three Mile Canyon Island and Crescent Island were created by dam impoundment and dredged material disposal, respectively, and so, like Rice Island, are anthropogenic islands. We have few data on the diets of terns nesting at these two upriver colonies but the diet data from Three Mile Canyon Island and the large number of smolt PIT tags recovered at Crescent Island suggest that terns nesting at these two upriver colonies are as or more specialized on juvenile salmonids as a food source compared with terns nesting on Rice Island."

NMFS. 2007. Magnuson-Stevens Reauthorization Act Klamath River Coho Salmon Recovery Plan. Prepared by Rogers, F. R., I. V. Lagomarsino and J. A. Simondet for the National Marine Fisheries Service, Long Beach, CA. 48 pp. Available: http://swr.nmfs.noaa.gov/salmon/MSRA_RecoveryPlan_FINAL.pdf. (November 2009).

- "Dams and improperly designed road crossings are obvious impediments to coho salmon passage within the Klamath River Basin, but other less obvious mechanisms can negatively influence fish migration. Insufficient flushing flows can lead to the formation of gravel/sediment berms at tributary confluences, likely impairing adult migration into natal tributary spawning habitat. Preserving cold tributary streamflows and implementing higher mainstem "channel maintenance" flows could alleviate these issues and increase fish passage opportunities within the Klamath HU. Furthermore, removing or modifying the Pacificorp hydropower project with fish ladders could allow coho salmon passage into 30 miles of historic mainstem habitat located above the dams A group representing federal, state, and local governments, as well as other non-governmental groups, is currently discussing passage and dam decommissioning options as part of FERC's proposed relicensing of Pacificorp's project. The outcome of these proceedings has the potential to substantially benefit salmon populations within the basin."

NMFS. 2002b. Biological opinion for the proposed license amendment for the Potter Valley Project (Federal Energy Regulatory Commission Project Number 77-110). National Marine Fisheries Service, Southwest Region. Available: http://swr.nmfs.noaa.gov/psd/Final_Potter_Valley_Project_BO.pdf. (November 2009).

- "Between the project dams on the Eel River there are 12 miles of mainstem spawning and rearing habitat for anadromous fish to rear to smolthood in a regulated system."
- "Scott Dam was constructed in 1921 without fish passage facilities. Anadromous salmon and steelhead have been extirpated from habitat above Lake Pillsbury by the construction of Scott Dam…During hot, dry years if the storage pool is drafted to 15,000 ac-ft before fall-rains, the remaining water is thermally polluted and is released as instream flow usually during September before the onset of cool weather."
- The Potter Valley project has had significant impacts on fish habitat in the Upper Eel River. The project is by far the largest diversion and damming of Eel River flows, and has damaged habitat by lowering summer and early fall flows to the remaining stream below the Project, and by blocking 50 to 150 miles of spawning and rearing habitats above the Project.

Upper Columbia Salmon Recovery Board (UCSRB). 2007. Upper Columbia spring Chinook salmon and steelhead recovery plan. Upper Columbia Salmon Recovery Board. Available: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Interior-Columbia/Upper-Columbia/upload/UC_Plan.pdf. (October 2009).

- "Seven mainstem dams lie between the Wenatchee River and the sea, eight downstream from the Entiat River, and nine between the Methow/Okanogan systems and the estuary. Adult salmon and steelhead losses at each project could be as high as 4% or more in some years (Chapman et al. 1994 and 1995), and juvenile losses at each project can amount to approximately 5-10%. Some of the losses result from physical effects of adult and juvenile/smolt passage. Others derive from altered limnological

conditions that increase predation by fish and birds. Whatever the direct causes, losses for Wenatchee adults and juveniles could accumulate to an estimated 25% and 52%, respectively. For Methow River fish, which must pass two additional dams, losses may accumulate to an estimated 31% and 61% for adults and juveniles, respectively. The cumulative loss rates also explain why so much mitigative effort has been allocated to hydroproject-related mortality rates."

McClure, M. M., S. M. Carlson, T. J. Beechie, G. R. Pess, J. C. Jorgensen, S. M. Sogard, S. E. Sultan, D. M. Holzer, J. Travis, B. L. Sanderson, M. E. Power, R. W. Carmichael. 2008. Evolutionary consequences of habitat loss for Pacific anadromous salmonids. Evolutionary Applications 1:300-318.

- "Large portions of anadromous salmonid habitat in the western United States has been lost because of dams and other blockages. This loss has the potential to affect salmonid evolution through natural selection if the loss is biased, affecting certain types of habitat differentially, and if phenotypic traits correlated with those habitat types are heritable. Habitat loss can also affect salmonid evolution indirectly, by reducing genetic variation and changing its distribution within and among populations."
- McClure et al. (2008) compare the characteristics of lost habitats with currently accessible habitats and review the heritability of traits which show correlations with habitat/environmental gradients.
- They found that although there is some regional variation, inaccessible habitats tend to be higher in elevation, wetter and both warmer in the summer and colder in the winter than habitats currently available to anadromous salmonids.
- McClure et al. (2008) present several case studies that demonstrate either a change in phenotypic or life history expression or an apparent reduction in genetic variation associated with habitat blockages. Their results suggest that loss of habitat will alter evolutionary trajectories in salmonid populations and Evolutionarily Significant Units.
- "Changes in both selective regime and standing genetic diversity might affect the ability of these taxa to respond to subsequent environmental perturbations. Both natural and anthropogenic and should be considered seriously in developing management and conservation strategies."

Dredging

Newell, R.C., L.J. Seiderer, D.R. Hitchcock. 1998. The impact of dredging on biological resources of the sea bed. Oceanography and Marine Biology Annual Review 336:127-178.

- Dredging adversely affects bottom-dwelling prey species at the site by directly removing or burying immobile invertebrates such as polychaete worms, crustacean, and other Pacific salmon prey types.

EPA. 2000. Environmental screening checklist and workbook for the water transportation industry. Available: www.epa.gov/Region2/capp/cip/water.pdf. (January 2010).

- Dredging can disturb aquatic habitats by resuspending bottom sediments and, thereby, recirculate toxic metals (e.g., lead, zinc, mercury, cadmium, copper etc.), hydrocarbons (e.g., polyaromatics) hydrophobic organics (e.g., dioxins), pesticides, pathogens, and nutrients into the water column (EPA 2000).
- Toxic metals and organics, pathogens, and viruses, absorbed or adsorbed to fine-grained particulates in the material, may become biologically available to organisms either in the water column or through food chain processes.

NMFS. 2003. Non-fishing impacts to essential fish habitat and recommended conservation measures. National Marine Fisheries Service.

- "The environmental effects of dredging on EFH can include 1) direct removal/burial of organisms; 2) turbidity/siltation effects, including light attenuation from turbidity; 3) contaminant release and uptake, including nutrients, metals, and organics; 4) release of oxygen consuming substances; 5) entrainment; 6) noise disturbances; and 7) alteration to hydrodynamic regimes and physical habitat."
- "Many EFH species forage on infaunal and bottom-dwelling organisms. Dredging may adversely affect these prey species at the site by directly removing or burying immobile invertebrates such as polychaete worms, crustacean, and other EFH prey types (Newell et al. 1998, Van der Veer et al. 1985). Similarly, the dredging activity may also force mobile animals such as fish to migrate out of the project area. Recolonization studies suggest that recovery may not be quite as straightforward. Physical factors including particle size distribution, currents, and compaction/stabilization processes following deposition reportedly can regulate recovery after dredging events. Rates of recovery listed in the literature range from several months for estuarine muds to up to 2 to 3 years for sands and gravels. Recolonization can also take up to 1 to 3 years in areas of strong current but up to 5 to 10 years in areas of low current. Thus, forage resources for benthic feeders may be substantially reduced."
- "The use of certain types of dredging equipment can result in greatly elevated levels of fine-grained mineral particles or suspended sediment concentration (SSC), usually smaller than silt, and organic particles in the water column."
- "Dredging, as well as the equipment used in the process such as pipelines, may damage or destroy spawning, nursery, and other sensitive habitats such as emergent marshes and subaquatic vegetation, including eelgrass beds and kelp beds. Dredging may also modify current patterns and water circulation of the habitat by changing the direction or velocity of water flow, water circulation, or dimensions of the water body traditionally used by fish for food, shelter, or reproductive purposes."
- The following are recommended conservation measures to mitigate for Dredging effects:
  1. Avoid new dredging to the maximum extent practicable. Activities that would likely require dredging (such as placement of piers, docks, marinas, etc.) should, instead, be

sited in deep water areas or designed to alleviate the need for maintenance dredging. Projects should be permitted only for water dependent purposes and only when no feasible alternatives are available.
2. Incorporate adequate control measures to minimize turbidity where the dredging equipment used is expected to create significant turbidity.
3. Undertake multi-season, pre-, and post-dredging biological surveys to assess impacts to animal and submerged aquatic vegetation communities.
4. Provide appropriate compensation for significant impacts (short-term, long-term and cumulative) to benthic environments resulting from dredging.
5. Perform dredging during the time frame when impacts due to entrainment of EFH managed species or their prey are least likely to be entrained. Dredging should be avoided in areas with submerged aquatic vegetation.
6. Reference all dredging latitude-longitude coordinates at the site so that information can be incorporated into a geographical information system (GIS) format. Inclusion of aerial photos may be useful to identify precise locations for long-term evaluation.
7. Test sediments for contaminants as per EPA and USACE requirements.
8. Address cumulative impacts of past and current dredging operations on EFH by considering them as part of the permitting process.
9. Identify excess sedimentation in the watershed that prompts excessive maintenance dredging activities and implement appropriate management techniques to ensure that actions are taken to curtail those causes.
10. Ensure that bankward slopes of the dredged area are slanted to acceptable side slopes (e.g., 3:1) to ensure that sloughing does not occur.
11. Avoid placing pipelines and accessory equipment used in conjunction with dredging operations to the maximum extent possible close to kelp beds, eelgrass beds, estuarine/salt marshes, and other high value habitat areas.

Nightingale, B., and C.A. Simenstad. 2001. Dredging activities: Marine issues. White Paper, Research Project T1803, Task 35, Overwater Whitepaper. University of Washington, Seattle, WA. http://depts.washington.edu/trac/bulkdisk/pdf/507.1a.pdf

- "…synthesizes scientific information on the effects of dredging activities on marine habitats. Direct and long-term effects, dredge methods, regulatory framework, contaminated sediment issues, and a separate bibliography of contaminated sediment-related reports are also presented."
- "…maintenance dredging conversion of shallower subtidal to deeper subtidal habitats is much more frequent than new construction dredging conversion of intertidal to subtidal habitats, which is rarely allowed." – loss of intertidal and shallow subtidal coastal habitats creates a potential loss in production and carrying capacity – recovery rates range from months to years, but are difficult to quantify based on lack of long-term pre- and post-project monitoring
- Direct effects of dredging:
    - Entrainment mortalities

    - Behavioral effects
    - Contaminant release
    - Increased turbidity
    - Fish injury due to suspended sediment exposure
    - Decreased dissolved oxygen levels
    - The effects of noise
- "Most relevant issue is likely the fish ability to avoid plumes and dredge areas…clearer understanding of the effects of dredging on a variety of marine fishes would come from a further synthesis of what is known about the life-history strategies, water column use, and timing of a wide variety of marine fishes in specific areas. This would enable further development of site- and species-specific environmental windows to avoid entrainment and limit risks."
- Provides a list of specific recommendations to limit the effects of dredging on marine organisms

Harvey, B.C., and T.E. Lisle. 1998. Effects of suction dredging on streams: A review and an evaluation strategy. Fisheries 23(8):8-17.

- "Suction dredging for gold in river channels is a small-scale mining practice whereby streambed material is sucked up a pipe, passed or a sluice box to sort out the gold, and discarded as tailings over another area of bed…The scientific literature contains few peer-reviewed studies of the effects of dredging, but knowledge of dredging practices, and the biology and physics of streams suggests a variety of mechanisms linking dredging to aquatic resources."
- "Fishery managers should be especially concerned when dredging coincides with the incubation of embryos in stream gravels or precedes spawning runs soon followed by high flows. We recommend that managers carefully analyze each watershed so regulations can be tailored to particular issues and effects."
- Authors suggest that current level of uncertainty about the effects of dredging requires managers to operate under the assumption that dredging is harmful to aquatic resources
- Authors suggest a strategy to:
    - "evaluate interactions between suction dredging and other activities and resources;
    - use this information to regulate dredging and other activities;
    - monitor implementation of regulations and on- off-site effects of dredging; and
    - adapt management strategies and regulations according to new information."

Estuarine Alteration

NMFS. 2007a. Puget Sound Salmon Recovery Plan. NMFS. Available: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/PS-Chinook-Plan.cfm. (October 2009).

- Puget Sound has been heavily altered by human development, with 33% of shorelines modified with bulkheads or other armoring and 73% of wetlands in major deltas of Puget Sound rivers have been lost in the last 100 years.
- The Salmon Recovery Funding Board has awarded $195 million in grants to improve degraded salmon habitat, including fixing and removing 132 barriers to fish migration, riparian vegetation plantings along 96 miles of streams, removing 19 dikes and tide gates to allow freshwater and saltwater to mix to create 6 miles of transition habitat for out-migrating salmon, and working with landowners to protect habitat through conservation easements and property acquisitions.

NMFS. 2008a. Federal Columbia River power system biological opinion. National Marine Fisheries Service. Available: http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/final-BOs.cfm. (October 2009).

- With changes in the Columbia River flow regime, the availability of shallow (between 10 cm and 2 m depth), low-velocity (less than 30 cm/s) habitat in the Columbia River Estuary now appears to decrease at a steeper rate with increasing flow than during the 1880s, and the absorption capacity of the estuary appears to have declined.

Fresh, K.L., E. Casillas, L.L. Johnson, and D.L. Bottom. 2005. Role of the estuary in the recovery of Columbia River Basin salmon and steelhead: an evaluation of the effects of selected factors on salmonid population viability. NOAA Tech. Memo., NMFS-NWFSC-69.

- Fresh et al. (2005) found that estuarine habitats clearly contribute to the viability and persistence of salmon populations in a number of ways. The amount of estuarine habitat that is accessible affects the abundance and productivity of a population. The distribution, connectivity, number, sizes, and shapes of estuarine habitats affect both the life history diversity and the spatial structure of a population.

Clark, K. W., M. D. Bowen, R. B. Mayfield, K. P. Zehfuss, J. D. Taplin, and C. H. Hanson. 2009. Quantification of pre-screen loss of juvenile steelhead in Clifton Court Forebay. California Department of Water Resources Bay-Delta Office, Sacramento, CA.

- The California Department of Water Resources (DWR) conducted a study in 2005, 2006, and 2007 to assess and quantify steelhead pre-screen losses within Clifton Court Forebay of California's State Water Project.
- Results of the steelhead pre-screen loss studies indicated that the pre-screen loss of PIT tagged juveniles steelhead is between 78 ±4% and 82 ±3% within Clifton Court Forebay.
- "As striped bass continue to be linked to pre-screen loss, the predator removal investigations conducted in the 1990's should be revisited. Moderate reductions in predator numbers could yield an increase in steelhead survival. Facilitating greater public fishing pressure may assist in this regard."

- "Additionally, as avian predation was shown to occur, further avian predation investigations should be conducted with an emphasis on diet composition and consumption-rate. Avian diet composition and consumption rate studies would provide information on prey selectivity of the avian predators near the radial gates and the magnitude of pre-screen loss rate due to avian predation."

NMFS. 2003. Non-fishing impacts to essential fish habitat and recommended conservation measures. National Marine Fisheries Service.

- "Dikes, levees, ditches, or other water controls at the upper end of a tidal marsh can cut off all tributaries feeding the marsh, preventing freshwater flushing and annual flushing, annual renewal of sediments and nutrients, and the formation of new marshes. Water controls within the marsh proper intercept and carry away freshwater drainage, block freshwater from flowing across seaward portions of the marsh, increase the speed of runoff of freshwater to the bay or estuary, lower the water table, permit saltwater intrusion into the marsh proper, and create migration barriers for aquatic species. In deeper channels where reducing conditions prevail, large quantities of hydrogen sulfide are produced that are toxic to marsh grasses and other aquatic life. Acid conditions of these channels can also result in release of heavy metals from the sediments."
- "Long-term effects on the tidal marsh include land subsidence (sometimes even submergence), soil compaction, conversion to terrestrial vegetation, greatly reduced invertebrate populations, and general loss of productive wetland characteristics. Loss of these low-salinity environments reduces estuarine fertility, restricts suitable habitat for aquatic species, and creates abnormally high salinity during drought years. Low-salinity environments form a barrier that prevents the entrance of many marine species, including competitors, predators, parasites and pathogens."
- The following are recommended conservation measures to mitigate for Estuarine Alteration effects:
- 1. Minimize the loss of riparian habitats as much as possible.
- 2. The diking and draining of tidal marshlands and estuaries should not be undertaken unless a satisfactory compensatory mitigation plan is in effect and monitored.
- 3. Wherever possible, "soft" approaches (such as beach nourishment, vegetative plantings, and placement of large woody debris) to shoreline modifications should be utilized.
- 4. Include efforts to preserve and enhance EFH by providing new gravel for spawning areas; removing barriers to natural fish passage; and using weirs, grade control structures, and low flow channels to provide the proper depth and velocity for fish.
- 5. Construct a low-flow channel to facilitate fish passage and help maintain water temperature in reaches where water velocities require armoring of the riverbed.
- 6. Replace in-stream fish habitat by providing rootwads, deflector logs, boulders, rock weirs and by planting shaded riverine aquatic cover vegetation.

- 7. Use an adaptive management plan with ecological indicators to oversee monitoring and ensure mitigation objectives are met. Take corrective action as needed.

NMFS. 2009. Biological opinion and conference opinion on the long-term operations of the Central Valley Project and State Water Project. National Marine Fisheries Service, Southwest Region.

- "Outmigrant juvenile salmonids in the Delta have been subjected to adverse environmental conditions created by water export operations at the CVP and SWP facilities. Specifically, juvenile salmonid survival has been reduced by: (1) water diversion from the mainstem Sacramento River into the Central Delta via the Delta Cross Channel (DCC); (2) upstream or reverse flows of water in the lower San Joaquin River and southern Delta waterways; (3) entrainment at the CVP/SWP export facilities and associated problems at Clifton Court Forebay; and (4) increased exposure to introduced, non-native predators such as striped bass (Morone saxatilis), largemouth bass (Micropterus salmoides), and sunfishes (Centrarchidae spp.) within the waterways of the Delta while moving through the Delta under the influence of CVP/SWP pumping."

Bottom, D.L., C.A. Simenstad, J. Burke, A.M. Baptista, D.A. Jay, K.K. Jones, E. Casillas, and M.H. Schiewe. 2005. Salmon at river's end: the role of the estuary in the decline and recovery of Columbia River salmon. NOAA Tech. Memo., NMFS-NWFSC-68.

- "The results indicate that habitat and food-web changes within the estuary and other factors affecting salmon population structure and life histories have altered the estuary's capacity to support juvenile salmon. Diking and filling activities that decrease the tidal prism and eliminate emergent and forested wetlands and floodplain habitats have likely reduced the estuary's salmon-rearing capacity."
- "Restoration of estuarine habitats, particularly diked emergent and forested wetlands, and flow manipulations to restore historical flow patterns might significantly enhance the estuary's productive capacity for salmon. It is possible that historical changes in population structure and salmon life histories, however, prevent salmon from fully utilizing the productive capacity of estuarine habitats even in their presently altered state. Therefore, efforts to improve or restore the estuary for salmon must be developed in concert with hatchery, harvest, and upriver habitat improvements to recover those life history types that can benefit from estuary restoration."
- "A sound historical and evolutionary context for interpreting modern estuarine habitat conditions and for developing salmon recovery strategies is needed. Without proper context, recovery actions may inappropriately target those few salmon life history types and habitats that are abundant today, further reinforcing salmon decline symptoms rather than expanding the basin's productive capacity. A strategy that continues emphasis on improving survival of a few Chinook salmon (O. tshawytscha) dominant types, particularly large hatchery yearlings and subyearlings with short estuarine residence times, may further narrow the distributions of size, migration timing, and

rates of migration. This would result in concentrated use of the estuary and thus would prevent salmon from utilizing its full productive potential."

- The following specific recommendations are offered for restoring the Columbia River's estuary:
    1) Adopt an Explicit Ecologically Based Conceptual Framework for Estuary Management and Restoration.
    2) Protect and Restore Opportunity for Salmon to Access Emergent and Forested Wetlands in the Estuary and Riparian Wetlands in the Tidal Floodplain.
    3) Reacquire Phenotypic Diversity of Salmon, Including a Broader Range of Sizes, Times of Entry, and Periods of Residency in the Estuary.
    4) Monitor Variations in Life History Diversity, Habitat Use, and Performance of Juvenile Salmon in the Estuary.
    5) Review the Scientific Basis for Proposed Habitat and Bathymetric Changes in the Estuary Relative to the Restoration Goals of the Columbia Basin Fish and Wildlife Program.
    6) Use Physical Observations and Hydrodynamic Modeling to Assess the Effects of Bathymetric Change, Flow Regulation, and Alternative Restoration Designs on Habitat Opportunity for Juvenile Salmon.
    7) Review Results of Estuarine Predation Studies in the Context of Salmon Population and Habitat Change.
    8) Assess the Effects of Altered Habitats and Food Webs on the Capacity of the Estuary to Support Juvenile Salmon.

Schmetterling, D. A., C. G. Clancy, and T. M. Brandt. 2001. Effects of riprap bank reinforcement on stream salmonids in the western United States. Fisheries 26(7): 6-23.

- "Riprap may provide habitat for juvenile salmonids and bolster densities on reaches of streams that have been severely degraded. However, riprap does not provide the intricate habitat requirements for multiple age classes or species provided by natural vegetated banks. Streambanks with riprap have fewer undercut banks, less low-overhead cover and are less likely than natural stream banks to contribute large woody debris to the stream. Lateral streambank erosion."
- "The use of natural materials (i.e., LWD, trees, rootwads, etc.) in bank reinforcement and restoration is a growing practice. These "soft" techniques aim to slow the rate of erosion rather than completely stop lateral erosion."

USBR. 2008. Central Valley Project and State Water Project operations criteria and plan biological assessment. U.S. Bureau of Reclamation Mid-Pacific Region, Sacramento, California.

- "As juvenile salmon from the Sacramento basin migrate through the Delta toward the Pacific Ocean, they encounter numerous junctions in the river and Delta channels (both natural and human-made). Tow such junctions are located near Walnut Grove at the

Delta Cross Channel (DCC) (a man-made channel with operable gate at the entrance) and Georgiana Slough (a natural channel)."

- "Significant amounts of flow and many juveniles salmon from the Sacramento River enter the DCC (when gates are open) and Georgiana Slough. Mortality of juvenile salmon entering the central Delta is higher than for those continuing downstream in the Sacramento River. This difference in mortality could be caused by many factors: the longer migration route through the central Delta to the western Delta, exposure to higher water temperatures, higher predation rates, exposure to seasonal agricultural diversions, water quality impairments due to agricultural and municipal discharges, and a more complex channel configuration making it more difficult for salmon to successfully migrate to the western Delta and ocean."

U.S. Fish and Wildlife Service. 2000. Impacts of riprapping to ecosystem functioning, lower Sacramento River, California. U.S. Fish and Wildlife Service, Sacramento Field Office, Sacramento, California. U.S. Fish and Wildlife Service, Sacramento Field Office, Sacramento, California. Prepared for US Army Corps of Engineers, Sacramento District.

- Like many large rivers, the lower Sacramento River exhibits fragmentation and disconnection from ecological processes. Much of the degradation results from river meandering and erosion being Over half (more in certain reaches) of the Sacramento River's banks within the lower 194 miles have been riprapped, mainly from 4 decades of work by the Corps of Engineers' Sacramento River Bank Protection Project (SRBPP).
- Riprapping prevents the recruitment of new LWD along the armored banks, and it reduces the retention of LWD inputted from nonarmored areas. The cumulative loss of LWD functioning for the lower river is now at least 67-90 percent, or more, compared to pre-SRBPP conditions.
- The use of set-back levees to achieve bank protection goals offers the best mitigation solution. Set-back levees allow both site- and reach-level impacts to be fully avoided, and they maximize habitat enhancement opportunities.

Forestry

NMFS. 2007. Magnuson-Stevens Reauthorization Act Klamath River Coho Salmon Recovery Plan. Prepared by Rogers, F. R., I. V. Lagomarsino and J. A. Simondet for the National Marine Fisheries Service, Long Beach, CA. 48 pp. Available: http://swr.nmfs.noaa.gov/salmon/MSRA_RecoveryPlan_FINAL.pdf. (November 2009).

- Several large tributaries in the Klamath Glen HSA historically supported healthy coho salmon populations, but timber harvesting and construction of the associated road network has impaired instream habitat conditions throughout much of the HSA.
- For example, McGarvey, Tarup, Tectah, and Ah Pah Creeks all suffer from excessive sediment input that has simplified instream habitat, limited food production, and lowered spawning and rearing success.

- High sediment loads resulting from upslope timber harvesting and road building in the Scott River watershed have simplified tributary rearing habitat, while sediment flushed from those tributaries often accumulates at tributary confluences, impairing mainstem-tributary connectivity.

Voight, H.N., and D.B. Gale. 1998. Distribution of fish species in tributaries of the lower Klamath River: an interim report, FY 1996. Yurok Tribal Fisheries Program, Habitat Assessment and Biological Monitoring Division Technical Report No. 3, Klamath, California.

- In many Klamath River tributaries large sediment loads (resulting from timber harvesting and construction of the associated road network) have accumulated at their confluence with the Klamath River, potentially interrupting tributary dispersal of coho salmon during winter months.

NMFS. 2003. Non-fishing impacts to essential fish habitat and recommended conservation measures. National Marine Fisheries Service.

- "Four major categories of forestry activities can adversely affect EFH: 1) construction of logging roads, 2) creation of barriers, 3) removal of streamside vegetation, and 4) disturbance associated with log transfer facilities."
- "Logging road construction can destabilize slopes and increase erosion and sedimentation. Two major types of erosion occur: mass wasting and surface erosion. Mass movement of soils, commonly referred to as landslides or debris slides, is associated with timber harvest and road building on high hazard soils and unstable slopes. Both frequency and size of debris slides are increased when logging roads are built on, or timber is harvested from, these unstable land forms. The result is increased erosion and sediment deposition in downslope waterways."

Flanders, L.S., J. Cariello. 2000. Tongass road condition survey report. Technical Report 00-7. Douglas, AK: Alaska Department of Fish and Game, Southeast Regional Office of the Habitat and Restoration Division.

- Logged streams have been associated with higher water temperatures, lower base flows and higher peak flows, and low oxygen levels that have resulted in significant mortalities of pink and chum salmon.

Beschta, R.L., M.R. Pyles, A.E. Skaugset, C.G. Surfleet. 2000. Peak flow response to forest practices in the western Cascades of Oregon, U.S.A. Journal of Hydrology 233:102-120.

- The effects of clearcut silviculture were evaluated using long-term peakflow records for three small watersheds (60-101 ha) and six large basins (62-640 km2) in the western Cascades of Oregon, USA.
- In the smaller basins, clearcut silviculture lead to increases in flood flows.

WSCC. 2001b. Habitat limiting factors: Yakima River Watershed. Washington State Conservation Commision. Available: http://www.scc.wa.gov/index.php/287-WRIA-37-38-39-Yakima-River-Watershed/View-category.html. (October 2009).

- "Bad roads have not only contributed excessive sediment loads to the stream system through erosion of road surfaces, cut and fill slopes, and road ditches, they have also increased the erosiveness of the stream environment by channelizing diffuse flow and delivering it rapidly to the stream, thereby increasing peak flows."
- "The effect of forestry activities on erosion is largely associated with the creation and use of the transportation system, especially during wet periods . Selective harvest practices and riparian buffers effectively minimize the direct delivery of sediment to streams from logging practices."

NMFS. 2007a. Puget Sound Salmon Recovery Plan. NMFS. Available: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/PS-Chinook-Plan.cfm. (October 2009).

- "The amount of historic timber harvest activities and the manner in which forestry was historically practiced have also contributed significantly to the decline in local salmon populations. Timber harvesting in riparian zones and on steep or unstable slopes, inappropriate forest road construction, and draining of forested wetlands have altered the delivery and rate of water to rivers, increased the amount of loose sediment, limited the amount of large woody debris entering rivers, raised water temperatures, and generally altered other important freshwater salmon and bull trout habitat conditions needed by all life stages."
- "Increased frequency and magnitude of high stream flows is due in part to the loss of forest cover from timber harvesting and the routing of surface runoff from forest roads into streams; thus the naturally challenging hydrology of the basin is exacerbated. High flows have contributed to scouring upstream salmon spawning beds, and smothering downstream spawning beds with high sediment levels. Peak flows may also flush juvenile salmon out of normally slower moving reaches of the river that are used for rearing habitat. In the future, climate change may lead to wetter winters and drier summers, aggravating the current flow challenges."

NMFS. 2002b. Biological opinion for the proposed license amendment for the Potter Valley Project (Federal Energy Regulatory Commission Project Number 77-110). National Marine Fisheries Service, Southwest Region. Available: http://swr.nmfs.noaa.gov/psd/Final_Potter_Valley_Project_BO.pdf. (November 2009).

- "Ongoing forest activities on non-Federal lands are likely to continue to degrade essential salmonid habitat values. Environmental impacts identified with timber harvest may include increased sediment production from roads and other sources, loss of large woody debris recruitment, reduced function of riparian areas, reductions in water quality and quantity, increased water temperatures and loss of channel complexity."

EPA. 1998. South Fork Trinity River and Hayfork Creek Sediment Total Maximum Daily Loads. U.S. EPA Region 9. 75 pp. Available: http://www.epa.gov/region09/water/tmdl/trinityso/fsftmdl.pdf. (December 2009).

- “Roads, skid trails and landings in the South Fork basin that are improperly located,designed, constructed or maintained may cause: 1) increased surface erosion and chronic fine sediment production and delivery to streams, and 2) episodic and occasionally catastrophic delivery of fine and coarse sediment to streams from crossing failures, gully development and landslides generated from improper placement. This has direct and immediate adverse impacts immediately downstream from the failures, but it can also affect areas much farther downstream and much farther into the future. This appears to be especially problematic in the highly erodible and unstable geologic terranes in the western third of the watershed.”

NMFS. 2010b. Biological Opinion: Klamath Project Operations. National Marine Fisheries Service, Southwest Region.

- “Substantial timber harvesting has occurred throughout the Southern Oregon/Northern California Coast (SONCC)coho salmon ESU. In many SONCC coho salmon streams, lack of large woody debris results in decreased cover and reduced storage of gravel and organic debris. Lack of large woody debris (LWD) has also resulted in loss of pool habitat and a reduction in overall habitat and hydraulic complexity in a variety of coho salmon streams. LWD also provides cover from predators and shelter from high flow events.
- “Timber harvest actions combined with rainfall events can cause stream bank erosion, landslides, and mass wasting, resulting in higher sedimentation rates than historical amounts throughout the SONCC coho salmon range. This can cause a reduction in food supply, increases in fine sediments which can destroy spawning gravels, and increase severity of peak flows during storm season. The removal of overhead canopy cover results in increased solar radiation reaching the stream, which results in increased water temperatures.”
- “Several forest practices and management plans have been enacted in the Klamath Basin. The Northwest Forest Plan (NFP) is an integrated, comprehensive design for ecosystem management, intergovernmental and public collaboration, and rural community economic assistance for federal forests in western Oregon, Washington, and northern California. Since adoption of the NFP in 1994, timber harvest and road building have decreased dramatically on federal lands within the range of the Northern spotted owl, including federal lands within the Klamath River Basin [i.e., Six River Klamath, and Shasta-Trinity National Forests] and road decommissioning has increased.”

Grazing

SRSRB. 2006. Snake River salmon recovery plan for Southeast Washington. Snake River Salmon Recovery Board. Available: http://www.snakeriverboard.org/resources/library.htm. (October 2009)

- Grazing by sheep and cattle removes riparian vegetation and eliminates natural shade. The lack of shade frequently results in increased water temperatures. The reduced input of leaves, insects, and other organic material limits the amount of food available to fish and their prey. Trampling of stream banks by grazing cattle can cause the banks to collapse, increasing the input of fine sediment. Fecal material from cattle can introduce excessive concentrations of nutrients which, in warm, slow-moving streams, can result in low levels of dissolved oxygen (eutrophication).

NMFS. 2007. Magnuson-Stevens Reauthorization Act Klamath River Coho Salmon Recovery Plan. Prepared by Rogers, F. R., I. V. Lagomarsino and J. A. Simondet for the National Marine Fisheries Service, Long Beach, CA. 48 pp. Available: http://swr.nmfs.noaa.gov/salmon/MSRA_RecoveryPlan_FINAL.pdf. (November 2009).

- The lower reaches of Klamath River estuarine tributaries such as Salt Creek, Hunter Creek and Terwer Creek often suffer from poor water quality and compromised riparian function, primarily due to unregulated cattle grazing adjacent to the stream channel.
- Riparian fencing projects implemented in cooperation with willing landowners would immediately improve habitat conditions within these critical watersheds by minimizing streambank erosion and rehabilitating riparian habitat, but further study will ultimately be necessary to fully understand how the lower Klamath River estuary and associated off-channel habitat function to provide for the different life stages of anadromous salmonids.

Bayley, P. B. and H. W. Li. 2008. Stream fish responses to grazing exclosures. North American Journal of Fisheries Management 28:135-147.

- Eight paired reaches of northeastern Oregon streams were selected such that one reach was an established livestock exclosure and a neighboring, geomorphologically similar reach was open to grazing.
- The greater density of age-0 O. mykiss in exclosures was attributed to the potential food supply and to increases in undercut banks, instream bank vegetation, width : depth ratio, and several riparian vegetation variables.
- These results are promising with respect to improvement of salmonid habitat through prevention of grazing, but the exclosures are too small and infrequent to be effective at the population or basin-wide level.

Strand, M., and R. W. Merritt. 1999. Impacts of livestock grazing activities on stream insect communities and the riverine environment. American Entomologist 45(1): 13-26.

- "Much of the riparian habitat along western rangeland has been altered fundamentally by livestock grazing… Relatively simple habitat restoration measures, including cattle exlusion and bank stabilization, have proved quite successful in reversing this trend and promoting recovery of native riparian vegetation. Vegetative recovery has, in turn, improved instream conditions for trout and their invertebrate prey in rangeland streams."

Clary, W.P., and W.H. Kruse. 2003. Chapter 11: Livestock grazing in riparian areas: environmental impacts, management practices and management implications. *In* Baker, M.B. et al. (eds) Riparian areas of the southwestern United States: hydrology, ecology, and management. CRC Press LLC, Boca Raton, FL.

- "Excessive grazing and trampling impacts by cattle and other ungulates causes mechanical damage to shrubs and small trees, reduction or elimination of woody seedlings and saplings, exposed soils, shift of herbaceous species from native species to weedy or exotic species with root systems that have lesser soil-holding capabilities and widening or encasement of stream channels."
- The following are grazing management principles recommended to preserve riparian habitat:
    - Grazing during seasons when grazing habitat is less vulnerable to degradation
    - Rotate the areas utilized for livestock grazing to prevent over-use of any riparian area
    - Adjust grazing season to coincide with times when livestock are more attracted to upland areas
    - Manage grazing to retain adequate herbaceous vegetation cover and height on streambanks and overflow areas to promote protection of streambanks, reduce use of riparian plant communities, encourage sediment entrapment and bank building, dissipate stream energy and improve aquifer recharge.
    - Allow for adequate regrowth time and rest for plants that are grazed.
    - Monitor grazing activities because changes can occur rapidly in riparian areas.
    - Active, continuous, hands-on management is required to have a successful riparian grazing management program.

Saunders, W.C., and K.D. Fausch. 2007. Improved grazing management increases terrestrial invertebrate inputs that feed trout in Wyoming rangeland streams. Transactions of the American Fisheries Society 136(5):1216-1230.

- "Research in forest and grassland ecosystems worldwide indicates that terrestrial invertebrates can be a significant source of prey for fish, providing about 50% of their annual energy."
- Authors examined the importance of terrestrial invertebrates as a prey source for brown trout *Salmo trutta* and brook trout *Salvelinus fontinalis* in rangeland streams and how it can be modified by grazing practices – sampled falling invertebrate input and trout diets in five pairs of streams with either high-density, short-duration (HDSD) grazing or season-long (SL) grazing
- Biomass of riparian vegetation and terrestrial invertebrate input were 2-3 times greater in HDSD reaches than SL reaches, but differences were only significant during late summer due to high variability

- 57% of afternoon diets in both reaches consisted of terrestrial prey
- Total trout biomass was more than twice as high in HDSD reaches compared to SL reaches – suggests that grazing practices have the potential to influence terrestrial invertebrate input and fish populations.

Gregory, J.S., and B.L. Gamett. 2009. Cattle trampling of simulated bull trout redds. North American Journal of Fisheries Management 29(2):361-366.

- "Listing of bull trout *Salvelinus confluentus* under the Endangered Species Act and concerns over livestock stepping on bull trout redds have led many U.S. Department of Agriculture Forest Service managers to remove livestock from bull trout spawning areas once spawning begins…policy has extensive ramifications for livestock producers…a lack of data precludes evaluation of the benefit of livestock removal to bull trout populations."
- Authors used simulated bull trout redds to assess the probability that cattle in grazing allotments would step on redds
- "During the 14-21 day grazing period, 15-83% of the simulated redds were affected by trampling. When the control period was standardized to the same time period as the treatment, cattle were found to be responsible for affecting 12-78% of simulated redds and breaking 6-49% of the clay targets. Impacts were higher in pastures where cattle stocking intensity was higher, but impacts were also determined by site conditions adjacent to the simulated redds."

Belsky, A.J., A. Matzke, and S. Uselman. 1999. Survey of livestock influences on stream and riparian ecosystems in the western United States. Journal of Soil and Water Conservation 54:419-431.

- "Livestock seek out water, succulent forage, and shade in riparian areas, leading to trampling and overgrazing of streambanks, soil erosion, loss of streambank stability, declining water quality, and drier, hotter conditions. These changes have reduced habitat for riparian plant species, cold-water fish, and wildlife, thereby causing many native species to decline in number or go locally extinct. Such modifications can lead to large-scale changes in adjacent and downstream ecosystems."
- "…recent studies clearly document that livestock continue to degrade western streams and rivers, and that riparian recovery is contingent upon total rest from grazing."
- Paper summarizes effects of grazing on streams and riparian areas in the western U.S. through review of results of published experimental studies and comparative studies of grazed vs. protected areas
- "Livestock grazing was found to negatively affect water quality and seasonal quantity, stream channel morphology, hydrology, riparian zone soils, instream and streambank vegetation, and aquatic and riparian wildlife. No positive environmental impacts were found. Livestock were also found to cause negative impacts at the landscape and regional levels…most recent scientific studies document that livestock grazing continues to be detrimental to stream and riparian ecosystems in the West."

Zoellick, B.W. 2004. Density and biomass of redband trout relative to stream shading and temperature in southwestern Idaho. Western North American Naturalist 64(1):18-26.

- Examined density and biomass of redband trout in relation to stream temperature in headwater reaches of two creeks in southwestern Idaho
- The two study creeks differed in shading (80% vs. 46%) and solar insolation (7.9 vs. 15.1mJ/m^2/day)
- "Trout density was negatively correlated with increases in water temperatures and solar insolation in both streams. Trout biomass increased with stream shading and was negatively correlated with solar insolation. Warmer water temperatures in Big Jacks Creek were likely due to historical summerlong livestock grazing, which drastically reduced riparian shading."
- Found almost 3-fold difference in trout density and biomass between the grazed and ungrazed (shaded and unshaded) stream.

Carline, R.F., and M.C. Walsh. 2007. Responses to riparian restoration in the Spring Creek watershed, central Pennsylvania. Restoration Ecology 15(4):731-742.

- Applied experimental treatments designed to enhance riparian habitats and stream function in two grazed streams in central Pennsylvania and compared treatment streams to one ungrazed control stream – monitored treatment streams before and 3-5 years after treatment
- "Few changes were found in channel widths and depths, but channel-structuring flow events were rare in the drought period after restoration. Stream bank vegetation increased from 50% or less to 100% in nearly all formerly grazed riparian buffers. The proportion of fine sediments in stream substrates decreased in Cedar Run but not in Slab Cabin Run (both treatment streams). After riparian treatments, suspended sediments during base flow and storm flow decreased 47-87% in both streams. Macroinvertebrate diversity did not improve after restoration in either treated stream. Relative to Spring Creek (control stream), macroinvertebrate densities increased in both treated streams by the end of the posttreatment sampling period."
- "Despite drought conditions that may have altered physical and biological effects of riparian treatments, goals of the riparian restoration to minimize erosion and sedimentation were met. A relatively narrow grass buffer along 2.4km of each stream was effective in improving water quality, stream substrates, and some biological metrics."
- "Excluding livestock from the riparian zone allowed grasses to quickly colonize and stabilize stream banks."

Clary, W.P. 1999. Stream channel and vegetation responses to late spring cattle grazing. Journal of Range Management 52(3):218-227.

- Conducted 10-year grazing study on a cold, mountain meadow riparian system in central Idaho – established six pastures to study the effects of no grazing, light grazing (20-25% utilization), and medium grazing (35-50% utilization) during late June – treatments were in comparison to heavier historic grazing

- “Stream channels narrowed, stream width-depth ratios were reduced, and channel bottom embeddedness decreased under all 3 grazing treatments…Streambank stability increased and streamside willow communities increased in both height and cover under all 3 treatments. Plant species richness increased on both streamside and dry meadow areas during the years of grazing and moderate drought. The numbers of species receded to near original levels in the ungrazed and light grazed pastures in 1996, a wet post-grazing year, primarily due to a decrease in forb species. Streamside graminoid height growth was similar among treatments after 1 year of rest.”
- “Most measurements of streamside variables moved closer to those beneficial for salmonid fisheries when pastures were grazed to 10 cm of graminoid stubble height; virtually all measurements improved when pastures were grazed to 14 cm stubble height, or when pastures were not grazed. Many improvements were similar under all 3 treatments indicating these riparian habitats are compatible with light to medium late spring use by cattle.”
- Authors suggest that all three treatments applied were within the annual ability of the site to recover from grazing
- Suggest that 10-15 cm of forage stubble should remain after the grazing season to limit potential impacts to riparian plant communities.

McIntosh, B.A., J.R. Sedell, R.F. Thurow, S.E. Clarke, G.L. Chandler. 2000. Historical changes in pool habitats in the Columbia River Basin. Ecological Applications 10(5):1478-1496.

- Compared a historical stream survey (1934-1945) to a current stream survey (1987-1997) to assess changes in pool frequencies in the Columbia River Basin
- “…the frequencies of large and deep pools have decreased significantly since the 1930s…In natural streams (watersheds minimally affected by human activities), large-pool frequencies increased or remained the same in 96% of the streams. In commodity streams (watersheds managed predominately for extraction of resources), large- and deep-pool frequencies decreased in 52% and 54% of the streams, respectively. Despite differences in stream size and the level of human activities, the magnitude and direction of these changes were consistent. Land ownership did not influence trends; pools decreased significantly on both private and public lands. Only where entire watersheds or headwaters were designated as wilderness or roadless areas did pools consistently remain unchanged or increase.”
- “We conclude that the persistent effects of human activities have simplified stream channels and reduced large- and deep-pool frequencies in watersheds outside of designated wilderness and road-less areas in the Columbia River Basin.”
- Spatial resolution for specific land-use practices was too coarse to tie specific practices to individual watersheds, so no cause-and-effect relationship could be determined
- Article provides a very good historical summary of grazing and grazing practices in the Pacific Northwest.

Scrimgeour, G.J., and S. Kendall. 2002. Consequences of livestock grazing on water quality and benthic algal biomass in a Canadian natural grassland plateau. Environmental Management 29(6):824-844.

- Used livestock enclosures and stream surveys to evaluate the effects of livestock grazing on riparian and stream attributes, water chemistry, and algal biomass over a two-year period in the Cypress Hills grassland plateau, Alberta, Canada
- Livestock enclosures consisted of four treatments partially replicated in three streams
    - Early season grazing (June-August)
    - Late season grazing (August-September)
    - All season grazing (June-September)
    - Livestock absent controls
- "Livestock grazing significantly decreased streambank stability, biomass of riparian vegetation, and the extent to which aquatic vegetation covered the stream channels compared with livestock-absent controls. Water quality comparisons indicated significant differences among the four livestock grazing treatments in Battle and Graburn creeks but not in Nine Mile Creek. In Graburn Creek, the concentration of total phosphorus in the all-season livestock grazing treatment was significantly higher than that in the livestock-absent control, and the early season and late season grazing treatments. Concentrations of soluble reactive phosphorus in the all-season livestock grazing treatment also exceeded that in livestock-absent control. In contrast, differences in water quality variables in the remaining 22 comparisons were minor even when differences were statistically significant. Effects of livestock grazing on algal biomass were variable, and there was no consistent pattern among creeks. At the watershed scale, spatial variation in algal biomass was related with concentrations of NO_2^- and NO_3^- and soluble reactive phosphorus in two of the four study creeks…exclusion of livestock for the two summer-fall periods typically resulted in a three- to fivefold increase in riparian vegetation biomass and a twofold increase in the extent to which vegetation covered stream channels."
- Authors found no meaningful differences in early vs. late grazing treatments
- Authors suggest that a natural disturbance grazing schedule similar to historic bison grazing (i.e., large amount of grazing and then time of recovery with no grazing) would be acceptable to both conservation groups and managers

Manoukian, M., and C.B. Marlow. 2002. Historical trends in willow cover along streams in a southwestern Montana cattle allotment. Northwest Science 76(3):213-220.

- Used air photos taken in 1942, 1965, and 1987 to measure willow canopy cover along streams within a USDA Forest Service grazing allotment
- Compared cover from each year to assess changes over the 46-year record – goal was to assess effectiveness of changes in livestock grazing management
- "Willow canopy cover fluctuated along the streams in the allotment, but the general trend was upward from 1942 to 1987. Willow stem population demography was evaluated to ascertain whether historic grazing patterns had affected stem replacement.

Stem age classes were normally distributed with a replacement cycle similar to those reported in other areas of the western United States and Canada. These data suggest that extended periods of rest (>3 yr) are not necessary for willow recovery if livestock or wildlife use is closely controlled…Short rest periods (<3 yr) are probably inadequate for willow recovery without concurrent changes in season and intensity of use."

- "…it appears that cattle grazing during 1942 to 1987 did not affect natural turnover patterns and that individual willows could continue to produce replacement stems at a sufficient rate under rest rotation grazing to expand willow canopy cover."
- "…the 46-yr photographic record of Long Creek indicates that long periods of nonuse can be avoided through close control of season and intensity of ungulate use. The photo record also supports the recommendation…that grazing practices might have to be in place for several decades before degraded riparian vegetation begins to improve."

Humphrey, J.W., and G.S. Patterson. 2000. Effects of late summer cattle grazing on the diversity of riparian pasture vegetation in an upland conifer forest. Journal of Applied Ecology 37(6):986-996.

- Authors present results from 9 years of monitoring the effects of cattle grazing on the diversity and composition of riparian pasture vegetation in an upland conifer forest in northern Scotland – used two treatments:
    - Late summer grazing (average stocking density 2.25-2.5 cows/ha – free range over 40-ha experimental site from early August to late September)
    - ungrazed
- Assessments of plant species richness and abundance were made prior to grazing in 1988, and in 1991 and 1997 in the three main vegetation types – calcareous springs, acid grassland, and rush pasture
- "Grazing had a significant effect on plant species richness, which declined in ungrazed plots and remained static in grazed plots over the 1988-97 period. There were no recorded effects of grazing on species abundance, nor on the frequency of rare sedges and herbs of particular conservation importance. Litter cover (dead plant material) was significantly higher in ungrazed plots, which may be a causal factor in declining richness values."
- Cattle utilized acid grassland and calcareous spring vegetation to a significantly greater degree than rush vegetation, but utilization appeared to be related to availability
- "Cattle grazing is of potential value as a management tool for species-rich grasslands in upland forests provided that: areas to be grazed are large enough to minimize localized impacts and allow free ranging of the cattle; the economics and practicalities of stock husbandry are considered; the type of grazing management used is linked clearly to management objectives…Over the experimental period cattle grazing has been effective in preventing a decline in plant species richness in all three of the vegetation types under study."

Weigel, B.M., J. Lyons, L.K. Paine, S.I. Dodson, and D.J. Undersander. 2000. Using stream macroinvertebrates to compare riparian land use practices on cattle farms in southwestern Wisconsin. Journal of Freshwater Ecology 15(1):93-106.

- Compared aquatic macroinvertebrate assemblages among stream segments within continuously grazed pastures, intensive rotationally grazed pastures, undisturbed grassy vegetative buffer strips, and undisturbed woody vegetative buffer strips – collected macroinvertebrate and stream sedimentation data from four streams in each land use category in two consecutive years – used upstream reference site to account for watershed condition
- "Watershed condition tended to have greater influence on macroinvertebrate measures than local riparian land use. However, local riparian land use influences were apparent if watershed condition was statistically accounted for with analysis of covariance."
- "Stream reaches with intensive rotational grazing tended to have macroinvertebrate assemblage characteristics intermediate of the buffer and continuously grazed reaches. Although we detected some differences in macroinvertebrate assemblages that apparently reflected very local land use, our results suggest the macroinvertebrates were mostly responding to large-scale watershed influences."
- "In this study, we found the macroinvertebrate assemblage responded in a way that suggests higher organic pollution in continuously grazed reaches than the woody buffer reaches."
- "We found that continuously grazed reaches, the reaches with the most erodible banks and embeddedness of coarse substrates, have the highest species and generic richness and lowest representation of EPT taxa."

Irrigation

WSCC. 2001b. Habitat limiting factors: Yakima River Watershed. Washington State Conservation Commision. Available: http://www.scc.wa.gov/index.php/287-WRIA-37-38-39-Yakima-River-Watershed/View-category.html. (October 2009).

- Irrigation water storage and delivery affects the flow timing regime and transfers flow into streams that otherwise would not naturally have flow. In the Yakima watershed, anadromous salmonid adults migrating to the upper watershed may be falsely attracted into lower watershed streams that are carrying operational spills or irrigation return flows of upper Yakima water that has been conveyed through the irrigation delivery network to the lower watershed. These fish may spawn in streams where habitat conditions are not suitable for egg incubation or for successful early rearing after emergence.
- Historically, the hydrologic cycle in each of the four major basins (Roslyn, Kittitas, Upper Yakima, and Lower Yakima) of the Yakima watershed was characterized by extensive exchange between the surface, hyporheic, and groundwater zones. This exchange would have occurred mainly in the vast alluvial valleys and floodplains, which would

have functioned as hydrologic buffers, distributing the energy of peak flows and moving cool, spring melt water out onto the floodplain.
- The diversions at Sunnyside and Wapato typically divert one half of the entire river flow during the irrigation season (May-October), while Prosser diverts 1400 cfs most of the year, both for irrigation and power production. Because of regulation and withdrawals for irrigation, the Yakima River experiences periods of both dewatering and elevated flows relative to the historic discharge regime .

NMFS. 2008a. Federal Columbia River power system biological opinion. National Marine Fisheries Service. Available: http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/final-BOs.cfm. (October 2009).
- Overbank flow events, important to habitat diversity, have become rare in the Columbia River, in part because flow management and irrigation withdrawals prevent high flows and in part because diking and revetments have increased the “bankfull” flow level (from about 18,000 to 24,000 m3/s).

NMFS. 2007. Magnuson-Stevens Reauthorization Act Klamath River Coho Salmon Recovery Plan. Prepared by Rogers, F. R., I. V. Lagomarsino and J. A. Simondet for the National Marine Fisheries Service, Long Beach, CA. 48 pp. Available: http://swr.nmfs.noaa.gov/salmon/MSRA_RecoveryPlan_FINAL.pdf. (November 2009).
- “The mainstem Scott and Shasta Rivers, and their low gradient tributaries favored by coho salmon, suffer many of the ailments common to drainages supporting extensive agricultural development. High summer diversion rates throughout both valleys limit mainstem and tributary flow levels, raise water temperatures, and lower water quality, making the mainstem Scott and Shasta Rivers unsuitable for rearing juvenile coho salmon.”
- “Earthen “push up” dams are still employed in some areas of the Scott Valley to divert streamflow for agriculture. These seasonal dams often block fish migration, and downstream reaches can go dry when diverters fail to release minimum bypass flows.”
- “To address these issues, restoration efforts should focus on working cooperatively with local ranchers to increase irrigation efficiency and water conservation through the implementation of “fish friendly” diversion structures and mandatory bypass flows. Incentives for local landowners with adjudicated water rights to forgo diverting during critical periods remains an important, yet currently not sufficiently funded, mechanism to establish coordinated water strategies in the Scott River and Shasta River.”

Herren, J.R. and S.S. Kawasaki. 2001. Inventory of water diversions in four geographic areas in California’s Central Valley. Pages 343-355. In: Contributions to the Biology of Central Valley Salmonids. R.L. Brown, editor. Volume. 2. California Fish and Game Fish Bulletin 179.
- As of 1997, 98.5 percent of the 3,356 diversions included in a Central Valley database were either unscreened or screened insufficiently to prevent fish entrainment. Most of the 370 water diversions operating in Suisun Marsh are unscreened.

NMFS. 2009. Biological opinion and conference opinion on the long-term operations of the Central Valley Project and State Water Project. National Marine Fisheries Service, Southwest Region.

- "The diversion and storage of natural flows by dams and diversion structures on Central Valley waterways have depleted streamflows and altered the natural cycles by which juvenile and adult salmonids base their migrations. As much as 60 percent of the natural historical inflow to Central Valley watersheds and the Delta have been diverted for human uses. Depleted flows have contributed to higher temperatures, lower dissolved oxygen (DO) levels, and decreased recruitment of gravel and large woody debris (LWD). More uniform flows year round have resulted in diminished natural channel formation, altered food web processes, and slower regeneration of riparian vegetation. These stable flow patterns have reduced bedload movement caused spawning gravels to become embedded, and decreased channel widths due to channel incision, all of which has decreased the available spawning and rearing habitat below dams."

Bottom, D.L., C.A. Simenstad, J. Burke, A.M. Baptista, D.A. Jay, K.K. Jones, E. Casillas, and M.H. Schiewe. 2005. Salmon at river's end: the role of the estuary in the decline and recovery of Columbia River salmon. NOAA Tech. Memo., NMFS-NWFSC-68.

- "The magnitude and timing of river flow, which significantly influence estuarine habitat of juvenile salmon, have been highly modified at the watershed level. The predevelopment flow cycle of the Columbia River has been totally reshaped by hydropower regulation and irrigation withdrawal. While there is a prominent climate signal in river-flow variability over the period of the analysis (1859–present), the magnitude of maximum spring-freshet flow has decreased more than 40% from the predevelopment period (1859–1899) to the present. Flow regulation is responsible for approximately 75% of this loss, irrigation withdrawal for approximately 20%, and climate change for approximately 5%."

Institute For Natural Systems Engineering. 1999. Evaluation of interim instream flow needs in the Klamath River: Phase I final report. Prepared for the Department of Interior. Utah Water Research Laboratory, Utah State University.

- "Depletion of stream flows in the Scott River and almost every tributary within this subbasin are associated with severe limitations for coho and steelhead juvenile rearing habitat availability and stranding of juvenile fall chinook, coho, and steelhead during the irrigation season in average and below average water years. Diversion of water for agricultural purposes, and the associated agricultural return flows, are attributed to higher than normal water temperatures and degraded water quality in both the Shasta and Scott River systems. Spring run chinook and spring run steelhead are considered to be extinct or at best remnant populations in the Scott and Shasta rivers and is attributed to poor summer flow conditions. Iron Gate Dam also blocked access to several cool water springs."

NMFS. 2007a. Puget Sound Salmon Recovery Plan. NMFS. Available: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/PS-Chinook-Plan.cfm. (October 2009).

- “People in the Dungeness River basin have been working for over ten years to address the chronic low flow problems there. The Agricultural Water Users Association and Jamestown S’Klallam Tribe obtained federal and state funding to improve irrigation infrastructure and conveyance efficiency. In the last five years, these actions have helped reduce the amount of water used for irrigation by one third, leaving more water in the river at times when salmon most need it. Additional conservation projects to improve summer flows are proposed in the Dungeness plan.”

NMFS. 2002b. Biological opinion for the proposed license amendment for the Potter Valley Project (Federal Energy Regulatory Commission Project Number 77-110). National Marine Fisheries Service, Southwest Region. Available: http://swr.nmfs.noaa.gov/psd/Final_Potter_Valley_Project_BO.pdf. (November 2002).

- “The Potter Valley project has had significant impacts on fish habitat in the Upper Eel River. The project is by far the largest diversion and damming of Eel River flows, and has damaged habitat by lowering summer and early fall flows to the remaining stream below the Project, and by blocking 50 to 150 miles of spawning and rearing habitats above the Project.”

Mineral Mining

Baldwin, D. H., J. F. Sandahl, J. S. Labenia, and N. L. Scholz. 2003. Sublethal effects of copper on coho salmon: Impacts on nonoverlapping receptor pathways in the peripheral olfactory nervous system. Environmental Toxicology and Chemistry 22:2266-2274.

- Baldwin et al. (2003) examined the sublethal effects of copper on the sensory physiology of juvenile coho salmon (Oncorhynchus kisutch).
- Results indicate that copper is broadly toxic to the salmon olfactory nervous system. Consequently, short-term influxes of copper to surface waters may interfere with olfactory-mediated behaviors that are critical for the survival and migratory success of wild salmonids.

Suttle, K. B., M. E. Power, J. M. Levine and C. McNeely. 2004. How fine sediment in rIverbeds impairs growth and survival of juvenile salmonids. Ecological Applications 14: 969-974.

- Suttle et al. (2004) experimentally manipulated fine bed sediment in a northern California river and examined responses of juvenile salmonids and the food webs supporting them.
- Increasing concentrations of deposited fine sediment decreased growth and survival of juvenile steelhead trout. These declines were associated with a shift in invertebrates

toward burrowing taxa unavailable as prey and with increased steelhead activity and injury at higher levels of fine sediment.
- The linear relationship between deposited fine sediment and juvenile steelhead growth suggests that there is no threshold below which exacerbation of fine-sediment delivery and storage in gravel bedded rivers will be harmless, but also that any reduction could produce immediate benefits for salmonid restoration.

Gilvear, D. J., T. M. Waters, A. M. Milner. 2006. Image analysis of aerial photography to quantify changes in channel morphology and instream habitat following placer mining in interior Alaska. Freshwater Biology 34:389-398.
- "Placer mining for alluvial deposits of gold in a number of stream systems in interior Alaska represents a major disturbance to the stream bed and affects habitat for biotic communities."
- "Image analysis demonstrated that a wide range of water depths and instream mesoscale habitats existed prior to mining. During mining, the stream was confined to a channelized reach with negligible deep water or habitat diversity."
- "It is suggested that geomorphological recovery and associated habitat recovery takes a number of large flood events and is likely to require more than 10 years."

NMFS. 2002. Biological Opinion: Klamath Project Operations. National Marine Fisheries Service.
- "Mining operations continue in the Klamath Basin, including suction dredging, placer mining, gravel mining, and lode mining. These mining operations can adversely affect spawning gravels, result in increased poaching activity, decreased survival of fish eggs and juveniles, decrease benthic invertebrate abundance, adversely affect water quality, and impact stream banks and channels."

NMFS. 2003. Non-fishing impacts to essential fish habitat and recommended conservation measures. National Marine Fisheries Service.
- "Potential impacts from mining include 1) adverse modification of hydrologic conditions so as to cause erosion of desirable habitats, 2) removal of substrates that serve as habitat for fish and invertebrates, 3) conversion of habitats, 4) release of harmful or toxic materials, and 5) creation of harmful turbidity levels."
- "The effects of mineral mining on EFH depend on the type, extent, and location of the activities. Minerals are extracted using several methods. Surface mining involves suction dredging, hydraulic mining, panning, sluicing, strip mining, and open-pit mining (including heap leach mining). Underground mining uses tunnels or shafts to extract minerals by physical or chemical means."
- "Mining operations can release harmful or toxic materials and their byproducts, either in association with actual mining, or in connection with machinery and materials used for mining. Mining can also introduce levels of heavy metals and arsenic that are naturally found within the stream bed sediments."

- "Commercial operations may also involve road building, tailings disposal and leaching of extraction chemicals, all of which may create serious impacts to EFH. Cyanide, sulfuric acid, arsenic, mercury, heavy metals, and reagents associated with such development are a threat to EFH. Improper or in-water disposal of tailings may be toxic to managed species or their prey downstream."
- The following are recommended conservation measures to mitigate for mining:
  1. Avoid mineral mining in waters and streams containing EFH.
  2. Schedule necessary in-water activities when the fewest species/least vulnerable life stages of federally managed species will be present.
  3. Use an integrated environmental assessment, management, and monitoring package in accordance with state and federal law. Allow for adaptive operations to minimize adverse effects on EFH.
  4. Avoid spills of dirt, fuel, oil, toxic materials, and other contaminants into EFH. Prepare a spill prevention plan and maintain appropriate spill containment and water repellent/oil absorbent cleanup materials on hand.
  5. Treat wastewater (acid neutralization, sulfide precipitation, reverse osmosis, electrochemical, or biological treatments) and recycle on site to minimize discharge to streams. Test wastewater before discharge for compliance with federal and state clean water standards.
  6. Minimize opportunities for sediments to enter or affect EFH. Use methods such as contouring, mulching, and construction of settling ponds to control sediment transport. Monitor turbidity during operations, and cease operations if turbidity exceeds predetermined threshold levels. Use turbidity/sediment curtains to limit the spread of suspended sediments and minimize the area affected.
  7. Reclaim, rather than bury, mine waste that contains heavy metals, acid materials, or other toxic compounds if leachate can enter EFH through groundwater.
  8. Restore natural contours and plant native vegetation on site after use to restore habitat function to the extent practicable. Monitor the site for an appropriate period of time to evaluate performance and implement corrective measures if necessary.
  9. Minimize the aerial extent of ground disturbance (e.g., through phasing of operations), and stabilize disturbed lands to reduce erosion.

NMFS. 2010b. Biological Opinion: Klamath Project Operations. National Marine Fisheries Service, Southwest Region.

- "All California instream suction dredge mining has been suspended following the Governor's signature on a new state law. The ban will be in effect until CDFG completes a court-ordered environmental review of its permitting program, expected in late summer 2011. The moratorium on instream suction dredge mining took effect immediately as an urgency measure, prohibiting the use of vacuum or other suction dredging equipment for instream mining in reliance on any permit previously issued by CDFG. The moratorium does not apply to suction dredging operations performed for the regular maintenance of energy or water supply management infrastructure, flood control, or navigational purposes."

Nonnative Species

Upper Columbia Salmon Recovery Board (UCSRB). 2007. Upper Columbia spring Chinook salmon and steelhead recovery plan. Upper Columbia Salmon Recovery Board. Available: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Interior-Columbia/Upper-Columbia/upload/UC_Plan.pdf. (October 2009).

- A critical uncertainty in the management of Salmon in the Upper Columbia River is the effect of invasive species on the viability of listed populations in the Upper Columbia Basin.
- Brook trout is an invasive species within the Upper Columbia Basin that competes with bull trout for food and space. Research is needed to assess the direct and indirect effects of invasive species (including invasive plants) on the abundance and survival of spring Chinook, steelhead, and bull trout in the Upper Columbia Basin.
- American shad may affect the abundance and survival of spring Chinook and steelhead in the lower Columbia River. It is possible that the growing population of shad is competing directly with juvenile Chinook and steelhead by cropping food sources important to salmonids in the lower Columbia River. It is also possible that the large numbers of shad in the lower river contribute to the growth of northern pikeminnow, smallmouth bass, and walleye, which are important predators of salmon and steelhead.

Zimmerman, M.P. 1999. Food habits of smallmouth bass, walleyes, and northern pikeminnow in the lower Columbia River basin during outmigration of juvenile anadromous salmonids. Transactions of the American Fisheries Society 128:1036-1054.

- A predator-prey study in the impounded and unimpounded lower Columbia River indicated relatively high rates of juvenile salmonid consumption by smallmouth bass during the summer.
- Smallmouth bass preyed on relatively small juvenile salmonids. They consumed few steelhead, preyed on smaller chinook salmon in spring than northern pikeminnow, and consumed far more subyearling chinook salmon in summer than yearling chinook salmon in spring. An important consequence of size-selective predation would be increased vulnerability of wild juvenile salmonids, which are typically smaller than those reared in hatcheries.

Nobriga, M.L. & M. Chotkowski. 2000. Recent historical evidence of centrarchid increases and tulle perch decrease in the Delta. Interagency Ecological Program Newsletter 131:23-27.

- Nobriga and Chotkowski (2000) found a significant increasing trend in nonnative centrarchid species that prey on juvenile salmonids in the Sacramento-San Joaquin Delta in correspondence with increasing spread of nonnative aquatic macrophytes.

Cohen, A.N., and P.B. Moyle. 2004. Summary of data and analyses indicating that exotic species have impaired the beneficial uses of certain California waters. A report submitted to the State Water Resources Control Board on June 14, 2004.

- The introduction of exotic Asiatic freshwater clams Corbicula fluminea and Potamocorbula amurensis in the Sacramento-San Joaquin estuary disrupted the normal benthic community structure and depressed phytoplankton levels in the estuary due to the highly efficient filter feeding of the introduced clams.
- The decline in the levels of phytoplankton reduces the population levels of zooplankton that feed upon them, and hence reduces the forage base available to salmonids transiting the Delta and San Francisco estuary which feed either upon the zooplankton directly or their mature forms.

NMFS. 2002b. Biological opinion for the proposed license amendment for the Potter Valley Project (Federal Energy Regulatory Commission Project Number 77-110). National Marine Fisheries Service, Southwest Region. Available: http://swr.nmfs.noaa.gov/psd/Final_Potter_Valley_Project_BO.pdf. (November 2009).

- The introduction of nonnative Sacramento pike minnow in the mainstem Eel River has increased the risk of predation of juvenile salmonids. Sacramento pikeminnow impacts are exacerbated by the presence of dam structures and reservoirs, and by summer thermal conditions and low flow that provide ideal conditions for Sacramento pikeminnow in the reservoir and mainstem Eel River.

Sanderson, B. L., K. A. Barnas, and A. M. Wargo. 2009. Nonindigenous species of the Pacific Northwest: an overlooked risk to endangered salmon. BioScience 59:245-256.

- "Throughout the Pacific Northwest, the causes of salmon population declines have been dominated by a discussion of the impact of the all-H's—hydrosystem, hatchery, harvest, and habitat. This all-H-centric view has largely ignored the impacts of key Nonindigenous species (NIS) in Pacific Northwest watersheds, which may rival the detrimental effects of the all-H's. For example, on a per-run basis, the mortality attributed to NIS predation may be similar to that associated with juvenile passage through each of the eight dams on the Columbia and Snake rivers, estimated at approximately 5% to 15% per dam."
- "Despite clear evidence of the impact of NIS, a consideration of their role still falls outside all-H thinking. To illustrate this point and to quantify the level of funding directed to studies of nonnative species, we analyzed the $385 million that the Bonneville Power Administration (BPA) Fish and Wildlife program has allocated to research, restoration and enhancement projects from 2007 to 2009."
- "Results of our survey indicate that of the $385 million distributed by BPA over the three-year study period, only approximately 0.3% was directed in whole or in part toward research on the impacts of NIS, and slightly less than 1% of funds were allocated to efforts to control nonindigenous fish species."

- "Future opportunities for understanding and managing NIS already exist within ongoing research and management programs. For example, as a cohort of juvenile salmon travel from their natal habitats to the ocean, what proportion of those individuals is lost to predation by nonnative species? Because many of the major NIS predators are popular game fishes managed by state agencies, the predator biomass data needed to quantify predation rates on salmonids are quite likely available. Additionally, native predator programs exemplify how the region might develop similar programs to mitigate the damage imposed by NIS and improve the chances of recovery for native species at risk. Only with a broad examination of NIS ecology and impacts by both existing and new research programs can we begin to answer questions that are key to evaluating the cumulative impact of NIS on salmonids."

NMFS. 2008a. Federal Columbia River power system biological opinion. National Marine Fisheries Service. Available: http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/final-BOs.cfm. (October 2009).

- Found in lakes, rivers, and streams, smallmouth bass (Micropterus dolomieu) have relatively large mouths that enable them to consume juvenile fish, including salmonids.
- Smallmouth bass are the dominant predators in reservoirs of the lower Snake River and are co-dominant with northern pikeminnow and percids in certain reaches of the Snake River.

NMFS. 2009. Biological opinion and conference opinion on the long-term operations of the Central Valley Project and State Water Project. National Marine Fisheries Service, Southwest Region.

- "From October 1976 to November 1993, CDFG conducted 10 mark/recapture studies at the SWP's Clifton Court Forebay to estimate pre-screen losses using hatchery-reared juvenile Chinook salmon. Pre-screen losses ranged from 69 percent to 99 percent. Predation by striped bass is thought to be the primary cause of the loss."

Upper Columbia Salmon Recovery Board (UCSRB). 2007. Upper Columbia spring Chinook salmon and steelhead recovery plan. Upper Columbia Salmon Recovery Board. Available: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Interior-Columbia/Upper-Columbia/upload/UC_Plan.pdf. (October 2009).

- "Exotic species are more likely to interact with spring Chinook, steelhead, and bull trout because exotics have not had time to segregate spatially or temporally in their resource use. For example, there is a possibility that brook trout interact with spring Chinook, steelhead, and bull trout in the upper basin."

Offshore Drilling

Helvey, M. 2002. Are southern California oil and gas platforms essential fish habitat? ICES Journal of Marine Science 59:S266-S271. Available: icesjms.oxfordjournals.org/cgi/reprint/59/suppl/S266.pdf. (January 2010).

- Physical, chemical, and biological disturbances that can result from offshore oil and gas operations include:
    - Noise from seismic surveys, vessel traffic, and construction of drilling platforms or islands, traffic from vessels.
    - Physical alterations to habitat from the construction, presence and eventual decommissioning and removal of facilities such as islands or platforms, storage and production facilities, and pipelines to onshore common carrier pipelines, storage facilities, or refineries.
    - Waste discharges including well drilling fluids, produced waters, surface runoff and deck drainage, domestic waste waters generated from the offshore facility, solid-waste from wells (drilling muds and cuttings) and other trash and debris from human activities associated with the facility.
    - Oil spills.

Heintz, R.A., S.D. Rice, A.C. Wertheimer, R.F. Bradshaw, F.P. Thrower, J.E. Joyce, J.W. Short. 2000. Delayed effects on growth and marine survival of pink salmon Oncorhynchus gorbuscha, after exposure to crude oil during embryonic development. Marine Ecology Progress Series 208:205-216.

- Heintz et al. (2000) report delayed effects on the growth and marine survival of pink salmon Oncorhynchus gorbuscha, which were exposed to oil as embryos under conditions similar to those observed after the 'Exxon Valdez' oil spill.
- Pink salmon eggs were incubated in water that became contaminated with polynuclear aromatic hydrocarbons (PAHs) after percolating through gravel coated with weathered oil.
- Pink salmon exposed to an initial concentration of total PAH equal to 5.4 ppb experienced a 15% decrease in marine survival compared to unexposed salmon. A delayed effect on growth was measured in juvenile salmon that survived embryonic exposure to doses as low as 18 ppb PAH.
- The demonstration of delayed effects on growth and survival support claims of delayed effects in pink salmon after the 'Exxon Valdez' oil spill, and indicate the potential for population-level effects resulting.

Wertheimer, A.C., R.A. Heintz, J.F. Thedinga, J.M. Maselko, S.D. Rice. 2000. Straying of adult pink salmon from their natal stream following exposure as embryos to weathered Exxon Valdez crude oil. Transactions of the American Fisheries Society 129:989-1004.

- Numbers of strays (adult salmon returning to a nonnatal stream), straying rates, and distribution of strays were estimated for pink salmon incubated in oil-contaminated gravel and for an unexposed control group.

- Although the frequency of observed strays was 30% and 9% (respectively) higher than the controls for the low- and high-dose groups, the differences among treatments were not statistically significant, and the rates did not increase with total polynuclear aromatic hydrocarbon dose. Exposed fish tended to be recovered at a greater distance from the natal stream than were control fish.
- Our results do not support the hypothesis that oil exposure of embryos in intertidal spawning grounds was responsible for the high rates of straying of wildstock pink salmon that were observed in Prince William Sound after the Exxon Valdez oil spill.

Carls, M.G., R.E. Thomas, S.D. Rice. 2003. Mechanism for transport of oil-contaminated water into pink salmon redds. Marine Ecology Progress Series 248:245-255.

- Carls et al. (2003) demonstrated that tides and the resultant hydraulic gradients provide a mechanism for groundwater transport of soluble and slightly soluble contaminants (such as oil) from beaches surrounding streams into the hyporheic zone where pink salmon eggs incubate. Oil may reach nearshore areas and affect productive nursery grounds or areas containing high densities of fish eggs and larvae.

Carls, M.G., S.D. Rice, J.E. Hose. 1999. Sensitivity of fish embryos to weathered crude oil: Part 1. Low Level exposure during incubation causes malformations and genetic damage in larval Pacific herring (Clupea pallasi). Environmental Toxicology and Chemistry 18:481-493.

- Pacific herring eggs were exposed for 16 days to weathered Alaska North Slope crude oil. Exposure to an initial aqueous concentration of 0.7 parts per billion polynuclear aromatic hydrocarbons (PAHs) caused malformations, genetic damage, mortality, and decreased size and inhibited swimming. Total aqueous PAH concentrations as low as 0.4 ppb caused sublethal responses such as yolk sac edema and immaturity consistent with premature hatching.

NMFS. 2003. Non-fishing impacts to essential fish habitat and recommended conservation measures. National Marine Fisheries Service.

- "These disturbances include 1) noise from seismic surveys, vessel traffic, and construction of drilling platforms or islands, traffic from vessels, 2) physical alterations to habitat from the construction, presence and eventual decommissioning and removal of facilities such as islands or platforms, storage and production facilities, and pipelines to onshore common carrier pipelines, storage facilities, or refineries, 3) waste discharges including well drilling fluids, produced waters, surface runoff and deck drainage, domestic waste waters generated from the offshore facility, solid-waste from wells (drilling muds and cuttings) and other trash and debris from human activities associated with the facility, 4) oil spills, and 5) platform storage, and pipeline decommissioning."
- "Noise sources may generate sound pressure that can disrupt or damage marine life. Oil and gas activities may generate noise from drilling activities, construction, production facility operations, seismic exploration and supply vessel and barge movements (see

Section 4.5). The impacts of oil exploration related seismic energy releases may interrupt and cause fish to disperse from the acoustic pulse with possible disruption to their feeding patterns."

- "Oil spills are a serious potential source of contamination to the marine environment from oil and gas development. Offshore oil and gas development will inevitably result in some oil entering the environment. Most spills are expected to be of small size, although there is a potential for large spills to occur. Many factors determine the degree of damage from a spill, including the type of oil, size and duration of the spill, geographic location of the spill, and the season. Although oil is toxic to all marine organisms at high concentrations, certain species are more sensitive than others."
- "In whatever quantities, lost oil can affect habitats and living marine resources. Accidental discharge of oil can occur during almost any stage of exploration development, or production on the outer continental shelf (OCS) or in nearshore coastal areas. Oil spills can occur from many possible sources including equipment malfunction, ship collisions, pipeline breaks, other human error, or severe storms. "
- The following are recommended conservation measures to mitigate for Dam effects:
  1. Conduct pre-project biological surveys in consultation with NMFS to determine the extent and composition of biological populations or habitat in the proposed production area. On the basis of the site-specific surveys a determination will be made whether or not the operations are likely to have an adverse effect upon EFH, or that a special biological population/habitat does not exist. Based on the information in the surveys, the following may be recommended:
  a. Redesign facilities to accommodate habitat concerns.
  b. Operate during those periods of time, as established in consultation with NMFS, that do not adversely affect biological resources.
  c. Modify operations to ensure that significant biological populations or habitats deserving protection
  are not affected.
  2. Limit the discharge of produced waters into marine and estuarine environments. Re-inject produced waters into the oil formation whenever possible.
  3. Avoid discharge of muds and cuttings into the marine and estuarine environment. Use methods to grind and re-inject such wastes down an approved injection well or use onshore disposal wherever possible. When not possible, provide for a monitoring plan to quantitatively assess whether effluent discharges are meeting the needs of EFH.
  4. Limit placement of causeways or structures in the nearshore marine environment.
  5. Encourage the use of geographic response strategies that identify EFH and environmentally sensitive areas and identify appropriate cleanup methods to include the prestaging of response equipment.
  6. Use methods to transport oil and gas that limit the need for handling in environmentally sensitive areas, including EFH.
  7. Prohibit drilling of the first development well into the targeted hydrocarbon formations during hazardous or sensitive environmental conditions, such as broken ice.

8. Prohibit drilling of exploration wells into untested formations during hazardous or sensitive environmental conditions.

Road Building

NMFS. 2007. Magnuson-Stevens Reauthorization Act Klamath River Coho Salmon Recovery Plan. Prepared by Rogers, F. R., I. V. Lagomarsino and J. A. Simondet for the National Marine Fisheries Service, Long Beach, CA. 48 pp. Available: http://swr.nmfs.noaa.gov/salmon/MSRA_RecoveryPlan_FINAL.pdf. (November 2009).

- "Implementing measures to reduce sediment input from upslope sources is critically necessary within the mid-Klamath River HSA, where vast road networks continue to degrade and contribute fine sediment into the stream environment."
- "Little-used road segments and skid trails should be decommissioned when possible; those not decommissioned should be upgraded and maintained to reduce hydrologic connectivity between upslope road surfaces and the aquatic environment."
- "Large, severe wildland fires can also precipitate chronic sediment routing between upslope sources and stream channels, particularly when coupled with salvage logging. Landscapes scorched by intense fire lose soil integrity as plant and tree roots degrade, triggering landslides that introduce large quantities of sediment into creeks and rivers. Re-establishing a more natural fire regime of smaller, more frequent controlled burns can help prevent the buildup of understory vegetation that fuel large, hot, catastrophic fires."
- "In light of the heavy road development within much of the HSA, impaired fish passage at road crossings is commonly a bottleneck to migrating coho salmon. Many roads administered by the California Department of Transportation have faulty or poorly designed culverts that block upstream and downstream migration."
- "Problem culverts should first be inventoried and ranked in order to optimize use of limited funding resources."

Trombulak, S.C., C.A. Frissell. 2000. Review of ecological effects of roads on terrestrial and aquatic communities. Conservation Biology 14(10):18-30.

- Trombulak and Frissell (200) reviewed scientific literature on the ecological effects of roads and found support for the general conclusion that they are associated with negative effects on biotic integrity in both terrestrial and aquatic ecosystems.

Madej, M.A. 2001. Erosion and sediment delivery following removal of forest roads. Earth Surface Processes and Landforms 26:175-190.

- Erosion control treatments were applied to abandoned logging roads in California, with the goal of reducing road-related sediment input to streams and restoring natural hydrologic patterns on the landscape. Treatment of stream crossings involved excavating culverts and associated road fill and reshaping streambanks. A variety of techniques were applied to road benches, which included decompacting the road surface, placing unstable road fill in more stable locations, and reestablishing natural surface drainage patterns.

- Sediment delivery from treated roads in upper, middle and lower hillslope positions was 10, 135, and 550 m of sediment/kilometer of treated roads, respectively. In contrast, inventories of almost 500 km of forest roads in adjacent catchments indicate that untreated roads produced 1500 to 4700 m of sediment/km of road length.
- Although road removal treatments do not completely eliminate erosion associated with forest roads, they do substantially reduce sediment yields from abandoned logging roads.

Castro, J. 2003. Geomorphologic impacts of culvert replacement and removal: avoiding channel incision. Portland, OR: U.S. Fish and Wildlife Service - Oregon Fish and Wildlife Office.

- Channel incision can often occur downstream of a culvert and generally moves upstream, potentially affecting fish habitat and impeding fish passage. An existing culvert can act as a grade control, halting the upstream progression of a headcut and causing further channel regrade.

WSCC. 2001b. Habitat limiting factors: Yakima River Watershed. Washington State Conservation Commision. Available: http://www.scc.wa.gov/index.php/287-WRIA-37-38-39-Yakima-River-Watershed/View-category.html. (October 2009).

- Actions that destabilize the landscape in high slope areas such as logging or road construction increase the frequency and severity of mass wasting events, leading to increased sedimentation.
- Stormwater runoff (particularly from roads), surface erosion, and increased streambank erosion are the main contributors of turbidity in the water column that may affect survival of eggs or fish.
- Bad roads have not only contributed excessive sediment loads to the stream system through erosion of road surfaces, cut and fill slopes, and road ditches, they have also increased the erosiveness of the stream environment by channelizing diffuse flow and delivering it rapidly to the stream, thereby increasing peak flows.

NMFS. 2002. Biological Opinion: Klamath Project Operations. National Marine Fisheries Service.

- “Roads associated with timber harvesting account for a large portion of the erosion occurring in logged areas. Poor road design, location, construction and maintenance caused erosion of all types: mass soil movement, surface, gullies, and stream bank. Harvesting has expanded from established roads into more inaccessible terrain and areas of greater environmental risk.”
- “Road systems, skid trails, and landings where the soils become compacted may also accelerate runoff.”

NMFS. 2003. Non-fishing impacts to essential fish habitat and recommended conservation measures. National Marine Fisheries Service.

- The effects of roads on aquatic habitat can be profound and include 1) increased deposition of fine sediments, 2) changes in water temperature, 3) elimination or introduction of migration barriers such as culverts, 4) changes in streamflow, 5) introduction of non-native plant species, and 6) changes in channel configuration.
- Roads can lead to increased rates of natural processes such as debris or landslides and sedimentation when slopes are destabilized and surface erosion and soil mass movement increases.
- Erosion is most severe when poor construction practices are allowed, combined with inadequate attention to proper road drainage and maintenance practices. Mass movement risks increase when roads are constructed on highhazard soils and overly steep slopes. In steep areas prone to landslides, rates of mass soil movements affected by roads include shallow debris slides, deep-seated slumps and earthflows, and debris flows.
- The following are recommended conservation measured to mitigate for road building:
  1. Avoid locating roads near fish-bearing streams. Roads should be sited to avoid sensitive areas such as streams, wetlands, and steep slopes.
  2. Incorporate erosion control and stabilization measures into road construction plans to reduce erosion potential.
  3. Build bridges when possible. If culverts are to be used, they should be sized, constructed, and maintained to match the gradient and width of the stream, so as to accommodate 100-year flood flows, but equally to provide for migratory passage of adult and juvenile fishes. Utilize guidelines provided in the document: "Guidelines for Salmonid Passage at Stream Crossing," NOAA Fisheries, Southwest Region, October 2001 (http://swr.nmfs.noaa.gov/hcd/NMFSSCG.PDF).
  4. Locate stream crossings in stable stream reaches.
  5. Design bridge abutments to minimize disturbances to streambanks and place abutments outside of the floodplain whenever possible.
  6. Avoid road construction across alluvial floodplains, mass wastage areas, or braided stream bottom lands unless site-specific protection can be implemented to ensure protection of soils, water, and associated resources.
  7. Avoid side-casting of road materials into streams year-round.
  8. Use only native vegetation in stabilization plantings.
  9. Maintenance practices should not cause existing problems to worsen.

NMFS. 2007a. Puget Sound Salmon Recovery Plan. NMFS. Available: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/PS-Chinook-Plan.cfm. (October 2009).

- "5,451 miles of road development occurs in the Olympic and Mt. Baker-Snoqualmie National Forest land surrounding Puget Sound. A majority of stream crossings in the

national forest road system in the Pacific Northwest cannot tolerate more than a 25-year flow event without the failure of culverts and other structures associated with the road system."

Beschta, R.L., M.R. Pyles, A.E. Skaugset, C.G. Surfleet. 2000. Peak flow response to forest practices in the western Cascades of Oregon, U.S.A. Journal of Hydrology 233:102-120.

- "Federal land management agencies in the Pacific Northwest are expending large sums of money to alter and obliterate roads on forested watersheds, partially because of concerns about forestry related peakflow increases…While forest roads may represent an important issue in mountainous terrain (e.g. slope stability, surface erosion), the analysis by Thomas and Megahan (1998) of the identical peakflow data sets used by Jones and Grant (1996) and our analysis of modified peakflow data sets for the same small watersheds do not support the concept that relatively large peakflows are increased by forest practices. "

Flanders, L.S., J. Cariello. 2000. Tongass road condition survey report. Technical Report 00-7. Douglas, AK: Alaska Department of Fish and Game, Southeast Regional Office of the Habitat and Restoration Division.

- "Velocity is the most common cause of fish passage restriction in culverts. If a culvert is installed at too steep a gradient or the culvert width is significantly narrower than the streambed width, the water velocity will be increased within the culvert. Very slight changes in the slope of the culvert and the roughness of the substrate within the culvert may significantly change velocity and the ability of fish to pass through the culvert during all of the times of year when they normally move upstream or downstream. Other frequent causes of fish passage problems include perching of the culvert outlet above the water surface, blockage by excessive substrate or woody debris within the culvert and structural damage to the culvert. In most cases, multiple factors interact to restrict fish passage."

NMFS. 2001. Guidelines for salmonid passage at stream crossings. NOAA Fisheries, Southwest Region, Long Beach, CA.

- This document provides guidelines for design of stream crossings to aid upstream and downstream passage of migrating salmonids. It is intended to facilitate the design of a new generation of stream crossings, and assist the recovery of threatened and endangered salmon species. These guidelines are offered by the National Marine Fisheries Service, Southwest Region (NMFS-SWR), as a result of its responsibility to prescribe fishways under the Endangered Species Act, the Magnuson-Stevens Act, the Federal Power Act, and the Fish and Wildlife Coordination Act. The guidelines apply to all public and private roads, trails, and railroads within the range of anadromou salmonids in California.
- The following are the alternative methods for designing or replacing culverts. The document describes them in detail:

- Active Channel Design Method
    - The Active Channel Design method is a simplified design that is intended to size a culvert sufficiently large and embedded deep enough into the channel to allow the natural movement of bedload and formation of a stable bed inside the culvert.
- Stream Simulation Design Method
    - The Stream Simulation Design method is a design process that is intended to mimic the natural stream processes within a culvert. Fish passage, sediment transport, flood and debris conveyance within the culvert are intended to function as they would in a natural channel.
- Hydraulic Design Method
    - The Hydraulic Design method is a design process that matches the hydraulic performance of a culvert with the swimming abilities of a target species and age class of fish. This method targets distinct species of fish and therefore does not account for ecosystem requirements of non-target species.

NMFS. 2010b. Biological Opinion: Klamath Project Operations. National Marine Fisheries Service, Southwest Region.

- "In many instances, ongoing maintenance of these roads is lacking or non-existent, leading to continuing impact. Where roads cross salmonid bearing streams, improperly placed culverts have blocked access to many stream reaches. Landslides and chronic surface erosion from road surfaces are large sources of sediment across the range of the species. Roads also have the potential to increase peak flows with consequent effects on the stability of stream substrates and banks. The consequent impacts on habitat include reductions in spawning, rearing and holding habitat, and increases in turbidity."
- "Across the SONCC ESU, this excessive sediment has contributed to decreased survival to emergence as spawning gravels are filled with fine sediments, reduced carrying capacity for juvenile salmonids due to pool filling and reduced feeding and growth due to high turbidity levels."

Sand Gravel Mining

NMFS. 2003. Non-fishing impacts to essential fish habitat and recommended conservation measures. National Marine Fisheries Service.

- "Mining of sand and gravel is extensive and occurs by several methods. These include wet-pit mining (i.e., remove material from below the water table), dry-pit mining on beaches, exposed bars and ephemeral streambeds, and subtidal mining. Sand and gravel mining in riverine, estuarine, and coastal environments can create EFH impacts including 1) turbidity plumes and resuspension effects, 2) removal of spawning habitat, and 3) alteration of channel morphology."

- “Mechanical disturbance of EFH spawning habitat by mining equipment can also lead to high mortality rates in early life stages. One result is the creation of turbidity plumes which can move several kilometers downstream. Sand and gravel mining in riverine, estuarine, and coastal environments can also suspend materials at the sites. Sedimentation may be a delayed effect, because gravel removal typically occurs at low flow when stream has the least capacity to transport fine sediments out of the system. Another delayed sedimentation effect results when freshets inundate extraction areas that are less stable than before.”
- “Additionally, extraction of sand and gravel in riverine ecosystems can directly eliminate the amount of gravel available for spawning if the extraction rate exceeds the deposition rate of new gravel in the system. Gravel excavation also locally reduces the supply of gravel to downstream habitats.”
- “Mining can also alter channel morphology by making the stream channel wider and shallower. Consequently, the suitability of stream reaches as rearing EFH may be decreased, especially during summer low-flow periods when deeper waters are important for survival.”
- The following are recommended conservation measures to mitigate for mining:
  1. Avoid sand/gravel mining in waters containing EFH. Many factors influence site selection for a gravel or sand mining site.
  2. Identify upland or off-channel (where channel will not be captured) gravel extraction sites as alternatives to gravel mining in or adjacent to EFH, if possible.
  3. Design, manage, and monitor sand and gravel mining operations to minimize potential direct and indirect impacts to EFH if operations in EFH cannot be avoided. This includes, but is not limited to, migratory corridors, foraging and spawning areas, stream/river banks, intertidal areas, etc.
  4. Minimize the areal extent and depth of extraction.
  5. Include restoration, mitigation, and monitoring plans in sand/gravel extraction plans.

Rempel, L. L. and M. Church. 2009. Physical and ecological response to disturbance by gravel mining in a large alluvial river. Canadian Journal of Fisheries and Aquatic Sciences 66:52-71.

- The role of sediment transport during high flows for restoring fish habitat was demonstrated following an experimental gravel removal from Fraser River, B.C. Effects of mining on the fish community could not be confirmed. Benthic invertebrates recolonized the removal site immediately after mining, and differences in community composition compared with three reference sites disappeared during the first flood. Results suggest that physical changes due to this mining operation fell within the range to which local aquatic populations are accustomed during flooding, because the ecological response was modest and short-lived.

Norman, D. K,, C. J. Cederholm, and W. S. Lingley. 1998. Flood plains, salmon habitat, and sand and gravel mining. Washington Geology 26 (2/3): 3-20.

- "Avulsion is characteristized by a sudden change in the course of a river that causes it to break through a low point such as a meander neck (to form an oxbow lake) or to rush into a gravel pit. Avulsion events occur in gravel pit lakes because the pit surface is lower than the river."
- "When a river breaches a pit, the river biota can be catastrophically changed. Water temperatures may rise during summer and early fall because the relatively slack water in the pits is exposed to sunlight for long periods. While moderate increases in water temperature can increase growth rates, large increases can cause disease outbreaks and may kill significant numbers of adult and juvenile fish."
- "Pits that are warmer than the adjacent river may be ideal habitat for warm-water fish, such as largemouth bass or yellow perch, which are predators of juvenile salmon."
- The following are effects of avulsion to the river channel:
    - Lowering the river bed upstream and downstream of mining operations, causing river bed erosion and channel incision and bank erosion and collapse.
    - Changing aquatic habitat
    - Unnaturally simplifying the complex natural stream system.
    - Increasing suspended sediment.
    - Abandoning reaches of spawning gravels or damaging these gravels by channel erosion or deposition of silts in spawning and rearing reaches.

Brown, A.V., M.M. Lyttle, and K.B. Brown. 1998. Impacts of gravel mining on gravel bed streams. Transactions of the American Fisheries Society 127(6):979-994.

- Studied the effects of gravel mining upstream, on-site, and downstream for one large mine in each of three Ozark Plateaus gravel bed streams – also sampled invertebrates and fish at disturbed and reference riffles for 10 small mines
- "Gravel mining significantly altered the geomorphology, fine-particle dynamics, turbidity, and biotic communities."
- "Stream channel form was altered by increased bank-full widths, lengthened pools, and decreased riffles in affected reaches."
- "Fine particulate organic matter transported from riffles to pools was decreased. Biofilm organic content was decreased on flats and increased on remaining riffles. Density and biomass of large invertebrates and density of small invertebrates were reduced at the small, more frequently mined sites. Total densities of fish in pools and game fish in pools and riffles were reduced by the large mines. Silt-sensitive species of fish were less numerous downstream from mines."
- "Attempts to mitigate or restore streams impacted by gravel mining may be ineffective because the disturbance results from changes in physical structure of the streambed over distances of kilometers upstream and downstream of mining sites. Stream morphology was changed by lack of gravel bedload, not by how bedload was removed. Mining gravel from stream channels results in irreconcilable multiple-use conflicts."

Stanislaus River. Report Produced for the Stanislaus River Group. Carl Mesick Consultants, El Dorado, CA.

- Compared characteristics of mined and unmined riffle reaches in the Stanislaus River, CA using historic and current spawning riffle maps
- "Over time, the upstream most riffles in the unmined reaches typically became degraded whereas the downstream riffles usually contain abundant gravel and still function as high quality spawning and rearing habitat. Conversely, the riffles in the mined reaches are typically isolated between ditches or ponds, and so the gravel is scoured away during high flows due to the absence of recruitment."
- Long ditches, 100 to 160ft wide, and large in-river pits were indicative of mined areas – unmined areas were relatively narrow, 60 to 80ft wide, and contained high densities of spawning riffles
- Historical maps indicate loss of upstream spawning riffles and creation of new riffles downstream by newly scoured and deposited materials
- Gravel scoured from riffles in mined reaches is likely absorbed by ditches and pits, which prevents the recruitment of new gravel in mined reaches – suggests that ditches and pits act as a sink for downstream gravel recruitment.

Vessel Operation

Haas, M.A., C.A. Simenstad, Jr., J.R. Cordell, D.A. Beauchamp, B.S. Miller. 2002. Effects of large overwater structures on epibenthic juvenile salmon prey assemblages in Puget Sound, Washington. Prepared for the Washington State Transportation Commission, Washington State Department of Transportation, the U.S. Department of Transportation, and Federal Highway Administration. Final research report No. WA-RS 550.1. 114 p. Available: http://depts.washington.edu/trac/bulkdisk/pdf/550.1.pdf. (January 2010).

- Disruption of vegetation, substrate coarsening, and decreased density of epibenthos at ferry terminals in Puget Sound, Washington, can all be partly attributed to propeller wash of vessels.

NMFS. 2003. Non-fishing impacts to essential fish habitat and recommended conservation measures. National Marine Fisheries Service.

- "An increase in the number and size of vessels can generate more wave and surge effects on shorelines. These vessel-wake, wash events can affect shorelines depending on the wake wave energy, the water depth, and the type of shoreline. Vessel wakes can cause a significant increase in shoreline erosion, impact wetland habitat, and increase water turbidity."
- The following are recommended conservation measures to mitigate for Dam effects:
  1. Locate marinas in areas of low biological abundance and diversity, for example, avoiding dense beds of eelgrass or other submerged aquatic vegetation including macroalgae.

2. Excavate uplands to create marina basins rather than converting intertidal or shallow subtidal to deeper subtidal for basin creation.
3. Avoid the disturbance of beds, mudflats and wetlands as part of the project design. In situations where such impacts are unavoidable, appropriate compensatory mitigation should be incorporated into the project with the approval of appropriate regulatory agencies.
4. Leave marine riparian buffers in place to enhance intertidal microclimate and nutrient input.
5. Adequate monitoring on the success of mitigation efforts should be included as part of the project and incorporated into a mitigation and monitoring plan.
6. Conduct preconstruction surveys by qualified biologists/botanists to identify and map areas of invasive plant species existing within potential project construction areas. Eradication of non-native species should be conducted well in advance of construction.
7. Include low-wake vessel technology, appropriate routes, and best management practices for wave attenuation structures as part of the design and permit process. Vessels should be operated at sufficiently low speeds to reduce wake energy, and no-wake zones should be designated near sensitive habitats.
8. Incorporate best management practices to prevent or minimize contamination from ship bilge waters, antifouling paints, shipboard accidents, shipyard work, maintenance dredging and disposal, and nonpoint source contaminants from upland facilities related to vessel operations and navigation.
9. Locate mooring buoys in water deep to avoid grounding and minimize affects of prop wash. Use subsurface floats or other methods to prevent contact of the anchor line with the substrate.
10. Collect and treat runoff from parking lots and other impervious surfaces to remove contaminants prior to delivery to any receiving waters
11. Locate facilities in areas with sufficient water velocities to dissipate fuels and pollutants from vessels and maintain temperature and dissolved oxygen levels within acceptable ranges.
12. Locate marinas where they do not interfere with drift sectors determining the structure and function of adjacent habitats.

Neira, C., F. Delgadillo-Hinojosa, A. Zirino, G. Mendoza, L. A. Levin, M. Porrachia, D. D. Deheyn. 2009. Spatial distribution of copper in relation to recreational boating in a California shallow-water basin. Chemistry and Ecology 25:417-433.

- Neira et al. (2009) examined the overall effect of the number of boats on the copper levels in the water column and sediment, along with their spatial variability within Shelter Island Yacht Basin (SIYB), San Diego, CA.
- They identified a horizontal gradient of increasing dissolved copper in sediment from outside to the head of SIYB which was coincident with the increasing number of boats. Spatial models found "hotspots" of copper concentration. In the sediment, dissolved

copper exceeded the effect range of 34 mg/kg (where adverse effects to fauna may occur).
- "Potential negative ecological effects of copper on benthic fauna include lowered diversity, impaired reaction to predation, reduced colonization and burrowing, reduced feeding rate or survivorship, impaired habitat selection, fertilization, embryonic development and chemosensation, and inhibition or larval settlement."

Wastewater/Pollutants

Michael, J. H. 2003. Nutrients in salmon hatchery wastewater and its removal through the use of wetland constructed to treat off-line settling pond effluent. Aquaculture 226:213-225.
- "The presence of nutrients in the wastewater of salmonid hatcheries is of growing concern to water quality managers. Presently, Washington State regulations require quiescent settling to remove settleable and suspended solids from the water but do not as yet address nutrient concerns."
- "In order to evaluate the load of nutrients discharged by salmon hatcheries, the Washington Department of Fish and Wildlife (WDFW) initiated two studies. Water from the Issaquah Hatchery, located in a watershed with identified excessive levels of anthropogenic phosphorus in the aquatic system, was monitored for total phosphorus for more than a year at the points of diversion from the creek, at the points of water return to the creek, and at the point of discharge from the off-line settling pond."
- "Monitoring showed that the hatchery's contribution to watershed phosphorus levels was low and that the primary phosphorous input from the hatchery appeared to be the process water as opposed to water from the off-line settling system."
- "In order to evaluate the efficacy of a constructed wetland in the removal of nutrients from a conventional offline settling system, WDFW installed a constructed wetland at the Dungeness Hatchery. Over the course of 4 years of monitoring, the wetland removed most of the solids, phosphorus, and nitrogenous compounds, which resulted in a reduction in biological oxygen demand (BOD) of the influent water. At times, the offline settling system actually increased the level of some of the nutrients, suggesting that treatment of hatchery effluent will need to include a combination of quiescent settling, constructed wetland, and some sort of process water treatment if anthropogenic solids and nutrients are to be more completely removed. The constructed wetland also provided habitat used by amphibians and birds for breeding and foraging. At facilities in locations with sufficient land base available to develop a constructed wetland, it should be possible to reduce the nutrient input to receiving waters and provide additional habitat for aquatic animals."

NMFS. 2003. Non-fishing impacts to essential fish habitat and recommended conservation measures. National Marine Fisheries Service.

- "There are many potential impacts from point-source discharge, but it is important to note that pointsource discharges and resulting altered water quality in aquatic environments does not necessarily result in adverse impacts to either marine resources or EFH. Because most point-source discharges are regulated by the state or EPA, effects to receiving waters are generally considered in those cases. Pointsource discharges can adversely affect EFH by 1) reducing habitat functions necessary for growth to maturity, 2) modifying community structure, 3) bioaccumulation, and 4) modifying habitat."
- The following are recommended conservation measures to mitigate for Wastewater effects:
  1. Locate discharge points in coastal waters well away from shellfish beds, sea grass beds, coral reefs, and other similar fragile and productive habitats.
  2. Reduce potentially high velocities by diffusing effluent to acceptable velocities.
  3. Determine benthic productivity by sampling prior to any construction activity related to installation of new or modified facilities. Outfall design (e.g., modeling concentrations within the predicted plume or likely extent of deposition along a productive nearshore), should be developed with input from appropriate resource and Tribal agencies.
  4. Provide for mitigation when the degradation or loss of habitat from placement and operation of the outfall structure and pipeline.
  5. Institute source-control programs that effectively reduce noxious materials to avoid introducing these materials into the waste stream.
  6. Ensure compliance with pollutant discharges regulated through discharge permits which set effluent discharge limitations and/or specify operation procedures, performance standards, or best management practices.
  8. Discharges should be treated to the maximum extent practicable, including implementation of up-todate methodologies for reducing discharges of biocides (e.g., chlorine) and other toxic substances.
  9. Use land-treatment and upland disposal/storage techniques where possible. Use of vegetated wetlands as natural filters and pollutant assimilators for large-scale discharges should be limited to those instances where other less damaging alternatives are not available and the overall environmental and ecological suitability of such an action has been demonstrated.
  10. Avoid siting pipelines and treatment facilities in wetlands and streams. Since pipelines and treatment facilities are not water dependent with regard to positioning, it is not essential that they be placed in wetlands or other fragile coastal habitats. Avoiding placement of pipelines within streambeds and wetlands will also reduce inadvertent infiltration into conveyance systems and retain natural hydrology of local streams and wetlands.

NMFS. 2007a. Puget Sound Salmon Recovery Plan. NMFS. Available: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/PS-Chinook-Plan.cfm. (October 2009).

- "In two of the most urban watersheds, King County's Comprehensive Plan and Regional Wastewater Service Plan both support the use of reclaimed water to help meet the region's diverse water supply needs. A specific goal is to use reclaimed water to assist the region in balancing needs of the environment and people. In 2004, King County used or distributed 268 million gallons of reclaimed water in place of drawing new potable water. Through substituting reclaimed water for potable water in operations at its two wastewater treatment plants alone, King County is leaving approximately 700,000 gallons of water per day in streams and rivers. This represents only a fraction of the potential of reclaimed water to benefit instream flows for salmon in the region, and King County is embarking on a regional water supply plan to bring a larger supply of reclaimed water to the region."

NMFS. 2009e. The use of treated wood products in aquatic environments: Guidelines to West Coast NOAA fisheries staff for Endangered Species Act and Essential Fish Habitat consultations in the Alaska, Northwest and Southwest Regions. NOAA Fisheries, Southwest Region.

- Main contaminants of concern in treated wood products are copper and polycyclic aromatic hydrocarbons (PAHs)
- "It is widely acknowledged that creosote and copper-treated wood products leach contaminants into the aquatic environment. The rate of leaching for both categories of products drops off rapidly following installation. For copper treated products…Effect level thresholds may only be exceeded for short periods of time. Copper can accumulate in sediments, where its bioavailability depends upon site-specific conditions. While the initial rate of leaching from creosote-treated pilings drops off rapidly, leaching stays elevated at easily detectable levels for many years and perhaps decades…PAHs from creosote also accumulate in sediments, where they are subject to degradation. However, the high molecular weight fraction can take a long time to degrade and contains known mutagens, teratogens, and carcinogens, which are most often associated with impacts to benthic species."
- "For copper, the most sensitive sublethal endpoint may be salmonid olfaction. This may be impacted by an increase in dissolved copper concentrations as low as 0.79 ug/L above background levels…However, the models and studies related to copper treated wood products show the impacts are localized and only prevalent with large surface area uses (such as bulkheads) in many cases. For creosote, the main impact of concern is accumulation in the sediments…Sediment impacts are also expected to occur on a localized scale. The impacts may occur for a longer period of time and at lower treated wood densities than the potential impacts of copper-treated products."
- In general, copper-treated products are considered to be safer than creosote-treated products
- In general, most projects using treated wood products do not pose a measurable risk to aquatic organisms unless large amounts of treated wood are used – keeping this in mind, each project needs to be evaluated on a case-by-case basis taking local conditions into consideration.

Arkoosh, M.R., and T.K. Collier. 2002. Ecological risk assessment paradigm for salmon: analyzing immune function to evaluate risk. Human and Ecological Risk Assessment 8(2):265-276.

- "Our research identifies and supports the possibility that certain environmental contaminants can alter salmon survival, and as a result may contribute to these species being at risk."
- "We have shown that juvenile Chinook salmon are exposed to polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) as they migrate through a contaminated urban estuary in Puget Sound WA. Immune function was analyzed in these fish by examining the ability of their anterior kidney and splenic leukocytes to produce a primary and secondary *in vitro* plague-forming cell (PFC) response to the hapten, trinitrophenyl (TNP), and by determining their susceptibility to a marine pathogen, *Vibrio anguillarum*. We found that fish outmigrating from the urban estuary produced a significantly lower PFC response to TNP and were more susceptible to the pathogen, compared to juvenile salmon collected from a rural estuary during their outmigration. In the laboratory, we exposed juvenile Chinook salmon collected from a hatchery to either a PCB technical mixture or a PAH compound to determine if these contaminants have the potential to alter immune function in salmon. Indeed, we found that salmon exposed in the laboratory to either the PCB mixture or the PAH also produced lower PFC responses and were more susceptible to disease compared to animals treated with the solvent vehicle. In summary, contaminants such as PAHs and PCBs are demonstrated to influence salmon health, and thus have the potential to adversely impact salmon populations."
- Authors conclude that juvenile salmon from polluted estuaries are at an increased risk for being immunosuppressed and more susceptible to disease than salmon from less polluted waters
- Authors point out studies that suggest that small decrease in first-year mortality could potentially reduce downward population trends and point to reducing contaminant levels as one way to accomplish this

Wetland Alteration

NMFS. 2008a. Federal Columbia River power system biological opinion. National Marine Fisheries Service. Available: http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/final-BOs.cfm. (October 2009).

- More than 50% of the original marshes and spruce swamps in the estuary have been converted to industrial, transportation, recreational, agricultural, or urban uses. More than 3,000 acres of intertidal marsh and spruce swamps have been converted to other uses since 1948. Many wetlands along the shore in the upper reaches of the estuary have been converted to industrial and agricultural lands after levees and dikes were constructed.

WSCC. 2002. Salmonid habitat limiting factors water resource inventory areas 33 (lower) and 35 (middle) Snake watersheds, and lower six miles of the Palouse River. Washington State Conservation Commission. Available: http://www.scc.wa.gov/index.php/288-WRIA-33-34-35-Snake-River-Watershed/View-category.html. (October 2009).

- "An extensive wetland complex was present near Dodge until the early 1900s when a local farmer channelized Pataha Creek, a Snake River tributary, to drain the wetlands. The channel modification coupled with conversion of thousands of acres of perennial grasslands to dryland wheat production led to rapid downcutting throughout the length of the stream channel. The historic floodplain became a terrace which no longer had a water table to support riparian vegetation."

NMFS. 2007a. Puget Sound Salmon Recovery Plan. NMFS. Available: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/PS-Chinook-Plan.cfm. (October 2009).

- "A mere 2% to 3% of the historic estuarine mudflats, saltwater marshes and wetlands remain for juvenile Chinook to use as they make their way from freshwater and the saltwater wedge out into the Sound as they head for the ocean waters."

Sommer, T., B. Harrell, M. Nobriga, R. Brown, W. Kimmerer, and L. Schemel. 2001a. California's Yolo Bypass: Evidence that flood control can be compatible with fisheries, wetlands, wildlife, and agriculture. Fisheries 26:(8)6-16.

- "Unlike conventional flood control systems that frequently isolate rivers from ecologically-essential floodplain habitat, California's Yolo Bypass has been engineered to allow Sacramento Valley floodwaters to inundate a broad floodplain. From a flood control standpoint, the 24,000 ha leveed floodplain has been exceptionally successful based on its ability to convey up to 80% of the flow of the Sacramento River basin during high water events."
- "…field studies demonstrate that the bypass seasonally supports 42 fish species, 15 of which are native. The floodplain appears to be particularly valuable spawning and rearing habitat for the splittail (*Pogonichthys macrolepidotus*), a federally listed cyprinid, and for young Chinook salmon (*Oncorhynchus tshawytscha*), which use the Yolo Bypass as a nursery area. The system may also be an important source to the downstream food web of the San Francisco Estuary as a result of enhanced production of phytoplankton and detrital material…alternative flood control systems can be designed without eliminating floodplain function and processes…"
- "Like natural floodplains, habitat diversity in the Yolo Bypass is much higher than adjacent river channels…has a mosaic of habitats including wetlands, ponds, riparian corridors, and upland areas…data on splittail and salmon growth support observations that natural river-floodplain systems can result in higher fish production on the floodplain than in river channels."

- "…possible improvements to the Yolo Bypass include the construction of more wetlands for wildlife, fixing fish passage and stranding problems at the floodplain weirs, and increasing the frequency of floodplain inundation in drier years."

Woody Debris Removal

Upper Columbia Salmon Recovery Board (UCSRB). 2007. Upper Columbia spring Chinook salmon and steelhead recovery plan. Upper Columbia Salmon Recovery Board. Available: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Interior-Columbia/Upper-Columbia/upload/UC_Plan.pdf. (October 2009).

- Loss of large woody debris and floodplain connectivity have reduced rearing habitat for Chinook, steelhead, and bull trout in larger rivers (e.g., Wenatchee, Entiat, Methow, and Okanogan rivers) in the Upper Columbia Basin.

Benda, L. E., D. J. Miller, T. Dunne, G. H. Reeves, and J. K. Agee. 2001. Dynamic Landscape Systems. In River Ecology and Management, Lessons from the Pacific Coastal Ecoregion. Edited by Naiman, R. J. and R. E. Bilby. Springer Verlag New York, Inc. 175 Fifth Avenue, New York, NY 10010. Pages 261-288.

- Woody debris recruitment is a long-term process since it first requires the presence of a functioning riparian zone comprised of large trees, and second, a means of getting the tree into the stream (i.e. flood, wind storm, landslide, beaver falling a tree, etc.).

Sedell, J. R., P. A. Bisson, F. J. Swanson, and S. V. Gregory. 2000. What We Know About Large Trees That Fall Into Streams and Rivers. Interior Columbia Ecosystem Management Project.

- The most productive habitats for salmonid fish are small streams associated with mature and old-growth coniferous forests where large organic debris and fallen trees greatly influence the physical and biological characteristics of such streams.

Bilby, R. E. and P. A. Bisson. 2001. Function and Distribution of Large Woody Debris. In River Ecology and Management, Lessons from the Pacific Coastal Ecoregion. Edited by Naiman, R. J. and R. E. Bilby. Springer-Verlag New York, Inc. 175 Fifth Avenue, New York, NY 10010. Pages 373-398.

- Large woody debris stabilizes streambeds and banks, captures spawning gravels, encourages pool formation, provides resting and hiding cover for salmonids, and creates habitat for insects and other forage important to salmonids.

NMFS. 2009. Biological opinion and conference opinion on the long-term operations of the Central Valley Project and State Water Project. National Marine Fisheries Service, Southwest Region.

- "The clearing of the riparian forests removed a vital source of snags and driftwood in the Sacramento and San Joaquin River basins. This has reduced the volume of LWD input needed to form and maintain stream habitat that salmon depend on in their various life stages. In addition to this loss of LWD sources, removal of snags and obstructions from the active river channel for navigational safety has further reduced the presence of LWD in the Sacramento and San Joaquin Rivers, as well as the Delta."

Collins, B.D., D.R. Montgomery, A.D. Haas. 2002. Historical changes in the distribution and functions of large wood in Puget Lowland rivers. Canadian Journal of Fisheries and Aquatic Sciences 59:66-76.

- Collins et al. (2002) examined changes in wood abundance and functions in Puget Lowland rivers from the last ~150 years of land use by comparing field data from an 11-km-long protected reach of the Nisqually River with field data from the Snohomish and Stillaguamish rivers and with archival data from several Puget Lowland rivers.
- "Current wood abundance is one to two orders of magnitude less than before European settlement in the Snohomish and Stillaguamish basins. Most importantly, wood jams are now rare because of a lack of very large wood that can function as key pieces and low rates of wood recruitment. These changes in wood abundance and size appear to have fundamentally changed the morphology, dynamics, and habitat abundance and characteristics of lowland rivers across scales from channel unit to valley bottom."
- "Establishing the condition of the riverine landscape before European settlement sets a reference against which to evaluate contemporary conditions and develop restoration objectives."

Dugan, J.E., D.M. Hubbard, D.L. Martin, J.M. Engle, D.M. Richards, G.E. Davis, K.D. Lafferty, R.F. Ambrose. 2000. Macrofauna communities of exposed sandy beaches on the Southern California mainland and Channel Islands. p. 339-346 In: D.R. Brown, Mitchell, K.L., Chang, H.W., eds. Proceedings of the Fifth California Islands Symposium. Minerals Management Service Publication #99-0038. Available: http://www.werc.usgs.gov/chis/DuganetalMMS00.pdf. (January 2010).

- Species richness, abundance, and biomass of macrofauna (e.g., sand crabs, isopods, amphipods and polychaetes) associated with beach wrack are higher compared to beach areas with lower amounts of wrack or that are groomed.
- Beach grooming can substantially alter the macrofaunal community structure of exposed sand beaches. In addition, there are concerns that beach grooming efforts to remove wrack may also harm the eggs of the grunion (Leuresthes tenuis), an important prey item of Pacific salmon.

WSCC. 2001b. Habitat limiting factors: Yakima River Watershed. Washington State Conservation Commision. Available: http://www.scc.wa.gov/index.php/287-WRIA-37-38-39-Yakima-River-Watershed/View-category.html. (October 2009).

- Historically large woody debris in Gold Creek, a Yakima River tributary, included large "old growth" trees, which would serve as stable key pieces in debris jams. "In-channel wood likely was a critical channel roughness element, dissipating stream energy and maintaining the stability of the alluvial channel."
- All of the large, old growth timber in the lower watershed was logged by 1990; there is now little or no residual key-piece size LWD in-channel and no opportunity for recruitment of new LWD key pieces. Although there is a substantial amount of small and medium sized woody debris in Gold Creek (and more is recruited from the banks with each flood), most all of it is readily mobilized by flood flows. Pieces are not large enough to provide bank protection, stable debris jams and stable LWD-related channel features.
- Potentially, the reintroduction of stable LWD features would restore bank stability, and aid in the return of deep pools and prolong the period when upstream fish passage is possible.

WSCC. 2002. Salmonid habitat limiting factors water resource inventory areas 33 (lower) and 35 (middle) Snake watersheds, and lower six miles of the Palouse River. Washington State Conservation Commission. Available: http://www.scc.wa.gov/index.php/288-WRIA-33-34-35-Snake-River-Watershed/View-category.html. (October 2009).

- "Large woody debris or (LWD) is an important component of stream habitat. Large trees that fall into streams, or are carried in by landslides and floods stabilize streambeds, collecting spawning gravels and encouraging pool formation. Woody debris also provides cover for salmonids and their prey. In the past woody debris was removed to aid navigation, transport logs downstream, speed floodwaters downstream, or remove barriers to salmonid migration. Large woody debris is lacking in many streams because of these activities and the reduction or modification of riparian vegetation. Unfortunately woody debris recruitment is a long-term process since it first requires the presence of a functioning riparian zone comprised of large trees, and second, a means of getting the tree into the stream."

NMFS. 2007a. Puget Sound Salmon Recovery Plan. NMFS. Available: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/PS-Chinook-Plan.cfm. (October 2009).

- Log jams in rivers form cool pools and back eddies, providing nursery areas for young fish and resting place for adults migrating upstream. Counts in the Stillaguamish River show current conditions provide approximately 1 piece of large woody debris for every river mile, compared with the desired 80 pieces per mile. This results in a significant loss of channel complexity and function for rearing and refuge.
- Over the next ten years, people of the Stillaguamish will create 51 engineered log jams to provide immediate channel complexity. As riparian planting and other restoration actions take place, the habitat forming processes that contribute large woody debris to the river will recover.

Bisson, P. A. and R. E. Bilby. 2001. Organic Matter and Trophic Dynamics. In River Ecology and Management, Lessons from the Pacific Coastal Ecoregion. Edited by Naiman, R. J. and R. E. Bilby. Springer-Verlag New York, Inc. 175 Fifth Avenue, New York, NY 10010. Pages 373-398.

- "Inputs of coarse particulate organic matter (CPOM) to headwater streams are transformed through processes of microbial decomposition, consumption by macroinvertebrates, and physical abrasion to fine particles and dissolved organic matter, which are utilized by aquatic communities downstream."
- "Human activities depriving streams of nutrients and organic matter or reducing the capacity of aquatic communities to store and process these materials (e.g., removal of streamside vegetation, loss of coarse woody debris, and reduction of salmon carcasses) often lead to changes in the trophic system that ultimately impair salmonid productivity."

Montgomery, D. R. and J. M. Buffington. 2001. Channel Processes, Classification, and Response. In River Ecology and Management, Lessons from the Pacific Coastal Ecoregion. Edited by Naiman, R. J. and R. E. Bilby. Springer-Verlag New York, Inc. 175 Fifth Avenue, New York, NY 10010. Pages 13-42.

- "LWD provides significant control on the formation and physical characteristics of pools, bars, and steps, thereby influencing channel type and the potential for change in sediment storage and bedform roughness in response to altered sediment supply, discharge, or LWD loading. LWD may also decrease the potential for channel widening by armoring stream banks: alternatively it may aid bank erosion by directing flow and scour toward channel margins. Furthermore, bed surface textures and their response potential are strongly controlled by hydraulic roughness resulting from inchannel LWD and debris-forced bedforms."

NMFS. 2002. Biological Opinion: Klamath Project Operations. National Marine Fisheries Service.

- "Increases in sediment contributions to streams are generally attributable to changes in rates of erosion on hillslopes through such processes as increased landslide activity, sheetwash erosion associated with road management activities (construction and maintenance) and yarding operations, and fires (both wildfires and controlled burns). Significant increases in the sediment supplied to streams can cause channel aggradation, pool filling, additional bank erosion, and losses of channel structures and habitat diversity. Stable large woody debris structures within the stream channel may be lost through direct removal, channel aggradation, debris torrents, or gradual attrition through lack of recruitment. These losses result in a reduction in sediment storage capacity, fewer and shallower scour pools, and a reduction of instream cover for fish."

NMFS. 2008b. Willamette Project Biological Opinion. National Marine Fisheries Service. Available: https://pcts.nmfs.noaa.gov/pls/pcts pub/pcts_upload.summary_list_biop?p_id=26588. (October 2009).

- "Over time, flood control tends to reduce channel complexity (e.g., reduces the frequency of side channels, and woody debris recruitment) and reduces the movement and recruitment of channel substrates. Side channels, backwaters, and instream woody debris accumulations have been shown to be important habitat features for rearing juvenile salmonids."
- "All woody debris that streams transport from the watersheds above Cougar, Blue River, and Trail Bridge dams (about half of the McKenzie's historic contributing area above Vida) is now trapped in reservoirs and fails to reach lower portions of the river system. Such wood is thought to have once contributed to the maintenance of high-quality salmonid habitats downstream by influencing how river channels interacted with their banks and floodplains and by providing hydraulic diversity and hiding cover. The wood could have created logjams, secondary channels, pools and stable gravel deposits, all habitats utilized by salmonids and the invertebrates upon which they feed."

Sweeney, B. W., Bott, T. L. Jackson, J. K. Kaplan, L. A. Newbold, J. D. Standley, L. J. Hession, W. C., and R. J. Horwitz. 2004. Riparian deforestation, stream narrowing, and loss of stream ecosystem services. National Academy of Sciences 101:14132-14137.

- Sweeney et al. conducted a study of16 streams in eastern North America shows to examine the effects of riparian deforestation on stream processes.
- Sweeney et al. measured the number of pieces of large woody coarse particulate organic matter as an ancillary habitat variable in this project and found the number to be significantly higher in the forested reaches [average (SE): 24.6 (3.0) versus 3.6 (0.9) for the deforested reaches.

NMFS. 2010b. Biological Opinion: Klamath Project Operations. National Marine Fisheries Service, Southwest Region.

- "Substantial timber harvesting has occurred throughout the Southern Oregon/Northern California Coast (SONCC)coho salmon ESU. In many SONCC coho salmon streams, lack of large woody debris results in decreased cover and reduced storage of gravel and organic debris. Lack of large woody debris (LWD) has also resulted in loss of pool habitat and a reduction in overall habitat and hydraulic complexity in a variety of coho salmon streams. LWD also provides cover from predators and shelter from high flow events.

Pile-Driving

Caltrans. 2001. Fisheries Impact Assessment, Pile Installation Demonstration Project for the San Francisco - Oakland Bay Bridge, East Span Seismic Safety Project. 59 p.

- The fisheries monitoring program during pile installation demonstration project (PIDP) for the San Francisco-Oakland Bay Bridge Seismic Safety Project documented near-term fish mortalities and the likelihood of a high rate of delayed mortality of differing sizes and species of fish that have swim bladders.
- Surveys with a fathometer before, during, and after pile driving indicated that fish schools did not move away from the PIDP site and suggested that the PIDP barge tended to aggregate fish.
- Based on acoustic measurements and experiments using shiner surfperch held in cages, the delayed mortality zone for pile driving using the large hammer without attenuation is estimated to extend out at least about 150 meters (about 500 feet) and possibly up to about 1,000 meters (3,280 feet) from the pile. The size of the IMZ and DMZ will vary with the species, species, size, physiological condition of the fish and environmental conditions.

Carlson, T.J., G. Ploskey, R.L. Johnson, R.P. Mueller, M.A. Weiland, P.N. Johnson. 2001. Observations of the behavior and distribution of fish in relation to the Columbia River navigation channel and channel maintenance activities. Prepared for the U.S. Army, Corps of Engineers, Portland District by Pacific Northwest National Laboratory, U.S. Department of Energy. 35 p. + appendices. Available: http://www.osti.gov/bridge/product.biblio.jsp?osti_id=787964&queryId=4&start=0. (January 2010).

- Underwater sounds generated by impact pile driving activities are within the frequency range to which juvenile salmonids have been observed to show an avoidance response.
- However, the duration of sound at fish avoidance frequencies is very short, on the order of 0.025 seconds per impact, which is below the 5-second duration found necessary to elicit avoidance responses from juvenile salmonids in laboratory studies.

Fisheries Hydroacoustic Working Group. 2008. Agreement in principle for interim criteria for injury to fish from pile driving activities. Memorandum to applicable agency staff, June 12, 2008. 4 pp.

- The Fisheries Hydroacoustic Working Group (FHWG) membership consists of the National Marine Fisheries Service (Northwest and Southwest Regions), the U.S. Fish and Wildlife Service (Regions 1 and 8), the U.S. Federal Highway Administration, the California Department of Transportation, the Oregon Department of Transportation, and the Washington State Department of Transportation.
- This agreement in principle was concluded at a meeting in Vancouver, Washington on June 10-11,2008 with key technical and policy staff from the signatory agencies and national experts on sound propagation activities that affect fish and wildlife species of concern.

- The agreed upon criteria identify sound pressure levels of 206 dB (re: 1 µPa) peak pressure and 187 dB (re: 1 μPa^2-sec) accumulated sound exposure level(SEL) for all listed fish except those that are less than 2 grams. In that case, the criteria for the accumulated SEL will be 183 dB (re: 1 μPa^2-sec).
- The agencies agreed to review the science periodically and revise the threshold and cumulative levels as needed to reflect current information.
- Behavioral impacts to fish and impact to marine mammals are not addressed in this agreement. Sub-injurious effects will continue to be discussed in future meetings.

Stadler, J.H. and D.P. Woodbury. 2009. Assessing the effects to fishes from pile driving: Application of new hydroacoustic criteria. Proceedings of Inter-Noise 2009, August 23-29, 2009, Ottawa, Canada. 8 pp.

- "A cooperative effort between several Federal and State transportation and resource agencies along the west coast of the United States has recently resulted in the establishment of interim criteria for the onset of physical injury to fishes exposed to the underwater sounds generated by impact pile driving. The National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries), in its administration of the Endangered Species Act (ESA) and the essential fish habitat provisions of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), is using these criteria to assess potential impacts to its trust resources during consultation with Federal agencies on projects that include pile driving in, or near, aquatic environments. The new criteria use two metrics – peak sound pressure level (SPL) and sound exposure level (SEL). For the purpose of these consultations, and until new information becomes available to refine the criteria, the onset of physical injury would be expected if either the peak SPL exceeds 206 dB (re: 1 µPa)) or the SEL, accumulated over all pile strikes generally occurring within a single day, exceeds 187 dB (re: 1 µPa2•sec) for fishes 2 grams or larger, or 183 dB for smaller fishes. Here we present how NOAA Fisheries uses these criteria to assess the risk to fishes that are listed under the ESA or the essential fish habitat managed under the MSA."
- This paper describes a method to determine the distance from a pile being driven by an impact hammer that injury to fishes would be expected to occur, based on the sound levels produced by the hammer strike and the number of times the pile is struck.

Hardyniec, S, and S. Steen. 2005. Pile driving and barotrauma effects. Transportation Research Record: Journal of the Transportation Research Board. No. 1941: 184-190.

- "High-capacity driven pipe piles have recently been shown to be a viable alternative to pile groups in terms of economy and strength. A complication has emerged for the construction of bridge foundations with large diameter pipe piles, however - the injury and mortality of fish from sound pressure waves produced from pile driving, otherwise known as barotrauma. Even though this issue has been prevalent in California, regulators have started to restrict other states. This has caused confusion as to how to avoid unexpected increases in construction costs while following environmental laws.

After several trials, California Department of Transportation (Caltrans) engineers have implemented solutions to this problem, including driving windows, cofferdams, and a few different versions of air bubble curtains. This paper presents an accumulation of knowledge from engineers, biologists, and sound experts. It is to serve as an avenue for informing those who may sound be affected with pile-driving and fish barotrauma issues to minimize harmful effects and costs in the future."

Gregory T. Ruggerone, G.T., S. Goodman, R. Miner. 2008. Behavioral Response and Survival of Juvenile Coho Salmon Exposed to Pile Driving Sounds. Report by Natural Resource Consultants, Seattle, WA to the Port of Seattle. 25 pp + appendices.

- A study was conducted to examine the effects to juvenile coho salmon from the underwater sounds produced by driving 20-inch diameter hollow steel piles with an impact hammer, at Fisherman's Terminal, located on the Lake Washington Ship Canal in Seattle WA.
- Caged, hatchery-reared juvenile coho salmon were exposed to up to 1,627 pile strikes, at distances ranging from 1.8 meters to 15 meters from the pile. Received sound levels were up to 208 dB (re: 1μPa) peak pressure, 194 dB (re: 1μPa) rms pressure, and 179 dB (re: 1μPa2-sec) single strike SEL and 207 dB (re: 1μPa 2-sec) cumulative SEL.
- No mortality was observed, in either control or exposed fish, for up to 19 days post-exposure.
- Behavioral responses to pile driving were subtle, with fish responding with a startle response to the first 4-14 strikes. These were generally fish that were close to the pile (1.8 m). No avoidance response was apparent, and feeding behavior was observed on the fifth day after exposure, the first day that feeding was conducted.
- No gross internal or external injuries were observed, in either control or exposed fish, but auditory system, cellular, and stress responses were not examined.

California Department of Transportation. 2010. Mad River Bridges Replacement Project. Effects of Pile Driving Sound on Juvenile Steelhead. Prepared by ICF International, Seattle, WA. 22 pp.

- This study used caged fish deployments within the Mad River (California) to expose juvenile steelhead (*Onchorhynchus mykiss*) to a variety of peak sound pressures levels (SPLs) and cumulative sound exposure levels (SELs) from 2.2-meter-diameter (7.2-foot-diameter) cast-in-steel- shell (CISS) piles driven immediately adjacent to the Mad River.
- Four experimental trials were conducted. Each trial consisted of the driving of one pile section (20 to 24 meters [60 to 80 feet]). During each trial, cages containing fish were placed at four exposure locations at different distances from the pile driving activity (approximately 35 to 150 meters [115 to 490 feet] away) and at a control location (350 meters [1,150 feet] away).
- Underwater sound (peak and SEL) was monitored and recorded at each location during the experiments. Following cessation of pile driving, blood samples were drawn from

each fish for hematocrit (i.e., packed cell volume) and plasma cortisol level, and a necropsy was performed on each fish. Organ samples were also collected for histopathology by a highly experienced fish veterinary pathologist

- During pile driving, fish were exposed to underwater peak SPLs ranging from 69 to 188 decibels (dB) relative to 1 micropascal (re: 1 µPa).
- Cumulative SELs, ranged from 179 to 194 dB (re: 1 µPa2-sec). The cumulative SEL exceeded the interim cumulative SEL threshold of 187 dB during the last two pile driving events, both times in the two cages closest to the pile being driven (thus, four exposure groups experienced cumulative SELs in excess of 187 dB).
- On-site necropsies of all exposed and control fish conducted following each trial, as well as histopathology of the fish from the cages closest to the pile driving and control fish, showed no physical trauma that could be related to exposure to underwater noise from pile driving, and no statistically significant differences between experimental and control animals were detected.
- Hematocrit and plasma cortisol levels were not significantly related to exposure to noise generated by pile driving.
- There were no immediate significant physical effects of exposure to cumulative SELs of ≤194 dB from pile driving at the project site.

Illingworth & Rodkin. 2007. Compendium of pile driving sound data. Prepared for the California Department of Transportation, Sacramento, CA. 129 pp.

- “This appendix provides information on sound pressures resulting from pile driving measured throughout Northern California. The information provides an empirical database to assist in predicting underwater sound levels from marine pile driving projects and determining the effectiveness of measures used to control the noise. This compendium includes information on major and minor projects with a variety of different pile and hammer types that were completed within the last 6-1/2 years and were completed since work began on the pile installation demonstration project for the San Francisco-Oakland Bay Bridge in December 2000.”
- The compendium covers a range of pile materials, types, and sizes, including wood, concrete, steel pipe or cast-in- steel-shell (CISS) piles, steel H-piles, and steel sheet piles. Both impact driving and vibratory driving are included.
- The compendium reports the calculated propagation loss equations, when available.
- Specific monitoring efforts for each type of pile are discussed in detail.
- The compendium is available online at: http://www.dot.ca.gov/hq/env/bio/files/pile_driving_snd_comp9_27_07.pdf

Washington State Department of Transportation. 2010. Noise impact assessment. section 7 *in:* Biological Assessment Preparation for Transportation Projects - Advanced Training Manual - Version 02-2010. Part 2: Guidance on specific biological assessment topics. Online at:

http://www.wsdot.wa.gov/NR/rdonlyres/A1F85352-90E0-457B-9A8C-B5103E097FAE/0/BA_ManualPart2.pdf.

- This guidance manual is intended to assist staff in preparing biological assessments for use by WSDOT in their Endangered Species Act and Essential Fish Habitat consultations.
- Presents important concepts of underwater sound, including metrics for measuring sound, sound propagation, sound sources, determining the extent of underwater project-related noise, and methods to estimate the potential effects to aquatic species.

WSDOT. 2010. Underwater noise monitoring plan. 6 pp. Available online at: http://www.wsdot.wa.gov/Environment/Biology/BA/BAtemplates.htm#Noise

- This is a protocol developed by the Washington State Department of Transportation for monitoring the underwater sound levels produced during pile driving activities. It describes the appropriate metrics for measuring and reporting the sound levels.

Popper, A. and M. Hastings. 2009. The effects of human-generated sound on fish. Integrative Zoology 44:43-52.

- "Findings suggest that human-generated sounds, even from very high intensity sources, might have no effect in some cases or might result in effects that range from small and temporary shifts in behavior all the way to immediate death. At this point, however, it is nearly impossible to extrapolate from results with one sound source, one fish species, or even fish of one size to other sources, species, or fish sizes."
- "To date, the concerns regarding the effects of increased background sound on fish far exceed the extent of data that is available to support such concerns. Although there is little doubt that increases in sound are likely to affect fish, we are far from understanding the extent of these effects and even further from being able to provide useful models that will enable us to predict such effects."
- "If excess particle motion significantly contributes to hearing loss and/or tissue damage, as we believe it does, then particle motion will need to be considered in risk analyses and assessments when planning sound-producing activities in the marine environment."
- "Methods must be developed that will allow for studies of behavior of "wild" animals that are not restrained in any way that examine their response, both short term and long term, to exposure to different sounds."

Hastings, M. C. and A. N. Popper. 2005. Effects of sound on fish. Admin. Rec. 151422SWR02SR6292. California Department of Transportation Contract No. 43A0139, Task Order 1.

- "It is important to note that there are no studies that have examined longer-term effects of exposure to pile driving sounds that may lead to delayed death or, perhaps, to other alteration in behavior that could affect the survival of individuals or of populations of fishes. Nor have studies examined the non-mortality responses of fishes outside of the "kill-zone" that, while not immediately apparent, may have significant effects on fish populations. Non-mortality effects may include temporary injury that heals, injury that leads to a slow death (e.g., break down of tissues in some organ system), temporary or permanent hearing loss, movement of fish away from feeding grounds due to high signal levels, and many other possible scenarios. Thus, future investigations must not only examine immediate mortality of pile driving exposure on fish, but they must also consider longer term effects on physiology and behavior, as well as effects on fishes that are at some distance from the source."

NMFS. 2003. Non-fishing impacts to essential fish habitat and recommended conservation measures. National Marine Fisheries Service.

- "The type and intensity of the sounds produced during pile driving depend on a variety of factors, including, but not limited to, the type and size of the pile, the firmness of the substrate into which the pile is being driven, the depth of water, and the type and size of the pile-driving hammer. Sound pressure levels (SPLs) are positively correlated with the size of the pile, as more energy is required to drive larger piles. Wood and concrete piles appear to produce lower sound pressures than hollow steel piles of a similar size, although it is not yet clear if the sounds produced by wood or concrete piles are harmful to fishes."
- "The degree to which an individual fish exposed to sound will be affected is dependent upon a number of variables, including 1) species of fish, 2) fish size, 3) presence of a swimbladder, 4) physical condition of the fish, 5) peak sound pressure and frequency, 6) shape of the sound wave (rise time), 7) depth of the water around the pile, 8) depth of the fish in the water column, 9) amount of air in the water, 10) size and number of waves on the water surface, 11) bottom substrate composition and texture, 12) effectiveness of bubble curtain sound/pressure attenuation technology, 13) tidal currents, and 14) presence of predators.
- The following are recommended conservation measures to mitigate for woody debris removal effects:
  1. Install hollow steel piles with an impact hammer at a time of year when larval and juvenile stages of fish species with designated EFH are not present. If this is not possible, then the following measures should be incorporated to minimize adverse effects.
  2. Drive piles during low tide periods when located in intertidal and shallow subtidal areas.
  3. Use a vibratory hammer when driving hollow steel piles. Under those conditions where impact hammers are required for reasons of seismic stability or substrate type, it is recommended that the pile be driven as deep as possible with a vibratory hammer prior to the use of the impact hammer.
  4. Monitor peak SPLs during pile driving to ensure that they do not exceed the 190 dB re:1 µPa threshold for injury to fish.
  5. Implement measures to attenuate the sound should SPLs exceed the 180 dB re: 1 µPa threshold. If sound pressure levels exceed acceptable limits, implement mitigative measures. Methods to reduce the sound pressure levels include, but are not limited to, the following:

a) Surround the pile with an air bubble curtain system or air-filled coffer dam.
b) Since the sound produced has a direct relationship to the force used to drive the pile, use of a smaller hammer should be used to reduce the sound pressures.
c) Use a hydraulic hammer if impact driving cannot be avoided. The force of the hammer blow can be controlled with hydraulic hammers; reducing the impact force will reduce the intensity of the resulting sound.
6. Drive piles when the current is reduced (i.e., centered around slack current) in areas of strong current to minimize the number of fish exposed to adverse levels of underwater sound.

Over-water Structures

Collis, K., D.D. Roby, D.P. Craig, S. Adamany, J. Adkins, and D.E. Lyons. 2002. Colony size and diet composition of piscivorous waterbirds on the lower Columbia River:
Implications for losses of juvenile salmonids to avian predation. Transactions of the American Fisheries Society: 131:537-550.

- Throughout the Columbia River basin, piscivorous birds congregate near hydroelectric dams and in the estuary near man-made islands and structures and eat large numbers of migrating juvenile salmonids.
- Hundreds of cormorants were regularly observed foraging on salmonids adjacent to the extensive system of pile dikes above Rice Island and roosting on the pile dikes between foraging bouts.
- “Smolt losses to cormorant predation may potentially be reduced by deploying bird excluders on pile dikes to prevent use by cormorants.”

Roby, D.E., K. Collis, D.P. Lyons, Y. Suzuki, J.Y. Adkins, L. Reinalda, C. Hand, N. Hostetter, A. Evans, and M. Hawbecker. 2007. Research, monitoring, and evaluation of avian predation on salmonid smolts in the lower and mid-Columbia River. Summary report to the Bonneville Power Administration and U.S. Army Corps of Engineers, Portland, Oregon.

- Double-crested cormorants were observed at Little Goose Dam and Lower Granite Dam on the Snake River during September-December 2007.
- At both dams, cormorants used the navigation lock walls, log booms, trash-shear walls, and spillway guide walls to roost and stage before foraging.
- Based on identifiable fish tissue in fore-gut samples, juvenile salmonids comprised 11.8% of the double-crested cormorant diet (by mass) at Little Goose and Lower Granite dams in 2007.

Nightingale, B., C.A. Simenstad, Jr. 2001. Overwater structures: Marine issues. White paper submitted to Washington Department of Fish and Wildlife, Washington Department of Ecology, and Washington Department of Transportation. 133 p.

- Empirical findings support the notion that overwater structures can have measurable effects on the distribution and abundance of marine resources. Based on the existing state of the knowledge and the fact that light levels are measurable and variable with each structure and location, we conclude that light limitation assessment and mitigation in the development of overwater structures is integral to ecosystem-based resource management.
- Evidence reveals that juvenile fish, such as salmonids, feeding in shallow nearshore waters utilize ultraviolet wavelengths for prey capture. Therefore, we conclude that allowing the transmission of increasing levels of natural light to the under-dock environment to include the transmission of required ultraviolet light spectra will reduce structural interference with fish ability to capture under-dock prey.

Kahler, T., M. Grassley, D.A. Beauchamp. 2000. A summary of the effects of bulkheads, piers, and other artificial structures and shorezone development on ESA listed salmonids in lakes. Final Report to the City of Bellevue, Washington. 74 p. Available: kitsapgov.com/dcd/lu_env/cao/bas/wetlands/bellevue_bas.pdf. (January 2010).

- Shading from overwater structures may reduce prey organism abundance and the complexity of the habitat by reducing aquatic vegetation and phytoplankton abundance.

Duffy-Anderson, J.T., K.W. Able. 1999. Effects of municipal piers on the growth of juvenile fishes in the Hudson River estuary: a study across a pier edge. Marine Biology 133:409-418.

- Growth rates of juvenile fishes under piers had significantly lower growth rates than fishes in openwater in the Hudson Bay estuary.

Johnson, L. 2000. An analysis in support of sediment quality thresholds for polycyclic aromatic hydrocarbons (PAHs) to protect estuarine fish. White paper from National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, WA. 29 p.

- Treated wood used for pilings and docks releases contaminants into saltwater environs. Poly-aromatic hydrocarbons (PAHs) are commonly released from creosote-treated wood. PAHs can cause a variety deleterious effects (cancer, reproductive anomalies, immune dysfunction, and growth and development impairment) to exposed fish.

Stehr, C.M., D.W. Brown, T. Hom, B.F. Anulacion, W.L. Reichert, T.K. Collier. 2000. Exposure of juvenile chinook and chum salmon to chemical contaminants in the Hylebos Waterway of Commencement Bay, Tacoma, Washington.

- The results of Stehr et al. (2000) show that juvenile chum and chinook salmon from the Hylebos Waterway take up a wide range of chemical contaminants, compared to fish from hatcheries or reference estuaries. These contaminants include high and low molecular weight polycyclic aromatic hydrocarbons (PAHs).
- Concentrations of contaminants in juvenile chinook and chum salmon from the Hylebos Waterway are comparable to levels previously shown to be associated with biological injury in juvenile Chinook salmon, such as impaired growth, suppression of immune

function as demonstrated by reduced B cell function, and increased mortality following pathogen exposure.

NMFS. 2003. Non-fishing impacts to essential fish habitat and recommended conservation measures. National Marine Fisheries Service.

- “Overwater structures create shade which reduces the light levels below the structure. The size, shape and intensity of the shadow cast by a particular structure depends upon its height, width, construction materials, and orientation. High and narrow piers and docks produce narrower, more diffuse shadows than do low and wide structures. Increasing the numbers of pilings used to support a given pier increases the shade cast by pilings on the under-pier environment. In addition, less light is reflected underneath structures built with light-absorbing materials (e.g., wood) than from structures built with light-reflecting materials (e.g., concrete or steel). Structures that are oriented north-south produce a shadow that moves across the bottom throughout the day, resulting in a smaller area of permanent shade than those that are oriented east-west.”
- “Fishes rely on visual cues for spatial orientation, prey capture, schooling, predator avoidance, and migration. The reduced-light conditions found under an overwater structure limit the ability of fishes, especially juveniles and larvae, to perform these essential activities.”
- “Wave energy and water transport alterations from overwater structures can impact the nearshore detrital foodweb by altering the size, distribution, and abundance of substrate and detrital materials. Disruption of longshore transport can alter substrate composition and can present potential barriers to the natural processes that build spits and beaches and provide substrates required for plant propagation, fish and shellfish settlement and rearing, and forage fish spawning.”
- “Treated wood used for pilings and docks releases contaminants into saltwater environs. Poly-aromatic hydrocarbons (PAHs) are commonly released from creosote-treated wood. PAHs can cause a variety of deleterious effects (cancer, reproductive anomalies, immune dysfunction, and growth and development impairment) to exposed fish. Wood also is commonly treated with other chemicals such as ammoniacal copper zinc arsenate (ACZA) and chromated copper arsenate. These preservatives are known to leach into marine waters for a relatively short period of time after installation, but the rate of leaching is highly variable and dependent on many factors. Concrete or steel, on the other hand, are relatively inert and do not leach contaminants into the water.”
- The following are recommended conservation measures to mitigate for overwater structures effects:
  1. Use upland boat storage whenever possible to minimize need for overwater structures.
  2. Locate overwater structures in sufficiently deep waters to avoid intertidal and shade impacts, to minimize or preclude dredging, to minimize groundings, and to avoid

displacement of submerged aquatic vegetation, as determined by a pre-construction survey.
3. Design piers, docks, and floats to be multi-use facilities in order to reduce the overall number of such structures and the nearshore habitat that is impacted.
4. Incorporate measures that increase the ambient light transmission under piers and docks. These measures include, but are not limited to, maximizing the height of the structure and minimizing the width of the structure to decrease shade footprint; grated decking material; using solar tubes to direct light under the structure and glass blocks to direct sunlight under the structure; illuminating the understructure area with meta halide lamps and use of reflective paint or materials (e.g., concrete or steel instead of materials that absorb light such as wood) on the underside of the dock t reflect ambient light; using the fewest number of pilings necessary to support the structures to allow light into under-pier areas and minimize impacts to the substrate; and aligning piers, docks and floats in north-south orientation to allow arc of sun to cross perpendicular to structure and reduce duration of light limitation.
5. Use floating breakwaters whenever possible and remove them during periods of low dock use. Encourage seasonal use of docks and off-season haul-out.
6. Use waveboards to minimize effects on littoral drift and benthic habitats.
7. Locate floats in deep water to avoid light limitation and grounding impacts to the intertidal zone, and maintain at least one foot of water between the substrate and the bottom of the float.
8. Conduct in-water work during the time of year when EFH-managed species and prey species are least likely to be impacted.
9. Avoid use of treated wood timbers or pilings to the extent practicable. Use of alternative materials such as untreated wood, concrete, or steel is recommended.
10. Fit all pilings and navigational aids, such as moorings and channel markers, with devices to prevent perching by piscivorous bird species.
11. Orient night lighting such that illumination of the surrounding waters is avoided.
12. Mitigate for unavoidable impacts to benthic habitats that is adequately provided, properly monitoried, and adaptively managed.

Williams, G. D., R. M. Thom, J. A. Southard, L. K. O'Rourke, S. L. Sargeant, V. I. Cullinan, D. K. Shreffler, R. Moursund, and M. Stamey. 2003. Assessing overwater structure-related predation risk on juvenile salmon: field observations and recommended protocols. Pacific Northwest National Laboratory, Sequim, Washington.

- “Large overwater structures have often been cited as potential migratory barriers and areas of increased predation for juvenile salmon migrating along shallow shoreline habitats, although conclusive evidence has not been demonstrated to date in situ. To help resolve this issue, Washington State Ferries (WSF) sponsored directed research to determine whether WSF terminals affect predation on juvenile salmon.”
- “We used a combination of standardized surveys, stomach content analyses, and new observational technologies to assess fish, avian, and mammal predation on salmon fry at

ferry terminals and paired reference sites during periods of pre- (early April) and peak (May) outmigration."

- "We observed no significant aggregation of potential bird or mammal predators at six ferry terminal study sites. Few potential fish predators were documented in SCUBA surveys, beach seines, or with a Dual frequency IDentification SONar (DIDSON) camera at Mukilteo, our single underwater study location. Only one instance of salmon predation by fish (staghorn sculpin –Leptocottus armatus) was confirmed, and this was at the corresponding reference site."
- "A tiered protocol (Minimum/ Recommended/ Preferred actions) was developed for assessing potential predation at other overwater structures. Likewise, recommendations were developed for incorporating design features into WSF terminal improvement projects that could minimize future impacts."

Alternative Energy

McMurray, G. 2007. Wave energy ecological effects workshop ecological assessment briefing paper. Wave energy ecological effects workshop, Hatfield Marine Science Center, Oregon State University.

- Assesment of environmental effects of wave energy generation showed minimal effects to marine life. The following potential issues affecting marine life were examined and found to only have minor effects:
    - Wave energy devices will necessarily remove some energy from the wave train, and thus, the littoral system. Resultant effects may include alterations in currents and sediment transport.
    - The deployment of structures in a previously clear area brings the risk of collision and/or entanglement of animals; primarily the larger fish, the seabirds and the marine mammals.
    - Wave energy arrays will provide a matrix of hard structures in areas previously devoid of any hard structure: this will include buoys at the surface and through much of the water column, subsea pods (see fig. 2.4), and anchors on sedimented substrates. This will likely have ecological consequences from the fouling community up through the highest levels of trophic structure.
    - Wave energy devices will create the potential for chemical effects from a variety of sources, including toxins in antifouling paints, metals including lead and zinc, and organics, such as those used for hydraulic fluids.
    - Wave energy devices will necessarily generate electrical (E fields) and magnetic (B fields) fields (EMF) as they produce and transmit electrical currents. At issue is the sensitivity of particular groups of the biota, especially the potential responses of elasmobranchs (attraction, repulsion, or other behavioral taxis), and the effectiveness of mitigation, primarily through shielding.

  - Wave energy devices will have acoustic signatures, from the impingement of waves on above-water structures to generators and switching systems. Fish and seabirds are sensitive to sounds and many marine mammals are dependent on sound for life processes from feeding to mating.
  - The lighting required by the US Coast Guard to address safety considerations may attract biota, especially seabirds, to the generation devices.

U.S. Department of Energy. 2009. Report to Congress: potential environmental effects of marine and hydrokinetic energy technologies. Prepared in response to the Energy Independence and Security Act of 2007, Section 633(b).

- Wave energy facilties will create pilings or mooring cables and may acts as fish aggregation devices (FADs). The aggregation of predators near FADs may adversely affect juvenile salmonids or Dungeness crabs moving through the project area.
- Four species of Pacific salmon were found to have of magnetite within them and it is believed that these crystals serve as a compass orients to the earth's magnetic field (Mann et al. 1988; Walker et al. 1988). Because some aquatic species use the Earth's magnetic field to navigate or orient themselves space, there is a potential for the magnetic fields created by the numerous electrical cables associated with offshore power projects to disrupt these movements.

Wilson, B., R. S. Batty, F. Daunt, and C. Carter. 2007. Collision risks between marine renewable energy devices and mammals, fish and diving birds. Report to the Scotttish Executive. Scottish Association for Marine Science, Oban, Scotland.

- A fish aggregation device (FAD) is a floating device placed in the water to attract fish (Dempster & Taquet 2004) and may closely parallel many of the designs of wave energy devices. This fishing method has arisen from a phenomenon where natural aggregations of fish form under and around floating objects.
- Pelagic fishes that live in a uniform environment are attracted by any physical anomaly, e.g. an object, bottom discontinuity, steep gradients etc, and fishermen have used these associations to increase their catch, as the fish occur in bigger schools and are easier to catch (Freon & Dagorn 2000). There have been many possible reasons suggested to explain why these floating structures attract marine life. It is thought that wave and tidal devices may also act as FADs, the difference being that these devices will have moving parts. It is possible that the presence of fish will also attract predators (such as marine mammals and birds) to these areas.

LNG Facilities

FERC. 2009. Biological assessment: Bradwood Landing Project. Federal Energy Regulatory Comission, Office of Energy Projects, Washington, DC.

- The purpose of the Bradwood Landing Project is to import and store liquefied natural gas (LNG) to provide a new source of natural gas to the Pacific Northwest. LNG is natural gas cooled to about -260 degrees Fahrenheit (127 degrees Celsius) to reduce its volume so that it can be transported long distances across oceans in specially designed ships from its point of origin to foreign markets. NorthernStar proposes to provide up to 1.3 billion cubic feet (ft3) (3.7 million cubic meters (m3)) per day of natural gas to the region through interconnects at two industrial facilities, an intrastate pipeline, and an interstate pipeline system.
- The Biological Assessment of the Bradwood Landing Project examined the project effects to Pacific salmon essential fish habitat. The following effects were described:
    - Designated critical habitat used by migrating juvenile Columbia River salmon for forage and rearing and adult salmon for upmigration would be permanently filled in at the LNG terminal.
    - Access by LNG carriers would be made possible by dredging a deep draft maneuvering area at the LNG terminal site. Dredging can lead to significant impacts on EFH including: removal or burial of fish or their prey items; turbidity/siltation effects; release of contaminants deposited in the sediment; release of oxygen consuming substances leading to decreased dissolved oxygen availability; fish entrainment; noise; and other alterations to hydrodynamic regimes and physical habitat.
    - The Bradwood Landing LNG terminal would include overwater structures. Overwater structures can lead to modified predator-prey interactions by providing ambush. Opportunities for larger fish and perching opportunities for piscivorous birds.
    - Construction of the ship berth and other overwater structures would require the installation of pilings. The primary adverse effect of this action is intense sound pressure waves that have been shown to harm fish and may affect the ecological functioning of EFH for groundfish and Pacific salmon.
    - The intake from and subsequent discharge of water to the Columbia River for facility operations can lead to adverse effects to EFH and its ecological function through entrainment of fish species and their prey (early life stages are especially susceptible) due to inadequate screening, impingement of fish and prey species, and increased water temperatures adjacent to and downstream of outfalls.
    - The operation of vessels associated with the Bradwood Landing Project may adversely affect EFH throughout the marine and riverine portions of the action area. Impacts could include: shoreline erosion from wake generation; increased turbidity and suspended contaminants from vessel propeller wash; degraded water quality from vessel discharge, engine operation, and bottom paint sloughing; introduction of nonnative invasive species in ballast water or on hulls; and accidental spills.

- Installation of pipelines can lead to the destruction of organisms and habitat, increased turbidity, and resuspension of contaminants. The new infrastructure and proposed pipeline required for project operations would only affect Pacific Salmon EFH (in the freshwater and tributary habitats).
- The Bradwood Landing Project would include habitat preservation, restoration, and enhancement activities, including both compensatory mitigation and the SEI (described in Biological Assessment). The long-term effects of these projects are expected to provide a benefit to the ecosystem and to EFH for groundfish and Pacific salmon.

Desalination

Danoun, R. 2007. Desalination plants: potential impacts of brine discharge on marine life. The University of Sydney, Australia.

- "Salinity, temperature and total alkalinity fluctuations, as a consequence of the brine discharge of the desalination plant, can play a considerable role in determining the abundance and distribution of flora and fauna's species."
- "Long term monitoring of the conditions proposed in relation to temperature, salinity and alkalinity at the site of the desalination discharge outlet vicinity during the desalination process is recommended. This would allow the verification of the appropriate distribution of the discharge plume into the seawater and the impact of the above factors on the aquatic organisms could be better understood."

Power Plant Intakes

Kock, T. J., S. D. Evans, T. L. Liedtke, D. W. Rondorf and M. Kohn. 2009. Evaluation of strobe lights to reduce turbine entrainment of juvenile steelhead at Cowlitz Falls Dam, Washington. Northwest Science 83: 308-314.

- Kock et al. (2009) conducted a radiotelemetry evaluation to determine if strobe lights could be used to decrease turbine entrainment of juvenile steelhead as Cowlitz Falls Dam, Washington.
- They found that radio-tagged juvenile steelhead approached and entered two spillways (one lighted, one unlighted) in equal proportions.
- However, the presence of strobe lights was associated with decreased spillbay residence time of juvenile steelhead.
- "Our results suggest that factors such as deployment location, exposure, and flow are important variables that should be considered when evaluating strobe lights as a potential fish-deterring management tool."

Ferguson, J. W., B. P. Sandford, R. E. Reagan, L. G. Gilbreath, E. B. Meyer, R. D. Ledgerwood, N. S. Adams. 2007. Bypass system modification at Bonneville Dam on the Columbia River improved the survival of juvenile salmon. Transactions of the American Fisheries Society 136:1487-1510.

- The survival of subyearling Chinook salmon Oncorhynchus tshawytscha released into the Bonnevile Dam Powerhouse fish bypass system ranged from 0.774 to 0.911 and was significantly lower than the survival of test fish released into turbines and the area immediately below the powerhouse where bypass system flow reentered the river. Yearling and subyearling Chinook salmon and yearling coho salmon O. kisutch released into the bypass system were injured or descaled.
- This original system was then extensively modified using updated design criteria, and the site where juvenile fish reentered the river was relocated 2.8 km further downstream to reduce predation on bypassed fish by northern pikeminnow Ptychocheilus oregonensis.
- Based on studies conducted from 1999 to 2001, the new bypass system resulted in high fish survival, virtually no injuries to fish, fish passage times that were generally similar to water travel times, and mild stress responses from which fish recovered quickly. The mean estimated survival of subyearling Chinook salmon passing through the new bypass system was 0.946 in 2001, which was an unusually lowflow year.
- Survival, physical condition, passage timing, and blood physiological indicators of stress were all useful metrics for assessing the performance of both bypass systems and are discussed.
- The engineering and hydraulic criteria used to design the new bypass system at the Bonnevile Dam that resulted in improved fish passage conditions are described in the paper.

NMFS. 2003. Non-fishing impacts to essential fish habitat and recommended conservation measures. National Marine Fisheries Service.

- “Adverse impacts to EFH from water intake structures and effluent discharges can interfere or disrupt EFH functions in the source or receiving waters by 1) entrainment, 2) impingement, 3) discharge, 4) operation and maintenance, and 5) construction-related impacts.”
- “Entrainment is the withdrawal of aquatic organisms along with the cooling water into the cooling system. These organisms are usually the egg and larval stages of managed species and their prey. Entrainment can subject these life stages to adverse conditions resulting from the effects of increased heat, antifouling chemicals, physical abrasion, rapid pressure changes, and other detrimental effects. Consequently, diverting water without adequate screening prevents that portion of the EFH from providing important habitat functions necessary for the early life stages of managed living marine resources and their prey.”

- "Impingement occurs to organisms that are too large to pass through in-plant screening devices and instead become stuck or impinged against the screening device or remain in the forebay sections of the system until they are removed by other means."
- "Other impacts to aquatic habitats can result from construction related activities (e.g., dewatering, dredging, etc.) (see Section 4.1) as well as routine operation and maintenance activities. There is a broad range of impacts associated with these activities depending on the specific design and needs of the system. For example, dredging activities can cause turbidity, degraded water quality, noise, and substrate alterations. Many of these impacts can be reduced or eliminated through the use of various techniques, procedures, or technologies, but some may not be fully eliminated except by eliminating the activity itself."
- The following are recommended conservation measures to mitigate for overwater structures effects:
  1. Locate facilities that rely on surface waters for cooling in areas other than estuaries, inlets, heads of submarine canyons, rock reefs or small coastal embayments where EFH species or their prey concentrate. Discharge points should be located in areas that have low concentrations of living marine resources. They should incorporate cooling towers to control temperature and employ sufficient safeguards to ensure against release of blow-down pollutants into the aquatic environment in concentrations that reduce the quality of EFH.
  2. Design intake structures to minimize entrainment or impingement. Velocity caps that produce horizontal intake/discharge currents should be employed and intake velocities across the intake screen should not exceed 0.5 foot per second.
  3. Design power plant cooling structures to meet the "best technology available" requirements (BTAs) as developed pursuant to Section 316(b) of the Clean Water Act. Use of alternative cooling strategies, such as closed cooling systems (e.g., dry cooling) should be used to completely avoid entrainment/impingement impacts in all industries which require cooling water. When alternative cooling strategies prove infeasible, other BTAs may include but are not limited to fish diversion or avoidance systems, fish return systems that convey organisms away from the intake and mechanical screen systems that prevent organisms from entering the intake system, and habitat restoration measures.
  4. Regulate discharge temperatures (both heated and cooled effluent) such that they do not appreciably alter the temperature that could cause a change in species assemblages and ecosystem function in the receiving waters. Strategies should be implemented to diffuse the heated effluent.
  5. Avoid the use of biocides (e.g., chlorine) to prevent fouling where possible. The least damaging antifouling alternatives should be implemented.
  6. Mitigate for impacts related to power plants and other industries requiring cooling water. Mitigation should compensate for the net loss of EFH habitat functions from placement and operation of the intake and discharge structures. Mitigation should be provided for the loss of habitat from placement of the intake structure and delivery

pipeline, the loss of fish larvae and eggs that may be entrained by large intake systems, and the degradation or loss of habitat from placement of the outfall structure and pipeline as well as the treated water plume.
7. Treat all discharge water from outfall structures to meet state water quality water standards at the terminus of the pipe. Pipes should extend a substantial distance offshore and be buried deep enough to not affect shoreline processes. Buildings and associated structures should be set well back from the shoreline to preclude the need for bank armoring.

Pesticides

Baldwin, D. H., J. A. Spromberg, T. K. Collier, N. L. Scholz. 2009. A fish of many scales: extrapolating sublethal pesticide exposures to the productivity of wild salmon populations. Ecological Applications 19:2004-2015.

- Because pesticide exposures are typically sublethal, a key question is whether toxicological effects at (or below) the scale of the individual animal ultimately reduce the productivity and recovery potential of wild populations.
- Baldwin et al. (2009) examined how the sublethal impacts of pesticides on physiology and behavior can reduce the somatic growth of juvenile chinook salmon (Oncorhynchus tshawytscha) and, by extension, subsequent sizedependent survival when animals migrate to the ocean and overwinter in their first year.
- “Our results indicate that short-term (i.e., four-day) exposures that are representative of seasonal pesticide use may be sufficient to reduce the growth and size at ocean entry of juvenile chinook. The consequent reduction in individual survival over successive years reduces the intrinsic productivity (lambda) of a modeled oceantype chinook population.”

Weinhold, B. 2009. Synergy for Salmon: Study Spawns Insight into Pesticide Mixtures. Environmental Health Perspectives 117:A117.

- The researchers evaluated the effects of diazinon, malathion, chlorpyrifos, carbaryl, and carbo furan—which are among the most extensively used pesticides in California and the Pacific Northwest—in the brains of juvenile coho salmon. These chemicals inhibit the enzyme acetylcholinesterase (AChE), resulting in an accumulation of acetylcholine, which in turn can affect behavior and, ultimately, survival.
- For each of 10 pairings of the 5 pesticides, concentrations were designed to elicit AChE reductions of 10%, 29%, or 50% (assuming the chemicals acted additively) for a total of 30 possible exposures. Other fish were exposed to single pesticides; none were tested for combinations of 3 or more chemicals.
- Nearly every pairing inhibited AChE activity after the salmon were exposed over a 96-hour period. Synergistic inhibition was observed in 20 of the 30 combinations,

producing anywhere from about 20% stronger inhibition than predicted by additive activity alone to more than 90% inhibition in 5 combinations. For 3 combinations, the salmon died within 24 hours. In contrast, there were no deaths among fish exposed to individual pesticides only.
- If synergistic effects occur at concentrations found in habitats supporting salmon stocks, which often include species designated as threatened or endangered, regulators may need to consider multichemical effects when setting exposure standards.

NMFS. 2008c. Biological Opinion: Environmental Protection Agency registration of pesticides containing Chlorpyrifos, Diazinon, and Malathion. National Marine Fisheries Service, Silver Spring, Mo.

- "A significant risk to threatened and endangered ESUs/DPSs is pesticide drift and runoff to salmonid aquatic habitats."
- "Given the species' life history, salmonids may be exposed to chlorpyrifos, diazinon, and malathion through direct contact with contaminated surface water or pore water. Of particular concern are small streams and off-channel habitats used by salmonids that have a lower capacity to dilute pesticide contaminants. These habitats are frequently in floodplain areas that overlap with agricultural, residential, and urban land uses. Dietary consumption via salmonid prey is a likely route of exposure and is significant exposure for chlorpyrifos. Chlorpyrifos accumulates in tissues of aquatic organisms and may be consumed by other fish and animals throughout the food chain. Salmonid prey items include dead or dying aquatic terrestrial insects that have been exposed to the three active ingredients."
- "Monitoring studies indicate that detection of chlorpyrifos, diazinon, and malathion occurs frequently throughout the action area in freshwater and nearshore environments associated with urban, agricultural or mixed land use watersheds. However, there is a limited amount of monitoring data available for streams and off-channel habitats. The available monitoring data are not adequate to define exposure at the ESU/DPS level."
- "We expect surface waters that contain chlorpyrifos, diazinon, and malathion to affect individuals and prey by additive toxicity as a result of the cumulative impairment of AChE activity and all AChE-associated physiological functions. Additionally, we also expect to see additive toxicity in the form of AChE inhibition in salmonids and their prey in surface waters containing other OPs and carbamates. Similarly, synergism occurs with certain combinations and specific concentrations of chlorpyrifos, diazinon, and malathion. This interaction translates into increased rates of mortality among exposed salmonids. While we have no predictive models for this phenomenon, we expect to see synergistic effects where these three pesticides co-occur in specific levels."

Johnson, L. L., G. M. Ylitalo, M. R. Arkoosh, A. N. Kagley, C. Stafford, J. L. Bolton, J. Buzitis, B. F. Anulacion and T. K. Collier. 2007. Contaminant exposure in outmigrant juvenile salmon from Pacific Northwest estuaries of the United States. Environmental Monitoring and Assessment 124:161-194.

- "To better understand the dynamics of contaminant uptake in outmigrant juvenile salmon in the Pacific Northwest, concentrations of polychlorinated biphenyls (PCBs), DDTs, polycylic aromatic hydrocarbons (PAHs) and organochlorine pesticides were measured in tissues and prey of juvenile Chinook and coho salmon from several estuaries and hatcheries in the Pacific Northwest."
- Of the two species sampled, Chinook salmon had the highest whole body contaminant concentrations, typically 2-5 times higher than coho salmon from the same sites.
- In comparison to estuarine Chinook salmon, body burdens of PCBs and DDTs in hatchery Chinook were relatively high, in part because of the high lipid content of the hatchery fish.
- Concentrations of PCBs were highest in Chinook salmon from thw Duwamish Estuary, the Columbia River and Yaquina Bay, exceeding the NOAA fisheries' estimated threshold for adverse health effects of 2400 ng/g lipid.
- Juvenile Chinook salmon are likely absorbing some contaminants during estuarine residence through their prey, as PCBs, PAHs, and DDTs were consistently present in stomach contents, at concentrations significantly correlated with contaminant body burdens in fish from the same sites.

Fulton, M. H., D.W. Moore, E.F. Wirth, G.T. Chandler, P.B. Key, J.W. Daugomah, E.D. Strozier, J. Devane, J.R. Clark and others. 1999. Assessment of risk reduction strategies for the management of agricultural nonpoint source pesticide runoff in estuarine ecosystems. Toxicology and Industrial Health 15:200-213.

- Incorporating integrated pest management (IPM) and best management practices as part of the authorization or permitting can help ensure the reduction of pesticide contamination in estuarine ecosystems.

DeLorenzo, M.E., G.I. Scott, P.E. Ross. 2001. Toxicity of pesticides to aquatic microorganisms: A review. Environmental Toxicology and Chemistry 20(1):84-98.

- "Microorganisms contribute significantly to primary production, nutrient cycling, and decomposition in estuarine ecosystems; therefore, detrimental effects of pesticides on microbial species may have subsequent impacts on higher trophic levels."
- "There is a great deal of variability in the toxicity of even a single pesticide among microbial species. When attempting to predict the toxicity of pesticides in estuarine ecosystems, effects of pesticide mixtures and interactions with nutrients should be considered. The toxicity of pesticides to aquatic microorganisms, especially bacteria and protozoa, is an area of research requiring further study."

Moore, A., C.P. Waring. 2001. The effects of a synthetic pyrethroid pesticide on some aspects of reproduction in Atlantic salmon (Salmo salar L). Aquatic Toxicology 52:1-12.

- The synthetic pesticide cypermethrin, a known contaminant of tributaries supporting spawning salmonid fish, had a significant sublethal impact upon the endocrine system in mature male Atlantic salmon parr, disrupting the reproductive fitness of the population.

NMFS. 2008a. Federal Columbia River power system biological opinion. National Marine Fisheries Service. Available: http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/final-BOs.cfm. (October 2009).

- Current environmental conditions in the Columbia River estuary indicate the presence of contaminants in the food chain of juvenile salmonids including DDT, PCBs, and polyaromatic hydrocarbons. This data also indicates that juvenile salmonids in the Columbia River estuary have contaminant body burdens in the range where sublethal effects may occur.
- The sources of exposure are not clear but may be widespread. Several pesticides and heavy metal contaminants have been sampled in Columbia River sediments (ODEQ 2007). In field studies, juvenile salmon from sites in the Pacific Northwest have demonstrated immunosuppression, reduced disease resistance, and reduced growth rates due to contaminant exposure during their period of estuarine residence.

Flood Control

WSCC. 2001b. Habitat limiting factors: Yakima River Watershed. Washington State Conservation Commision. Available: http://www.scc.wa.gov/index.php/287-WRIA-37-38-39-Yakima-River-Watershed/View-category.html. (October 2009).

- There are two major types of human impacts to floodplain functions. First, channels are disconnected from their floodplain. This occurs both laterally as a result of the construction of dikes and levees, which often occur simultaneously with the construction of roads, and longitudinally as a result of the construction of road crossings. This has: 1) eliminated off-channel habitats such as sloughs and side channels; 2) increased flow velocity during flood events due to the constriction of the channel; 3) reduced subsurface flows and groundwater contribution to the stream; and 4) simplified channels since LWD is lost and channels are often straightened when levees are constructed. Channels can also become disconnected from their floodplains as a result of down-cutting and incision of the channel from losses of LWD, decreased sediment supplies, and increased high flow events.
- Elimination of off-channel habitats results in the loss of important habitats for juvenile salmonids. Sloughs and backwaters that are protected from flood flow impacts function as prime spawning habitat for chum, pink, and coho, and rearing and over-wintering habitat for spring chinook and coho juveniles.

- The second major type of impact is loss of natural riparian and upland vegetation. Riparian forests are typically reduced or eliminated as levees and dikes are constructed. Loss of vegetation on the floodplain reduces shading of water in floodplain channels, eliminates LWD contribution, reduces filtering of sediments, nutrients and toxics, and results in increased water energy and loss of bank stability during flood flows.

SRSRB. 2006. Snake River salmon recovery plan for Southeast Washington. Snake River Salmon Recovery Board. Available: http://www.snakeriverboard.org/resources/library.htm. (October 2009)

- Large portions of the Tucannon, Touchet and Walla Walla rivers have been channelized and confined by levees and dikes to protect nearby fields and farms that have been repeatedly damaged by floods. The cumulative impact of these projects destabilizes the rivers by increasing their erosive power. As a consequence, the Tucannon River is now actively degrading its banks and bed and causing serious problems with regard to fine sediment deposition and habitat complexity.

Ziemer, R. R. and T. E. Lisle. 2001. Hydrology. In River Ecology and Management, Lessons from the Pacific Coastal Ecoregion. Edited by Naiman, R. J. and R. E. Bilby. Springer- Verlag New York, Inc. 175 Fifth Avenue, New York, NY 10010. Pages 43-68.

- Confining streamflow through channelization and diking increases stream energy (and the potential for serious flooding downstream) by negating the benefits of water dispersing onto the floodplain.
- Functional floodplains moderate instream flow peaks by substantially increasing the area available for water storage. Water seeps into the groundwater table during floods, recharging wetlands, off-channel areas and shallow aquifers. Wetlands and aquifers in turn release water to the stream during the summer months through a process called hydraulic continuity. This maintenance of flow ensures adequate flows for salmonids during the summer months, and reduces the possibility of high energy flood events that can destroy salmonid redds during the winter months.

U.S. Fish and Wildlife Service. 2000. Impacts of riprapping to ecosystem functioning, lower Sacramento River, California. U.S. Fish and Wildlife Service, Sacramento Field Office, Sacramento, California. U.S. Fish and Wildlife Service, Sacramento Field Office, Sacramento, California. Prepared for US Army Corps of Engineers, Sacramento District.

- Like many large rivers, the lower Sacramento River exhibits fragmentation and disconnection from ecological processes. Much of the degradation results from river meandering and erosion being Over half (more in certain reaches) of the Sacramento River's banks within the lower 194 miles have been riprapped, mainly from 4 decades of work by the Corps of Engineers' Sacramento River Bank Protection Project (SRBPP).
- Riprapping prevents the recruitment of new LWD along the armored banks, and it reduces the retention of LWD inputted from nonarmored areas. The cumulative loss of

LWD functioning for the lower river is now at least 67-90 percent, or more, compared to pre-SRBPP conditions.
- The use of set-back levees to achieve bank protection goals offers the best mitigation solution. Set-back levees allow both site- and reach-level impacts to be fully avoided, and they maximize habitat enhancement opportunities.

Williams, G.D., R.M. Thom. 2001. Marine and estuarine shoreline modification issues. White paper submitted to Washington Department of Fish and Wildlife, Washington Department of Ecology, and Washington Department of Transportation. Available: wdfw.wa.gov/hab/ahg/finalsl.pdf. (January 2010).
- Armoring of shorelines to prevent erosion and maintain or create shoreline real estate simplifies habitats, reduces the amount of intertidal habitat, and affects nearshore processes and the ecology of a myriad of species.
- Hydraulic effects to the shoreline include increased energy seaward of the armoring, reflected wave energy, dry beach narrowing, substrate coarsening, beach steepening, changes in sediment storage capacity, loss of organic debris, and downdrift sediment starvation.
- Installation of breakwaters and jetties can result in community changes from burial or removal of resident biota; changes in cover and preferred prey species; and predator attraction. As with armoring, breakwaters and jetties modify hydrology and nearshore sediment transport as well as movement of larval forms of many species.

NMFS. 2007a. Puget Sound Salmon Recovery Plan. NMFS. Available: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/PS-Chinook-Plan.cfm. (October 2009).
- Puget Sound has been heavily altered by human development, with 33% of shorelines modified with bulkheads or other armoring and 73% of wetlands in major deltas of Puget Sound rivers have been lost in the last 100 years.

NMFS. 2008a. Federal Columbia River power system biological opinion. National Marine Fisheries Service. Available: http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/final-BOs.cfm. (October 2009).
- With changes in the Columbia River flow regime, the availability of shallow (between 10 cm and 2 m depth), low-velocity (less than 30 cm/s) habitat in the Columbia River Estuary now appears to decrease at a steeper rate with increasing flow than during the 1880s, and the absorption capacity of the estuary appears to have declined.

NMFS. 2003. Non-fishing impacts to essential fish habitat and recommended conservation measures. National Marine Fisheries Service.
- "Dikes, levees, ditches, or other water controls at the upper end of a tidal marsh can cut off all tributaries feeding the marsh, preventing freshwater flushing and annual flushing, annual renewal of sediments and nutrients, and the formation of new marshes. Water

controls within the marsh proper intercept and carry away freshwater drainage, block freshwater from flowing across seaward portions of the marsh, increase the speed of runoff of freshwater to the bay or estuary, lower the water table, permit saltwater intrusion into the marsh proper, and create migration barriers for aquatic species. In deeper channels where reducing conditions prevail, large quantities of hydrogen sulfide are produced that are toxic to marsh grasses and other aquatic life. Acid conditions of these channels can also result in release of heavy metals from the sediments."

- The following are recommended conservation measures to mitigate for Estuarine Alteration effects:
  1. Minimize the loss of riparian habitats as much as possible.
  2. The diking and draining of tidal marshlands and estuaries should not be undertaken unless a satisfactory compensatory mitigation plan is in effect and monitored.
  3. Wherever possible, "soft" approaches (such as beach nourishment, vegetative plantings, and placement of large woody debris) to shoreline modifications should be utilized.
  4. Include efforts to preserve and enhance EFH by providing new gravel for spawning areas; removing barriers to natural fish passage; and using weirs, grade control structures, and low flow channels to provide the proper depth and velocity for fish.
  5. Construct a low-flow channel to facilitate fish passage and help maintain water temperature in reaches where water velocities require armoring of the riverbed.
  6. Replace in-stream fish habitat by providing rootwads, deflector logs, boulders, rock weirs and by planting shaded riverine aquatic cover vegetation.
  7. Use an adaptive management plan with ecological indicators to oversee monitoring and ensure mitigation objectives are met. Take corrective action as needed.

NMFS. 2009. Biological opinion and conference opinion on the long-term operations of the Central Valley Project and State Water Project. National Marine Fisheries Service, Southwest Region.

- "The armoring and revetment of stream banks tends to narrow rivers, reducing the amount of habitat per unit channel length. As a result of river narrowing, benthic habitat decreases and the number of macroinvertebrates, such as stoneflies and mayflies, per unit channel length decreases, affecting salmonid food supply."

Culvert Construction

Castro, J. 2003. Geomorphologic impacts of culvert replacement and removal: avoiding channel incision. Portland, OR: U.S. Fish and Wildlife Service - Oregon Fish and Wildlife Office.

- Channel incision can often occur downstream of a culvert and generally moves upstream, potentially affecting fish habitat and impeding fish passage. An existing culvert can act as a grade control, halting the upstream progression of a headcut and causing further channel regrade.

NMFS. 2007. Magnuson-Stevens Reauthorization Act Klamath River Coho Salmon Recovery Plan. Prepared by Rogers, F. R., I. V. Lagomarsino and J. A. Simondet for the National Marine Fisheries Service, Long Beach, CA. 48 pp. Available: http://swr.nmfs.noaa.gov/salmon/MSRA_RecoveryPlan_FINAL.pdf. (November 2009).

- “In light of the heavy road development within much of the HSA, impaired fish passage at road crossings is commonly a bottleneck to migrating coho salmon. Many roads administered by the California Department of Transportation have faulty or poorly designed culverts that block upstream and downstream migration.”
- “Problem culverts should first be inventoried and ranked in order to optimize use of limited funding resources.”

NMFS. 2003. Non-fishing impacts to essential fish habitat and recommended conservation measures. National Marine Fisheries Service.

- The following is a recommended conservation measure to mitigate for road building: 3. Build bridges when possible. If culverts are to be used, they should be sized, constructed, and maintained to match the gradient and width of the stream, so as to accommodate 100-year flood flows, but equally to provide for migratory passage of adult and juvenile fishes. Utilize guidelines provided in the document: “Guidelines for Salmonid Passage at Stream Crossing,” NOAA Fisheries, Southwest Region, October 2001 (http://swr.nmfs.noaa.gov/hcd/NMFSSCG.PDF).

Flanders, L.S., J. Cariello. 2000. Tongass road condition survey report. Technical Report 00-7. Douglas, AK: Alaska Department of Fish and Game, Southeast Regional Office of the Habitat and Restoration Division.

- “Velocity is the most common cause of fish passage restriction in culverts. If a culvert is installed at too steep a gradient or the culvert width is significantly narrower than the streambed width, the water velocity will be increased within the culvert. Very slight changes in the slope of the culvert and the roughness of the substrate within the culvert may significantly change velocity and the ability of fish to pass through the culvert during all of the times of year when they normally move upstream or downstream. Other frequent causes of fish passage problems include perching of the culvert outlet above the water surface, blockage by excessive substrate or woody debris within the culvert and structural damage to the culvert. In most cases, multiple factors interact to restrict fish passage.”

Chestnut, T.J. 2002. A review of closed bottom stream crossing structures (culverts) on fish-bearing streams in the Kamloops forest district, June 2001. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2602.

- “A review of closed bottom culverts was conducted to assess whether the fish and fish habitat provisions of the Fisheries Act were being achieved. A total of 31 culverts, installed on fish-bearing streams, in the Kamloops Forest District, B.C., were assessed.”

- "At each culvert site the likelihood of juvenile fish passage and the maintenance of fish habitat was assessed. Only one of the thirty-one culverts assessed met Fisheries and Oceans objectives for juvenile fish passage and maintenance of fish habitat."
- "Fisheries and Oceans fish passage and fish habitat protection objectives associated with closed bottom stream crossing structures are rarely being achieved in the Kamloops Forest District. It is recommended that clear span, open bottom structures, i.e. bridges, be used on all fish bearing streams."

NMFS. 2001. Guidelines for salmonid passage at stream crossings. NOAA Fisheries, Southwest Region, Long Beach, CA.

- This document provides guidelines for design of stream crossings to aid upstream and downstream passage of migrating salmonids. It is intended to facilitate the design of a new generation of stream crossings, and assist the recovery of threatened and endangered salmon species. These guidelines are offered by the National Marine Fisheries Service, Southwest Region (NMFS-SWR), as a result of its responsibility to prescribe fishways under the Endangered Species Act, the Magnuson-Stevens Act, the Federal Power Act, and the Fish and Wildlife Coordination Act. The guidelines apply to all public and private roads, trails, and railroads within the range of anadromou salmonids in California.
- The following are the alternative methods for designing or replacing culverts. The document describes them in detail:
  - Active Channel Design Method
    - The Active Channel Design method is a simplified design that is intended to size a culvert sufficiently large and embedded deep enough into the channel to allow the natural movement of bedload and formation of a stable bed inside the culvert.
  - Stream Simulation Design Method
    - The Stream Simulation Design method is a design process that is intended to mimic the natural stream processes within a culvert. Fish passage, sediment transport, flood and debris conveyance within the culvert are intended to function as they would in a natural channel.
  - Hydraulic Design Method
    - The Hydraulic Design method is a design process that matches the hydraulic performance of a culvert with the swimming abilities of a target species and age class of fish. This method targets distinct species of fish and therefore does not account for ecosystem requirements of non-target species.

Sylte, T.L. 2002. Providing for stream function and aquatic organism passage: An interdisciplinary design. Stream Notes: January 2002. Stream Systems Technology Center, Rocky Mountain Research Station, Fort Collins, CO.

- “Despite many standards and guidelines that address the importance of fish movement, the number of culverts either partially or fully impeding passage is high…Although the impact of any one culvert in most cases is not substantial, cumulatively, impacts can be significant.”
- “Four primary issues explain the large number of existing inadequate culverts:
    - Former design approaches,
    - Lack of cross-disciplinary communication and understanding,
    - Salmo- and adult-centric knowledge and application, and
    - New knowledge and awareness.”
- “Culverts commonly impede fish movement by one of the following mechanisms:
    - Excessive velocities,
    - Excessive outlet perch heights,
    - Inadequate depths for fish migrating during lower flow conditions, or
    - Debris blockage at the inlet.”
- “…culverts should provide passage whenever fish are present…Generally, weaker swimming fish are the limiting factor in passage considerations…Properly designed culverts do not produce water velocities that exceed fish swimming abilities. Properly designed culverts also accommodate stream structure and function, which in most cases means at least spanning the active channel width…Spanning the active channel width and simulating a channel bottom through the culvert will satisfy most biological and hydrological concerns.”
- “For the engineer, planner, and manager, the initial costs of designing for aquatic passage will likely increase because the culvert will be larger and thus more expensive. However, failure risks will be reduced and structure life will be optimized. Maintenance levels and replacement frequency will decrease creating more economic opportunities with limited budgetary resources.”

Wheeler, A.P., P.L. Angermeier, and A.E. Rosenberger. 2005. Impacts of new highways and subsequent landscape urbanization on stream habitat and biota. Reviews in Fisheries Science 13(3):141-164.

- “The presence of culverts destabilizes stream channels by interrupting the downstream transport of woody debris, sediment, substrate, and waters…Unlike dynamic natural stream channels, culverts are rigid and un-accommodating to changes in channel morphology. In addition, the stream channel is often widened above the culvert, reducing current velocities and forming a sediment trap. Although downstream sediment flow is reduced above the culvert, it continues or accelerates below the culvert causing channel downcutting and resulting in an elevation drop, even if initial construction put the pipe at stream level. Typically, culverts are sized to accommodate rare flood flows but are too small to allow passage of woody debris. Accumulations of woody debris near the inlet can starve downstream areas of this important component of stream habitat and may plug the culvert, causing failure of road fill during floods and increasing the risk of catastrophic debris torrents.”

- "Culverts provide poor internal habitat due to low-bottom complexity and uniformly high-flow velocities…they are notorious fish movement barriers. The effects of highway crossings on stream fish movement depend on the swimming speed and behavior of individual species. Fish passage is obstructed by high current velocities and shallow depths inside culverts, as well as vertical drops at the culvert outflow."
- Overall fish movement may be an order of magnitude lower through culverts when compared to other crossing types or natural channels
- "Culverts throughout a tributary network can reduce production of species that require spawning migrations…by preventing adults from reaching spawning habitat. Barriers can isolate populations, resulting in reduced genetic diversity and increased probability of extinction due to demographic instability and impeded recolonization…importance of movement and movement barriers to nongame fishes and fish communities is poorly understood…engineers designing passable culverts may narrowly focus on the effects of singular parameters…and not consider the cumulative effects of multiple passage inhibiting features."

Vaughan, D.M. 2002. Potential impact of road-stream crossings (culverts) on the upstream passage of aquatic macroinvertebrates. U.S. Forest Service Report, U.S. Forest Service, Portland, OR.

- To minimize the impact of culverts on upstream dispersal and the overall effect on the hydro-geomorphology of a stream:
    - Make culverts as wide as possible or use a bridge to allow lateral movement of stream
    - Culvert bottoms should be at least 20cm below the surface of stream's substrate
- Little data available on ability of aquatic macroinvertebrates to pass through culverts – suggest species-specific impacts need to be studied for each culvert placement – insects with flight generally not a problem – culverts may pose more of a problem for non-insects (i.e., mollusks and crustaceans) – upstream movement of parasitic macroinvertebrates may be blocked by culverts that block upstream movement of hosts
- Actual effect of culverts on upstream passage of threatened and endangered species will need to be assessed on a case-by-case basis
- In limited number of cases, culverts may block upstream dispersal of invasive species – if true barriers are needed, culverts cannot be considered reliable
- Channelization and subsequent erosion and sedimentation that accompanies culverts likely has a much greater negative impact on macroinvertebrate communities than the culvert itself.

Wargo, R.S., and R.N. Weisman. 2006. A comparison of single-cell and multicell culverts for stream crossings. Journal of the American Water Resources Association 42(4):989-995.

- "Single-barrel culverts are a common means of roadway crossings for smaller streams. While this culvert design provides an economical solution for a crossing, the adverse effects of conveying the stream through a single opening can be far reaching. The single-barrel culvert is typically sized for a design storm much greater than the channel forming discharge. This oversizing causes an interruption of the normal flow patterns and sediment transport for the system. Shallow depths at low flow in the pipe and perching at the outlet can impede fish passage."

- "Multicell culverts (where the main culvert at the channel invert is sized for bankfull discharge, and additional pipes are placed at the floodplain elevation to convey overbank flow up to the design discharge) have been recommended as a best management practice to minimize erosion and improve fish passage."
- Authors used flumes and scaled prototype single-barrel and multicell culverts to compare outlet scour and flow depths between the two designs
- Depths in the multicell design were higher than the single-barrel design at all three test flows and the single-cell scour pool was larger and perched higher than the multicell design at all flows – suggests that multicell designs are better for fish passage at all flows
- Authors only recommend using multicell designs in channels that are not incised and do not carry large debris loads – also need to evaluate economic costs and ecological benefits before installation as multicell designs are more expensive

Climate Change

National Wildlife Federation. 2005. Fish Out of Water: A Guide to Global Warming and Pacific Northwest Rivers. National Wildlife Federation, Western Natural Resource Center. Seattle, WA.

- Increase in stream temperatures due to climate change can contribute to a reduction in the preferred species of insects that are used for food by salmon

Climate Impacts Group. 2004. Overview of Climate Change Impacts in the U.S. Pacific Northwest. University of Washington. Seattle,WA

- Although the impacts of global climate change are less clear in the ocean environment, early modeling efforts suggest that, warmer temperatures are likely to increase ocean stratification, which in the past has coincided with relatively poor ocean habitat for most Pacific Northwest salmon, herring, anchovies, and smelt populations.

Schindler, D.E., X. Augerot, E. Fleishman, N. J. Mantua, B. Ridell, M. Ruckelshaus, J. Seeb, and M. Webster. 2008. Climate change, ecosystem impacts, and management for Pacific salmon. Fisheries 33:502-506.

- Shindler et al. identify the following study areas that can reduce key uncertainties about climate change impacts on pacific salmon and improve salmon-climate policy:
    - Developing quantitative models that allow projections for temperature, precipitation, and hydrologic conditions to be reliably downscaled to the watershed level.

- Exploring the extent to which salmon and co-occuring organisms might adapt to ongoing climate change, thus affecting the direction and magnitude of overall ecosystem response.
- Improving understanding of how climate change affects the metapopulation processes important to salmon evolutionary and ecological dynamics.

Battin, J., M. W. Wiley, M. H. Ruckelshaus, R. N. Palmer, E. Korb, K. K. Bartz, and H. Imaki. 2007. Projected impacts of climate change on salmon habitat restoration. Proceedings of the National Academy of Sciences 104:6720-6725.

- Using a series of linked models of climate, land cover, hydrology, and Chinook salmon population dynamics in the Snohomish River Basin, Washington, Battin et al. found a large negative impact of climate change on freshwater salmon habitat.
- River basins that span the current snow line appear especially vulnerable to climate change, and salmon recovery plans that enhance lower-elevation habitats are likely to be more successful over the next 50 years than those that target the higher-elevation basins likely to experience the greatest snow-rain transition.

Stewart, I. T., D. R. Cayan, and M. D. Dettinger. 2004. Changes in snowmelt runoff timing in western north america under a ‘business as usual' climate change scenario. Climatic Change 62:217-232.

Under21st

- Under 21st century warming trends predicted by the Parallel Climate Model under business-as-usual greenhouse-gas emissions, springtime snowmelt is predicted to occur earlier than observed to date.
- The strongest changes in streamflow timing are expected to occur in the Pacific Northwest, Sierra Nevada, and Rocky Mountains, where many rivers are projected to run 30-40 days earlier.
- A one-month advance in the timing of snowmelt runoff would increase the length of the summer drought that occurs in much of western North America, affecting habitat availability for rearing or migrating juvenile pacific salmon.

Mote, P. W., E. A. Parson, A. F. Hamlet, W. S. Keeton, D. Letternmaier, N. Mantua, E. L. Miles, D. W. Peterson, D. L. Peterson, R. Slaughter, and A. K. Snover. 2003. Preparing for climate change: the water, salmon, and forests of the Pacific Northwest. Climate Change 61:45-88.

- Using output from eight climate models, Mote et al. project a further warming of 0.5–2.5 ◦C (central estimate 1.5 ◦C) by the 2020s, 1.5–3.2 ◦C (2.3 ◦C) by the 2040s, and an increase in precipitation except in summer. The foremost impact of a warming climate will be the reduction of regional snowpack, which presently supplies water for ecosystems and human uses during the dry summers.

Miles, E. L., A. K. Snover, A. F. Hamlet, B. Callahan, and D. Fluharty. 2000. Pacific northwest regional assessment: the impacts of climate variability and climate change on the water

resources of the Columbia River Basin. Journal of American Water Resources Association 36:399-420.

- Climate change projections suggest exacerbated conditions of conflict between users as a result of low summertime streamflow conditions. An understanding of the patterns and consequences of regional climate variability is crucial to developing an adequate response to future changes in climate.
- Miles et al. identify four elements necessary for an effective response to climate variability: centralized management of the resource, managerial flexibility and the ability to incorporate new information, development of institutional memory, and coordination.

Northwest Power and Conservation Council (NPCC). 2004. Draft Columbia River Basin research plan. Northwest Power and Conservation Council, Portland, OR.

- The risks of global climate change are potentially great for Upper Columbia stocks because of the sensitivity of salmon stocks to climate-related shifts in the position of the sub-arctic boundary, the strength of the California Current, the intensity of coastal upwelling, and the frequency and intensity of El Nino events.

ISAB (Independent Scientific Advisory Board). 2007. Climate change impacts on Columbia River basin fish and wildlife. ISAB, Report 2007-2, Portland, Oregon.

- The ISAB (2007c) identified the following list of likely effects of projected climate changes on Columbia basin salmon:
  - Anticipated water temperature increases, and the subsequent depletion of cold water habitat, could reduce the areal extent of suitable inland salmon habitats.
  - Variations in intensity of precipitation may alter the seasonal hydrograph and water available for salmon.
  - Eggs of fall and winter spawning fish, including Chinook, coho, chum, and sockeye salmon, may suffer higher levels of mortality when exposed to increased flood flows.
  - Earlier snowmelt and earlier, higher spring flows, warmer temperatures, and a greater proportion of precipitation falling as rain rather than snow, may cause spring Chinook and steelhead yearlings to smolt and emigrate to the estuary and ocean earlier in the spring.
  - Within the Columbia estuary, increased sea levels in conjunction with higher winter river flows could cause the degradation of estuary habitats created by increasing wave damage during storms.
  - Changes in the intensity and timing of coastal upwelling. These changes will alter primary and secondary productivity, the structure of marine communities, and, in turn, the growth, productivity, survival, and migrations of salmonids.

Cramer, S.P., J. Norris, P. Mundy, G. Grette, K. O'Neal, J. Hogle, C. Steward, and P. Bahls. 1999. Status of Chinook salmon and their habitat in Puget Sound, volume 2. Final report. S.P. Cramer and Associates, Gresham, Oregon.

- Evidence suggests that marine survival of salmonids fluctuates in response to the PDO's 20 to 30 year cycles of climatic conditions and ocean productivity.

Zabel, R. W., M.D. Scheuerell, M.M. McClure, and J.G. Williams. 2006. The interplay between climate variability and density dependence in the population viability of Chinook salmon. Conservation Biology 20 (1):190-200.

- Population viability analysis of Snake River Chinook salmon supports the premise that climate conditions can have extreme effects on the viability of natural populations.
- "Our results also emphasize that the impacts of climate go beyond just good or bad climate conditions. The autocorrelation associated with climate conditions leads to a greater tendency for populations to grow or decline exponentially, which clearly has important implications for population viability."

Luce C. H. and Z. A. Holden. 2009. Declining annual streamflow distributions in the Pacific Northwest United States, 1948-2006. Geophysical Research Letters, Volume 36.

- Luce and Holden (2009) tested for trends in the distribution of annual runoff using quantile regression at 43 gages in the Pacific Northwest.
- Seventy-two percent of the gauging stations showed significant (a = 0.10) declines in the 25th percentile annual flow, with half of the stations exceeding a 29% decline and a maximum decline of 47% between 1948 and 2006.
- "The driest 25% of years are becoming substantially drier. Reliance on tests of trends in the mean alone has promoted a view that only shifts in flow timing caused by temperature increases are occurring in snow dominated watersheds. This view could result in management adaptations that are locally inappropriate and may also lead to misinterpretation of ecological process. Because many aspects of managed and natural systems operate without impairment within some range of the mean, trends in less central parts of the distribution may be more important than trends in the mean. The decreasing trends in the lowest quartile, in particular, represent increasing challenges for land and water managers who must cope with water scarcity and its ecological consequences on more frequent and acute basis."

Mote, P.W. 2006. Climate-driven variability and trends in mountain snowpack in western North America. Journal of Climate 19: 6209-6220.

- Widespread declines in springtime snow-water equivalents (SWE) have occurred in much of the North American West since the 1920s, especially since mid-century. This decrease in SWE can be largely attributed to a general warming trend in the western United States since the early 1900s.

Stewart, I. T., D. R. Cayan, and M. D. Dettinger. 2005. Changes toward earlier streamflow timing across western North America. Journal of Climate 18: 1136-1155.

- Climactic changes have resulted in earlier onsets of springtime snowmelt and streamflow across western North America, as well as lower flows in the summer.
- The projected runoff-timing trends over the course of the 21st century are most pronounced in the Pacific Northwest, Sierra Nevada, and Rocky Mountain regions, where the eventual temporal centroid of streamflow (i.e. peak streamflow) change amounts to 20–40 days in many streams.
- A 1-month advance in timing centroid of streamflow would also increase the length of the summer drought that characterizes much of western North America, with important consequences for water supply, ecosystem, and wildfire management.

Vicuna, S., E. P. Maurer, B. Joyce, J. A. Dracup, and D. Purkey. 2007. The sensitivity of California water resources to climate change scenarios. Journal of the American Water Resources Association 43:482-498.

- Using the latest available General Circulation Model (GCM) results Vicuna et al. (2007) present an assessment of climate change impacts on California hydrology and water resources.
- Our results show greater negative impacts to California hydrology and water resources than previous assessments of climate change impacts in the region. These impacts, which translate into smaller streamflows, lower reservoir storage and decreased water supply deliveries and reliability, will be especially pronounced later in the 21st Century and south of the San Francisco bay Delta.

Crozier, L.G., R.W. Zabel, and A.F. Hamlet. 2008. Predicting differential effects of climate change at the population level with life-cycle models of spring Chinook salmon. Global Change Biology 14(2):236-249.

- Crozier et al. (2008) linked predicted changes ion air temperature and precipitation from several General Circulation Models to a local hydrological model to project streamflow and air temperature under two climate-change scenarios. Using a stochastic, density-dependent life-cycle model, they found that mean abundance decreased 25-50% and the probability of quasi-extinction increased dramatically for all populations in response to climate change.
- Results demonstrate that detailed population models can usefully incorporate climate-change predictions, and that global warming poses a direct threat to freshwater stages in these fish, increasing their risk of extinction.

NMFS. 2009d. Public draft recovery plan for the Evolutionary Significant Units of Sacramento winter-run Chinook salmon and Central Valley spring-run Chinook salmon and the Distinct Population Segment of Central Valley Steelhead. National Marine Fisheries Service, Southwest Regional Office, Sacramento, California. Available:

http://swr.nmfs.noaa.gov/recovery/cent_val/Public_Draft_Recovery_Plan.pdf. (December 2009).

- "Current climate change information suggests that the Central Valley will become warmer, a challenging prospect for Chinook salmon and steelhead – both of which are coldwater fish at the southern end of their distribution."
- "To recover Central Valley salmon ESUs and the steelhead DPS, some populations will need to be established in cooler, high elevation areas now blocked by dams or insufficient flows."

NMFS. 2007a. Puget Sound Salmon Recovery Plan. NMFS. Available: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/PS-Chinook-Plan.cfm. (October 2009).

- "Climate change, both natural and induced, could have significant effects on Chinook salmon and other salmonids in the Puget Sound region and beyond. Possible effects include alteration of the hydrologic cycle resulting in changes in low and high flow patterns, changes to habitat forming processes, changes in terrestrial and riparian vegetation that affect habitat forming processes, changes in erosion patterns, and impacts to water quality. Significant research on this topic is being conducted in the region, however none of the watershed plans have proposed means of monitoring climate change or its impacts. This is a significant uncertainty in the Puget Sound Recovery Plan and should be addressed through the detailed watershed and regional adaptive management plan."

Osgood, K. E. 2008. Climate impacts on U.S. living marine resources: National Marine Fisheries Service Concerns, activities and needs. NOAA Technical Memorandum NMFS-F/SPO-89.

- "Altered freshwater systems, due to increased air temperatures and changes in the timing, amount and type (i.e. rain vs. snow) of precipitation, are a major climate induced ecosystem concern for the California Current Ecosystem. The focus is on anadramous fish such as salmon that use river systems and coastal regions for habitat. The primary concerns center on altered stream flows and warmer temperatures affecting survival and passage through tributaries, and changes in coastal ocean habitat quality and productivity due to altered freshwater input. Changes to freshwater input are also important in other regions where species depend upon coastal habitat or coastal currents which are influenced by freshwater input."

Scheuerell, M.D., J.G. Williams. 2005. Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook salmon (Oncorhynchus tshawytscha). Fisheries Oceanography 14(6):448-457.

- "While numerous retrospective analyses show a strong correlation between past changes in the ocean environment and salmon production within the north Pacific, these correlations rarely make good predictions. Using a Bayesian timeseries model to make successive 1-yr-ahead forecasts, we predicted changes in the ocean survival of

Snake River spring/summer chinook salmon (O. tshawytscha) from indices of coastal ocean upwelling with a high degree of certainty (R2=0.71). Furthermore, another form of the dynamic times-series model that used all of the available data indicated an even stronger coupling between smolt-to-adult survival and ocean upwelling in the spring and fall (R2=0.96). This suggests that management policies directed at conserving this threatened stock of salmon need to explicitly address the important role of the ocean in driving future salmon survival."

Task 4. Salmon Life History

Chinook Salmon

Eggs and Spawning

Montgomery, D.R., E.M. Beamer, G.R. Pess, & T.P. Quinn. 1999. Channel type and salmonid spawning distribution and abundance. Canadian Journal of Fisheries and Aquatic Science 56:377-387.

- Adult Chinook salmon tend to spawn in stream reaches characterized as low-gradient pool-riffle reaches.

Moyle, P.B. 2002. Inland fish of California, 2nd edition. University of California Press, Berkeley, California.

- The optimal water temperature for Central Valley Chinook salmon egg incubation ranges from 41^{o}F to 55.4^{o}F.

Merz, J. 2001. Association of fall-run Chinookk salmon redds with woody debris in the Lower Mokelumne River, Califronia. California Fish and Game 87:51-60.

- Surveys in the lower Mokelumne River during 1994-1995 indicated that fall-run chinook salmon, Oncorhynchus tshawytscha, redds associated with woody debris (WD) had smaller substrate and greater mean depths. Also, the proportion of redds associated with WD was negatively related to stream gradient. Female chinook salmon selected spawning sites containing WD in some instances. Woody debris may make less desirable habitats more suitable for spawning and may allow greater concentrations of redds on suitable sites.

Bratovich, P. M., G. W. Link, B. J. Ellrot, and J. A. Pinero. 2005. Impacts on lower American River salmonids and recommendations associated with Folsom Reservoir operations to meet Delta water quality objectives and demands. Surface Water Resources, Inc., Sacramento, CA.

- "The dewatering redds in the main channel, or isolation of redds in the river side channels in the American River, can result from flow reductions from levels at which spawning initially occurred. Redd dewatering can affect salmonid embryos and alevins by impairing development and causing direct mortality due to desiccation, insufficient

oxygen levels, waste metabolite toxicity, and thermal stress… The primary period of concern for redd dewatering and isolation extends from about mid October through May, corresponding to fall-run Chinook salmon and steelhead spawning and incubation period in the lower American River."

Connor, E.J. and D. E. Pflug. 2004. Changes in the distribution and density of Pink, Chum, and Chinook salmon spawning in the Upper Skagit River in response to flow management measures. North American Journal of Fisheries Management 24:835-852.

- "Densities of spawning salmon were compared among three contiguous reaches of the upper Skagit River before and after the implementation of flow management measures in 1981. The measures were intended to minimize redd dewatering during the spawning and incubation periods and fry stranding during the emergence and outmigration periods.
- "Field monitoring confirmed that increasing the minimum incubation flows created improvements in redd protection levels… Spawner abundance of all three species progressively increased in an upstream direction following implementation of flow measures; increases were greatest in the reach immediately below the hydroelectric project. The upstream shift in spawner abundance was highly significant based on factorial analyses of variance. The greatest increases in spawner abundance for Chinook salmon and chum salmon were observed during even years, when pink salmon did not spawn. Mean spawner abundance in the upstream-most study reach increased from 311 to 1,169 carcasses/mi (odd years) for pink salmon, from 6 to 115 fish/mi (odd years) or 58 to 462 fish/mi (even years) for chum salmon, and from 48 to 49 redds/mi (odd years) or 59 to 65 redds/ mi (even years) for Chinook salmon."
- "These increases were substantially greater than those observed concurrently in other areas of the Skagit River basin and in other northern Puget Sound rivers. The average number of Chinook salmon spawners remained unchanged in the study area after 1981, while substantially declining in other unregulated Skagit River subbasins and most Puget Sound rivers. The study area now possesses the greatest percentage of pink, chum, and Chinook salmon spawners within the Skagit River basin. The Skagit River presently supports the largest run of native Chinook salmon in the Puget Sound region and the largest runs of pink and chum salmon in the coterminous United States."

SRSRB. 2006. Snake River salmon recovery plan for Southeast Washington. Snake River Salmon Recovery Board. Available: http://www.snakeriverboard.org/resources/library.htm. (October 2009).

- Preferred habitat for spawning spring and summer Snake River Chinook includes Pool or glides with a minimum velocity of 3 ft./sec., depth of 20-36 inches, and temperatures between 42^{o}F and 51^{o}F.

USBR. 2008. Central Valley Project and State Water Project operations criteria and plan biological assessment. U.S. Bureau of Reclamation Mid-Pacific Region, Sacramento, California.

- "Central Valley spring-run Chinook salmon spawning timing occurs from mid to late August through early October, with peak spawning times varying among locations. For instance, in Deer Creek, spawning begins first at higher elevations, which are the coolest reaches… Water temperatures between 42 F and 58 F are considered most suitable for spawning."

Juveniles(Freshwater)

Upper Columbia Salmon Recovery Board (UCSRB). 2007. Upper Columbia spring Chinook salmon and steelhead recovery plan. Upper Columbia Salmon Recovery Board. Available: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Interior-Columbia/Upper-Columbia/upload/UC_Plan.pdf. (October 2009).

- Juvenile Chinook salmon in the Upper Columbia Basin are most often associated with streams that contain large woody debris (LWD) and pools in low-gradient alluvial valleys. In higher-gradient fluvial canyons, large boulders provide habitat complexity.

Gregory, R.S. & C.D. Levings. 1998. Turbidity reduces predation on migrating juvenile Pacific salmon. Transactions of the American Fisheries Society 127:275-85.

- Gregory and Levings (1998) compared predation on salmonids by potential predators caught by beach seine and by the rate of predator attack on tethered juvenile chinook salmon O. tshawytscha in the Harrison River and Frasier River, British Columbia.
- During their seaward migration in the Fraser River system, age-0 Chinook salmon were less likely to encounter and be consumed by fish piscivores in turbid water than in clear water.
- Juvenile Chinook salmon use low-velocity areas where substrate irregularities and other habitat features create velocity refuges and they may increasingly rely on turbidity as cover.
- Juvenile salmon losses to predators may be reduced at least 45 percent in turbid-water stream reaches relative to clear-water reaches.

Marine, K.R. & J.J. Cech, Jr. 2004. Effects of high water temperature on growth, smoltification, and predator avoidance in juvenile Sacramento River Chinook salmon. North American Journal of Fisheries Management 24:198-210.

- For Central Valley Chinook salmon, sublethal impairment of predator avoidance, smoltification, and disease begins in the range of about 64 to 68^{o}F.

Sommer, T. R., M. L. Nobriga, W. C. Harrel, W. Batham, and W. J. Kimmerer. 2001. Floodplain rearing of juvenile Chinook salmon: evidence of enhanced growth and survival. Canadian Journal of Fisheries and Aquatic Sciences 58:325-333.

- Sommer et al. (2001) found evidence that the Yolo Bypass, the primary floodplain of the lower Sacramento River (California, U.S.A.), provides better rearing and migration habitat for juvenile chinook salmon (Oncorhynchus tshawytscha) than adjacent river channels.
- During 1998 and 1999, salmon increased in size substantially faster in the seasonally inundated agricultural floodplain than in the river, suggesting better growth rates. Similarly, coded-wire tagged juveniles released in the floodplain were significantly larger at recapture and had higher apparent growth rates than those concurrently released in the river.
- Improved growth rates in the floodplain were in part a result of significantly higher prey consumption, reflecting greater availability of drift invertebrates. These findings support the predictions of the flood pulse concept and provide new insight into the importance of floodplain habitat for juvenile salmon.

Brandes, P.L. and J S. McLain. 2001. Juvenile Chinook salmon abundance, distribution, and survival in the Sacramento-San Joaquin Estuary. California Department of Fish and Game Fish Bulletin 179:39-136.

- Analyses of the lower river and Delta beach seine data and the trawl data at Sacramento and Chipps Island, indicates that many juveniles Chinook salmon enter the Sacramento-San Joaquin Delta as fry in wet years and that overall, juvenile production leaving the Delta is higher in wet years.
- Increased river flows appeared to increase fry survival upstream, but likely caused a greater proportion of them to migrate to the estuary where fry survival appears lower than upriver in the higher flow years.
- The survival of marked fry and smolts in the Central Delta appeared lower than in the North Delta, especially in the drier years. Both fry and smolts in the Central Delta may be more vulnerable to exports than those released in the North Delta in drier years.

Martin, C.D., P.D. Gaines, and R.R. Johnson. 2001. Estimating the abundance of Sacramento River juvenile winter Chinook salmon with comparisons to adult escapement. Red Bluff Research Pumping Plant Report Series, Volume 5. U.S. Fish and Wildlife Service, Red Bluff, California.

- Similar to adult movement, juvenile salmonid downstream movement in California's Central Valley is crepuscular. The daily migration of juvenile Chinook salmon passing RBDD is highest in the 4-hour period prior to sunrise.

Beckman, B. R., B. Gadberry, P. Parkins, K. Cooper amd K. D. Arkush. 2007. State-dependent life history plasticity in Sacramento River winter-run chinook salmon (Oncorhynchus tshawytscha): interactions among photoperiod and growth modulate smolting and early male maturation. Canadian Journal of Fisheries and Aquatic Sciences 64: 256-271.

- Beckman et al. (2007) examined the relative effects of photoperiod at emergence and growth rate on smolting pattern and early male maturation in Sacramento River winter-run Chinook salmon.
- “Male maturation was growth dependent, with high feed groups maturing at a rate double that found in low feed groups. Male maturation was also photoperiod dependent with a linear relation found between emergence date and rate of male maturation. These resilts demonstrate that individual life history pattern was variable and dependent on emergence timing and growth rate.”

Sykes, G. E., C. J. Johnson and J. M. Shrimpton. 2009. Temperature and flow effects on migration timing of Chinook salmon smolts. Transactions of the American Fisheries Society 138: 1252-1265.

- Sykes et al. (2009) used an information-theoretic model comparison analysis to investigate the roles of daily mean temperature, temperature experience (accumulated thermal units [ATU]), photoperiod, and flow on the timing of the downstream migration of Chinook salmon O. tshawytscha smolts from the Nechako River in central British Columbia.
- “The analyses identified a combination of temperature experience, flow, and the number of spawners as best able to describe the observed migration patterns. In addition, increasing ATU had a positive influence on migration, while increasing flow had a negative influence. “
- “Based on the results of this study, flow manipulations that change the timing, duration, or magnitude of temperature and flow in the spring could affect the migration of Chinook salmon. Both temperature and river flow should be considered when one is managing flow-controlled watersheds for salmon productivity.”

Geist, D. R., C. S. Abernathy, K. D. Hand, V. I. Cullinan, J. A. Chandler and P. A. Groves. 2006. Survival, development, and growth of fall Chinook salmon embryos, alevins, and fry exposed to variable thermal and dissolved oxygen regimes. Transactions of the American Fisheries Society 135:1462-1477.

- Geist et al. (2006) found that exposure to water temperatures up to 16.58C will not have deleterious effects on survival or growth of Chinook salmon from egg to emergence if temperatures decline at a rate of 0.28C/d or more after spawning.
- “Although fall Chinook salmon survived low initial dissolved oxygen levels, the delay in emergence could have significant long-term effects on their survival. Thus, an exemption to the state water quality standards for temperature—but not oxygen—may be warranted for the portions of the Snake River where fall Chinook salmon spawn.”

Jeffres, C. 2006. Ephemeral floodplain habitats provide best growth conditions for juvenile Chinook salmon in a California river. Master's thesis. University of California - Davis, Davis, CA.

- Jeffres (2006) reared juvenile Chinook salmon for two consecutive flood seasons within various habitats of the Cosumnes River and its floodplain (California) to compare growth rates of in river and newly created floodplain habitats.
- Jeffres (2006) found significant differences in growth rates between salmon rearing in floodplain and river sites. Salmon reared in seasonally inundated habitats with annual terrestrial vegetation showed higher growth rates than those reared in a perennial pond on the floodplain.
- Overall, ephemeral floodplain habitats supported higher growth rates for juvenile Chinook salmon than more permanent habitats in either the floodplain or river.

Beechie, T. J., M. Liermann, E. M. Beamer, R. Henderson. 2005. A classification of habitat types in a large river and their use by juvenile salmonids. Transactions of the American Fisheries Society, 134:717-729.

- "Densities of juvenile Chinook salmon and coho salmon were highest in bank and backwater units in winter in the Skagit River basin, WA. In summer, coho salmon densities were significantly different among edge unit types, densities being highest in banks and backwaters. Microhabitat selection (velocity, depth, and cover type) by juvenile salmonids mirrored that in small streams, most fish occupying areas with a velocity less than 15 cm/s and wood cover. Among ocean-type salmon, Chinook and chum salmon fry were captured in large numbers in all edge units and exhibited only slightly higher densities in low-velocity areas (,15 cm/s)."

Connor, E.J. and D. E. Pflug. 2004. Changes in the distribution and density of Pink, Chum, and Chinook salmon spawning in the Upper Skagit River in response to flow management measures. North American Journal of Fisheries Management 24:835-852.

- "Densities of spawning salmon were compared among three contiguous reaches of the upper Skagit River before and after the implementation of flow management measures in 1981. The measures were intended to minimize redd dewatering during the spawning and incubation periods and fry stranding during the emergence and outmigration periods.
- "Greater protection of fry from stranding was achieved by substantially reducing the annual number of downramping events and by reducing downramping during daytime, when fry are most vulnerable to stranding."

SRSRB. 2006. Snake River salmon recovery plan for Southeast Washington. Snake River Salmon Recovery Board. Available: http://www.snakeriverboard.org/resources/library.htm. (October 2009).

- Preferred habitat for rearing juvenile spring and summer Snake River Chinook includes edge habitat along the main channel with a variety of cover types, maximum depth of 4 feet, and temperatures between 53^{o}F and 60^{o}F.

USBR. 2008. Central Valley Project and State Water Project operations criteria and plan biological assessment. U.S. Bureau of Reclamation Mid-Pacific Region, Sacramento, California.

- "For Central Valley spring-run, yearling emigration occurs from October through March and may be triggered in part by precipitation events. In some years however, under certain flow and/or water temperature conditions, greater proportions of juveniles in Mill and Deer Creeks may emigrate as fry or fingerlings soon after emergence. The bulk of Butte and Big Chico Creek may emigrate as fry or fingerlings soon after emergence."

NMFS. 2009d. Public draft recovery plan for the Evolutionary Significant Units of Sacramento winter-run Chinook salmon and Central Valley spring-run Chinook salmon and the Distinct Population Segment of Central Valley Steelhead. National Marine Fisheries Service, Southwest Regional Office, Sacramento, California. Available: http://swr.nmfs.noaa.gov/recovery/cent_val/Public_Draft_Recovery_Plan.pdf. (January 2010).

- Winter-run and spring-run Central Valley Chinook salmon rearing fry seek streamside habitats containing beneficial aspects such as riparian vegetation and associated substrates that provide aquatic and terrestrial invertebrates for food, predator avoidance cover, and slower water velocities for resting. These shallow water habitats have been described as more productive juvenile salmon rearing habitat than the deeper main river channels.

NMFS. 2009. Biological opinion and conference opinion on the long-term operations of the Central Valley Project and State Water Project. National Marine Fisheries Service, Southwest Region.

- "The channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento River system are much degraded, and typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators. However, some complex, productive habitats with floodplains remain in the system [e.g., Sacramento River reaches with setback levees (i.e., primarily located upstream of the City of Colusa)] and flood bypasses (i.e., Yolo and Sutter bypasses). Juvenile life stages of salmonids are dependant on the function of this habitat for successful survival and recruitment."

Seesholtz, A., B.J. Cavallo, J. Kindopp, & R. Kurth. 2004. Juvenile fishes of the lower Feather River: Distribution, emigration patterns, and associations with environmental variables. Pages 141-166. In F. Feyrer, L.R. Brown, R.L. Brown, and J.J. Orsi (Eds.), Early life history of fishes in the San Francisco Estuary and watershed. American Fisheries Society, Symposium 39, Bethesda, Maryland.

- Rotary screw traps and beach seines in the Feather River were used to assess distribution, abundance, and emigration patterns of juvenile Chinook salmon between 1997 and 2001.
- More than 80% of Chinook salmon captured were less than 50 mm, demonstrating that most Feather River Chinook salmon emigrate before smolting. In multiple linear

regression models, Chinook salmon spawn timing and water temperature were statistically significant predictors of weekly Chinook salmon catch.

Juveniles (Estuarine)

Ehinger, W., T. Quinn, G. Volkhardt, M. McHenry, E. Beamer, P. Roni, C. Greene, and R. Bilby. 2007. Study plan for the intensively monitored watershed program: Skagit River estuary complex. Intensively monitored watersheds scientific oversight committee.

- Skagit River system studies indicate that the quantity of certain types of delta habitat may have a major effect on juvenile Chinook productivity

Newman, K. 2003. Modelling paired release-recovery data in the presence of surival and capture heterogeneity with application to marked juvenile salmon. Statistical Modelling 3:157-177.

- Statistical models suggest that reducing export pumping in the California Sacramento-San Joaquin Delta will increase the survival of outmigrating juvenile Chinook salmon smolts.

MacFarlane, B.R. and E.C. Norton. 2002. Physiological ecology of juvenile Chinook salmon (Oncorhynchus tshawytscha) at the southern end of their distribution, the San Francisco Estuary and Gulf of the Farallones, California. California. Fisheries Bulletin 100:244-257.

- Juvenile Chinook salmon were found to spend about 40 days migrating through the Sacramento-San Joaquin Delta to the mouth of San Francisco Bay and grew little in length or weight until they reached the Gulf of the Farallones.
- Based on the mainly oceantype life history observed (i.e., fall-run), MacFarlane and Norton (2002) concluded that unlike other salmonid populations in the Pacific Northwest, Central Valley Chinook salmon show little estuarine dependence and may benefit from expedited ocean entry.

Semmens, B. X. 2008. Acoustically derived fine-scale behaviors of juvenile Chinook salmon (Onchorhynchus tshawytscha) associated with intertidal benthic habitats in an estuary. Canadian Journal of Fisheries and Aquatic Sciences 65:2053-2062.

- "A hierarchical Bayesian state–space model of movement was developed to associate the behaviors of tagged fall Chinook salmon in Willapa Bay, Washington, with characteristics of benthic habitat in the enclosure."
- "Model results indicated that smolts had a strong preference for remaining in native eelgrass (Zostera marina). Conversely, no such preference existed for other structured benthic habitats such as oyster (Crassostrea gigas) beds, non-native eelgrass (Zostera japonica), and non-native smooth cordgrass (Spartina alterniflora). There was a positive relationship between individual survivorship in the enclosure and the strength of

behavioral preference for native eelgrass, suggesting that predator avoidance may be the evolutionary mechanism driving behavioral responses of smolts to benthic habitats."

Bottom, D. L., K. K. Jones, T. J. Cornwell, A. Grey and C. A. Simenstad. 2005. Patterns of Chinook salmon migration and residency in the Salmon River estuary. Estuarine, Coastal and Shelf Science 64:79-93.

- "The absence of Chinook fry migrants in the Salmon River estruary during spring and early summer in 1975-1977 – a period that precedes restoration of any of the diked marshes - and the extensive use of marsh habitats by fry and fingerlings during April-July, 2000-2002, indicate that wetland restoration has increased estuarine rearing for juvenile Chinook salmon."

Webster, S. J., L. M. Dill and J. S. Korstrom. 2007. The effects of depth and salinity on juvenile Chinook salmon Oncorhynchus tshawytscha (Walbaum) habitat choice in an artificial estuary. Journal of Fish Biology 71:842-851.

- Webster et al. (2007) examined the energetic cost for juvenile Chinook salmon Oncorhynchus tshawytscha to forage in habitats of different salinity and depth was quantified using a behavioural titration based on ideal free distribution theory.
- Their results indicate that the preference for deep saline habitats during the stratified phase was driven by some benefit associated with residency in deeper water, rather than salinity. "The low perceived cost of low salinity might be in part due to the fish's ability to minimize this cost by only making brief forays into the alternate freshwater habitat."
- "When the food ration delivered to the more costly, shallow habitat was 50% greater than that delivered to the less costly, deep habitat, fish distributed themselves equally between the two habitats, presumably because of equal net benefits."
- "This study demonstrates that juvenile Chinook salmon prefer deep saline habitat to shallow freshwater habitats but will make brief forays into the freshwater habitat if food availability is sufficiently high."

NMFS. 2009d. Public draft recovery plan for the Evolutionary Significant Units of Sacramento winter-run Chinook salmon and Central Valley spring-run Chinook salmon and the Distinct Population Segment of Central Valley Steelhead. National Marine Fisheries Service, Southwest Regional Office, Sacramento, California. Available: http://swr.nmfs.noaa.gov/recovery/cent_val/Public_Draft_Recovery_Plan.pdf. (January 2010).

- "Juvenile Chinook salmon movements within the Sacramento-San Joaquin estuarine habitat are dictated by the interaction between tidally-driven salt water intrusions through the San Francisco Bay and fresh water outflow from the Sacramento and San Joaquin rivers."
- The timing of migration through the Delta varies somewhat due to changes in river flows, dam operations, and water year type.

Winter-run Chinook salmon juveniles remain in the Delta until they reach a fork length (FL) of approximately 118 millimeters (mm) and are from five to 10 months of age.

NMFS. 2009. Biological opinion and conference opinion on the long-term operations of the Central Valley Project and State Water Project. National Marine Fisheries Service, Southwest Region.

- "In the Sacramento-San Joaquin Estuary significant amounts of flow and many juvenile spring-run enter the Delta Cross Channel (when the gates are open), and Georgiana Slough, especially during increased Delta pumping. Mortality of juvenile salmon entering the central Delta is higher than for those continuing downstream in the Sacramento River. This difference in mortality could be caused by a combination of factors: the longer migration route through the central Delta to the western Delta, exposure to higher water temperatures, higher predation rates, exposure to seasonal agricultural diversions, water quality impairments due to agricultural and municipal discharges, and a more complex channel configuration making it more difficult for salmon to successfully migrate to the western Delta and the ocean. In addition, the State and Federal pumps and associated fish facilities increase mortality of juvenile spring-run through various means, including entrainment into the State and Federal canals, handling, trucking, and release."
- "The current condition of the estuarine habitat in the project area has been substantially degraded from historic conditions. Over 90 percent of the fringing fresh, brackish, and salt marshes have been lost to human actions. This loss of the fringing marshes reduces the availability of forage species and eliminates the cycling of nutrients from the marsh vegetation into the water column of the adjoining waterways. The channels of the Delta have been modified by the raising of levees and armoring of the levee banks with stone riprap. This reduces habitat complexity by reducing the incorporation of woody debris and vegetative material into the nearshore area, minimizing and reducing local variations in water depth and velocities, and simplifying the community structure of the nearshore environment."

Maier, G. O. and C. A. Simenstad. 2009. The role of marsh-derived macrodetritus to the food webs of juvenile Chinook salmon in a large altered estruary. Estuaries and Coasts 32: 984-998.

- "Using multiple stable isotope analysis, we distinguished the role of various organic matter sources in Chinook food webs in the Columbia River Estuary and interpreted the dynamics of their use both spatially and temporally within the estuary."
- "Our results indicate that subyearling Chinook are associated with fluvial, anthropogenic, estuarine, and marine organic matter sources, with hatchery food and vascular plant detritus being the most dominant sources in juvenile Chinook food webs. Although freshwater phytoplankton is involved in many food web pathways to subyearling Chinook, increased phytoplankton production from the impounded river has not replaced the loss of autochthonous marsh production to fish."

- "Our results indicate that large-scale ecosystem alteration may have decreased the availability and quality of food webs in the estuary and potentially diminished the ability of the Columbia to support Chinook salmon."

Juveniles (Marine)

Scheuerell, M.D., J.G. Williams. 2005. Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook salmon (Oncorhynchus tshawytscha). Fisheries Oceanography 14(6):448-457.

- Scheuerell and Williams (2005) showed that the coastal upwelling index is a strong determinant of year-class strength and subsequent smolt-to-adult return ratios for Snake River Chinook salmon.
- When winds do not blow south, the forces that create upwelling off the U.S. coast are reduced, as are nutrient inputs to the euphotic zone, reducing near-shore ocean productivity. This reduction in ocean productivity has been shown to reduce juvenile salmon growth and survival.

Lindley, S.T., C.B. Grimes, M.S. Mohr, W. Peterson, J. Stein, J.T. Anderson, L.W. Botsford, D. L. Bottom, C.A. Busack, T.K. Collier, J. Ferguson, J.C. Garza, A.M. Grover, D.G. Hankin, R.G. Kope, P.W. Lawson, A. Low and R.B. MacFarlane. 2009. What caused the Sacramento River fall Chinook stock collapse? Pre-publication report to the Pacific Fishery Management Council. March 18.

- Lindley et al. (2009) reviewed the possible causes for the decline in Sacramento River fall-run in 2007 and 2008 for which reliable data were available. They concluded that a broad body of evidence suggested that anomalous conditions in the coastal ocean in 2005 and 2006 resulted in unusually poor survival of the 2004 and 2005 broods of fallrun.
- However, Lindley et al. (2009) recognize that the rapid and likely temporary deterioration in ocean conditions acted on top of a long-term, steady degradation of the freshwater and estuarine environment.

Ruggerone, G. T., J. L. Nielsen and B. A. Agler. 2009. Linking marine and freshwater growth in western Alaska Chinook salmon. Journal of Fish Biology 75: 1287-1301.

- The hypothesis that growth in Pacific salmon Oncorhynchus spp. is dependent on previous growth was tested using annual scale growth measurements of wild Chinook salmon Oncorhynchus tshawytscha returning to the Yukon and Kuskokwim Rivers, Alaska, from 1964 to 2004.
- First year marine growth in individual *O. tshawytscha* was significantly correlated with growth in fresh water. Furthermore, growth during each of 3 or 4 years at sea was related to growth during the previous year. The magnitude of the growth response to

the previous year's growth was greater when mean year-class growth during the previous year was relatively low.

- Positive growth response to previous growth in O. tshawytscha was probably related to piscivorous diet and foraging benefits of large body size. Faster growth among *O. tshawytscha* year classes that initially grew slowly may reflect high mortality in slow growing fish and subsequent compensatory growth in survivors.

Jarrin, J. R., A. L. Shanks and M. A. Banks. 2009. Confirmation of the presence and use of sandy beach surf-zones by juvenile Chinook salmon. Environmental Biology of Fishes 85: 119-125.

- "Twenty-five years ago, subyearling Chinook salmon were hypothesized to stay close to shore (<5 km). To test this hypothesis we sampled the surf-zone of a southern Oregon dissipative sandy beach throughout the summer of 2006 (06/07–09/29) using a beach seine in 1 m of water depth."
- "We caught 48 sub-yearlings over six dates (07/22 to 09/01). Mean standard length of Chinook salmon caught in the surf-zone increased from 9.1±0.6 (07/22/06) to 11.6± 0.7 cm (09/01/06), suggesting a mean increase of 0.6 mm in standard length (S.L.) per day.
- "Early in the summer, smaller fish fed mostly on amphipods. Later in the summer, larger juveniles fed primarily on larval and juvenile fish. All prey items were common in the surfzone. Juveniles appear to migrate from the estuary to the surf-zone where they feed on the local zooplankton for up to two summer months before migrating offshore."

NMFS. 2009d. Public draft recovery plan for the Evolutionary Significant Units of Sacramento winter-run Chinook salmon and Central Valley spring-run Chinook salmon and the Distinct Population Segment of Central Valley Steelhead. National Marine Fisheries Service, Southwest Regional Office, Sacramento, California. Available: http://swr.nmfs.noaa.gov/recovery/cent_val/Public_Draft_Recovery_Plan.pdf. (January 2010).

- "Central Valley Chinook salmon begin their ocean life in the Gulf of the Farallones, then they distribute north and south along the continental shelf primarily between Point Conception and Washington State. "

Brennan, J. S., K. F. Higgins, J. R. Cordell and V. A. Stamatiou. 2004. Juvenile salmon composition, timing, distribution, and diet in marine nearshore waters of the Central Puget Sound in 2001-2002. King County Department of Natural Resources and Parks, Seattle, WA.

- Diet samples from juvenile Chinook salmon caught in marine nearshore waters of Puget Sound showed distinct seasonal patterns in diet composition. Polychaete worms dominated the <90 and 90-149 mm FL size classes of juvenile Chinook prey early in the sampling season (May) but were replaced by other prey organisms later in the season. For example, in September, insects made up over 50% of the prey weight in Chinook from 90-149 mm size class and over 80% of the >150 mm size class. There was a great deal of similarity between diets of juvenile Chinook classified as hatchery and wild.

Weitkamp, L. A. and M. V. Sturdevant. 2008. Food habits and marine survival of juvenile Chinook and coho salmon from marine waters of Southeast Alaska. Fisheries Oceanography 17: 380-395.

- Chinook salmon from marine waters of Southeast Alaska generally consumed more and slightly larger fish prey than coho salmon, whereas coho consumed more crustacean prey (e.g., crab larvaeand hyperiid amphipods).
- …"If high fullness and low frequency of empty stomachs contribute to higher coho salmon marine survival, it is surprising that differences between Chinook and coho salmon in Southeast Alaska were not more pronounced, given the nearly order of magnitude difference in marine survival rates. The difference in fullness between the two species was only 22%, and, although proportionally far fewer coho salmon had empty stomachs, the overwhelming majority (95%) of Chinook salmon had prey in their stomachs. If diet does, indeed, play a role in survival differences between Chinook and coho salmon, the differences are quite subtle, and may be difficult to detect when survival differences are less extreme."

Adults

CDFG. 1998. A status review of the spring-run Chinook salmon (Oncorhynchus tshawytscha) in the Sacramento River drainage. Candidate Species Report 98-01.

- Spring-run Chinook salmon in the Sacramento River Basin hold in pools that have moderate water velocities (0.5 to 1.3 feet per second) and cover, such as bubble curtains.
- The preferred temperature range for upstream migration of Chinook salmon in the Sacramento Basin is 38^{o}F to 56^{o}F.

Lindley, S.T., R. Schick, B.P. May, J.J. Anderson, S. Greene, C. Hanson, A. Low, D. McEwan, R.B. MacFarlane, C. Swanson, and J.G. Williams. 2004. Population structure of threatened and endangered Chinook salmon ESU in California's Central Valley basin. NMFS Southwest Science Center NOAA-TM-NMFS-SWFSC-360. Santa Cruz, CA.

- Chinook salmon adult migration in California's Central Valley is blocked when temperatures reach 70^{o}F, and fish can become stressed as temperatures approach 70^{o}F.

Keefer, M. L., C. A. Perry, M. A. Jepson, and L. C. Stuehrenberg. 2004. Upstream migration rates of radio-tagged adult Chinook salmon in riverine habitats of the Columbia River basin. Journal of Fish Biology 65:1126-1141.

- Keefer et al. (2004) found migration rates of adult Chinook salmon ranging from approximately 10 kilometers (km) per day to greater than 35 km per day and to be primarily correlated with date, and secondarily with discharge, year, and reach, in the Columbia River basin.

Hughes, N.F. 2004. The wave-drag hypothesis: an explanation for sized-based lateral segregation during the upstream migration of salmonids. Canadian Journal of Fisheries and Aquatic Sciences 61:103-109.

- The wave-drag model created by Hughes (2004) predicts that larger fish will swim upstream further from the bank because the minimum cost migration corridor moves offshore as fish size increases. Fish that use this corridor optimize the trade-off between swimming in deeper faster water to reduce wave drag and swimming in shallower slower water to reduce skin friction and form drag. Compared with the traditional model, the wave-drag hypothesis predicts that fish will swim against faster water and pay higher energetic costs to migrate.

Yoshiyama, R. M., F. W. Fisher, and P. B. Moyle. 1998. Historical abundance and decline of Chinook salmon in the Central Valley Region of California. North American Journal of Fisheries Management 18:487-521.

- Central Valley spring-run Chinook salmon utilize mid- to high elevation streams that provide appropriate temperatures and sufficient flow, cover, and pool depth to allow over-summering while conserving energy and allowing their gonadal tissue to mature (Yoshiyama et al. 1998).

Torgensen, C. E., D. M. Price, H. W. Li and B. McIntosh. 1999. Multiscale thermal refugia and stream habitat associations of Chinook salmon in Northeastern Oregon. Ecological Applications 9:301-319.

- Torgensen et al. (1999) quantified distribution and behavior of adult spring chinook salmon related to patterns of stream temperature and physical habitat at channel-unit, reach-, and section-level spatial scales in a wilderness stream and a disturbed stream in the John Day River basin in northeastern Oregon.
- “Our observations of thermal refugia and their use by chinook salmon at multiple spatial scales reveal that, although heterogeneity in the longitudinal stream temperature profile may be viewed as an ecological warning sign, thermal patchiness in streams also should be recognized for its biological potential to provide habitat for species existing at the margin of their environmental tolerances.”

Goniea, T. M., M. L. Keefer, T. C. Bjornn, C. A. Peery, D. Bennet and L. C. Stuehrenberg. 2006. Behavioral thermoregulation and slowed migration by adult fall Chinook Salmon in response to high Columbia River water temperatures. Transactions of the American Fisheries Society 135:408-419.

- “The relationships between lower Columbia River water temperatures and migration rates, temporary tributary use, and run timing of adult fall Chinook salmon were studied using historical counts at dams and recently collected radiotelemetry data.”
- “The results from more than 2,100 upriver bright fall Chinook salmon radio-tagged over 6 years (1998, 2000–2004) showed that mean and median migration rates through the lower Columbia River slowed significantly when water temperatures were above about

20oC. Slowed migration was strongly associated with temporary use of tributaries, which averaged 2–78C cooler than the main stem. "

- "Collectively, these observations suggest that Columbia River fall Chinook salmon predictably alter their migration behaviors in response to elevated temperatures. Coolwater tributaries appear to represent critical habitat areas in warm years, and we recommend that both main-stem thermal characteristics and areas of refuge be considered when establishing regulations to protect summer and fall migrants."

SRSRB. 2006. Snake River salmon recovery plan for Southeast Washington. Snake River Salmon Recovery Board. Available: http://www.snakeriverboard.org/resources/library.htm. (October 2009).

- Preferred habitat for pre-spawn holding spring and summer Snake River Chinook Salmon includes deep holes and log jams, with minimum depth of 5 ft. and temperatures between 53^{o}F and 60^{o}F.

USBR. 2008. Central Valley Project and State Water Project operations criteria and plan biological assessment. U.S. Bureau of Reclamation Mid-Pacific Region, Sacramento, California.

- Central Valley spring-run salmon hold during summer months in pools that need to be sufficiently deep, cool (about 64 F or less), and oxygenated to allow over-summer survival. Adults tend to hold in pools near quality spawning gravel.

NMFS. 2009d. Public draft recovery plan for the Evolutionary Significant Units of Sacramento winter-run Chinook salmon and Central Valley spring-run Chinook salmon and the Distinct Population Segment of Central Valley Steelhead. National Marine Fisheries Service, Southwest Regional Office, Sacramento, California. Available: http://swr.nmfs.noaa.gov/recovery/cent_val/Public_Draft_Recovery_Plan.pdf. (January 2010).

- "Winter-run Chinook salmon are immature when upstream migration begins, and need to hold in suitable habitat for several months prior to spawning."
- "Because water temperatures in the lower Sacramento River below the RBDD generally begin exceeding 60°F in April, it is likely that little, if any, suitable holding habit at exists in the lower Sacramento River. It most likely is only used by adults as a migrati on corridor. Following installation of the water temperature control device on Shasta Dam in 1997, it is possible that
some deep water pool habitat may exist for a short distance downstream of the RBDD with suitable cold water temperatures for adult holding."

Coho Salmon

Eggs and Spawning

Juveniles(Freshwater)

CDFG. 2004. Recovery strategy for California coho salmon. Report to the California Fish and Game Commission. California Department of Fish and Game, Native Anadromous Fish and Watershed Branch, 1419 9th Street, Sacramento, CA. Available: http://www.dfg.ca.gov/nafwb.cohorecovery. (December 2009).

- Flooded riparian vegetation and oxbow channels associated with beaver ponds are critical to both winter and summer survival of juvenile coho salmon in the Klamath River.

Sutton, R., M. 2007. Klamath River thermal refugia study, 2006. U.S. Bureau of Reclamation technical memorandum no. 86-68290-01-07.

- thermal refugial studies conducted by Sutton (2007) on the mainstem Klamath River have documented the persistence of small numbers of coho salmon young-of-the-year near select tributary confluence habitat throughout the summer period.

National Research Council (NRC). 2002. Scientific evaluation of biological opinions on Endangered and Threatened fishes in the Klamath River Basin - interim report. Committee on Endangered and Threatened fishes in the Klamath River Basin - interim report. Committee on Endangered and Threatened Fishes in the Klamath River Basin. National Academy Press. Washington, D.C. 26 pp.

- The National Research Council Committee on Endangered and Threatened Fishes in the Kamath Basin (NRC) addressed the importance of mainstem Klamath River habitat to listed coho salmon in its review of NMFS' 2002 Biological Opinion regarding the effects of Klamath Project Operations on listed coho salmon.
- The NRC concluded that although the importance of tributary rearing habitats to coho salmon YOY survival is widely recognized and restoring degraded tributary habitat within the Klamath River Basin will likely be paramount to recovering the species, mainstem habitat may nevertheless play a critical role in YOY coho salmon survival in rivers such as the Klamath where tributary conditions are particularly inhospitable.

NMFS. 2007. Magnuson-Stevens Reauthorization Act Klamath River Coho Salmon Recovery Plan. Prepared by Rogers, F. R., I. V. Lagomarsino and J. A. Simondet for the National Marine

Fisheries Service, Long Beach, CA. 48 pp. Available: http://swr.nmfs.noaa.gov/salmon/MSRA_RecoveryPlan_FINAL.pdf. (November 2009).

- As part of their ongoing coho salmon overwintering study, the Yurok Tribe has documented substantial use of off-channel habitat by juvenile coho salmon within non-natal tributaries of the Klamath River estuary.
- Preliminary results from the study suggest displaced fish exhibit high fidelity with regard to this non-natal habitat, as well as a greater fitness level at the smolt stage as compared to fish that overwintered solely within their natal tributary.

Roni, P. 2002. Habitat use by fishes and pacific giant salamanders in small western Oregon and Washington streams. Transactions of the American Fisheries Society 131(4): 743-761.

- In 30 streams in western Washington and northwestern Oregon, Roni (2002) found juvenile coho salmon summer densities to be highest in backwater, dam, and scour pools and, to a lesser extent, glides. Also, coho salmon summer densities among streams were positively correlated with both site elevation and the number of pieces of large woody debris (LWD).
- During winter months, the highest coho densities were associated with backwater and dam pools.

Beechie, T. J., M. Liermann, E. M. Beamer, R. Henderson. 2005. A classification of habitat types in a large river and their use by juvenile salmonids. Transactions of the American Fisheries Society, 134:717-729.

- "Densities of juvenile Chinook salmon and coho salmon were highest in bank and backwater units in winter in the Skagit River basin, WA. In summer, coho salmon densities were significantly different among edge unit types, densities being highest in banks and backwaters. Microhabitat selection (velocity, depth, and cover type) by juvenile salmonids mirrored that in small streams, most fish occupying areas with a velocity less than 15 cm/s and wood cover. Among ocean-type salmon, Chinook and chum salmon fry were captured in large numbers in all edge units and exhibited only slightly higher densities in low-velocity areas (,15 cm/s)."

USBR. 2008. Central Valley Project and State Water Project operations criteria and plan biological assessment. U.S. Bureau of Reclamation Mid-Pacific Region, Sacramento, California.

- "Juvenile coho salmon in the Trinity River spend up to a full year in freshwater before migrating to the ocean. Their habitat preferences change throughout the year and are highly influenced by water temperature. During the warmer summer months when coho are most actively feeding and growing, they spend more time closer to main channel habitats."
- "When the water cools in the fall, juvenile coho move further into backwater areas or into off-channel areas and beaver ponds if available."

Juveniles (Estuarine)

Koski, K. V. 2009. The fate of coho salmon nomads: the story of an estuarine-rearing strategy promoting resilience. Ecology and Society 14: 4.

- "The downstream movement of coho salmon nomads (age 0), conventionally considered surplus fry, has been an accepted characteristic of juvenile coho salmon for the past 40 to 50 yr. The fate of these nomads, however, was not known and they were assumed to perish in the ocean."
- "Several studies and observations have recently provided new insights into the fate of nomads and the role of the stream-estuary ecotone and estuary in developing this life history strategy that promotes coho resilience."
- "Nomad coho can acclimate to brackish water, and survive and grow well in the stream-estuary ecotone and estuary, but instead of migrating to the ocean they return upstream into freshwater to overwinter before migrating to the ocean as smolts."
- "Nomads may enter the estuarine environment from natal or non-natal streams, rear there throughout the summer, and then emigrate to a non-natal stream for overwintering and smolting in the spring. These estuarine and overwintering habitats have enabled coho to develop this unique nomad life history strategy that may help to ensure their resilience."
- "Restoring estuarine habitats may be essential to the recovery of depressed populations of coho."

Juveniles (Marine)

Weitkamp, L. A. and M. V. Sturdevant. 2008. Food habits and marine survival of juvenile Chinook and coho salmon from marine waters of Southeast Alaska. Fisheries Oceanography 17: 380-395.

- Weitkamp and Sturdevant (2008) found that Alaskan coho salmon achieved extremely high marine survival rates despite a diet consisting largely of small, less energetically-efficient crustacean prey. Their results suggest that diet quantity (how much is eaten) rather than diet quality (what is eaten) is important to marine survival.

Malick, M. J., M. D. Adkison and A. C. Wertheimer. 2009. Variable effects of biological and environmental processes on Coho salmon marine survival in southeast Alaska. Transactions of the American Fisheries Society 138:846-860.

- Malick et al. (2009) used correlation analyses, linear regression models, and multistock mixed effects models to examine the relationships between coho salmon Oncorhynchus kisutch marine survival and six biological and environmental covariates across 14 southeast Alaska (SEAK) stocks.

- "An index representing local hatchery pink salmon and chum salmon fry abundance was the most important variable in explaining the variation in coho salmon marine survival, having a stronger estimated effect on survival than an index of local wild pink salmon fry abundance."
- "The magnitude and sign of the hatchery pink salmon and chum salmon effect varied greatly among different localities. Our results suggest that (1) SEAK coho salmon stocks are not equally influenced by the same factors and (2) there are factors that appear to affect marine survival of SEAK coho salmon stocks at varying spatial scales."
- "This study also provides evidence that coho salmon stocks throughout SEAK experience some degree of regional concordance in the marine environment but also that local stock-specific conditions are important in fully understanding variation in marine survival."

Van Doornik, D. M., D. J. Teel, D. R. Kuligowski, C. A. Morgan, and E. Casillas. 2007. Genetic analyses provide insight into the early ocean stock distribution and survival of juvenile coho salmon off the coasts of Washington and Oregon. North American Journal of Fisheries Management 27:220-237.

- Van Doornik et al. (2007) created a database of coho salmon microsatellite allele frequencies. Using genetic distance calculations, they identified six major geographic regions and 15 smaller subregions into which the populations grouped.
- Van Doornik et al. (2007) used the database to estimate stock proportions and densities of 2,344 coho salmon sampled over eight summers in a juvenile marine ecology study conducted off the coasts of Washington and Oregon.
- "Columbia River juveniles were caught at higher densities than coastal fish throughout the summer. Fish from Columbia River and coastal sources were captured both north and south of their points of sea entry in early summer and at higher densities than in late summer. September catch of Columbia River juveniles was correlated with adult abundance in the following year, indicating that year-class strength for this stock is largely set during the first summer in the ocean."

Brennan, J. S., K. F. Higgins, J. R. Cordell and V. A. Stamatiou. 2004. Juvenile salmon composition, timing, distribution, and diet in marine nearshore waters of the Central Puget Sound in 2001-2002. King County Department of Natural Resources and Parks, Seattle, WA.

- The majority of the diet of juvenile coho salmon in marine nearshore areas of Puget Sound consisted of plankton (e.g. crab larvae, copepods, amphipods). By weight, prey composition was dominated by fishes, especially larval and juvenile sand lance.

Adults

Roni, P., D.V. Slyke, B.A. Miller, J.L. Ebersole, and G. Pess. 2008. Adult coho salmon and steelhead use of boulder weirs in southwest Oregon streams. North American Journal of Fisheries Management 28(3):970-978.

- Compared redd and spawner densities for coho salmon and steelhead in 10 reach pairs in seven Oregon streams and additional sites in the West Fork of the Smith River – specifically looking at the effects of artificially placed boulder weirs
- In 10 reach pairs, found significantly higher coho salmon spawner numbers and peak redd counts in reaches with boulder weirs
- No differences in coho salmon or steelhead spawner counts or redd numbers were observed in the West Fork of the Smith River, but coho salmon redd densities did differ between reach types examined – highest redd densities in tributary reaches – both spawner density and redd density were positively correlated to percent gravel
- Authors suggest that placement of boulder weirs in bedrock channels leads to localized increases in spawning abundance, but other large-scale factors influence coho salmon and steelhead spawner abundance at the watershed level – also state need to consider gravel availability when placing instream structures designed to improve spawning habitat
- Boulder weirs primarily improved spawning habitat through accumulation of suitable spawning gravel immediately upstream of structure

Pink Salmon

Eggs and Spawning

Connor, E.J. and D. E. Pflug. 2004. Changes in the distribution and density of Pink, Chum, and Chinook salmon spawning in the Upper Skagit River in response to flow management measures. North American Journal of Fisheries Management 24:835-852.

- "Densities of spawning salmon were compared among three contiguous reaches of the upper Skagit River before and after the implementation of flow management measures in 1981. The measures were intended to minimize redd dewatering during the spawning and incubation periods and fry stranding during the emergence and outmigration periods.
- "Field monitoring confirmed that increasing the minimum incubation flows created improvements in redd protection levels… Spawner abundance of all three species progressively increased in an upstream direction following implementation of flow measures; increases were greatest in the reach immediately below the hydroelectric project. The upstream shift in spawner abundance was highly significant based on factorial analyses of variance. The greatest increases in spawner abundance for Chinook

salmon and chum salmon were observed during even years, when pink salmon did not spawn. Mean spawner abundance in the upstream-most study reach increased from 311 to 1,169 carcasses/mi (odd years) for pink salmon, from 6 to 115 fish/mi (odd years) or 58 to 462 fish/mi (even years) for chum salmon, and from 48 to 49 redds/mi (odd years) or 59 to 65 redds/ mi (even years) for Chinook salmon."

- "These increases were substantially greater than those observed concurrently in other areas of the Skagit River basin and in other northern Puget Sound rivers. The average number of Chinook salmon spawners remained unchanged in the study area after 1981, while substantially declining in other unregulated Skagit River subbasins and most Puget Sound rivers. The study area now possesses the greatest percentage of pink, chum, and Chinook salmon spawners within the Skagit River basin. The Skagit River presently supports the largest run of native Chinook salmon in the Puget Sound region and the largest runs of pink and chum salmon in the coterminous United States."

Juveniles(Freshwater)

Connor, E.J. and D. E. Pflug. 2004. Changes in the distribution and density of Pink, Chum, and Chinook salmon spawning in the Upper Skagit River in response to flow management measures. North American Journal of Fisheries Management 24:835-852.

- Mean spawner abundance of pink salmon in the upper Skagit River, Washington, increased significantly (from 311 to 1,169 carcasses/mi) following implementation of flow management measures that increased minimum incubation flows and decreased stranding events.

Juveniles (Estuarine)

Murphy, M.L., S.W. Johnson, and D.J. Csepp. 2000. A comparison of fish assemblages in eelgrass and adjacent subtidal habitats near Craig, Alaska. Alaska Fishery Research Bulletin 7:11-21. http://adfg.alaska.gov/pubs/afrb/vol7/murphyv7.pdf

- Seined monthly from April to June and in September 1998 to compare fish assemblages between sites with eelgrass and sites with either kelp or only filamentous algae
- "Catch of pink salmon *Oncorhynchus gorbuscha* fry, chum salmon *O. keta* fry, and coho salmon *O. kisutch* smolts was similar at eelgrass and non-eelgrass sites, except for chum salmon in June when catch was significantly lower at eelgrass sites."
- "Juvenile salmon were not significantly associated with eelgrass."
- "Although previous authors have suggested juvenile salmon in Puget Sound use eelgrass for feeding and cover, direct evidence is lacking."
- Pink salmon fry were 84, 49, and 0% of catch in April, May, and June, respectively.

Mortensen, D., A. Wertheimer, S. Taylor, and J. Landingham**.** 2000. The relation between early marine growth of pink salmon, *Oncorhynchus gorbuscha*, and marine water temperature, secondary production, and survival to adulthood. Fish Bull. 98:319-335.

- Tagged juvenile pink salmon as they emigrated to the estuarine waters of Auke Bay – used four consecutive brood years – emigration period extended from late March to mid-May, with most fish emigrating during 2-3 weeks in mid- to late April
- Later emigrating juveniles spent significantly less time in the estuary
- Individual growth rates ranged from 3.1-3.7% per day – growth occurred more slowly in early April than in late April and early May – growth was significantly correlated to water temperature, but not to prey availability – early marine growth was significantly related to survival to the adult stage
- Data suggests that early emigrants encounter poor conditions for growth (i.e., low water temperatures and low zooplankton abundance) compared to later emigrants, but fish that survive are typically larger when compared to later emigrants later on in the season
- Juveniles abundant in nearshore areas in April and May, but moved offshore by late May and early June

Juveniles (Marine)

Moss, J. H., D. A. Beauchamp, A. D. Cross, E. V. Farley, J. H. Hellel and K. W. Myers. 2007. Spatial patterns in consumption demand and growth potential of juvenile pink salmon (Oncorhynchus gorbuscha) in the gulf of Alaska. North Pacific Anadromous Fish Commission Technical Report 7:35-36.

- Moss et al. (2007) examined if localized conditions affecting growth during the first summer in coastal shelf regions could determine the severity of over winter survival.
- Daily growth potential for juvenile pink salmon inhabiting the Coastal Gulf of Alaska increased from 2001 to 2002, as did marine survival for juvenile pink salmon Prince Willian Sound (PWS) hatchery stocks. Total returns to PWS (hatchery and wild stocks combined) were greater in 2002 relative to 2001 by a factor of 2.21. This suggests that the daily growth potential metric has the ability to describe variation in marine survival.
- A large proportion of juvenile pink salmon were concentrated in nearshore habitats, which ranked the lowest in daily growth potential relative to other habitats during 2001, and average juvenile pink salmon body size and estimated consumption rates were lower in 2001 than 2002, thus, density dependent forces may have contributed to lower survival.

Orsi, J.A., M.V. Sturdevant, J.M. Murphy, D.G. Mortensen, and B.L. Wing. 2000. Seasonal habitat use and early marine ecology of juvenile Pacific salmon in southeastern Alaska. NPAFC Bulletin No. 2:111-122.

- Monitored habitat use and early marine ecology of juvenile (age-0) Pacific salmon at inshore, strait, and coastal habitats along a seaward migration corridor in southeastern Alaska on a monthly basis from May through October 1997-1999
- Juvenile pink salmon most abundant in strait habitats throughout all sampling and most abundant in June samples
- Catches for all 5 species of juvenile salmon generally were confined to <25km from shore and declined with distance from shore – higher proportion of pink and chum salmon were captured closer to shore
- Juvenile pink salmon growth rates in June and July declined in years with lower temperatures and zooplankton indices
- Juvenile pink salmon captures were very low in all waters in May, peak captures occurred in June with the vast majority captured in strait areas, and captures steadily declined and became more evenly distributed throughout habitat types during later months

Adults

Salmon (General)

Eggs and Spawning

Juveniles(Freshwater)

Juveniles (Estuarine)

Collis, K., S. Adamany, D. Roby, D. Craig, and D. Lyons. 2000. Avian predation on juvenile salmonids in 22 the lower Columbia River. 1998 Annual Report to the Bonneville Power Administration and U.S. Army Corps of Engineers, Portland, OR.

- Collis et al. initiated a field study in 1997 to assess the impacts of fish-eating colonial waterbirds (i.e., terns, cormorants, and gulls) on the survival of juvenile salmonids in the lower Columbia River.
- "Diet analysis indicated that juvenile salmonids were an important part of the diet of fisheating colonial waterbirds in the Columbia River estuary. As in 1997, Caspian terns were most dependent on salmonids (74% of diet mass), followed by double-crested cormorants (21% of diet mass) and glaucous-winged/western gulls (approx. 8% of diet mass). Juvenile salmonids were especially prevalent in the diets of fish-eating waterbirds in the estuary during April and May. The diet samples from California and ring-billed gulls nesting at up-river colonies included few fish and very few juvenile salmonids."
- "We estimated that Caspian terns in the Columbia River estuary consumed 10.8 million juvenile salmonids (range = 7.4 – 15.2 million), or approximately 11% (range = 8% - 16%) of the estimated 95 million out-migrating smolts that reached the estuary during the 1998 migration year. The best estimate the number of juvenile salmonids consumed by double-crested cormorants in the estuary was 4.6 million (range = 2.2 – 9.2 million), or approximately 5% of out-migrating smolts (range = 2% - 10%) that reached the estuary in 1998. A rough estimate of the number of juvenile salmonids consumed by glaucouswinged/western gulls in the estuary was 1.3 million (range = 0.4 – 3.9 million). Thus the estimated total consumption of juvenile salmonids by fish-eating colonial waterbirds in the Columbia River estuary was 16.7 million smolts (range = 10.0 – 28.3 million smolts), or 18% (range = 11% – 30%) of those smolts that reached the estuary in 1998."
- "We recommend relocation of part of the Rice Island Caspian tern colony to East Sand Island in 1999 to test whether this approach will reduce smolt losses to terns. In the longer term, it would probably benefit both salmonids and terns if much of the tern population was relocated to other coastal colony sites, possibly restored former colony sites in Grays Harbor, Willapa Bay, and Puget Sound, where greater diversities of non-salmonid prey are presumably available."

Fresh, K.L., E. Casillas, L.L. Johnson, and D.L. Bottom. 2005. Role of the estuary in the recovery of Columbia River Basin salmon and steelhead: an evaluation of the effects of selected factors on salmonid population viability. NOAA Tech. Memo., NMFS-NWFSC-69.

- "From the perspective of the estuary, we conclude that population viability of stream type ESUs is most affected by tern predation and flow while flow and habitat most affect ocean type ESUs. At this time, we do not know how much of a change in each factor is required to affect improvements in population responses of relevant ESUs. Based upon available information, we hypothesize that the greatest opportunity to affect ESUs in the Columbia River basin by the manipulation of estuarine factors is with restoration of shallow water habitat. These actions will primarily affect ocean type ESUs and the shallow water dependent strategies of stream type ESUs. This is because there is a strong linkage between the fry and fingerling life history strategies, which dominant ocean type ESUs, and shallow water habitat. Thus, the main affect on ocean type ESUs of making changes in habitat and flow will be realized as gains in abundance and productivity. The main affect on stream type ESUs of reducing tern predation and altering flow will be realized as gains in spatial structure and diversity."

Juveniles (Marine)

NMFS. 2007a. Puget Sound Salmon Recovery Plan. NMFS. Available: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/PS-Chinook-Plan.cfm. (October 2009).

- The Pacific Decadal Oscillation (PDO) and the El Nino/Southern Oscillation (ENSO) are cycles that appear to have significant influence on salmon survival and migratory patterns. During El Nino and/or warm phase PDO cycles, higher Pacific Ocean temperatures and changes in wind patterns may reduce the upwelling of nutrients from the ocean floor, thereby affecting the entire food web in the Pacific.

National Wildlife Federation. 2005. Fish Out of Water: A Guide to Global Warming and Pacific Northwest Rivers. National Wildlife Federation, Western Natural Resource Center. Seattle, WA.

- Wind driven mixing in the ocean replenishes nutrients to rich surface waters where phytoplankton occur, thereby promoting biological productivity at the base of the food chain and working its way up to salmon and other species of fish.
- As scientific understanding of these processes has improved, fisheries managers have started to utilize information on favorable or unfavorable ocean conditions in their harvest planning forums

NMFS. 2008a. Federal Columbia River power system biological opinion. National Marine Fisheries Service. Available: http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/final-BOs.cfm. (October 2009).

- The Columbia River plume is that portion of the near-shore ocean environment sufficiently influenced by Columbia River energy, water quality, and biotic constituents to affect the local ecosystem. The plume is important juvenile salmonid habitat, particularly during the first month or two of ocean.

Robertis, A., C. A. Morgan, R. A. Schabetsberger, R. W. Zabel, R. D. Brodeur, R. L. Emmett, C. M. Knight, G. K. Krutzikowsky, and E. Casillas. 2005. Columbia river plume fronts II: distribution, adundance, and feeding ecology of juvenile salmon. Marine Ecology Progress Series 299:33-44.

- Robertis et al. (2005) examined the spatial distribution of juvenile Pacific salmonids Oncorhynchus spp. in and around plankton-rich frontal regions of the Columbia River plume to test the hypothesis that juvenile salmonids aggregate at riverine plume fronts to feed.

- "Juvenile salmonids tended to be abundant in the frontal and plume regions compared to the more marine shelf waters, but this pattern differed among species and was not consistent across the 2 study years. Stomach fullness tended to be higher in the more marine shelf waters than either the front or plume areas, which does not support the hypothesis that salmonids consistently ingest more prey at frontal regions. However, the short persistence time of these fronts may prevent juvenile salmon from exploiting these food-rich, but ephemeral, features."

Hare, S. R., N. J. Mantua, and R. C. Francis. 1999. Inverse production regimes: Alaska and West Coast Pacific salmon. Fisheries 24 (1): 6-14.

- Recent evidence suggests that marine survival among salmonids fluctuates in response to 20- to 30-year cycles of climatic conditions and ocean productivity. This phenomenon has been referred to as the Pacific Decadal Oscillation.

Wells, B.K., C.B. Grimes, J.C. Field and C.S. Reiss. 2006. Covariation between the average lengths of mature coho (Oncorhynchus kisutch) and Chinook salmon (O. tshawytscha) and the ocean environment. Fisheries Oceanography. 15:1, 67-79.

- Wells et al. (2006) used the average fork length of age-3 returning coho (Oncorhynchus kisutch) and age-3 ocean-type and age-4 stream-type Chinook (Oncorhynchus tshawytscha) salmon along the northeast Pacific coast to assess the covariability between established oceanic environmental indices and growth.
- Washington, Oregon, and California salmon sizes were negatively correlated with the Multivariate El Nino-Southern Oscillation Index values indicating that ultimate fish size was affected negatively by El Nino-like events.
- Size variation of coho salmon stocks south of Alaska was synchronous and negatively correlated with warm conditions and weak North Pacific high pressure during ocean residence.

Peterson, W.T., R.C. Hooff, C.A. Morgan, K.L. Hunter, E. Casillas, and J.W. Ferguson. 2006. Ocean Conditions and Salmon Survival in the Northern California Current.

- A brief cold cycle in the California current was immediately succeeded by a 4-year period of predominantly warm ocean conditions beginning in late 2002, which appeared to have negatively impacted salmon populations in the California Current.
- There are indications that these regime shifts in ocean conditions affect the migration patterns of larger animals that prey on salmon (e.g., Pacific hake, sea birds) resulting in a "top-down" effect as well.

Wells, B.K., J.C. Field, J.A. Thayer, C.B. Grimes, S.J. Bograd, W.J. Sydeman, F.B. Schwing, and R. Hewitt. 2008. Untangling the relationships among climate, prey, and top predators in an ocean ecosystem. Marine Ecology Progress Series, 364:15-29.

- Wells et al. (2008a) developed a multivariate environmental index that can be used to assess ocean productivity on a finer scale for the central California region. This index (also referred to as the Wells Ocean Productivity Index) has also tracked the Northern Oscillation Index, which can be used to understand ocean conditions in the North Pacific Ocean in general.
- The Wells et al. (2008a) index incorporates 13 oceanographic variables and indices and has correlated well with the productivity of zooplankton, juvenile shortbelly rockfish, and common murre production along the California coast (MacFarlane et al. 2008).
- In addition to its use as an indicator of ocean productivity in general, the index may also relate to salmon dynamics due to their heavy reliance on krill and rockfish as prey items during early and later life stages. For instance, not only did the extremely low index values in 2005 and 2006 correlate well with the extremely low productivity of salmon off the central California coast in those years, but the index also appears to have correlated well with maturation and mortality rates of adult salmon from 1990-2006 in that region.

Francis, R.C. and N. Mantua. 2003. Climatic influences on salmon populations in the Northeast Pacific. In: Assessing Extinction Risk for West Coast Salmon. Proceedings of the Workshop November 13-15, 1996. NOAA Technical Memorandum NMFS-NWFSC-56.

- Analysis by Francis and Mantua (2003) demonstrate clear linear relationships between naturally occurring and large-scale changes to the physical environment and a number of salmon populations in the Northeast Pacific.
- "Of particular interest to the issue of climatic influences on salmon extinctions, interdecadal environmental fluctuations, associated with the Pacific Interdecadal Oscillation (PDO), appear to have significantly reduced the ecosystem(s) carrying capacity for West Coast coho salmon since the 1977 regime shift."
- "The overall productivity of salmon in Alaska has dramatically increased during this same time period in response to PDO-related climate changes."
- "Our results agree with those of previous studies that identify the first few months of the salmon's ocean life as the period of critical climatic influences on survival, which in turn, suggests that coastal and estuarine environments are key areas of biophysical interaction."
- Francis and Mantua (2003) point out that climate patterns would not likely be the sole cause of extinctons of salmon populations but could certainly increase the risk of extinction when combined with other factors, especially in ecosystems under stress from humans.

MacFarlane, R.B., S. Hayes, and B. Wells. 2008. Coho and Chinook Salmon Decline in California during the Spawning Seasons of 2007/08. National Marine Fisheries Service. Southwest Region. Santa Cruz, California.

- Data from across the range of coho salmon on the coast of California reveal there was a 73% decline in returning adults in 2007/08 compared to the same cohort in 2004/05. The problem extends beyond California: preliminary data from the Oregon coast show a

70% decline. The low coho salmon numbers come on the heels of the Pacific Management Council's report of exceptionally low Chinook salmon returns to California's Central Valley (and other streams in California, Oregon, Washington, and British Columbia) in the fall of 2007.
- The Wells Ocean Productivity Index (WOPI), an accurate measure of central California ocean productivity, reveals poor conditions during the spring and summer of 2006, when juvenile coho from the 2004/05 spawn entered the ocean. The WOPI also showed low productivity potential for the spring and summer of 2005, which may explain low returning Chinook salmon numbers in 2007.

Behrenfeld, M.J., R.T. O'Malley, D.A. Siegel, C.R. McClain, J.L. Sarmiento, G.C. Feldman, A.J. Milligan, P.G. Falkowski, R.M. Letelier, and E.S. Boss. 2006. Climate-driven trends in contemporary ocean productivity. Nature 444: 752-755.
- The link between the physical environment and ocean biology functions through changes in upper-ocean temperature and stratification, which influence the availability of nutrients for phytoplankton growth. The observed reductions in ocean productivity during the recent post-1999 warming period provide insight on how future climate change can alter marine food webs.

Emmett, R. L., G. K. Krutzikowsky and P. Bentley. 2006. Abundance and distribution of pelagic piscivorous fishes in the Columbia River plume during spring/early summer 1998-2003: Relationship to oceanographic conditions, forage fishes, and juvenile salmonids. Progress In Oceanography 68:1-26.
- From 1998 to 2003, Emmett et al. (2006) observed large fluctuations in the abundance and distribution of four pelagic predatory (piscivorous) fishes off northern Oregon and southern Washington. They found that predatory and forage fish distributions respond to ocean temperatures, predator/prey interactions, and possibly turbidity.
- "A shift in ocean conditions in 1999 decreased overall predator fish abundance in the Columbia River plume, particularly for Pacific hake. Marine survival of juvenile salmon started to increase in 1999, and forage fish densities increased in 2000, lagging by one year."

Adults

HABITAT COMMITTEE REPORT ON SALMON ESSENTIAL FISH HABITAT (EFH) REVIEW

The Habitat Committee (HC) received an overview of the draft report, Pacific Coast Salmon Essential Fish Habitat (EFH) Review (Agenda Item C.5.a, Attachment 1), by Mr. Kerry Griffin, Council staff and member of the Oversight Panel. It was noted that the draft report is a work in progress and that revisions may be necessary prior to adoption of the final version at the March Council meeting based on feedback from the Council and other interested parties. In addition, several topics in the report were highlighted as warranting input from the HC and Council. The HC offered the following comments and recommendations on those:

- The HC endorses the list of potential Habitat Areas of Particular Concern (HAPCs) and supports the recommendation in the draft report that the Council consider designating these as HAPCs. The descriptions of these areas are appropriate for consultation purposes and may be aided where applicable by mapping.
- Although the HC understood the basis of the decision to continue designating freshwater salmon EFH using 4^{th} field HUCs instead of 6^{th} field watersheds, the importance of salmon biologists being able to refine these designations during the EFH consultation process was noted. The potential to use 6^{th} field USGS watersheds should continue to be investigated in the next five-year review process.
- The HC became aware of a significant new issue at this meeting regarding the potential designation of stocks currently under the Pacific Coast Salmon Plan as ecosystem component species. This issue is discussed in detail in the Salmon Amendment Committee's draft environmental assessment report for Pacific Coast Salmon Plan Amendment 16 (C2.b, SAC Report). Such reclassification results in the loss of EFH designations for these stocks (e.g., mid-Columbia Chinook stock) and the associated EFH consultation requirement for federal agencies. The HC believes EFH should be maintained for these stocks.
- Potential impacts associated with climate change (e.g., ocean acidification, direct thermal effects, changes in the hydrologic cycle, sea level rise, and the increasing importance of flood plain habitat) need to be further developed.
- The HC supports the two recommendations associated with identifying impassable barriers that mark the upstream extent of EFH. Specifically, the list should be updated to correct/update typographical and naming errors, and to reflect barriers that have been recently removed or retrofitted with fish passage facilities; and certain barriers that mark the upstream extent of EFH should be considered for removal from the list if considered by NMFS to be necessary for the conservation of the species.
- Finally, although the HC is providing preliminary comments at this time, we plan to continue this discussion in November and provide comments to the Oversight Panel at that time.

PFMC
09/12/10

Agenda Item C.5.b
Supplemental SSC Report
September 2010

SCIENTIFIC AND STATISTICAL COMMITTEE REPORT ON SALMON ESSENTIAL FISH HABITAT (EFH) REVIEW

Mr. Kerry Griffin provided the Scientific and Statistical Committee (SSC) with a situation summary and an overview of issues related to the evaluation and designation of Essential Fish Habitat (EFH) and Habitat Areas of Particular Concern (HAPCs) for Pacific Salmon. The EFH Review Oversight Panel provided two documents for SSC review: a review of Pacific Salmon EFH and a bibliography of pertinent information for the 2010 EFH update.

Mr. Griffin highlighted, and the SSC discussed, three major topics: 1) HAPCs are not currently designated for Pacific Salmon, 2) dams that are impassable generally limit the upstream extent of EFH, and 3) stock distribution maps may be out of date or inaccurate.

The SSC notes that EFH designation is based on imprecise science and is generally consistent with fish presence. There are many areas (e.g., coho salmon south of San Francisco) where ambiguity exists, particularly at the edge of a species' range.

The SSC recommends that HAPC designation criteria be clearly defined (e.g., rarity of habitat type). This is complicated by the nature of the HAPCs, some of which are geographically specific (e.g., San Francisco Bay), whereas others are more generically described (e.g., complex channels). The SSC suggests that physical description of habitat and its function should be consistently included for each HAPC in the review.

The SSC also notes that clear criteria for the relationship between fish presence, current and historical, and the designation of EFH are needed, as are criteria for the importance and potential for access to habitat above dams when designating EFH.

The SSC generally agrees with the five types of habitat identified by the Oversight Panel as potential HAPCs, but requests better documentation of why they were included and others were not.

The SSC highlights the value of documenting the process by which new threats were added to the list in Table 4 and fisheries and gear were included in Table 5.

PFMC
09/11/2010