NATIONAL MARINE FISHERIES SERVICE REPORT

National Marine Fisheries Service (NMFS) Northwest and Southwest Fisheries Science Centers and Northwest and Southwest Regions (SWR) will briefly report on recent developments relevant to salmon fisheries and issues of interest to the Pacific Fishery Management Council (Council). Potential topics include Mr. Rod McInnis speaking to NMFS SWR Central Valley salmon improvement projects.

Council Task:

Discussion.

Reference Materials:

None.

Agenda Order:

a. Agenda Item Overview	Chuck Tracy
b. Regulatory Activities	Rod McInnis
c. Fisheries Science Center Activities	
d. Reports and Comments of Advisory Bodies and Management Entities	
e. Public Comment	
f. Council Discussion	

PFMC
03/23/11

NMFS Southwest Fisheries Science Center's Research on Salmon in Freshwater and Estuaries





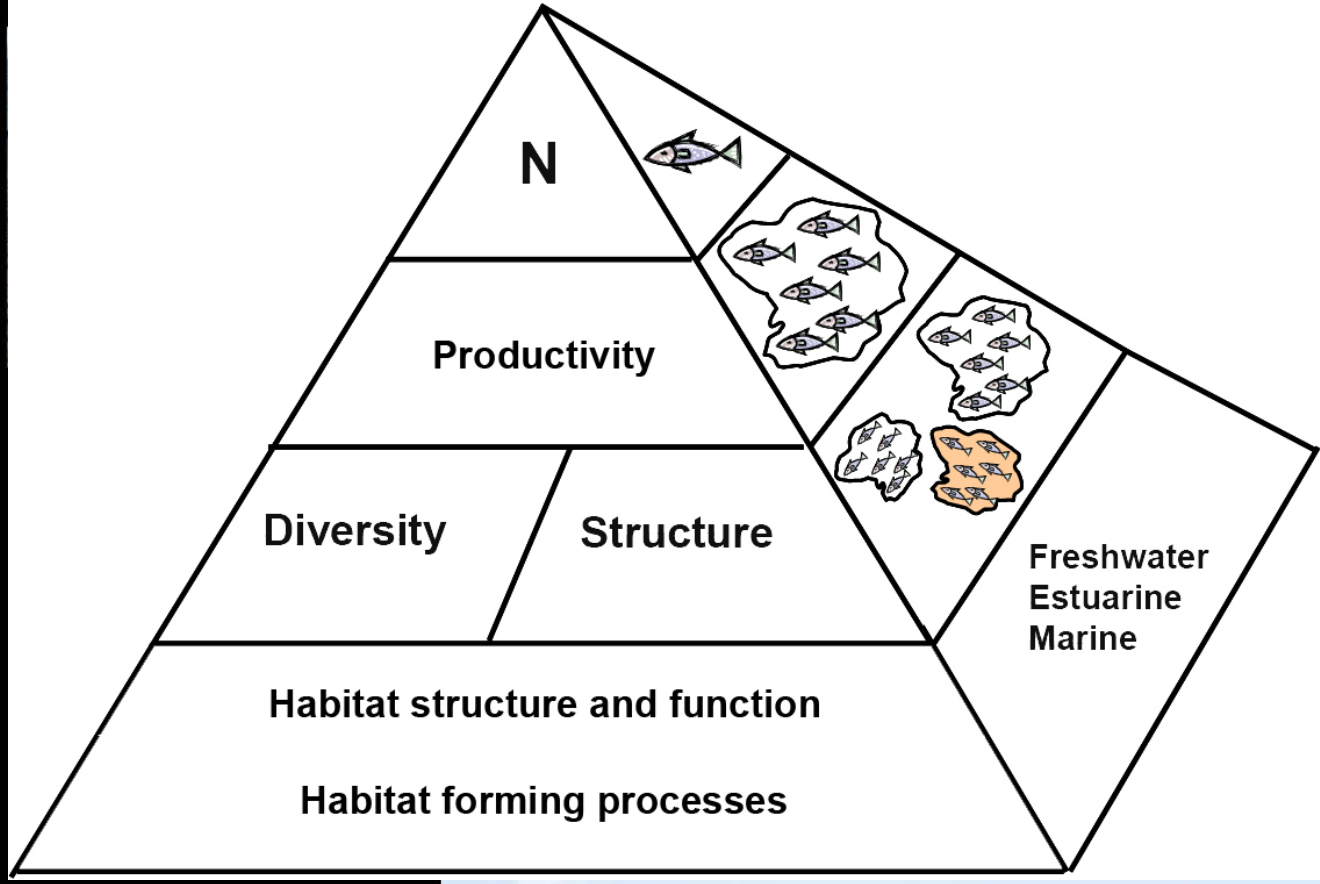











N
Productivity
Diversity
Structure
Freshwater
Estuarine
Marine
Habitat structure and function
Habitat forming processes

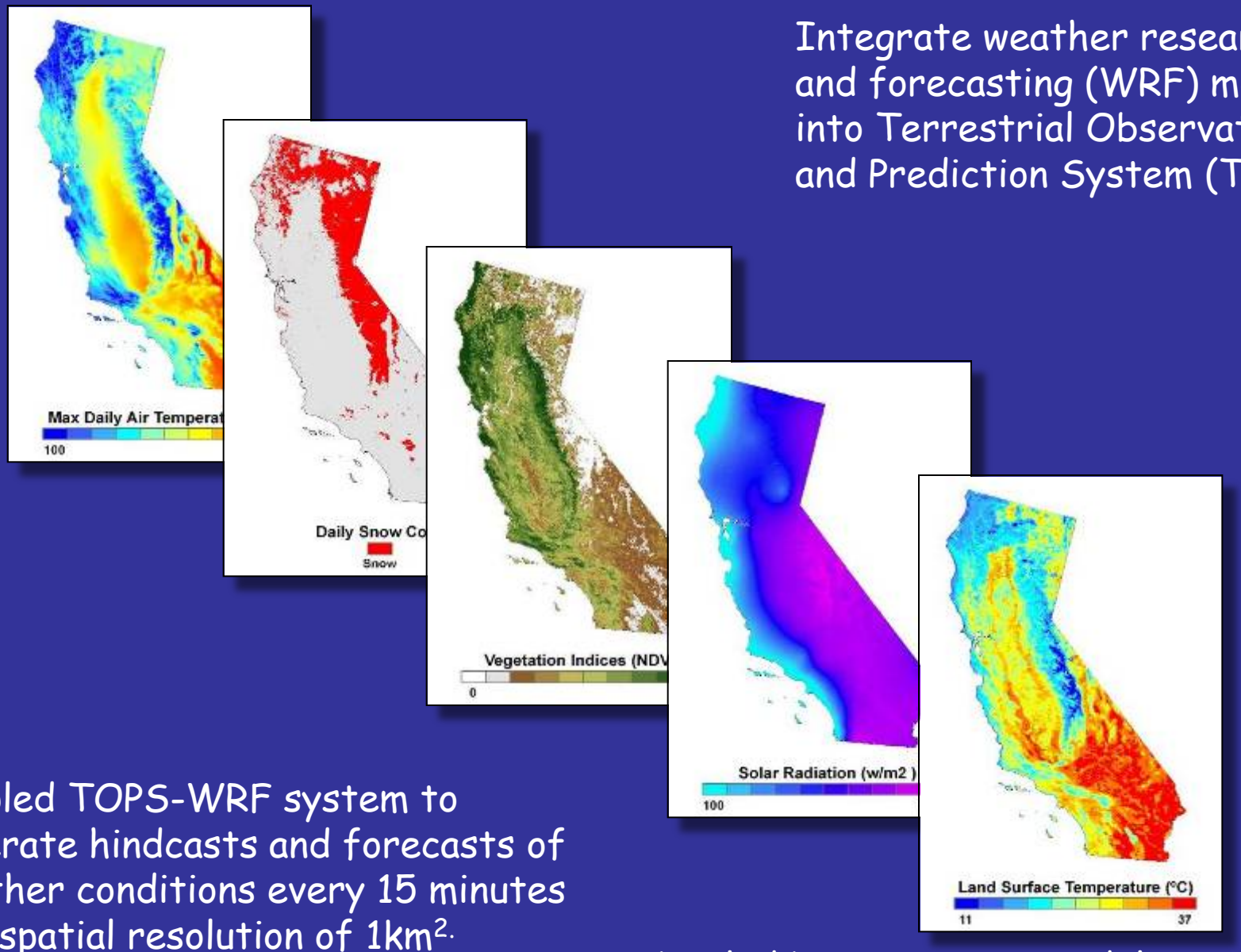
Examples of freshwater research projects

1. River temperature modeling
2. Measuring survival during migration
3. Models to evaluate management in ecosystem context
4. Models to support Klamath River restoration
5. Population effects of disease in Klamath River
6. Use of cold-water refugia in the Klamath River
7. Modeling to support BDCP BiOp

Improving stream temperature predictions for Sacramento River water decision support systems





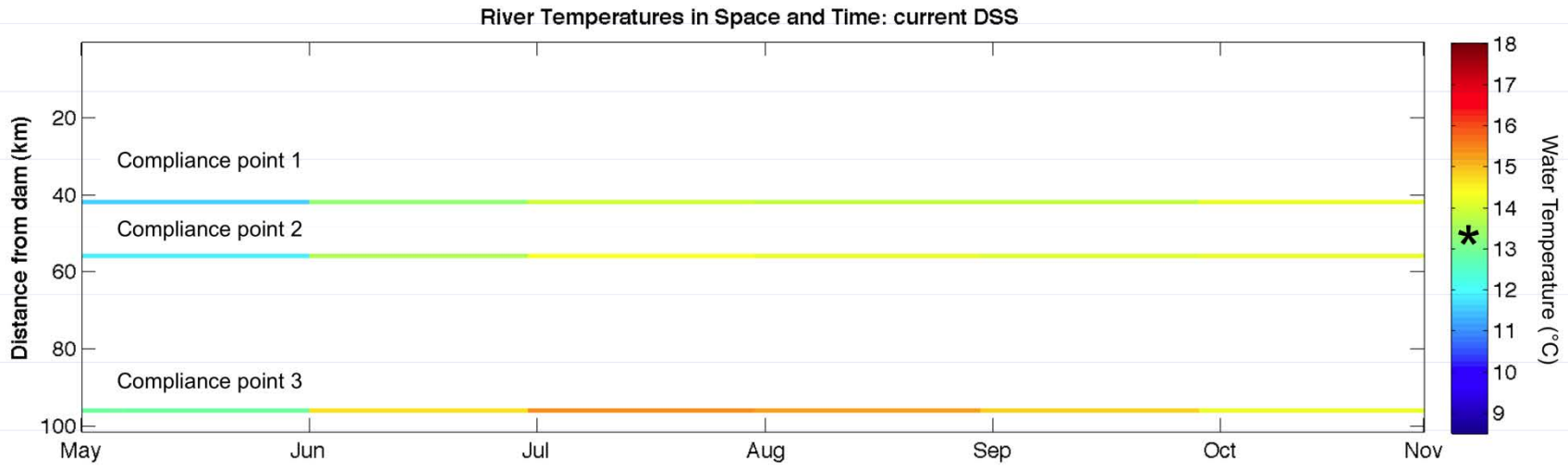


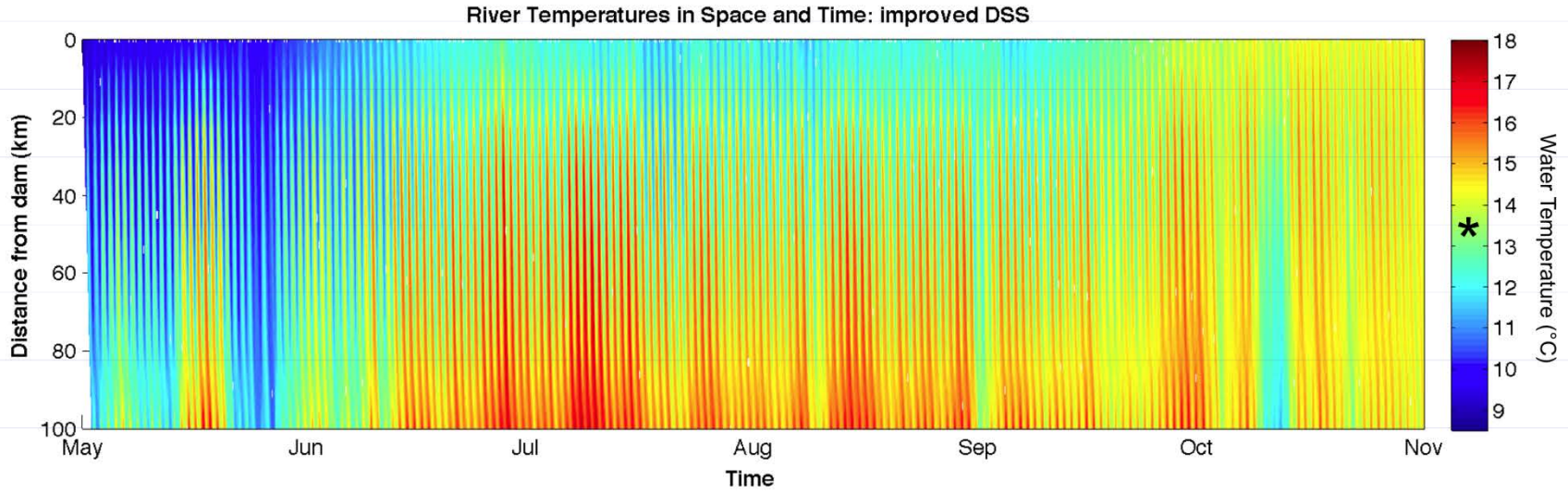
Integrate weather research and forecasting (WRF) model into Terrestrial Observation and Prediction System (TOPS)

Coupled TOPS-WRF system to generate hindcasts and forecasts of weather conditions every 15 minutes at a spatial resolution of 1km^2.

Coupled bioenergetics model

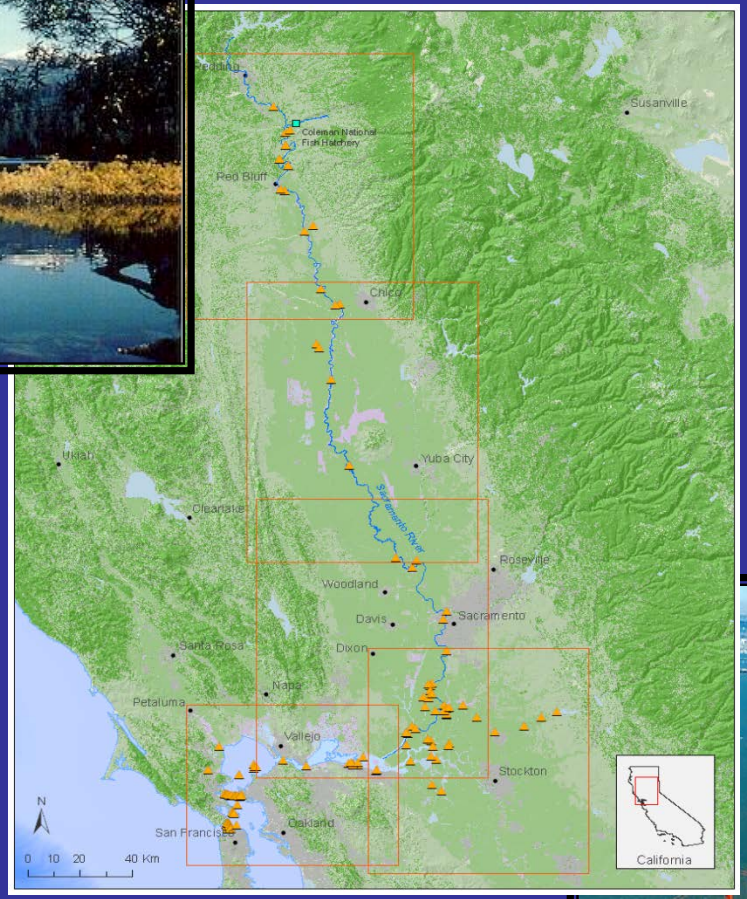
Comparison of Old and New Decision Support Models





Migration & Survival of Juvenile Salmonids in California's Central Valley & San Francisco Estuary

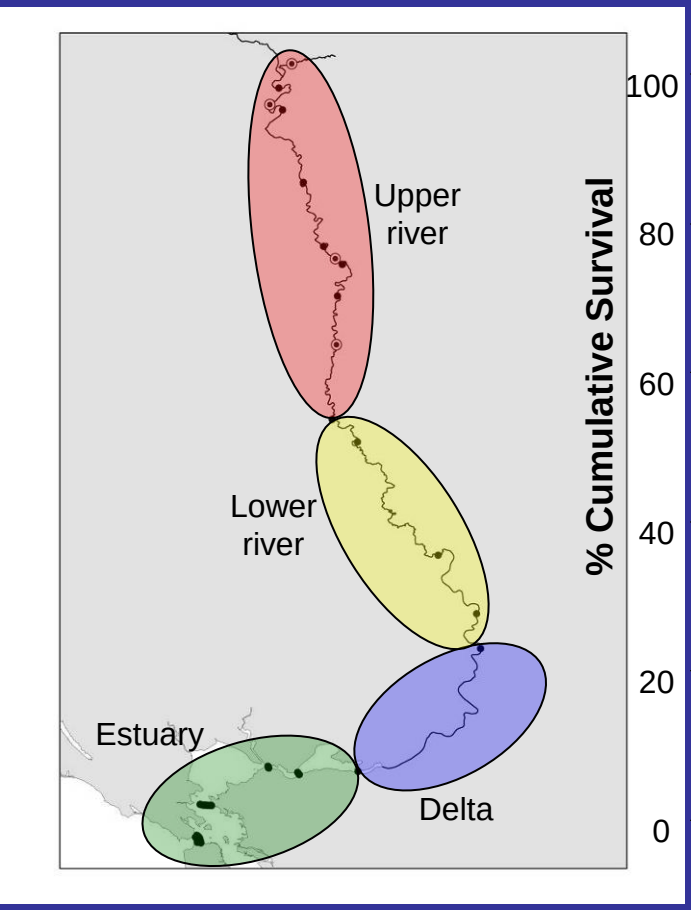


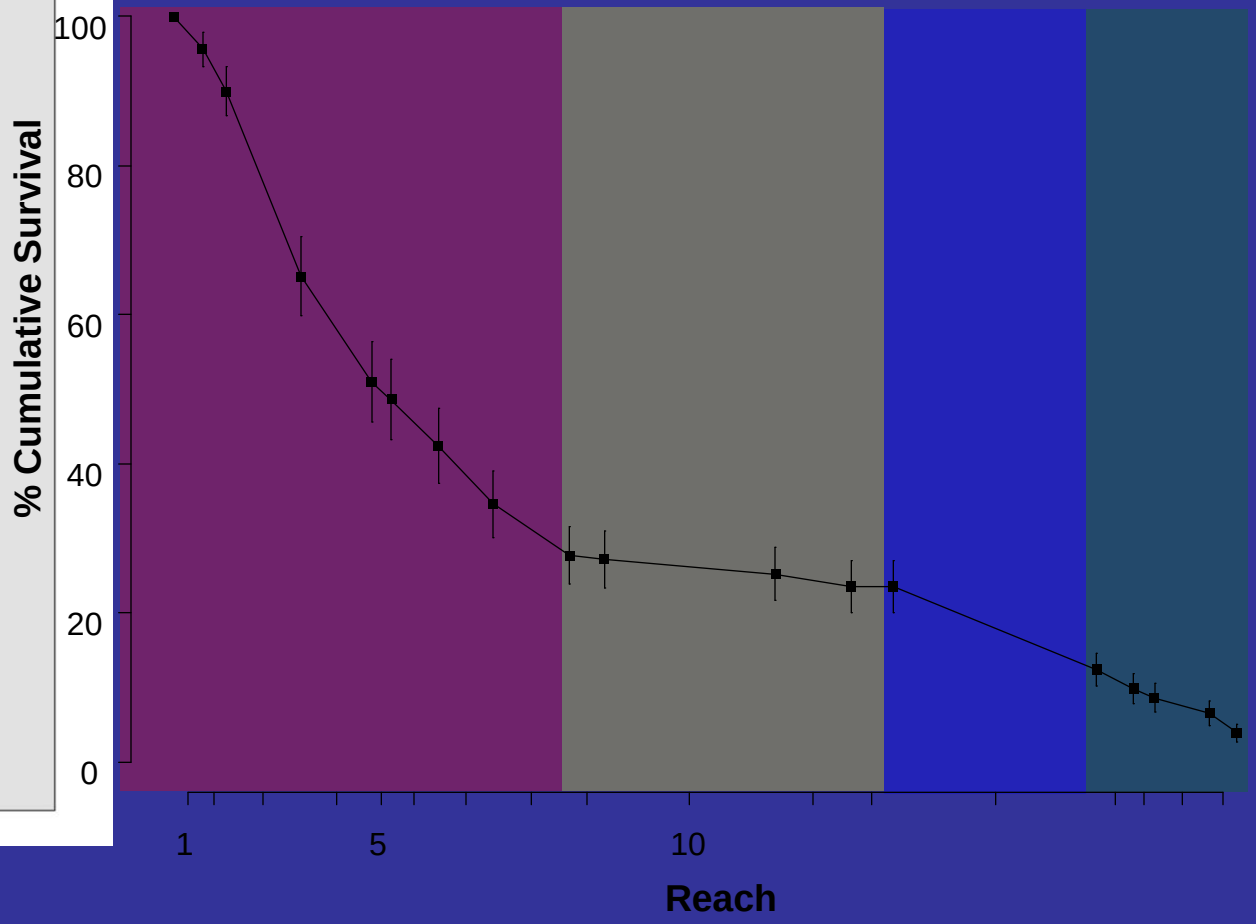




CALFED BAY-DELTA PROGRAM

Cumulative Downstream Migration and Survival 2007-2009





The future of the California Chinook salmon fishery: roles of climate variation, habitat restoration, hatchery practices, and biocomplexity.

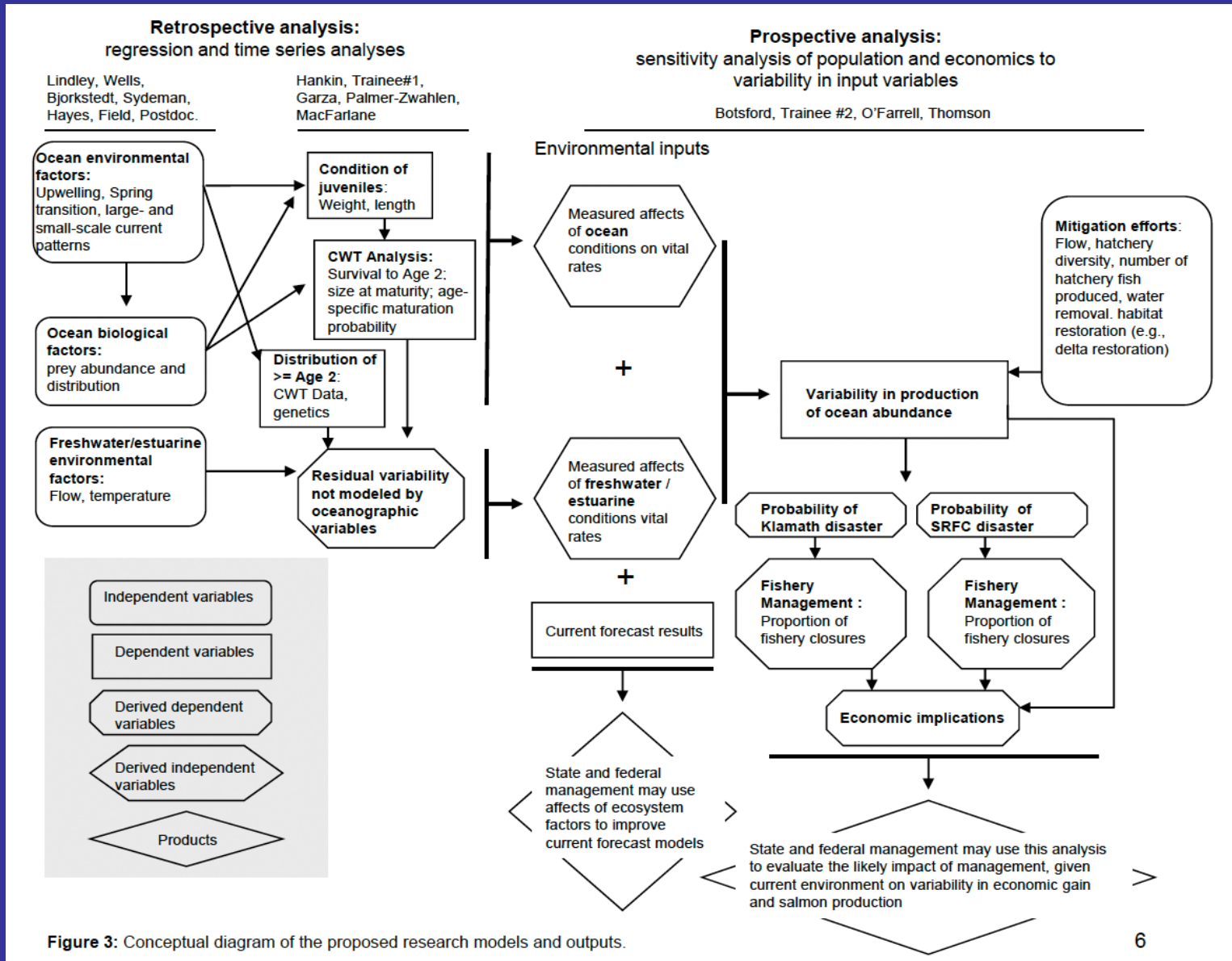
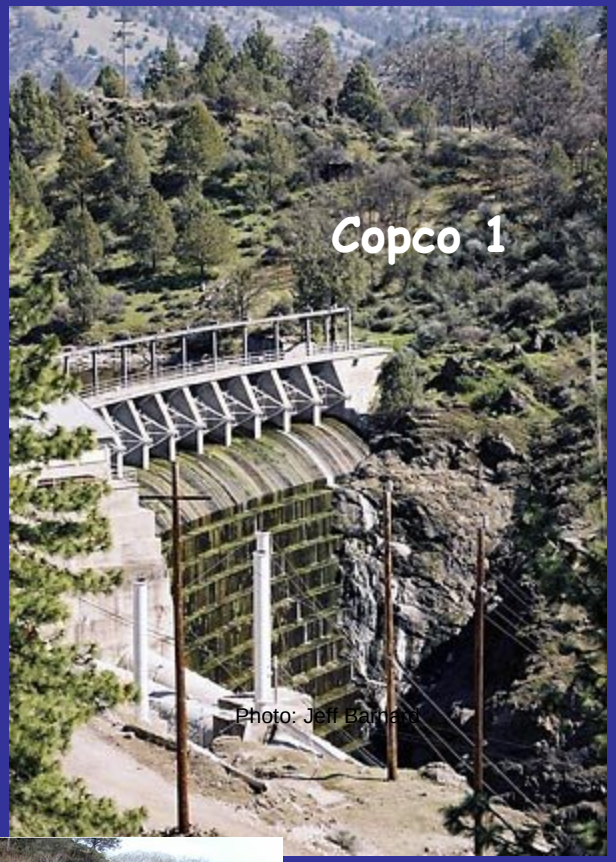


Figure 3: Conceptual diagram of the proposed research models and outputs.

Klamath River Restoration

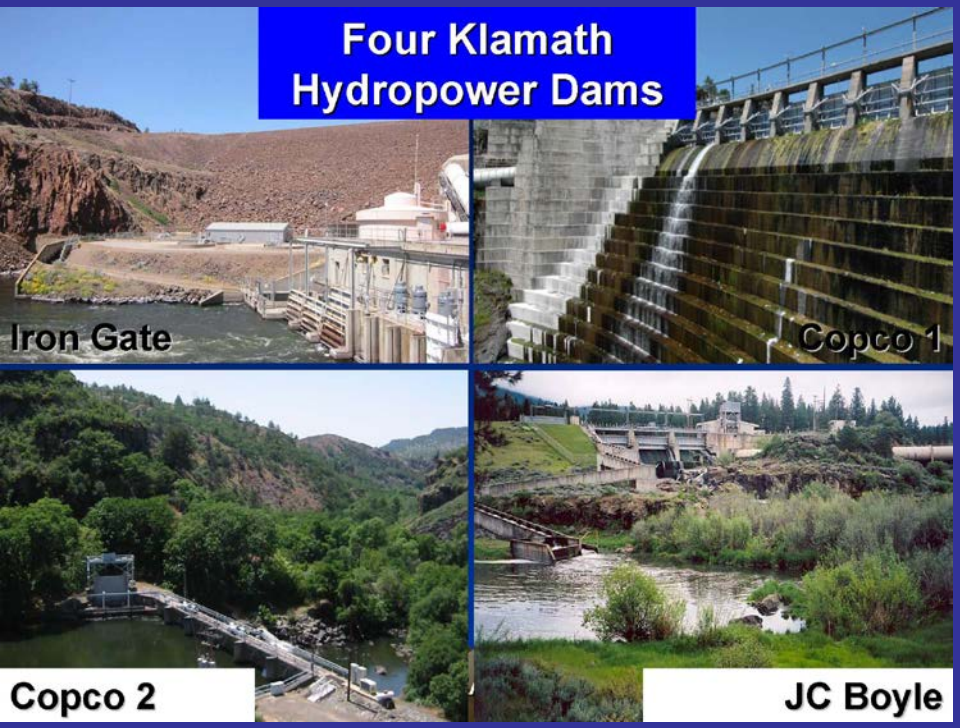








The Agreements



Klamath Hydroelectric Settlement Agreement

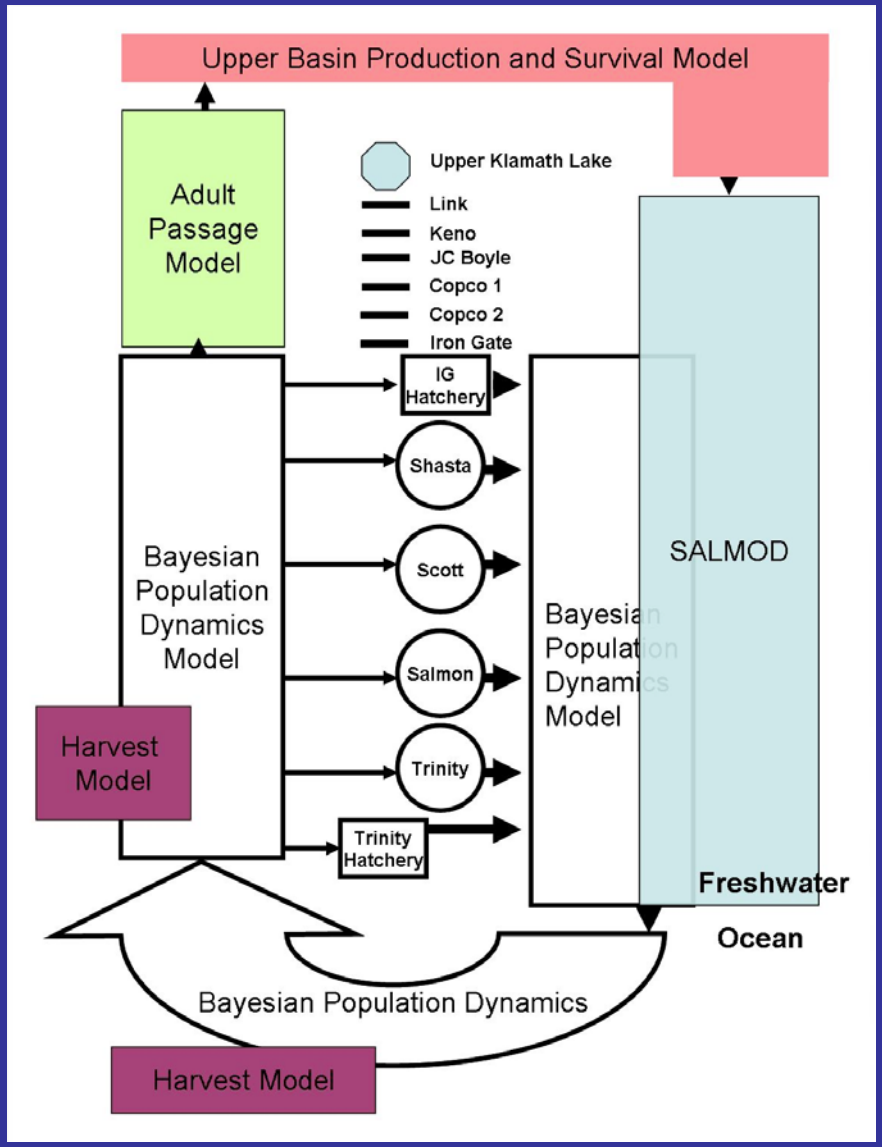
- 45 signatories including U.S. Govt, PacifiCorp, CA, OR, counties, tribes, fishing & environmental groups (notable exceptions: Hoopa Tribe, Siskiyou County)
- Criteria for dam removal:
  - > advance salmonid fishery restoration
  - > enhance 'public interest' (including interests of local communities and tribes)
- Cost cap: $200M PacifiCorp ratepayers, $250M CA taxpayers
- Designation of Dam Removal Entity
- Secretarial Determination by 2012, dam removal by 2020

Klamath Basin Restoration Agreement

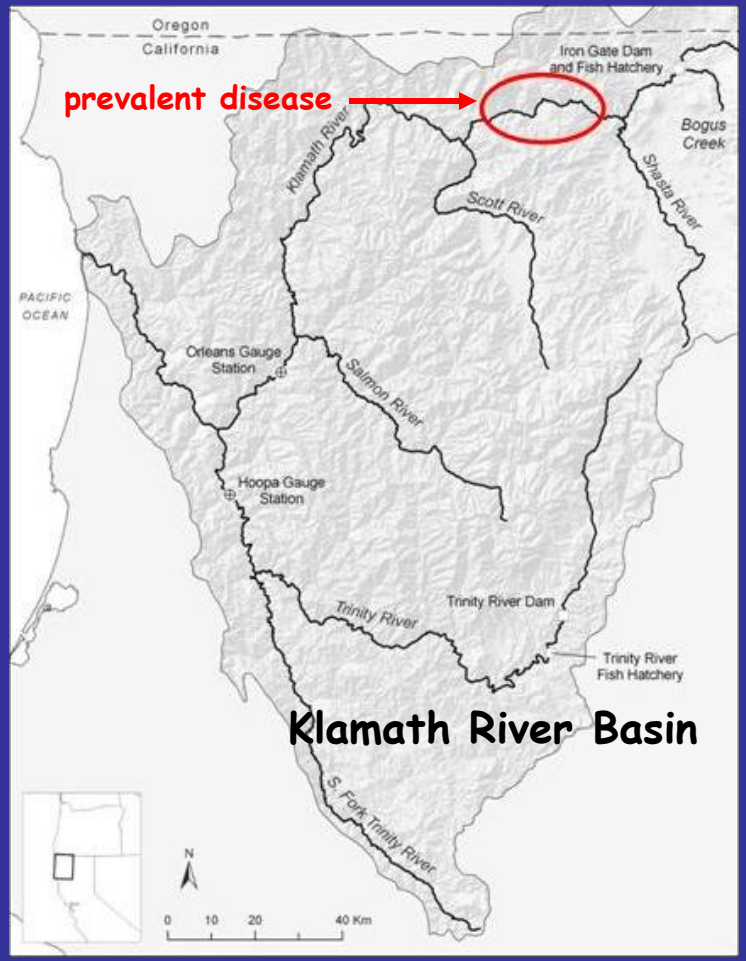
- Indivisible from KHSA
- Regional actions and processes: e.g., restore natural fish production, allocate/manage water
- Cost: $1 billion over 10 years
- Signed by all KHSA parties except U.S. Govt and PacifiCorp

Klamath Production Model: Evaluate the Fish Response to Dam Removal

- Biological component of cost-benefit analysis
- Dams in and out scenarios
- Combines new and existing models
  - -Bayesian life cycle
  - -SALMOD (USGS)
  - -Ocean and river harvest models

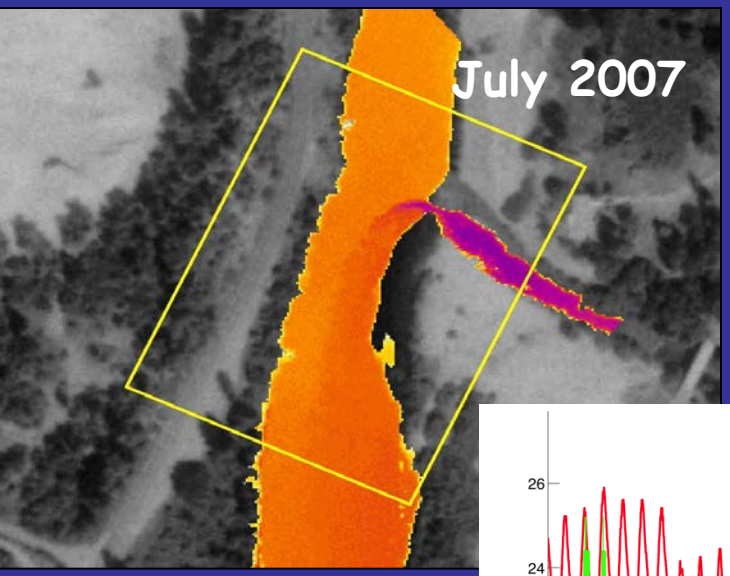


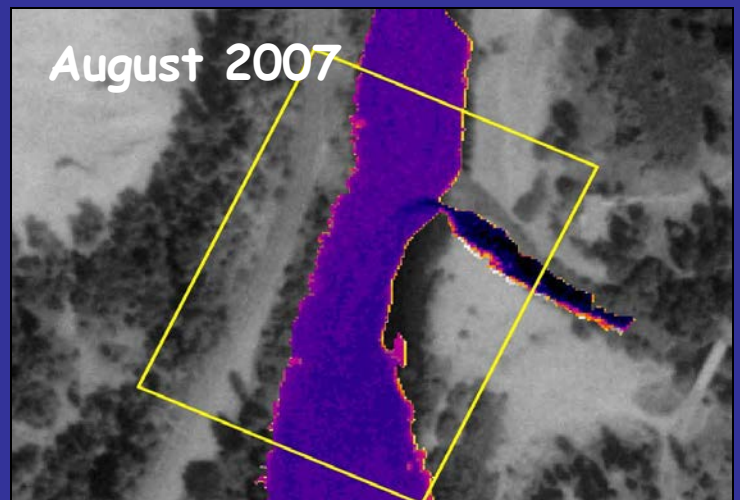
Population level effects of disease on KRFC salmon

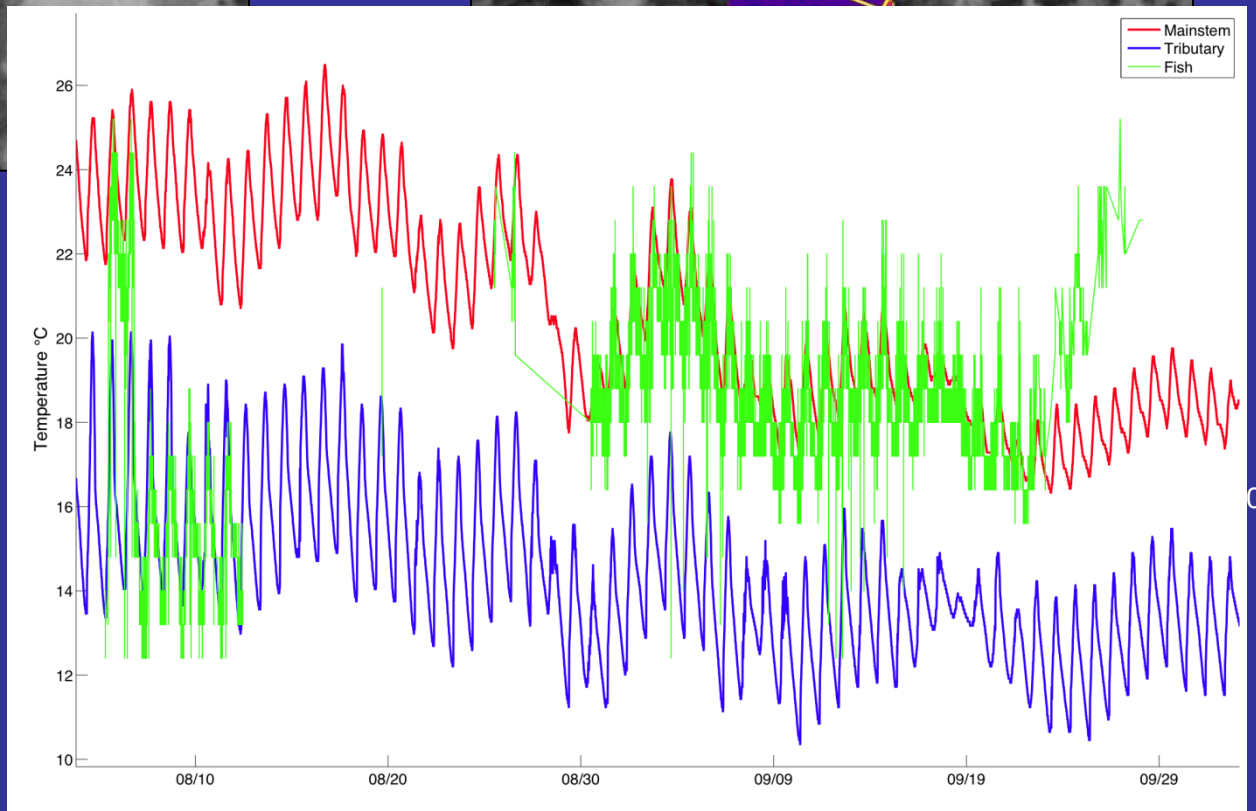


- Evaluate how disease affects KRFC population dynamics, abundance, and harvest
- Construct KRFC life-cycle models with disease incorporated
- Collaboration with fish pathologists

Thermal habitat utilization to inform bioenergetics modeling







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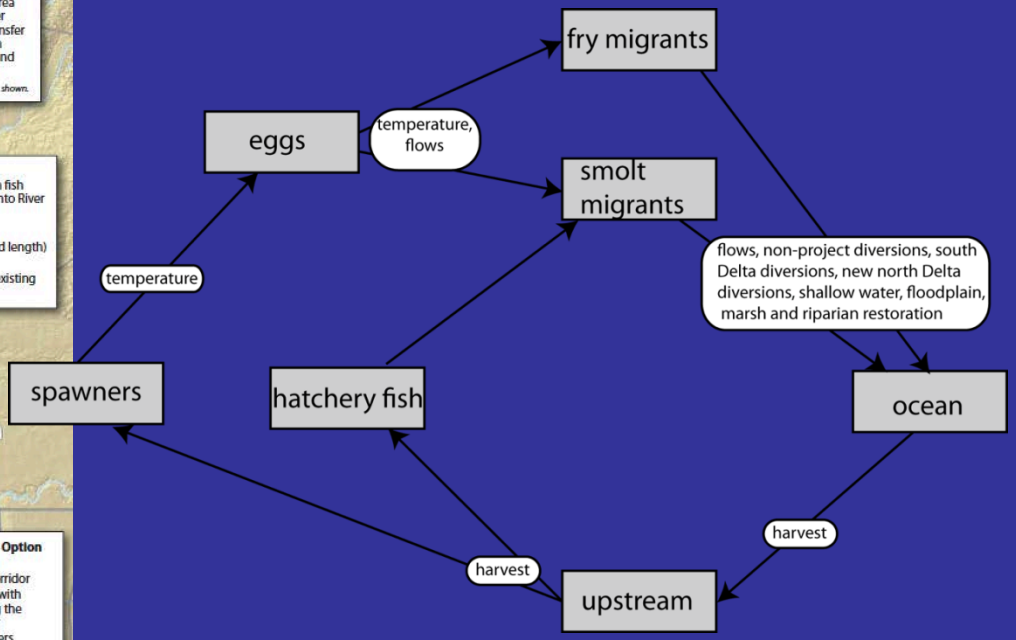
Bay Delta Conservation Plan





Science, Service, Stewardship

Agenda Item G.1.a
Supplemental SWR PowerPoint (McInnis)
April 2011

NMFS Southwest Region and Southwest Fisheries Science Center

Salmon Conservation and Habitat Restoration Efforts in California

NOAA FISHERIES SERVICE

Addressing Inland Impacts to Salmon

- Numerous NMFS activities/resources to protect ESA salmon and restore habitat
- Statutes granting NMFS authority for salmon conservation:
  - — Endangered Species Act
  - — Magnuson-Stevens Act; Essential Fish Habitat
  - — Fish and Wildlife Coordination Act
  - — Federal Power Act

NOAA FISHERIES SERVICE

Salmon Activities

- About 130 Regional staff working on salmon and steelhead; average of 30 biological opinions and 200 informal reviews/EFH annually
- 6 ESA Recovery Plans underway (salmon, steelhead)
- Estimated funds supporting PR and HC salmon activities:

Fiscal Year	Estimated salmon funds – CA Regional Office
2010	$16 million
2009	$11 million
2008	$11 million

NOAA
FISHERIES
SERVICE

Arcata Office

Served on more than 30 planning teams (2009)

- Shasta River and Big Springs Creek restoration
- Salt River Channel Restoration/Excavation Project
- Trinity Management Council participation/guidance
- Conservation banks

NOAA Fisheries Regional Offices



Klamath Hydroelectric Settlement Agreement / Klamath Basin Restoration Agreement

- Working with Interior Secretary on decision to remove four Klamath River dams
- Would restore 300 miles of historic salmonid habitat
- Intends to restore/sustain natural fish production; provide full participation in Basin harvest opportunities; establish reliable water/power supplies

NOAA FISHERIES SERVICE

Sacramento Office

- Red Bluff Diversion Dam Fish Passage Improvement Project
- Lower Yuba River Accord
- Battle Creek Salmon and Steelhead Restoration Project

NOAA Fisheries Regional Offices



Operations Criteria and Plan (OCAP)

- NMFS ESA Section 7 consultation – Bureau of Reclamation operations of Central Valley Project/ State Water Project
- Jeopardy & destruction or adverse modification of critical habitat
- Reasonable and Prudent Alternatives issued

Bay Delta Conservation Plan

- Large-scale restoration of habitat/reconfiguration of water operations (Sacramento-San Joaquin Delta)
- Monitoring and adaptive management plans
- NMFS/USFWS' integrated BiOp for BDCP and OCAP for Federal, non-Federal actions

NOAA FISHERIES SERVICE

Santa Rosa Office

- NMFS ESA Section 7 consultation on Russian River
- Russian River coho salmon captive broodstock program
- Frost Protection Task Force
- Regional Engineering Team – provides fisheries engineering support for all area offices and program activities; promotes effectiveness of engineered fish passage facilities

NOAA Fisheries Regional Offices



NOAA FISHERIES SERVICE

Habitat Conservation Activities

- EFH consultations
- Relicensing of non-federal hydropower projects
- Water rights/stream flow in water-scarce climate
- Fish Passage program
- Fish Friendly Farming Program

NOAA FISHERIES SERVICE

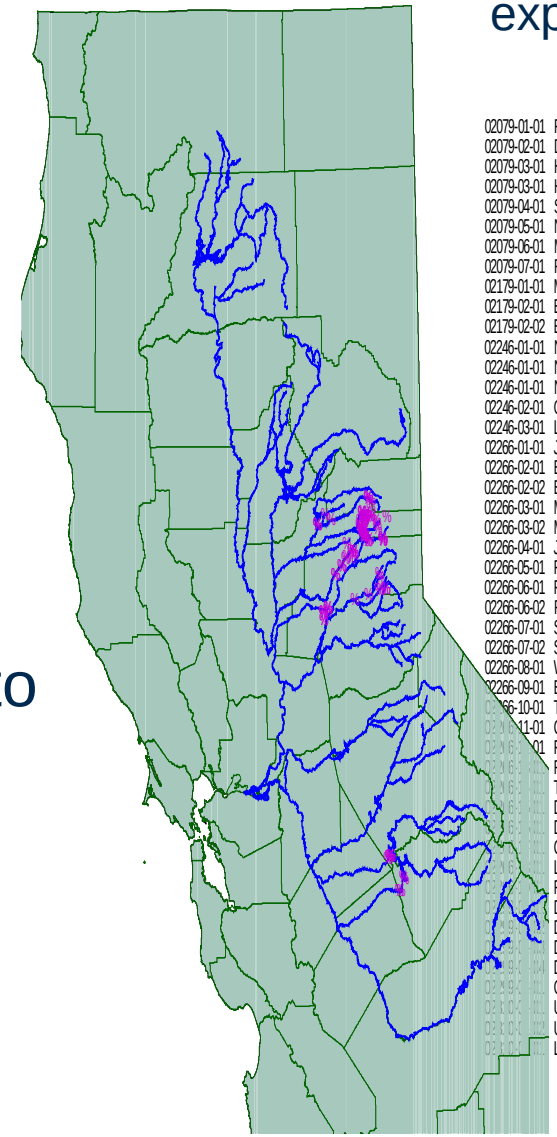
Federal Power Act: Hydropower Licensing Program

Major FERC Program Accomplishments to date:

Project Name	Resulting Benefits for Anadromous Fish
Battle Creek	Restore 43 habitat miles; remove dams/construct fishways
Kilarc-Cow Creek	Hydro decommissioning: remove small obsolete barrier dams-restore access to 97 miles of historic salmonid habitat
Klamath Dam Removal Agreement	Remove 4 mainstem hydropower dams- restore access to approximately 350 miles of historic salmonid habitat
Oroville Hydro Settlement	Provides $60M in habitat restoration benefits for salmon
Feather River Habitat Expansion Agreement	Provides for specific benefits to spring Chinook salmon and steelhead via habitat expansion actions in the Sacramento watershed
Yuba Salmon Forum	NMFS-led stakeholder forum to resolve complex water management and species recovery issues in the Yuba basin
Multiple licensing efforts throughout California	McCloud, Butte Creek, Upper Yuba, Upper American, Stanislaus, Tuolumne, Merced Rivers…

NOAA FISHERIES SERVICE

FERC CA. licenses expiring 2012-2016



02079-01-01	French Meadows; 2013	02310-03-01	Culbertson Lake; 2013
02079-02-01	Duncan Creek Diversion; 2013	02310-04-01	Upper Lindsey; 2013
02079-03-01	Hell Hole; 2013	02310-05-01	Middle Lindsey; 2013
02079-03-01	Hell Hole; 2013	02310-06-01	Lower Lindsey; 2013
02079-04-01	South Fork Long Canyon Div2013	02310-07-01	Upper Feeley; 2013
02079-05-01	North Fork Long Canyon Div; 2013	02310-08-01	Lower Feeley; 2013
02079-06-01	Middle Fork Interbay; 2013	02310-09-01	Blue Lake; 2013
02079-07-01	Ralston Afterbay; 2013	02310-10-01	Rucker Lake; 2013
02179-01-01	McSwain; 2014	02310-11-01	Fuller Lake; 2013
02179-02-01	Exchequer Main; 2014	02310-12-01	Spaulding No. 3 Forebay; 2013
02179-02-02	Exchequer Dike; 2014	02310-13-01	Spaulding No. 3 Afterbay; 2013
02246-01-01	New Bullards Bar; 2016	02310-14-01	Kidd Lake Main; 2013
02246-01-01	New Bullards Bar; 2016	02310-14-02	Kidd Lake Auxiliary; 2013
02246-01-01	New Bullards Bar; 2016	02310-15-01	Upper Peak Lake; 2013
02246-02-01	Our House; 2016	02310-16-01	Lower Peak Lake Main; 2013
02246-03-01	Log Cabin; 2016	02310-16-02	Lower Peak Lake Auxiliary; 2013
02266-01-01	Jackson Meadows; 2013	02310-17-01	White Rock Lake; 2013
02266-02-01	Bowman Main; 2013	02310-18-01	Meadow Lake; 2013
02266-02-02	Bowman Arch; 2013	02310-19-01	Lake Sterling; 2013
02266-03-01	Milton Main; 2013	02310-20-01	Lake Fordyce; 2013
02266-03-02	Milton South; 2013	02310-21-01	Jordan Creek Diversion; 2013
02266-04-01	Jackson Lake; 2013	02310-22-01	Lake Spaulding No. 1; 2013
02266-05-01	French Lake; 2013	02310-22-01	Lake Spaulding No. 1; 2013
02266-06-01	Faucherie Lake Main; 2013	02310-22-02	Lake Spaulding No. 2; 2013
02266-06-02	Faucherie Spillway Auxilia; 2013	02310-22-03	Lake Spaulding No. 3 Auxil; 2013
02266-07-01	Sawmill Main; 2013	02310-23-01	Lake Valley Main; 2013
02266-07-02	Sawmill Spillway; 2013	02310-23-02	Lake Valley Auxiliary; 2013
02266-08-01	Wilson Creek Forebay; 2013	02310-24-01	Kelly Lake; 2013
02266-09-01	Bowman Diversion; 2013	02310-25-01	Lake Valley Diversion; 2013
02266-10-01	Texas Creek Diversion; 2013	02310-26-01	Drum Forebay; 2013
02[illegible]11-01	Clear Creek Diversion; 2013	02310-26-01	Drum Forebay; 2013
02[illegible]01	Fall Creek Diversion; 2013	02310-27-01	Drum Afterbay; 2013
02[illegible]	Rucker Creek Diversion; 2013	02310-28-01	Drum Afterbay Toe; 2013
02[illegible]	Trap Creek Diversion; 2013	02310-29-01	Bear River Canal Diversion; 2013
02[illegible]	Dutch Flat Forebay; 2013	02310-30-01	Halsey Forebay No. 1; 2013
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02[illegible]	Gasburg Creek Dike; 2016	02310-36-01	Towle Canal Diversion; 2013
02[illegible]	Upper Rock Lake Main; 2013	02310-37-01	Alta Forebay; 2013
02[illegible]	Upper Rock Lake Auxiliary; 2013	02467-01-01	Merced Falls; 2014
02[illegible]	Lower Rock Lake; 2013		

Current hydropower program emphasis:

- Klamath River
- Yuba River
- Merced River
- McCloud, upper Sacramento
- Kilarc-Cow, Butte Creek
- Tuolumne River
- American River
- Stanislaus River
- San Joaquin River

NMFS-SWR
Habitat Conservation Division

Other Efforts and Funding

- American Recovery and Reinvestment Act
- Pacific Coast Salmon Recovery Funds
- NOAA Damage Assessment, Remediation, and Restoration Program

EMERGENCY CHANGES TO THE SALMON FISHERY MANAGEMENT PLAN (FMP)
(Excerpt from Council Operating Procedure 10)

CRITERIA FOR REQUESTING EMERGENCY CHANGES TO THE SALMON FMP

Section 305(c) of the Magnuson-Stevens Fishery Conservation and Management Act allows the U.S. Secretary of Commerce (Secretary) to implement emergency regulations independently or in response to a Council recommendation of an emergency if one is found to exist. The Secretary has not published criteria for determining when an emergency exists. A Council FMP may be altered by emergency regulations, which are treated as an amendment to the FMP for a limited period of 180 days and which can be extended for an additional 180 days.

Council FMPs can be changed by the amendment process which takes at least one to two years, or modified temporarily by emergency regulations, which can be implemented in a few weeks. Framework plans, like the Council's Salmon FMP, have been developed to allow flexibility in modifying management measures between seasons and during the season.

Some measures, like most conservation objectives and allocation schemes, are deliberately fixed in the plan and can be changed only by amendment or temporarily modified by emergency regulation. (Certain conservation objectives also may be changed by court order or without an amendment if; in the view of the Salmon Technical Team (STT), Scientific and Statistical Committee, and Council; a comprehensive review justifies a change.) They are fixed because of their importance and because the Council wanted to require a rigorous analysis, including extensive public review, to change them. Such an analysis and review were conducted when these management measures were originally adopted. It is the Council's intent to incorporate any desired flexibility of conservation objectives into the framework plan, making emergency changes prior to the season unnecessary. The Oregon coastal natural coho conservation objective is an example of a flexible objective, which is more conservative when stock abundance is low.

The use of the emergency process essentially "short circuits" the plan amendment process and reduces public participation, thus there needs to be sufficient rationale for using it. Moreover, experience demonstrates that if there is disagreement or controversy over a council's request for emergency regulations, the Secretary is unlikely to approve it. An exception would be an extreme resource emergency.

To avoid protracted, last-minute debates each year over whether or not the Council should request an emergency deviation from the Salmon FMP, criteria have been developed and adopted by the Council to screen proposals for emergency changes. The intent is to limit requests to those which are justified and have a reasonable chance of approval, so that the time spent in developing the case is not wasted and expectations are not unnecessarily raised.

Criteria

The following criteria will be used to evaluate requests for emergency action by the Secretary:

1. The issue was not anticipated or addressed in the salmon plan, or an error was made.

2. Waiting for a plan amendment to be implemented would have substantial adverse biological or economic consequences.

3. In the case of allocation issues, the affected user representatives support the proposed emergency action.

4. The action is necessary to meet FMP objectives.

5. If the action is taken, long-term yield from the stock complex will not be decreased.

Process

The Council will consider proposals for emergency changes at the March meeting and decide whether or not a specific issue appears to meet all the applicable criteria. If the Council decides to pursue any proposal, it will direct the STT to prepare an impact assessment for review by the Council at the April meeting, prior to final action. Any proposals for emergency change will be presented at the public hearings between the March and April meetings. It is the clear intent of the Council that any proposals for emergency change be considered no later than the March meeting in order that appropriate attention be devoted at the April meeting to developing management recommendations which maximize the social and economic benefits of the harvestable portion of the stocks.

The Council may consider other proposals for emergency change at the April meeting if suggested during the public review process, however, such proposals must clearly satisfy all of the applicable criteria and are subject to the requirements for an impact assessment by the STT.

PFMC
03/22/11

TENTATIVE ADOPTION OF 2011 OCEAN SALMON MANAGEMENT MEASURES FOR ANALYSIS

The Council adopted three salmon management Alternatives in March which were published in Preseason Report II and sent out for public review. Summaries of the testimony presented at public hearings will be provided at the meeting in supplemental reports (Agenda Item G.2.c).

In action under this agenda item, the Council must narrow the March management Alternatives to a single season recommendation for analysis by the Salmon Technical Team (STT). To allow adequate analysis before final adoption, the tentatively-adopted recommendations should resolve any outstanding conflicts and be as close as possible to the final management measures.

Any agreements by outside parties (e.g., North of Cape Falcon Forum, etc.) to be incorporated into the Council's management recommendations must be presented to the Council prior to adoption of the tentative options. Procedure also stipulates any new options or analyses must be reviewed by the STT and public prior to the Council's final adoption.

Management measures considered for adoption that deviate from Salmon Fishery Management Plan (FMP) objectives will require implementation by emergency rule. If an emergency rule appears to be necessary, the Council must clearly identify and justify the need for such an action consistent with emergency criteria established by the Council (Agenda Item G.2.a, Attachment 1) and National Marine Fisheries Service (Agenda Item G.2.a, Attachment 2).

The STT will check back with the Council on Monday, April 11, 2011 (Agenda Item G.4) or at other times to clarify any questions or obvious problems with the tentative measures.

Council Action:

Adopt tentative treaty Indian ocean and non-Indian commercial and recreational management measures for STT collation and analysis.

Reference Materials:

1. *Preseason Report II: Proposed Alternatives and Environmental Assessment - Part 2 for 2011 Ocean Salmon Fishery Regulations.* (mailed prior to the hearings and available at meeting).
2. Agenda Item G.2.a, Attachment 1: Emergency Changes to the Salmon FMP.
3. Agenda Item G.2.a, Attachment 2: FR 97-22094: Policy Guidelines for the Use of Emergency Rules.
4. Agenda Item G.2.b, STT Memo: March PFMC Alternatives for Chinook following PSC-CTC Chinook Model calibration.
5. Agenda Item G.2.c, Supplemental Public Hearing Reports 1 through 3: Summary of Public Hearings.
6. Agenda Item G.2.f, Supplemental SAS Report: Proposed 2011 Ocean Salmon Management Measures For Tentative Adoption.
7. Agenda Item G.2.g, Public Comment.

Agenda Order:

a.	Agenda Item Overview	Chuck Tracy
b.	Update of Estimated Impacts of March 2011 Alternatives	Robert Kope
c.	Summary of Public Hearings	Hearings Officers
d.	Recommendations of the U.S. Section of the Pacific Salmon Commission	Gordy Williams
e.	Recommendations of the North of Cape Falcon Forum	Oregon, Washington, and Tribes
f.	Reports and Comments of Advisory Bodies and Management Entities	
g.	Public Comment	
h.	**Council Action**: Adopt Tentative 2011 Ocean Salmon Management Measures for Analysis	

PFMC
03/23/11

THEFT RATES OF MODEL YEAR 1995 PASSENGER MOTOR VEHICLES STOLEN IN CALENDAR YEAR 1995—Continued

Manufacturer	Make/model (line)	Thefts 1995	Production (mfgr's) 1995	1995 (per 1,000 vehicles produced) theft rate
205 ROLLS-ROYCE	SIL SPIRIT/SPUR/MULS	0	132	0.0000
206 ROLLS-ROYCE	TURBO R	0	19	0.0000
207 VOLKSWAGEN	EUROVAN	0	1,814	0.0000
208 VOLVO	LIMOUSINE	0	6	0.0000

Issued on: August 18, 1997.

L. Robert Shelton,

Associate Administrator for Safety Performance Standards.

[FR Doc. 97–22263 Filed 8–20–97; 8:45 am]

BILLING CODE 4910–59–P

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

50 CFR Chapter VI

[Docket No. 970728184–7184–01; I.D. 060997C]

Policy Guidelines for the Use of Emergency Rules

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Policy guidelines for the use of emergency rules.

SUMMARY: NMFS is issuing revised guidelines for the Regional Fishery Management Councils (Councils) in determining whether the use of an emergency rule is justified under the authority of the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act). The guidelines were also developed to provide the NMFS Regional Administrators guidance in the development and approval of regulations to address events or problems that require immediate action. These revisions make the guidelines consistent with the requirements of section 305(c) of the Magnuson-Stevens Act, as amended by the Sustainable Fisheries Act.

DATES: Effective August 21, 1997.

FOR FURTHER INFORMATION CONTACT: Paula N. Evans, NMFS, 301/713–2341.

SUPPLEMENTARY INFORMATION:

Background

On February 5, 1992, NMFS issued policy guidelines for the use of emergency rules that were published in the **Federal Register** on January 6, 1992 (57 FR 375). These guidelines were consistent with the requirements of section 305(c) of the Magnuson Fishery Conservation and Management Act. On October 11, 1996, President Clinton signed into law the Sustainable Fisheries Act (Public Law 104–297), which made numerous amendments to the Magnuson-Stevens Act. The amendments significantly changed the process under which fishery management plans (FMPs), FMP amendments, and most regulations are reviewed and implemented. Because of these changes, NMFS is revising the policy guidelines for the preparation and approval of emergency regulations. Another change to section 305(c), concerning interim measures to reduce overfishing, will be addressed in revisions to the national standards guidelines.

Rationale for Emergency Action

Section 305(c) of the Magnuson-Stevens Act provides for taking emergency action with regard to any fishery, but does not define the circumstances that would justify such emergency action. Section 305(c) provides that:

1. The Secretary of Commerce (Secretary) may promulgate emergency regulations to address an emergency if the Secretary finds that an emergency exists, without regard to whether a fishery management plan exists for that fishery;

2. The Secretary shall promulgate emergency regulations to address the emergency if the Council, by a unanimous vote of the voting members, requests the Secretary to take such action;

3. The Secretary may promulgate emergency regulations to address the emergency if the Council, by less than a unanimous vote of its voting members, requests the Secretary to take such action; and

4. The Secretary may promulgate emergency regulations that respond to a public health emergency or an oil spill. Such emergency regulations may remain in effect until the circumstances that created the emergency no longer exist, provided that the public has had an opportunity to comment on the regulation after it has been published, and in the case of a public health emergency, the Secretary of Health and Human Services concurs with the Secretary's action.

Policy

The NOAA Office of General Counsel has defined the phrase ''unanimous vote,'' in paragraphs 2 and 3 above, to mean the unanimous vote of a quorum of the voting members of the Council only. An abstention has no effect on the unanimity of the quorum vote. The only legal prerequisite for use of the Secretary's emergency authority is that an emergency must exist. Congress intended that emergency authority be available to address conservation, biological, economic, social, and health emergencies. In addition, emergency regulations may make direct allocations among user groups, if strong justification and the administrative record demonstrate that, absent emergency regulations, substantial harm will occur to one or more segments of the fishing industry. Controversial actions with serious economic effects, except under extraordinary circumstances, should be done through normal notice-and-comment rulemaking.

The preparation or approval of management actions under the emergency provisions of section 305(c) of the Magnuson-Stevens Act should be limited to extremely urgent, special circumstances where substantial harm to or disruption of the resource, fishery, or community would be caused in the time it would take to follow standard rulemaking procedures. An emergency action may not be based on administrative inaction to solve a long-recognized problem. In order to approve an emergency rule, the Secretary must have an administrative record justifying emergency regulatory action and demonstrating its compliance with the national standards. In addition, the preamble to the emergency rule should indicate what measures could be taken

or what alternative measures will be considered to effect a permanent solution to the problem addressed by the emergency rule.

The process of implementing emergency regulations limits substantially the public participation in rulemaking that Congress intended under the Magnuson-Stevens Act and the Administrative Procedure Act. The Councils and the Secretary must, whenever possible, afford the full scope of public participation in rulemaking. In addition, an emergency rule may delay the review of non-emergency rules, because the emergency rule takes precedence. Clearly, an emergency action should not be a routine event.

Guidelines

NMFS provides the following guidelines for the Councils to use in determining whether an emergency exists:

Emergency Criteria

For the purpose of section 305(c) of the Magnuson-Stevens Act, the phrase ''an emergency exists involving any fishery'' is defined as a situation that:

(1) Results from recent, unforeseen events or recently discovered circumstances; and

(2) Presents serious conservation or management problems in the fishery; and

(3) Can be addressed through emergency regulations for which the immediate benefits outweigh the value of advance notice, public comment, and deliberative consideration of the impacts on participants to the same extent as would be expected under the normal rulemaking process.

Emergency Justification

If the time it would take to complete notice-and-comment rulemaking would result in substantial damage or loss to a living marine resource, habitat, fishery, industry participants or communities, or substantial adverse effect to the public health, emergency action might be justified under one or more of the following situations:

(1) Ecological—(A) to prevent overfishing as defined in an FMP, or as defined by the Secretary in the absence of an FMP, or (B) to prevent other serious damage to the fishery resource or habitat; or

(2) Economic—to prevent significant direct economic loss or to preserve a significant economic opportunity that otherwise might be foregone; or

(3) Social—to prevent significant community impacts or conflict between user groups; or

(4) Public health—to prevent significant adverse effects to health of participants in a fishery or to the consumers of seafood products.

Dated: August 14, 1997.

Gary C. Matlock,

Acting Assistant Administrator for Fisheries, National Marine Fisheries Service.

[FR Doc. 97–22094 Filed 8–20–97; 8:45 am]

BILLING CODE 3510–22–F

DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

50 CFR Part 285

[Docket No. 970702161–7197–02; I.D. 041097C]

RIN 0648–AJ93

Atlantic Highly Migratory Species Fisheries; Import Restrictions

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Final rule.

SUMMARY: NMFS amends the regulations governing the Atlantic highly migratory species fisheries to prohibit importation of Atlantic bluefin tuna (ABT) and its products in any form harvested by vessels of Panama, Honduras, and Belize. The amendments are necessary to implement International Commission for the Conservation of Atlantic Tunas (ICCAT) recommendations designed to help achieve the conservation and management objectives for ABT fisheries.

DATES: Effective August 20, 1997. Restrictions on Honduras and Belize are applicable August 20, 1997; restrictions on Panama are applicable January 1, 1998.

ADDRESSES: Copies of the supporting documentation are available from Rebecca Lent, Chief, Highly Migratory Species Management Division, Office of Sustainable Fisheries (F/SF1), NMFS, 1315 East-West Highway, Silver Spring, MD 20910–3282.

FOR FURTHER INFORMATION CONTACT: Chris Rogers or Jill Stevenson, 301–713–2347.

SUPPLEMENTARY INFORMATION: The Atlantic tuna fisheries are managed under the authority of the Atlantic Tunas Convention Act (ATCA). Section 971d(c)(1) of the ATCA authorizes the Secretary of Commerce (Secretary) to issue regulations as may be necessary to carry out the recommendations of the ICCAT. The authority to issue regulations has been delegated from the Secretary to the Assistant Administrator for Fisheries, NOAA (AA).

Background information about the need to implement trade restrictions and the related ICCAT recommendation was provided in the preamble to the proposed rule (62 FR 38246, July 17, 1997) and is not repeated here. These regulatory changes will further NMFS' management objectives for the Atlantic tuna fisheries.

Proposed Import Restrictions

In order to conserve and manage North Atlantic bluefin tuna, ICCAT adopted two recommendations at its 1996 meeting requiring its Contracting Parties to take the appropriate measures to prohibit the import of ABT and its products in any form from Belize, Honduras, and Panama. The first recommendation was that its Contracting Parties take appropriate steps to prohibit the import of ABT and its products in any form harvested by vessels of Belize and Honduras as soon as possible following the entry into force of the ICCAT recommendation. Accordingly, the prohibition with respect to these countries is effective August 20, 1997. The second recommendation was that the Contracting Parties take appropriate steps to prohibit such imports harvested by vessels of Panama effective January 1, 1998. This would allow Panama an opportunity to present documentary evidence to ICCAT, at its 1997 meeting or before, that Panama has brought its fishing practices for ABT into consistency with ICCAT conservation and management measures. Accordingly, the prohibition with respect to Panama will become effective January 1, 1998.

Under current regulations, all ABT shipments imported into the United States are required to be accompanied by a Bluefin Statistical Document (BSD). Under this final rule, United States Customs officials, using the BSD, will deny entry into the customs territory of the United States of shipments of ABT harvested by vessels of Panama, Honduras, and Belize and exported after the effective dates of the trade restrictions. Entry will not be denied for any shipment in transit prior to the effective date of trade restrictions.

Upon determination by ICCAT that Panama, Honduras, and/or Belize has brought its fishing practices into consistency with ICCAT conservation and management measures, NMFS will publish a final rule in the **Federal Register** that will remove import restrictions for the relevant party. In

MEMORANDUM

DATE: March 25, 2011

TO: STT

FROM: Larrie La Voy

SUBJECT: March PFMC Alternatives for Chinook following PSC-CTC Chinook Model calibration

The PSC CTC Analytical Work Group (AWG) has completed this year's Chinook Model calibration that produces the Abundance Index (AI) that establishes the landed catches in the AABM fisheries (southeast Alaska, northern BC, and WCVI) according to the 2008 PST Agreement. This analysis also provides forecasts for Fraser Early, Fraser Late, WCVI, Lower Georgia Strait, and Oregon north coast Chinook stocks that are used in FRAM. The calibration and the AIs for 2011 determined by the AWG through the model calibrations are now out for review by the full CTC and should be presented to the Pacific Salmon Commissioners next week. Hence, the numbers are not "final" but the AWG has no additional work scheduled on the calibration. The AIs, associated TACs, and northern stock forecasts can be considered good for updating the March PFMC Chinook Alternatives with FRAM.

For all of the AABM fisheries, the 2011 AI's are up substantially from the 2010 levels.

Table 1. Preseason AI and TAC in AABM fisheries, 2010-2011.

AABM	2010		2011 (preliminary)	
Fishery	Preseason AI	Preseason TAC	Preseason AI	Preseason TAC
SEAK trl,nt,spt	1.35	221,800	1.69	294,800
No. BC trl, spt	1.17	152,100	1.38	182,400
WCVI trl, spt	0.96	143,700	1.15	196,800

The increase in AIs relative to 2010 are due primarily to increased abundance of Columbia River Bright and Oregon North Coast Chinook in SEAK and NBC fisheries and Fraser Late Chinook in WCVI as well as an overall increase in many other contributing stocks to these fisheries. In addition, the AIs for SEAK and WCVI stepped up to the next higher harvest rate tier in the AI-to-TAC relationship in the 2008 PST Agreement.

For the March PFMC model runs, we modeled the AABM fisheries (except WCVI sport) as effort scalars rather than TACs which were intended to better reflect the change in stock abundances that contribute to these northern fisheries. We also used 2010 forecasts for Oregon north coast and Canadian stocks in FRAM pending the outcome of the Chinook Model calibration that provides 2011 forecasts for these stocks.

I have updated the March PFMC model runs with the new forecasts for Canadian and Oregon coast Chinook stocks and the TACs associated with the 2011 AIs in the AABM fisheries. I assumed that all of the AABM fisheries would be fished to the PST ceiling limit. The effort scalar based approach adequately adjusted for the new TACs and additional forecasts for modeling SEAK and NBC. Model estimates of landed catches for these fisheries matched reasonably well with the new TACs. On the other hand, WCVI needed significant increases in fishing level to produce the TAC associated with this year's 1.16 AI. My hunch is that the stock contribution rates differ somewhat between the PSC Chinook Model and FRAM and that influence is exaggerated when there is dramatic changes in dominant stocks like Fraser Late (record high forecast of age 4 in 2011) or Spring Creek Hatchery tules (much lower in 2011 than 2010).

The effect of incorporating the new northern fishing levels and forecast information into the March PFMC Alternatives generally increases to a varying degree the total impacts across all fisheries. This is most problematic for lower Columbia natural tule Chinook (LCN) where now all of the alternatives exceed the 37% ER ceiling for the updated model runs. Alternative 2 and 3 were under the 37% ceiling for the March PFMC runs. Below is a formatted Table 5 from the Preseason Report II showing the two sets of model runs for the alternatives.

Table 5 PFMC Preseason Report

	Adult Ocean Escapement or Other Crit.					
	Alt 1		Alt 2		Alt 3	
Stock	March PFMC	w/ New North	March PFMC	w/ New North	March PFMC	w/ New North
Col Upriver Brt	417.5	397.3	418.5	398.3	419.5	399.3
Mid-Col Brt	104.9	99.8	105.2	100.0	105.4	100.3
Col Lower Hatch	125.7	122.6	129.3	126.2	134.7	131.6
Col Nat Tule ER	**39.3%**	**42.5%**	36.8%	**40.2%**	34.4%	**37.9%**
Col LRW	13.1	13.0	13.1	13.1	13.2	13.1
Spring Creek	112.1	109.5	116.7	113.9	122.5	119.5

Below is Table 7 from Preseason Report II showing LCN ERs by fishery. Canadian fishery ERs increased nearly 5% from those calculated from the March PFMC model runs. ERs in the other fisheries went down slightly as is commonly the case when there is a shift in the proportion of the total impacts attributed to individual fisheries.

Table 7 PFMC Preseason LCN ER by fishery

	Alt 1		Alt 2		Alt 3	
Fishery	**March PFMC**	**w/ New North**	**March PFMC**	**w/ New North**	**March PFMC**	**w/ New North**
SEAK	2.7%	2.6%	2.8%	2.6%	2.9%	2.7%
BC	11.5%	15.9%	11.7%	16.1%	11.9%	16.4%
Puget Sound	0.5%	0.4%	0.5%	0.4%	0.5%	0.4%
NoF						
T troll	5.4%	5.2%	4.5%	4.3%	3.6%	3.4%
Sport	3.3%	3.2%	2.6%	2.5%	1.9%	1.8%
NT troll	5.9%	5.6%	4.6%	4.4%	3.3%	3.2%
SoF						
Sport	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%
Troll	2.0%	2.0%	1.9%	1.9%	1.9%	1.8%
Estuary/FW	7.9%	7.5%	8.2%	7.8%	8.5%	8.1%
Total	39.2%	42.4%	36.8%	40.2%	34.4%	37.9%

To reiterate, these model runs are based on estimates of AIs (and associated TACs and forecasts) that have not received full review by PSC-CTC members. However, I do not expect the values to change unless some unforeseen circumstance arises. Also, there are no other FRAM related adjustments needed to fully incorporate this new information. These are the best estimates at this time.

SALMON MANAGEMENT ALTERNATIVES HEARING SUMMARY

Date:	March 28, 2011	Hearing Officer:	Mr. Mark Cedergreen
Location:	Chateau Westport Westport, WA	Other Council Members:	Mr. Phil Anderson
		NMFS:	Dr. Peter Dygert
Attendance:	54	Coast Guard:	Mr. Brian Corrigan Dan Martin
Testifying:	16	Salmon Team Member:	Mr. Doug Milward
		Council Staff:	Dr. Kit Dahl
Organizations Represented: City of Westport Washington Trollers Association Westport Charterboat Association Ilwaco Charterboat Association			

Special Opening Remarks

Mr. Doug Milward reviewed Alternatives for the commercial and sport salmon seasons.

Synopsis of Testimony

Of the 16 people testifying:

- Eight commented primarily on the commercial troll fishery.
- Seven commented primarily on the recreational (charterboat) fishery
- One commented primarily on community impacts to Westport.

Commercial Troll Comments

- The 37% exploitation rate for LCR tules is unnecessarily low. LCR tule recovery would not be impacted by a higher exploitation rate. NMFS should show more flexibility in setting this exploitation rate.
- Consider using a multi-year average for the LCR tule exploitation rate or increasing the 2011 exploitation rate consistent with the harvest rate below 37% last year.
- Management restrictions are hurting the economy in coastal and Columbia River communities.
- Trollers are negotiating to find common ground on season recommendations.
- When the North of Falcon non-treaty quota is below 30,000 Chinook the halibut quota is not caught by the troll fleet. This should be considered when setting the halibut

allowance.
- More effort should be put into enhancing wild (non-hatchery) salmon stocks. Programs should involve communities and schools in stock enhancement projects.

Recreational Comments

- The Alternatives are only 45-85% of last year and last year didn't work.
- Charterboats are losing their customer base because of management measures. Businesses are on the brink of going out of business because of bad seasons.
- A mark-selective fishery is not workable after July 1. It should only be considered a bonus fishery outside the July-August time frame.
- Charter customers do not like mark-selective fisheries so it is leading to the permanent loss of the customer base. It is important for customers to be able to take home some fish. Even though it prolongs the season it's not worth it.
- Mark-selective fisheries may work when there are a lot of fish but not when there are severe restrictions.
- Recommend a 1 or 2 coho bag limit starting July 3rd or a little later.

Other Comments

- Inside fisheries shouldn't be "held harmless" in terms of harvest opportunity.
- The Pacific Salmon Treaty process needs to be revisited. Canada and Alaska are getting an unfair portion of the Chinook harvest at the expense of North of Falcon fisheries. North of Falcon fisheries are having to fish around Canada's critical stocks while they are benefitting from the strong Columbia River Chinook run.
- Make sure to disseminate accurate information so that the public is not dissuaded from recreational fisheries.

Written Statements (Attached)

- Doug Fricke, Washington troller

PFMC
04/01/11

Corrected copy

Mr. Mark Cedergreen, Chairman

Pacific Fisheries Management Council

Portland, Oregon

Subject: Concerns for the 2011 Salmon Troll Season

I am testifying as a commercial salmon troller out of Westport WA that has been an active salmon fisherman for over 35 years and involved in the PFMC season setting process for over 30 years. My comments will deal with three 2011 salmon season issues.

First is questioning why is the NMFS so set on allowing only 37% Exploitation Rate (ER) on lower Columbia River Tule Stocks (LCRT).

- In 2010 NMFS made a statement that 36% or 37% ER would be used without knowing the strength of the LCRT for 2011. In fact the projection for LCRT in 2011 is significantly higher than in 2010. There is a PFMC Tule Abundance Workshop in which NMFS participates indicating that the LCRT can recover when the LCRT is high abundance and the allowed ER is 40% or higher.
- In 2009 and 2010, the allowed ER on LCRT was 38% and higher. At the higher ER and lower stock size, the post season review showed that the desired ER on LCRT was below the preseason goal.
- In 2009 and 2010 there was a mistake in the Chinook model that allowed ER on LCRT to exceed the desired ER by two %. Even with the model mistake, the post season review showed that the ER for the LCRT was lower than the preseason goal.
- The Pacific Salmon Treaty agreement on chinook management has forced the fisheries in 2011 South of the Canadian border to make draconian cuts in order to have an ER on LCRT below 37%. Because the impacts on LCRT is small from the fisheries South of Cape Falcon, most of the fishery reductions are made are forced on the Ocean north of Cape Falcon and inside the Columbia River.

Based on the above considerations, it appears that the long term prospects for the recovery of LCRT wild component would not be in jeopardy if NMFS were to reconsider the allowed ER on LCRC stocks and allow the 2011 ER go to 38% or 39%. For the ocean fisheries, .7% change represents approximate access to 10,000 chinook when the other healthy chinook stocks are considered. Any increase in the allowed LCRT would help alleviate the dramatic forced reductions for the fisheries North of Cape Falcon.

The second issue to address is the makeup of the salmon troll fleet North of Cape Falcon (NOF). We have two distinct types of businesses that troll NOF and have two distinct business models. One type wants an extended season to service personal markets, to fish only good weather in mid summer, or to supplement a semi retirement mode. The other types of salmon trollers have a business plan of maximizing their profit when they are salmon trolling in the area NOF. There has been struggle between these two groups for years within the Washington Trollers Association (WTA). WTA represents over half of the licensed salmon trollers that fish NOF. Hopefully, by the April 9 when it comes time for the PFMC to determine the final 2011 season, WTA will have a compromise agreement from these two diverse business models within WTA that you can endorse for 2011. However, tonight you will be hearing arguments in favor of each interest group.

The third issue that I want to bring to your attention is the allowed halibut bycatch by the salmon trollers. Attached are two charts that show a trend developing in the appropriate bycatch allowance for a yearly halibut to salmon ratio. Notice a few trends that are shown in the charts:

- Regardless of the South of Falcon season, it appears that when the NOF treaty troll quota is below 30,000 chinook, that the halibut quota is not caught by the salmon troll fleet.
- When the NOF treaty troll fishery is below 30,000, the salmon troll fleet has not harvested over 28,000 lbs. of halibut which is the 2011 non treaty salmon troll allowance.
- Notice particularly the year 2000 when the South of Falcon season was open and the landing ratio was one halibut to three chinook, the troll harvest was far below the 28,000 lb halibut allowance for 2011

Please consider the trend in halibut landings when deciding the allowed halibut bycatch for the 2011 season in 2011.

Thanks for your considering,

Douglas Fricke

Halibut – Troll TAC comparison

Since inception

Year	NT Troll	Halibut Alloc	alibut Harvest	%	ratio
2002	82.5	39300	41000	1.04	3
2003	64.4	39300	41917	1.07	3
2010	56.0	25035	28627	1.14	3
2004	44.5	44554	42798	0.96	3
2005	43.3	39918	42187	1.06	3
2006	34.0	41464	34354	0.83	3
2001	30.0	30046	43100	1.43	3
1999	28.5	23490	9955	0.42	5
2009	20.5	29352	11310	0.39	2
2008	20.0	37707	16685	0.44	2
2007	16.3	43667	24126	0.55	3
2000	12.5	24464	22350	0.91	3
1997	11.5	21635	17570	0.81	10
1998	6.5	25344	13124	0.52	8
1995	0.0	16068	2125	0.13	20
1996	0.0	16068	9521	0.59	15
2011		28126	21633	0.77	
			Total for Avg	12.31	
			Average %	0.77	

TAC <30000

1999	28.5	23490	9955	0.42	5
2009	20.5	29352	11310	0.39	2
2008	20.0	37707	16685	0.44	2
2007	16.3	43667	24126	0.55	3
2000	12.5	24464	22350	0.91	3
1997	11.5	21635	17570	0.81	10
1998	6.5	25344	13124	0.52	8
1995	0.0	16068	2125	0.13	20
1996	0.0	16068	9521	0.59	15
2011		28126	13423	0.48	
			Total for Avg	4.772437	
			Average %	0.477244	

The 2011 harvest is calculated using the average % from previous year and this year's a

SALMON MANAGEMENT ALTERNATIVES HEARING SUMMARY

Date:	March 28, 2011	Hearing Officer:	Mr. Rod Moore
Location:	Coos Bay Red Lion Coos Bay OR		
		NMFS:	Ms. Peggy Busby
Attendance:	19	Coast Guard:	LTJG Ian Leonard
Testifying:	9	Salmon Team Member:	Mr. Craig Foster
		Council Staff:	Mr. Chuck Tracy
Organizations Represented: Salmon Harbor Marina			

Special Opening Remarks

Mr. Craig Foster reviewed Alternatives for the commercial and sport salmon seasons.

Synopsis of Testimony

Of the nine people testifying:

Five commented primarily on the commercial troll fishery.
Four commented primarily on the recreational fishery.

Commercial Troll Comments

- All those testifying supported Alternative I for Central Oregon
- One requested some limited opportunity in September with a landing limit of 100 fish per week for the Central Oregon fishery.

Recreational Comments

- Three supported Alternative I for central Oregon
- One supported Alternative III for the Central Oregon because of the non-mark-selective coho opportunity

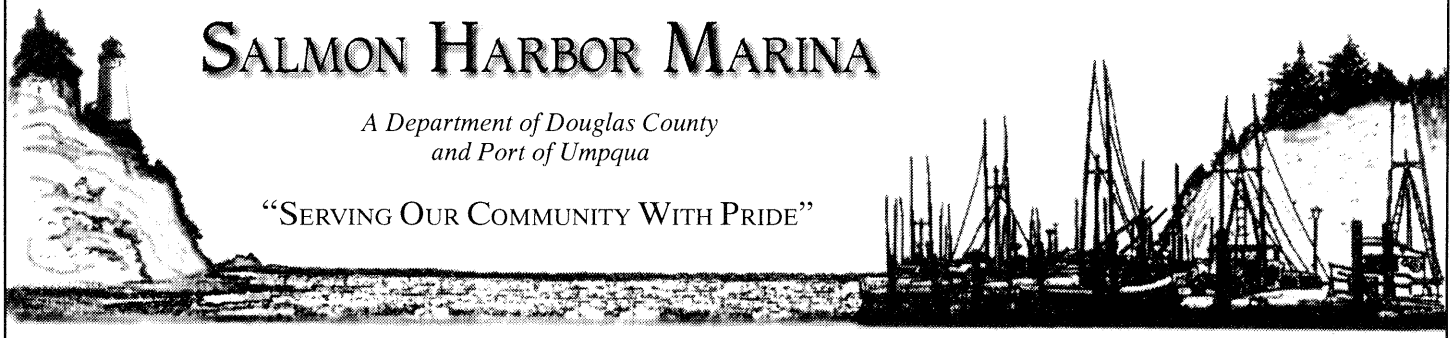
Other Comments

- Two opposed any form of mark-selective-fishery.

Written Statements (Attached)

- Salmon Harbor Marina

PFMC
04/01/11



SALMON HARBOR MARINA

A Department of Douglas County and Port of Umpqua

"SERVING OUR COMMUNITY WITH PRIDE"

March 28, 2011

Pacific Fishery Management Council
7700 NE Ambassador Place, Suite 101
Portland, OR 97220-1384

RE: Cape Falcon to Humbug Mountain
2011 Recreational management alternatives for non-Indian ocean salmon fisheries

Dear Chair Cedargreen and members of the Council:

Salmon Harbor Marina in Winchester Bay, Oregon is a public entity created through an intergovernmental agreement between the Douglas County Board of Commissioners and the Port of Umpqua Board of Commissioners.

We are appreciative of the three recreational alternatives for ocean salmon fisheries in the area from Cape Falcon to Humbug Mountain; although it is unfortunate that the coho quotas continue to be significantly lower than prior years.

This is to express our support for adoption of Alternative I which provides the longest Chinook season together with the longest season and highest quota for mark-selective coho. The longest possible seasons are important because of the downturn in the economy, increased bar restrictions and anticipated high fuel prices which combined create an undue hardship on our local businesses. Therefore, Alternative I provides the best opportunity for the fishermen and for our local businesses.

Thank you for consideration of our comments.

Sincerely,

Linda Noel

Linda Noel, Project Manager

OREGON CLEAN MARINA

C: Douglas County Board of Commissioners
Port of Umpqua Board of Commissioners
Salmon Harbor Management Committee
Jeff Vander Kley, Harbor Manager

P.O. Box 1007, Winchester Bay, Oregon 97467 - Office (541) 271-3407 • FAX (541) 271-2060

SALMON MANAGEMENT ALTERNATIVES HEARING SUMMARY

Date:	March 29, 2011	Hearing Officer:	Mr. David Crabbe
Location:	Red Lion Hotel Eureka, CA	Other Council Members:	
		NMFS:	Mr. Mark Helvey
Attendance:	41	Coast Guard:	CWO Curt Barthel
Testifying:	12	Salmon Technical Team:	Ms. Jennifer Simon
		Council Staff:	Mr. Chuck Tracy
Organizations Represented: Klamath Management Zone Fisheries Coalition; Humboldt Area Saltwater Anglers; Trinity River Guides Association; Salmon Trollers Marketing Association; Humboldt Fishermen Marketing Association			

Special Opening Remarks

Ms. Jennifer Simon provided a summary of the recreational and commercial Alternatives.

Synopsis of Testimony

Of the 12 people testifying:

Two commented primarily on the commercial troll fishery.
Eight commented primarily on the recreational fishery.
Two commented on both recreational and commercial fisheries

Commercial Troll Comments

- All supported Alternative I for the California KMZ
- One recommended opening June south of Point Sur and trading the Fort Bragg quota fisheries for time in June south of Point Arena or providing more open days in Fort Bragg to catch the quota.

Recreational Comments

- All those testifying supported Alternative I in the KMZ
- One recommended Alternative I for the recreational river fishery allocation in the Klamath Basin.

Other Comments

- Two recommended the Council maintain an annual management target of 35,000 natural adult spawners in the Klamath Basin as part of Amendment 16 to the Salmon Fishery Management Plan.

Written Statements (Attached)

- Humboldt Area Saltwater Anglers
- Dave Bitts
- Trinity River Guides Association

PFMC
04/01/11

Comments for PFMC public hearing, March 29, 2011

1. Let's open up June below Pt. Sur. There's no reason not to, and we believe it's simply an oversight that it's not in there.
2. The small quota fisheries in Ft. Bragg and the KMZ may not be the most effective way to use our California troll share of Klamath River fall Chinook. We'd like to be able to use some of those fish to open either some time in July in the Fort Bragg area, or some time in June below Pt. Arena.
3. If we decide to go with the quota fisheries, let's a) give them a big enough time window so weather doesn't keep the fish from being used, and b) make sure we get some GSI work done during the openings – we have very scant data on stock composition especially in the KMZ during June, July, and August.

Thanks for considering these changes to the March options.

Dave Bitts

HUMBOLDT AREA SALTWATER ANGLERS, INC.

March 29, 2011

PFMC Members
Public Comment –Salmon Options 2011
Eureka, CA

Dear Council Members and Staff,

I am here tonight as president of Humboldt Area Saltwater Anglers or HASA. HASA is a non-profit organization representing recreational anglers in Humboldt and Del Norte counties. I urge you to support Option 1 for the recreational salmon season with the California Klamath Management Zone (KMZ).

The 2011 abundance forecasts for both the Sacramento and Klamath Rivers are up significantly from recent previous years and will support the recreational harvest modeled for Option 1.

The recreational salmon season has a major positive economic benefit on the coastal communities within the KMZ. The benefit of having a May 7th season opening as opposed to an opening date on May 28th during the Memorial Day weekend is significant. The May 7th opener will provide the opportunity for local anglers to demonstrate that there are fish to catch with enough lead time for out of the area anglers to make arrangements to come to the coast contributing greatly to the local economy. Our coastal communities have experienced economic hardship with the reduction or closure of both recreational and commercial salmon fisheries within the KMZ and critical fishing infrastructure has been jeopardized.

The salmon stocks will support Option 1and Option 1 will provide the maximum economic benefit to the coastal communities within the KMZ. I urge you to adopt Option 1.

Thank you,

Jim Yarnall, President
Humboldt Area Saltwater Anglers

P.O. BOX 6191
EUREKA, CA. 95502

E-MAIL hasa6191@gmail.com

WEB SITE www.humboldttuna.com

PO BOX 327 Douglass City C96024

Trinityriverguidesassociation.com

Pacific Fisheries Management Council
Red Lion, Eureka Hearing

March 29, 2011

Mr. Dan Wolford, Hearing Official

The Trinity River Fishing Guides Association Inc. represents 100 licensed, registered and permitted recreational fishing guides that fish the 110+ river miles of the Trinity River. We collectively average 10,000 client days per year fishing the Trinity River. The recreational sport fishing value of the Trinity River and its anadromous fishing spans a ten month fishing opportunity. It is one of the longest recreational inland sports fishing seasons of any West Coast river systems. It also contributes approximately $4 million annually to the economies of Trinity and Humboldt Counties.

The TRGA supports ~~Option II or~~ Option III of the PFMC Pre Season Report I dated March 8, 2011, for Recreational In-River Sport Fishing of the Klamath River Basin Fall Chinook salmon.

The TRGA also supports Option I of the PFMC Pre Season I report dated March 8, 2011, of the California KMZ for Recreational Ocean Sport Fishing, May 7 through September 5, 2011, Fall Chinook salmon.

Thank you for your consideration of our request.
Respectful y submitted,

Liam Gogan, President

Board of Directors:

Bill Dickens	Travis Michel	Michael Caranci	Steve Townzen
E. B. Duggan	Paul Catanese	Bob Norman	Scott Stratton

Agenda Item G.2.f
Supplemental SAS Report
April 2011

SALMON ADVISORY SUBPANEL

PROPOSED 2011
OCEAN SALMON MANAGEMENT MEASURES
FOR TENTATIVE ADOPTION

Sunday
April 10, 2011

TABLE 1. Commercial troll management measures proposed by the SAS for non-Indian ocean salmon fisheries, 2011.Apr-11 08:09
(Page 1 of 5)

A. SEASON DESCRIPTIONS

North of Cape Falcon

Supplemental Management Information

1. Overall non-Indian TAC: 67,800 (non-mark-selective equivalent of 65,000) Chinook and 80,000 coho marked with a healed adipose fin clip (marked).
2. Non-Indian commercial troll TAC: 32,500 Chinook and 12,800 marked coho.
3. No preseason trade of Chinook or coho between non-Indian commercial and recreational fisheries.

U.S./Canada Border to Cape Falcon

- May 1 through earlier of June 30 or 22,000 Chinook quota.

Seven days per week (C.1). All salmon except coho (C.7). Cape Flattery, Mandatory Yelloweye Rockfish Conservation Area, and Columbia Control Zones closed (C.5). See gear restrictions and definitions (C.2, C.3).
An inseason conference call will occur when it is projected that 14,500 Chinook have been landed to consider modifying the open period to five days per week and adding landing and possession limits to ensure the guideline is not exceeded.

U.S./Canada Border to Cape Falcon

- July 1 through earlier of September 15 or 10,500 preseason Chinook guideline (C.8) or a 12,800 marked coho quota (C.8.d).

Friday through Tuesday; landing and possession limit of 50 Chinook and 50 coho per vessel per open period north of Leadbetter Point or 50 Chinook and 50 coho south of Leadbetter Point (C.1). All Salmon except no chum retention north of Cape Alava, Washington in August and September (C.7). All coho must be marked (C.8.d). See gear restrictions and definitions (C.2, C.3). Cape Flattery, Mandatory Yelloweye Rockfish Conservation Area, and Columbia Control Zones closed (C.5).

Vessels must land and deliver their fish within 24 hours of any closure of this fishery. Under state law, vessels must report their catch on a state fish receiving ticket. Vessels fishing or in possession of salmon while fishing north of Leadbetter Point must land and deliver their fish within the area and north of Leadbetter Point. Vessels fishing or in possession of salmon while fishing south of Leadbetter Point must land and deliver their fish within the area and south of Leadbetter Point, except that Oregon permitted vessels may also land their fish in Garibaldi, Oregon. Oregon State regulations require all fishers landing salmon into Oregon from any fishery between Leadbetter Point, Washington and Cape Falcon, Oregon must notify ODFW within one hour of delivery or prior to transport away from the port of landing by either calling 541-867-0300 Ext. 271 or sending notification via e-mail to nfalcon.trollreport@state.or.us. Notification shall include vessel name and number, number of salmon by species, port of landing and location of delivery, and estimated time of delivery. Inseason actions may modify harvest guidelines in later fisheries to achieve or prevent exceeding the overall allowable troll harvest impacts (C.8).

TABLE 1. Commercial troll management measures proposed by the SAS for non-Indian ocean salmon fisheries, 2011. Apr-11 08:09 (Page 2 of 5)

A. SEASON DESCRIPTIONS

South of Cape Falcon

Supplemental Management Information

1. Sacramento River Basin recreational fishery catch assumption: _____ adult Sacramento River fall Chinook.
2. Sacramento River fall Chinook spawning escapement of _____ adults.
3. Klamath River recreational fishery allocation: _____ adult Klamath River fall Chinook.
4. Klamath tribal allocation: _____ adult Klamath River fall Chinook.

Cape Falcon to Humbug Mt.

- April 15 through July 9, July 17 through August 31, October 1-31. (C.9).

Seven days per week. All salmon except coho; landing and possession limit of 50 Chinook per vessel per calendar week in October (C.7). All vessels fishing in the area must land their fish in the State of Oregon. See gear restrictions and definitions (C.2, C.3) and Oregon State regulations for a description of special regulations at the mouth of Tillamook Bay.

In 2012, the season will open March 15 for all salmon except coho. This opening could be modified following Council review at its March 2012 meeting.

Humbug Mt. to OR/CA Border (Oregon KMZ)

- May 1-31;
- June 1 through earlier of June 30, or a 1,500 Chinook quota;
- July 1 through earlier of July 31, or a 1,200 Chinook quota;
- Aug. 1 through earlier of Aug. 31, or a 1,000 Chinook quota (C.9).

Seven days per week. All salmon except coho (C.7). Chinook 28 inch total length minimum size limit (B). June 1 through August 31, landing and possession limit of 30 Chinook per vessel per day. Any remaining portion of the June and/or July Chinook quotas may be transferred inseason on an impact neutral basis to the next open quota period (C.8). All vessels fishing in this area must land and deliver all fish within this area or Port Orford, within 24 hours of any closure in this fishery, and prior to fishing outside of this area (C.1, C.6). Oregon State regulations require all fishers landing salmon from any quota managed season within this area to notify Oregon Dept. of Fish and Wildlife (ODFW) within 1 hour of delivery or prior to transport away from the port of landing by either calling (541) 867-0300 ext. 252 or sending notification via e-mail to KMZOR.trollreport@state.or.us. Notification shall include vessel name and number, number of salmon by species, port of landing and location of delivery, and estimated time of delivery. See gear restrictions and definitions (C.2, C.3).

In 2012, the season will open March 15 for all salmon except coho, with a 28 inch Chinook minimum size limit. This opening could be modified following Council review at its March 2012 meeting.

OR/CA Border to Humboldt South Jetty (California KMZ)

- July 2 through the earlier of July 20 or a 1,400 Chinook quota, Saturday to Wednesday;
- Aug. 1 through earlier of Aug. 15 or a 1,000 Chinook quota, seven days per week;
- Sept. 15 through earlier of Sept 30, or a 2,000 Chinook quota, seven days per week (C.9).

All salmon except coho (C.7). Chinook 27 inch total length minimum size limit (B). Landing and possession limit of 15 Chinook per vessel. Any remaining portion of the July Chinook quota may be transferred inseason on an impact neutral basis to the August quota (C.8) All vessels fishing in this area must land and deliver all fish within this area, within 24 hours of any closure in this fishery, and prior to fishing outside of this area (C.1, C.6). See compliance requirements (C.1) and gear restrictions and definitions (C.2, C.3). Klamath Control Zone closed (C.5.e). See California State regulations for additional closures adjacent to the Smith and Klamath rivers. When the fishery is closed between the OR/CA border and Humbug Mt. and open to the south, vessels with fish on board caught in the open area off California may seek temporary mooring in Brookings, Oregon prior to landing in California only if such vessels first notify the Chetco River Coast Guard Station via VHF channel 22A between the hours of 0500 and 2200 and provide the vessel name, number of fish on board, and estimated time of arrival.

Humboldt South Jetty to Horse Mt.

Closed.

California State regulations require all salmon be made available to a CDFG representative for sampling immediately at port of landing. Any person in possession of a salmon with a missing adipose fin, upon request by an authorized agent or employee of the CDFG, shall immediately relinquish the head of the salmon to the state. (California Fish and Game Code §8226)

TABLE 1. Commercial troll management measures proposed by the SAS for non-Indian ocean salmon fisheries, 2011. Apr-11 08:09 (Page 3 of 5)

A. SEASON DESCRIPTIONS

South of Cape Falcon

Horse Mt. to Point Arena (Fort Bragg)

- July 23-27
- July 30 through Aug. 29;
- Sept. 1-30 (C.9).

Seven days per week. All salmon except coho (C.7). Chinook 27 inch total length minimum size limit (B). All vessels fishing in this area during quota fisheries must land and deliver all fish within this area, within 24 hours of any closure in this fishery, and prior to fishing outside of this area. All fish caught in the area when the KMZ quota fisheries are open must be landed south of Horse Mt.; all fish must be landed in California and offloaded within 24 hours of the August 29 closure (C.1, C.6). See gear restrictions and definitions (C.2, C.3).

Pt. Arena to Pigeon Pt.

- May 1-31
- June 25 through July 6
- July 9-27
- July 30 through Aug. 29
- September 1-30 (C.9).

Seven days per week through July 6; Saturday through Wednesday July 9-27; Seven days per week thereafter. All salmon except coho (C.7). Chinook minimum size limit of 27 inches total length (B). All fish must be landed in California and offloaded within 24 hours of the August 29 closure. All fish caught in the area when the KMZ quota fisheries are open must be landed south of Horse Mt. (C.1, C.6). See gear restrictions and definitions (C.2, C.3).

Pt. Reyes to Pt. San Pedro (Fall Area Target Zone)

- October 3-14.

Monday through Friday. All salmon except coho (C.1). Chinook minimum size limit 27 inches total length (B). All vessels fishing in this area must land and deliver all fish between Point Arena and Pigeon Point (C.1, C.6). See gear restrictions and definitions (C.2, C.3).

Pigeon Pt. to Pt. Sur (Monterey)

Same as Pt. Arena to Pigeon Pt.

Pt. Sur to U.S./Mexico Border (Monterey south)

- May 1 through September 30 (C.9).

Seven days per week. All salmon except coho (C.7). Chinook minimum size limit of 27 inches total length (B). All fish must be landed in California. All fish caught in the area when the KMZ quota fisheries are open must be landed south of Horse Mt. (C.1, C.6). See gear restrictions and definitions (C.2, C.3).

California State regulations require all salmon be made available to a CDFG representative for sampling immediately at port of landing. Any person in possession of a salmon with a missing adipose fin, upon request by an authorized agent or employee of the CDFG, shall immediately relinquish the head of the salmon to the state. (California Fish and Game Code §8226)

B. MINIMUM SIZE (Inches) (See C.1)

	Chinook		Coho		
Area (when open)	Total Length	Head-off	Total Length	Head-off	Pink
North of Cape Falcon	28.0	21.5	16.0	12.0	None
Cape Falcon to OR/CA Border	28.0	21.5	-	-	None
OR/CA Border to U.S./Mexico Border	27.0	20.5	-	-	None

C. REQUIREMENTS, DEFINITIONS, RESTRICTIONS, OR EXCEPTIONS

C.1. Compliance with Minimum Size or Other Special Restrictions: All salmon on board a vessel must meet the minimum size, landing/possession limit, or other special requirements for the area being fished and the area in which they are landed if the area is open. Salmon may be landed in an area that has been closed more than 96 hours only if they meet the minimum size, landing/possession limit, or other special requirements for the area in which they were caught. Salmon may be landed in an area that has been closed less than 96 hours only if they meet the minimum size, landing/possession limit, or other special requirements for the areas in which they were caught and landed.

States may require fish landing/receiving tickets be kept on board the vessel for 90 days after landing to account for all previous salmon landings.

C. REQUIREMENTS, DEFINITIONS, RESTRICTIONS, OR EXCEPTIONS (continued)

C.2. Gear Restrictions:
- a. Salmon may be taken only by hook and line using single point, single shank, barbless hooks.
- b. Cape Falcon, Oregon, to the OR/CA border: No more than 4 spreads are allowed per line.
- c. OR/CA border to U.S./Mexico border: No more than 6 lines are allowed per vessel, and barbless circle hooks are required when fishing with bait by any means other than trolling.C.3. Gear Definitions:

Trolling defined: Fishing from a boat or floating device that is making way by means of a source of power, other than drifting by means of the prevailing water current or weather conditions.

Troll fishing gear defined: One or more lines that drag hooks behind a moving fishing vessel. In that portion of the fishery management area (FMA) off Oregon and Washington, the line or lines must be affixed to the vessel and must not be intentionally disengaged from the vessel at any time during the fishing operation.

Spread defined: A single leader connected to an individual lure and/or bait.

Circle hook defined: A hook with a generally circular shape and a point which turns inward, pointing directly to the shank at a 90º angle.

C.4. Transit Through Closed Areas with Salmon on Board: It is unlawful for a vessel to have troll or recreational gear in the water while transiting any area closed to fishing for a certain species of salmon, while possessing that species of salmon; however, fishing for species other than salmon is not prohibited if the area is open for such species, and no salmon are in possession.

C.5. Control Zone Definitions:
- a. *Cape Flattery Control Zone* - The area from Cape Flattery (48º23'00" N. lat.) to the northern boundary of the U.S. EEZ; and the area from Cape Flattery south to Cape Alava (48º10'00" N. lat.) and east of 125º05'00" W. long.
- b. *Mandatory Yelloweye Rockfish Conservation Area* – The area in Washington Marine Catch Area 3 from 48°00.00' N. lat.; 125°14.00' W. long. to 48°02.00' N. lat.; 125°14.00' W. long. to 48°02.00' N. lat.; 125°16.50' W. long. to 48°00.00' N. lat.; 125°16.50' W. long. and connecting back to 48°00.00' N. lat.; 125°14.00' W. long.
- c. *Columbia Control Zone* - An area at the Columbia River mouth, bounded on the west by a line running northeast/southwest between the red lighted Buoy #4 (46°13'35" N. lat., 124°06'50" W. long.) and the green lighted Buoy #7 (46°15'09' N. lat., 124°06'16" W. long.); on the east, by the Buoy #10 line which bears north/south at 357° true from the south jetty at 46°14'00" N. lat.,124°03'07" W. long. to its intersection with the north jetty; on the north, by a line running northeast/southwest between the green lighted Buoy #7 to the tip of the north jetty (46°15'48" N. lat., 124°05'20" W. long.), and then along the north jetty to the point of intersection with the Buoy #10 line; and, on the south, by a line running northeast/southwest between the red lighted Buoy #4 and tip of the south jetty (46°14'03" N. lat., 124°04'05" W. long.), and then along the south jetty to the point of intersection with the Buoy #10 line.
- d. *Klamath Control Zone* - The ocean area at the Klamath River mouth bounded on the north by 41°38'48" N. lat. (approximately six nautical miles north of the Klamath River mouth); on the west, by 124°23'00" W. long. (approximately 12 nautical miles off shore); and on the south, by 41°26'48" N. lat. (approximately six nautical miles south of the Klamath River mouth).

C.6. Notification When Unsafe Conditions Prevent Compliance with Regulations: If prevented by unsafe weather conditions or mechanical problems from meeting special management area landing restrictions, vessels must notify the U.S. Coast Guard and receive acknowledgment of such notification prior to leaving the area. This notification shall include the name of the vessel, port where delivery will be made, approximate amount of salmon (by species) on board, the estimated time of arrival, and the specific reason the vessel is not able to meet special management area landing restrictions.

In addition to contacting the U.S. Coast Guard, vessels fishing south of the Oregon/California border must notify CDFG within one hour of leaving the management area by calling 800-889-8346 and providing the same information as reported to the U.S. Coast Guard. All salmon must be offloaded within 24 hours of reaching port.

C.7. Incidental Halibut Harvest: During authorized periods, the operator of a vessel that has been issued an incidental halibut harvest license may retain Pacific halibut caught incidentally in Area 2A while trolling for salmon. Halibut retained must be no less than 32 inches in total length, measured from the tip of the lower jaw with the mouth closed to the extreme end of the middle of the tail, and must be landed with the head on. License applications for incidental harvest must be obtained from the International Pacific Halibut Commission (phone: 206-634-1838). Applicants must apply prior to April 1 of each year. Incidental harvest is authorized only during May and June troll seasons and after June 30 if quota remains and if announced on the NMFS hotline (phone: 800-662-9825). ODFW and Washington Department of Fish and Wildlife (WDFW) will monitor landings. If the landings are projected to exceed the 25,035 pound preseason allocation or the total Area 2A non-Indian commercial halibut allocation, NMFS will take inseason action to prohibit retention of halibut in the non-Indian salmon troll fishery.

Beginning May 1, license holders may land no more than one Pacific halibut per each 3 Chinook, except one Pacific halibut may be landed without meeting the ratio requirement, and no more than 35 halibut may be landed per trip. Pacific halibut retained must be no less than 32 inches in total length (with head on).

C. REQUIREMENTS, DEFINITIONS, RESTRICTIONS, OR EXCEPTIONS (continued)

A "C-shaped" yelloweye rockfish conservation area is an area to be voluntarily avoided for salmon trolling. NMFS and the Council request salmon trollers voluntarily avoid this area in order to protect yelloweye rockfish. The area is defined in the Pacific Council Halibut Catch Sharing Plan in the North Coast subarea (Washington marine area 3), with the following coordinates in the order listed:

48°18' N. lat.; 125°18' W. long.;
48°18' N. lat.; 124°59' W. long.;
48°11' N. lat.; 124°59' W. long.;
48°11' N. lat.; 125°11' W. long.;
48°04' N. lat.; 125°11' W. long.;
48°04' N. lat.; 124°59' W. long.;
48°00' N. lat.; 124°59' W. long.;
48°00' N. lat.; 125°18' W. long.;
and connecting back to 48°18' N. lat.; 125°18' W. long.

C.8. Inseason Management: In addition to standard inseason actions or modifications already noted under the season description, the following inseason guidance is provided to NMFS:

a. Chinook remaining from the May through June non-Indian commercial troll harvest guideline north of Cape Falcon may be transferred to the July through September harvest guideline on a fishery impact equivalent basis.
b. Chinook remaining from the June and/or July non-Indian commercial troll quotas in the Oregon KMZ may be transferred to the Chinook quota for the next open period on a fishery impact equivalent basis.
c. Chinook remaining from the July non-Indian commercial troll quota in the California KMZ area may be transferred to the August quota on a fishery impact equivalent basis.
d. NMFS may transfer fish between the recreational and commercial fisheries north of Cape Falcon on a fishery impact equivalent basis if there is agreement among the areas' representatives on the Salmon Advisory Subpanel (SAS).
e. At the March 2012 meeting, the Council will consider inseason recommendations for special regulations for any experimental fisheries (proposals must meet Council protocol and be received in November 2011).
f. If retention of unmarked coho is permitted by inseason action, the allowable coho quota will be adjusted to ensure preseason projected mortality of critical stocks is not exceeded.
g. Landing limits may be modified inseason to sustain season length and keep harvest within overall quotas.

C.9. State Waters Fisheries: Consistent with Council management objectives:

a. The State of Oregon may establish additional late-season fisheries in state waters.
b. The State of California may establish limited fisheries in selected state waters.

Check state regulations for details.

C.10. For the purposes of California Department of Fish and Game (CDFG) Code, Section 8232.5, the definition of the Klamath Management Zone (KMZ) for the ocean salmon season shall be that area from Humbug Mt., Oregon, to Horse Mt., California.

TABLE 2. Recreational management measures proposed by the SAS for non-Indian ocean salmon fisheries, 2011. (Page 1 of 4)
4/10/11 08:09

A. SEASON DESCRIPTIONS

North of Cape Falcon

Supplemental Management Information

1. Overall non-Indian TAC: 67,800 (non-mark-selective equivalent of 65,000) Chinook and 80,000 coho marked with a healed adipose fin clip (marked).
2. Recreational TAC: 35,300 (non-mark selective equivalent of 32,500) Chinook and 67,200 marked coho; all retained coho must be marked.
3. No preseason trade of Chinook or coho between non-Indian commercial and recreational fisheries.
4. No Area 4B add-on fishery.
5. Buoy 10 fishery opens Aug. 1 with an expected landed catch of _____ marked coho in August and September.

U.S./Canada Border to Cape Falcon

- June 18 through earlier of June 25 or a coastwide **marked Chinook quota of 4,800** (C.5).

Seven days per week. Two fish per day, all salmon except coho, **all Chinook must be marked with a healed adipose fin clip (C.1)**. Chinook 24-inch total length minimum size limit (B). See gear restrictions (C.2). Inseason management may be used to sustain season length and keep harvest within the overall Chinook recreational TAC for north of Cape Falcon (C.5).

U.S./Canada Border to Cape Alava (Neah Bay)

- June 26 through earlier of September 18 or 6,990 marked coho subarea quota with a subarea guideline of 3,300 Chinook. (C.5).

Seven days per week. All salmon except no chum beginning August 1; two fish per day, no more than one of which can be a Chinook, plus one additional pink salmon. All coho must be marked (C.1). See gear restrictions (C.2). Beginning August 1, Chinook non-retention east of the Bonilla-Tatoosh line (C.4.a) during Council managed ocean fishery. Inseason management may be used to sustain season length and keep harvest within the overall Chinook and coho recreational TACs for north of Cape Falcon (C.5).

Cape Alava to Queets River (La Push Subarea)

- June 26 through earlier of September 18 or 1,700 marked coho subarea quota with a subarea guideline of 1,450 Chinook. (C.5).
- September 24 through earlier of October 9 or 50 marked coho quota or 50 Chinook quota (C.5) in the area north of 47°50'00 N. lat. and south of 48°00'00" N. lat.

Seven days per week. All salmon; two fish per day, no more than one of which can be a Chinook, plus one additional pink salmon. All coho must be marked (C.1). See gear restrictions (C.2). Inseason management may be used to sustain season length and keep harvest within the overall Chinook and coho recreational TACs for north of Cape Falcon (C.5).

Queets River to Leadbetter Point (Westport Subarea)

- June 26 through earlier of September 18 or 24,860 marked coho subarea quota with a subarea guideline of 17,800 Chinook (C.5).

Sunday through Thursday. All salmon; two fish per day, no more than one of which can be a Chinook. All coho must be marked (C.1). See gear restrictions and definitions (C.2, C.3). Grays Harbor Control Zone closed beginning August 1 (C.4). Inseason management may be used to sustain season length and keep harvest within the overall Chinook and coho recreational TACs for north of Cape Falcon (C.5).

Leadbetter Point to Cape Falcon (Columbia River Subarea)

- June 26 through earlier of September 30 or 33,600 marked coho subarea quota with a subarea guideline of 7,900 Chinook (C.5).

Seven days per week. All salmon; two fish per day, no more than one of which can be a Chinook. All coho must be marked (C.1). See gear restrictions and definitions (C.2, C.3). Columbia Control Zone closed (C.4.c). Inseason management may be used to sustain season length and keep harvest within the overall Chinook and coho recreational TACs for north of Cape Falcon (C.5).

TABLE 2. Recreational management measures proposed by the SAS for non-Indian ocean salmon fisheries, 2011. (Page 2 of 4)
4/10/11 08:09

A. SEASON DESCRIPTIONS

South of Cape Falcon

Supplemental Management Information

1. Sacramento River Basin recreational fishery catch assumption: _____ adult Sacramento River fall Chinook.
2. Sacramento River fall Chinook spawning escapement of _____ adults.
3. Klamath River recreational fishery allocation: _____ adult Klamath River fall Chinook.
4. Klamath tribal allocation: _____ adult Klamath River fall Chinook.
5. Overall recreational TAC: 15,000 marked coho and 3,000 unmarked coho.

Cape Falcon to Humbug Mt.

- Except as provided below during the all-salmon mark-selective **and non-mark-selective coho fisheries**, the season will be March 15 through October 31 (C.6).

All salmon except coho; two fish per day (C.1). See gear restrictions and definitions (C.2, C.3).

- Cape Falcon to Humbug Mt. all-salmon mark-selective coho fishery: July 2 through earlier of August 13 or a landed catch of 15,000 marked coho.

Seven days per week. All salmon, two fish per day. All retained coho must be marked (C.1). Any remainder of the mark selective coho quota will be transferred on an impact neutral basis to the September non-selective coho quota listed below. The all salmon except coho season reopens the earlier of August 14 or attainment of the coho quota, through August 31.

- Cape Falcon to Humbug Mt. **non-mark-selective coho fishery**: September 1 through the earlier of September 10 or a landed catch of 3,000 **non-mark-selective coho quota (C.5)**.

Thursday through Saturday all salmon, two fish per day; Sunday through Wednesday, all salmon except coho, two fish per day. The all salmon except coho season reopens the earlier of September 11 or attainment of the coho quota (C.5). Open days may be adjusted inseason to utilize the available coho quota (C.5).

Fishing in the Stonewall Bank yelloweye rockfish conservation area restricted to trolling only on days the all depth recreational halibut fishery is open (call the halibut fishing hotline 1-800-662-9825 for specific dates) (C.3.b, C.4.d).

In 2012, the season between Cape Falcon and Humbug Mt. will open March 15 for all salmon except coho, two fish per day (B, C.1, C.2, C.3).

Humbug Mt. to OR/CA Border. (Oregon KMZ)

- May 7 through September 5 (C.6).

Seven days per week. All salmon except coho, two fish per day (C.1). Chinook minimum size limit of 24 inches total length (B). See gear restrictions and definitions (C.2, C.3).

OR/CA Border to Horse Mt. (California KMZ)

- May 7 through September 5 (C.6).

Seven days per week. All salmon except coho, two fish per day (C.1). Chinook minimum size limit of 24 inches total length (B). See gear restrictions and definitions (C.2, C.3). Klamath Control Zone closed in August (C.4.e). See California State regulations for additional closures adjacent to the Smith, Eel, and Klamath rivers.

Horse Mt. to Point Arena (Fort Bragg)

- April 2 through November 13.

Seven days per week. All salmon except coho, two fish per day (C.1). Chinook minimum size limit of 24 inches total length (B). See gear restrictions and definitions (C.2, C.3).

In 2012, season opens February 18 for all salmon except coho, two fish per day (C.1). Chinook minimum size limit of 24 inches total length (B); and the same gear restrictions as in 2011 (C.2, C.3).

Point Arena to Pigeon Pt. (San Francisco)

- April 2 through November 13.

Seven days per week. All salmon except coho, two fish per day (C.1). Chinook minimum size limit of 24 inches total length (B). See gear restrictions and definitions (C.2, C.3).

In 2012, season opens April 7 for all salmon except coho, two fish per day (C.1). Chinook minimum size limit of 24 inches total length (B); and the same gear restrictions as in 2011 (C.2, C.3).

TABLE 2. Recreational management measures proposed by the SAS for non-Indian ocean salmon fisheries, 2011. (Page 3 of 4)
4/10/11 08:09

A. SEASON DESCRIPTIONS

South of Cape Falcon

Pigeon Point to U.S./Mexico Border (Monterey South)

- April 2 through October 2.

Seven days per week. All salmon except coho, two fish per day (C.1). Chinook minimum size limit of 24 inches total length (B). See gear restrictions and definitions (C.2, C.3).

In 2012, season opens April 7 for all salmon except coho, two fish per day (C.1). Chinook minimum size limit of 24 inches total length (B); and the same gear restrictions as in 2011 (C.2, C.3).

California State regulations require all salmon be made available to a CDFG representative for sampling immediately at port of landing. Any person in possession of a salmon with a missing adipose fin, upon request by an authorized agent or employee of the CDFG, shall immediately relinquish the head of the salmon to the state. (California Fish and Game Code §8226)

B. MINIMUM SIZE (Inches) (See C.1)

Area (when open)	Chinook	Coho	Pink
North of Cape Falcon	24.0	16.0	None
Cape Falcon to OR/CA Border	24.0	16.0	None
OR/CA Border to U.S./Mexico Border	24.0	-	24.0

C. REQUIREMENTS, DEFINITIONS, RESTRICTIONS, OR EXCEPTIONS

C.1. Compliance with Minimum Size and Other Special Restrictions: All salmon on board a vessel must meet the minimum size or other special requirements for the area being fished and the area in which they are landed if that area is open. Salmon may be landed in an area that is closed only if they meet the minimum size or other special requirements for the area in which they were caught.

Ocean Boat Limits: Off the coast of Washington, Oregon, and California, each fisher aboard a vessel may continue to use angling gear until the combined daily limits of salmon for all licensed and juvenile anglers aboard has been attained (additional state restrictions may apply).

C.2. Gear Restrictions: Salmon may be taken only by hook and line using barbless hooks. All persons fishing for salmon, and all persons fishing from a boat with salmon on board, must meet the gear restrictions listed below for specific areas or seasons.

a. *U.S./Canada Border to Point Conception, California*: No more than one rod may be used per angler; and no more than two single point, single shank barbless hooks are required for all fishing gear. [Note: ODFW regulations in the state-water fishery off Tillamook Bay may allow the use of barbed hooks to be consistent with inside regulations.]

b. *Horse Mt., California, to Point Conception, California*: Single point, single shank, barbless circle hooks (see gear definitions below) are required when fishing with bait by any means other than trolling, and no more than two such hooks shall be used. When angling with two hooks, the distance between the hooks must not exceed five inches when measured from the top of the eye of the top hook to the inner base of the curve of the lower hook, and both hooks must be permanently tied in place (hard tied). Circle hooks are not required when artificial lures are used without bait.

C.3. Gear Definitions:

a. *Recreational fishing gear defined*: Angling tackle consisting of a line with no more than one artificial lure and/or natural bait attached. Off Oregon and Washington, the line must be attached to a rod and reel held by hand or closely attended; the rod and reel must be held by hand while playing a hooked fish. No person may use more than one rod and line while fishing off Oregon or Washington. Off California, the line must be attached to a rod and reel held by hand or closely attended; weights directly attached to a line may not exceed four pounds (1.8 kg). While fishing off California north of Point Conception, no person fishing for salmon, and no person fishing from a boat with salmon on board, may use more than one rod and line. Fishing includes any activity which can reasonably be expected to result in the catching, taking, or harvesting of fish.

b. *Trolling defined*: Angling from a boat or floating device that is making way by means of a source of power, other than drifting by means of the prevailing water current or weather conditions.

c. *Circle hook defined*: A hook with a generally circular shape and a point which turns inward, pointing directly to the shank at a 90° angle.

TABLE 2. Recreational management measures proposed by the SAS for non-Indian ocean salmon fisheries, 2011. (Page 3 of 4)
4/10/11 08:09

C. REQUIREMENTS, DEFINITIONS, RESTRICTIONS, OR EXCEPTIONS

C.4. Control Zone Definitions:

a. *The Bonilla-Tatoosh Line*: A line running from the western end of Cape Flattery to Tatoosh Island Lighthouse (48°23'30" N. lat., 124°44'12" W. long.) to the buoy adjacent to Duntze Rock (48°28'00" N. lat., 124°45'00" W. long.), then in a straight line to Bonilla Point (48°35'30" N. lat., 124°43'00" W. long.) on Vancouver Island, British Columbia.

b. *Grays Harbor Control Zone* - The area defined by a line drawn from the Westport Lighthouse (46° 53'18" N. lat., 124° 07'01" W. long.) to Buoy #2 (46° 52'42" N. lat., 124°12'42" W. long.) to Buoy #3 (46° 55'00" N. lat., 124°14'48" W. long.) to the Grays Harbor north jetty (46° 36'00" N. lat., 124°10'51" W. long.).

c. *Columbia Control Zone*: An area at the Columbia River mouth, bounded on the west by a line running northeast/southwest between the red lighted Buoy #4 (46°13'35" N. lat., 124°06'50" W. long.) and the green lighted Buoy #7 (46°15'09' N. lat., 124°06'16" W. long.); on the east, by the Buoy #10 line which bears north/south at 357° true from the south jetty at 46°14'00" N. lat., 124°03'07" W. long. to its intersection with the north jetty; on the north, by a line running northeast/southwest between the green lighted Buoy #7 to the tip of the north jetty (46°15'48" N. lat., 124°05'20" W. long. and then along the north jetty to the point of intersection with the Buoy #10 line; and on the south, by a line running northeast/southwest between the red lighted Buoy #4 and tip of the south jetty (46°14'03" N. lat., 124°04'05" W. long.), and then along the south jetty to the point of intersection with the Buoy #10 line.

d. *Stonewall Bank Yelloweye Rockfish Conservation Area*: The area defined by the following coordinates in the order listed:
   44°37.46' N. lat.; 124°24.92' W. long.;
   44°37.46' N. lat.; 124°23.63' W. long.;
   44°28.71' N. lat.; 124°21.80' W. long.;
   44°28.71' N. lat.; 124°24.10' W. long.;
   44°31.42' N. lat.; 124°25.47' W. long.;
   and connecting back to 44°37.46' N. lat.; 124°24.92' W. long.

e. *Klamath Control Zone*: The ocean area at the Klamath River mouth bounded on the north by 41°38'48" N. lat. (approximately six nautical miles north of the Klamath River mouth); on the west, by 124°23'00" W. long. (approximately 12 nautical miles off shore); and, on the south, by 41°26'48" N. lat. (approximately 6 nautical miles south of the Klamath River mouth).

C.5. Inseason Management: Regulatory modifications may become necessary inseason to meet preseason management objectives such as quotas, harvest guidelines, and season duration. In addition to standard inseason actions or modifications already noted under the season description, the following inseason guidance is provided to NMFS:

a. Actions could include modifications to bag limits, or days open to fishing, and extensions or reductions in areas open to fishing.

b. Coho may be transferred inseason among recreational subareas north of Cape Falcon on a fishery impact equivalent basis to help meet the recreational season duration objectives (for each subarea) after conferring with representatives of the affected ports and the Council's SAS recreational representatives north of Cape Falcon.

c. Chinook and coho may be transferred between the recreational and commercial fisheries north of Cape Falcon on a fishery impact equivalent basis if there is agreement among the representatives of the Salmon Advisory Subpanel (SAS).

d. If retention of unmarked coho is permitted in the area from the U.S./Canada border to Cape Falcon, Oregon, by inseason action, the allowable coho quota will be adjusted to ensure preseason projected mortality of critical stocks is not exceeded.

e. Marked coho remaining from the June/July through August Cape Falcon to OR/CA border recreational coho quota may be transferred inseason to the September Cape Falcon to Humbug Mt. non-mark-selective recreational fishery on a fishery impact equivalent basis.

C.6. Additional Seasons in State Territorial Waters: Consistent with Council management objectives, the States of Washington, Oregon, and California may establish limited seasons in state waters. Check state regulations for details.

TESTIMONY OF THE COLUMBIA RIVER TREATY TRIBES
BEFORE THE PACIFIC FISHERIES MANAGEMENT COUNCIL
San Mateo, CA

April 10, 2011

Good day, Mr. Chairman and members of the Council. My name is Chris Williams. I am a member of the Fish and Wildlife Committee of the Umatilla Tribe. I am here with Wilbur Slockish Jr., Herb Jackson, and Bruce Jim to provide testimony on behalf of the four Columbia River treaty tribes: the Yakama, Warm Springs, Umatilla and Nez Perce tribes.

We are here to provide testimony related to the 2011 ocean salmon fisheries. The tribes are concerned with both restoring and recovering weak runs of fish and ensuring that tribal harvest is both enough to meet tribal needs and is fairly shared with non-tribal harvest.

The tribes only support ad-clipping and tagging of fish at levels needed to appropriately monitor and evaluate fisheries, not to simply allow more fishing. This was the original purpose of these programs. The tribes view mark selective fisheries as a significant risk to maintaining the system of fairly sharing harvest. We see continued pressure to implement mark selective fisheries in the fall season in-river fisheries in future years. But as of right now we do not have agreed-to models or assumptions about release mortality rates for these fisheries. We think there needs to be more analysis about the impacts of ocean mark selective fisheries on potential mark selective fisheries in the river especially relative to multiple encounters and hooking mortality. There also needs to be a full assessment of impacts of past coho mark selective fisheries on wild coho populations so that we may understand the longer term effects of mark selective fisheries on wild fish.

While some groups continue to argue that there is a conservation benefit from mark selective fisheries through reducing the number of hatchery fish that spawn naturally, the evidence does not support this. There has been no demonstration of any conservation benefit from past mark selective fisheries. First, mark selective fisheries in ocean and mainstem mixed stock areas have not been shown to significantly alter the proportions of hatchery fish spawning in natural areas. A broad look at the available scientific literature indicates that it is still very much an open question about the potential risk that hatchery fish spawning naturally pose to wild fish. In many cases, with modern hatchery practices, hatchery fish pose little to no risk to natural populations. Mark selective fisheries have simply been used as a harvest tool that allows certain fisheries to benefit at the expense of others.

The tribes are also concerned about increased pressure to ad-clip more fish. Currently the vast majority of salmon are already ad-clipped. Washington has proposed marking the rest of the fall chinook production at Priest Rapids Hatchery. Until the tribes are certain that this will not adversely affect tribal fisheries and the fair sharing of treaty and non-treaty harvest, the tribes will not agree to this. The tribes continue to engage in discussions with WDFW regarding this issue.

This concludes our statement, Thank you.

09 March 2011

To: Washington Troll Salmon Managers

From: Geoff Lebon

Subject: Economic Value of Summer Troll Fishery

There has been a strong push lately to put more and more of the troll catch into the spring fishery for non-biological reasons. While the personal reasons for doing this are clear, the economic and marketing reasons make no sense. Since I am about to leave the country for the next 3 weeks, I felt I needed to weigh in on the issue of moving more fish from the summer fishery into the spring fishery at this time.

In the table below, I have outlined the average weight for the total catch and price paid for the 11 to 18 pound size of king salmon for several weeks throughout the 2010 troll season. I only used the price for the 11 to 18 pound class but generally speaking, the price for the 7 to 11 pound class is $.50 lower per pound.

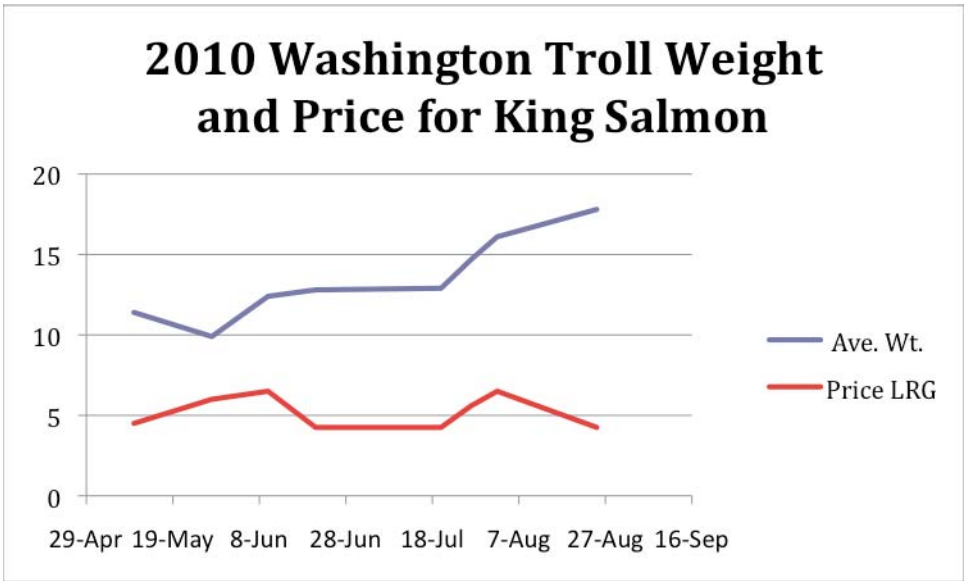
During the season, the price rises and falls as the market dictates. Generally speaking, it starts at a fair level and falls after Copper River kings hit the market. Then it will rise till about the 1st of July when the Alaska troll opens or late June if the Skeena or other SE Alaskan rivers have a decent net harvest of early kings. After the Alaska king troll fishery closes, the price generally rises again until another terminal harvest kicks in.

Date	Fish Tickets	Ave. Wt.	Price LRG
10-May	224483-212454	11.4	$4.50
28-May	212485-224486	9.9	$6.00
10-Jun	224487-212209	12.4	$6.50
21-Jun	212224-224488	12.8	$4.25
20-Jul	224491-212353	12.9	$4.25
27-Jul	224492-224488	14.7	$5.60
2-Aug	212367-224493	16.1	$6.50
25-Aug	224495	17.8	$4.25

n is 30 or greater for all data sets.

For 2010, the price started at a fair level, lower than past years because of the higher than normal Columbia spring catch, but never dropped in late May as the Copper River harvest did no materialize and in fact rose till mid June. The price then dropped in mid-late June as the SE Alaska net king harvest came in at a pretty good

level and stayed low through the SE Alaska troll opening. The price then started to climb, peaking in early August until impacted by the larger than normal Fraiser River sockeye harvest. Overall, the price for 2010 had ups and downs but hovered around $5/lb for the whole season. See graph below.



The weight of the fish though is a different story. They started out around 10 to 11 pounds per fish and rose to a higher level of 16 to 18 pounds in August. For 2011, this size differential will be even greater with a strong 4 year old age class vs. 2010 which was a large percentage of 3 year old fish. The 4 year old age class generally shows up off of Washington around mid June till early July and is available to be caught until they enter the Columbia River in late August. Thus, for 2011, the economic impact of putting more fish in the spring will be even greater than in 2010.

The graph and data above clearly shows that it makes little if any sense to move fish into the spring for economic reasons. 25,000 kings caught in May, would fetch a value of about $1,237,500, using an average weight of 11 pounds and average price of $4.50. Those same fish caught in early August would be worth about $1,911,875, using an average of 16.1 pounds and a price of $4.75. The higher price would be due to the fact that nearly all the kings in August would be in the 11-18 pound range and only half of those caught in May, would be in this class.

As you can see from the numbers above, catching those fish in May versus August would result in a direct loss of $674,375 to the coastal communities in the form of wages, actual dollars. This would also transform into a direct loss of $37,899.88 to the State in the form of fish landing taxes not collected.

While I do not look to restrict the spring troll fishery, having a steady supply of salmon throughout the year is paramount to effective marketing for troll salmon. The troll allocation should be managed to provide maximum economic input to the State and its citizens and to provide a steady supply of salmon to the consumers, who after all pay the taxes to run the hatcheries, maintain the habitat and resource, and are the true owners of these fish. The consumer's preferences are rarely heard. Using weekly catch limits at levels appropriate to the quota and effort is a very effective way to accomplish this.

Moving salmon into the spring fishery for biological reasons makes prudent sense, moving them into the spring so that a few can catch them all and move on to other states or fisheries, makes no sense.

O'Laughlin & Paris LLP Attorneys at Law

VIA Electronic Mail (pfmc.comments@noaa.gov)

March 24, 2011

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

Re: 2011 Pacific Fishing Season, April Briefing Book - alternatives for 2011 harvest for Sacramento River Fall-run Chinook salmon

Dear Mr. Chairman and members of the Council:

The San Joaquin River Group Authority ("SJRGA")[1], on whose behalf this letter is submitted, has had an opportunity to review the March 2011 Council Decision Document issued by the Pacific Fishery Management Council ("PFMC").

According to the Decision Document, the PFMC accepted the Salmon Technical Team's recommendation to consider the Sacramento River Fall-run Chinook salmon ("SRFC") stock not overfished and that overfishing did not occur in 2007-2009. Further, based on preliminary information showing that the Sacramento River fall Chinook spawning escapement in 2010 was within the management objectives of 122,000-180,000 adult spawners, the PFMC declared the overfishing concern status for this stock to be ended and that the stock is not currently in an overfished condition. (PFMC 2011c, p. 3.)

The PFMC's decision retroactively determining that SRFC were never overfished appears based on Amendment 16 to the *Fishery Management Plan for Commercial and Recreational Salmon Fisheries off the Coasts of Washington, Oregon and California* ("Salmon FMP"). However, Amendment 16 has not yet been enacted into regulation. Unless and until it is, the management objectives in the Salmon FMP, adopted in Amendment 14, remain the legal and regulatory requirement.[2]

[1] The SJRGA is a joint power authority consisting of irrigation and water districts, throughout the San Joaquin River basin. The SJRGA's member agencies use and divert water from the San Joaquin River and from its tributaries, pursuant to contract rights, riparian rights and pre-1914 and post-1914 rights of appropriation. They put the water to various beneficial uses, including irrigation, hydropower, storage, and municipal and domestic use. The SJRGA member agencies participate in a multitude of efforts focused on preserving and restoring Fall-run Chinook salmon, such as the Vernalis Adaptive Management Plan. They are also subject to a variety of regulatory conditions, especially in licenses issued by the Federal Energy Regulatory Commission, intended to protect, restore, and preserve SRFC.

[2] The Habitat Committee concurred with this assessment. (PFMC 2011d, p. 1)

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Furthermore, guidance issued by the National Marine Fisheries Service ("NMFS") instructed the PFMC to adopt management measures designed to achieve escapement at the upper end of the conservation objective. Although the management measures adopted by the PFMC were anticipated to result in escapement of 245,500, the actual escapement achieved fell far short, with actual escapement, 152,857 adults, approximately 1.6 times *less* than forecast and far less that the conservation objective's upper bound of 180,000. (75 FR 24484 (May 5, 2010); PFMC 2011a, p. 15; PFMC 2011c, p. 12.)

Failure to meet the anticipated escapement of 245,500 in 2010 was due to uncertainty in the Sacramento Index ("SI") forecast. There is considerable variability in the relationship between the SI forecast and the previous year's Jack escapement value, which is how the PFMC forecasts the abundance of SRFC. Figure 1 shows the percent difference between the forecasted index and post-season abundance index, demonstrating that since 2003, the actual post-season index was less than the forecast almost every year (exceptions are 2004 & 2008). The highest difference occurred in 2009 when the preseason forecast was over three times the actual post-season value (PFMC 2010a). According to the (PFMC 2010a, page 3), due to the use of jacks as basis for the SI, there is "a potential for the SI forecast to be biased high in years when the strength of successive cohorts is increasing… Hence there is potential for the 2011 SI forecast to be biased high."

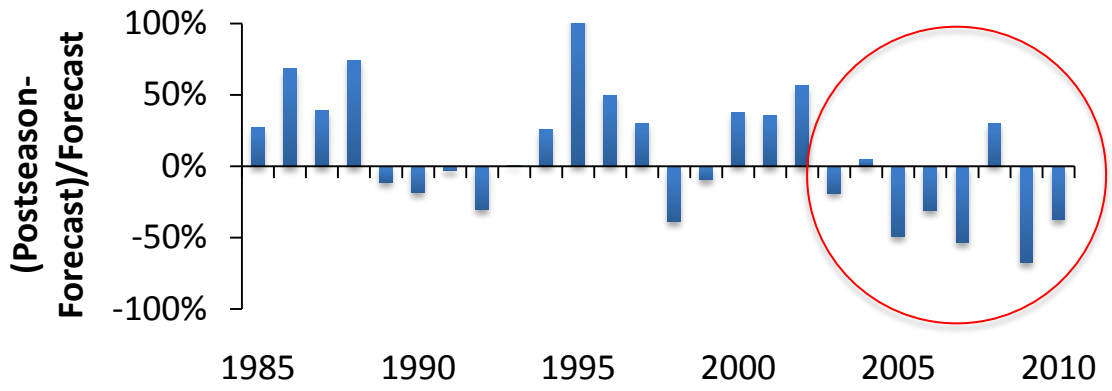

Figure 1. Percent difference between forecasted and post-season SRFC abundance indices.

Based on the SI forecast, the *2011 Preseason Report I* projected an abundance of 729,893 adult SRFC, but due to uncertainty in the SI forecast, the upper and lower bounds of the prediction interval range from 1,228,114 to 231,671. (PFMC 2011a, p. 15.) The report further forecasts that the No-Action Alternative, a repeat of the 2010 regulations, which included a Sacramento River Basin recreational quota of 8,200 SRFC, would be expected to result in an escapement of 572,600 natural and hatchery SRFC adults. (PFMC 2011a, p. 66.) The forecast for the No-Action Alternative can only be as accurate as the information it is based. Since the forecast for the No-Action Alternative is based on the SI forecast abundance, it would suffer from the same uncertainty, but no

upper and lower bound is given for the No-Action Alternative. Due to the substantial uncertainty of the SI forecast, even the No-Action Alternative could fail to meet the Salmon FMP conservation criteria. The 2011 alternatives similarly suffer from the uncertainty of the SI index. Escapement goals for the alternatives range from 368,700 to 376,800, but, again, no upper and lower bound is given for each alternative and, just like the No-Action Alternative, all three could fail to meet the Salmon FMP conservation criteria.

SRFC are not listed as threatened or endangered under the Endangered Species Act ("ESA"), as amended, 16 U.S.C. § 1531 et seq., but are nonetheless listed as a "species of concern" by NMFS. (69 FR 19978 (Apr. 15, 2004); 64 FR 60394 (Sept. 16, 1999).) The three consecutive years of 2007-2009 had the worst escapements on record, with ocean conditions cited by the *Supplemental SRFC Stock Assessment* as the "proximate cause." (PFMC 2011d, p. 8.) The stock also has a high hatchery component, high enough to make the stock highly homogeneous and vulnerable to catastrophic crashes. (Id., p. 1.) Although escapement improved in 2010, escapement in 2011 will be lower. (SJGA 2011, p. 10.) Parental stock is lower, ocean conditions in the Northern California current were better for most fish contributing to the 2010 escapement than for 2011, and, based on the proposed alternatives, commercial harvest in 2011 will be higher than in 2010. (SJRGA 2011.) When combined with the uncertainty inherent in the SI forecast used to develop the proposed alternatives, escapement in 2011 could easily fail to meet the lower bound of the Salmon FMP's SRFC conservation objective and again trigger a conservation alert. Under the Salmon FMP, the PFMC would again be required to close the salmon fisheries south of Cape Falcon.

Considering the status of SRFC, the efforts currently being made in the Delta and in freshwater streams to restore their numbers, and the economic impacts to the fishing industry caused by previous closures, the SJRGA recommends that the PFMC either close the salmon fishery South of Cape Falcon for another year or, at the least, adopt more conservative alternatives. Either will allow for additional SRFC recovery and reduce the risk of another closure in the near future. The PFMC has erred by substantial margins during the last several years (Figure 1). Nobody can afford for the PFMC to be wrong again.

Very truly yours,
O'LAUGHLIN & PARIS LLP

By: _____
KENNETH PETRUZZELLI

References

Pacific Fishery Management Council. 1999. Fishery Management Plan for Commercial and Recreational Salmon Fisheries off the Coasts of Washington, Oregon and

California. Pacific Fishery Management Council, Portland. http://www.pcouncil.org/wp-content/uploads/fmpthrua14.pdf

Pacific Fishery Management Council. 2011a. 2011 Preseason Report I: Stock Abundance Analysis and Environmental Assessment Part 1 for 2011 Ocean Salmon Fishery Regulations. Pacific Fishery Management Council, Portland. http://www.pcouncil.org/wp-content/uploads/Preseason_Report_I_2011.pdf

Pacific Fishery Management Council. 2011b. 2011 Preseason Report II: Proposed Alternatives and Environmental Assessment Part 2 for 2011 Ocean Salmon Fishery Regulations. Pacific Fishery Management Council, Portland. http://www.pcouncil.org/wp-content/uploads/Preseason_Report_II_2011.pdf

Pacific Fishery Management Council. 2011c. March 2011 Council Decisions. Pacific Fishery Management Council, Portland. http://www.pcouncil.org/wp-content/uploads/0311decisions.pdf

Pacific Fishery Management Council. 2011d. Habitat Committee Report on Sacramento River Fall Chinook Overfishing Assessment, Agenda Item G.3.b, March 2011. Pacific Fishery Management Council, Portland. http://www.pcouncil.org/wp-content/uploads/G3b_SUP_HC_MAR2011BB.pdf

Pacific Fishery Management Council. 2011e. Supplemental SRFC Stock Assessment, Agenda Item G.3.b, March 2011. Pacific Fishery Management Council, Portland. http://www.pcouncil.org/wp-content/uploads/G3b_SUP_SRFC_SA_MAR2011BB.pdf

San Joaquin River Group Authority. 2011. 2011 Fishing Season, Agenda Item G.4.d, March 2011. Pacific Fishery Management Council, Portland. http://www.pcouncil.org/wp-content/uploads/G4d_PC_MAR2011BB.pdf

San Luis & Delta-Mendota Water Authority

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State Water Contractors

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March 24, 2011

Via Electronic Mail
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7700 NE Ambassador Place, Suite 101
Portland, Oregon 97220-1384

Re: Addendum to San Luis & Delta-Mendota Water Authority/State Water Contractor February 28, 2011, Comments on 2011-April 2012 Salmon Management Measures

Dear Council Members:

The San Luis & Delta-Mendota Water Authority ("Authority") and State Water Contractors ("SWC") submit this letter as an addendum to their letter dated February 28, 2011, which commented on the 2011-April 2012 Salmon Management Measures. For your convenience, a copy of the February 28, 2011, comment letter is attached hereto as **Exhibit A**. The Authority and SWC make four changes to that letter.

1) In Table 1 to the February 28, 2011 letter, the values for Natural and Hatchery escapement under the spawning escapement header were transposed. In the revised Table 1, attached hereto as **Exhibit B**, the values for those columns are corrected. Also, in the revised Table 1, the harvest columns and the Sacramento Index and Harvest Index columns are updated with data presented in the 2011 Preseason Report I: Stock Abundance Analysis and Environmental Assessment Part 1 for 2011 Ocean Salmon Fishery Regulations ("2011 Report"). The 2011 Report was not available at the time the Authority and SWC submitted the February 28, 2011, comment letter.

2) In a revised Table 3 to the February 28, 2011 letter, attached hereto as **Exhibit C**, the Authority and SWC updated the preseason forecast and postseason estimates of the Sacramento Index with data provided in the 2011 Report.

3) On page 3, paragraph 3 of the February 28, 2011 letter, the Authority and SWC wrote that the Council's forecast of the SRFC Index overestimated the 2010 Sacramento Index postseason estimate by 200%. The Authority and SWC update that statement. Based on information contained in the 2011 Report, the Council's forecast overestimated the postseason estimate by 160%.

4) On page 2, final paragraph of the February 28, 2011 letter, the Authority and SWC cited to "Lindley 2009." The full citation for the article cited is Lindley, et al. 2009, *What caused the Sacramento River fall Chinook decline? Pre-publication report to the Pacific Fisheries Management Council*, March 18, 2009. The article is attached hereto as **Exhibit D**.

These revisions do not change the position of the Authority and SWC, that adopting salmon management measures that do not strictly limit ocean harvest, will place Chinook salmon at substantial risk.

Thank you for your consideration of these comments.

Daniel Nelson, Executive Director
San Luis & Delta-Mendota Water Authority

Terry Erlewine, General Manager
State Water Contractors

CC: The Honorable Ken Salazar, Secretary, Department of Interior
The Honorable David Hayes, Deputy Secretary, Department of the Interior
The Honorable Mike Connor, Commissioner, Bureau of Reclamation
The Honorable Diane Feinstein, California Senator
The Honorable Barbara Boxer, California Senator
The Honorable Mike Thompson, Congressman, CA01
The Honorable Dennis Cardoza, Congressman, CA18
The Honorable Jeff Denham, Congressman, CA 19
The Honorable Jim Costa, Congressman, CA20
The Honorable Norm Dicks, Congressman, WA06
Mark Cowin, Director, California Department of Water Resources
Donald McIsaac, Executive Director, Pacific Fishery Management Council
John McCamman, Director, California Department of Fish and Game
Jim Kellogg, President, California Fish and Game Commission

EXHIBIT A

San Luis & Delta-Mendota Water Authority

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State Water Contractors

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February 28, 2011

Via Electronic Mail
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7700 NE Ambassador Place, Suite 101
Portland, Oregon 97220-1384

Re: San Luis & Delta-Mendota Water Authority/State Water Contractor: Comments on 2011-April 2012 Salmon Management Measures

Dear Council Members:

The San Luis & Delta-Mendota Water Authority (Authority)[1] and State Water Contractors, Inc. (SWC)[2] are gratified to see the return of the commercial and sport fishing season. As we commented last year, we hope that improved ocean conditions and a resultant increase in estimated salmon escapement will continue.

However, we have certain grave concerns which were noted in our letter on May 20, 2010 with respect to last year's salmon management measures recommended by the Pacific Fishery Management Council (Council) and adopted by the National Marine

[1] The Authority, which was formed in 1992 as a joint powers authority, consists of 29 member agencies, 27' of which contract with the United States Department of the Interior, Bureau of Reclamation (Reclamation), for supply of water from the federal Central Valley Project (CVP). The Authority's member agencies hold contracts with Reclamation for the delivery of approximately 3.3 million acre-feet of CVP water. CVP water provided to the Authority's member agencies supports approximately 1.2 million acres of agricultural land, as well as more than 100,000 acres of mangaged wetlands, private and public, in California's Central Valley. The Authority's member agencies also use CVP water to serve more than 1 million people in the Silicon Valley and the Central Valley. A list of the Authority's member agencies is included in Attachment 1.

[2] The SWC represents 27 public agencies that contract with the State of California for water from the State Water Project ("SWP"). These agencies are each organized under California law and provide water supplies to nearly 25 million Californians and 750,000 acres of prime farmland from Napa County to San Diego and points between. A list of the SWC member agencies is included in Attachment 1.

Fisheries Service (NOAA Fisheries) for 2010-April 2011 ocean salmon fisheries. Those concerns remain today.[3]

- NOAA Fisheries continues to support a jeopardy standard for the continued operation of the Central Valley Project and State Water Project that is very different from the jeopardy standard employed for the salmon management measures;

- NOAA Fisheries refuses to improve harvest management through (a) use of genetic stock composition monitoring and (b) selective harvest of hatchery salmon; and

- Salmon management measures must be improved to ensure that they comply with the National Environmental Policy Act, Magnuson-Stevens Fishery Conservation and Management Act, and the federal Endangered Species Act.

For 2011-April 2012, as the Council considers recommendations and NOAA Fisheries considers adoption of those recommendations, the Council and NOAA Fisheries must do a better job protecting the population of Sacramento River Fall Chinook (SRFC), while ensuring the measures (a) do not jeopardize species protected under the federal Endangered Species Act, and (b) are recommended and adopted only after thoroughly considering the effect of the measures on the human environment.

A. 2011-April 2012 Salmon Management Measures Must Remain Very Restrictive To Reasonably Protect Chinook Salmon

Based on the low escapement of adult SRFC and the adult Sacramento River Winter-run Chinook (SRWRC) for the three years, 2007-2009, salmon management measures must substantially restrict ocean harvest again in 2011-April 2012. The very low abundance of the three year classes from 2007 to 2009 has adversely affected the entire population of SRFC and SRWRC. The SRFC and SRWRC spawning escapements have dropped to very low levels since 2006, and the SRFC escapement has been at record low levels from 2007 to 2009. (*See* Exhibit 2, Tables 1 and 2).

NOAA Fisheries reported that this downward trend starting in 2007 was caused when the juveniles associated with the 2007 and 2008 spawning escapement were exposed to the poor ocean conditions in 2005 and 2006 (Lindley, 2009). The 2008 SRFC adult escapement, the parents of the 2011 potential harvest and escapement, was only 65,364; the second lowest on record. The 2008 SRWRC adult escapement, parents of the 2011 potential escapement, was only 2,521; relatively, a very low number. Regardless of the ocean conditions of 2009, at these very low parental

[3] A copy of the Authority/SWC May 20, 2010 comment letter is attached hereto as Exhibit 1 and is incorporated herein by this reference.

escapement numbers, the potential SRFC and SRWRC escapements will likely be low compared to the escapement numbers prior to 2007.

Further, the SRFC ocean harvest index ranged from 35% to 71% the last ten years prior to 2007. (*See* Exhibit 2, Table 1.) The SRWRC ocean harvest impact on returning spawners was estimated by NOAA Fisheries to average 20%, and to have been as high as 25%, regardless of abundance or ocean harvest regulations. (April 30, 2010 biological opinion that considered the effects of the Pacific Coast Salmon Fishery Management Plan on Sacramento River winter-run Chinook salmon, p. 58.) Indeed, in 2010, NOAA Fisheries concluded that the then existing ocean harvest regulations would jeopardize the existence of the SRWRC. (*Id.*, p. 62-63).

Finally, the Council's forecast of the SRFC Index (since 2008) and the CVI (from 1985 to 2007) has ranged from 50% under the postseason estimate to 300% over the postseason estimate. (*See* Exhibit 2, Table 3). Even as recently as 2009 and 2010, the overestimate was 300% (in 2009) and 200% (in 2010). Given that variation, extensive ocean harvest in 2011-April 2012 would place the population of SRFC at undue risk, particularly with a parent population of only 65,364 adult SRFC.

For all of these reasons, recommending and adopting 2011-April 2012 salmon management measures that do not strictly limit ocean harvest would place Chinook salmon at substantial risk.

B. Before The Council Recommends And NOAA Fisheries Adopts The 2011-April 2012 Salmon Management Measures There Must Be A Thorough Consideration Of The Effect Of The Measures On Species Protected Under The Federal Endangered Species Act.

There is no dispute that salmon management measures affect species listed under the federal Endangered Species Act. Species potentially affected by 2011-April 2012 salmon management measures include SRWRC, California Central Valley Spring-Run Chinook, and Southern Resident killer whales. As a result, the Council, before it makes any recommendations, must carefully consider the adverse impacts the 2011-April 2012 salmon management measures will have on those species. In addition, before NOAA Fisheries adopts salmon management measures, it should prepare a biological assessment and biological opinion that consider whether salmon management measures are likely to appreciably reduce the species' likelihood of both surviving and recovering in the wild.

Last year, NOAA Fisheries relied upon three biological opinions:

- An April 2000 biological opinion that considered the effects of the Pacific Coast Salmon Fishery Management Plan on California Central Valley Spring-Run Chinook and California Coastal Chinook Salmon;

- An April 30, 2010 biological opinion that considered the effects of the Pacific Coast Salmon Fishery Management Plan on Sacramento River winter-run Chinook salmon; and

- A May 5, 2009 biological opinion that considered the effects of the Pacific Coast Salmon Fishery Management Plan on the Southern Resident Killer Whale (Orcinus orca) Distinct Population Segment.

Is it appropriate for the Council and NOAA Fisheries to continue to rely upon those biological opinions? Under section 402.16 of title 50 to the Code of Federal Regulations, NOAA Fisheries must re-initiate consultation (prepare a new biological opinion), if "new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered [or] the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological opinion."

In view of this requirement, the Council should not develop recommendations and NOAA Fisheries should not adopt 2011-April 2012 salmon management measures based on the April 28, 2000, spring-run Chinook biological opinion. That opinion is more than a decade old, utilizes an outdated environmental baseline, and incorporates an effects analysis that fails to reflect current conditions. Given the current circumstances, an eleven-year old biological opinion cannot adequately consider the effects on listed species of the salmon management measures. Further, the Council and NOAA Fisheries should review the range of alternative measures and critically evaluate whether the effect of each alternative is adequately analyzed and whether an alternative might cause impacts on listed species not considered in the above-cited biological opinions.

C. Before The Council Recommends And NOAA Fisheries Approves 2011-April 2012 Salmon Management Measures, NEPA Requires Thorough Consideration Of The Effect Of The Measures On The Human Environment.

Annual fishery regulations constitute a major federal action that requires environmental analysis in compliance with the National Environmental Policy Act (NEPA). Accordingly, as the Council considers 2011-April 2012 salmon management measures, it must ensure that its recommendations to NOAA Fisheries are informed by adequate environmental review under NEPA of the effect of those measures on the human environment.

During the decade prior to 2007, NOAA Fisheries adopted salmon management measures that caused (1) SRFC take 50 times higher than the historical Central Valley juvenile SRFC take at the Central Valley Project and State Water Project pumping facilities, (Exhibit 2, Table 4), and (2) SRWRC take 20 times higher than the respective SRWRC take at the Central Valley Project and State Water Project pumping facilities. (Exhibit 2, Table 5). In light of the severity of the restrictions that apply to California's

water system for the benefit of juvenile salmon, the Council and NOAA Fisheries – and the public – must be informed of the impacts the proposed salmon management measures will have on the human environment in areas served with water conveyed through the Sacramento-San Joaquin Delta.

These areas continue to suffer due to significant reductions in the water supplies available to more than 25 million people and millions of acres of prime farm land. The reduced water supply has resulted in significant adverse impacts to the human environment. As an example, farmers have fallowed hundreds of thousands of acres of prime farmland, which, in turn, has reduced farm employment, devastating farm employees, their families, and communities. Reduced water deliveries have also resulted in increased groundwater overdraft, renewed land subsidence and impaired water quality. The severe impact on the San Joaquin Valley's economic base of reduced water deliveries has led to numerous social ills within the Valley.

The millions of Californians who receive at least a portion of their water supplies through the Delta have a clear, common interest with the fishing industry. All will benefit from a healthy salmon fishery. As noted above, NOAA Fisheries concedes that salmon management measures result in the incidental take of, and adverse impact to, listed salmon species that are the subjects of severe regulatory constraints. These adverse effects will almost certainly impair the year-to-year abundance of these species, and their consequential diminished abundance will exacerbate the water supply shortages that are adversely impacting the San Joaquin Valley and other regions of California. NEPA requires thorough consideration of effects on the human environment caused (directly or indirectly) by the Council's salmon management measures before they are advanced for approval.

This duty under NEPA is not satisfied, as NOAA Fisheries has attempted to do in the past, by making reference to multiple outdated documents. Rather, as NOAA Fisheries recognizes in its NEPA Handbook, every project subject to NEPA requires its *own* NEPA document based on reasonably current, accurate and reliable information, whether it be a Categorical Exclusion memorandum (CE), an environmental assessment/finding of no significant impact or environmental impact statement.

For an action that NOAA Fisheries determines does not automatically require an environmental impact statement and is not eligible for a CE, the proposed action requires preparation of an environmental assessment. Such is the case here, and careful environmental review of impacts and alternatives is required before the Council recommends, and NOAA Fisheries adopts, 2011-April 2012 salmon management measures.

D. 2011-April 2012 Salmon Management Measures Must Comply With Important Equitable Principles Inherent In Magnuson-Stevens Fishery Conservation and Management Act.

Section 301 of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) establishes national standards with which NOAA Fisheries must comply when formulating and implementing Fisheries Management Plans. Inherent in the standards are equitable and anti-discrimination provisions, consistent with fundamental principles of equal protection. (MSA § 301(a)(4); U.S. Const., 14th Amend.) Thus, as the Council develops its recommendations and when NOAA Fisheries makes its decision regarding salmon management measures, they must respect those standards and principles; the actions by the Council and NOAA Fisheries must reflect a broad ecosystem perspective and an effective, holistic plan for species management. To do that, the Council and the NOAA Fisheries must account for the effect the measures might have on non-fishing activities, such as realizing the benefits of fishery restoration activities within the Sacramento/San Joaquin River watershed and water diversions.

Thank you for your consideration of these comments.

Daniel Nelson, Executive Director
San Luis & Delta-Mendota Water Authority

Terry Erlewine, General Manager
State Water Contractors

CC: The Honorable Ken Salazar, Secretary, Department of Interior
The Honorable David Hayes, Deputy Secretary, Department of the Interior
The Honorable Mike Connor, Commissioner, Bureau of Reclamation
The Honorable Diane Feinstein, California Senator
The Honorable Barbara Boxer, California Senator
The Honorable Mike Thompson, Congressman, CA01
The Honorable Dennis Cardoza, Congressman, CA18
The Honorable Jeff Denham, Congressman, CA 19
The Honorable Jim Costa, Congressman, CA20
The Honorable Norm Dicks, Congressman, WA06
Mark Cowin, Director, California Department of Water Resources
Donald McIsaac, Executive Director, Pacific Fishery Management Council
John McCamman, Director, California Department of Fish and Game
Jim Kellogg, President, California Fish and Game Commission

Attachment 1

San Luis & Delta-Mendota Water Authority Member Agencies

Banta-Carbona Irrigation District; Broadview Water District; Byron-Bethany Irrigation District; Central California Irrigation District; Centinella Water District; City of Tracy; Del Puerto Water District; Eagle Field Water District; Firebaugh Canal Water District; Fresno Slough Water District; Grassland Water District; James Irrigation District; Laguna Water District; Mercy Springs Water District; Oro Loma Water District; Pacheco Water District; Pajaro Valley Water Management Agency; Panoche Water District; Patterson Water District; Pleasant Valley Water District; Reclamation District 1606; San Benito County Water District; San Luis Water District; Santa Clara Valley Water District; Tranquillity Irrigation District; Turner Island Water District; West Side Irrigation District; West Stanislaus Irrigation District; Westlands Water District; and Widren Water District. Columbia Canal Company receives water delivered by the Authority and participates in the Authority under a non-member Friend status.

State Water Contractor Member Agencies

Alameda County Flood Control and Water Conservation District Zone 7, Alameda County Water District, Antelope Valley-East Kern Water Agency, Casitas Municipal Water District, Castaic Lake Water Agency, Central Coast Water Authority, City of Yuba City, Coachella Valley Water District, County of Kings, Crestline-Lake Arrowhead Water Agency, Desert Water Agency, Dudley Ridge Water District, Empire-West Side Irrigation District, Kern County Water Agency, Littlerock Creek Irrigation District, Metropolitan Water District of Southern California, Mojave Water Agency, Napa County Flood Control and Water Conservation District, Oak Flat Water District, Palmdale Water District, San Bernardino Valley Municipal Water District, San Gabriel Valley Municipal Water District, San Gorgonio Pass Water Agency, San Luis Obispo County Flood Control and Water Conservation District, Santa Clara Valley Water District, Solano County Water Agency, Tulare Lake Basin Water Storage District.

EXHIBIT 1

San Luis & Delta-Mendota Water Authority

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May 20, 2010

The Honorable Gary Locke
Secretary, U.S. Department of Commerce
1401 Constitution Avenue, North West
Washington, D.C. 20230

RE: 0648-AY60 – 2010 NMFS Salmon Fishery Management Measures

Dear Secretary Locke,

It is gratifying to see the return of a commercial and sport salmon fishing season for 2010. We are hopeful that the improved ocean conditions and resultant increases in estimated salmon escapement is a continuing trend. We empathize with the suffering fishermen and fisherwomen, fishing communities, and tribes have endured through the fisheries closures; many of the communities we serve are experiencing equally tragic social trauma as a result of the salmon's most recent population decline.

However, at the same time, we must also question the equity of NMFS' policy decisions. How is it that on one hand NMFS can continue to restrict pumping by the Central Valley Project and State Water Project to a bare minimum, ostensibly to protect Sacramento River salmon, while on the other simultaneously allow their killing through commercial and sport fishing? Clearly, if there are enough salmon to support a 2010 fishing season, then there must also be enough to alleviate constraints on State and federal pumping. Because it is in the best interest of water importers and fishing interests alike to improve the current situation, we offer you the following observations and recommendations intended to improve the equity and efficacy of fishery management actions aimed to protect and recover this ennobled species.

Disparity in the Jeopardy Standard:

Comparison of the 2009 biological opinion (Projects BiOp) of the ongoing operations of the Central Valley Project and State Water Project (Projects) and the 2010 biological opinion (Harvest BiOp) for the effects of ocean harvest on Sacramento winter-run Chinook salmon clearly demonstrates that your agency has applied sharply different standards to establish the

jeopardy threshold. The kill rate approved by NMFS in the ocean fishery is more than an order of magnitude greater than that allowed due to pumping by the Projects.

In the Harvest BiOp, NMFS states:

"*The RPA became the so-called jeopardy standard for purposes of the FMP conservation objective.*" (page 3, 2010 Harvest BiOp). NMFS goes on to explain, "*For purposes of the 2010 fishing year, NMFS determined that impacts from the fishery needed to be constrained from reaching the levels estimated during the years of 2000 to 2007 (age-3 impact rates up to 0.21; total spawner reduction rates up to 0.25), due to the significant decline in abundance of winter-run spawning returns since 2006.....As such, steps must be taken to constrain impacts from the ocean salmon fishery against reaching total spawner reduction rates of 20% or more until there is an indication that the status of this species is improving.*" (page 66, 2010 Harvest BiOp).

Thus, since 2000, NMFS had established a jeopardy standard for winter-run Chinook that accepted a 25% mortality of the adult population as a result of ocean fisheries, and is now reducing that standard to 20% in 2010. This stands in dramatic contrast to the take standard of only 1% set for the Projects' pumps.

The Projects BiOp states:

"*Based on the actions provided in the RPA to minimize direct and indirect losses, combined incidental take of juvenile winter-run will not exceed 2 percent (based on size criteria described above, which is actually approximately 1 percent genetically determined winter-run) of the estimated JPE between the CVP and SWP pumping plants.*" (page 775, Projects BiOp).

Not only does the 20% standard for harvest equate to 20 times greater allowed mortality than the 1% standard for the Projects' pumps, but the amount of take by ocean harvest is far more likely to reach the take limit than the take by the Projects. According to the Harvest BiOp, ocean harvesting in recent years has taken an average of 25% of the winter-run population, while take at the Projects, in recent years, have averaged about $1/10^{th}$ of the 1% of the total take limit based on genetic identification. Further, it is far less certain that a 1% mortality of juveniles will eventually equate to a 1% mortality of adults (smolt-to-adult survival is typically 1-4%) than it is that 20% mortality on ocean adults will equate to a 20% mortality on spawning adults.

Take limits are established to provide for the incidental take of listed species that result from, but are not the purpose of, carrying out an otherwise lawful activity. These limits essentially identify a level of mortality considered safe to avoid jeopardy. Jeopardizing the continued existence of a species means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species. Therefore, if we assume that the take of juvenile and adult salmon are equivalent, then the total

level of take from Projects' pumping and salmon harvest determined by NMFS to avoid jeopardy is 21% of the total population. What we are unable to understand is how NMFS has chosen to distribute this safe level of take between the two otherwise lawful activities.

Improving Harvest Management:

The Reasonable and Prudent Alternative (RPA) proposed in the 2010 Harvest BiOp employs selectivity as the strategy to reduce harvest mortality on federally listed winter and spring-run Chinook salmon. NMFS institutes selective fishery protections in three ways. The first is species selectivity, wherein all Coho salmon caught must be released alive. The second is length selectivity, which involves allowing for the harvest of only those salmon longer than 24 inches. The third is time selectivity, which involves allowing salmon fishing when the presence of listed stocks is expected to be low relative to non-listed or hatchery origin stocks. While well intentioned, these selective measures are inefficient because they do not provide any protection for sensitive, wild fall run Chinook, salmon that may be larger than average, or for winter and spring-run salmon that may have remained in the ocean another year or two. Effectively protecting these adults would increase population viability and genetic diversity by increasing the number of age classes. The RPA's band-aid approach offers listed salmon little protection from harvest while decreasing access to hatchery fish that are intended to support harvest. In order to improve protections for listed species while enhancing fishing opportunities, we offer two suggestions.

1. *Genetic Stock Composition Monitoring:*

Given that most hatchery origin Chinook are currently unmarked, as are nearly all listed stocks, we recommend NMFS implement a comprehensive monitoring effort to estimate stock composition among harvested fish using genetic stock identification techniques. Currently, NMFS relies solely upon post-hoc analysis of estimated harvest rates for tagged surrogates of listed stocks. These surrogate stocks are always hatchery origin fish, which are known to exhibit age structure and behavior distinct from natural origin, ESA listed stocks. This is particularly true for Central Valley spring-run Chinook, where probable harvest for spring-run Chinook originating from Deer, Mill and Butte Creeks is assessed by surrogates from the Feather River Hatchery spring-run Chinook; a stock known to be more similar to fall-run Chinook than to spring-run. Given NMFS' reliance on selective harvest strategies and considerable uncertainties in the accuracy of expected size at age and stock composition estimates, it is essential that NMFS immediately apply additional methods to evaluate the effectiveness of their proposed harvest regulations.

Staff in your Southwest Fishery Science Center has already developed the genetic tools (genetic stock identification, or GSI), which can quickly and inexpensively identify stock of origin for all California Chinook salmon. NMFS could immediately begin a program to estimate stock composition among harvested Chinook using these genetic stock identification tools. Furthermore, we recommend that NMFS establish a harvest quota for ESA listed stocks using

GSI as a means to quantify in near real-time the harvest take for spring and winter-run Chinook. Thus, rather than relying on highly uncertain, post-hoc analyses of coded wire tag recoveries for surrogate stocks, NMFS could instead rely upon GSI to more accurately assess stock composition. When GSI estimates indicate the allotted take of ESA species has occurred, the fishery should immediately be closed.

While results from genetic stock assessment can validate the current management strategy, it will also provide new information to inform future harvest management strategies. Given the status of listed salmon stocks and the role of harvest practices in inhibiting stock viability (NMFS 2009 Draft Recovery Plan), it is essential for all of us dependent upon their status for NMFS to implement new monitoring strategies (e.g., GSI) and begin to implement hatchery selective harvest as a complement to length and time selective harvest.

2. *Hatchery Selective Fishery:*

Considering NMFS' reliance upon species, size and time-selective harvest strategies, the absence of a hatchery selective harvest strategy is conspicuous. Selective harvest of hatchery salmon an established tool already successfully and widely used from the coast of northern Oregon through Washington and on into British Columbia. A hatchery selective fishery off the coast of California and southern Oregon is likely to be even more effective than existing programs in protecting listed and sensitive salmon stocks because hatchery origin fall run salmon dominate the ocean population throughout this region. In addition to better protecting wild salmon, a hatchery selective fishery would greatly improve the efficacy of the hundreds of millions of dollars and millions of acre-feet of water being expended each year to increase wild salmon populations, half of which are taken by allowed harvest.

The NMFS 2003 Programmatic EIS for ocean harvest has already identified mark-selective fisheries as the preferred alternative for managing ocean fisheries. A fishery with specifically targeted marked hatchery fish would provide stronger protection for all wild runs of salmon while allowing fishermen to retain a greater share of their catch. For example, under current size-selective regulations, of all winter-run salmon caught, fishermen release approximately 45% because they are too small while the other 55% are kept. Of the fish released, up to 25% die due to catch and release stress. Under mark-selective regulations, all wild winter-run would be released and so of the ~55% now guaranteed to die, 75% would likely survive. While there would be continued catch and release mortality of non-hatchery fish, this mortality would occur at precisely the same rate as with the length selective harvest regulations currently in place. Thus, the benefits from a hatchery-selective harvest program stem from the fact that when all hatchery fish are marked (with an adipose fin clip) they can be easily and immediately be distinguished from wild and ESA listed stocks, and this distinction allows us to greatly reduce the incidental take of the listed and sensitive species. In order to allow flexibility for future hatchery-selective harvest, NMFS should actively work to support a mass-marking program for all California hatchery origin fall run Chinook salmon.

Compliance with National Environmental Policy Act:

On April 15, 2010, the Pacific Fishery Management Council (Council) adopted its recommended 2010 salmon fishery regulations.[i] The Council recommended NMFS adopt regulations that would allow commercial and recreational salmon fishing north of Cape Falcon (in northern Oregon), which depends largely on Columbia River stocks, and south of Cape Falcon, which depends largely on Sacramento River fall-run Chinook. NMFS adopted the Council's recommended management measures effective May 1, 2010 ("2010 Fishery Regulations"). (75 Fed.Reg. 24482 (May 5, 2010).) Under these measures, the total allowable catch north of Cape Falcon is 172,000 Chinook and 120,500 marked hatchery Coho. South of Cape Falcon, the commercial fishery is allowed a total catch of 30,375 Chinook and no Coho. The recreational fishery south of Cape Falcon is allowed a total catch of 26,000 marked hatchery Coho, and an unlimited number of adult Chinook between May 1 and September 6, 2010. The allowable catch does not include the tens of thousands of threatened and endangered adult salmon that will be taken as an incident to the catch of fall-run and Coho salmon. As a result, we contend the 2010 salmon fishery regulations were adopted without the requisite environmental analysis.

The NMFS concedes that it "must complete a National Environmental Policy Act (NEPA) review" of the 2010 Salmon Fishery Regulations. (Memorandum from Frank D. Lockhart to Barry A. Thom, "Environmental Effects Internal Determination Regarding NEPA Analysis Associated with the 2010 Regulations for West Coast Ocean Salmon Fisheries Annual Specifications and Management Measures – REQUEST FOR CONCURRENCE", April 27, 2010, p. 10 ["Lockhart Memorandum"].) Indeed, NMFS must make that concession, as its own Handbook states that annual fishery regulations constitute a major federal action that requires environmental analysis. (Handbook, pp. 30-31; NOAA Administrative Order Series 216-6 (May 20, 1999), § 6.03d.) The NMFS, however, did not do that.

Instead, the NMFS adopted the 2010 Fishery Regulations without performing environmental review. The NMFS explains:

"The effects of fisheries that would be managed under the 2010 regulations for west coast ocean salmon fisheries annual management measures were analyzed in prior NEPA reviews prepared by NOAA Fisheries, as described above. Additional analysis of the effects of the options the Council considered for the 2010 fishing season and the Council's final recommendation is included in the Pre documents described above."

* * *

"Therefore, NOAA Fisheries will not prepare a separate NEPA document on implementation of the 2010 regulations for west coast ocean salmon fisheries annual management measures." (*Id.*)

The NMFS' reference to multiple documents is insufficient to satisfy NEPA.

Every project subject to NEPA requires its own NEPA document, regardless of whether that document is a Categorical Exclusion memorandum ("CE"), EA/FONSI, or EIS. (Handbook, pp. 12, 30.) Where, as here, the NMFS determines that an action does not automatically require an EIS and is not eligible for a CE, the NMFS must prepare an EA. (Handbook, p. 30; 40 C.F.R. § 1501.3; see, e.g., *Sierra Club v. Babbitt*, 69 F. Supp. 2d 1202, 1212 (E.D. Cal. 1999) (*Sierra Club*).) NEPA allows an EA to incorporate information from other NEPA documents by reference (Handbook, p. 41; 40 C.F.R. § 1502.21; but see *Sierra Club* at p. 1216 [limiting incorporation into EAs]), but other documents can only be incorporated into a new NEPA document prepared for the new federal action.

NEPA further mandates that federal agencies conclude and document their NEPA decision-making process: (1) by issuing a CE (Handbook, p. 29); (2) by issuing a FONSI after preparing an EA (Handbook, p. 43); or (3) by issuing a Record of Decision ("ROD") after preparing an EIS (Handbook, p. 65). NEPA imposes substantive requirements for each type of document. For example, a FONSI must:

"Clearly articulate how the impacts of the proposed action are not significant, and how that conclusion was reached with regard to each of the appropriate significance criteria from NAO 216-6 §§ 6.01 and 6.02. The FONSI should also have the following elements: a heading, the name of the action, a description of the action, a description of the alternatives, a summary of the environmental consequences of the proposed action, and a determination statement." (Handbook, p. 43; 40 C.F.R. § 1508.13.)[ii]

Each document must further be accompanied by a supporting record. (Handbook, pp. 46, 71.) Strict compliance in this regard is necessary to establish an administrative record appropriate for judicial review. (*Ibid.*; see, e.g., *Get Oil Out, Inc. v. Andrus*, 468 F.Supp. 82 (C.D. Cal. 1979).)

Here, the NMFS prepared only the Lockhart Memorandum. The Lockhart Memorandum cannot substitute for a FONSI or other "concluding" NEPA document. The Lockhart Memorandum did not identify alternatives, did not summarize the environmental consequences of its action, and did not provide a determination statement. The Lockhart Memorandum is also not labeled as a FONSI and gives no notice to the public that a NEPA review occurred, much less concluded. The Lockhart Memorandum cannot serve as a CE memorandum or ROD for similar inadequacies. As such, the NMFS has functionally cut the public out of its NEPA decision making process and hindered any judicial review of that process, in violation of NEPA.

Finally, the NMFS' reliance on a cobbling of multiple documents without the issuance of a CE, FONSI, or ROD runs afoul of its mandate to initiate the environmental review process as early as possible during the planning stages of an action. (Handbook, p. 13.) Prior to publication of the Lockhart Memorandum, NMFS never informed the public of the process it was following to comply with NEPA. Indeed, NMFS staff were unable, even within a week of

the 2010 Fishery Regulations' planned adoption, to inform the public what type of NEPA document, if any, NMFS would prepare for the 2010 regulations. The Lockhart Memorandum explains the lengthy public process afforded development of the 2010 Fishery Regulations, but this public process wholly excluded any discussion of NEPA or analysis of environmental impacts outside immediate fishery conservation objectives. This failure violates a fundamental NEPA policy, which is to "[e]ncourage and facilitate public involvement in decisions which affect the quality of the human environment." (40 C.F.R. § 1500.2(d).)

The failures by the NMFS are not harmless. Under NEPA and the Handbook, NMFS was required, but failed, to consider the 2010 salmon fishery's indirect effects, (40 C.F.R. § 1508.8(b); Handbook, p. 59), including indirect impacts to areas served by water conveyed through the Sacramento-San Joaquin Rivers Delta.

Areas served by water conveyed through the Sacramento-San Joaquin Rivers Delta are currently suffering. Restrictions on water supply caused by the Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project (June 4, 2009) ("Projects BiOp") have significantly reduced the water supply available to more than 25 million people and millions of acres of prime farm land. The reduced water supply has resulted in significant adverse impacts to the human environment. Farmers have fallowed hundreds and thousands of acres, which in turn has reduced farm employee working hours, salaries, and positions, devastating farm employees, their families, and communities. The severe impact on the San Joaquin Valley's economic base has led to hunger and other social ills within the Valley. Dust emissions from fallowed lands have impaired air quality and increased dependence on limited groundwater. That increased dependence on groundwater has resulted in subsidence.

The NMFS concedes the 2010 salmon fishery will result in the incidental take of listed salmon species that are the subjects of severe regulatory constraints currently imposed by the Projects BiOp upon the Projects' pumping. The 2010 salmon fishery will adversely impact these listed salmon species. As an example, the NMFS acknowledges the 2010 salmon fishery could result in the take of up to 25% (averaging 20%) of adult Sacramento River winter-run that would otherwise return to inland waters to spawn. (Biological Opinion on the Authorization of Ocean Salmon Fisheries Pursuant to the Pacific Coast Salmon Fishery Management Plan and Additional Protective Measures as it affects Sacramento River Winter Chinook Salmon, April 30, 2010 ["2010 Harvest Opinion"], pp. 57, 61.) That take will likely impair the year-to-year abundance of winter-run, one of the species addressed in the Projects BiOp. The diminished abundance will thereby likely exacerbate the water supply shortages that are adversely impacting the San Joaquin Valley and other regions of the State.

Compliance with the Magnuson-Stevens Fishery Conservation and Management Act:

Section 301 of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) establishes national standards with which NMFS must comply in formulating and implementing

Fisheries Management Plans. Inherent in the standards are equitable and anti-discrimination provisions, consistent with fundamental principles of equal protection. (MSA § 301(a)(4); U.S. Const., 14th Amend.) The 2010 Salmon Fishery Regulations violate those standards and principles. Nowhere has the NMFS considered the factors of fairness and equity among stakeholders in establishing the allowable catch. Instead, the 2010 Salmon Fishery Regulations result in unequal, unfair and inequitable treatment of fishing and non-fishing activities.

The NMFS abuse of its discretion is egregious, particularly in light of the MSA's emphasis on ecosystem approaches to fisheries management. (See, e.g., MSA § 406; 50 C.F.R. § 600.815.) The MSA requires NMFS to develop effective means of bringing stakeholders and their interests into the fisheries management process, not only to ensure fairness and equity, but also to provide a broader ecosystem perspective and to formulate more effective, holistic plans and regulations. The 2010 Salmon Fishery Regulations fail to consider stakeholder requirements and undermine ecosystem management efforts that must account for, and give equal treatment to, non-fishing activities. (See, e.g., 50 C.F.R. § 600.815(a) [FMPs and regulations must address non-fishing activities such as water diversions].)

Spring Run Chinook Salmon Biological Opinion:

The 2010 NMFS Salmon Fishery Management Measures rely upon the April 28, 2000, biological opinion, titled "Effects of the Pacific Coast Salmon Plan on California Central Valley Spring-Run Chinook, and California Coastal Chinook Salmon" (Spring Run BiOp). Reliance upon a decade old opinion is insufficient to satisfy the federal endangered species act. Among other defects, the environmental baseline presented and effects analysis contained in the Spring Run BiOp are simply outdated. Conditions within the action area for the Salmon Fishery Management Measures have substantially changed in the 10 years since the Spring Run BiOp issued. Thus, under title 50, section 402.16 of the Code of Federal Regulations, NMFS must re-initiate formal consultation.

Conclusion:

We appreciate the economic and cultural significance salmon fishing has on a number of communities and tribes. The comments and recommendation conveyed herein are by no means intended to extend or expand the harm befallen them due to the most recent decline of salmon populations throughout the Pacific region. However, the incongruity of NMFS decisions and failure to follow established federal procedures and laws compels comment. At a minimum, we believe an explanation of how NMFS plans to rectify these issues is in order. Such an explanation should include a schedule as to when each issue will be addressed and how stakeholders will be incorporated into the process. We believe your swift response to our comments and recommendations is warranted and should result in significant improvements in the equity and efficacy of fishery management practices. We look forward to your response and stand by to assist you in any way we can.

Sincerely,

Daniel G. Nelson
Executive Director
San Luis & Delta-Mendota Water Authority

Terry L. Erlewine
General Manager
State Water Contractors

CCs:
The Honorable Ken Salazar, Secretary, Department of Interior
The Honorable David Hayes, Deputy Secretary, Department of the Interior
The Honorable Mike Connor, Commissioner, Bureau of Reclamation
The Honorable Diane Feinstein, California Senator
The Honorable Barbara Boxer, California Senator
The Honorable Mike Thompson, Congressman, CA01
The Honorable Dennis Cardoza, Congressman, CA18
The Honorable George Radanovich, Congressman, CA 19
The Honorable Jim Costa, Congressman, CA20
The Honorable Norm Dicks, Congressman, WA06
Mark Cowin, Director, California Department of Water Resources
Donald McIsaac, Executive Director, Pacific Fishery Management Council
John McCamman, Director, California Department of Fish and Game
Jim Kellogg, President, California Fish and Game Commission

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[i]/ See Pacific Fishery Management Council News Release, April 15, 2010, available at http://www.pcouncil.org/wp-content/uploads/April-15-2010-Salmon-Seasons-press-release.pdf.

[ii]/ The Handbook species that a CE memorandum should contain the following:

1. Brief description of the proposed action.
2. Brief description of the expected direct, indirect, and cumulative impacts of the proposed action noting how they address the criteria in NAO 216-6 § 5.l05b and c.
3. Identification of what categorical exclusion in NAO 216-6 meets the proposed action.
4. Explanation of how the proposed action is consistent with the identified categorical exclusion.

(Handbook, p. 25.) The Handbook further specifies that a ROD must include the following:

1. A clear statement describing the decision (which alternative was selected).
2. A listing and summary of all alternatives considered in reaching the decision, specifying the environmentally preferable alternative or alternatives.
3. If deemed appropriate, a discussion of preferences among alternatives based on relevant factors including economic and technical considerations and agency statutory missions.
4. An identification and discussion of all factors that led to the decision and how those considerations entered into the decision.
5. A statement as to whether all practicable means to avoid or minimize environmental harm form the alternative selected have been adopted, and if not, why they were not.
6. For the identified mitigation measures, a summary of the monitoring and enforcement program that will be utilized.

(Handbook, p. 65; 40 C.F.R. § 1505.2.)

EXHIBIT 2

TABLE 1. Spawning Escapement, Ocean Harvest, Sacramento Index, and Sacramento Index Harvest Index of Sacamento River Fall Chinook (SFRC), and Escapement of Sacramento River Winter Chinook (SRWC) X 1,000. Data from PFMC Preseason Report 2010 and 2010 Review of Ocean Salmon Fisheries.

YEAR	Spawning Escapement			SRFC Ocean Harvest South of Cape Falcon			River Harvest	Sacramento Index (SI)	SI Harvest Index (%)
	Natural	Hatchery	Total	Troll	Sport	Total	Fall		
1983	18.847	91.401	110.248	246.100	86.100	332.100	18.100	460.500	72.0
1984	39.467	119.505	158.972	266.100	87.000	353.100	26.100	538.200	66.0
1985	29.856	209.450	239.306	355.400	158.900	514.300	39.300	792.900	65.0
1986	23.793	216.310	240.103	618.900	137.500	756.500	39.400	1036.000	73.0
1987	20.273	174.791	195.063	686.100	173.200	859.200	32.000	1086.300	79.0
1988	29.515	197.953	227.468	1162.600	188.300	1350.800	37.300	1615.600	84.0
1989	25.880	126.683	152.563	611.700	159.200	770.800	25.000	948.400	81.0
1990	21.892	83.198	105.090	514.200	150.500	664.700	17.200	787.000	84.0
1991	27.466	91.403	118.869	298.800	90.200	389.000	26.000	533.400	73.0
1992	22.088	59.457	81.545	232.400	70.100	302.600	13.300	396.300	76.0
1993	26.834	110.556	137.390	342.400	115.300	457.800	27.700	622.800	73.0
1994	32.556	133.030	165.586	303.200	164.700	468.000	28.900	662.400	71.0
1995	41.827	253.487	295.314	735.700	387.900	1123.600	48.500	1467.400	77.0
1996	34.561	267.071	301.632	426.700	157.000	583.700	49.500	934.800	62.0
1997	65.241	279.599	344.840	579.700	210.200	790.000	56.600	1191.400	66.0
1998	77.763	168.144	245.908	292.800	113.900	406.700	69.800	722.400	56.0
1999	46.112	353.718	399.830	308.300	76.600	384.900	68.900	853.600	45.0
2000	48.323	369.214	417.537	431.300	153.200	584.500	59.500	1061.500	55.0
2001	59.360	537.415	596.775	284.400	93.400	377.900	97.900	1072.600	35.0
2002	87.173	682.695	769.868	447.400	184.000	631.400	89.200	1490.500	42.0
2003	109.578	413.438	523.016	501.600	106.500	608.000	85.800	1216.800	50.0
2004	83.407	203.478	286.885	621.500	212.600	834.100	47.100	1168.000	71.0
2005	185.299	210.706	396.005	367.600	127.000	494.600	65.000	955.600	52.0
2006	79.906	195.124	275.030	149.900	107.600	257.500	44.200	570.900	45.0
2007	21.376	69.998	91.374	120.500	32.300	152.700	14.300	255.000	60.0
2008	18.512	46.852	65.364	3.200	0.900	4.100	0.100	68.700	6.0
2009	17.536	23.337	40.873	0.000	0.200	0.200	0.000	39.800	0.0
2010	39.702	85.651	125.353	*	*	*	*	*	*

TABLE 2. Sacramento River Winter Run Chinook Escapement. Data from PFMC 2010 Review of Ocean Salmon Fisheries. Counts taken from Red Bluff Diversion Dam (RBDD) and Carcass Surveys (CS).

Brood Year	Adults RBDD	Juveniles RBDD	Total RBDD	Cohor RBDD	CRR RBDD	Adults CS	Juveniles CS	Cohort CS	Total CS	CRR CS
1970	32.085	8.324	40.409	*	*	*	*	*	*	*
1971	32.225	20.864	53.089	40.549	*	*	*	*	*	*
1972	28.592	8.541	37.133	49.456	*	*	*	*	*	*
1973	19.456	4.623	24.079	27.997	*	*	*	*	*	*
1974	18.109	3.788	21.897	22.732	0.56	*	*	*	*	*
1975	15.932	7.498	23.430	19.720	0.40	*	*	*	*	*
1976	26.462	8.634	35.096	33.960	1.21	*	*	*	*	*
1977	15.028	2.186	17.214	23.662	1.04	*	*	*	*	*
1978	23.669	1.193	24.862	25.855	1.31	*	*	*	*	*
1979	2.251	0.113	2.364	3.444	0.10	*	*	*	*	*
1980	0.084	1.072	1.156	0.197	0.01	*	*	*	*	*
1981	18.297	1.744	20.041	19.369	0.75	*	*	*	*	*
1982	0.972	0.270	1.242	2.716	0.79	*	*	*	*	*
1983	1.439	0.392	1.831	1.709	8.68	*	*	*	*	*
1984	0.794	1.869	2.663	1.186	0.06	*	*	*	*	*
1985	3.633	0.329	3.962	5.502	2.03	*	*	*	*	*
1986	2.101	0.496	2.597	2.430	1.42	*	*	*	*	*
1987	1.909	0.277	2.186	2.405	2.03	*	*	*	*	*
1988	1.878	1.008	2.886	2.155	0.39	*	*	*	*	*
1989	0.571	0.125	0.696	1.579	0.65	*	*	*	*	*
1990	0.387	0.043	0.430	0.512	0.21	*	*	*	*	*
1991	0.192	0.019	0.211	0.235	0.11	*	*	*	*	*
1992	1.160	0.080	1.240	1.179	0.75	*	*	*	*	*
1993	0.250	0.137	0.387	0.330	0.64	*	*	*	*	*
1994	0.062	0.124	0.186	0.199	0.85	*	*	*	*	*
1995	1.267	0.030	1.297	1.391	1.18	*	*	*	*	*
1996	0.708	0.629	1.337	0.738	2.24	*	*	*	*	*
1997	0.528	0.352	0.880	1.157	5.81	*	*	*	*	*
1998	2.079	0.923	3.002	2.431	1.75	*	*	*	*	*
1999	0.822	2.466	3.288	1.745	2.36	*	*	*	*	*
2000	0.563	0.789	1.352	3.029	2.62	*	*	*	*	*
2001	1.696	3.827	5.523	2.485	1.02	7.443	0.781	*	8.224	*
2002	7.614	1.555	9.169	11.441	6.56	7.047	0.417	7.828	7.464	*
2003	6.172	3.585	9.757	7.727	2.55	7.675	0.543	8.092	8.218	*
2004	2.588	4.604	7.192	6.173	2.48	5.786	2.083	6.329	7.869	*
2005	3.521	1.778	5.299	8.125	0.71	14.683	1.156	16.766	15.839	2.14
2006	4.792	2.623	7.415	6.570	0.85	16.764	0.385	17.920	17.149	2.21
2007	3.004	3.140	6.144	5.627	0.91	2.402	0.131	2.787	2.533	0.44
2008	1.504	2.131	3.635	4.644	0.57	2.521	0.204	2.652	2.725	0.16
2009	*	*	*		*	4.363	0.053	4.567	4.416	0.25
2010	*	*	*		*	1.555	0.041	1.608	1.596	0.58
2011										0.00

TABLE 3. Comparisons of preseason forecast and postseason estimates for the Central Valley Index (CVI) or Sacramento Index (SI) X 1,000. 1985-2007 based on CVI, 2008-2010 based on SI. Data from PFMC Preseason Reports 2008 and 2010.

YEAR	Forecast CVI<2008 SI>2008	PostSeason CVI<2008 SI>2008	%Forecast/ PostSeason
1985	524.800	667.400	79.0%
1986	546.500	921.400	59.0%
1987	592.900	824.100	72.0%
1988	707.100	1232.400	57.0%
1989	625-885	667.700	94-133%
1990	500-900	568.600	88-158%
1991	466.000	451.300	103.0%
1992	452.000	313.800	144.0%
1993	501.000	504.600	99.0%
1994	503.000	632.200	80.0%
1995	654.000	1343.800	49.0%
1996	533.000	798.600	67.0%
1997	849.000	1105.200	77.0%
1998	1051.000	646.000	163.0%
1999	847.700	766.400	111.0%
2000	790.400	1088.800	73.0%
2001	649.400	882.000	74.0%
2002	825.400	1292.000	64.0%
2003	1108.100	896.700	124.0%
2004	831.800	869.600	96.0%
2005	1678.300	849.700	198.0%
2006	632.500	434.900	145.0%
2007	499.900	232.000	216.0%
2008/1	54.570	69.962	78.0%
2009	122.196	39.805	307.0%
2010	245.483	125.000	196.4%

/1 2008 SI (without river harvest component) CVI = 157,000

TABLE 4. Juvenile Fall-Run Chinook Take at the Delta Export Facilities.

Life Stage	Hatchery	Release Site	Years	Number of Releases	Total Number Released	Direct Loss at Delta Exports	% Direct Loss at Delta Exports		
							Average	Minimum	Maximum
Yearling	Merced	Hatchery	1994-1995	3	215828	13871	6.53	5.61	8.34
YOY	Merced	Hatchery	1993-2007	36	6665115	79236	1.36	0.00	10.86
YOY	Merced	SJR Delta	1996-2006	23	3341710	27107	0.90	0.00	6.56
YOY	Feather	SJR Delta	1993-1998	21	1983272	16422	0.87	0.00	2.03
Yearling	Mokelumne	Hatchery	1993-2003	12	1158842	3513	0.31	0.03	1.36
YOY	Mokelumne	Sac Delta	1996-2002,2009	14	1273137	785	0.10	0.00	1.29
YOY	Mokelumne	Hatchery	1993-2008	38	4157503	1091	0.02	0.00	0.21
YOY	Coleman	Hatchery	1993-2009	31	15297463	7294	0.08	0.00	2.20
YOY	Coleman	Sac Delta	1993-2008	26	2156626	1247	0.05	0.00	0.37
YOY	Feather	Sac Delta	1993-2009	89	10138857	2933	0.03	0.00	0.43
YOY	Feather	Hatchery	1994-2008	13	1485843	14.16	0.00	0.00	0.01

TABLE 5. Juvenile Winter-Run Chinook Take at the Delta Export Facilities.			
YEAR	Natural Winter Run Juvenile Chinook Entering Delta	Direct Juvenile Winter Run Length Chinook Mortality at Delta Exports	% Direct Juvenile Winter Run Length Chinook Mortality at Delta Exports
1992/1993	242617	4674	1.93
1993/1994	73466	3053	4.16
1994/1995	31491	4712	14.96
1995/1996	338107	2437	0.72
1996/1997	165069	630	0.38
1997/1998	138316	1542	1.11
1998/1999	454792	3720	0.82
1999/2000	289724	5830	2.01
2000/2001	370221	20042	5.41
2001/2002	1864802	3295	0.18
2002/2003	2136700	6813	0.32
2003/2004	1896649	7778	0.41
2004/2005	881719	1376	0.16
2005/2006	3831300	2610	0.07
2006/2007	3739069	3302	0.09
2007/2008	589900	1298	0.22
2008/2009	617783	1583	0.26
2009/2010	1179633	1663	0.14

EXHIBIT B

TABLE 1. Spawning Escapement, Ocean Harvest, Sacramento Index, and Sacramento Index Harvest Index of Sacamento River Fall Chinook (SFRC), and Escapement of Sacramento River Winter Chinook (SRWC) X 1,000. Data from PFMC 2011 Preseason Report I and Review of 2010 Ocean Salmon Fisheries.

YEAR	Spawning Escapement			SRFC Ocean Harvest South of Cape Falcon				River Harvest	Sacramento Index (SI)	SI Harvest Index (%)c/
	Natural	Hatchery	Total	Troll	Sport	Non-Ret	Total	Fall		
1983	91.401	18.847	110.248	248.000	86.700	0.000	334.700	18.100	463.000	76.0
1984	119.505	39.467	158.972	266.900	87.200	0.000	354.100	26.100	539.100	71.0
1985	209.450	29.856	239.306	359.500	160.200	0.000	519.700	39.300	798.300	70.0
1986	216.310	23.793	240.103	620.600	138.400	0.000	759.000	39.400	1038.500	77.0
1987	174.791	20.273	195.063	687.900	176.300	0.000	864.200	32.000	1091.300	82.0
1988	197.953	29.515	227.468	1163.200	188.800	0.000	1352.000	37.300	1616.800	86.0
1989	126.683	25.880	152.563	606.500	160.100	0.000	766.600	25.000	944.100	84.0
1990	83.198	21.892	105.090	508.000	152.400	0.000	660.400	17.200	782.700	87.0
1991	91.403	27.466	118.869	301.000	90.800	0.000	391.800	26.000	536.600	78.0
1992	59.457	22.088	81.545	233.300	70.500	0.000	303.800	13.300	398.700	80.0
1993	110.556	26.834	137.390	342.800	115.800	0.000	458.600	27.700	623.600	78.0
1994	133.030	32.556	165.586	303.400	165.700	0.000	469.100	28.900	663.600	75.0
1995	253.487	41.827	295.314	730.700	390.300	0.000	1121.000	48.500	1464.800	80.0
1996	267.071	34.561	301.632	426.800	157.100	0.000	583.900	49.500	935.100	68.0
1997	279.599	65.241	344.840	582.400	219.500	0.000	801.900	56.600	1203.300	71.0
1998	168.144	77.763	245.908	293.700	117.500	0.000	411.200	69.800	726.800	66.0
1999	353.718	46.112	399.830	308.800	78.000	0.000	386.800	68.900	855.400	53.0
2000	369.214	48.323	417.537	432.800	154.600	0.000	587.400	59.500	1064.400	63.0
2001	537.415	59.360	596.775	285.800	95.800	0.000	381.600	97.900	1076.300	45.0
2002	682.695	87.173	769.868	458.200	194.600	0.000	652.800	89.200	1511.900	49.0
2003	413.438	109.578	523.016	508.300	109.000	0.000	617.300	85.800	1226.100	57.0
2004	203.478	83.407	286.885	622.300	214.000	0.000	836.300	47.100	1170.300	75.0
2005	210.706	185.299	396.005	370.400	128.000	0.000	498.400	65.000	959.300	59.0
2006	195.124	79.906	275.030	150.000	107.900	0.000	257.900	44.200	578.100	52.0
2007	69.998	21.376	91.374	120.000	32.200	0.000	152.200	14.300	257.800	65.0
2008	46.852	18.512	65.364	3.200	0.900	0.000	4.100	0.100	69.600	6.0
2009	23.337	17.536	40.873	0.000	0.200	0.100	0.300	0.000	41.200	1.0
2010	85.651	39.702	125.353	12.700	12.500	0.300	25.500	2.000	152.900	18.0

EXHIBIT C

TABLE 3. Comparisons of preseason forecast and postseason estimates for the Central Valley Index (CVI) or Sacramento Index (SI) X 1,000. 1985-2007 based on CVI, 2008-2010 based on SI. Data from PFMC Preseason Reports 2008 and 2011.

YEAR	Forecast CVI<2008 SI>2008	PostSeason CVI<2008 SI>2008	%Forecast/ PostSeason
1985	524.800	667.400	79.0%
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1999	847.700	766.400	111.0%
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2003	1108.100	896.700	124.0%
2004	831.800	869.600	96.0%
2005	1678.300	849.700	198.0%
2006	632.500	434.900	145.0%
2007	499.900	232.000	216.0%
2008/1	54.570	69.600	78.4%
2009	122.196	41.200	296.6%
2010	245.483	152.900	160.6%

/1 2008 SI (without river harvest component) CVI = 157,000

Subject: RE: 2011 Pacific Fishing Season, April Briefing Book
From: Tim O'Laughlin <towater@olaughlinparis.com>
Date: Sat, 26 Mar 2011 14:49:55 -0700
To: Kenneth Petruzzelli <KPetruzzelli@olaughlinparis.com>, pfmc.comments@noaa.gov
CC: demko@digitalpath.net, Michele Palmer <michele-palmer@sbcglobal.net>, Sunny Snider <sunnysnider@gmail.com>

I really think we need to focus on winter run and spring run. What protection are they getting? FRCS numbers may be up but their numbers are still going down. If I remember right the 2005 status had good spring and winter run numbers but still went on to say that the species was headed toward extirpation. Well, if the numbers have declined dramatically since that statement, what is their status now?

How are the proposed regulations going to protect spring and winter run in the ocean this year? Answer, they are not.

From: Kenneth Petruzzelli
Sent: Thursday, March 24, 2011 12:39 PM
To: 'pfmc.comments@noaa.gov'
Cc: 'Doug Demko (demko@digitalpath.net)'; 'Michele Palmer'; Tim O'Laughlin
Subject: 2011 Pacific Fishing Season, April Briefing Book

Please see the attached comments, submitted on behalf of the San Joaquin River Group Authority, for the April Briefing book regarding alternatives for 2011 harvest for Sacramento River Fall-run Chinook salmon.

Ken Petruzzelli

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O'Laughlin & Paris LLP Attorneys at Law

VIA Electronic Mail (pfmc.comments@noaa.gov)

March 24, 2011

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

Re: 2011 Pacific Fishing Season, April Briefing Book - alternatives for 2011 harvest for Sacramento River Fall-run Chinook salmon

Dear Mr. Chairman and members of the Council:

The San Joaquin River Group Authority ("SJRGA")[1], on whose behalf this letter is submitted, has had an opportunity to review the March 2011 Council Decision Document issued by the Pacific Fishery Management Council ("PFMC").

According to the Decision Document, the PFMC accepted the Salmon Technical Team's recommendation to consider the Sacramento River Fall-run Chinook salmon ("SRFC") stock not overfished and that overfishing did not occur in 2007-2009. Further, based on preliminary information showing that the Sacramento River fall Chinook spawning escapement in 2010 was within the management objectives of 122,000-180,000 adult spawners, the PFMC declared the overfishing concern status for this stock to be ended and that the stock is not currently in an overfished condition. (PFMC 2011c, p. 3.)

The PFMC's decision retroactively determining that SRFC were never overfished appears based on Amendment 16 to the *Fishery Management Plan for Commercial and Recreational Salmon Fisheries off the Coasts of Washington, Oregon and California* ("Salmon FMP"). However, Amendment 16 has not yet been enacted into regulation. Unless and until it is, the management objectives in the Salmon FMP, adopted in Amendment 14, remain the legal and regulatory requirement.[2]

[1] The SJRGA is a joint power authority consisting of irrigation and water districts, throughout the San Joaquin River basin. The SJRGA's member agencies use and divert water from the San Joaquin River and from its tributaries, pursuant to contract rights, riparian rights and pre-1914 and post-1914 rights of appropriation. They put the water to various beneficial uses, including irrigation, hydropower, storage, and municipal and domestic use. The SJRGA member agencies participate in a multitude of efforts focused on preserving and restoring Fall-run Chinook salmon, such as the Vernalis Adaptive Management Plan. They are also subject to a variety of regulatory conditions, especially in licenses issued by the Federal Energy Regulatory Commission, intended to protect, restore, and preserve SRFC.

[2] The Habitat Committee concurred with this assessment. (PFMC 2011d, p. 1)

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Furthermore, guidance issued by the National Marine Fisheries Service ("NMFS") instructed the PFMC to adopt management measures designed to achieve escapement at the upper end of the conservation objective. Although the management measures adopted by the PFMC were anticipated to result in escapement of 245,500, the actual escapement achieved fell far short, with actual escapement, 152,857 adults, approximately 1.6 times *less* than forecast and far less that the conservation objective's upper bound of 180,000. (75 FR 24484 (May 5, 2010); PFMC 2011a, p. 15; PFMC 2011c, p. 12.)

Failure to meet the anticipated escapement of 245,500 in 2010 was due to uncertainty in the Sacramento Index ("SI") forecast. There is considerable variability in the relationship between the SI forecast and the previous year's Jack escapement value, which is how the PFMC forecasts the abundance of SRFC. Figure 1 shows the percent difference between the forecasted index and post-season abundance index, demonstrating that since 2003, the actual post-season index was less than the forecast almost every year (exceptions are 2004 & 2008). The highest difference occurred in 2009 when the preseason forecast was over three times the actual post-season value (PFMC 2010a). According to the (PFMC 2010a, page 3), due to the use of jacks as basis for the SI, there is "a potential for the SI forecast to be biased high in years when the strength of successive cohorts is increasing… Hence there is potential for the 2011 SI forecast to be biased high."

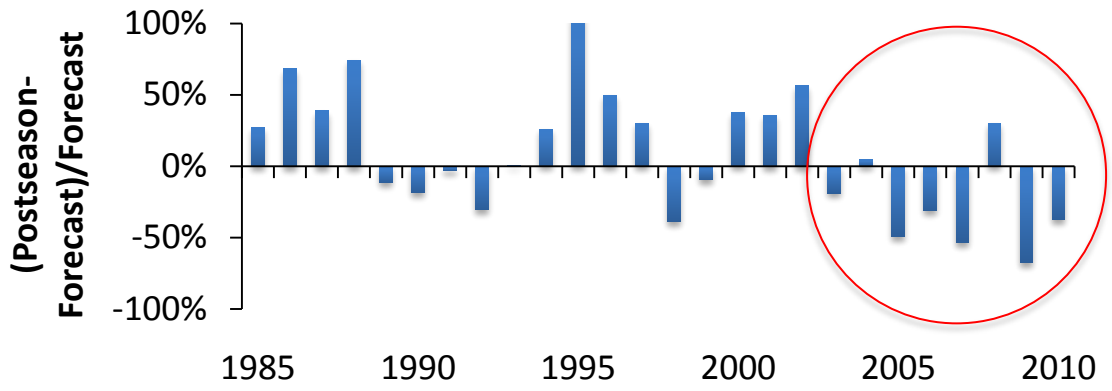


Figure 1. Percent difference between forecasted and post-season SRFC abundance indices.

Based on the SI forecast, the *2011 Preseason Report I* projected an abundance of 729,893 adult SRFC, but due to uncertainty in the SI forecast, the upper and lower bounds of the prediction interval range from 1,228,114 to 231,671. (PFMC 2011a, p. 15.) The report further forecasts that the No-Action Alternative, a repeat of the 2010 regulations, which included a Sacramento River Basin recreational quota of 8,200 SRFC, would be expected to result in an escapement of 572,600 natural and hatchery SRFC adults. (PFMC 2011a, p. 66.) The forecast for the No-Action Alternative can only be as accurate as the information it is based. Since the forecast for the No-Action Alternative is based on the SI forecast abundance, it would suffer from the same uncertainty, but no

upper and lower bound is given for the No-Action Alternative. Due to the substantial uncertainty of the SI forecast, even the No-Action Alternative could fail to meet the Salmon FMP conservation criteria. The 2011 alternatives similarly suffer from the uncertainty of the SI index. Escapement goals for the alternatives range from 368,700 to 376,800, but, again, no upper and lower bound is given for each alternative and, just like the No-Action Alternative, all three could fail to meet the Salmon FMP conservation criteria.

SRFC are not listed as threatened or endangered under the Endangered Species Act ("ESA"), as amended, 16 U.S.C. § 1531 et seq., but are nonetheless listed as a "species of concern" by NMFS. (69 FR 19978 (Apr. 15, 2004); 64 FR 60394 (Sept. 16, 1999).) The three consecutive years of 2007-2009 had the worst escapements on record, with ocean conditions cited by the *Supplemental SRFC Stock Assessment* as the "proximate cause." (PFMC 2011d, p. 8.) The stock also has a high hatchery component, high enough to make the stock highly homogeneous and vulnerable to catastrophic crashes. (Id., p. 1.) Although escapement improved in 2010, escapement in 2011 will be lower. (SJGA 2011, p. 10.) Parental stock is lower, ocean conditions in the Northern California current were better for most fish contributing to the 2010 escapement than for 2011, and, based on the proposed alternatives, commercial harvest in 2011 will be higher than in 2010. (SJRGA 2011.) When combined with the uncertainty inherent in the SI forecast used to develop the proposed alternatives, escapement in 2011 could easily fail to meet the lower bound of the Salmon FMP's SRFC conservation objective and again trigger a conservation alert. Under the Salmon FMP, the PFMC would again be required to close the salmon fisheries south of Cape Falcon.

Considering the status of SRFC, the efforts currently being made in the Delta and in freshwater streams to restore their numbers, and the economic impacts to the fishing industry caused by previous closures, the SJRGA recommends that the PFMC either close the salmon fishery South of Cape Falcon for another year or, at the least, adopt more conservative alternatives. Either will allow for additional SRFC recovery and reduce the risk of another closure in the near future. The PFMC has erred by substantial margins during the last several years (Figure 1). Nobody can afford for the PFMC to be wrong again.

Very truly yours,
O'LAUGHLIN & PARIS LLP

By: _____
KENNETH PETRUZZELLI

References

Pacific Fishery Management Council. 1999. Fishery Management Plan for Commercial and Recreational Salmon Fisheries off the Coasts of Washington, Oregon and

California. Pacific Fishery Management Council, Portland. http://www.pcouncil.org/wp-content/uploads/fmpthrua14.pdf

Pacific Fishery Management Council. 2011a. 2011 Preseason Report I: Stock Abundance Analysis and Environmental Assessment Part 1 for 2011 Ocean Salmon Fishery Regulations. Pacific Fishery Management Council, Portland. http://www.pcouncil.org/wp-content/uploads/Preseason_Report_I_2011.pdf

Pacific Fishery Management Council. 2011b. 2011 Preseason Report II: Proposed Alternatives and Environmental Assessment Part 2 for 2011 Ocean Salmon Fishery Regulations. Pacific Fishery Management Council, Portland. http://www.pcouncil.org/wp-content/uploads/Preseason_Report_II_2011.pdf

Pacific Fishery Management Council. 2011c. March 2011 Council Decisions. Pacific Fishery Management Council, Portland. http://www.pcouncil.org/wp-content/uploads/0311decisions.pdf

Pacific Fishery Management Council. 2011d. Habitat Committee Report on Sacramento River Fall Chinook Overfishing Assessment, Agenda Item G.3.b, March 2011. Pacific Fishery Management Council, Portland. http://www.pcouncil.org/wp-content/uploads/G3b_SUP_HC_MAR2011BB.pdf

Pacific Fishery Management Council. 2011e. Supplemental SRFC Stock Assessment, Agenda Item G.3.b, March 2011. Pacific Fishery Management Council, Portland. http://www.pcouncil.org/wp-content/uploads/G3b_SUP_SRFC_SA_MAR2011BB.pdf

San Joaquin River Group Authority. 2011. 2011 Fishing Season, Agenda Item G.4.d, March 2011. Pacific Fishery Management Council, Portland. http://www.pcouncil.org/wp-content/uploads/G4d_PC_MAR2011BB.pdf

Subject: CA. KMZ SALMON SEASON
Date: Sat, 02 Apr 2011 19:17:41 -0700
From: Joe Wallace <bfdolopp@msn.com>
To: Chuck.Tracy@noaa.gov

I WOULD LIKE TO GO ON THE RECORD SUPPORTING ALTERNATIVE 1 FOR NORTHERN CA. KMZ. WE DON'T THINK IT'S ENOUGH COMPARED TO THE ALTERNATIVES FOR SOUTHERN CA. BUT IT'S BETTER THAN NOTHING, AND A WHOLE LOT BETTER THAN WHAT WE HAVE HAD IN THE LAST FEW YEARS. ROBT. WAKEFIELD OF THE "F/V LORI" ASKED ME TO ALSO INCLUDE HIS SUPPORT FOR ALTERNATIVE 1. THANK YOU...

JOE WALLACE
F/V SEA PEARL
121 REDWOOD LANE
CRESCENT CITY,CA. 95531

G 2.g
Supp. PC3
April 2011

Fishermen's Association of Moss Landing

PO Box 44

Moss Landing, CA 95039

Dear Chairman Cedergreen, and Members of the Pacific Council:

Our organization represents salmon fishermen in Moss Landing who fish the Central California and West Coast fisheries. Our larger fleet trolls for salmon until albacore show up on the coast and then switch over to that fishery in July. The month of June then becomes important to our local ports. Table 1.Alternatives Horse Mountain to Point Arena (Fort Bragg); these are token fisheries proposed at 15 Chinook per day during high Klamath impact times in June and early July. Alternatives Point Arena to the Pigeon Point / Mexican Border; June options are minimal with option I at 6 fishing days, option II no fishing days, and option III at 7 fishing days.

We respectfully request you consider making the best use of the Klamath fish by allowing increased opportunity South of Point Arena and reduce quota fish days in the token fisheries in the area of Horse Mountain to Point Arena. Fifteen fish per day in that region extrapolates to a higher opportunity below Point Arena. In seeking information from fishermen in the North we understand that Crescent City boats in the past landed 90% of their fish caught in Eureka and some boats in that area own permits for Oregon and fish Oregon salmon. Therefore, concerns of impacts from boats moving South are unlikely.

We request a review of the 16% cap placed on the Klamath Ocean Harvest model and it being as a surrogate for the California Coastal Fall Chinook. If we had the extra 16% of harvestable fish which is about 4,000 of the 35,000 harvestable fish it would relieve the restraint and eliminate leaving those fish on the table which is restraining all west coast salmon fisheries. It prevents us from catching the Sacramento Fish. Maximum escapement goal is 180,000 and there are 354,000 which will leave 174,000 being left on the table. The goal of not being draconian is a real problem under the current conditions.

Our ports on the Central Coast are concerned along with other ports from the loss of troll fish and trawl fish and the stability of our fishery. We politely request more time in June or one week-on and one-week off, or June 12th through the end of June that could run into the first week of July, allowing the last two weeks of June to be open. Please allow us a little more fishing time. When the fish were in trouble, our port supported a complete closure, knowing ocean fisheries were not the problem. We want to come up with something that is reasonable and logical so we request a constructive change to stager the fishery in July in South of Arena and put savings into June and get rid of the token fisheries and put those fish into June. Ten additional days in June would help our fisheries.

We would like to see more opportunity in Fort Bragg during a time of least Klamath impact. We understand your consideration for people in that area. However, please consider the large number of people making a sacrifice to put all those small quotas in place. Thank you.

Kathy Fosmark, President FAML

I am a California salmon fisherman and my home port is in San Francisco. Please delete the quotas in Crescent City and put the time into July in Ft. Bragg or June in San Francisco and Moss Landing and Monterey. This is a better choice for the coastal economies.

Signature	Print Name	Boat Name	Phone Number
[illegible]	Rick Sullivan	Wet & Wild	831-254-7006
William Boswell	William Boswell	BETICIA	8315126986
Scott Thomson	SCOTT THOMSON	TOPAZ	8312473271
~~Bill Cook~~			
William W. Cook	William W. Cook	FOUR C'S	831-3848185
D. Deas	DUGG DEAS	SUSIE	502 727 5093
Johnny C. Bikker	JOHNNY BIKKER	SEA MISTRESS	831-724-3541
[illegible]	MERRILL P. MELIN	TIFFANY	8314642993
Steve Fosmark	Steve Fosmark	Seealder	8316014074
[illegible]	RON LATHAM	SKAGIT	408-842-9068
Larry [illegible]	LARRY J. BYRD	GREY BEAUD	831-394 1295
Ben Antrim	BEN ANTRIM	Moko Lii	(408) 848-3020
Francesca Crow	Francesca Crow	Beticia	831 229 7373
Richard L. Snyder	RICHARD SNYDER	JEANNE "B"	408-898-0848
Tom McCray	TOM MCCRAY	TONTO II	831-633-3826
Jim Cunningham	Jim Cunningham	MARRIETTE	831-657-9045
[illegible]	A. VANDAGS	TICA	7077030644
Tom Eckert	Tom Eckert	Barbara Ann II	831-3352457
[illegible]	Kathy Fosmark	Seealder	831-373-5238

Agenda item G.2.h
Supplemental Tribal Motion
April 2011

Tentative Adoption of 2011 Management Measures

- For coho, there are specific conservation concerns for the Lower Columbia River wild stock. We are also aware of the need to keep all U.S. fisheries south of the Canadian border to the level in the Pacific Salmon Treaty coho agreement. This includes the Interior Fraser (Thompson) coho.

- For Chinook, we have a complex task of meeting the exploitation rate objectives defined in our Comprehensive Chinook Harvest Plan for Puget Sound Chinook, and meeting the guidelines for Columbia Lower River Natural Tules.

- We have been in the process of establishing, cooperatively with the Washington Department of Fish and Wildlife (WDFW), a package of fisheries that will ensure acceptable levels of impact on natural stocks of concern as well as providing opportunity to harvest hatchery stocks. In many cases we have reached agreement on specific 2011 management measures and terminal area fisheries agreements. The tribes are continuing to work cooperatively with WDFW in hopes of finding successful outcomes for the remaining regions and terminal area fisheries.

For the Treaty Indian ocean troll fishery, I would like to offer the following Treaty troll management measures for ***tentative*** adoption and for analysis by the Salmon Technical Team:

A Chinook quota of: 45,000

A coho quota of: 42,000

This would consist of a May/June chinook only fishery and a July/August/September all species fishery. The chinook will be split 22,500 in May/June and 22,500 in July-September. Gear restrictions, size limits and other appropriate regulations would be as stated in previous Salmon Technical Team analysis, (Table 3).

METHODOLOGY REVIEW PROCESS AND PRELIMINARY TOPIC SELECTION FOR 2011

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. The process normally involves: developing a list of potential topics for review at the April Council meeting; final selection of review topics at the September Council meeting; review of selected topics in October by the SSC Salmon Subcommittee and the Salmon Technical Team (STT); and review by the full SSC at the November Council meeting. This review process 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, providing directions for handling any unresolved methodology problems prior to the formulation of salmon management options in 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 SSC will receive input from the STT, the Tule Chinook Workgroup, and the Model Evaluation Workgroup, and provide recommendations for methodologies to be reviewed in 2011.

Council Task:

1. **Provide guidance to the SSC regarding potential topics and priorities for methodologies to be reviewed in 2011.**
2. **Request affected agencies develop and provide needed materials to the SSC, as appropriate.**

Reference Materials:

1. Agenda Item G.3.b, TCW Report: Tule Chinook Workgroup Progress Report on Potential Abundance Based Management Approaches.
2. Agenda Item G.3.b, Supplemental SSC Report: Scientific and Statistical Committee Report on Methodology Reviews for 2011.

Agenda Order:

a. Agenda Item Overview — Chuck Tracy
b. Reports and Comments of Advisory Bodies and Management Entities
c. Public Comment
d. Council Guidance on Potential Methodologies to Review in 2011

PFMC
03/23/11

MODEL EVALUATION WORKGROUP REPORT ON SALMON METHODOLOGY REVIEW PROCESS AND PRELIMINARY TOPIC SELECTION FOR 2011

The Model Evaluation Workgroup (MEW) has one on-going methodology project still in progress, and we also have some new projects that may also be appropriate for review this fall by the Salmon Subcommittee of the Scientific and Statistical Committee (SSC) and the Salmon Technical Team (STT). The on-going project is:

1. A continuing examination of the potential bias introduced by mark-selective fisheries (MSF) upon our harvest models' estimation of fishery related mortality for unmarked coho, with the goal of incorporation of MSF bias correction equations into program code for the Coho Fishery Regulation Assessment Model (FRAM).

Potential new methodology items are:

2. Conversion of Council pre-season salmon modeling tool from FRAM Visual Basic version to FRAM Visual Studio version, with summary of related improvement to FRAM and associated documentation.

3. Conduct a multi-year review of preseason and postseason north of Cape Falcon ocean mark selective coho fisheries.

There are other projects MEW members will be working on this summer that may become future methodology review items. We hope to schedule a MEW meeting, after the April preseason process concludes, to discuss the above work projects and to develop a future list of methodology review items.

PFMC
04/10/11

SALMON ADVISORY SUBPANEL REPORT ON METHODOLOGY REVIEW PROCESS AND PRELIMINARY TOPIC SELECTION FOR 2011

The Salmon Advisory Subpanel (SAS) is composed of stakeholders from Idaho, Washington, Oregon and California, who work together to devise solutions to salmon fisheries issues affecting the entire coast. These issues may include season-setting and environmental issues, among others. We would like to take this opportunity to publicly thank the Pacific Fishery Management Council (Council) and NOAA Fisheries for embarking on an examination of abundance based management of Columbia River tule fall Chinook. To date, the process has been an open and transparent one, with meetings that have been attended by a number of stakeholders and documents that have been informative and widely disseminated.

As members of fishing communities we recognize that the key to our future is salmon production and recovery. We are encouraged by the commitment to recovery and the on-the-ground work being done in a variety of settings, by numerous agencies and non-profit groups. We have looked at the harvest model ranges being assessed for risk to the stocks and would like to request that a risk analysis be conducted for a higher range, perhaps at the 50-52% level, and possibly a lower range. Our reasons for this are that as the various salmon recovery plans are implemented, we should see a corresponding increase in salmon productivity. Further, tule fall Chinook have been fished at higher levels in the past e.g. over 60%. We believe that a risk analysis for a higher exploitation rate should be conducted to see whether a higher harvest rate might be justifiable in the future. We are not averse to harvest modeling at a lower rate as well, in the 20-22% range, in case of catastrophic failure of a brood year or some other disaster, so that we will have some idea of the magnitude of such a situation.

After some discussion, we agreed that we would like to avoid wide gaps between exploitation rates in the low, medium and high categories, and prefer that they be expressed as ranges or a sliding scale. We are very encouraged by the progress that has been made to date, and urge that an aggressive timetable for completion of this work be followed. Our communities are frequent advocates for fish, and the draconian harvest cuts over the past years have been discouraging and difficult to deal with. We know the costs of these sinking exploitation rates; the benefits to the stock have not been adequately quantified, in our view. Our communities need to feel that they have a stake in the fish runs and fisheries and that there is a future for them. We would appreciate your serious consideration of our comments and requests.

PFMC
04/10/11

SCIENTIFIC AND STATISTICAL COMMITTEE REPORT ON METHODOLOGY REVIEW AND PRELIMINARY TOPIC SELECTION FOR 2011

The Scientific and Statistical Committee (SSC) met with the Salmon Technical Team (STT) and Mr. Chuck Tracy to discuss possible methodology review topics for 2011. The following items were identified for potential SSC review this fall. The lead entity for each work product is identified at the end of the item.

1) A multi-year review of preseason and postseason Council North of Falcon ocean mark-selective fisheries for coho salmon – Model Evaluation Workgroup.
2) Proposed methods for bias correction and possible effects on coho Fishery Regulation Assessment Model (FRAM) estimates of total mortality for unmarked stocks - Model Evaluation Workgroup.
3) Forecast methodology for Lower Columbia River (LCR) tule fall Chinook – Tule Chinook Workgroup.
4) Abundance-based management options for LCR tule fall Chinook – Tule Chinook Workgroup.
5) Revisions to Amendment 13 matrix control rules for Oregon coastal natural (OCN) coho stocks – Oregon Department of Fish and Wildlife.

The SSC requires proper 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
04/10/11

SALMON TECHNICAL TEAM REPORT ON SALMON METHODOLOGY REVIEW PROCESS AND PRELIMINARY TOPIC SELECTION FOR 2011

The Salmon Technical Team (STT) met with the Scientific and Statistical Committee and Mr. Chuck Tracy of the Council staff to discuss potential topics for review in 2011. The following topics for potential review were discussed:

1) A multi-year review of pre-season expectations and post-season evaluations of mark selective fisheries for coho salmon.
2) Proposed methods for bias correction of impacts on unmarked stocks in the coho Fishery Regulation Assessment Model (FRAM).
3) Options for abundance-based management of Lower Columbia River tule fall Chinook salmon.
4) Revisions to the Oregon Coast Natural (OCN) coho matrix of harvest control rules.

PFMC
4/10/11

Agenda Item G.3.b
Supplemental Tribal Report
April 2011

Salmon Methodology Review

The tribes have requested a multi-year review of the ocean mark-selective fisheries for coho that have been ongoing in Areas 1-4 for the past twelve years.

WDFW suggested that the STT should first review previous ocean mark selective fishery reports for accuracy and see if the reports adequately summarize mark selective fishery impacts to wild fish. They would then determine if a multi-year evaluation would be practical or necessary.

The tribes would like to know the status of the STT review.

The tribes did receive the 2010 Chinook and coho ocean mark selective report from WDFW. The 2010 report is a big improvement from past years reports. The exchange of these reports between the STT, SSC, NOAA Fisheries and the Tribes is very important, and the tribes feel that this kind of reporting of the mark selective fisheries is needed in order for these types of fisheries to continue in the ocean.

TULE CHINOOK WORKGROUP PROGRESS REPORT ON POTENTIAL ABUNDANCE BASED MANAGEMENT APPROACHES

The Tule Chinook Workgroup (TCW) developed a draft work plan, which identified four primary tasks involving Lower Columbia River (LCR) natural tule fall Chinook. These included identification and evaluation of:

1) effects of alternative fishing rate strategies,
2) forecasting methods for LCR tule Chinook abundance,
3) alternative abundance-based fishing rate strategies, and
4) effects of alternative fishing rate strategies on escapement and population risks.

Task 1 – Fishing Effects: This task evaluates the feasibility and fishery implications of lower or higher tule impact rate limits. Results will help guide identification of abundance-based fishery alternatives that will be evaluated by the TCW. Retrospective analyses of 2008-2010 fisheries were conducted using the Fishery Regulation Assessment Model (FRAM) to identify example changes in fishery-specific exploitation rates that would have resulted from a low status estimate for LCR natural tule Chinook under implementation of an abundance-based management system. This analysis considered the recent distribution of exploitation in Alaskan, Canadian, Council area, and Columbia River fisheries. In these examples, impacts on the LCN tule stock in the southern U.S. fisheries would have to be reduced by nearly 50 percent in order to remain under an exploitation rate ceiling of 28 percent and by 23 percent to remain under a ceiling of 33 percent, assuming current conditions in northern fisheries.

Task 2 – Forecasting Methods: Forecast methods were evaluated because the success of an abundance-based fishery strategy will depend in part on the ability to accurately forecast abundance. Forecast accuracy will also be explicitly incorporated into the fishery risk modeling. Precision and accuracy of historical forecasts of hatchery tules was documented for use in assessing risks associated with forecast errors. In addition, alternatives were explored for improving forecast precision by incorporating ocean environmental indicators and advanced statistical methods. Based on these analyses, the Joint staff has determined that current forecast methods based on sibling regressions are likely to continue to provide relatively unbiased and accurate forecasts for the time being. Continuing investigations might provide improved forecasting methods in the future. Fishery risk analysis will include sensitivity analyses of the potential risk reduction benefits associated with improvements in forecast accuracy.

Task 3 – Alternative Identification: Examples of abundance-based matrix fishery strategies were identified based on preliminary analyses described above. Initial analyses focused on matrices based on forecasts of the aggregate lower Columbia River hatchery (LRH) run with Columbia River run size tiers of less than 40,000 (27 percent occurrence), 40,000 to 100,000 (45 percent occurrence), and greater than 100,000 (27 percent occurrence). Other alternatives might also include indicators based on natural index populations, ocean survival indices, environmental correlates, and/or natural tule seeding levels. By way of example, an abundance-based matrix might identify a fishery impact rate of 33 percent in the lower tier, 38 percent in the middle tier, and 43 percent in the upper tier. Other potential matrices might involve lower rates (28 percent) at low run size tiers, higher rates (48 percent) at high run sizes, differences in the base 38 percent

exploitation rate in combination with different tiers, or fixed rates in middle and upper tiers depended on the desired balance in risk reduction versus fishery flexibility.

Task 4 – Risk Analysis: A conceptual approach was identified for analysis of natural tule population risks using stochastic stock-recruitment modeling. This approach is consistent with population viability analyses employed in salmon Endangered Species Act (ESA) status assessments and recovery plans. Similar modeling approaches have previously been utilized by the Council in conservation risk analyses for other stocks, including Klamath River fall Chinook. A contractor has been engaged to develop and implement this risk analysis consistent with guidance from the TCW. A quantitative risk assessment model was configured and used to begin exploring the sensitivity of fishery harvest and natural escapement to different combinations of model inputs. For initial assessments, fishery effects of different impact rates were modeled based on average harvests of the aggregate LRH run. Fishery risks to natural tule populations were modeled based on the frequency of critical low escapement levels in natural populations of varying size and productivity representative of the range of population status within the lower Columbia River Chinook ESU.

Preliminary modeling results presented to the TCW on 2/10/2011 indicated that an abundance-based exploitation rate strategy might be effective in reducing risks to natural population viability and increasing fishery opportunity under certain combinations of conditions and assumptions.

Exploratory analyses suggested that the effectiveness of an abundance-based fishery strategy depends strongly on the degree of correlation between marine survival of natural and hatchery fish. The TCW subsequently analyzed correlations between population-specific natural escapements and the aggregate LRH run sizes and marine survival rates. Data on historical releases and returns of LRH tule stock were compiled and analyzed to estimate an annual marine survival index for potential use as an indicator of natural tule abundance. Results of these analyses identified significant correlations among historical data on total LRH returns, hatchery releases, a hatchery survival index, and naturally-produced fish returning to Washington streams. The LRH return was at least partially correlated with natural Chinook numbers considered in aggregate and in many or most natural populations throughout the historical data set and in the recent 10-year period. The strongest relationships were observed between the LRH and total natural returns. Population-specific correlations to the LRH return varied as did correlations among the individual natural populations. Interestingly, correlations were generally no better to the survival rate index than the total LRH return; stronger correlations to the survival rate index, which controlled for effects of variable hatchery release numbers over time, were expected.

These results suggest that further analysis of an abundance-based approach to tule harvest rate management is appropriate. The next step will be to fully configure the risk model with explicit inputs and functions representing partial correlations between LRH and natural abundance, and sources of variability that affect risk including forecast uncertainty and fishery implementation error. The model will then be subjected to a comprehensive suite of calibration, validation, sensitivity, and scenario analyses, with associated documentation for review by the TCW.

CLARIFY COUNCIL DIRECTION ON 2011 MANAGEMENT MEASURES

The Salmon Technical Team (STT) will present a preliminary analysis of the tentative management measures for additional Council guidance.

Council Task:

Provide any needed guidance to assist the STT in its analysis of the tentative management measures.

Reference Materials:

1. Agenda Item G.4.b, Supplemental STT Report: Preliminary Analysis of Tentative 2011 Ocean Salmon Fishery Management Measures.

Agenda Order:

a. Agenda Item Overview — Chuck Tracy
b. Reports and Comments of Advisory Bodies and Management Entities
c. Public Comment
d. Council Guidance and Direction

PFMC
03/17/11

Agenda Item G.4.b
Supplemental STT Report
April 2011

SALMON TECHNICAL TEAM

PRELIMINARY ANALYSIS OF TENTATIVE 2011 OCEAN SALMON FISHERY MANAGEMENT MEASURES

April 11, 2011

TABLE 1. Commercial troll management measures collated by the STT for non-Indian ocean salmon fisheries, 2011.4/10/11 17:48 (Page 1 of 5)

A. SEASON DESCRIPTIONS

North of Cape Falcon

Supplemental Management Information

1. Overall non-Indian TAC: 67,800 (non-mark-selective equivalent of 65,000) Chinook and 80,000 coho marked with a healed adipose fin clip (marked).
2. Non-Indian commercial troll TAC: 32,500 Chinook and 12,800 marked coho.
3. No preseason trade of Chinook or coho between non-Indian commercial and recreational fisheries.

U.S./Canada Border to Cape Falcon

- May 1 through earlier of June 30 or 22,000 Chinook quota.

Seven days per week (C.1). All salmon except coho (C.7). Cape Flattery, Mandatory Yelloweye Rockfish Conservation Area, and Columbia Control Zones closed (C.5). See gear restrictions and definitions (C.2, C.3).
An inseason conference call will occur when it is projected that 14,500 Chinook have been landed to consider modifying the open period to five days per week and adding landing and possession limits to ensure the guideline is not exceeded.

U.S./Canada Border to Cape Falcon

- July 1 through earlier of September 15 or 10,500 preseason Chinook guideline (C.8) or a 12,800 marked coho quota (C.8.d).

Friday through Tuesday; landing and possession limit of 50 Chinook and 50 coho per vessel per open period north of Leadbetter Point or 50 Chinook and 50 coho south of Leadbetter Point (C.1). All Salmon except no chum retention north of Cape Alava, Washington in August and September (C.7). All coho must be marked (C.8.d). See gear restrictions and definitions (C.2, C.3). Cape Flattery, Mandatory Yelloweye Rockfish Conservation Area, and Columbia Control Zones closed; Grays Harbor Control Zone closed in August and September (C.5).

Vessels must land and deliver their fish within 24 hours of any closure of this fishery. Under state law, vessels must report their catch on a state fish receiving ticket. Vessels fishing or in possession of salmon while fishing north of Leadbetter Point must land and deliver their fish within the area and north of Leadbetter Point. Vessels fishing or in possession of salmon while fishing south of Leadbetter Point must land and deliver their fish within the area and south of Leadbetter Point, except that Oregon permitted vessels may also land their fish in Garibaldi, Oregon. Oregon State regulations require all fishers landing salmon into Oregon from any fishery between Leadbetter Point, Washington and Cape Falcon, Oregon must notify ODFW within one hour of delivery or prior to transport away from the port of landing by either calling 541-867-0300 Ext. 271 or sending notification via e-mail to nfalcon.trollreport@state.or.us. Notification shall include vessel name and number, number of salmon by species, port of landing and location of delivery, and estimated time of delivery. Inseason actions may modify harvest guidelines in later fisheries to achieve or prevent exceeding the overall allowable troll harvest impacts (C.8).

TABLE 1. Commercial troll management measures collated by the STT for non-Indian ocean salmon fisheries, 2011. 4/11/11 11:43 (Page 2 of 5)

A. SEASON DESCRIPTIONS

South of Cape Falcon

Supplemental Management Information

1. Sacramento River Basin recreational fishery catch assumption: 61,300 adult Sacramento River fall Chinook.
2. Sacramento River fall Chinook spawning escapement of 376,400 adults.
3. Klamath River recreational fishery allocation: 7,900 adult Klamath River fall Chinook.
4. Klamath tribal allocation: 34,800 adult Klamath River fall Chinook.

Cape Falcon to Humbug Mt.

- April 15 through July 9, July 17 through August 31, October 1-31. (C.9).

Seven days per week. All salmon except coho; landing and possession limit of 50 Chinook per vessel per calendar week in October (C.7). All vessels fishing in the area must land their fish in the State of Oregon. See gear restrictions and definitions (C.2, C.3) and Oregon State regulations for a description of special regulations at the mouth of Tillamook Bay.

In 2012, the season will open March 15 for all salmon except coho. This opening could be modified following Council review at its March 2012 meeting.

Humbug Mt. to OR/CA Border (Oregon KMZ)

- May 1-31;
- June 1 through earlier of June 30, or a 1,500 Chinook quota;
- July 1 through earlier of July 31, or a 1,200 Chinook quota;
- Aug. 1 through earlier of Aug. 31, or a 1,000 Chinook quota (C.9).

Seven days per week. All salmon except coho (C.7). Chinook 28 inch total length minimum size limit (B). June 1 through August 31, landing and possession limit of 30 Chinook per vessel per day. Any remaining portion of the June and/or July Chinook quotas may be transferred inseason on an impact neutral basis to the next open quota period (C.8). All vessels fishing in this area must land and deliver all fish within this area or Port Orford, within 24 hours of any closure in this fishery, and prior to fishing outside of this area (C.1, C.6). Oregon State regulations require all fishers landing salmon from any quota managed season within this area to notify Oregon Dept. of Fish and Wildlife (ODFW) within 1 hour of delivery or prior to transport away from the port of landing by either calling (541) 867-0300 ext. 252 or sending notification via e-mail to KMZOR.trollreport@state.or.us. Notification shall include vessel name and number, number of salmon by species, port of landing and location of delivery, and estimated time of delivery. See gear restrictions and definitions (C.2, C.3).

In 2012, the season will open March 15 for all salmon except coho, with a 28 inch Chinook minimum size limit. This opening could be modified following Council review at its March 2012 meeting.

OR/CA Border to Humboldt South Jetty (California KMZ)

- July 2 through the earlier of July 20 or a 1,400 Chinook quota, Saturday to Wednesday;
- Aug. 1 through earlier of Aug. 15 or a 1,000 Chinook quota, seven days per week;
- Sept. 15 through earlier of Sept 30, or a 2,000 Chinook quota, seven days per week (C.9).

All salmon except coho (C.7). Chinook 27 inch total length minimum size limit (B). Landing and possession limit of 15 Chinook per vessel. Any remaining portion of the July Chinook quota may be transferred inseason on an impact neutral basis to the August quota (C.8) All vessels fishing in this area must land and deliver all fish within this area, within 24 hours of any closure in this fishery, and prior to fishing outside of this area (C.1, C.6). See compliance requirements (C.1) and gear restrictions and definitions (C.2, C.3). Klamath Control Zone closed (C.5.e). See California State regulations for additional closures adjacent to the Smith and Klamath rivers. When the fishery is closed between the OR/CA border and Humbug Mt. and open to the south, vessels with fish on board caught in the open area off California may seek temporary mooring in Brookings, Oregon prior to landing in California only if such vessels first notify the Chetco River Coast Guard Station via VHF channel 22A between the hours of 0500 and 2200 and provide the vessel name, number of fish on board, and estimated time of arrival.

Humboldt South Jetty to Horse Mt.

Closed.

California State regulations require all salmon be made available to a CDFG representative for sampling immediately at port of landing. Any person in possession of a salmon with a missing adipose fin, upon request by an authorized agent or employee of the CDFG, shall immediately relinquish the head of the salmon to the state. (California Fish and Game Code §8226)

TABLE 1. Commercial troll management measures collated by the STT for non-Indian ocean salmon fisheries, 2011. 4/10/11 17:48 (Page 3 of 5)

A. SEASON DESCRIPTIONS

South of Cape Falcon

Horse Mt. to Point Arena (Fort Bragg)

- July 23-27
- July 29 through Aug. 29;
- Sept. 1-30 (C.9).

Seven days per week. All salmon except coho (C.7). Chinook 27 inch total length minimum size limit (B). All fish caught in the area when the KMZ quota fisheries are open must be landed south of Horse Mt.; all fish must be landed in California and offloaded within 24 hours of the August 29 closure (C.1, C.6). See gear restrictions and definitions (C.2, C.3).

Pt. Arena to Pigeon Pt. (San Francisco)

- May 1-31 seven days per week
- June 25 through July 5 seven days per week
- July 9-27 Saturday through Wednesday
- July 29 through Aug. 29 seven days per week
- September 1-30 seven days per week (C.9).

All salmon except coho (C.7). Chinook minimum size limit of 27 inches total length (B). All fish must be landed in California and offloaded within 24 hours of the August 29 closure. All fish caught in the area when the KMZ quota fisheries are open must be landed south of Horse Mt. (C.1, C.6). See gear restrictions and definitions (C.2, C.3).

Pt. Reyes to Pt. San Pedro (Fall Area Target Zone)

- October 3-14

Monday through Friday. All salmon except coho (C.1). Chinook minimum size limit 27 inches total length (B). All vessels fishing in this area must land and deliver all fish between Point Arena and Pigeon Point (C.1, C.6). See gear restrictions and definitions (C.2, C.3).

Pigeon Pt. to Pt. Sur (Monterey)

Same as Pt. Arena to Pigeon Pt.

Pt. Sur to U.S./Mexico Border (Monterey south)

- May 1 through July 5 seven days per week
- July 9-27 Saturday through Wednesday
- July 29 through Aug. 29 seven days per week
- September 1-30 seven days per week (C.9).

All salmon except coho (C.7). Chinook minimum size limit of 27 inches total length (B). All fish must be landed in California; all fish caught in the area June 1-24 must be landed south of Pt. San Pedro; all fish caught in the area when the KMZ quota fisheries are open must be landed south of Horse Mt. (C.1, C.6). See gear restrictions and definitions (C.2, C.3).

California State regulations require all salmon be made available to a CDFG representative for sampling immediately at port of landing. Any person in possession of a salmon with a missing adipose fin, upon request by an authorized agent or employee of the CDFG, shall immediately relinquish the head of the salmon to the state. (California Fish and Game Code §8226)

B. MINIMUM SIZE (Inches) (See C.1)

	Chinook		Coho		
Area (when open)	Total Length	Head-off	Total Length	Head-off	Pink
North of Cape Falcon	28.0	21.5	16.0	12.0	None
Cape Falcon to OR/CA Border	28.0	21.5	-	-	None
OR/CA Border to U.S./Mexico Border	27.0	20.5	-	-	None

C. REQUIREMENTS, DEFINITIONS, RESTRICTIONS, OR EXCEPTIONS

C.1. Compliance with Minimum Size or Other Special Restrictions: All salmon on board a vessel must meet the minimum size, landing/possession limit, or other special requirements for the area being fished and the area in which they are landed if the area is open. Salmon may be landed in an area that has been closed more than 96 hours only if they meet the minimum size, landing/possession limit, or other special requirements for the area in which they were caught. Salmon may be landed in an area that has been closed less than 96 hours only if they meet the minimum size, landing/possession limit, or other special requirements for the areas in which they were caught and landed.

States may require fish landing/receiving tickets be kept on board the vessel for 90 days after landing to account for all previous salmon landings.

C. REQUIREMENTS, DEFINITIONS, RESTRICTIONS, OR EXCEPTIONS (continued)

C.2. Gear Restrictions:

a. Salmon may be taken only by hook and line using single point, single shank, barbless hooks.
b. Cape Falcon, Oregon, to the OR/CA border: No more than 4 spreads are allowed per line.
c. OR/CA border to U.S./Mexico border: No more than 6 lines are allowed per vessel, and barbless circle hooks are required when fishing with bait by any means other than trolling.C.3. Gear Definitions:

Trolling defined: Fishing from a boat or floating device that is making way by means of a source of power, other than drifting by means of the prevailing water current or weather conditions.

Troll fishing gear defined: One or more lines that drag hooks behind a moving fishing vessel. In that portion of the fishery management area (FMA) off Oregon and Washington, the line or lines must be affixed to the vessel and must not be intentionally disengaged from the vessel at any time during the fishing operation.

Spread defined: A single leader connected to an individual lure and/or bait.

Circle hook defined: A hook with a generally circular shape and a point which turns inward, pointing directly to the shank at a 90º angle.

C.4. Transit Through Closed Areas with Salmon on Board: It is unlawful for a vessel to have troll or recreational gear in the water while transiting any area closed to fishing for a certain species of salmon, while possessing that species of salmon; however, fishing for species other than salmon is not prohibited if the area is open for such species, and no salmon are in possession.

C.5. Control Zone Definitions:

a. *Cape Flattery Control Zone* - The area from Cape Flattery (48º23'00" N. lat.) to the northern boundary of the U.S. EEZ; and the area from Cape Flattery south to Cape Alava (48º10'00" N. lat.) and east of 125º05'00" W. long.
b. *Mandatory Yelloweye Rockfish Conservation Area* – The area in Washington Marine Catch Area 3 from 48°00.00' N. lat.; 125°14.00' W. long. to 48°02.00' N. lat.; 125°14.00' W. long. to 48°02.00' N. lat.; 125°16.50' W. long. to 48°00.00' N. lat.; 125°16.50' W. long. and connecting back to 48°00.00' N. lat.; 125°14.00' W. long.
c. *Grays Harbor Control Zone* - The area defined by a line drawn from the Westport Lighthouse (46° 53'18" N. lat., 124° 07'01" W. long.) to Buoy #2 (46° 52'42" N. lat., 124°12'42" W. long.) to Buoy #3 (46° 55'00" N. lat., 124°14'48" W. long.) to the Grays Harbor north jetty (46° 36'00" N. lat., 124°10'51" W. long.).
d. *Columbia Control Zone* - An area at the Columbia River mouth, bounded on the west by a line running northeast/southwest between the red lighted Buoy #4 (46°13'35" N. lat., 124°06'50" W. long.) and the green lighted Buoy #7 (46°15'09' N. lat., 124°06'16" W. long.); on the east, by the Buoy #10 line which bears north/south at 357° true from the south jetty at 46°14'00" N. lat.,124°03'07" W. long. to its intersection with the north jetty; on the north, by a line running northeast/southwest between the green lighted Buoy #7 to the tip of the north jetty (46°15'48" N. lat., 124°05'20" W. long.), and then along the north jetty to the point of intersection with the Buoy #10 line; and, on the south, by a line running northeast/southwest between the red lighted Buoy #4 and tip of the south jetty (46°14'03" N. lat., 124°04'05" W. long.), and then along the south jetty to the point of intersection with the Buoy #10 line.
e. *Klamath Control Zone* - The ocean area at the Klamath River mouth bounded on the north by 41°38'48" N. lat. (approximately six nautical miles north of the Klamath River mouth); on the west, by 124°23'00" W. long. (approximately 12 nautical miles off shore); and on the south, by 41°26'48" N. lat. (approximately six nautical miles south of the Klamath River mouth).

C.6. Notification When Unsafe Conditions Prevent Compliance with Regulations: If prevented by unsafe weather conditions or mechanical problems from meeting special management area landing restrictions, vessels must notify the U.S. Coast Guard and receive acknowledgment of such notification prior to leaving the area. This notification shall include the name of the vessel, port where delivery will be made, approximate amount of salmon (by species) on board, the estimated time of arrival, and the specific reason the vessel is not able to meet special management area landing restrictions.

In addition to contacting the U.S. Coast Guard, vessels fishing south of the Oregon/California border must notify CDFG within one hour of leaving the management area by calling 800-889-8346 and providing the same information as reported to the U.S. Coast Guard. All salmon must be offloaded within 24 hours of reaching port.

C. REQUIREMENTS, DEFINITIONS, RESTRICTIONS, OR EXCEPTIONS (continued)

C.7. Incidental Halibut Harvest: During authorized periods, the operator of a vessel that has been issued an incidental halibut harvest license may retain Pacific halibut caught incidentally in Area 2A while trolling for salmon. Halibut retained must be no less than 32 inches in total length, measured from the tip of the lower jaw with the mouth closed to the extreme end of the middle of the tail, and must be landed with the head on. License applications for incidental harvest must be obtained from the International Pacific Halibut Commission (phone: 206-634-1838). Applicants must apply prior to April 1 of each year. Incidental harvest is authorized only during May and June troll seasons and after June 30 if quota remains and if announced on the NMFS hotline (phone: 800-662-9825). ODFW and Washington Department of Fish and Wildlife (WDFW) will monitor landings. If the landings are projected to exceed the 28,126 pound preseason allocation or the total Area 2A non-Indian commercial halibut allocation, NMFS will take inseason action to prohibit retention of halibut in the non-Indian salmon troll fishery.

Beginning May 1, license holders may land no more than one Pacific halibut per each 3 Chinook, except one Pacific halibut may be landed without meeting the ratio requirement, and no more than 35 halibut may be landed per trip. Pacific halibut retained must be no less than 32 inches in total length (with head on).

A "C-shaped" yelloweye rockfish conservation area is an area to be voluntarily avoided for salmon trolling. NMFS and the Council request salmon trollers voluntarily avoid this area in order to protect yelloweye rockfish. The area is defined in the Pacific Council Halibut Catch Sharing Plan in the North Coast subarea (Washington marine area 3), with the following coordinates in the order listed:

48°18' N. lat.; 125°18' W. long.;
48°18' N. lat.; 124°59' W. long.;
48°11' N. lat.; 124°59' W. long.;
48°11' N. lat.; 125°11' W. long.;
48°04' N. lat.; 125°11' W. long.;
48°04' N. lat.; 124°59' W. long.;
48°00' N. lat.; 124°59' W. long.;
48°00' N. lat.; 125°18' W. long.;
and connecting back to 48°18' N. lat.; 125°18' W. long.

C.8. Inseason Management: In addition to standard inseason actions or modifications already noted under the season description, the following inseason guidance is provided to NMFS:

a. Chinook remaining from the May through June non-Indian commercial troll harvest guideline north of Cape Falcon may be transferred to the July through September harvest guideline on a fishery impact equivalent basis.
b. Chinook remaining from the June and/or July non-Indian commercial troll quotas in the Oregon KMZ may be transferred to the Chinook quota for the next open period on a fishery impact equivalent basis.
c. Chinook remaining from the July non-Indian commercial troll quota in the California KMZ area may be transferred to the August quota on a fishery impact equivalent basis.
d. NMFS may transfer fish between the recreational and commercial fisheries north of Cape Falcon on a fishery impact equivalent basis if there is agreement among the areas' representatives on the Salmon Advisory Subpanel (SAS).
e. At the March 2012 meeting, the Council will consider inseason recommendations for special regulations for any experimental fisheries (proposals must meet Council protocol and be received in November 2011).
f. If retention of unmarked coho is permitted by inseason action, the allowable coho quota will be adjusted to ensure preseason projected mortality of critical stocks is not exceeded.
g. Landing limits may be modified inseason to sustain season length and keep harvest within overall quotas.

C.9. State Waters Fisheries: Consistent with Council management objectives:

a. The State of Oregon may establish additional late-season fisheries in state waters.
b. The State of California may establish limited fisheries in selected state waters.

Check state regulations for details.

C.10. For the purposes of California Department of Fish and Game (CDFG) Code, Section 8232.5, the definition of the Klamath Management Zone (KMZ) for the ocean salmon season shall be that area from Humbug Mt., Oregon, to Horse Mt., California.

TABLE 2. Recreational management measures collated by the STT for non-Indian ocean salmon fisheries, 2011. (Page 1 of 4)
4/11/11 11:39

A. SEASON DESCRIPTIONS

North of Cape Falcon

Supplemental Management Information

1. Overall non-Indian TAC: 67,800 (non-mark-selective equivalent of 65,000) Chinook and 80,000 coho marked with a healed adipose fin clip (marked).
2. Recreational TAC: 35,300 (non-mark selective equivalent of 32,500) Chinook and 67,200 marked coho; all retained coho must be marked.
3. No preseason trade of Chinook or coho between non-Indian commercial and recreational fisheries.
4. No Area 4B add-on fishery.
5. Buoy 10 fishery opens Aug. 1 with an expected landed catch of 7,000 marked coho in August and September.

U.S./Canada Border to Cape Falcon

- June 18 through earlier of June 25 or a coastwide **marked Chinook quota of 4,800** (C.5).

Seven days per week. Two fish per day, all salmon except coho, **all Chinook must be marked with a healed adipose fin clip (C.1)**. Chinook 24-inch total length minimum size limit (B). See gear restrictions (C.2). Inseason management may be used to sustain season length and keep harvest within the overall Chinook recreational TAC for north of Cape Falcon (C.5).

U.S./Canada Border to Cape Alava (Neah Bay)

- June 26 through earlier of September 18 or 6,990 marked coho subarea quota with a subarea guideline of 3,300 Chinook. (C.5).

Seven days per week. All salmon except no chum beginning August 1; two fish per day, no more than one of which can be a Chinook, plus one additional pink salmon. All coho must be marked (C.1). See gear restrictions (C.2). Beginning August 1, Chinook non-retention east of the Bonilla-Tatoosh line (C.4.a) during Council managed ocean fishery. Inseason management may be used to sustain season length and keep harvest within the overall Chinook and coho recreational TACs for north of Cape Falcon (C.5).

Cape Alava to Queets River (La Push Subarea)

- June 26 through earlier of September 18 or 1,700 marked coho subarea quota with a subarea guideline of 1,450 Chinook. (C.5).
- September 24 through earlier of October 9 or 50 marked coho quota or 50 Chinook quota (C.5) in the area north of 47°50'00 N. lat. and south of 48°00'00" N. lat.

Seven days per week. All salmon; two fish per day, no more than one of which can be a Chinook, plus one additional pink salmon. All coho must be marked (C.1). See gear restrictions (C.2). Inseason management may be used to sustain season length and keep harvest within the overall Chinook and coho recreational TACs for north of Cape Falcon (C.5).

Queets River to Leadbetter Point (Westport Subarea)

- June 26 through earlier of September 18 or 24,860 marked coho subarea quota with a subarea guideline of 17,800 Chinook (C.5).

Sunday through Thursday. All salmon; two fish per day, no more than one of which can be a Chinook. All coho must be marked (C.1). See gear restrictions and definitions (C.2, C.3). Grays Harbor Control Zone closed beginning August 1 (C.4). Inseason management may be used to sustain season length and keep harvest within the overall Chinook and coho recreational TACs for north of Cape Falcon (C.5).

Leadbetter Point to Cape Falcon (Columbia River Subarea)

- June 26 through earlier of September 30 or 33,600 marked coho subarea quota with a subarea guideline of 7,900 Chinook (C.5).

Seven days per week. All salmon; two fish per day, no more than one of which can be a Chinook. All coho must be marked (C.1). See gear restrictions and definitions (C.2, C.3). Columbia Control Zone closed (C.4.c). Inseason management may be used to sustain season length and keep harvest within the overall Chinook and coho recreational TACs for north of Cape Falcon (C.5).

TABLE 2. Recreational management measures collated by the STT for non-Indian ocean salmon fisheries, 2011. (Page 2 of 4)
4/11/11 11:43

A. SEASON DESCRIPTIONS

South of Cape Falcon

Supplemental Management Information

1. Sacramento River Basin recreational fishery catch assumption: 61,300 adult Sacramento River fall Chinook.
2. Sacramento River fall Chinook spawning escapement of 376,400 adults.
3. Klamath River recreational fishery allocation: 7,900 adult Klamath River fall Chinook.
4. Klamath tribal allocation: 34,800 adult Klamath River fall Chinook.
5. Overall recreational TAC: 15,000 marked coho and 3,000 unmarked coho.

Cape Falcon to Humbug Mt.

- Except as provided below during the all-salmon mark-selective **and non-mark-selective coho fisheries**, the season will be March 15 through October 31 (C.6).

All salmon except coho; two fish per day (C.1). See gear restrictions and definitions (C.2, C.3).

- Cape Falcon to Humbug Mt. all-salmon mark-selective coho fishery: July 2 through earlier of August 13 or a landed catch of 15,000 marked coho.

Seven days per week. All salmon, two fish per day. All retained coho must be marked (C.1). Any remainder of the mark selective coho quota will be transferred on an impact neutral basis to the September non-selective coho quota listed below. The all salmon except coho season reopens the earlier of August 14 or attainment of the coho quota, through August 31.

- Cape Falcon to Humbug Mt. **non-mark-selective coho fishery**: September 1 through the earlier of September 10 or a landed catch of 3,000 **non-mark-selective coho quota (C.5)**.

Thursday through Saturday **all salmon**, two fish per day;
Sunday through Wednesday, **all salmon except coho**, two fish per day.

The all salmon except coho season reopens the earlier of September 11 or attainment of the coho quota (C.5). Open days may be adjusted inseason to utilize the available coho quota (C.5).

Fishing in the Stonewall Bank yelloweye rockfish conservation area restricted to trolling only on days the all depth recreational halibut fishery is open (call the halibut fishing hotline 1-800-662-9825 for specific dates) (C.3.b, C.4.d).

In 2012, the season between Cape Falcon and Humbug Mt. will open March 15 for all salmon except coho, two fish per day (B, C.1, C.2, C.3).

Humbug Mt. to OR/CA Border. (Oregon KMZ)

- May 7 through September 5 (C.6).

Seven days per week. All salmon except coho, two fish per day (C.1). Chinook minimum size limit of 24 inches total length (B). See gear restrictions and definitions (C.2, C.3).

OR/CA Border to Horse Mt. (California KMZ)

- May 7 through September 5 (C.6).

Seven days per week. All salmon except coho, two fish per day (C.1). Chinook minimum size limit of 24 inches total length (B). See gear restrictions and definitions (C.2, C.3). Klamath Control Zone closed in August (C.4.e). See California State regulations for additional closures adjacent to the Smith, Eel, and Klamath rivers.

Horse Mt. to Point Arena (Fort Bragg)

- April 2 through November 13.

Seven days per week. All salmon except coho, two fish per day (C.1). Chinook minimum size limit of 24 inches total length (B). See gear restrictions and definitions (C.2, C.3).

In 2012, season opens February 18 for all salmon except coho, two fish per day (C.1). Chinook minimum size limit of 24 inches total length (B); and the same gear restrictions as in 2011 (C.2, C.3).

Point Arena to Pigeon Pt. (San Francisco)

- April 2 through November 13.

Seven days per week. All salmon except coho, two fish per day (C.1). Chinook minimum size limit of 24 inches total length (B). See gear restrictions and definitions (C.2, C.3).

In 2012, season opens April 7 for all salmon except coho, two fish per day (C.1). Chinook minimum size limit of 24 inches total length (B); and the same gear restrictions as in 2011 (C.2, C.3).

TABLE 2. Recreational management measures collated by the STT for non-Indian ocean salmon fisheries, 2011. (Page 3 of 4)
4/10/11 17:49

A. SEASON DESCRIPTIONS

South of Cape Falcon

Pigeon Point to U.S./Mexico Border (Monterey South)

- April 2 through October 2.

Seven days per week. All salmon except coho, two fish per day (C.1). Chinook minimum size limit of 24 inches total length (B). See gear restrictions and definitions (C.2, C.3).

In 2012, season opens April 7 for all salmon except coho, two fish per day (C.1). Chinook minimum size limit of 24 inches total length (B); and the same gear restrictions as in 2011 (C.2, C.3).

California State regulations require all salmon be made available to a CDFG representative for sampling immediately at port of landing. Any person in possession of a salmon with a missing adipose fin, upon request by an authorized agent or employee of the CDFG, shall immediately relinquish the head of the salmon to the state. (California Fish and Game Code §8226)

B. MINIMUM SIZE (Inches) (See C.1)

Area (when open)	Chinook	Coho	Pink
North of Cape Falcon	24.0	16.0	None
Cape Falcon to OR/CA Border	24.0	16.0	None
OR/CA Border to U.S./Mexico Border	24.0	-	24.0

C. REQUIREMENTS, DEFINITIONS, RESTRICTIONS, OR EXCEPTIONS

C.1. Compliance with Minimum Size and Other Special Restrictions: All salmon on board a vessel must meet the minimum size or other special requirements for the area being fished and the area in which they are landed if that area is open. Salmon may be landed in an area that is closed only if they meet the minimum size or other special requirements for the area in which they were caught.

Ocean Boat Limits: Off the coast of Washington, Oregon, and California, each fisher aboard a vessel may continue to use angling gear until the combined daily limits of salmon for all licensed and juvenile anglers aboard has been attained (additional state restrictions may apply).

C.2. Gear Restrictions: Salmon may be taken only by hook and line using barbless hooks. All persons fishing for salmon, and all persons fishing from a boat with salmon on board, must meet the gear restrictions listed below for specific areas or seasons.

a. *U.S./Canada Border to Point Conception, California*: No more than one rod may be used per angler; and no more than two single point, single shank barbless hooks are required for all fishing gear. [Note: ODFW regulations in the state-water fishery off Tillamook Bay may allow the use of barbed hooks to be consistent with inside regulations.]

b. *Horse Mt., California, to Point Conception, California*: Single point, single shank, barbless circle hooks (see gear definitions below) are required when fishing with bait by any means other than trolling, and no more than two such hooks shall be used. When angling with two hooks, the distance between the hooks must not exceed five inches when measured from the top of the eye of the top hook to the inner base of the curve of the lower hook, and both hooks must be permanently tied in place (hard tied). Circle hooks are not required when artificial lures are used without bait.

C.3. Gear Definitions:

a. *Recreational fishing gear defined*: Angling tackle consisting of a line with no more than one artificial lure and/or natural bait attached. Off Oregon and Washington, the line must be attached to a rod and reel held by hand or closely attended; the rod and reel must be held by hand while playing a hooked fish. No person may use more than one rod and line while fishing off Oregon or Washington. Off California, the line must be attached to a rod and reel held by hand or closely attended; weights directly attached to a line may not exceed four pounds (1.8 kg). While fishing off California north of Point Conception, no person fishing for salmon, and no person fishing from a boat with salmon on board, may use more than one rod and line. Fishing includes any activity which can reasonably be expected to result in the catching, taking, or harvesting of fish.

b. *Trolling defined*: Angling from a boat or floating device that is making way by means of a source of power, other than drifting by means of the prevailing water current or weather conditions.

c. *Circle hook defined*: A hook with a generally circular shape and a point which turns inward, pointing directly to the shank at a 90° angle.

TABLE 2. Recreational management measures collated by the STT for non-Indian ocean salmon fisheries, 2011. (Page 3 of 4)
4/10/11 17:49

C. REQUIREMENTS, DEFINITIONS, RESTRICTIONS, OR EXCEPTIONS

C.4. Control Zone Definitions:

a. *The Bonilla-Tatoosh Line*: A line running from the western end of Cape Flattery to Tatoosh Island Lighthouse (48°23'30" N. lat., 124°44'12" W. long.) to the buoy adjacent to Duntze Rock (48°28'00" N. lat., 124°45'00" W. long.), then in a straight line to Bonilla Point (48°35'30" N. lat., 124°43'00" W. long.) on Vancouver Island, British Columbia.

b. *Grays Harbor Control Zone* - The area defined by a line drawn from the Westport Lighthouse (46° 53'18" N. lat., 124° 07'01" W. long.) to Buoy #2 (46° 52'42" N. lat., 124°12'42" W. long.) to Buoy #3 (46° 55'00" N. lat., 124°14'48" W. long.) to the Grays Harbor north jetty (46° 36'00" N. lat., 124°10'51" W. long.).

c. *Columbia Control Zone*: An area at the Columbia River mouth, bounded on the west by a line running northeast/southwest between the red lighted Buoy #4 (46°13'35" N. lat., 124°06'50" W. long.) and the green lighted Buoy #7 (46°15'09' N. lat., 124°06'16" W. long.); on the east, by the Buoy #10 line which bears north/south at 357° true from the south jetty at 46°14'00" N. lat., 124°03'07" W. long. to its intersection with the north jetty; on the north, by a line running northeast/southwest between the green lighted Buoy #7 to the tip of the north jetty (46°15'48" N. lat., 124°05'20" W. long. and then along the north jetty to the point of intersection with the Buoy #10 line; and on the south, by a line running northeast/southwest between the red lighted Buoy #4 and tip of the south jetty (46°14'03" N. lat., 124°04'05" W. long.), and then along the south jetty to the point of intersection with the Buoy #10 line.

d. *Stonewall Bank Yelloweye Rockfish Conservation Area*: The area defined by the following coordinates in the order listed:
   44°37.46' N. lat.; 124°24.92' W. long.;
   44°37.46' N. lat.; 124°23.63' W. long.;
   44°28.71' N. lat.; 124°21.80' W. long.;
   44°28.71' N. lat.; 124°24.10' W. long.;
   44°31.42' N. lat.; 124°25.47' W. long.;
   and connecting back to 44°37.46' N. lat.; 124°24.92' W. long.

e. *Klamath Control Zone*: The ocean area at the Klamath River mouth bounded on the north by 41°38'48" N. lat. (approximately six nautical miles north of the Klamath River mouth); on the west, by 124°23'00" W. long. (approximately 12 nautical miles off shore); and, on the south, by 41°26'48" N. lat. (approximately 6 nautical miles south of the Klamath River mouth).

C.5. Inseason Management: Regulatory modifications may become necessary inseason to meet preseason management objectives such as quotas, harvest guidelines, and season duration. In addition to standard inseason actions or modifications already noted under the season description, the following inseason guidance is provided to NMFS:

a. Actions could include modifications to bag limits, or days open to fishing, and extensions or reductions in areas open to fishing.

b. Coho may be transferred inseason among recreational subareas north of Cape Falcon on a fishery impact equivalent basis to help meet the recreational season duration objectives (for each subarea) after conferring with representatives of the affected ports and the Council's SAS recreational representatives north of Cape Falcon.

c. Chinook and coho may be transferred between the recreational and commercial fisheries north of Cape Falcon on a fishery impact equivalent basis if there is agreement among the representatives of the Salmon Advisory Subpanel (SAS).

d. If retention of unmarked coho is permitted in the area from the U.S./Canada border to Cape Falcon, Oregon, by inseason action, the allowable coho quota will be adjusted to ensure preseason projected mortality of critical stocks is not exceeded.

e. Marked coho remaining from the June/July through August Cape Falcon to OR/CA border recreational coho quota may be transferred inseason to the September Cape Falcon to Humbug Mt. non-mark-selective recreational fishery on a fishery impact equivalent basis.

C.6. Additional Seasons in State Territorial Waters: Consistent with Council management objectives, the States of Washington, Oregon, and California may establish limited seasons in state waters. Check state regulations for details.

TABLE 3. Treaty Indian ocean troll management measures Collated by the STT for ocean salmon fisheries, 2011. 4/10/2011 5:49 PM

A. SEASON DESCRIPTIONS

Supplemental Management Information

1. Overall Treaty-Indian TAC: 45,000 Chinook and 42,000 coho.

May 1 through the earlier of June 30 or 22,500 Chinook quota.
All salmon except coho. If the Chinook quota for the May-June fishery is not fully utilized, the excess fish cannot be transferred into the later all-salmon season. If the Chinook quota is exceeded, the excess will be deducted from the later all-salmon season. See size limit (B) and other restrictions (C).

• July 1 through the earlier of September 15, or 22,500 preseason Chinook quota, or 42,000 coho quota.
All salmon. See size limit (B) and other restrictions (C).

B. MINIMUM SIZE (Inches)

	Chinook		Coho		
Area (when open)	Total Length	Head-off	Total Length	Head-off	Pink
North of Cape Falcon	24.0 (61.0 cm)	18.0 (45.7 cm)	16.0 (40.6 cm)	12.0 (30.5 cm)	None

C. REQUIREMENTS, DEFINITIONS, RESTRICTIONS, OR EXCEPTIONS

C.1. Tribe and Area Boundaries. All boundaries may be changed to include such other areas as may hereafter be authorized by a Federal court for that tribe's treaty fishery.

S'KLALLAM - Washington State Statistical Area 4B (All).

MAKAH - Washington State Statistical Area 4B and that portion of the FMA north of 48°02'15" N. lat. (Norwegian Memorial) and east of 125°44'00" W. long.

QUILEUTE - That portion of the FMA between 48°07'36" N. lat. (Sand Pt.) and 47°31'42" N. lat. (Queets River) and east of 125°44'00" W. long.

HOH - That portion of the FMA between 47°54'18" N. lat. (Quillayute River) and 47°21'00" N. lat. (Quinault River) and east of 125°44'00" W. long.

QUINAULT - That portion of the FMA between 47°40'06" N. lat. (Destruction Island) and 46°53'18"N. lat. (Point Chehalis) and east of 125°44'00" W. long.

C.2. Gear restrictions
- a. Single point, single shank, barbless hooks are required in all fisheries.
- b. No more than eight fixed lines per boat.
- c. No more than four hand held lines per person in the Makah area fishery (Washington State Statistical Area 4B and that portion of the FMA north of 48°02'15" N. lat. (Norwegian Memorial) and east of 125°44'00" W. long.)

C.3. Quotas
- a. The quotas include troll catches by the S'Klallam and Makah tribes in Washington State Statistical Area 4B from May 1 through September 15.
- b. The Quileute Tribe will continue a ceremonial and subsistence fishery during the time frame of September 15 through October 15 in the same manner as in 2004-2010. Fish taken during this fishery are to be counted against treaty troll quotas established for the 2011 season (estimated harvest during the October ceremonial and subsistence fishery: 100 Chinook; 200 coho).

C.4. Area Closures
- a. The area within a six nautical mile radius of the mouths of the Queets River (47°31'42" N. lat.) and the Hoh River (47°45'12" N. lat.) will be closed to commercial fishing.
- b. A closure within two nautical miles of the mouth of the Quinault River (47°21'00" N. lat.) may be enacted by the Quinault Nation and/or the State of Washington and will not adversely affect the Secretary of Commerce's management regime.

TABLE 5. Projected key stock escapements (thousands of fish) or management criteria for 2011 ocean fishery management measures collated by the STT.a/ (Page 2 of 3)

Key Stock/Criteria	Projected Ocean Escapement[b/] or Other Criteria (Council Area Fisheries)	Spawner Objective or Other Comparative Standard as Noted
		CHINOOK
COLUMBIA RIVER		
Columbia Upriver Brights	399.3	74.0 Minimum ocean escapement to attain 60.0 adults over McNary Dam, with normal distribution and no mainstem harvest.
	NA	≤ 60.0% ISBM Index (PSC general obligation) not applicable for 2011 because escapement objective met
Deschutes Upriver Brights	NA	≤ 60.0% ISBM Index (PSC general obligation) not applicable for 2011 because escapement objective met
Snake River Fall (threatened) SRFI	NA	≤ 70.0% Of 1988-1993 base period exploitation rate for all ocean fisheries (NMFS ESA consultation standard).
Mid-Columbia Brights	100.3	11.0 Minimum ocean escapement to attain 4.7 adults for Bonneville Hatchery and 2.0 for Little White Salmon Hatchery egg-take, assuming average conversion and no mainstem harvest.
Columbia Lower River Hatchery Tules	127.9	23.8 Minimum ocean escapement to attain 12.6 adults for hatchery egg-take, with average conversion and no lower river mainstem or tributary harvest.
Columbia Lower River Natural Tules (threatened)	37.6%	≤ 37.0% Total adult equivalent fishery exploitation rate; 2011 ESA guidance (NMFS ESA consultation standard).
Columbia Lower River Wild[c/] (threatened)	13.1	6.9 Minimum ocean escapement to attain MSY spawner goal of 5.7 for N. Lewis River fall Chinook (NMFS ESA consultation standard).
	NA	≤ 60.0% ISBM Index (PSC general obligation) not applicable for 2011 because escapement objective met
Spring Creek Hatchery Tules	115.3	8.2 Minimum ocean escapement to attain 7.0 adults for Spring Creek Hatchery egg-take, assuming average conversion and no mainstem harvest.
Upriver Summer	NA	≤ 60.0% ISBM Index (PSC general obligation) not applicable for 2011 because escapement objective met
OREGON COAST:		
Nehalem Fall	NZ	≤ 60.0% ISBM Index (PSC general obligation)[d/]
Siletz Fall	NA	≤ 60.0% ISBM Index (PSC general obligation)
Siuslaw Fall	NA	≤ 60.0% ISBM Index (PSC general obligation)
CALIFORNIA		
Klamath River Fall	35.0	35.0 Minimum number of adult spawners to natural spawning areas; FMP.
Federally recognized tribal harvest	50.0%	50.0% Equals 34.8 (thousand) adult fish for Yurok and Hoopa tribal fisheries.
Spawner Reduction Rate	53.8%	≤ 66.7% Equals 40.8 (thousand) fewer natural adult spawners due to fishing.
Adult river mouth return	101.5	NA Natural and hatchery adults.
Age-4 ocean harvest rate	16.0%	≤ 16.0% NMFS ESA consultation standard for threatened California Coastal Chinook.
KMZ sport fishery share	13.2%	No Council guidance for 2011.
River recreational fishery share	22.5%	≥ 15% 2011 Council Guidance. Equals 7.9 (thousand) adult fish for recreational inriver fisheries.
Sacramento River Winter (endangered)	Met	Recreational seasons: Point Arena to Pigeon Point between the first Saturday in April and the second Sunday in November; Pigeon Point to the U.S./Mexico Border between the first Saturday in April and the first Sunday in October. Minimum size limit ≥ 20 inches total length. In addition, for 2011, fisheries south of Pt. Arena must have either a minimum size limit ≥ 24 inches total length, or be closed for two consecutive months between May 1 and August 31. Commercial seasons: Point Arena to the U.S./Mexico border between May 1 and September 30, except Point Reyes to Point San Pedro between October 1 and 15. Minimum size limit ≥ 26 inches total length. (NMFS ESA Guidance for 2011).
Sacramento River Fall	376.4	180.0 2011 Council and NMFS guidance for natural and hatchery adult spawners.
Ocean commercial impacts	190.3	Include fall (Sept-Dec) 2010 impacts; equals 0 SRFC.
Ocean recreational impacts	102.0	Include fall (Sept. -Dec.) 2010 impacts (76 SRFC).
River recreational impacts	61.3	No guidance in 2011.
Hatchery spawner goal	≥ 22.0	22.0 Aggregate number of adults to meet egg take goals at Coleman, Feather River and Nimbus hatcheries.

TABLE 5. Projected key stock escapements (thousands of fish) or management criteria for 2011 ocean fishery management measures collated by the STT.a/ (Page 3 of 3)

Key Stock/Criteria	Projected Ocean Escapement[b/] or Other Criteria (Council Area Fisheries)	Spawner Objective or Other Comparative Standard as Noted	
		COHO	
Interior Fraser (Thompson River)	10.8%(4.1%)	≤ 10.0%	2011 Southern U.S. exploitation rate ceiling; 2002 PSC coho agreement.
Skagit	37.8%(3.7%)	≤ 60.0%	2011 total exploitation rate ceiling; FMP matrix[e/]
Stillaguamish	27.4%(2.6%)	≤ 50.0%	2011 total exploitation rate ceiling; FMP matrix[e/]
Snohomish	26.2%(2.6%)	≤ 60.0%	2011 total exploitation rate ceiling; FMP matrix[e/]
Hood Canal	40.7%(3.8%)	≤ 65.0%	2011 total exploitation rate ceiling; FMP matrix[e/]
Strait of Juan de Fuca	11.8%(3.1%)	≤ 40.0%	2011 total exploitation rate ceiling; FMP matrix[e/]
Quillayute Fall	26.5	6.3-15.8	FMP objective MSY adult spawner range[e/]
Hoh	10.0	2.0-5.0	FMP objective MSY adult spawner range[e/]
Queets Wild	10.5	5.8-14.5	FMP objective MSY adult spawner range[e/]
Grays Harbor	82.0	35.4	FMP objective MSY adult spawner range[e/]
Lower Columbia River Natural (threatened)	10.7%	≤ 15.0%	Total marine and mainstem Columbia River fishery exploitation rate (NMFS ESA consultation standard).
Upper Columbia	≥ 70%	≥ 50%	Minimum percentage of the run to Bonneville Dam.
Columbia River Hatchery Early	162.1	36.7	Minimum ocean escapement to attain hatchery egg-take goal of 14.2 early adult coho, with average conversion and no mainstem or tributary fisheries.
Columbia River Hatchery Late	101.0	9.6	Minimum ocean escapement to attain hatchery egg-take goal of 6.2 late adult coho, with average conversion and no mainstem or tributary fisheries.
Oregon Coastal Natural	13.1%	≤ 15.0%	Marine and freshwater fishery exploitation rate.
Northern California (threatened)	8.7%	≤ 13.0%	Marine fishery exploitation rate for R/K hatchery coho (NMFS ESA consultation standard).

a/ Assumptions for Canadian and Southeast Alaska Chinook fisheries operating under aggregate abundance based management (AABM) regimes are based on allowable catch levels determined under the 2009 PST Chinook agreement and the 2011 calibration of the PSC Chinook Model. The allowable catch levels are for an Alaska all-gear catch of 294,800, a Northern BC troll and Queen Charolette Islands catch of 182,400, and a WCVI troll and outside sport catch of 196,800.

b/ Ocean escapement is the number of salmon escaping ocean fisheries and entering freshwater with the following clarifications. Ocean escapement for Puget Sound stocks is the estimated number of salmon entering Area 4B that are available to U.S. net fisheries in Puget Sound and spawner escapement after impacts from the Canadian, U.S. ocean, and Puget Sound troll and recreational fisheries have been deducted. Numbers in parentheses represent Council area exploitation rates for Puget sound coho stocks. For Columbia River early and late coho stocks, ocean escapement represents the number of coho after the Buoy 10 fishery. Exploitation rates for LCN coho include all marine impacts prior to the Buoy 10 fishery. Exploitation rates for OCN coho include impacts of freshwater fisheries.

c/ Includes minor contributions from East Fork Lewis River and Sandy River.

e/ Annual management objectives may be different than FMP goals, and are subject to agreement between WDFW and the treaty tribes under U.S. District Court orders. Total exploitation rate includes Alaskan, Canadian, Council area, Puget Sound, and freshwater fisheries and is calculated as total fishing mortality divided by total fishing mortality plus spawning escapement.

TABLE 7. Expected coastwide lower Columbia Natural (LCN) Oregon coastal natural (OCN) and Rogue/Klamath (RK) coho, and Lower Columbia River (LCR) tule Chinook exploitation rates by fishery for 2011 ocean fisheries management measures collated by the STT.

	Exploitation Rate (Percent)			
Fishery	LCN Coho	OCN Coho	RK Coho	LCR Tule
SOUTHEAST ALASKA	0.0%	0.0%	0.0%	2.6%
BRITISH COLUMBIA	0.1%	0.3%	0.2%	16.1%
PUGET SOUND/STRAIT/WA COAST BAYS	0.2%	0.1%	0.0%	0.5%
NORTH OF CAPE FALCON				
Treaty Indian Ocean Troll	2.1%	0.5%	0.0%	4.3%
Recreational	4.4%	0.8%	0.0%	2.4%
Non-Indian Troll	1.5%	0.4%	0.0%	4.1%
SOUTH OF CAPE FALCON				
Recreational:				0.1%
Cape Falcon to Humbug Mt.	1.2%	2.5%	0.2%	
Humbug Mt. OR/CA border (KMZ)	0.1%	0.4%	0.8%	
OR/CA border to Horse Mt. (KMZ)	0.1%	0.8%	3.5%	
Fort Bragg	0.0%	0.5%	1.3%	
South of Pt. Arena	0.0%	0.4%	1.0%	
Troll:				1.9%
Cape Falcon to Humbug Mt.	0.8%	1.0%	0.1%	
Humbug Mt. OR/CA border (KMZ)	0.0%	0.0%	0.0%	
OR/CA border to Horse Mt. (KMZ)	0.0%	0.1%	0.6%	
Fort Bragg	0.0%	0.2%	0.5%	
South of Pt. Arena	0.0%	0.2%	0.2%	
BUOY 10	0.6%	0.0%	0.0%	5.6%
ESTUARY/FRESHWATER	4.3%	4.8%	0.2%	
TOTAL[a/]	15.0%	13.1%	8.7%	37.6%

a/ Totals do not include estuary/freshwater or Buoy 10 for RK coho.

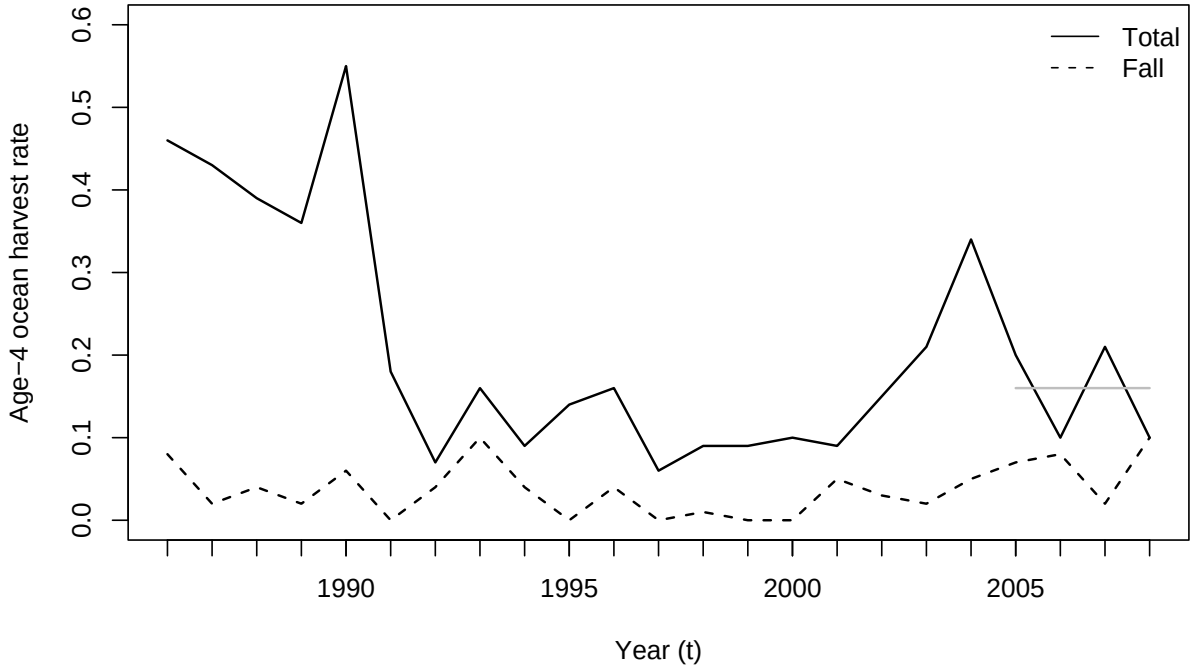


Figure 3. Klamath River fall Chinook (KRFC) age-4 ocean harvest rate estimates for the entire year (solid line; September 1 $(t-1)$ to August 31 (t)) and fall fisheries (dashed line; September 1 $(t-1)$ to December 31 $(t-1)$). The solid grey line denotes the California Coastal Chinook ESA consultation standard of a KRFC age-4 ocean harvest rate of 16 percent or less, in expectation.

determined by annual differences in fishing opportunity and effort among port areas, the observed variation in the location of age-4 harvest is not solely determined by fishing regulations. For example, a large proportion of the age-4 ocean harvest rate in 2008 (from fall 2007 fisheries) can be attributed to harvest in KC. The fall harvest of age-4 KRFC in the KC management area was primarily taken by the commercial fishery which had a 6,000 Chinook quota. The fishery was closed after three days (the season lasted from September 10–12, 2007) and the quota was exceeded. In comparison, for fishing year 2006, a year with a roughly similar fall age-4 ocean harvest rate as 2008, the age-4 ocean harvest rate taken in KC was a small proportion of the total rate from fall fisheries even though the commercial fishery was open for 13 days in September. Instead, age-4 KRFC harvest primarily came from Oregon areas, which had comparable levels of commercial opportunity in fall 2005 and fall 2007.

Fall harvest of age-4 KRFC appears to be relatively low in the more southern management

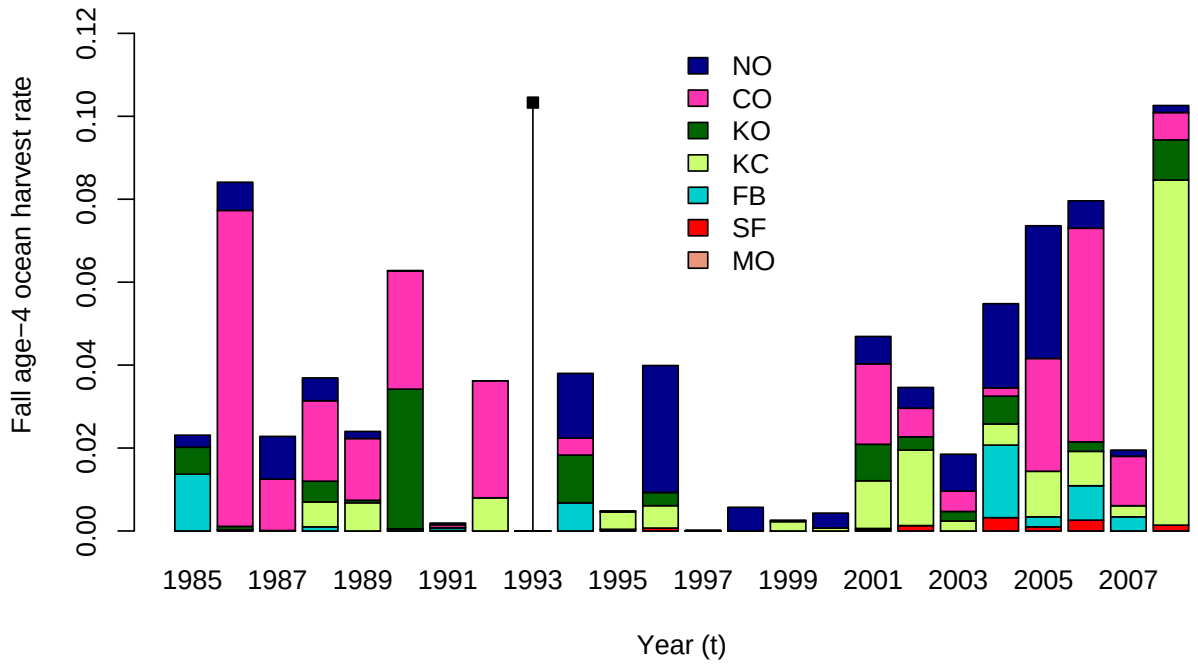


Figure 4. Klamath River fall Chinook (KRFC) age-4 ocean harvest rate estimates derived from harvest in the period from September 1 $(t-1)$ to December 31 $(t-1)$, for the seven management areas south of Cape Falcon, Oregon. For 1993, it was not possible to make a credible estimates of the geographic partitioning of the harvest rate owing to low numbers of coded-wire tag recoveries.

areas and the recreational fishery. Table 1 provides summary statistics of the age-4 ocean harvest rates by management area and fishery, as well as for the totals over all areas and fisheries south of Cape Falcon. Both commercial and recreational fisheries in the MO port area have not harvested age-4 KRFC in the fall and therefore do not contribute to the fall age-4 ocean harvest rate. Both commercial and recreational fisheries in the SF port area have contributed very little to the fall age-4 ocean harvest rate. Fall recreational fisheries in the FB management area also have not contributed historically to the KRFC age-4 ocean harvest rate.

In summary, fall age-4 ocean harvest rates of greater than 10.3 percent have never been observed. Thus, for future fall fisheries that are not expanded relative to past fall fisheries, we could reasonably expect the age-4 ocean harvest rate to be less than 10 percent in the fall period. In terms of the average rate that could be expected, the mean or median estimate over all years is currently 3.8 and 3.5 percent, respectively. The spatial distribution of past fall age-4 KRFC harvests would seem particularly relevant for managers in crafting future fall fisheries.

SALMON ESSENTIAL FISH HABITAT (EFH) REVIEW FINAL REPORT

The Pacific Coast Salmon Essential Fish Habitat (EFH) Review Oversight Panel (Panel) has completed its review of Pacific salmon EFH. The report is presented to the Pacific Fishery Management Council (Council) in Attachment 1. Periodic review of EFH is required under the National Marine Fisheries Service (NMFS) 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 Magnuson-Stevens Act 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 research needs. Amendment 14 also identified about 50 large dams that lacked adequate fish passage, and interpreted those to be the upstream extent of EFH in those watersheds. The Council considered, but did not establish Habitat Areas of Particular Concern (HAPC) for salmon at that time.

The **Idaho County v. Donald Evans** court decision (United States District Court for the District of Idaho, Case No. CV02-80-C-EJL) required NMFS to codify EFH for Pacific salmon, which was issued as a Final Rule in 2008 (78 FR 60987). This rule included some revisions to EFH, mostly to correct errors and clarify information.

The Panel met between June 2009 and April 2011, mostly via conference calls, to consider new information and literature, tools to assess habitat suitability, the list of barriers that represent the upstream extent of EFH, the potential to designate HAPCs, fishing and non-fishing threats to EFH, and other topics. The Council contracted with Cramer Fish Sciences to develop an annotated bibliography (Attachment 2) designed to inform the Panel's review process.

At its September 2010 meeting, the Council adopted the initial Pacific salmon EFH review report for public review and suggested that the EFH Oversight Panel incorporate comments from the Scientific and Statistical Committee (SSC) and the Habitat Committee (HC) to the extent possible. The SSC suggested providing clearer criteria and documentation for the potential HAPCs, impassible barriers, and the new threats that were presented in the report. The HC suggested improving the climate change section, offered general support for establishing HAPCs, and supported updating the list of impassible barriers. The Council also requested a clearer explanation of the role of the report relative to Amendment 14 to the Pacific Coast Salmon Plan.

Following up on the Council's recommendations, the Panel issued a solicitation for comments in late 2010 via email and web postings on the NMFS Northwest Region site. Three comments were received in response. One comment stated that the seal population should be controlled in order to help recover salmon. Another comment (from Oregon Department of Fish and Wildlife) provided suggestions of data sets that could be used to more precisely identify salmon EFH. A

third comment (from Oceana) was focused on the importance of prey species as EFH for salmon.

The Panel also requested guidance from NMFS Headquarters, to maximize consistency with national policy and regulatory guidance.

The Panel incorporated, to the extent possible, all comments and guidance. In some cases, the Panel concluded that the requests were not possible to accommodate. For example, NMFS Headquarters suggested that the broad geographic range of Pacific salmon EFH should be refined to a smaller scale, such as stream reaches or smaller Hydrologic Units (HUs). The Panel explored this possibility but concluded that the available data precluded refining the spatial extent of salmon EFH significantly at this time.

The Panel report and annotated bibliography represent a thorough review of literature and other information that could be used to revise elements of Pacific salmon EFH. These elements could include, but are not limited to, changes to the definition, spatial extent, HAPCs, threats, or research needs relevant to Pacific salmon EFH. Other than simply updating the body of supporting literature for the Council's EFH description, should the Council choose to incorporate these or other changes in its identification and description of salmon EFH, it would likely require an FMP amendment.

If the Council does decide the necessary changes are sufficient to proceed with an FMP amendment, staff proposes to return at a future meeting with a proposed schedule and process for accomplishing the amendment. Within any amendment, it may be useful to include consideration of a mechanism for making some revisions to EFH in the future based on a technical review that does not require a plan amendment.

Council Action:

1. Accept the Panel's report, thereby concluding the EFH review.
2. Decide which, if any, of the Panel's recommendations to consider for adoption.
3. Consider the need for FMP amendment and provide appropriate guidance to Council staff.

Reference Materials:

1. Agenda Item G.5.b, Attachment 1: *Pacific Coast Salmon Essential Fish Habitat Review Final Report to the Pacific Fishery Management Council.*
2. Agenda Item G.5.b, Attachment 2: Summary Table of Major Recommendations.
3. Agenda Item G.5.b, Attachment 3: *Appendix A: Annotated Bibliography for 2010 Essential Fish Habitat Update (Electronic Only).*

Agenda Order:

a. Agenda Item Overview — Kerry Griffin
b. Report of the NMFS Salmon EFH Oversight Panel — John Stadler
c. Reports and Comments of Advisory Bodies and Management Entities
d. Public Comment
e. **Council Action**: Accept Final Report and Provide Future Guidance

PFMC
3/28/11

MEMORANDUM

Date: May 25, 2011

From: Pacific Coast Salmon Essential Fish Habitat (EFH) Review Oversight Panel

To: All interested parties

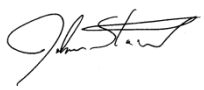
Re: Revisions to Final Report on the 5-year review of EFH for Pacific Coast salmon

In response to comments by Council Members, Advisory Committees, Management Bodies, and the public at the April Council Meeting, the Oversight Panel made several revisions to the March 23, 2011 Final Report on the 5-year review of EFH for Pacific Coast salmon. The revised report is available as an "electronic attachment" in the June 2011 Briefing Book (see Supplemental Informational Report 3, ELECTRONIC Attachment 1) . These revisions include:

1. Addition of a cover page that was inadvertently omitted from the March 23 Final Report.
2. Correction of several typographical errors.
3. Page 36: Added the following sentence to the caption for Table 6: "Note that an impassible barrier limits EFH extent only above that particular barrier. The remainder of the HU would still be considered EFH." This sentence clarifies that designation of a dam as "the upstream extent of EFH" means that only the waters that are blocked by that dam are not designated as EFH. The remaining waters in the 4th field HU are designated as EFH, unless access to them is blocked by another dam on the list. In response to comments made by CRITFC, McKay Dam was specifically identified as the upstream extent of EFH in McKay Creek.
4. Page 36: Correctly identified the Umatilla River as being in the State of Oregon.
5. Page 55: Included additional literature on the loss of marine-derived nutrient from salmon carcasses.
6. Page 56: Referenced the State of Washington's requirement for biodegradable cord on recreational crab traps.
7. Pages 56-57: Refined the section on derelict gillnets. In particular, the revisions include additional information on the threat to salmon from derelict gillnets in Puget Sound, and that in the Columbia River, white sturgeon are the only species that have been documented to have been caught in derelict nets. An inaccurate citation was also removed.
8. Page 57: Revised text on effects to survival of eggs and alevins from trampling of redds.

It is important to note that this report is purely advisory in nature, and does not, by itself, constitute any actual changes to EFH. Any changes would have to be made by the Council and NMFS, via normal processes. The Oversight Panel considers this Revised Final Report as the final step in the 5-year review process.

Thank you,



John Stadler, PhD
Oversight Panel Chair

Pacific Coast Salmon 5-Year Review of Essential Fish Habitat

Final Report to the Pacific Fishery Management Council

John H. Stadler[1], Kerry F. Griffin[2], Eric J. Chavez[1], Brian C. Spence[1], Phil Roni[1], Charleen A. Gavette[1], Barbara A. Seekins[1], and Adam K. Obaza[1]

[1] National Marine Fisheries Service
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March 23, 2011

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TABLE OF CONTENTS

1. Introduction 1
Essential Fish Habitat Consultation 1
Essential Fish Habitat Periodic Reviews 2
Methods/Approach 3
Chronology 3
2. Current EFH Designations for Pacific Coast Salmon 3
Chinook salmon 4
Coho salmon 8
Puget Sound Pink Salmon 8
3. Review Essential Fish Habitat for Pacific Coast Salmon 13
Historical and Current Distribution 13
Freshwater Distribution 14
Spatial Resolution of Salmon Distribution 14
Distribution Modeling 31
Impassible Dams Designated as the Upstream Extent of EFH 33
Marine Distribution 43
Essential Fish Habitat Descriptions 44
Existing EFH Descriptions 44
New Information 44
Habitat Areas of Particular Concern 47
4. Threats to EFH 54
Fishing Activities That May Affect EFH 54
Effects To EFH By Gear Type 55
Removal of Salmon Carcasses 56
Vessel impacts 57
Harvest of prey species 57
Derelict gear 58
Recreational fishing 58
Minimizing Effects 59
Non-Fishing Activities That May Affect EFH 59
Pile driving 60
Overwater Structures 62
Alternative Energy Development 65
Liquefied Natural Gas Projects 68
Desalination 70
Power Plant Intakes 71
Pesticide use 74
Flood Control Maintenance 75
Culvert construction 77
Climate change 79
5. Information and Research Needs 80
6. References 81

List of Tables

Table 1 Members of the Oversight Panel. 2

Table 2. 4th field HUs lacking current distribution data but designated as EFH in Amendment 14, and the reason they are included in Amendment 14. 19

Table 3. 4th field HUs having current or historical distribution data but are not designated as EFH in Amendment 14. 21

Table 4. . 4th field HUs in California that are currently designated as EFH for Chinook salmon in Amendment 14, but due to revisions in the HU codes and names, no longer exist. 21

Table 5. All 4th field HUs with current or historical distribution data for each species of Pacific Coast salmon and potential changes to the current EFH designations. 25

Table 6. Potential changes to the impassible dams representing the upstream extent of EFH. 37

Table 7. Summary of fishing activities that potentially affect to EFH. 55

Table 8. Non-fishing threats to Pacific Coast salmon EFH. 60

List of Figures

Figure 1. 4th field HUs and marine waters currently identified as EFH for Chinook salmon in relation to current Chinook salmon distribution for the U.S. West Coast and Alaska. 5
Figure 2. . 4th field HUs currently identified as EFH for Chinook salmon in relation to current Chinook salmon distribution in Washington, Oregon, and Idaho. 6
Figure 3. . 4th field HUs currently identified as EFH for Chinook salmon in relation to current Chinook salmon distribution in California. 7
Figure 4. 4th field HUs and marine waters currently identified as EFH for coho salmon in relation to current coho salmon distribution in the U.S. West Coast and Alaska. 9
Figure 5. 4th field HUs currently identified as EFH for coho salmon in relation to current coho salmon distribution in Washington, Oregon, and Idaho. 10
Figure 6. 4th field HUs currently identified as EFH for coho salmon in relation to coho salmon distribution in California. 11
Figure 7. 4th field HUs currently identified as EFH for PS pink salmon in relation to current PS pink salmon distribution in western Washington. 12
Figure 8. Example comparison of 6th field HUs with current or historical distribution data for coho salmon with those lacking distribution data. 16
Figure 9. Example comparison of 5th field HUs with current or historical distribution data for coho salmon with those lacking distribution data. 17
Figure 10. Example 4th field HU showing stream segments that are designated as EFH.. 18
Figure 11. Comparison of the California Central Valley 4th field HUs designated as EFH in Amendment 14 with the newly defined HUs having current or historical Chinook salmon distribution data. 22
Figure 12. Example of how Intrinsic Potential can help identify potentially suitable habitats for Pacific Coast salmon. 32

List of Acronyms and Abbreviations

EEZ	exclusive economic zone
EFH	essential fish habitat
ESA	Endangered Species Act
ESU	evolutionarily significant unit
FERC	Federal Energy Regulatory Commission
FMC	Fishery Management Council
FMP	fisheries management plan
FMU	fishery management unit
GIS	geographic information system
HAPC	habitat area of particular concern
HU	hydrologic unit
IP	intrinsic potential
LWD	large woody debris
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
NPFMC	North Pacific Fishery Management Council
PFMC	Pacific Fishery Management Council
PS	Puget Sound
SAV	submerged aquatic vegetation
USGS	United States Geological Survey
LNG	liquefied natural gas

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1. INTRODUCTION

The Magnuson-Stevens Fishery Conservation and Management Act (MSA)(16 USC 1801 et seq) 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 (FMCs) to describe and identify EFH in fishery management plans (FMPs). The FMPs should identify EFH based on current distribution, habitat components, historical presence, or other factors; and should also identify habitat requirements at each life stage and research needs. FMPs must evaluate potential adverse impacts from both fishing and non-fishing activities, as well as minimize adverse effects of fishing to the extent practicable. FMPs should 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. The National Marine Fisheries Service (NMFS) has approval authority for the designations provided by the FMCs.

The Pacific Fishery Management Council (Council) has, in Appendix A to Amendment 14 of the Pacific Coast Salmon FMP (Amendment 14)(PFMC 1999), identified EFH for Pacific Coast salmon as all those streams, lakes, ponds, wetlands, and other currently viable water bodies and most of the habitat historically accessible to salmon in Washington, Oregon, Idaho, and California. In estuarine and marine areas, salmon EFH extends from the nearshore and tidal submerged environments within state territorial waters out to the full extent of the exclusive economic zone (EEZ) offshore of Washington, Oregon, and California north of Point Conception. Pacific Coast salmon EFH also includes those areas off Alaska designated as salmon EFH by the North Pacific Fishery Management Council (NPFMC). Exceptions in freshwater include cases in which certain man-made or naturally occurring barriers represent the current upstream extent of Pacific salmon access. The Council designated Pacific salmon EFH in 1999, and made minor revisions during the EFH codification process in 2008 (2008 Final Rule)(78 FR 60987).

This report summarizes the results of a review conducted by an oversight panel (Panel) made up of staff from the Council and NMFS (Table 1), of the EFH for Pacific Coast salmon. The report includes a description of the general requirements and elements of EFH, including guidance for periodic reviews; a summary of existing designations of EFH for Pacific Coast salmon; the currently available information on the distribution of Pacific Coast salmon in both fresh and marine waters; potential changes to the existing EFH designations; potential changes to the list of impassible dams that currently form the upstream extent of EFH; an inquiry into whether appropriate models exist to predict salmon distribution where data on distribution are lacking; a discussion of potential HAPCs; a brief summary of new information on the life history and habitat requirements of salmon; updated information on threats to EFH both from fishing and non-fishing activities; and identification of research needs to further refine EFH.

Essential Fish Habitat Consultation

Federal agencies must consult with the NMFS on activities that may adversely affect EFH, regardless of whether or not those activities occur within designated EFH. In other words, an activity can adversely affect EFH without occurring within EFH. An adverse effect means any impact that reduces either the quantity or quality of EFH (50 CFR 600.810). For those activities that would adversely affect EFH, NMFS then provides EFH conservation recommendations to the Federal agency to avoid, minimize, or offset those adverse effects. Fishery Management Councils may also comment on proposed actions that may

adversely affect EFH, and is obligated to provide comments on any activity that is likely to substantially affect the habitat, including EFH, of an anadromous fishery resource under its authority. 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 receives information that an activity will adversely affect EFH. Whenever possible, NMFS utilizes existing coordination procedures to transmit EFH conservation recommendations.

Table 1 Members of the Oversight Panel.

Name	Affiliation
Chuck Tracy	Pacific Fishery Management Council
Kerry Griffin	Pacific Fishery Management Council
John Coon	Pacific Fishery Management Council
John Stadler – Chair	NMFS Northwest Region, Habitat Conservation Division
Barbara Seekins	NMFS Northwest Region, Protected Resources Division
Phil Roni	NMFS Northwest Fisheries Science Center
Eric Chavez	NMFS Southwest Region, Habitat Conservation Division
Adam Obaza	NMFS Southwest Region, Habitat Conservation Division
Bryant Chesney	NMFS Southwest Region, Habitat Conservation Division
Charleen Gavette	NMFS Southwest Region, Habitat Conservation Division
Brian Spence	NMFS Southwest Fisheries Science Center
Nancy Munn	NMFS Northwest Region, Habitat Conservation Division
Steve Copps	NMFS Northwest Region, Sustainable Fisheries Division

The designations and detailed descriptions of EFH in the FMPs are used during the EFH consultation process to determine where and for what species EFH has been designated in the project area. The analysis of the adverse effects from the proposed action, and potential conservation measures that avoid, minimize, or offset those effects, are informed by the information contained in the FMP.

Essential Fish Habitat Periodic Reviews

The regulatory guidelines for implementing the EFH provisions of the MSA state that Regional FMCs and NMFS should periodically review the EFH provisions of FMPs and revise or amend EFH provisions as warranted, based on available information (50 CFR 600.815(a)(10)). This review included evaluating published scientific literature and unpublished reports, soliciting input from interested parties, and searching for previously unavailable information on salmon stocks identified in the FMP. The Council may provide suggested changes to existing EFH to NMFS for their approval, if the information warrants changes. The regulatory guidance provides that a complete review should be conducted periodically, but at least once every five years. Pacific Coast salmon EFH was first designated in 1999 by the Council as part of Amendment 14 to the Pacific Coast Salmon FMP, and was codified in 2008 as a result of the Idaho County versus Commerce court case (Idaho County et al. v. Donald Evans et al., United States District Court for the District of Idaho, Case No. CV02-80-C-EJL). The current review was initiated in 2009.

Since EFH for Pacific Coast salmon was first designated in 1999, NMFS has taken steps to clarify the process for designating and refining EFH. In 2002, NMFS published final rules to implement the EFH provisions of the MSA (50 CFR Part 600), and, in 2006, issued a memo providing additional guidance to refine the description and identification of EFH (NMFS 2006). The 5-year review presented was guided by these two clarifying documents.

Methods/Approach

The Panel convened via conference call, on an intermittent basis, from June, 2009 through March, 2011.

Available information on salmon distribution in freshwater and marine habitats, impassible barriers in freshwater, salmon life history, and threats to EFH from fishing and non-fishing activities was compared to the information in Amendment 14 to the Pacific Coast Salmon FMP. Using these comparisons, the Panel evaluated potential modifications to EFH and identified potential changes to EFH where warranted. The information used was gathered from publicly available sources.

Chronology

- Early 2009 NMFS and the Council received $100k from NMFS Headquarters to provide support for the review and the Oversight Panel was established
- September 2009 – The Council Staff provided an informational report at the September Council meeting
- September 2009 – The Council hired Cramer Fish Sciences to compile new references and develop an annotated bibliography on the list of barriers, the habitats used by salmon at all life stages, and threats to EFH, as well as review and synthesize potential actions to avoid, minimize, or offset 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
- September 2010 – Draft report presented to the Council
- October 2010 – December 2010 - Comments on draft report solicited by the Panel
- April 2011 – Final report delivered to the Council

2. CURRENT EFH DESIGNATIONS FOR PACIFIC COAST SALMON

This section summarizes existing EFH for Pacific salmon contained in Amendment 14 and the 2008 Final Rule.

In Amendment 14 to the Pacific Coast Salmon FMP (PFMC 1999), the Council chose a comprehensive approach to designate 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. This means that the species-specific maps of the U.S. Geological Survey (USGS) 4th field hydrologic hnits (HUs) across a large geographic area oblige the user to make a more refined determination as to whether a particular activity is within, or may adversely affect, Pacific Coast salmon EFH, within that HU. EFH identification based on USGS 4th field HUs recognizes the diversity of habitats essential to the species through 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 designated by the North Pacific FMC (NPFMC) as EFH for salmon. This highlights the importance of habitats in 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.

Pacific salmon EFH underwent minor revisions in 2008 as a result of the Idaho County v. Department of Commerce lawsuit (Case No. CV02–C–EJL), 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 an MSA-required review.

This section presents a summary of existing EFH descriptions for the three species of Pacific salmon managed by the Council. More detailed information can be found in Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999) and the Final Rule that codified Pacific Coast 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 and descriptions will be amended over time.

The 2008 Final Rule merged the marine and freshwater designations of EFH to simplify the description. It identifies 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" and adds caveats for impassible barriers and for Puget Sound pink salmon (see following sections).

Chinook salmon

Chinook salmon (*Oncorhynchus tshawytscha*) EFH, as currently designated, 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 long-standing naturally occurring barriers (e.g., waterfalls) or specifically identified man-made barriers (e.g., dams) represent the current upstream extent of Pacific salmon access. Chinook salmon EFH includes the marine areas off Alaska designated as salmon EFH by the NPFMC. Including marine EFH designated by the NPFMC serves to recognize the migratory patterns of Chinook salmon, and the importance of habitat during all life stages. Current marine EFH for Chinook salmon includes the entire exclusive economic zone (EEZ) around Alaska. The southern extent of Chinook salmon marine EFH extends to Point Conception, CA, which represents the approximate southern extent of the Chinook range.

The designation of EFH is based on distribution data available at the time of Amendment 14, and all U.S. Geologic Survey (USGS) 4th field HUs with known or historical Chinook salmon presence at the time of Amendment 14, with the exception of those above certain man-made barriers, are currently designated as EFH for this species (Figures 1-3).

Amendment 14 includes descriptions of relevant habitat parameters, including the four major components of Chinook salmon 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 detailed description of the life history and habitat requirements at each life stage.

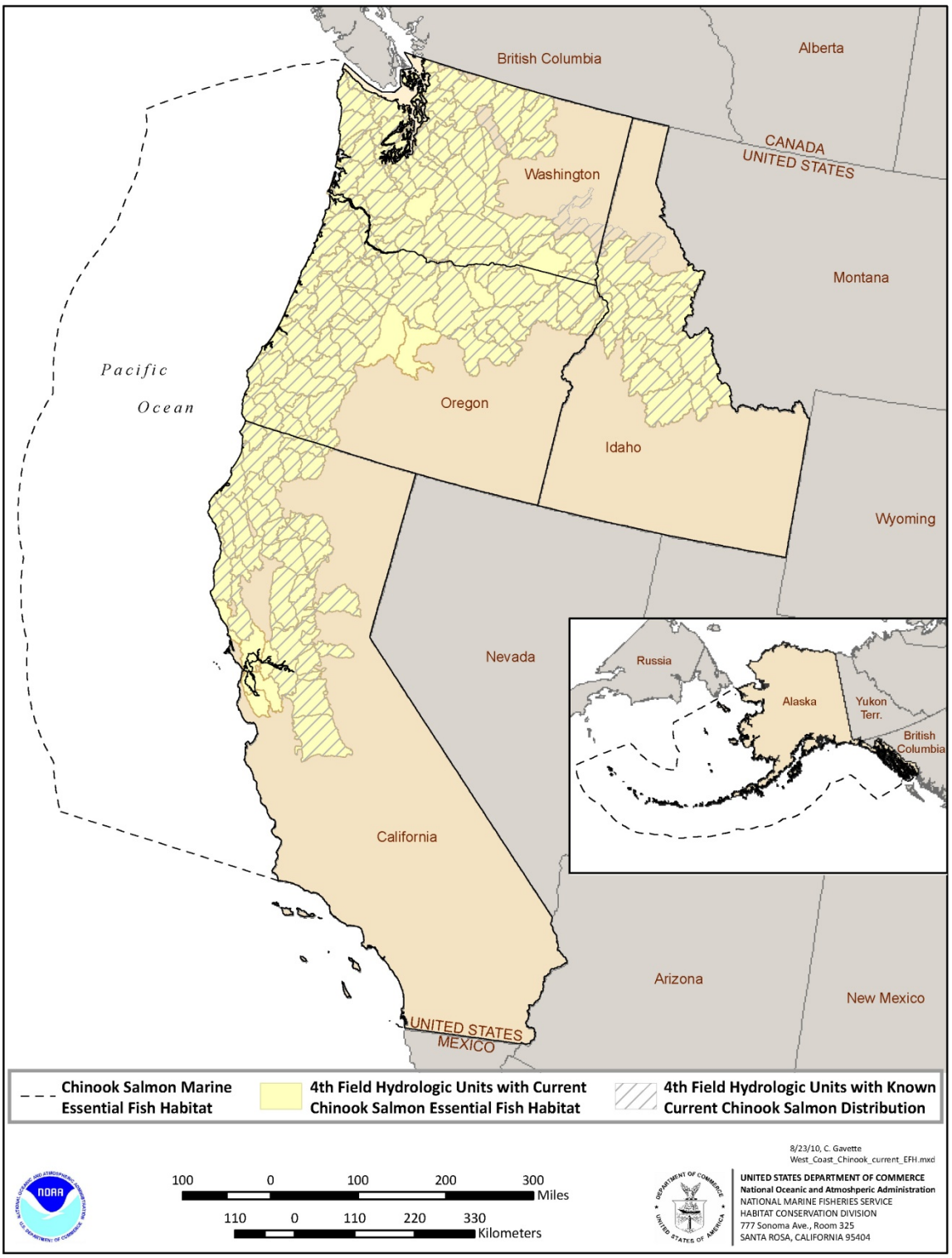

Figure 1. 4th field HUs and marine waters currently identified as EFH for Chinook salmon in relation to current Chinook salmon distribution for the U.S. West Coast and Alaska.

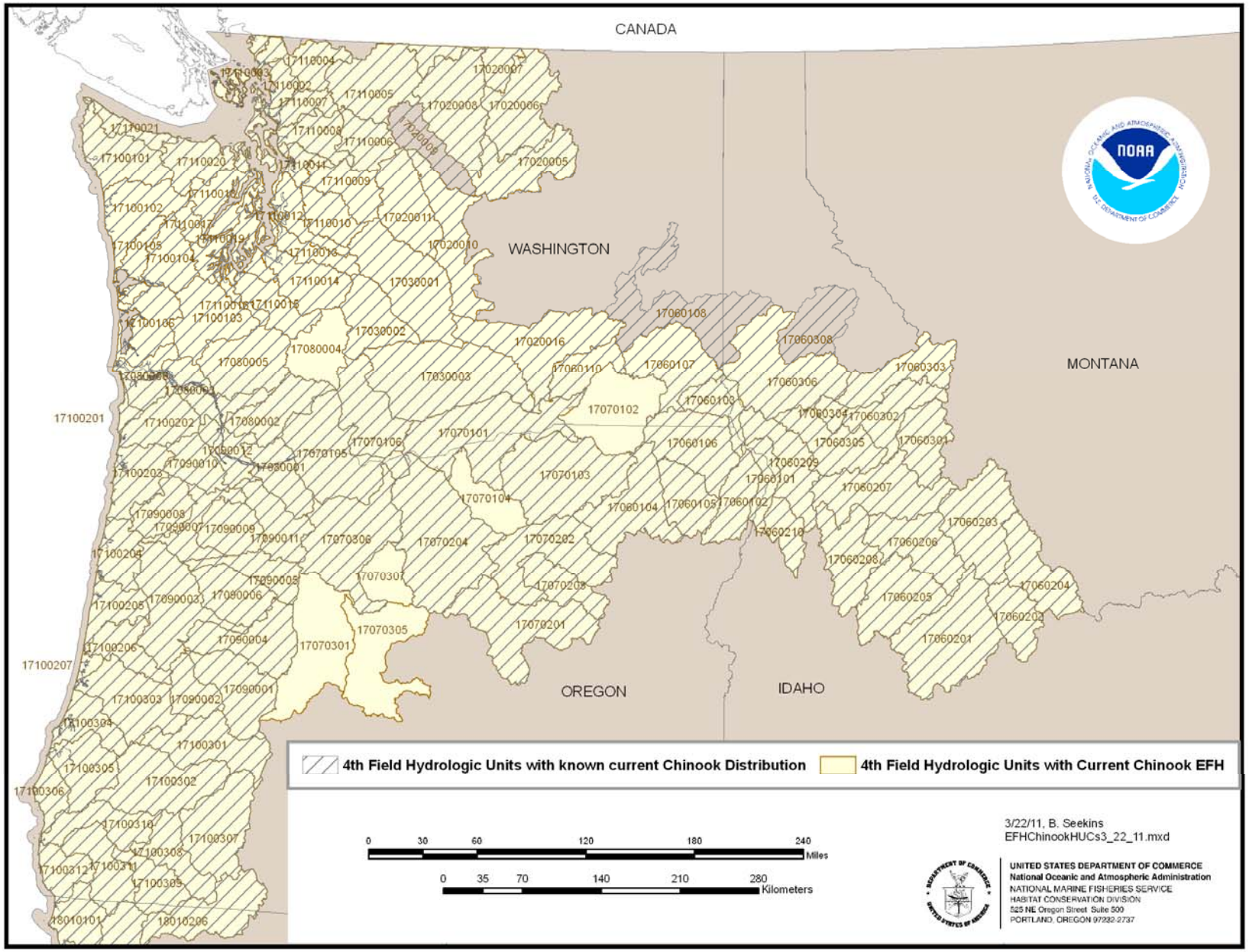

Figure 2. . 4th field HUs currently identified as EFH for Chinook salmon in relation to current Chinook salmon distribution in Washington, Oregon, and Idaho.



Figure 3. . 4th field HUs currently identified as EFH for Chinook salmon in relation to current Chinook salmon distribution in California.

Coho salmon

Coho salmon (*O. kisutch*) EFH, as designated in Amendment 14, includes all streams, estuaries, marine waters, and other water bodies occupied or historically accessible to coho salmon in Washington, Oregon, Idaho, and California. Exceptions include cases in which long-standing naturally occurring barriers (e.g., waterfalls) or specifically identified man-made barriers (e.g., dams) represent the current upstream extent of Pacific salmon access. Coho salmon EFH includes the marine areas off Alaska designated as salmon EFH by the NPFMC. Including marine EFH designated by the NPFMC serves to recognize the migratory patterns of coho salmon, and the importance of habitat during all life stages. Current marine EFH for coho salmon includes the entire EEZ around Alaska. The southern extent of coho salmon marine EFH is Point Conception, CA, which represents the approximate southern extent of the range of coho salmon.

The designation of EFH is based on distribution data available at the time of Amendment 14, and all U.S. Geologic Survey (USGS) 4th field HUs with known or historical coho salmon presence at the time of Amendment 14, with the exception of those above the identified man-made barriers, are currently designated as EFH for this species (Figures 4-6).

Amendment 14 includes descriptions of relevant habitat parameters, including the four major components of coho salmon freshwater EFH: (1) spawning and incubation; (2) juvenile rearing; (3) juvenile migration corridors; and (4) adult migration corridors. The current EFH for coho salmon does not include adult holding habitat. Amendment 14 also includes detailed description of the life history and the habitat requirements for each life stage.

Puget Sound Pink Salmon

Puget Sound (PS) pink salmon (*O. gorbuscha*) life history and migratory patterns are distinctly different than Chinook and coho salmon, and are described in Amendment 14. Puget Sound pink salmon EFH, as currently designated, includes all streams, estuaries, marine waters, and other water bodies occupied or historically accessible to pink salmon within Washington State. Exceptions include cases in which long-standing naturally occurring barriers (e.g., waterfalls) or specifically identified man-made barriers (e.g., dams) represent the current upstream extent of Pacific salmon access. 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. It is difficult to determine a western limit for pink salmon essential marine habitat because of limited information on their ocean distribution, but most PS pink salmon are typically found in Canadian, Alaskan, and international waters both within and outside the EEZ north of Cape Flattery, Washington.

The designation of EFH is based on distribution data available at the time of Amendment 14, and USGS 4th field HUs with known or historical PS pink salmon presence at the time of Amendment 14, with the exception of those above the identified man-made barriers, are currently designated as EFH for this species (Figure 7).

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. The current EFH description for PS pink salmon does not include adult holding habitat. Amendment 14 also includes a detailed description of the life history and the habitat requirements per life stage.

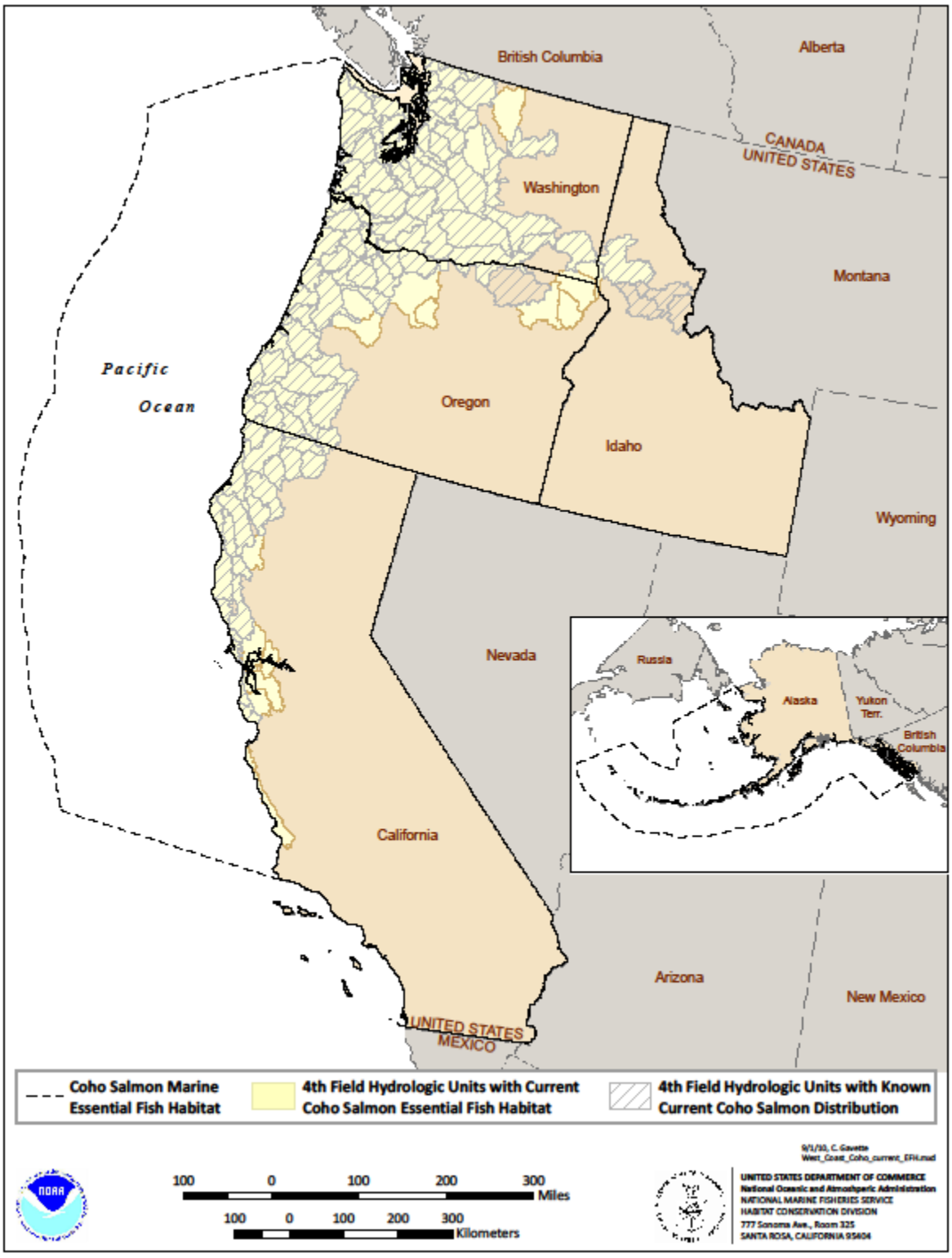

Figure 4. 4th field HUs and marine waters currently identified as EFH for coho salmon in relation to current coho salmon distribution in the U.S. West Coast and Alaska.

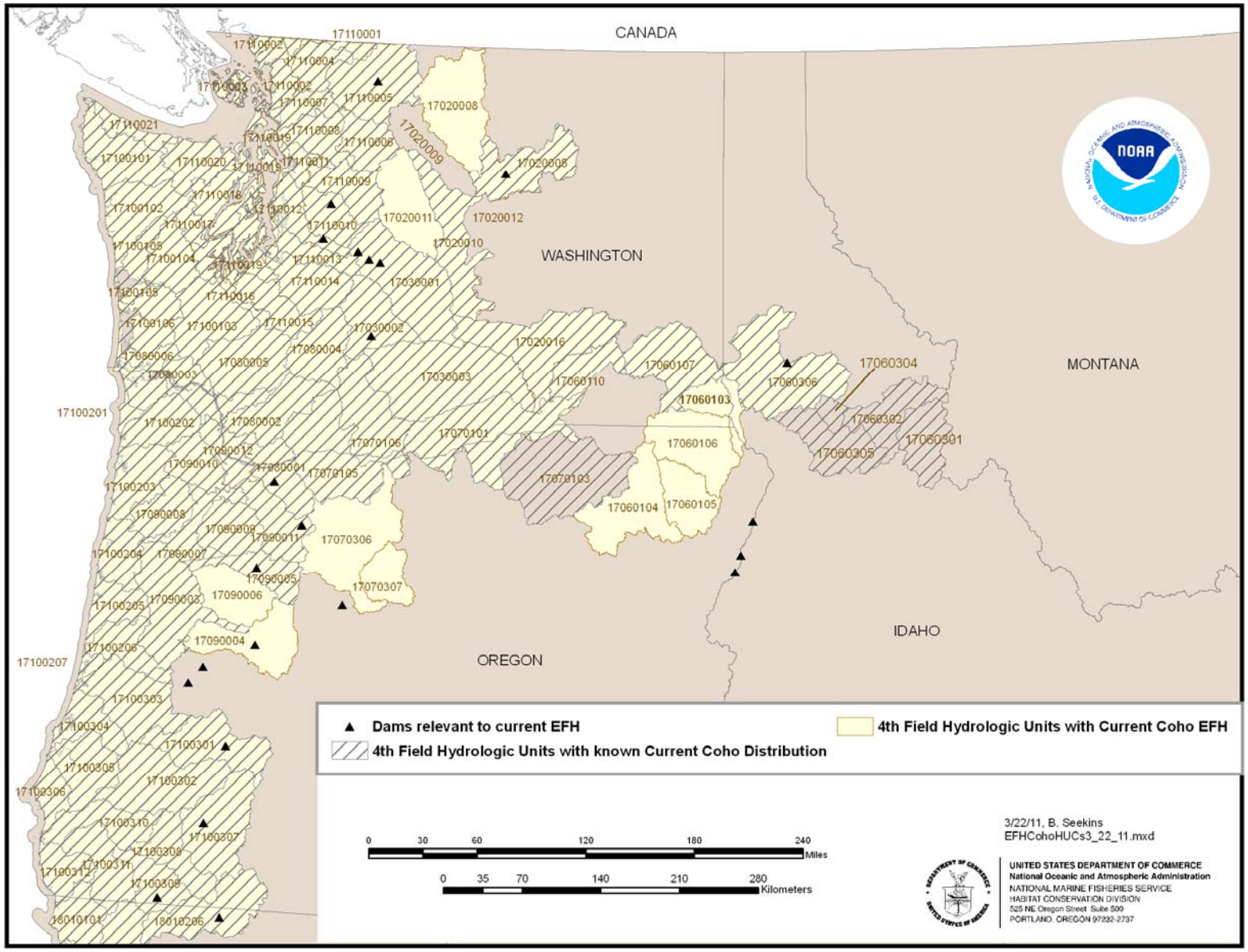

Figure 5. 4th field HUs currently identified as EFH for coho salmon in relation to current coho salmon distribution in Washington, Oregon, and Idaho.



Figure 6. 4th field HUs currently identified as EFH for coho salmon in relation to coho salmon distribution in California.

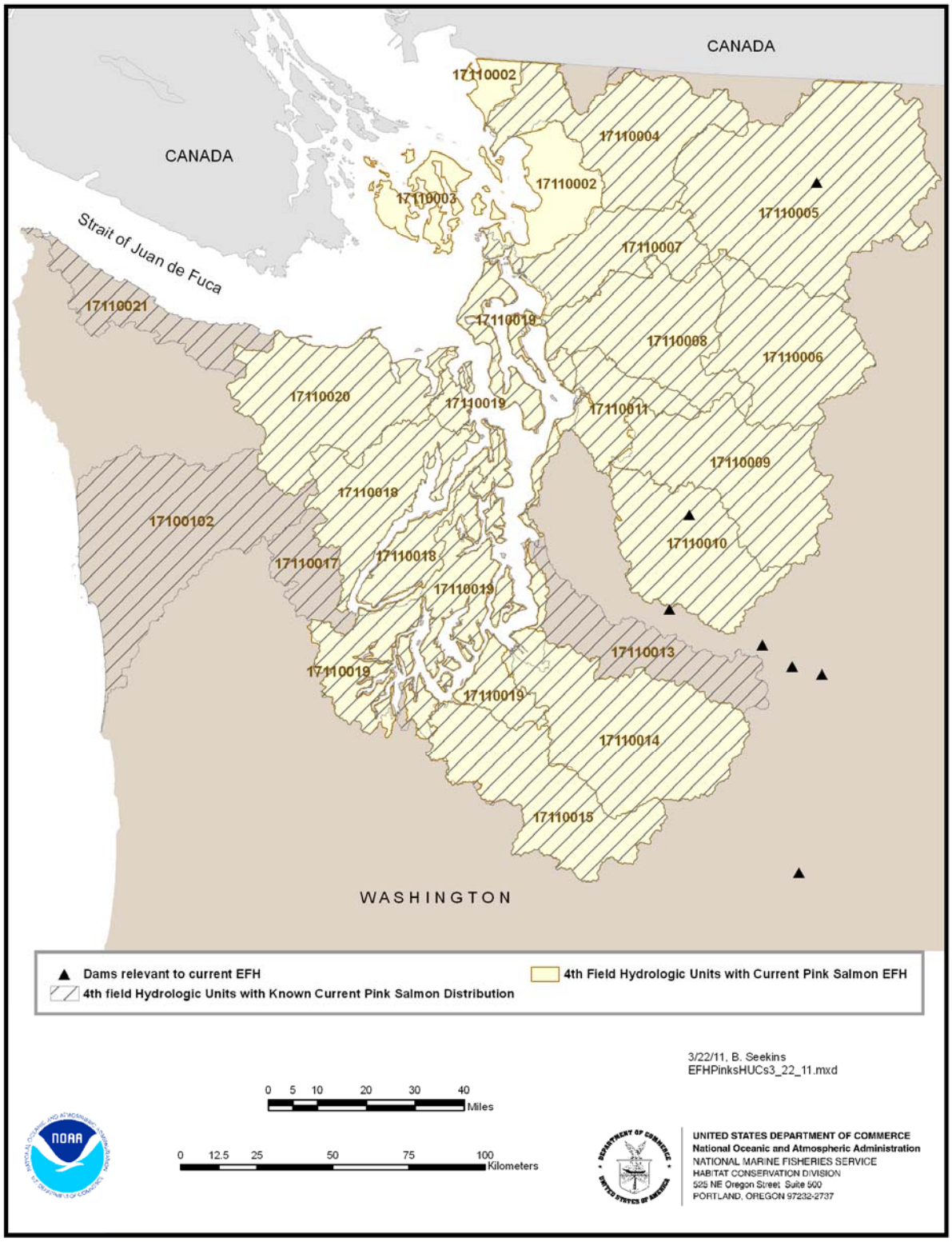

Figure 7. 4th field HUs currently identified as EFH for PS pink salmon in relation to current PS pink salmon distribution in western Washington.

3. REVIEW ESSENTIAL FISH HABITAT FOR PACIFIC COAST SALMON

A primary purpose of an EFH review is to examine new or newly-available information, especially as it relates to the information that was used as the basis for the original EFH designations. The regulatory guidance provides guidelines for organizing information. They recommend organizing the habitat information into one of four levels, and then suggest describing EFH based on the highest level of data (50 CFR 600.815(a)(1)(B)). These levels are:

Level 1: Distribution data are available for some or all portions of the geographic range of the species. At this level, only distribution data are available to describe the geographic range of a species (or life stage).

Level 2: Habitat-related densities of the species are available. At this level, quantitative data (i.e., density or relative abundance) are available for the habitats occupied by a species or life stage.

Level 3: Growth, reproduction, or survival rates within habitats are available. At this level, data are available on habitat-related growth, reproduction, and/or survival by life stage.

Level 4: Production rates by habitat are available. At this level, data are available that directly relate the production rates of a species or life stage to habitat type, quantity, quality, and location.

The available data on the habitat of Pacific Coast salmon includes some from all four levels. Pacific Coast salmon are distributed over a wide geographic range, with populations adapted to local habitat conditions that can vary widely across this range. Current distribution data (Level 1) is generally available across the entire geographic range. However, historical distribution data are lacking in certain parts of the range, and particularly in areas in which salmon populations have been extirpated. Information from the other levels, on the other hand, is generally not available across the entire range, and where available is usually limited to a smaller geographic area (i.e., a watershed or basin). Habitat-specific information from one location does not necessarily apply across the entire range. Therefore, it is appropriate to determine the geographic distribution of EFH for Pacific Coast salmon using Level 1 information, and incorporate information from the other levels, when possible, in the species- and life-stage-specific descriptions of EFH.

The Panel included two geographic information system (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. Updates, refinements, and revisions have occurred to both the hydrologic units and the salmon distribution data sets since the 1999 designation of EFH. The data used to create the 1999 designation was compared to recent data and NMFS GIS specialists provided potential updates to EFH where appropriate.

Historical and Current Distribution

The Panel recognizes that, as currently designated, EFH for Pacific Coast salmon is very broad, and includes virtually all freshwater habitats in those river systems that are currently or were historically occupied by salmon. However, the MSA defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." The anadromous life history strategies of Pacific salmon rely on the connectedness of their habitats, from the rivers and streams downstream to the estuary and out to marine waters. Every habitat along this continuum serves a vital function in salmon life history, whether it is spawning, rearing, foraging, migrating, or a combination of these functions. Excluding any of these habitats from EFH would ignore the dependency that salmon have on this continuum and would conflict with the statutory definition of EFH. The Panel also recognized that

within any river system, there is a limit on the upstream extent of habitats utilized by salmon, and that the three species will utilize the various habitats differently (e.g., coho salmon will spawn in smaller streams than either Chinook salmon or PS pink salmon). However, the data to allow for identification of EFH on a stream-by-stream basis are not available.

The Panel compared the current data on distribution of Pacific Coast salmon in freshwater and marine habitats with the current EFH designations. The freshwater and marine habitats are discussed separately because freshwater systems are classified by spatially-explicit HUs and marine waters are not. In addition, the physical nature of the habitats is different (e.g., freshwater systems have both natural and man-made barriers to salmon).

Freshwater Distribution

This section describes the various strategies that the Panel considered for determining the freshwater distribution of Pacific Coast salmon. The strategies included using current subbasin-scale distribution data and information on man-made impassible barriers (dams) to determine the current and historical distribution of salmon at the subbasin scale (4th field HU) and modeling the freshwater habitat to estimate salmon distribution at a finer resolution (e.g., stream reach). The resulting salmon distribution data were then compared to the data used to designate EFH in Amendment 14. Finally, the Panel makes recommendations to the Council on where and at what spatial resolution EFH for Pacific Coast salmon should be designated.

Amendment 14 provided the following rationale for adopting a subbasin-based designation of EFH:

> *"Adopting an inclusive, watershed-based description of EFH using USGS HUCs is appropriate, because it (1) recognizes the species' use of diverse habitats and underscores the need to account for all of the habitat types supporting the species' freshwater and estuarine life stages, from small headwater streams to migration corridors and estuarine rearing areas; (2) considers the variability of freshwater habitat as affected by environmental conditions (droughts, floods, etc.) that make precise mapping difficult; and (3) reinforces important linkages between aquatic and adjacent upslope areas. Habitat available and utilized by salmon changes frequently in response to floods, landslides, woody debris inputs, sediment delivery, and other natural events. To expect the distribution of salmon within a stream, watershed, province, or region to remain static over time is unrealistic. Furthermore, this watershed-based approach is consistent with other Pacific salmon habitat conservation and recovery efforts such as those implemented under the Endangered Species Act (ESA). "*

The Panel agrees with this rationale, and used it for this review to designate EFH for Pacific Coast salmon.

Spatial Resolution of Salmon Distribution

Distribution data were obtained from the publicly available GIS data sets Streamnet (http://www.streamnet.org/) and Calfish (http://www.calfish.org/). These data were examined to determine whether it would be possible or practical to delineate EFH at finer spatial resolution.

Using USGS Hydrologic Units for EFH Designations

The current designations of freshwater EFH designations for the three species of Pacific Coast salmon are based on USGS 4th field HUs. Defining EFH at a 4th field HU level results in relatively coarse

geographic descriptors. Geospatial mapping has improved significantly since the original Amendment 14, and USGS 5th or 6th field HUs 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 historical and current distribution in smaller HUs. The resulting descriptions would provide a more precise spatial representation of EFH and would remove areas that are neither current nor historical salmon habitat from EFH.

However, several obstacles make this task difficult. First, and most significant, is the paucity of salmon distribution data for the 5th and 6th field HUs, where many of the HUs have no distribution data. Within the 174 4th field HUs that are currently designated as EFH, there are approximately 1052 5th field HUs and 5492 6th field HUs. Approximately 808 (77%) of the 5th field and 2990 (54%) 6th field HUs have known presence data. Figures 8 and 9 illustrate the extent of the 5th and 6th field HUs that lack distribution data. It is important to note that because neither Streamnet nor Calfish contain data on salmon absence, it is not reasonable to assume that all units without distribution data are unoccupied. Nor is current distribution information necessarily a good indicator of historical occupancy. The Panel concluded that the uncertainty associated with these smaller hydrologic units that lack distribution data, and the need to maintain a consistent approach across the geographic range of Pacific Coast salmon, precluded refining EFH down to the 5th or 6th field HU.

The second and less problematic issue is the magnitude of staff resources required to analyze all 5492 6th field HUs or 1052 5th field HUs. To ensure areas were not being erroneously omitted from, or included in, EFH designations, biologists with detailed knowledge of salmon distribution in a particular geographic region would need to evaluate these individual 5th or 6th field HUs. This task could not be completed during this review process. Therefore, the Panel concluded that designating EFH at the 4th field HU was both reasonable and appropriate at this time.

Mapping EFH at the 4th field HU may be seen as overly broad because it appears to incorporate not only the streams, but the upland areas as well. However, EFH can be designated only in aquatic habitats, so it is the streams in each HU that are designated as EFH, and not the uplands. Figure 10 illustrates how the extent of EFH is actually far less than the entire 4th field HU.

Designating at the 4th field level also may be seen as overly broad because it designates all streams, in their entirety, within that HU as EFH. However, the Panel recognizes that there will be portions of the streams in each 4th field HU that are not currently or historically utilized by salmon, especially in the upper reaches. Similar to the difficulty in designating EFH at the 6th field HU level, salmon distribution for each stream reach is not available across the entire geographic range of salmon. This apparent broadness can be reduced if the designations are modified in practice according to location and species-specific information. If, for example, a stream reach is upstream of the upper-most reach occupied, either currently or historically, by a particular species, then it should not be considered EFH for that species. Consulting biologists with a better understanding of salmon distribution in a particular region should be able to make this type of determination.

The 4th field HUs used to designate EFH in Amendment 14 were based on data created by the USGS in 1987. However, in 1999 the U.S. Department of Agriculture's Natural Resource Conservation Service published an updated GIS dataset that differs slightly from the 1987 data in the spatial extent, names, and codes of some of the HUs. These inconsistencies appear to be confined to the California Central Valley and the Puget Sound Region, where in some areas the subbasins have been more accurately

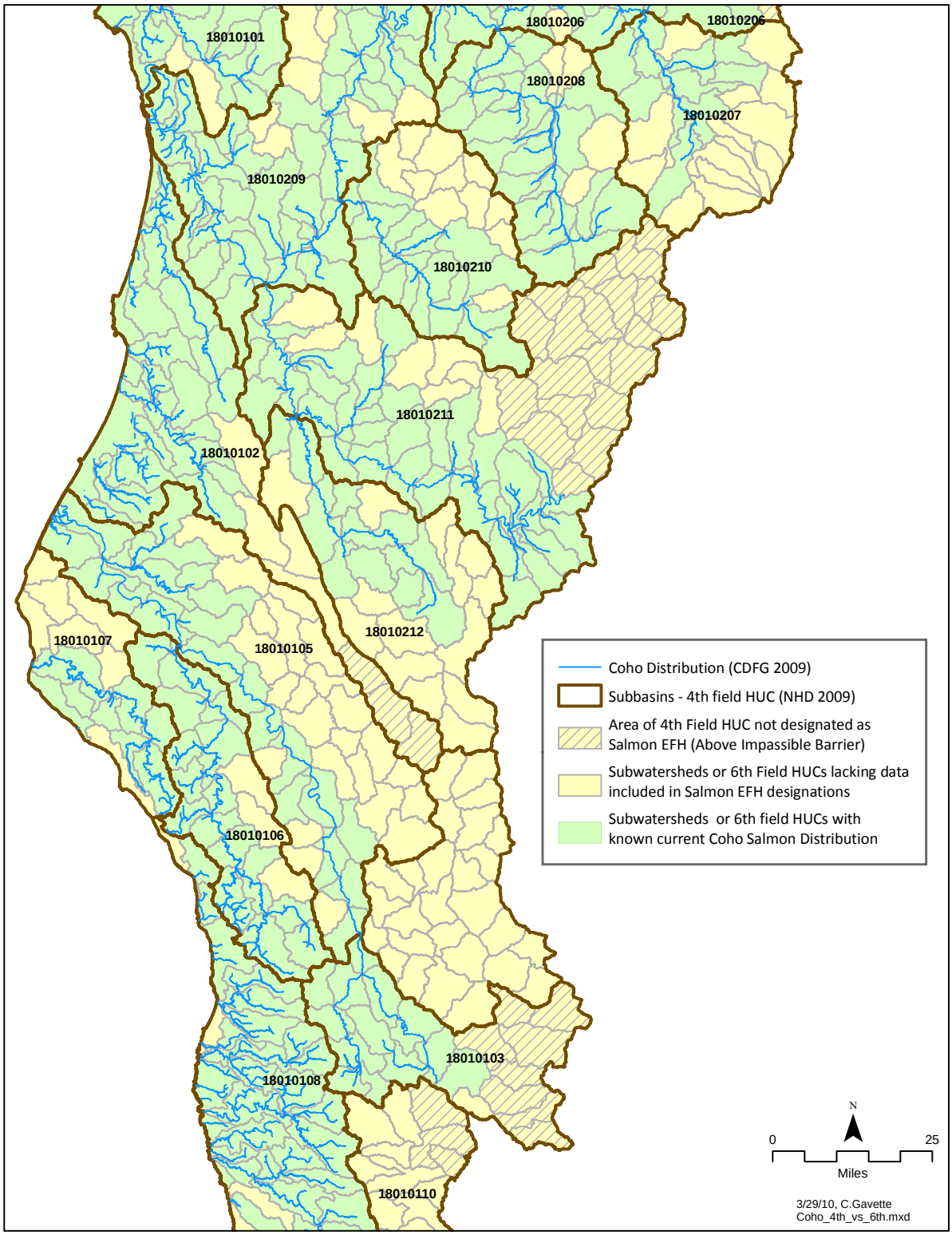

Figure 8. Example comparison of 6th field HUs with current or historical distribution data for coho salmon with those lacking distribution data.

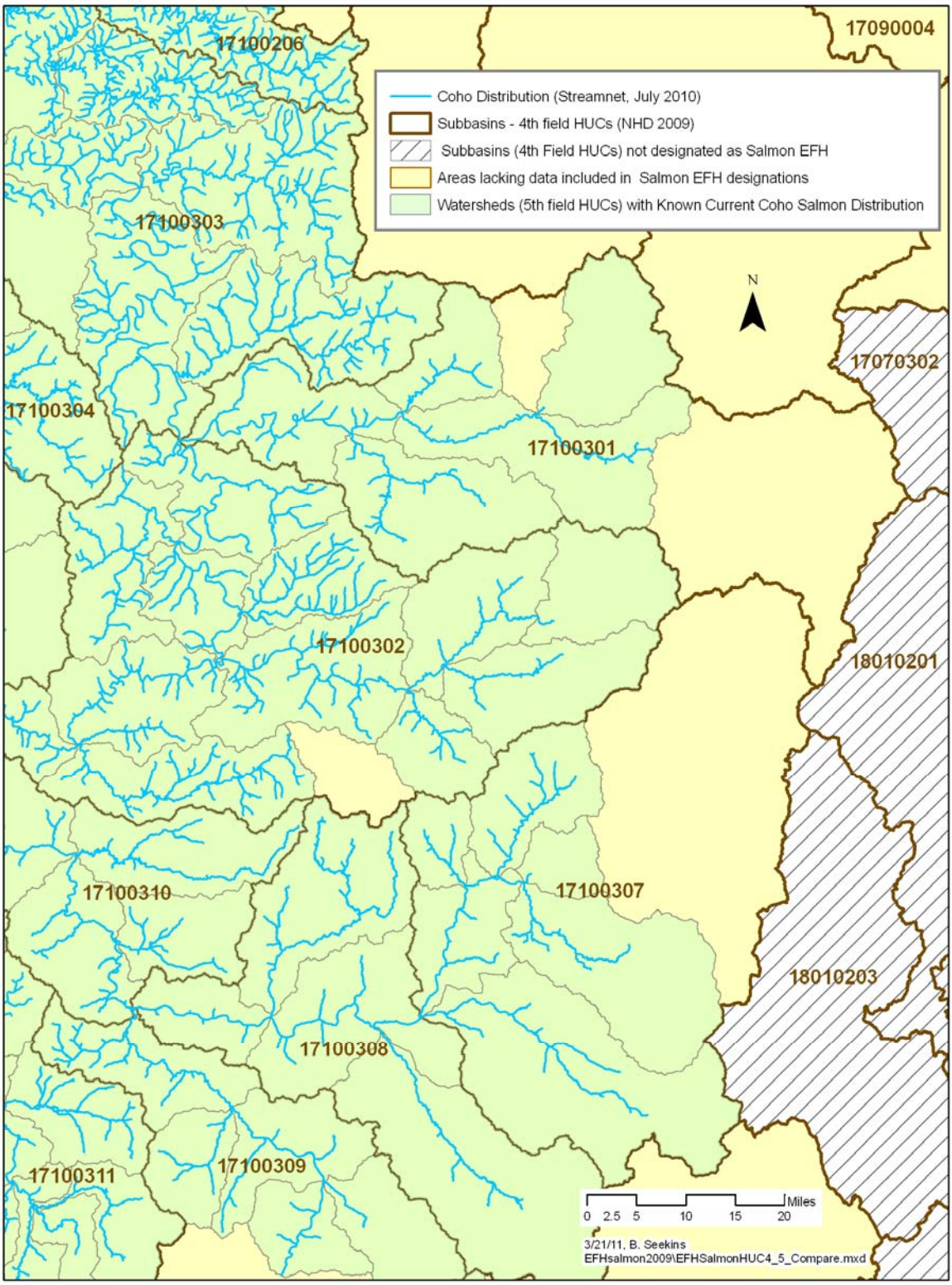

Figure 9. Example comparison of 5th field HUs with current or historical distribution data for coho salmon with those lacking distribution data.

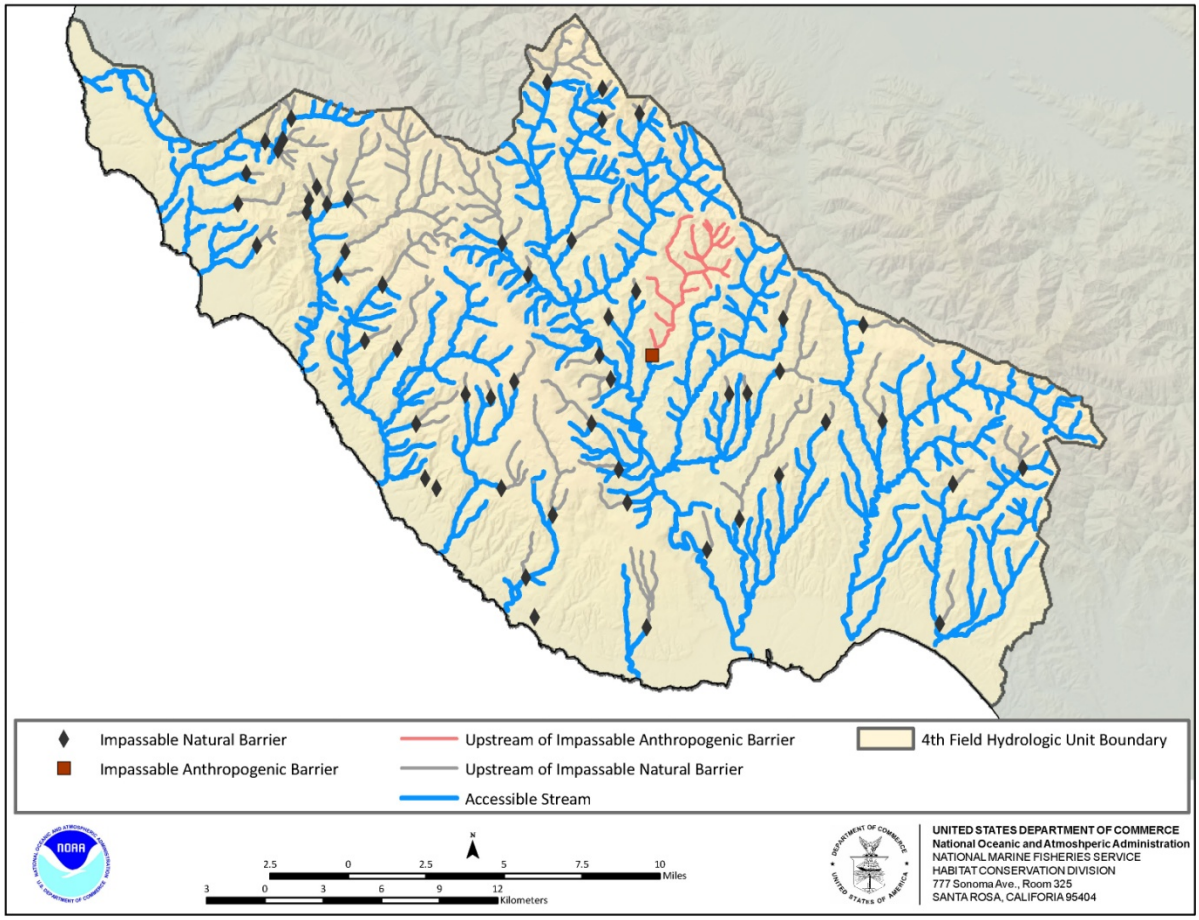

Figure 10. Example 4th field HU showing stream segments that are designated as EFH. Accessible stream reaches below anthropogenic and natural barriers that represent the upstream extent of EFH are shown.

delineated. The Panel determined that the updated GIS data is the most appropriate information to use for this review. Differences between these datasets, and the potential changes are noted in the tables where they affect the designation of EFH.

4th Field Distribution Data by Species

The Panel determined the current distribution, at the 4th field HU, of all three species of Pacific Coast salmon in Oregon, Washington, and Idaho using data on the presence of these species obtained from Streamnet (http://www.streamnet.org/), and in California from Calfish (http://www.calfish.org/). These data sets include data from stream surveys. However, because not all stream reaches are surveyed, Streamnet includes streams where, based on the best professional judgment of the state fisheries biologists, salmon are expected to occur. Additionally, Calfish represents only the known distribution based on where the species has been recently observed and reported. The majority of observations only indicate where the species was sampled for or otherwise observed. Because of this, the data likely underestimates the absolute geographic distribution of the species. And, as the species may not be found on an annual basis in all indicated reaches due to natural variations, the data does not verify that the species are currently present in a given stream. Conversely, the absence of distribution for a given stream does not necessarily indicate that the species does not occur in that stream. In addition, the Panel is aware of some current distribution data that are not reflected in the Calfish database (e.g., Leidy et al. 2007; Ettlinger et al. 2010).

Chinook Salmon

The current distribution data for Chinook salmon is depicted in Figures 1-3, which also compares these data with Amendment 14. There are 10 4th field HUs that are currently designated as EFH, but have no current distribution data for Chinook salmon (Table 2). In three cases, Amendment 14 indicates that these were either inaccessible historical habitat, or currently accessible but underutilized habitat. Therefore, they meet the general description of EFH and should retain their designation. These HUs are either currently accessible or were historically occupied by Chinook salmon, and therefore meet the designation criteria as described in Amendment 14. Of the remaining seven HUs, five were indicated in Amendment 14 as having data on presence in 1999, but that data was either not incorporated into the GIS databases used in this review or was found in the intervening years to be erroneous. The remaining two HUs are the San Juan Islands and Strait of Georgia, where Chinook salmon are known to occur in the marine waters, but not in the streams. Therefore, it is only the marine waters of these HUs that qualify as EFH for this species.

Four 4th field HUs have current Chinook salmon distribution data, but were not designated as EFH in Amendment 14 (Table 3). The presence of Chinook salmon in Lake Chelan (17020009) appears to be limited to the lower reaches, below a naturally impassible stream reach. Although Chinook salmon are present in the lake, these are non-anadromous fish, and are not likely to part of the FMU and therefore not managed by the Council. Another HU, Palouse (17060108) has current Chinook salmon distribution data but was not designated as EFH. The third, the lower north fork of the Clearwater River (17060308) had no data on presence in 1999, but now does. These data are from the relatively short portion of river that is below Dworshak Dam. The fourth HU is Tomales-Drakes Bay (18050005). Ettlinger et al (2010) reported that Chinook salmon have been observed in this subbasin (Lagunita Creek) in 12 out of the last 15 years.

Although Calfish lacks Chinook salmon distribution data for Coyote Creek (18050003), an HU that is currently designated as EFH for this species, Leidy et al. (2007) report that Chinook salmon are present in this subbasin.

Using the most recent 4thfield HU GIS data produces potential alterations to the Chinook salmon EFH designation. Comparing the 1999 HUCs designated as EFH to the most recent data reveal several differences in HU numbers, names, and spatial extent, primarily in the California Central Valley. Figure 11 illustrates those differences. While some new areas may be designated as EFH, other areas that were previously designated as EFH may now be excluded. For example, the Fresno River is now defined as a separate subbasin where it was previously incorporated into the larger San Joaquin HU. The lack of historical or current Chinook salmon presence in the Fresno River precludes its inclusion in EFH. In the same way the area covered by the southwest corner of the current designation would no longer be included. This is due to the newer data more accurately defining the subbasin boundaries. Table 4 shows the 4th field HUs from Amendment 14 that should be removed from EFH for Chinook salmon because they no longer exist.

Recommendation

The Panel recommends consideration of updating EFH designations for Chinook salmon, based on the distribution information provided above and the potential changes indicated in Tables 4 and 5.

Table 2. 4th field HUs lacking current distribution data but designated as EFH in Amendment 14, and the reason they are included in Amendment 14. Species: CK = Chinook salmon, CO = coho salmon, PK = PS pink salmon. Basis for inclusion in Amendment 14: C = occupied in 1999; H = inaccessible historical habitat; H*= accessible as of 1999 but unutilized, NA = not indicated.

4th Field Hydrologic	Tributary/Basin	State	Species	Basis for Inclusion in Amendment 14

Unit				
17020008	Methow River	WA	CO	H*
17020011	Wenatchee River	WA	CO	C
17060103	Lower Snake – Asotin Creek	ID/WA	CO	H*
17060104	Upper Grande Ronde	OR	CO	H*
17060105	Wallowa River	OR	CO	H*
17060106	Lower Grande Ronde	OR/WA	CO	H*
17070102	Walla Walla River	OR/WA	CK	H*
17070301	Upper Deschutes River	OR	CK	H
17070305	Lower Crooked River	OR	CK	H
17070306	Lower Deschutes River	OR	CO	C
17070307	Willow Creek	OR	CK	H*
17070307	Trout Creek	OR	CK and CO	H*
17080004	Upper Cowlitz	WA	CK	C
17090004	McKenzie River	OR	CO	C
17090006	South Santiam	OR	CO	C
17110002	Strait of Georgia*	WA	CH and PK	NA
17110003	San Juan Islands*	WA	CK and PK	NA
18010104	Middle Fork Eel River	CA	CO	C
18010109	Gualala-Salmon River	CA	CK	C
18010111	Bodega Bay	CA	CK	C
18050001	Suisun Bay	CA	CK and CO	C
18050002	San Pablo Bay	CA	CK and CO	C
18050004	San Francisco Bay	CA	CK and CO	C
18060006	Central Coastal	CA	CO	H*

* These hydrologic units include marine waters, but no Chinook salmon or PS pink salmon distribution data in freshwater.

Table 3. 4th field HUs having current or historical distribution data but are not designated as EFH in Amendment 14. Ck=Chinook salmon; CO = coho salmon, PK = PS pink salmon.

4th Field hydrologic unit	Tributary/Basin	State	Species	Basis for Exclusion From Amendment 14
17020009	Lake Chelan	WA	CK	No data reported.
17060108	Palouse	ID/ WA	CH	No data reported
17060301	Upper Selway River	ID	CO	No data reported
17060302	Lower Selway River	ID	CO	No data reported
17060304	MF Clearwater River	ID	CO	No data reported
17060305	SF Middle Clearwater River	ID	CO	No data reported
17060308	Lower NF Clearwater River	ID	CH	No data reported
17070103	Umatilla River	OR	CO	No data reported
17110013	Duwamish River	WA	PK	No data reported, but recent large returns
17110017	Skokomish River	WA	PK	No data reported. Outside of FMU?
17110021	Hoko-Crescent	WA	PK	No data reported. Outside of FMU?
17100102	Queets-Quinault	WA	PK	No data reported. Outside of FMU?
18050005	Tomales-Drakes Bay	CA	CK	No data reported

Table 4. . 4th field HUs in California that are currently designated as EFH for Chinook salmon in Amendment 14, but due to revisions in the HU codes and names, no longer exist.

USGS 4th Field Hydrologic Unit	Hydrologic Unit Name
18010111	Bodega Bay
18020101	Sac.–Lower Cow–Lower Clear
18020102	Lower Cottonwood Creek
18020103	Sacramento – Lower Thomes
18020105	Lower Butte Creek
18020106	Lower Feather River
18020107	Lower Yuba River
18020108	Lower Bear River
18020109	Lower Sacramento River
18020110	Lower Cache
18020112	Sacramento–Upper Clear
18020113	Cottonwood Headwaters
18020114	Upper Elder – Upper Thomas
18020118	Upper Cow – Battle Creek
18020119	Mill – Big Chico
18020120	Upper Butte Creek
18040004	L. Calaveras – Mormon Slough
18040005	L. Consumnes– L. Mokelumne



Figure 11. Comparison of the California Central Valley 4th field HUs designated as EFH in Amendment 14 with the newly defined HUs having current or historical Chinook salmon distribution data. Note that the spatial extent of EFH for Chinook salmon has expanded in some areas.

Coho Salmon

The current distribution data for coho salmon is depicted in Figures 4-6, which also compares these data with Amendment 14. There are 16 4th field HUs that are currently designated as EFH, but have no current distribution data for coho salmon (Table 2). Of these, Amendment 14 indicates that six were currently accessible but not occupied The remaining 10 were indicated in Amendment 14 as having data on presence in 1999, but that data was either not incorporated into the GIS databases used in this review or was found in the intervening years to be erroneous. These HUs are either currently accessible or were historically occupied by coho salmon, and therefore meet the designation criteria as described in Amendment 14.

Although Calfish lacks coho salmon distribution data for Coyote Creek (18050003) and San Pablo Bay (18050002), HUs that are currently designated as EFH for this species, Leidy et al. (2005, cited in Leidy et al. 2007)) found evidence for probable occurrence in these subbasins.

Seven 4th field HUs have current data on presence of coho salmon, but were not designated as EFH in Amendment 14 (Table 3).

Recommendation

The Panel recommends further consideration of the designation of EFH for coho salmon based on the distribution information provided above and the potential changes indicated in Table 5.

Puget Sound Pink Salmon

The current distribution of PS pink salmon is depicted in Figure 7, which also compares these data with Amendment 14. There are two 4th field HUs that are currently designated as EFH, but for which Streamnet has no distribution data (Table 2), and no distribution data are noted in Amendment 14. Although PS pink salmon utilize the adjacent marine waters, they are not known to occur in the streams of these hydrologic HUs. However, these two HUs also include marine waters that are assumed to support emigrating juveniles and returning adults. Therefore, despite the lack of PS pink salmon in the stream systems of these HUs, they do qualify as EFH, but only the marine waters. There are four 4th field HUs that have current data on the presence of pink salmon, but are not currently designated as EFH (Table 3). Of these, the Duwamish (17110013) has experienced dramatic returns of pink salmon in recent years. The Washington State Department of Fish and Wildlife estimates that up to 2.1 million pink salmon will return to the Duwamish system in 2011. Despite the lack of data on presence in the Duwamish in 1999, there is no question that pink salmon occupy this system.

The three remaining HUs, the Skokomish River (17110017), the Hoko-Crescent (17110021) and the Queets-Quinault (17110102) are shown in SteamNet as being occupied by pink salmon. However, their distribution in these systems is limited and they may have simply been missed by Amendment 14.

Another possible explanation for the exclusion of the Hoko-Crescent and Queets-Quinault pink salmon is that they are not part of the PS pink salmon fishery management unit (FMU). The PS pink salmon FMU is not clearly defined in the FMP and the western boundary is uncertain. The Elwha River is the western-most subbasin that was designated as EFH for this species. This coincides with the westernmost populations of the pink salmon Evolutionarily Significant Unit (ESU) identified by NMFS in the 1996 status review (NMFS 1996). In this Status Review, two pink salmon ESUs (even-year and odd-year) were found to be distributed in the Elwha River and eastward. Whether or not the status review erroneously excluded the Hoko-Crescent and Queets-Quinault HUs is unknown, but it appears that the 1999 designation of EFH for PS pink salmon is based on the ESUs.

Recommendation

The Panel recommends further consideration of the designation of EFH for PS pink salmon based on the distribution information provided above and the potential changes indicated in Table 5.

Table 5. All 4th field HUs with current or historical distribution data for each species of Pacific Coast salmon and potential changes to the current EFH designations. C = currently designated as EFH; D = current or historical distribution data but not currently designated as EFH. The new HUs are from the updated dataset that overlap with the out-of-date HUs that are designated as EFH in Amendment 14.

USGS 4th Field Hydrologic Unit	State(s)	Hydrologic Unit Name	Species Distribution Data			Potential change
			Chinook	Coho	PS Pink	
17020005	WA	Columbia River	C	C		None
17020006	WA	Okanogan River	C			None
17020009	WA	Lake Chelan	D			Designate as EFH for Chinook salmon
17020007	WA	Similkameen	C			None
17020008	WA	Methow River	C	C		None
17020010	WA	Upper Columbia – Entiat River	C	C		None
17020011	WA	Wenatchee River	C	C		None
17020016	WA	Upper Columbia – Priest Rapids	C	C		None
17030001	WA	Upper Yakima River	C	C		None
17030002	WA	Naches River	C	C		None
17030003	WA	Lower Yakima River	C	C		None
17060101	OR/ID	Hells Canyon	C			None
17060102	OR	Imnaha River	C			None
17060103	OR/WA/ID	Lower Snake – Asotin Creek	C	C		None
17060104	OR	Upper Grande Ronde	C	C		None
17060105	OR	Wallowa River	C	C		None
17060106	OR/WA	Lower Grande Ronde	C	C		None
17060107	WA	Lower Snake – Tucannon River	C	C		None
17060110	WA	Lower Snake River	C	C		None
17060201	ID	Upper Salmon River	C			None
17060202	ID	Pahsimeroi River	C			None
17060203	ID	Mid. Salmon – Panther River	C			None
17060204	ID	Lemhi River	C			None
17060205	ID	Upper Middle Fork Salm-on River	C			None
17060206	ID	Lower Middle Fork Salm-on River	C			None
17060207	ID	Mid. Salmon – Chamber-lain	C			None
17060208	ID	S.F. Salmon River	C			None
17060209	ID	Lower Salmon River	C			None

USGS 4th Field Hydrologic Unit	State(s)	Hydrologic Unit Name	Species Distribution Data			Potential change
			Chinook	Coho	PS Pink	
17060210	ID	Little Salmon River	C			None
17060301	ID	Upper Selway River	C	D		Designate as EFH for coho salmon
17060302	ID	Lower Selway River	C	D		Designate as EFH for coho salmon
17060304	ID	M.F. Clearwater River	C	D		Designate as EFH for coho salmon
17060305	ID	S.F. Clearwater River	C	D		Designate as EFH for coho salmon
17060306	WA/ID	Clearwater River	C	C		None
17060308	ID	Lower NF Clearwater River	D	D		Designate as EFH for Chinook salmon and coho salmon
17070101	OR/WA	Mid. Columbia – Lake Wallula	C	C		None
17070102	OR/WA	Walla Walla River	C			None
17070103	OR	Umatilla River	C	D		Designate as EFH for coho salmon
17070104	OR	Willow	C			None
17070105	OR/WA	Mid. Columbia – Hood	C	C		None
17070106	WA	Klickitat River	C	C		None
17070201	OR	Upper John Day River	C			None
17070202	OR	North Fork John Day River	C			None
17070203	OR	Middle Fork John Day River	C			None
17070204	OR	Lower John Day River	C			None
17070301	OR	Upper Deschutes River	C			None
17070305	OR	Lower Crooked River	C			None
17070306	OR	Lower Deschutes River	C	C		None
17070307	OR	Trout Creek	C	C		None
17080001	OR/WA	Lower Columbia–Sandy River	C	C		None
17080002	WA	Lewis River	C	C		None
17080003	OR/WA	Lower Columbia – Clatskanie River	C	C		None
17080004	WA	Upper Cowlitz River	C	C		None
17080005	WA	Cowlitz River	C	C		None
17080006	OR/WA	Lower Columbia	C	C		None
17090001	OR	Middle Fork Willamette River	C			None
17090002	OR	Coast Fork Willamette River	C			None
17090003	OR	Upper Willamette River	C	C		None
17090004	OR	McKenzie River	C	C		None

USGS 4th Field Hydrologic Unit	State(s)	Hydrologic Unit Name	Species Distribution Data			Potential change
			Chinook	Coho	PS Pink	
17090005	OR	N. Santiam River	C	C		None
17090006	OR	S. Santiam River	C	C		None
17090007	OR	Mid. Willamette River	C	C		None
17090008	OR	Yamhill River	C	C		None
17090009	OR	Molalla – Pudding River	C	C		None
17090010	OR	Tualatin River	C	C		None
17090011	OR	Clackamas River	C	C		None
17090012	OR	Lower Willamette River	C	C		None
17100101	WA	Hoh – Quillayute	C	C		None
17100102	WA	Queets – Quinault	C	C	D	Designate as EFH for PS pink salmon
17100103	WA	Upper Chehalis River	C	C		None
17100104	WA	Lower Chehalis River	C	C		None
17100105	WA	Grays Harbor	C	C		None
17100106	WA	Willapa Bay	C	C		None
17100201	OR	Necanicum River	C	C		None
17100202	OR	Nehalem River	C	C		None
17100203	OR	Wilson – Trask – Nestucca	C	C		None
17100204	OR	Siletz–Yaquina River	C	C		None
17100205	OR	Alsea River	C	C		None
17100206	OR	Siuslaw River	C	C		None
17100207	OR	Siltcoos River	C	C		None
17100301	OR	N. Umpqua River	C	C		None
17100302	OR	S. Umpqua River	C	C		None
17100303	OR	Umpqua River	C	C		None
17100304	OR	Coos River	C	C		None
17100305	OR	Coquille River	C	C		None
17100306	OR	Sixes River	C	C		None
17100307	OR	Upper Rogue River	C	C		None
17100308	OR	Middle Rogue River	C	C		None
17100309	CA/OR	Applegate River	C	C		None
17100310	OR	Lower Rogue River	C	C		None

USGS 4th Field Hydrologic Unit	State(s)	Hydrologic Unit Name	Species Distribution Data			Potential change
			Chinook	Coho	PS Pink	
17100311	CA/OR	Illinois River	C	C		None
17100312	CA/OR	Chetco River	C	C		None
17110001	WA	Fraser (Whatcom)		C		None
17110002	WA	Strait of Georgia†	C	C	C	None
17110003	WA	San Juan Islands†	C	C	C	None
17110004	WA	Nooksack River	C	C	C	None
17110005	WA	Upper Skagit	C	C	C	None
17110006	WA	Sauk River	C	C	C	None
17110007	WA	Lower Skagit River	C	C	C	None
17110008	WA	Stillaguamish River	C	C	C	None
17110009	WA	Skykomish River	C	C	C	None
17110010	WA	Snoqualmie River	C	C	C	None
17110011	WA	Snohomish River	C	C	C	None
17110012	WA	Lake Washington	C	C		None
17110013	WA	Duwamish River	C	C	D	Designate as EFH for PS pink salmon
17110014	WA	Puyallup River	C	C	C	None
17110015	WA	Nisqually River	C	C	C	None
17110016	WA	Deschutes River	C	C		None
17110017	WA	Skokomish River	C	C	D	Designate as EFH for PS pink salmon
17110018	WA	Hood Canal†	C	C	C	None
17110019	WA	Puget Sound†	C	C	C	None
17110020	WA	Dungeness – Elwha†	C	C	C	None
17110021	WA	Hoko – Crescent	C	C	D	Designate as EFH for PS pink salmon
18010101	CA/OR	Smith River	C	C		None
18010102	CA	Mad–Redwood	C	C		None
18010103	CA	Upper Eel River	C	C		None
18010104	CA	Middle Fork Eel River	C	C		None
18010105	CA	Lower Eel River	C	C		None
18010106	CA	South Fork Eel River	C	C		None
18010107	CA	Mattole River	C	C		None
18010108	CA	Big – Navarro – Garcia	C	C		None

USGS 4th Field Hydrologic Unit	State(s)	Hydrologic Unit Name	Species Distribution Data			Potential change
			Chinook	Coho	PS Pink	
18010109	CA	Gualala – Salmon Creek	C	C		None
18010110	CA	Russian River	C	C		None
18010206	CA/OR	Upper Klamath River	C	C		None
18010207	CA	Shasta River	C	C		None
18010208	CA	Scott River	C	C		None
18010209	CA/OR	Lower Klamath River	C	C		None
18010210	CA	Salmon River	C	C		None
18010211	CA	Trinity River	C	C		None
18010212	CA	S.F. Trinity River	C	C		None
18020104	CA	Sacramento – Stone Corral	C			None
18020111	CA	Lower American River	C			None
18020115	CA	Upper Stony	C			Designate as EFH due to the new HU dataset
18020116	CA	Upper Cache	C			Designate as EFH due to the new HU dataset
18020125	CA	Upper Yuba	C			None
18020126	CA	Upper Bear	C			Designate as EFH due to the new HU dataset
18020151	CA	Cow Creek	C			Designate as EFH due to the new HU dataset
18020152	CA	Cottonwood Creek	C			Designate as EFH due to the new HU dataset
18020153	CA	Battle Creek	C			Designate as EFH due to the new HU dataset
18020154	CA	Clear Creek-Sacramento River	C			Designate as EFH due to the new HU dataset
18020155	CA	Paynes Creek-Sacramento River	C			Designate as EFH due to the new HU dataset
18020156	CA	Thomes Creek-Sacramento River	C			Designate as EFH due to the new HU dataset
18020157	CA	Big Chico Creek-Sacramento River	C			Designate as EFH due to the new HU dataset
18020158	CA	Butte Creek	C			Designate as EFH due to the new HU dataset
18020159	CA	Honcut Headwaters-Lower Feather	C			Designate as EFH due to the new HU dataset
18020161	CA	Upper Coon-Upper Auburn	C			Designate as EFH due to the new HU dataset
18020162	CA	Upper Putah	C			Designate as EFH due to the new HU dataset
18020163	CA	Lower Sacramento	C			Designate as EFH due to the new HU dataset
18040001	CA	Middle San Joaquin– LowerChowchilla	C			None
18040002	CA	LowerSan Joaquin	C			None
18040003	CA	San Joaquin Delta	C			None
18040008	CA	Upper Merced	C			Designate as EFH due to the new HU dataset

USGS 4th Field Hydrologic Unit	State(s)	Hydrologic Unit Name	Species Distribution Data			Potential change
			Chinook	Coho	PS Pink	
18040009	CA	Upper Tuolumne	C			Designate as EFH due to the new HU dataset
18040010	CA	Upper Stanislaus	C			None
18040011	CA	Upper Calveras	C			None
18040012	CA	Upper Mokelumne	C			Designate as EFH due to the new HU dataset
18040013	CA	Upper Cosumnes	C			None
18040051	CA	Rock Creek-French Camp Slough	C			Designate as EFH due to the new HU dataset
18050001	CA	Suisun Bay	C	C		None
18050002	CA	San Pablo Bay	C	C		None
18050003	CA	Coyote Creek	C	C		None
18050004	CA	San Francisco Bay	C	C		None
18050005	CA	Tomales–Drakes Bay	D	C		Designate as EFH for Chinook salmon
18050006	CA	San Francisco–Coastal South		C		None
18060001	CA	San Lorenzo–Soquel		C		None
18060006	CA	Central Coastal		C		None

Distribution Modeling

The Panel considered using new modeling applications that could be useful for assessing salmon habitat suitability. The desired outcome was to use a modeling approach to infer salmon distribution in areas that lack such information and to increase the precision of spatial distribution maps. To have utility, a model must be applicable across the entire geographic range of Pacific Coast salmon, yet be sufficiently precise to provide information on a relatively small spatial scale. Although many models to assess salmonid habitat are in use, most are applicable to a relatively limited geographic scope. Only Intrinsic Potential (IP) was considered to potentially be of use and was the only model explored past the discussion stage.

Intrinsic Potential

Intrinsic Potential models are 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, geomorphic, 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 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 12 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 watersheds and subwatersheds. 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.

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" (Sheer et al. 2009). An excerpt from the report reads "IP models have been developed for some salmon and steelhead ESUs listed under the ESA, 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."

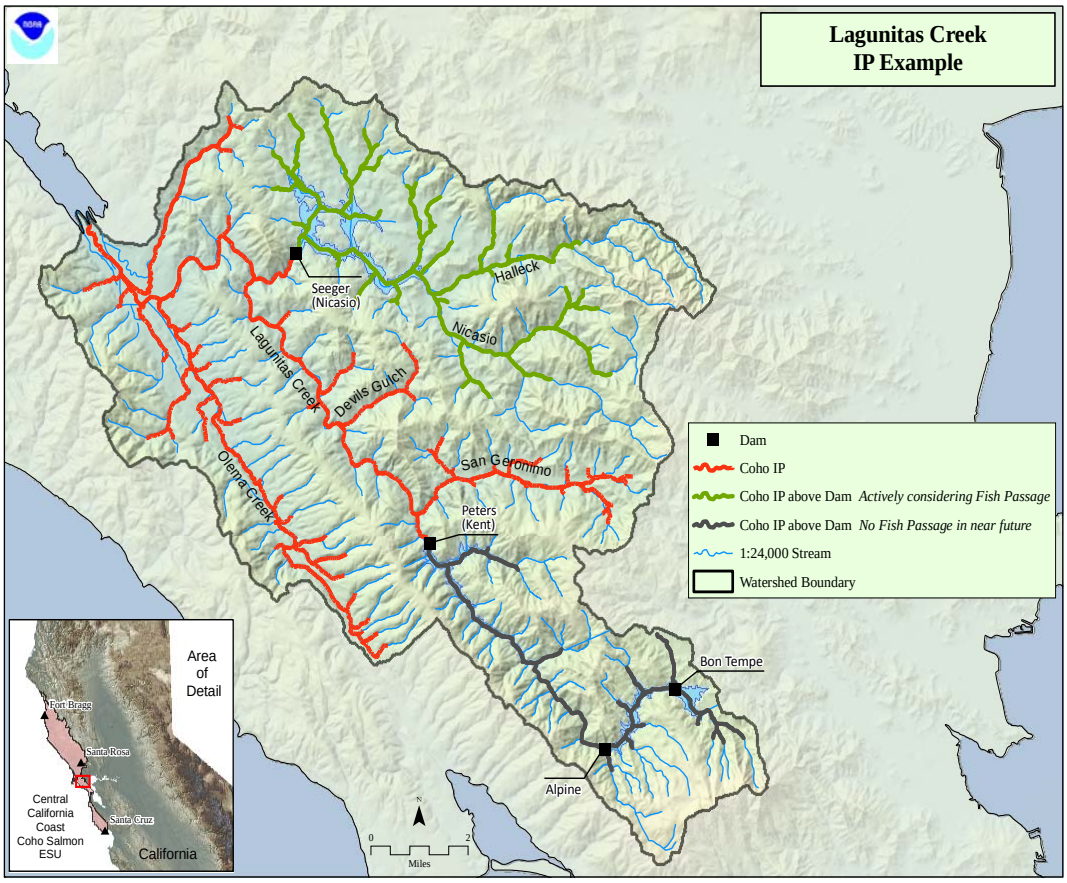

Figure 12. Example of how Intrinsic Potential can help identify potentially suitable habitats for Pacific Coast salmon.

To date, IP models have been limited to several ESUs of Pacific salmon that are listed under the ESA. Although ESUs are not directly relevant to the MSA and EFH, the Panel assumed that IP models for ESA-listed salmon are applicable to all managed salmon of the same species in that area. These ESUs include:

Lower Columbia coho salmon
Lower Columbia Chinook salmon
Oregon Coast coho salmon
Willamette Chinook salmon
Puget Sound Chinook salmon
Snake River spring/ summer Chinook salmon
Upper Columbia River spring-run Chinook salmon
Southern Oregon/Northern California Coast coho salmon
Central California Coast coho salmon
California Coastal Chinook salmon

No GIS data for Snake River fall Chinook salmon are available, and the Panel is not aware of any IP models that have been developed for pink salmon. The NMFS Southwest Region GIS staff currently have resultant GIS data for the IP model work done in that region. However, individual data files do not exist for each hydrologic unit making any desired analysis fairly time-consuming. The NMFS Northwest

Region GIS staff do not currently have GIS data for the IP models and would need to obtain it to use IP to infer EFH for particular hydrologic units.

Before IP modeling can be utilized to refine EFH for any of the species of Pacific Coast salmon managed under the FMP there must be regionally based models that that lead to similar spatial resolution of salmon habitat. Those models must, when taken together, cover the entire geographic range of that species. It is clear that IP modeling is inconsistent, at best, covering only a relatively small portion of the geographic range of any species. These gaps preclude the use of IP models in EFH designations, and will require significant time and effort to fill. However, the Panel also recognizes that in some cases of sparse information, existing IP can be used as a tool to investigate the likelihood of suitable salmonid habitat on a site- by-site basis for the purposes of EFH consultation.

Impassible Dams Designated as the Upstream Extent of EFH

Numerous dams block access to historical salmon habitat and/or alter the hydrography of downstream river reaches. In identifying EFH in Amendment 14, the Council considered dams that completely 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?* This criterion assures the dam is of sufficient size, permanence, impassibility, and legal identity to warrant consideration for inclusion in this list;

2. *Is the dam upstream of any other impassible dam?* This criterion provides for a continuous boundary of designated habitat;

3. *Is fish passage to upstream areas under consideration, or are fish passage facilities in the design or construction phase?* There is no currently, or soon to be, accessible freshwater salmon habitat that is expendable. All such habitat is key to the conservation of these species and needs the special considerations for protection and restoration incumbent with designation; and

4. *Has NMFS determined that the dam does not block access to habitat that is key for the conservation of the species?* This criterion provides for designation of habitat upstream of, and exclusion of, otherwise listed dams when NMFS is able to determine restoration of passage and conservation of such habitat is necessary for long-term survival of the species and sustainability of the fishery.

As a result, EFH was designated above a number of impassible dams that met one or more of these criteria, including Elwha Dam, Merwin Dam, Landsburg Dam, Howard Hanson Dam, Condit Dam, Cushman Dam, Mayfield Dam, Foster Dam, Pelton Dam, and Englebright Dam. Justification for designating EFH above impassable barriers has been provided in both the EFH regulations and Amendment 14 to the FMP. The regulatory text at 50 CFR §600.815(a)(1)(iv)(F) states:

> *"If degraded or inaccessible aquatic habitat has contributed to reduced yields of a species or assemblage and if, in the judgment of the Secretary and the appropriate Council(s), the degraded conditions can be reversed through such actions as improved fish passage techniques (for stream or river blockages), improved water quality measures (removal of contaminants or increasing flows), and similar measures that are technologically and economically feasible, EFH should include those habitats that would be necessary to the species to obtain increased yields."*

Amendment 14 included the following language regarding habitat needed to support a sustainable fishery and the identification of such habitat through other processes and analyses:

> *"While available information is not sufficient to conclude that currently accessible habitat is sufficient for supporting sustainable salmon fisheries and a healthy ecosystem, subsequent analyses (e.g., in recovery planning, ESA consultations, or hydropower proceedings) may conclude that inaccessible habitat should be made available to the species."*

Amendment 14 then focused specifically on the importance of considering the need to restore fish passage to historically accessible areas through the FERC relicensing process noting:

> *"Even though habitat above such barriers may not currently be designated as EFH, this conclusion does not diminish the potential importance of restoring access to these areas. Therefore, a determination on a case-by-case basis during FERC relicensing proceedings whether fish passage facilities will be required to provide access to habitat above currently impassible barriers will be necessary. Should salmon access or reintroduction above any of the dams listed in Table A-2 become feasible, the Council will remove them from the list, and the areas above the barriers would be designated as salmon EFH."*

The EFH provisions of the MSA are intended to ensure conservation and protection of EFH to promote a sustainable fishery, which requires a more robust population than necessary to ensure persistence of the population or ESU. Therefore, the Panel determined that if the habitat may be necessary for the persistence of the population or ESU, it is clearly necessary to promote a sustainable fishery. As demonstrated in both the EFH regulations and Amendment 14 to the FMP, designating EFH above impassable dams is appropriate under certain conditions and has been done in the past. The Panel agreed that the four criteria identified in Amendment 14 were still applicable and further elaborated on the interpretation of criterion 4. Specifically, habitats that may be necessary to contribute to the conservation or recovery of a species, as identified in a document such as a biological opinion, recovery plan, critical habitat designation, or FERC/Federal Power Act fish passage prescriptions, are clearly necessary to support a sustainable fishery. When available, economic analyses regarding the cost of providing fish passage should also be taken into consideration. Recovery plans must identify 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 dams marking the upstream extent of EFH, thereby providing support for designating EFH above those dams. Consultation under the ESA typically includes issuance of a biological opinion (Opinion), which includes mandatory actions to protect the species and/or its designated critical habitat. These actions may include fish passage above dams on the list of impassable dams marking the upstream extent of EFH, again providing support for designating EFH above those dams. Another example is that of fish passage "prescriptions" issued under Section 18 of the Federal Power Act, in which NMFS may require fish passage installation and/or upgrades to existing facilities to address the impacts of a hydropower project and expand access to historical and currently suitable habitat above dams to contribute to the conservation of the species. In such cases, habitat above the dam should be designated as EFH and a new upstream extent of EFH should be identified.

The Panel applied the selection criteria to the dams that were previously determined to be the upstream extent of EFH, as published in the 2008 Final Rule that codified the EFH descriptions for Pacific Coast salmon, along with two others that were recommended to NMFS by the Bureau of Reclamation in 2007. Table 5 lists all the dams that were considered, the potential changes to the dams that are designated as the upstream extent of EFH, and the rationale behind those changes. Designation of the habitat above any of these dams as EFH would mean that consultation would be required for any Federal action that may adversely affect EFH in those areas. Designating EFH above a dam would also require that the

upstream habitats be examined to see what, if any, impassible dams there are further upstream and any additional 4th field HUs that would become accessible. In areas where EFH may be designated above impassable dams, the Panel did not investigate the dams located further upstream to determine the new extent of EFH.

The potential changes to the dams that are designated as the upstream extent of EFH fall into 4 broad categories and several subcategories, as follows:

1 Corrections to the 2008 Final Rule, where a dam was designated as the upstream extent of EFH in Amendment 14, but was inadvertently omitted from 2008 Final Rule;
2 Update HU name and code to match those published by the USDA in 1999;
3 Delete a dam from the list and designate the habitat upstream as EFH because:
   a Fish passage is now occurring or passage facilities are under construction;
   b Fish passage at the dam is in the planning stage;
   c Fish passage at the dam is being considered;
   d Critical habitat has been designated above this dam;
   e Habitat above this dam has been identified in a document as habitat that may be necessary to contribute to the conservation or recovery of a species; or
   f The dam is upstream of another impassible barrier, either natural or man-made;
4 Designate a dam as the upstream extent of EFH because it was investigated due to a comment by a Federal agency and found to meet the criteria.

Not all of these changes are as strongly supported as others. Some, such as corrections to the final rule, updating HU names and codes, and designating the habitat above a dam as EFH because fish are now being passed, are not seen by the Panel as being controversial and can be easily implemented. However, designating habitat above a dam as EFH because passage is being considered or that it "may be essential to" or "is necessary for" the conservation of the species has broader implications, with the potential for significantly expanding EFH. Such changes will require careful consideration by the Council. In doing so, the Council should consider several factors, including, but not limited to, the strength of the information that supports the changes, the likelihood that passage will be possible in the foreseeable future, and the extent of EFH that will be designated above the dam. For these reasons, the Panel is not making specific recommendations for revising this list.

The results from this evaluation process, including potential changes to the list of dams that form the upstream extent of EFH and the rationale behind those potential changes, are shown in Table 5. The Panel notes that recovery plans for a number of ESA-listed salmon ESUs are in draft form and have not been finalized. Consequently, there are uncertainties regarding which populations will be targeted in recovery scenarios and which of these populations may require passage above currently impassable dams in order to achieve recovery goals. Assessments regarding both the necessity of above-dam habitats for recovery and the feasibility of providing passage are currently underway. In some cases, it is clearly evident in draft recovery plans that passage will be required above specified dams to achieve recovery criteria for a particular ESU. In others, passage will almost certainly be required above one or more dams in order for recovery criteria to be met; however, the specific dams to be targeted for passage have not yet been explicitly identified. In the former case, we believe there is strong justification for designating the habit above identified dams as EFH. In the latter cases, we have noted the dams under consideration for passage in Table 5, but acknowledge that the justification for designating EFH upstream of these dams is not as straightforward. These specific cases will need to be revisited in a future EFH review.

Because of the changes to the 4th field HUs in the California Central Valley, areas that were not previously designated as EFH may become EFH. This may mean that additional dams may need to be designated as the upstream extent of EFH. One example is the Monticello Dam on Putah Creek.

Recommendations

The Panel recommends that the Council consider updating the list of impassible dams that mark the upstream extent of EFH based on the information provided in Table 5. The habitat above dams that are deleted from the list would then be designated as EFH for the appropriate species. The next natural or manmade barrier(s) upstream would then represent the new upstream extent of EFH.

Table 6. Potential changes to the impassible dams representing the upstream extent of EFH.

4th field Hydrologic Unit	State(s)	Hydrologic Unit Name	Impassible Man-made Barrier (from 2008 F.R.)	Supporting information	Potential Change
17020005	WA	Columbia River	Chief Joseph Dam	N/A	N/A
17030001	WA	Upper Yakima River	Keechelus Dam Kachess Dam (Kachess R.)	Bureau of Reclamation has conducted preliminary assessment of passage at Keechelus and Kachess Dams (BOR 2008; 2010), but is not moving forward with additional study until after passage is provided at Cle Elum and Bumping Dams.	Designate habitat above Keechelus and Kachess Dams as EFH
17030001	WA	Upper Yakima River	Cle Elum Dam (Cle Elum R.)	Bureau of Reclamation is in the process of planning passage for salmonids at Cle Elum Dam (BOR 2010).	Designate habitat above Cle Elum Dam as EFH.
17030002	WA	Naches River	Rimrock Dam (Tieton R.)	Bureau of Reclamation has conducted preliminary assessment of passage at Rimrock (Tieton) Dam (BOR 2008; 2010), but is not moving forward with additional study until after passage is provided at Cle Elum and Bumping Dams.	Designate habitat above Rimrock Dam as EFH.
17060101	OR/ID	Hells Canyon	Hells Canyon Complex (Hells Canyon, Oxbow, and Brownlee Dams)	Oxbow and Brownlee Dams are upstream of Hells Canyon Dam.	Change to Hells Canyon Dam, and delete Oxbow and Brownlee Dams
17060306	WA/ID	Clearwater River	Dworshak Dam (at border of HUCs 17060306 and 17060308)	N/A	N/A
17070103	WA	Umatilla	McKay Dam	Bureau of Reclamation (BOR 2007) proposed that McKay Dam be designated as upstream extent of EFH. NMFS staff subsequently verified that this dam meets the selection criteria for upstream extent of EFH.	Designate McKay Dam as the upstream extent of EFH
17070305	OR	Lower Crooked River	Opal Springs Dam	According to Scot Carlon, Hydro Division, NWR, a settlement agreement is possible to provide passage for Willamette River spring-run Chinook salmon at Opal Springs Dam.	Designate habitat above Opal Springs Dam as EFH for Chinook salmon
17080001	OR/WA	Lower Columbia-Sandy River	Impassable man-made barrier	The name of the impassible dam on the Bull Run River was inadvertently omitted from the 2008 Final Rule. It is Bull Run Dam #2. The CHART final report (NMFS 2005a) noted that habitat above the Bull Run Dam complex "may be essential" to the conservation of LCR Chinook salmon.	Two possible recommendations: (1) Designate habitat above as EFH for Chinook only; or (2) Keep the dam and properly identify as Bull Run Dam #2.

4th field Hydrologic Unit	State(s)	Hydrologic Unit Name	Impassible Man-made Barrier (from 2008 F.R.)	Supporting information	Potential Change
17090001	OR	Middle Fork Willamette River	Dexter Dam	Critical Habitat has been designated above Dexter Dam (70 FR 52630, September 2, 2005). In addition, spring-run Chinook salmon are currently being trapped and hauled above Dexter Dam. EFH above Dexter should be for Chinook only.	Designate habitat above Dexter Dam as EFH for Chinook
17090002	OR	Coast Fork Willamette River	Dorena Dam	N/A	N/A
17090004	OR	McKenzie River	Cougar Dam	N/A	N/A
17090005	OR	N. Santiam River	Big Cliff Dam	The CHART final report (NMFS 2005a) maintained that areas above the North Santiam dams "may be essential" for the conservation of Upper Willamette Chinook salmon and agreed that the Technical Recovery Team's viability assessment (McElhany et al., 2003) strongly suggests that these areas may warrant designation. In addition, the reintroduction of Upper Willamette Chinook salmon is underway, via trucking around the dams.	Designate habitat above Big Cliff Dam as EFH for Chinook salmon (coho salmon are not trucked around the dams)
17090011	OR	Clackamas River	Oak Grove Dam	According to the CH designations (70 FR 52630, September 2, 2005) and Google Earth, CH stops about 1 mile downstream of Oak Grove Dam. There may be a naturally-impassible waterfalls below this dam.	Delete Oak Grove Dam from list if a falls that is downstream of the dam is a natural barrier.
17100301	OR	N. Umpqua River	Soda Springs Dam	PacifiCorp is in process of constructing fish passage facility, with construction scheduled for completion in 2012 (http://www.pacificorp.com/about/newsroom/2010nrl/ptbwossfpp.html)	Designate habitat above Soda Springs Dam as EFH
17100307	OR	Upper Rogue River	Lost Creek Dam	N/A	N/A
17100308	OR	Middle Rogue	Emigrant Dam	Bureau of Reclamation (BOR 2007) proposed that Emigrant Dam be designated as upstream extent of EFH. NMFS staff subsequently verified that this dam meets the four selection criteria for upstream extent of EFH.	Designate Emigrant Dam as the upstream extent of EFH
17100309	CA/OR	Applegate	Applegate Dam	N/A	N/A
17110005	WA	Upper Skagit	Gorge Lake Dam	N/A	N/A
17110010	WA	Snoqualmie	Tolt Dam (S. Fork Tolt R.)	N/A	N/A
17110012	WA	Lake Washington	Cedar Falls (Masonry) Dam (Cedar R.)	N/A	N/A
18010102	CA	Mad-Redwood	Robert W. Matthews dam	N/A	N/A

4th field Hydrologic Unit	State(s)	Hydrologic Unit Name	Impassible Man-made Barrier (from 2008 F.R.)	Supporting information	Potential Change
18010103	CA	Upper Eel	Scott Dam	N/A	N/A
18010110	CA	Russian	Coyote Valley Dam (E. Fork Russian R.)\Warm Springs Dam (Dry Cr.)	N/A	N/A
18010206	CA/OR	Upper Klamath	Iron Gate Dam	NMFS/USFWS jointly filed final FPA prescriptions for fishways for the Klamath Hydroelectric Project (NMFS 2007b) , which withstood the trial-type hearing challenging the scientific basis. This led to the Klamath Hydropower Settlement Agreement process, which is ongoing and would provide for the removal of four dams on the mainstem Klamath River. NMFS Klamath Opinion on Operation of the Klamath Project between 2010 and 2018 (2010B) notes that the loss of historical habitat above Iron Gate Dam, combined with other factors (e.g., hatchery practices, land management activities, water withdrawals), "have contributed to the high risk of extinction of this population".	Designate habitat above Iron Gate Dam as EFH for coho and Chinook
18010207	CA	Shasta	None	This dam was mistakenly deleted from the 2008 F.R.	Re-designate Dwinnell Dam as the upstream extent of EFH
18010211	CA	Trinity	Lewiston Dam	N/A	N/A
18020111	CA	Lower American	Nimbus Dam	Public Draft CV Recovery Plan (NMFS 2009c) notes areas upstream of Nimbus and Folsom dams (NF, MF, and SF American River) are being considered for re-introduction of spring-run Chinook salmon	The designation of EFH above Nimbus and Folsom Dams warrants special consideration in a future EFH review and/or as new information becomes available. EFH designation above Nimbus and Folsom Dams warrant special consideration in a future EFH review and/or as new information becomes available.
18020115	CA	Upper Stony		This dam was mistakenly deleted from the 2008 F.R.	Designate Black Butte Dam as the upstream extent of EFH
18020126	CA	Upper Bear		This dam was mistakenly deleted from the 2008 F.R.	Add Camp Far West Dam

4th field Hydrologic Unit	State(s)	Hydrologic Unit Name	Impassible Man-made Barrier (from 2008 F.R.)	Supporting information	Potential Change
18020154	CA	Clear Creek-Sacramento River	Keswick Dam (Sacramento R.) Whiskeytown Dam (Clear Cr.)	Keswick Dam should have remained on the list of impassible dams in 2008 Final Rule. However, as noted below, based on newly available information, there is strong support for designating EFH above Keswick Dam and Shasta Dam NMFS Opinion on the Long-term Operations of the Central Valley Project and State Water Project (NMFS 2009a) includes long-term passage prescriptions at Shasta Dam and re-introduction of winter-run into its native habitat above the dam Public Draft CV Recovery Plan (NMFS 2009c) identifies the re-establishment of viable winter-run Chinook populations in both the Little Sacramento and McCloud rivers as critical to recovery of the Central Valley winter-run Chinook ESU. Public Draft CV Recovery Plan (NMFS 2009c) identifies the re-establishment of viable spring-run populations in the Little Sacramento and McCloud rivers as critical to recovery of the Basalt and Porous Lava Diversity Group within the Central Valley spring-run Chinook ESU.	Leave Whiskeytown Dam as the upstream extent of EFH Designate habitat above Keswick Dam and Shasta Dam as EFH for Chinook. Correct 4th field HUC. Listed in Amendment 14 as 18020112
18020159	CA	Honcut Headwaters-Lower Feather	None	Oroville Dam was listed in Amendment 14 as the upstream extent of EFH, but mistakenly was deleted from the 2008 F.R. NMFS staff recommended at that time 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 dam, and there is yet another impassible dam between Oroville and the Fish Barrier Dams. Public Draft CV Recovery Plan (NMFS 2009c) notes the area upstream of Oroville Dam (NF Feather River) is being considered for re-introduction of spring-run Chinook salmon	Designate Feather River Fish Barrier Dam as the upstream extent of EFH The designation of EFH above Feather River Fish Barrier Dam and Oroville Dam warrants special consideration in a future EFH review and/or as new information becomes available Correct 4th field HUC. Listed in Amendment 14 as 18020121 &18020123
18040006	CA	Upper San Joaquin		This dam was mistakenly deleted from the 2008 F.R.	Designate Friant Dam as the upstream extent of EFH

4th field Hydrologic Unit	State(s)	Hydrologic Unit Name	Impassible Man-made Barrier (from 2008 F.R.)	Supporting information	Potential Change
18040008	CA	Upper Merced	Crocker Diversion Dam	This dam was mistakenly deleted from the 2008 F.R. Public Draft CV Recovery Plan (NMFS 2009c) identifies areas upstream of Crocker Diversion and New Exchequer dams (Merced River) among three above-dam alternatives to be considered for re-introduction of spring-run Chinook salmon in the Southern Sierra Diversity Group; the establishment of a viable spring-run population in one of these three alternatives (i.e., upper Stanislaus, upper Tuolumne, or upper Merced) is identified as critical to recovery of the Central Valley spring-run Chinook ESU	Designate Crocker Diversion Dam as the upstream extent of EFH The designation of EFH above Crocker Diversion and New Exchequer Dams warrants special consideration in a future EFH review and/or as new information becomes available
18040009	CA	Upper Tuolumne	La Grange Dam (Tuolumne R.)	Public Draft CV Recovery Plan (NMFS 2009c) identifies areas upstream of LaGrange and Don Pedro dams (Tuolumne River) among three above-dam alternatives to be considered for re-introduction of spring-run Chinook salmon in the Southern Sierra Diversity Group; the establishment of a viable spring-run population in one of these three alternatives (i.e., upper Stanislaus, upper Tuolumne, or upper Merced) is identified as critical to recovery of the Central Valley spring-run Chinook ESU	The designation of EFH above La Grange and Don Pedro Dams warrants special consideration in a future EFH review and/or as new information becomes available Correct 4th field HUC. Listed in Amendment 14 as 18040002
18040010	CA	Upper Stanislaus	Goodwin Dam	Public Draft CV Recovery Plan (NMFS 2009c) identifies areas upstream of Goodwin, Tulloch, and New Melones dams (NF Stanislaus River) among three above-dam alternatives to be considered for re-introduction of spring-run Chinook salmon in the Southern Sierra Diversity Group; the establishment of a viable spring-run population in one of these three alternatives (i.e., upper Stanislaus, upper Tuolumne, or upper Merced) is identified as critical to recovery of the Central Valley spring-run Chinook ESU	The designation of EFH above Goodwin, Tullock and New Melones Dams warrants special consideration in a future EFH review and/or as new information becomes available
18040011	CA	Upper Calaveras California	New Hogan Dam	N/A	N/A

4th field Hydrologic Unit	State(s)	Hydrologic Unit Name	Impassible Man-made Barrier (from 2008 F.R.)	Supporting information	Potential Change
18040012	CA	Upper. Mokelumne	Camanche Dam	Public Draft CV Recovery Plan (NMFS 2009c) identifies areas upstream of Camanche and Pardee dams (Upper Mokelumne River) to be considered for re-introduction of spring-run Chinook salmon	The designation of EFH above Camanche and Pardee Dams warrants special consideration in a future EFH review and/or as new information becomes available Correct 4th field HUC. Listed in Amendment 14 as 18040005
18050002	CA	San Pablo Bay	San Pablo Dam (San Pablo Cr.)	N/A	N/A
18050003	CA	Coyote	LeRoy Anderson Dam	N/A	N/A
18050005	CA	Tomales-Drake Bays	Nicasio Dam (Nicasio Cr.)/Peters Dam (Lagunitas Cr.)	N/A	N/A
18060001	CA	San Lorenzo-Soquel	Newell Dam (Newell Cr.)	N/A	NA

Marine Distribution

As currently designated, the geographic extent of marine EFH for Chinook salmon and coho salmon includes all marine waters within the EEZ north of Point Conception, California to the U.S. - Canada border and the marine areas off Alaska designated as salmon EFH by the NPFMC. For PS pink salmon, marine EFH is currently designated to include all nearshore marine waters north and east of Cape Flattery, Washington, including Puget Sound, the Strait of Juan de Fuca, and the Strait of Georgia. It is difficult to determine a western limit for pink salmon essential marine habitat because of limited information on their ocean distribution, but it is clear that the vast majority are found in Canadian, Alaskan, and international waters both within and outside the EEZ north of Cape Flattery, Washington. The current designation of marine EFH for PS pink salmon is based on the Elwha River being the western most extent of the FMU. However, if pink salmon from the Hoko-Crescent and Queets-Quinault systems were included in the FMU, some portion of the marine waters off the coast of Washington, from Cape Flattery, south to the Queets-Quinault should be considered EFH.

The current marine EFH designations are necessarily broad due to insufficient data in 1999 to more narrowly define EFH. In recent years, additional data have been collected on the marine distribution of Pacific Coast salmon (e.g., Bi et al. 2008; Peterson et al. 2010; Pool et al. *in prep*.). However, the Panel concluded that it would be better to wait to refine marine EFH until an effort to model marine distribution of salmon in Alaskan waters is complete. Similar to the PFMC, when the NPFMC designated EFH for salmon, the lack of data and resources resulted in designations that included the entire EEZ off the coast of Alaska. To address this issue, the NPFMC and the Alaska Region of NMFS are developing a model to predict marine distribution for each life-stage of five species of Pacific Coast salmon (Chinook salmon, coho salmon, pink salmon, sockeye salmon and chum salmon) in Alaskan waters. The model uses fish catch and hydrographical data compiled from multiple research efforts conducted within the Alaskan EEZ using systematic surface and midwater trawls at designated survey stations. Data sets include those obtained from NMFS and its Alaskan Fisheries Science Center, U.S. Global Ocean Ecosystem Dynamics program, the University of Alaska Fairbanks, the Department of Fisheries and Oceans Canada, and the International North Pacific Fisheries Commission. This model is expected to significantly reduce the extent of salmon EFH in Alaskan waters and can provide a basis for future refinement of marine EFH for the three species of Pacific Coast salmon managed by the Council.

The effort by the NPFMC to refine marine EFH for salmon would also have direct implications on the EFH designations for salmon managed by the Council. As described above, the EFH designations in Amendment 14 included Alaskan marine waters designated 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. Because the salmon managed by the Council rely heavily on habitats in Alaskan waters, maintaining these waters as EFH is justifiable. However, it is unclear to the Panel whether changes to EFH in Alaskan waters made by the NPFMC would automatically result in changes to EFH for Council-managed stocks, or whether the Council would need to take action to adopt these changes.

Recommendation

The Panel recommends further consideration of the designation of marine EFH and better definition of the FMU for coho salmon and PS pink salmon, based on the available information provided on marine distribution of Pacific Coast Salmon.

Essential Fish Habitat Descriptions

Pursuant to the EFH guidelines (50 CFR 600), FMPs should summarize the life history information necessary to understand each species' relationship to or dependence on its various habitats, using text, tables, and figures, as appropriate. A major part of the periodic EFH review process is aimed at updating the descriptions of EFH, which provide detailed information on the habitats used by Council-managed species.

Existing EFH Descriptions

Amendment 14 provides descriptions of EFH for each species and life stage that were developed through an extensive review and synthesis of the literature available in 1999. They provide a review of life history for each species, text descriptions, and tables that summarize, for each species, the habitats used by each life history stage and the important features of those habitats.

New Information

The Council enlisted Cramer Fish Sciences to develop an annotated bibliography (Bergman 2010) of relevant information that could inform and update the library of information relative to the habitat requirements of Pacific Coast salmon (Appendix A). The literature on salmon is very rich, and the Panel recognized that it did not have the necessary resources to compile an annotated bibliography of all recent and relevant information. Instead, the bibliography was intended to present a representative sample of the recent literature. Bergman (2010) includes about 100 references in the annotated bibliography, which presents literature for Chinook salmon, coho salmon, and PS pink salmon. The bibliography divides the literature into five distinct life stages: eggs and spawning, freshwater juveniles, estuarine juveniles, marine juveniles, and adults. For each life stage, the annotated bibliography presents several key or representative references. Because Pacific Coast salmon have been extensively studied for more than 100 years, especially in the freshwater environment, the Panel expects that the new information would help to refine the EFH descriptions.

This section highlights some of the literature that can be used to supplement the habitat descriptions in Amendment 14. The literature cited here provides information, such as use of a specific type of habitat not discussed in Amendment 14, and demonstrates that the descriptions should be revised to be more comprehensive.

Chinook Salmon

Eggs and Spawning

Chinook salmon have been shown to spawn in stream reaches characterized as low-gradient pool-riffle reaches (Montgomery et al. 1999). Chinook salmon redds were associated with large woody debris (LWD) in the Lower Mokelumne River (Merz 2001), where substrate was smaller and the mean depth of the redds was greater. The study concluded that the presence of LWD improves otherwise lower-quality habitat, making it more suitable for spawning, and may allow greater concentration of redds on suitable sites.

Juveniles -Freshwater

In low-gradient alluvial valleys of the upper Columbia River basin, juvenile Chinook salmon are most often associated with streams that contain LWD and pools (UCSRB 2007). In higher-gradient fluvial valleys, large boulders provide habitat complexity.

Recent studies provide new insight into the importance of floodplain habitat to juvenile Chinook salmon. Floodplain and other seasonally inundated habitats provide better rearing habitat, with higher growth

rates, for juvenile Chinook salmon than the adjacent river (Sommer et al. 2001; Jeffres 2006). Sommer et al. (2001) attributed the higher growth rates in inundated floodplains to significantly greater abundance of drift invertebrates. Inundated floodplains also appear to be better migration habitat than the adjacent river.

Effects of river flows on juvenile migration were investigated by Brandes and McLain (2001) and Sykes et al. (2009). Brandes and McLain (2001) found that more juveniles enter the Sacramento-San Joaquin Delta as fry during wet years and overall juvenile production leaving the delta is higher in wet years. Fry survival appears lower in delta than upriver in higher-flow years. This speaks to the diversity of the habitats used by salmonids, and this diversity maintains production under changing environmental conditions. Sykes et al. (2009) found that flow manipulations that change the timing, duration, and magnitude of temperature and flow in the spring could affect the migration of juvenile Chinook salmon.

Juveniles - Estuaries

Estuaries are important rearing, foraging, and migration habitat for juvenile Chinook salmon. Bottom et al. (2005) found that fry and fingerlings make extensive use of marsh habitats in the Salmon River estuary. A study by Semmens (2008) found that juvenile Chinook salmon have a strong preference for native eelgrass. No such preference was found for other structured benthic habitats such as oyster beds, non-native eelgrass, or non-native cordgrass. Ehinger et al. (2007) found that certain types of delta habitat, distributary channels and wetlands in particular, may have a major role in juvenile Chinook salmon productivity.

Juveniles – marine

Juvenile Chinook salmon migrate from the estuary to the surf zone, where they feed for up to two summer months before migrating offshore (Jarrin et al. 2009). When in the surf zone, they had growth rates of 0.6 mm per day. Smaller fish fed on amphipods but switched to a piscivorous diet as they grew.

Several studies have investigated the growth and survival of juvenile Chinook salmon in the marine environment. Analyzing the growth rings on scales of adults returning to the Yukon and Kuskokwim Rivers, Ruggerone et al. (2009) found a positive correlation between growth during the first year of marine residence and growth during the freshwater phases, and that growth during each year of marine residence was positively correlated with growth during the previous year. The authors related this correlation to the piscivorous diet and foraging benefits of larger size.

Coastal upwelling is a strong determinant of year class strength (Scheuerell and Williams 2005). Upwelling increases near-shore ocean productivity, and leads to increased growth and survival of juveniles, while reduced upwelling leads to reduced growth and survival of juvenile salmon.

Adults

Elevated water temperature has been shown to affect the upstream migration of adults. Spring run Chinook salmon in Sacrament river basin hold in pools that have moderate water velocities and cover and preferred temperatures between 3 and 13°C (CDFG 1998). Lindley et al. (2004) found that upstream migration of Central Valley Chinook salmon was blocked at 21°C, with fish becoming stressed as temperatures approached 20°C. Similarly, Goniea et al. (2006) reported that migration rates for upriver bright Chinook salmon in the lower Columbia River slowed when water temperature exceeds 20°C. This slowed migration was associated with temporary use of tributaries that averaged 2-7°C cooler than the mainstem.

Central Valley spring-run Chinook salmon utilize mid- to high-elevation streams that provide appropriate temperatures and sufficient flow, cover, and pool depth as over-summering habitat (Yoshiyama et al. 1998). Thermal patchiness in streams provides habitat for Chinook salmon at the margin of their temperature tolerance (Torgensen et al. 1999).

Coho Salmon

Juveniles – freshwater
Flooded riparian vegetation and oxbow channels associated with beaver ponds are critical to winter and summer survival of juvenile coho salmon in Klamath River (CDFG 2004). Juvenile coho salmon make substantial use of off-channel habitat within non-natal tributaries of Klamath estuary (NMFS 2007a). Displaced fish display high fidelity with regard to this non-natal habitat, as well as greater fitness at the smolt stage compared to fish that overwintered in natal tributary. Coho salmon juveniles have been found to move into non-natal tributaries in fall and winter and exhibit higher winter growth and survival than fish that stay in mainstem areas (Ebersole et al. 2006; Ebersole et al. 2009).

Although tributary rearing habitat is widely recognized as important to young-of-the-year coho salmon, the mainstem habitats may also play a critical role in their survival in rivers such as Klamath where tributary conditions are particularly hostile (NRC 2002).

Koski (2009), describe several studies and observations that have recently provided new insights into the fate of "nomads", juvenile coho salmon that move downstream between the time of emergence and October, and the role of the stream-estuary ecotone and estuary in developing this life history strategy that promotes coho salmon resilience. Nomad coho salmon can acclimate to brackish water, survive, and grow well in the stream-estuary ecotone and estuary, and then 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 immigrate to a non-natal stream for overwintering and smolting in the spring. These estuarine and overwintering habitats have enabled coho salmon to develop this unique nomad life history strategy that may help to ensure their resilience.

Juveniles - Estuaries

Pink salmon

Juveniles – marine
Moss et al. (2007) found that juvenile pink salmon were concentrated in nearshore habitats, but had lower growth rates relative to other habitats. This lower survival was attributed to density-dependent factors.

Salmon – General

Juveniles – estuarine
River plumes are important foraging habitat for juvenile salmon. Juvenile salmon tend to be abundant in the frontal and plume regions compared to more marine shelf waters (Robertis et al. 2005), but stomach fullness is higher in marine waters than the front or plume areas. The Columbia River plume is important juvenile salmon habitat, particularly during first month or two of ocean residence (NMFS 2008c).

Juveniles - Marine
Ocean conditions play a critical role in the growth and survival of juvenile Pacific salmon. The first few months of ocean residency is the period of critical climatic influences on survival, suggesting that coastal and estuarine environments are key areas of biological interactions (Francis and Mantua 2003). Wind-driven upwelling in the ocean replenishes nutrients in surface waters and promotes productivity at the base of the food chain (NWF 2007). Warm water conditions negatively impact salmon in California Current and also affect migration patterns of salmon predators for a top-down effect (Peterson et al. 2006). Pacific Decadal Oscillation (PDO) and El Nino Southern Oscillation events appear to have

significant influence on survival and migratory patterns (Shared Strategy 2007) with Pacific salmon size being negatively correlated with El Nino events (Wells et al. 2006). Predatory and forage fish distributions respond to ocean temperatures, predator/prey interactions and possibly turbidity (Emmett et al. 2006).

Wells et al. (2008) found that salmon rely heavily on krill and rockfish during early and later life stages.

The literature cited above identifies relevant information pertaining to specific habitats and habitat features, for each species, that were not discussed in Amendment 14. These habitats include tributaries, floodplains, oxbows and other offchannel areas, thermal refugia, river plumes, estuaries, eelgrass, surf-zone and general marine habitats. The literature identifies a number of important habitat features that contribute to the growth, survival, and productivity of Pacific Coast salmon, such as large woody debris, water temperature, stream flow, prey availability, and ocean upwelling. This information should be used to revise and refine the descriptions of EFH for each species and life stage.

Recommendation

The Panel recommends further consideration by the Council of the descriptions of EFH contained in the Pacific Coast salmon FMP, based on the information described above.

The Panel also recommends that the Council consider incorporating the additional information cited in this report into the annotated bibliography.

Habitat Areas of Particular Concern

The implementing regulations for the EFH provisions of the MSA (50 CFR part 600) recommend that the FMPs include 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 that are of high ecological importance. This designation is manifested in EFH consultations, in which NMFS can call attention to a HAPC and recommend that the Federal action agency make an extra effort to protect these important habitats.

The Council designated HAPCs in Amendment 19 to the Pacific Coast Groundfish FMP (seagrasses, canopy kelp, estuaries, rocky reefs, and a number of clearly defined areas of interest), but not in its three other FMPs. Amendment 14 discusses HAPCs for each species but stops short of establishing HAPCs, citing lack of sufficient data on which to base HAPCs.

Several FMCs have designated discrete habitat areas as HAPCs, while others broadly designated all areas of a specific habitat type as HAPCs. The "areas of interest" and estuaries designated by the Council in the Pacific Coast Groundfish FMP are examples of discrete HAPCs, while the seagrass, canopy kelp, and rocky reef HAPCs are examples of the broadly defined HAPCs that are not mapped, but are based on a description of the habitat. 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.

As part of this 5-year review, the Panel developed five potential HAPCs. Habitat types were initially identified using the best available information and the collective professional knowledge and experience gained by the Panel through scientific research and conducting EFH and ESA consultations. These habitats were then evaluated according to the four considerations listed above. The five potential HAPCs for Pacific Coast salmon are discussed below.

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 LWD, 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 LWD 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).

Complex channels and floodplain habitat and the HAPC considerations.

1. *The importance of the ecological function provided by the habitat.* Complex floodplains habitats, including wetlands, oxbows, side channels, sloughs, and beaver ponds, have been shown to be important habitats for salmonids. Juvenile coho salmon frequently move from main-channel habitats to off-channel habitats during the winter months, presumably to seek refuge from high winter flows (Cederholm and Scarlett 1982; Peterson 1982). Juvenile coho salmon inhabiting beaver ponds and other off-channel ponds exhibit higher densities, higher growth rates, and higher overwinter survival rates than coho salmon inhabiting other main-channel and side-channel habitats (Bustard and Narver 1975; Swales et al. 1986; Swales and Levings 1989).

   Side channels are important spawning habitat for Chinook salmon as well as coho salmon, and complex floodplain habitat and associated channels have higher densities of spawning fish than modified or constrained habitats (Vronskiy 1972; Drucker 2006; NOAA unpublished data).

   In higher-gradient reaches with more confined channels, large wood plays a major role in creating deep, complex pools that provide winter refuge where off-channel habitats are not available. Densities of juvenile coho salmon and other salmonids are often substantially higher in stream reaches with higher wood volumes compared to streams with little wood (reviewed in Bilby and Bisson 1998).

2. *The extent to which the habitat is sensitive to human-induced environmental degradation.* In most river systems throughout the Pacific Northwest and California, complex floodplain habitats have been subject to a high degree of direct anthropogenic modification. Floodplain areas have been cleared of woodland vegetation, drained, and filled to allow agricultural, residential, and urban development (Pess et al. 2002, 2003). Channelization and diking of rivers has effectively separated rivers from many off-channel habitats once available to salmonids (Beechie et al. 1994; Reeves et al. 1998). Clearing of large wood accumulations in rivers was commonplace to both improve navigation and facilitate transport of logs from upstream forest to mill sites downstream (Bilby and Bisson 1998). Active removal of beaver ponds or isolation of beaver ponds by levees has resulted in substantial losses of these habitats in many Pacific Northwest rivers (Beechie et al. 1994; 2001).

   Low-gradient, unconstrained reaches that typify where complex floodplain habitats are expressed are also highly responsive to disturbances that happen higher up in the watershed. For example, sediments generated by land-use and road-building practices are typically routed through higher-gradient, transport reaches and are deposited in low-gradient reaches. This can lead to widening and shallowing of the river channel, filling in of pool habitats, and reductions in the average particle size of the substrate (Montgomery and Buffington 1998). These changes, in turn, diminish the quality of spawning and rearing habitats for salmon, as well the capacity of affected reached to produce invertebrates that salmonids depend on for food.

   In moderate-gradient stream reaches, historical land-use practices including logging of riparian forests, splash damming, and active removal of wood from the stream channel to facilitate fish passage and protect local infrastructure has fundamentally altered the structure and function of salmon habitats. Despite improvements in riparian forest management that have occurred in the last 40-50 years, the legacy of early practices remains apparent in diminished sources for recruitment of large wood (particularly of coniferous origin), decreased quantities of large wood in stream channels, and a shift in composition of large wood pieces from large-diameter pieces of coniferous origin to smaller diameter pieces of hardwood origin, which decompose at a much faster rate (Bilby and Bisson 1998).

3. *Whether, and to what extent, development activities are, or will be, stressing the habitat type*. Many areas that historically were part of complex floodplain habitats have been permanently lost to urban development. Restoration of other such habitats would require major shifts in land-use practices including abandonment of agricultural lands and removal dikes and levees. Consequently, maintaining those few relatively intact floodplain habitats that remain on the landscape should be a high priority in salmon conservation.

   Conditions in riparian forests along more confined channels are likely to improve over the long-term in response to forest practice rules; however, the time lag between establishment of these rules and expected attainment of instream benefits is long (100-200 years). Consequently, ensuring protection of stream reaches that are characterized by intact, coniferous riparian stands and/or that currently have high amounts of inchannel wood is a high priority to bridge this gap.

4. *The rarity of the habitat type*. Historically, neither complex floodplain habitats nor mid-gradient channels with large quantities of inchannel wood were inherently rare within forested landscapes of the Pacific Northwest and California, but they have become increasingly so in response to human alterations of the landscape. For example, in the Skagit and Stillaguamish River watersheds, agricultural and urban development in floodplain areas has led to a 50% loss of side-channel sloughs habitats, and roughly 90% of beaver ponds have been isolated from main channel habitats (Beechie et al. 1994, 2001). As a consequence of intensive forest management on the vast majority of

landscape within the Pacific Coastal Ecoregion, streams throughout the region have experienced reductions in the quantity and average size of in-channel large wood, as well as loss of wood recruitment potential from adjacent riparian zones (Bilby and Bisson 1998).

The location and extent of these complex habitats can vary over space and time, and maps or spatial descriptions may not be reliable from year to year. As such, this HAPC should rely on detailed text that describes the general attributes of these habitats, rather than spatially explicit descriptions or maps.

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; Ebersole 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.

Thermal refugia and the HAPC considerations.

1. *The importance of the ecological function provided by the habitat.* Studies have shown that salmon increase their use of thermal refugia (e.g., cool water tributaries) when exposed to elevated water temperatures (Sutton et al. 2007), which can significantly reduce migration rates and suggests these areas provide crucial habitat in warm years (Goniea et al. 2006). Torgersen et al. (1999) state that the ability for cold water fish such as salmon to persist in warm water environments (>25°C) that experience elevated summer temperatures and seasonal low flows may be attributed to thermal refugia because even relatively minor differences in temperature are ecologically relevant for fish. In addition, climate change is expected to cause a rise in freshwater temperatures and a reduction in snowpack, which would lead to lower flows in the summer and fall (Battin et al. 2007; Mote et al. 2003; Stewart et al. 2004). These impacts would likely result in a reduction in the quantity and quality of fresh water salmon habitat, making thermal refugia even more important in the future.

2. *The extent to which the habitat is sensitive to human-induced environmental degradation.* Artificial barriers can block access to thermal refugia, which are often located at higher elevations. These barriers can also restrict flows, potentially increasing downstream temperatures (Yoshiyama et al. 1998). In addition, human-induced climate change is anticipated to lead to increased freshwater temperatures, thereby degrading or eliminating thermal refugia that currently exist (Battin et al. 2007).

3. *Whether, and to what extent, development activities are, or will be, stressing the habitat type.* As noted previously, artificial barriers can block access to thermal refugia, especially those located higher up in the watershed, and cause increased temperatures downstream (Yoshiyama et al. 1998). Land-use practices and resource extraction (e.g., agricultural and forestry practices) can affect riverine habitat and alter thermal spatial structure leading to elevated temperatures and reduced cool water habitat (Torgersen et al. 1999). Climate change is expected to exacerbate these impacts (ISAB 2007; Miles et al. 2000; Stewart et al. 2004).

4. *The rarity of the habitat type.* The abundance of cool water habitat features can vary substantially depending upon many factors including geographic location, flow characteristics and time of year. However, in certain areas with hot, dry summers (e.g., lower Sacramento River); it is likely that little, if any, suitable holding habitat exists for salmon to take refuge from elevated water temperatures (NMFS 2009a). Moreover, because climate change is expected to cause an increase in freshwater temperatures and prolonged summer drought periods (Battin et al. 2007; Mote et al. 2003; Stewart et al. 2004), these habitat types can be expected to become more rare (ISAB 2007).

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.

1. *The importance of the ecological function provided by the habitat. S*pawning is a particularly important element of the life history of any species of fish. Adverse effects to salmon spawning habitat can be caused by natural conditions such as drought, as well as from human activities. Regardless of potential impacts, the selection of suitable habitat and successful spawning can mean the difference between a successful recruitment year and a poor one.

2. *The extent to which the habitat is sensitive to human-induced environmental degradation.* Spawning habitat consists of the combination of gravel, depth, flow, temperature, and dissolved oxygen, among others. Impacts to any of these factors can make the difference between a successful spawning event and failure. Several anthropogenic activities are known to impact various physical, chemical, or biological features of spawning habitat, including road construction, timber harvest, agriculture, and residential development among others.

3. *Whether, and to what extent, development activities are, or will be, stressing the habitat type.* Although there are modest differences in spawning preferences between the species, all salmon require cold, highly oxygenated, flowing water as suitable spawning habitat. Many human activities and natural occurrences can affect spawning habitat, including road building, culvert construction, forestry activities, agriculture, dams, and others. The population of the contiguous U.S. west coast grew nearly 27% between 1990 and 2009 (U.S. Census 2010). This represents about 10 million people who need housing, transportation, and other infrastructure. As population growth continues to spur development, stresses to salmon habitat are inevitable.

4. *The rarity of the habitat type.* Chinook salmon spawn in a broad range of habitats. Depths can range from a few centimeters to several meters deep, and in small tributaries to large river systems (PFMC 1999). Coho salmon typically spawn in smaller tributaries than Chinook salmon, but are known to also spawn in larger rivers and occasionally lakes. Puget Sound pink salmon tend to spawn in larger rivers, but can also spawn in a variety of niche habitats including the lower reaches of rivers and even the intertidal zone (Quinn 2005). But as with other salmon species, pink salmon require high dissolved oxygen and adequate temperatures. Although salmon do require suitable habitat for successful spawning, such habitat is generally available and therefore not considered rare.

The location and extent of spawning habitat can vary over space and time, and maps or spatial descriptions may not be reliable from year to year. As such, this HAPC should rely on detailed text that describes the general attributes of these habitats, rather than spatially explicit descriptions or maps.

Estuaries. Estuaries can be defined as "waters that are semi-enclosed by land but have open, partly obstructed, or sporadic access to the ocean, and in which seawater is at least occasionally diluted by freshwater runoff from land" (Dethier 1990), and include nearshore areas such as bays, sounds, inlets, river mouths and deltas, pocket estuaries, 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.

The inland extent of the estuary HAPC is defined as the mean higher high water tidal level, or the upriver extent of saltwater intrusion, defined as upstream and landward to where ocean-derived salts measure less than 0.5 parts per thousand during the period of average annual low flow. The seaward extent is an imaginary line closing the mouth of a river, bay, or sound; and to the seaward limit of wetland emergents, shrubs, or trees occurring beyond the lines closing rivers, bays, or sounds. This HAPC also includes those estuary-influenced offshore areas of continuously diluted seawater. This definition is based on Cowardin, et al. (1979).

Estuaries were designated as a HAPC in Amendment 19 to the Pacific Coast Groundfish FMP (PFMC 2005).

Estuaries and HAPC considerations.

1. *The importance of the ecological function provided by the habitat.* 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; Blackmon et al. 2006). 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). Chinook salmon are well known for utilizing natal river tidal deltas, non-natal "pocket estuaries" (nearshore lagoons and marshes), and other estuarine habitats for rearing during outmigration (Ehinger et al. 2007). In the larger, deeper estuaries of the west coast of North America (e.g., Puget Sound, Columbia River, and 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).

2. *The extent to which the habitat is sensitive to human-induced environmental degradation.* Estuaries are highly sensitive to anthropogenic activities (Johnston 1994). 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.

3. *Whether, and to what extent, development activities are, or will be, stressing the habitat type.* 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). Shipping ports are often located in estuaries because they provide protected harbors. Development of port facilities (e.g., dredging and filling, armoring, overwater structures) has resulted in extensive loss of estuarine habitats along the West Coast. Although the effects of water withdrawals and control structures are little studied (Good 2000), there is evidence that they can alter the estuarine mixing zone (Jay and Simenstad 1996). Population growth is expected to increase water withdrawals from streams, which will reduce freshwater inflow to estuaries and lead to reduced flushing capacity for wastes, changes in habitat types and distribution, and other unknown risks to these ecosystems (Good 2000). Many estuaries have been converted to agriculture and urban land uses. For example, the Duwamish River has lost more than 99% of its tidal delta habitat (Simenstad et al. 1982), while the Skagit River, which contains the largest tidal delta in Puget Sound, has lost 80-90% of its aquatic habitat area (Collins et al. 2003).

4. *The rarity of the habitat type.* Estuaries are not especially rare, although many have been reduced in size through diking, draining, filling, dredging, and other human activities. Therefore, much of the historical estuarine habitat has been lost and much of the remaining habitat is often severely degraded.

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).

Eelgrasses (Zostera *marina*) form dense beds of leafy shoots year-round in the soft sediments of the lower intertidal and shallow subtidal zone, and they form a three-dimensional structure in an otherwise two-dimensional (sand or mud) environment (Mumford 2007).

Both kelps (canopy-forming) and eelgrass (seagrasses) were designated as HAPCs in Amendment 19 to the Pacific Coast Groundfish FMP (PFMC 2005)

Marine and estuarine SAV and HAPC considerations

1. *The importance of the ecological function provided by the habitat.* These habitats provide important 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. 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).

2. *The extent to which the habitat is sensitive to human-induced environmental degradation.* 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). Activities that produce such stressors include shoreline development (bulkheads, docks and piers, etc.), dredging, faulty septic systems, and stormwater discharge. These activities can alter shoreline erosion and sediment transport, alter depth profiles, generate turbidity plumes, and impair water quality, all of which can degrade eelgrass habitat (Fresh 2006) and, presumably, kelp habitat as well. Vessels can directly damage SAV through prop scour, groundings, and anchoring (Nightingale and Simenstad 2001). Eelgrass beds near ferry terminals are often heavily impacted by the propwash from these large vessels, and those near recreational facilities often show clear propeller damage. A number of studies (e.g., Walker et al. 1989; Hastings et al. 1995) have shown that anchor chains, especially those anchoring a mooring buoy, can scour a sizable area of seagrass when they drag across the bottom.

3. *Whether, and to what extent, development activities are, or will be, stressing the habitat type.* Short et al. (2006) noted a world-wide decline in seagrass habitats, many of which were attributable to anthropogenic activities. Development has altered a significant portion of the estuarine and marine shores along the West Coast, and is expected to increase in the future.

4. *The rarity of the habitat type.* Although marine and estuarine SAV are not especially rare across the geographic range of Pacific Coast salmon, they can be locally rare. In Puget Sound, for example, only 11 % of the shoreline has kelp, while up to 34% of the shoreline has eelgrass (Mumford, 2007).

The location and size of both kelp and seagrass beds vary over space and time, and maps or spatial descriptions may not be reliable from year to year. As such, this HAPC should rely on detailed text that describes the general attributes of these habitats, rather than spatially explicit descriptions or maps.

In addition to the five HAPCs discussed above, the Panel considered the potential for designating migratory corridors as a HAPC. Given the life history strategies of salmon, migratory corridors have extremely high ecological value and are often at risk of degradation due to human activities (e.g., impassible culverts). However, the migratory corridors of salmon extend from the spawning habitats, downstream to the estuary, and through marine waters. While HAPCs are intended to be a subset of EFH, a HAPC based on the migratory corridors would include all habitats used by salmon, and, therefore, all of EFH. As such, migratory corridors do not meet the intent of the HAPC provisions in the implementing regulations, and the Panel did not pursue it further.

Recommendation

The Panel recommends further consideration of designation of HAPCs based on the information provided on the value to salmon of channels and floodplains; thermal refugia; spawning habitat; estuaries; and marine and estuarine submerged aquatic vegetation.

4. THREATS TO EFH

Fishing Activities That May Affect EFH

The MSA requires FMCs for each FMP to identify fishing activities that may adversely affect EFH and to minimize adverse effects of those activities to the extent practicable. Fishing activities should include those regulated under the Pacific salmon FMP that affect EFH identified under any FMPs, as well as

those fishing activities regulated under other FMPs that affect EFH designated under the Pacific salmon FMP. The fishing activities that have the potential to adversely affect EFH for Pacific Coast salmon are shown in Table 6. These include fishing activities not managed under the MSA that may adversely affect salmon EFH.

Fishing activities, derelict gear, 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.

Although commercial and recreational fishing activities and harvest levels that potentially adversely affect Pacific salmon have not changed substantially since 1999, the activities identified in Amendment 14 warrant a more thorough review and description. In addition, the Panel identified marine debris (and derelict fishing gear, separately) as a potential adverse affect. Although minor changes in location may have occurred, it is unlikely that these would have a substantial 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.

Table 7. Summary of fishing activities that potentially affect to EFH. CK=Chinook salmon ; CO=coho salmon; P=PS pink salmon.

Fishing Activity	Habitat Type		
	Freshwater	Estuarine	Marine
Roundhaul gear		CK, CO, P	CK
Pot/trap		CK, CO, P	CK
Bottom trawl			CK
Mid-water trawl			CK
Long lines			CK
Carcass removal	CK, CO, P		
Vessel impacts	CK, CO, P	CK, CO, P	CK, CO, P
Harvest of prey species		CK, CO, P	CK, CO, P
Marine debris	CK, CO, P	CK, CO, P	CK
Derelict gear	CK, CO, P	CK, CO, P	CK
Shellfish harvest		CK, CO, P	
Recreational fishing	CK, CO, P	CK, CO, P	CK, CO, P

Effects To EFH By Gear Type

Roundhaul Gear (includes purse seines, lampara nets, dip nets, and drum seines): Fisheries for coastal pelagic and highly migratory species use purse seines, lampara nets, and other roundhaul gear to target Pacific sardine, northern anchovy, Pacific mackerel, jack mackerel, market squid, and tuna. Most tuna fishing occurs in the western and central Pacific, and tropical eastern Pacific. However, tuna are highly migratory and are present off the U.S. West Coast. They are therefore included in this consideration of habitat impacts from fishing activities.

Roundhaul gear can affect EFH by direct removal of species that are prey for Pacific salmon, as well as for other managed species. It can also affect squid EFH if nets are allowed to contact the benthos of squid spawning areas.

Pot and Trap Gear: This gear type is dominated by commercial and recreational crab fisheries prevalent in estuaries and the marine environment along the entire West Coast. Lobster traps are used in

California, but not typically north of the central California coast. To a lesser extent, pot gear is used in the sablefish fishery but typically at depths in the marine environment much greater than are associated with salmon (NWFSC 2009).

Pot and trap gear can adversely affect EFH by smothering estuarine eelgrass beds and other marine/estuarine benthic habitats such as cobble and vegetated surfaces utilized by Pacific salmon. Although typically placed in areas of sandy bottom, gear can also be deployed in areas of EFH and are often dragged across the benthos by strong tidal or ocean currents. Lost trap and pot gear also can affect EFH and is discussed below under derelict gear.

Bottom Trawling: Bottom trawling activity is conducted primarily by the West Coast groundfish fishery, harvesting over 90 species. These include 64 species of rockfish (e.g., widow, cowcod, yelloweye, and Pacific ocean perch); 12 species of flatfish (e.g., English sole, starry flounder, sanddab); six species of roundfish (e.g., lingcod, sablefish, and whiting); six species of sharks and skates (e.g., leopard shark, big skate and spiny dogfish); and several other species (e.g., ratfish, finescale codling, and Pacific rattail grenadier). Bottom trawling is managed under biennial specifications and includes a complicated matrix of sectors, seasons, and spatial limitations. There are many areas closed to bottom contact gear, including bottom trawling, many based on the designated HAPCs in the groundfish FMP EFH designations. (PFMC 2008).

Appendix C to Amendment 19 of the Pacific Coast Groundfish FMP (PFMC 2005) presents a risk assessment framework, including a sensitivity index and recovery rates for a variety of groundfish habitats. Several habitats considered would likely overlap with salmonid habitat in the marine environment. Amendment 14 to the Pacific Salmon FMP states that Chinook salmon may be associated with "bottom topography" at depths of 30-70 meters, and juveniles are associated with pinnacles, reefs and vertical walls.

Impacts of bottom trawling to physical and biogenic habitats include removal of vegetation, corals, and sponges that provide structure for prey species; disturbance of sediments; and possible alteration of physical formations such as boulders and rocky reef formations (NMFS 2005b).

Midwater trawling: Midwater trawls are used to harvest Pacific whiting, shrimp, and other species (PFMC 2008). Like bottom trawling, it is managed under the Pacific groundfish FMP. Effects are generally limited to the effects of (1) removal of prey species, (2) direct removal of adult and juvenile salmon (Bellinger 2009), and (3) effects resulting from loss of trawl gear, potentially resulting in impacts to bottom habitats and ghost fishing.

Long Line: Pelagic and bottom long-line fishing in the marine environment is prevalent on the Pacific Coast. Pelagic long-lining targets chiefly tuna and swordfish, while bottom long lining targets halibut, sablefish, and other species. Both types of long lining can incidentally harvest managed species as well as prey species. If long-line gear breaks loose and is lost, it can continue ghost fishing and potentially harm bottom habitat (see Derelict gear section).

Removal of Salmon Carcasses

Salmon carcasses provide vital nutrients to stream and lake ecosystems (Scheuerell et al. 2005). 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. One study in Willapa Bay basin estimated that more than several thousand metric tons of salmon tissue have been lost each year as a nutrient source to streams because of reductions in salmon returns. Gresh et al (2000) estimated that just 6-7% of the marine-derived nitrogen and phosphorous

once delivered to the rivers of the Pacific Northwest by salmon carcasses is currently reaching those streams.

Carcasses have been shown to be an important habitat component, enhancing smolt growth and survival by contributing significant amounts of nitrogen and phosphorus compounds to streams (Spence et al. 1996). These are the nutrients that most often limit production in oligotrophic systems.

Vessel impacts

The variety of fishing and other vessels on the Pacific Coast range can be found in freshwater streams, estuaries, and the marine environment. Vessel size ranges from small single-person vessels used in streams and estuaries, to mid-size commercial or recreational vessels, to large-scale vessels limited to deep-draft harbors and marine waters.

Vessels can adversely affect EFH by affecting physical or chemical mechanisms. Physical effects can include physical contact with spawning gravel and redds (freshwater streams) and propeller wash in eelgrass beds (estuaries). Derelict, sunk, or abandoned vessels can cause physical damage to essentially any bottom habitat the vessel comes into contact with. This could cause harm to corals, sponges, rocky reefs, sandy ocean floor, eelgrass beds, and other habitats.

Chemical effects could come in the form of anti-fouling paint, oil/gas spills, bilge waste, or other potential contaminants associated with commercial or recreational vessels, and could occur in freshwater, estuaries, or the marine environment.

Studies in Alaska and New Zealand (Horton 1994; Sutherland and Ogle 1975) have found that in shallow water where boat use is high and especially where channels are constricted, developing salmon eggs and alevins in the gravel can suffer high mortalities as a result of pressure changes caused by boat operations, which can result in removal of gravel or mechanical shock generated in the area under the midline of the boat. Studies done on the effects of jet sleds, drift boat, or kayak operation on the behavior and survival of free swimming juvenile salmon on the Rogue River have shown minimal effects, although behavioral responses are observed when vessels pass directly overhead (especially nonmotorized kayaks or driftboats) (Satterwaithe 1995). Studies along the Columbia River indicated that the wake of large ships caused significant numbers of Chinook salmon juveniles to be killed from being washed up and stranded on sand bars and mud flats. Stranding was not observed on the Skagit River from jet sled use (K. Bauersfel, 1998 or on the Rogue River from private motorboat and commercial tour boat use (Satterwaithe 1995).

Harvest of prey species

Prey species can be considered a component of EFH (NMFS 2006). For Pacific salmon, commercial and recreational fisheries for many types of prey species potentially decrease the amount of prey available to Pacific salmon. Herring, sardine, anchovy, squid, smelt, groundfish, shrimp, crab, burrowing shrimp, and other species of finfish and shellfish are potential salmon prey species that are directly fished, either commercially or recreationally.

Amendment 14 notes that some prey species (e.g., herring and crab) are state-managed while others are federally managed and it concluded that both state and federal management already set aside a portion of the biomass as forage reserves for predator species. For example, the harvest guideline formula for Pacific sardine incorporates a 150,000 metric ton (mt) cutoff, meaning that the annual harvest guideline is based on the estimated biomass minus 150,000 mt. Other prey species such as krill, copepods, and amphipods, are salmon prey species that are not directly fished, but that can be adversely affected by fishing activities.

Derelict gear

When gear associated with commercial or recreational fishing breaks free, is abandoned, or becomes otherwise lost in the aquatic environment, it becomes derelict gear. This phenomenon occurs in fishing activities managed under all four Pacific Coast FMPs, as well as recreational fishing and fishing activities not managed by the Council. In commercial fisheries, trawl nets, long lines, purse seines, crab and lobster pots, and other material, are occasionally lost to the aquatic environment. Recreational fisheries also contribute to the problem, mostly via lost crab pots.

Derelict fishing gear, as with other types of marine debris, can directly affect salmon habitat and can directly affect managed species via "ghost fishing." Ghost fishing is included here as an impact to EFH because the presence of marine debris affects the physical, chemical, or biological properties of EFH. For example, once plastics enter the water column, they contribute to the properties of the water. If debris is ingested by fish, it would likely cause harm to the individual. Another example is in the case of a lost net in a river. Once lost, the net becomes not only a potential barrier to fish passage, but also a more immediate entanglement threat to the individual.

Along the Pacific Coast, Dungeness crab pots are especially prevalent as derelict gear (NWSI 2010). Commercial pots are required to use degradable cord that allows the trap lid to open after some time. This is thought to significantly reduce the effects of ghost fishing. However, there is no such requirement for recreational crab pots. Nor is there any reliable information regarding the numbers or impacts of lost recreational derelict crab pots.

Derelict gear can adversely affect salmon EFH directly by such means as physical harm to eelgrass beds or other estuarine benthic habitats; harm to coral and sponge habitats or rocky reefs in the marine environment; and by simply occupying space that would otherwise be available to salmon. Derelict gear also causes direct harm to salmon (and potentially prey species) by entanglement. Once derelict gear becomes a part of the aquatic environment, it affects the utility of the habitat in terms of passive use and passage to adjacent habitats. More specifically, if a derelict net is in the path of a migrating fish, that net can entangle and kill the individual fish.

In Puget Sound, derelict fishing nets as well as lost crab traps constitute a significant problem. And estimated 2493 lost nets were removed recently during 18 months of a project funded under the American Recovery and Reinvestment Act. The Northwest Straits Initiative estimates that these nets were entangling 1.5 million animals annually. Hundreds of crab pots have also been removed (NWSI 2010).

In the Columbia River, derelict salmon gill nets continue to ghost fish for salmon, sturgeon, and other species (Callahan Grant, pers comm. 2008). The nets are typically made from non-degradable nylon or plastic monofilament and persist in the aquatic environment for years (NWSI 2010).

Recreational fishing

Most recreational fishing impacts are combined in the sections above. One activity not yet captured is the potential for impacts to juvenile salmon and eggs in redds resulting from trampling by recreational fishers. In freshwater streams, recreational fishers often use waders and boots to walk in streams to access good fishing spots. This can crush eggs and alevins in a salmon redd. Trampling of redds has potential to cause high mortality of salmonids. Most information on redd disturbance is anecdotal. However, one study of angler wading caused high mortality (43%-96% of alevins with only one or two passes per day (Roberts and White 1992).

Minimizing Effects

Fishery Management Plans are required to minimize adverse affects to EFH to the extent practicable. Minimization measures can include, but are not limited to, time/area closures, fishing equipment restrictions, and harvest limits. Adverse impacts include incidental harvest of managed species through legal fishing activity, but incidental harvest is addressed in other sections of FMPs, rather than under EFH provisions.

Gear Effects

Amendment 14 does not identify any studies that indicate direct gear effects on Pacific Coast salmon EFH from Council-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 6 lists gear types used in Council-area fisheries that could impact Pacific Coast salmon EFH. 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.'" Amendment 14 recommends research to study gear effects on salmon EFH and their prey, especially disturbance to eelgrass beds and rocky habitat. Amendment 14 also offers minimization measures for prey harvest, carcass removal, redd disturbance, and vessel impacts. However, several fishing impacts are presented here that were not considered in Amendment 14.

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.

Recommendation

The Panel recommends consideration of newly identified fishing activities that may adversely affect EFH and the consideration of measures to minimize impacts to Pacific salmon EFH, in accordance with the 2002 EFH regulatory guidance.

Non-Fishing Activities That May Affect EFH

The MSA requires FMCs and NMFS to identify non-fishing activities that may adversely affect EFH, as well as actions to encourage the conservation and enhancement of EFH, including recommended options to avoid, minimize, or mitigate 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 (Table 7). This section provides a description of 10 non-fishing threats to EFH that have gained attention since Amendment 14 was published. Some threats are more developed than others, and some include preliminary conservation measures while others do not. However, each threat description contains the information necessary to, at a minimum, inform the Council on the potential severity of the adverse effects from these activities. See Amendment 14 for a description of the 21 threats to EFH of Pacific Coast salmon identified in 1999. It is important to note that many projects consist of more than one of these 31 threats, and the cumulative effects of those threats should be considered when making EFH conservation recommendations.

The Panel anticipates that, should the Council amend the Pacific Coast Salmon FMP, the descriptions of all 31 threats will be expanded upon and refined, and that conservation measures will be developed for each threat. In addition, the Council may determine that threats in addition to those discussed here and in Amendment 14 merit inclusion in the amendment.

Table 8. 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 Amendment 14.

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	

Pile driving

Pile driving can generate intense underwater sound pressure waves that can adversely affect the ecological functioning of EFH. These pressure waves have been shown to injure and kill fishes, including salmon (e.g., Caltrans 2001; Longmuir and Lively 2001; Stotz and Colby 2001; Abbott and Bing-Sawyer 2002; Stadler, pers. com. 2002). This issue came to light in 2001 and has gained considerable attention from Federal and state resource and transportation agencies because of the large number of piles that are driven into aquatic habitats for transportation infrastructure and other purposes.

Potential Adverse Impacts

Injuries associated directly with pile driving are poorly studied but include rupture of the swimbladder and internal hemorrhaging. The sounds can over-stimulate the auditory system of fishes and may result in temporary threshold shifts (a non-injurious temporary reduction in hearing sensitivity) or physical injury, such as a loss of hair cells of the sensory maculae (Hastings and Popper 2005).

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. Injury or

death associated with pile driving appears to be positively correlated with the size of the pile because the greater energy required to drive larger piles produces higher sound levels. Fish-kills have been associated with driving of hollow steel piles ranging from 24 to 96 inches in diameter. 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. Firmer substrates require more energy to drive piles, and produce more intense sound pressures. Sound attenuates more rapidly with distance from the source in shallow than in deep water (Rogers and Cox 1988).

Two main types of hammers are used to drive piles – impact and vibratory. Impact hammers use a large weight or piston to strike the top of the pile and drive it into the substrate and appear to pose the greater risk to fishes. All reported instances of fishes killed or injured during pile driving have occurred when impact hammers were used. Vibratory hammers, on the other hand, vibrate the pile vertically to emulsify the surrounding sediment and cause the pile to sink. While injury and death have not been observed from vibratory hammers, there are no data to show they are harmless. One reason for these observed differences is the different types of sounds that each hammer produces. Impact hammers produce intermittent but intense spikes of sound while vibratory hammers produce continuous sounds of lower intensity. The magnitude of the effect on salmon that are exposed to the sounds from pile driving will depend on the size and physical condition of the fish, the depth of the fish in the water column, and the characteristics of the received sound including the shape and energy content of the sound pressure wave.

To aid in the assessment of the risks posed by impact pile driving, the Fisheries Hydroacoustic Working Group (FHWG), a group of Federal and state agencies with a stake in this issue, developed and adopted a set of interim criteria to estimate the response of fishes exposed to these sounds (FHWG 2008). These are dual criteria based on protective thresholds for two sound metrics: peak pressure and sound exposure level (SEL). SEL is an energy index that is indicative of mechanical work done on the tissues and can be summed over all pile strikes to which the fishes are exposed. Using these criteria, injury is expected to any fish that is exposed to either a peak pressure that exceeds 206 decibel (dB) (re: 1 µPa) or a size-dependent cumulative SEL that exceeds 187 dB (re: 1 μPa^2-sec) for fishes larger than 2 grams, and 183 dB (re: 1 μPa^2-sec) for fishes smaller than 2 grams.

Sounds have been shown to alter the behavior of fishes; including salmon (see review by Hastings and Popper 2005). The observed behavioral changes include startle responses and increases in stress hormones. Other potential changes include reduced predator awareness and reduced feeding. Feist et al (1991) observed that, juvenile pink salmon and chum salmon appeared to be less prone to spooking by an observer on the shore when piles were being driven. This reduced awareness could lead to increased predation. Directed studies on the effects of pile driving sound on the behavior of salmonids are limited, although Ruggerone et al (2008) found no observable changes in the behavior of caged coho salmon in the vicinity of pile driving. Faced with the paucity of data, NMFS is currently using a conservative criteria of 150 dB (re: 1 µPa) root-mean-square as a trigger for closer analysis of potential adverse behavioral effects from all types of sounds, including those from impact and vibratory hammers. The potential for adverse behavioral effects will depend on a number of factors, including the life stages that are present. For example, the level of concern would be higher for juvenile salmon that are migrating through an estuary and are more prone to predation than for a subadult or adult in marine waters.

<u>Potential Conservation Measures</u>

- Avoid driving piles when salmon are present, if possible, especially the younger life stages.

- Avoid driving hollow steel piles with an impact hammer. Drive the piles with a vibratory hammer or select piles that are made of alternate materials produce less-harmful sounds.
- Drive piles during low tide periods when located in intertidal and shallow subtidal areas.
- Under those conditions where impact hammers are required, the piles should be driven as deep as possible with a vibratory hammer prior to the use of the impact hammer.
- Implement measures to attenuate the sound. Such measures include the use of a bubble curtain or a dewatered pile sleeve or coffer dam. Monitor the sound levels during pile driving to ensure that the attenuation measures are functioning as expected.
- Drive piles when the current is reduced (i.e., centered on slack current) in areas of strong current to minimize the number of fish exposed to adverse levels of underwater sound.

Overwater Structures

Overwater structures include commercial and residential piers and docks, floating breakwaters, barges, rafts, booms, and mooring buoys. These structures are typically located in intertidal areas out to about 15 meters below the area exposed by the mean lower low tide (i.e., the shallow subtidal zone). Light, wave energy, substrate type, depth, and water quality are the primary factors controlling the plant and animal assemblages found at a particular site. Overwater structures and associated activities can alter these factors and interfere with key ecological functions such as spawning, rearing, and refugia. Site-specific factors (e.g., water clarity, current, depth) and the type and use of a given overwater structure determine the occurrence and magnitude of these impacts.

Potential Adverse Effects

The following description of the potential impacts of overwater structures and associated activities on EFH, unless otherwise cited, is taken from a recent, comprehensive literature review by Nightingale and Simenstad (2001). For a more detailed discussion, the reader is directed to this review.

Overwater structures and associated developments may adversely affect EFH in a variety of ways, including construction related impacts, changes in ambient light conditions, alteration of the wave and current energy regime, and through activities associated with the use and operation of the facilities, such as increased vessel traffic and pollutants.

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 depend upon its height, width, construction materials, and orientation. High and narrow piers and docks produce narrower and 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 materials that allow light transmission (e.g., glass, steel grates). Structures that are oriented north-south produce a shadow that moves across bottom substrate throughout the day, resulting in a smaller area of permanent shade than those with an east-west orientation.

The shadow cast by an overwater structure affects both the plant and animal communities below the structure. Distributions of plants, invertebrates, and fishes have been found to be severely limited in under-dock environments when compared to adjacent, unshaded vegetated habitats. Light is the single most important factor affecting aquatic plants. Under-pier light levels have been found to fall below threshold amounts for the photosynthesis of diatoms, benthic algae, eelgrass, and associated epiphytes and other autotrophs. These photosynthesizers are an essential part of nearshore habitat and the estuarine and nearshore foodwebs that support many species of marine and estuarine fishes. Eelgrass

and other macrophytes can be reduced or eliminated, even through partial shading of the substrate, and have little chance to recover.

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. Shading from overwater structures may also reduce prey organism abundance and the complexity of the habitat by reducing aquatic vegetation and phytoplankton abundance (Kahler et al. 2000; Haas et al. 2002). Biotic assemblages on pilings have been demonstrated to differ from natural hard substrate (Glasby 1999a) with these differences attributed to shading effects (Glasby 1999b). Other studies have shown shaded epibenthos to be reduced relative to that in open areas. These factors are thought to be responsible for the observed reductions in juvenile fish populations found under piers and the reduced growth and survival of fishes held in cages under piers when compared to open habitats (Able et al. 1998; Duffy-Anderson and Able 1999).

The shadow cast by an overwater structure may increase predation on EFH managed species by creating a light/dark interface that allows ambush predators to remain in a darkened area (barely visible to prey) and watch for prey to swim by against a bright background (high visibility) (Helfman 1981). Prey species moving around the structure are unable to see predators in the dark area under the structure and are more susceptible to predation. Furthermore, the reduced vegetation (i.e., eelgrass) densities associated with overwater structures decrease the available refugia from predators.

In-water structures (e.g., pilings) also provide perching platforms for avian predators such as double-crested cormorants (*Phalacrocorax auritis*), from which they can launch feeding forays or dry their plumage. These piscivorous birds congregate near hydroelectric dams throughout the Columbia River Estuary and forage on salmonids (Roby et al. 2007; Collis et al. 2002).

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 that provide substrates required for plant propagation, fish and shellfish settlement and rearing, and forage fish spawning.

Pilings can alter adjacent substrates by increasing shell deposition from piling communities and changing substrate bathymetry. Changes in substrate type can alter the nature of the flora and fauna native to a given site. In the case of pilings, native dominant communities typically associated with sand, gravel, mud, and eelgrass substrates are replaced by communities associated with shell hash substrates.

Treated wood used for pilings and docks releases contaminants into saltwater environs. Polyaromatic 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 (Johnson et al. 1999; Johnson 2000; Stehr et al. 2000). Wood also is commonly treated with other copper-based chemicals such as ammoniacal copper zinc arsenate (ACZA) and chromated copper arsenate (CCA) (Poston 2001). Copper is a common contaminant in salmon habitat and can increase susceptibility to disease, cause hyperactivity, impair respiration, or disrupt osmoregulation. Moreover, salmon use olfactory cues to convey important information about habitat quality, predators, mates, and the animal's natal stream, and copper can impair olfactory performance. Research has shown that fish behaviors can be disrupted at concentrations of dissolved copper that are at, or slightly above, background concentrations. Therefore, substantial copper-induced loss of olfactory capacity will likely impair behaviors essential for the survival or reproductive success of salmon. 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.

Although not the cause of direct introductions, artificial overwater structures and associated substrate may provide increased opportunity for nonnative species colonization and exacerbate the increase in their abundance and distribution (Bulleri and Chapman 2010). In the San Francisco Estuary, the Smithsonian Institute conducts Rapid Assessment Surveys to determine nonnative species distribution on overwater structures. Of the294 distinct nonnative taxa observed, 60% were found on floating docks, 20% on intertidal benthos, and 13% from benthic grabs (Cohen et al. 2005). Overwater structures can serve as focal points for nonnative species known to prey on salmon (Kahler et al. 2000) or otherwise alter salmon habitat processes and functions (Nightingale and Simenstad 2001).

Construction and maintenance of overwater structures often involves driving of pilings (see Pile Driving) and dredging of navigation channels (see Dredging and Dredged Spoil Disposal in Amendment 14). Both activities may also adversely affect EFH.

Construction of docks may result in increased vessel traffic. Docks may be built for small marinas (small boats), ferry terminals (ferries), or commercial use. Depending on the size of the boat using the dock, increased vessel traffic may have negligible to significant effects on EFH. Boat traffic creates energy that suspends fine sediments and increases turbidity. Ferry docking and departing may result in multiple propeller wash events per hour (Olson et al. 1997). Ferry propeller wash may cause elevated turbidity, coarsening of sediments underneath ferry terminals (Francisco 1995), and scour pits (Shreffler and Gardiner 1999; Haas et al. 2002). Propeller wash may increase current by up to six times the background current (Olson et al. 1997), which may result in epibenthic meiofauna flushing (Haas et al. 2002). Ferry terminals have been shown to significantly alter epibenthic juvenile salmonid prey during periods of salmon outmigration in Washington (Haas et al. 2002).

Boat traffic may adversely affect submerged aquatic vegetation present in the area. Eelgrass has been shown to be shorter in areas directly affected by boat traffic (Burdick and Short 1999). Propeller wash may erode away the rhizome of seagrasses or cause extensive scarring (Sargent et al. 1995). Boat traffic creates energy that suspends fine sediments and increases turbidity. Ferry docking and departing may result in multiple propeller wash events per hour (Olson et al. 1997). Ferry propeller wash may cause elevated turbidity, coarsening of sediments underneath ferry terminals (Francisco 1995), and scour pits (Shreffler and Gardiner 1999; Haas et al. 2002). Propeller wash may increase current by up to six times the background current (Olson et al. 1997), which may result in epibenthic meiofauna flushing (Haas et al. 2002). Ferry terminals have been shown to significantly alter epibenthic juvenile salmonid prey during periods of salmon outmigration in Washington (Haas et al. 2002).

While the effect of some individual overwater structures on EFH may be minimal, the overall impact may be substantial when considered cumulatively. The additive effects of these structures increase the overall magnitude of impact and reduce the ability of the EFH to support native plant and animal communities.

Potential Conservation Measures

- Use upland boat storage whenever possible to minimize need for overwater structures.
- 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.
- 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.

- 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 under-structure area with metal 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 to 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.
- Use floating breakwaters whenever possible and remove them during periods of low dock use. Encourage seasonal use of docks and off-season haul-out.
- Use waveboards to minimize effects on littoral drift and benthic habitats.
- 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.
- Use mid-water floats or other technology to keep anchor chains from contacting the substrate.
- Conduct in-water work during the time of year when EFH-managed species and prey species are least likely to be impacted.
- 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.
- Fit all pilings and navigational aids, such as moorings and channel markers, with devices to prevent perching by piscivorous bird species.
- Orient night lighting such that illumination of the surrounding waters is avoided.
- Mitigate for unavoidable impacts to benthic habitats that is adequately provided, properly monitored, and adaptively managed.
- Elevated turbidity during construction may be avoided with the use of a silt curtain if site conditions allow.

Alternative Energy Development

Marine, estuarine, and freshwater hydrokinetic energy refers to electrical energy that comes from "waves, tides, and currents in oceans, estuaries, and tidal areas; free flowing water in rivers, lakes, and streams; free flowing water in man-made channels; and differentials in ocean temperatures (ocean thermal energy conversion)" (US DOE 2009). For the purpose of considering threats to designated salmon EFH on the West Coast of the United States, this report focuses on nearshore wave energy and tidal turbine energy development because it is the most likely form of hydrokinetic technology to move forward within the next 5-years. Ocean thermal energy and offshore wind development is not considered in this discussion because they are not likely to be proposed off the West Coast of the United States in the near future.

Wave energy conversion devices can be grouped by the design features to capture wave energy, into six main types: point absorbers, attenuators, oscillating wave surge converters, oscillating water column, overtopping devices, and submerged pressure differential devices (U.S.DOE 2009). Tidal turbines are placed on the bottom and can have an exposed or closed blade. Although each design is unique, these devices are typically attached to the seafloor, channel bottom, or some type of structure and deployed at or near the water's surface or at depth.

In order to develop and operate wave or tidal hydrokinetic projects, there are four phases of activities that can potentially affect salmon EFH. The potential effects of each phase of a hydrokinetic project (preconstruction, construction, operation and maintenance, and decommissioning) need to be considered (Boehlert and Gill 2010; Gill 2005; Kramer et al. 2010; Previsic 2010; U.S.DOE 2009). In addition to the design features and footprint of an individual device, the spatial and temporal scales of a project (single device /short-term; single device /long term; multiple devices /short term; multiple devices /long term) are important considerations when evaluating effects to salmon EFH (Boehlert and Gill 2010). The potential cumulative effects of the spatial arrangement (vertical and horizontal) of multiple devices in the water column also need to be evaluated.

Construction activities typically include: horizontal directional drilling to land cables from the device to the shoreline; laying of subsea transmission cable; foundation/mooring installation; deployment and commissioning of device(s). Operation and maintenance include the mechanical functioning of the devices and appurtenances, as well as inspection and repair of equipment. Decommissioning at the end of the project (typically 5-30 years) involves removal of all equipment in the water column and transmission cables and restoration of the site, if needed.

Related activities that pertain to both the construction and operations phases include installation and maintenance of navigation buoys to mark the deployment area; and reliable port infrastructure to accommodate work vessels as well as delivery and retrieval of large hydrokinetic devices to pier-side for repair and maintenance, if necessary.

Potential Adverse Impacts

Because the majority of hydrokinetic renewable energy technologies remain at the conceptual stage and have not yet been developed as full-scale prototypes or tested in the field, there have been few studies of their environmental effects. Currently, identification of the potential environmental effects have been developed from: (1) predictive studies; (2) workshop reports from expert panels; and (3) report syntheses prepared from published literature related to other technologies, e.g., noise generated by similar marine construction activities, measurements of electromagnetic fields (EMFs) from existing submarine cables, environmental monitoring of active offshore wind farms in Europe, and turbine passage injury reduction mechanisms employed in conventional hydropower turbines.(Boehlert and Gill 2010; Kramer et al. 2010; Nelson et al. 2008; U.S. DOE 2009).

The majority of potential effects to salmon EFH are from the presence and operation of a wave energy convertor device or turbine. Although all phases of an individual project will alter the physical marine environment, the types and duration of those changes are varied. Numerous reviews (Kramer et al. 2010; U.S.DOE 2009) have identified the following potential effects of the wave energy converter devices, all of which may affect the quality and quantity of salmon EFH: (1) alteration of current and wave strengths and directions; (2) alteration of substrates and sediment transport and deposition; (3) interference with animal movements and migrations, including fish (prey and predators) and invertebrate attraction to subsurface components of device, concentration of displaced fishing gear; (4) presence of rotor blades or other moving parts; and attraction and concentration of predators on surface components of device; (5) alteration of habitats for benthic organisms; (6) sound and vibration in water column during construction and operation; (7) generation of EMFs by electrical equipment and transmission lines; (8) release into water column of toxic chemicals from paints, lubricants, antifouling coatings, as well as spills of petroleum products from service vessels. These potential effects to salmon EFH apply to tidal turbines as well.

Presence of subsurface structures may affect water movements, as well as sediment transport, erosion, and deposition at a local scale. During construction and decommissioning, the installation and removal

of the foundations, anchors, and transmission cables will disturb and suspend sediments, and may mobilize contaminants, if present. Disturbances to the benthic habitat will occur during temporary anchoring of construction vessels; clearing, digging and refilling trenches for power cables; and installation of permanent anchors, pilings, and other mooring devices. Prior to installation of a buried cable, any debris is typically cleared from the cable route using a ship-towed grapnel (Carter et al. 2009). Cables are buried using a ship mounted plow, whereas buried cables are usually exposed and reburied using a water-jetting technique when needing repair (Carter et al. 2009). Water quality will be temporarily affected by: (1) increased suspended sediments and resultant increased turbidity and decreased water clarity; (2) localized reduction of dissolved oxygen where anoxic sediments are suspended; and (3) mobilization of anoxic or buried contaminated sediments during cable route clearing and installation of cables.

The physical structures associated with ocean and tidal energy operations could potentially interfere with the migration and rearing habitat functions for juvenile and adult salmonids (U.S.DOE 2009). The floating and submerged structures, mooring lines, and transmission cables may create complex structural habitat that could act as a fish aggregation/attraction device (FAD), as well as provide substrate for attachment of invertebrates (considered biofouling where unwanted). Salmonids may be attracted to the physical structure itself, and/or to forage fish attracted to the structure. Floating offshore wave energy facilities could potentially (1) create artificial haul-out sites for marine mammals (pinnipeds) and roosting of seabirds; and (2) trap floating vegetation (e.g., kelp, eelgrass, large wood), and lost fishing gear (e.g., nets, traps, and crab pots). Aggregation of predators (e.g., fish, marine mammals, sea birds) near FADs may reduce the safe passage attribute of a migration corridor by subjecting juvenile or adult salmonids to increased predation. Drifting nets and other fishing gear that may become entangled on mooring lines or the devices may decrease the quality of salmon migration routes due to capture from passive fishing of gear. Deposition of organic matter from biofouling on the structure can change the chemical properties and biological communities near the structures. There will be new lighted, fixed surface structures (devices and navigation buoys marking the project area) in the marine environment which may attract prey and predators of juvenile and adult salmonids.

Depending on the frequency and amplitude of the sound of the moving parts of the device, as well as how far the sound waves propagate, the operational sounds of the devices may affect rearing and migration corridor habitat. There is limited information on sound levels produced during construction (e.g., offshore pile driving) and operation of ocean energy conversion devices, as well as the spatial extent of any altered acoustic environment. Turbines with exposed rotor blades may imped or entrained salmon.

Migrating adult and juvenile salmonids may be exposed to EMFs generated at a project site, which may affect the movement of salmon. The electric current in the cables will induce a magnetic field in the immediate vicinity (U.S.DOE 2009). During transmission of produced electricity, the matrix of vertical and horizontal cables will emit low-frequency EMFs. The source and effects of EMFs in the marine environment are limited and uncertain (Gill 2005).

Accidental, but acute, release of chemicals from leaks or spills (e.g., hydraulic fluids from a wave energy conversion device, drilling fluids during horizontal drilling) could have adverse effects to water quality. Anti-fouling coatings inhibit the settling and growth of marine organisms, and chronic releases of dissolved metals or organic compounds could occur from these compounds (U.S.DOE 2009). The cumulative effects to salmon and their prey from decreased water quality associated with the release of toxic chemicals could vary substantially depending upon the number of units deployed, type of antifouling coating used, and the maintenance frequency of the coating.

Recommended Conservation Measures

Structural and operational mitigation options are often unique to the technology or issue of concern.

- Locate and operate devices at sites and times of the year, to avoid salmon migration routes and seasons, respectively.
- Schedule the noisiest activities, i.e., pile driving, at times of the year to minimize exposure of juvenile and adult salmon.
- Schedule transmission cable installation to minimize overlap with salmon migration seasons.
- Conduct pre-construction contaminant surveys of the sediment in excavation and scour areas.
- To avoid concentration of predators, above water structures could have design features to prevent or minimize pinniped haul-out and bird roosting.
- Sheath or armor the vertical transmission cable to reduce transmission of EMF into the water column.
- Bury transmission cables on the sea floor to minimize benthic and water column EMF exposure.
- Align transmission cables along the least environmentally damaging route. Avoid sensitive habitats (e.g., rocky reef, kelp beds) and critical migratory pathways.
- Use horizontal drilling where cables cross nearshore and intertidal zones to avoid disturbance of benthic and water column habitat.
- Design the mooring systems to minimize the footprint by reducing anchor size, and cable/chain sweep.
- Develop and implement a device/array maintenance program to remove entangled derelect fishing gear and other materials that may affect passage.
- Use non-toxic paints and lubricating fluids where feasible.
- Limit the number of devices and size of projects until effects are better understood and minimization measures tested.

Liquefied Natural Gas Projects

Liquefied natural gas (LNG) is expected to provide a large proportion of the future energy needs in the United States. In recent years there has been an increase in proposals for new LNG facilities along the west coast including a number of onshore and offshore facilities in Oregon and California. The LNG process cools natural gas to its liquid form at approximately -162° C. This reduces the volume of natural gas to approximately 1/600th of its gaseous state volume, making it possible for economical transportation with tankers. Upon arrival at the destination the LNG is either vaporized onshore or offshore and sent out into an existing pipeline infrastructure or transported onshore for storage and future vaporization. The process of vaporization occurs when LNG is heated and converted back to its gaseous state. LNG facilities can utilize open loop, closed loop, combined loop, or ambient air systems for vaporization. Open loop systems utilize warm water for vaporization, and closed loop systems generally utilize a recirculating mixture of ethylene glycol for vaporization. Another type of closed-loop system is submerged combustion vaporization (SCV) which provides a water bath with submerged pipe coils. Combined loop systems utilize a combination of these systems.

Onshore LNG facilities generally include a deepwater access channel, land-based facilities for vaporization and distribution, storage facilities, and a pipeline to move the natural gas. Offshore facilities generally include some type of a deepwater port with a vaporization facility and pipelines to transport natural gas into existing gas distribution pipelines or onshore storage facilities. Deepwater ports and onshore terminals require specific water depths and include an exclusion zone for LNG vessel and/or port facility security.

<u>Potential adverse effects to EFH</u>

Construction and operation of LNG facilities can affect the habitat of salmonids in a variety of ways. Direct conversion and loss of habitat can occur through dredging and filling, construction of overwater structures, placement of pipelines, and shoreline armoring. Construction-related effects to habitat include generation of underwater noise from pile driving and vessel operations, turbidity, and discharge of contaminants. Long-term degradation of habitat can result from impingement and entrainment at water intakes for vaporization water and ballast and engine cooling water for LNG vessels, discharge of contaminants, discharge of cooled water from open-loop systems, and stranding of fishes by vessel wakes. Short- and long-term habitat degradation can result from accidental spills of LNG and other contaminants. With the exception of the discharge of contaminated water, discharge of vaporization water, and accidental spills of LNG, these effects are covered under other threats described in either this document or Amendment 14.

Contaminants can enter aquatic habitats through accidental releases associated with onshore and offshore operations, discharge of water containing biocides used to control fouling of piping systems, and discharges of the condensates from heat exchangers. A rapid phase transition can occur when a portion of LNG spilled onto water changes from a liquid to a gas virtually instantaneously. The rapid change from a liquid to vapor state can cause locally large overpressures ranging from a small pop to a blast large enough to potentially damage structures (Luketa et al. 2008). Because rapid phase transition would occur at the surface of the water it would be unlikely to affect fishes that are several feet under the surface. However, any fish present at or near the surface of the water would likely be killed. Effects on the aquatic environment from an LNG spill include thermal shock from the initial release (cold shock from the cryogenic liquid) and thermal shock from ignition of the vapor (Hightower et al. 2004). Condensates from heat exchanger such as SCV systems are generally acidic and require buffering with alkaline chemicals (FERC 2010). The condensate can include a wide range of metals and other contaminants. These contaminants may include copper, a known disruptor of salmonid olfactory function (e.g., Baldwin et al. 2003). The concentration of these chemicals will vary depending on the water source and facility design.

The operation of LNG facilities can result in the alteration of temperature regimes. Water utilized for the purposes of vaporization could be discharged at temperatures that differ significantly from the receiving waters and can be 5-10° C below ambient temperature. Changes in water temperatures can alter physiological functions of marine organisms including respiration, metabolism, reproduction, and growth; alter migration pathways; and increase susceptibility to disease and predation. Thermal effluent in inshore habitat can cause severe problems by directly altering the benthic community or adversely affecting marine organisms, especially egg and larval life stages (Pilati 1976, cited in NMFS 2008; Rogers 1976, cited in NMFS 2008).

Potential Conservation Measures

- Site LNG facilities in areas that minimize the loss of habitat such as naturally deep waters adjacent to uplands that are not in the floodplain.
- Recommend the vaporization systems that do not rely on surface waters as a heat source, such as an ambient air system. This will avoid impingement and entrainment of living resources. If a water-sourced system must be used, recommend closed loop systems over open loop systems. This will minimize water withdrawals and the associated impingement and entrainment of living marine resources.
- Locate facilities that use surface waters for vaporization and engine cooling purposes away from areas of high biological productivity, such as estuaries.
- Design intake structures to minimize entrainment or impingement.

- Regulate discharge temperatures (both heated and cooled effluent) such that they do not appreciably alter the temperature regimes of the receiving waters. Strategies should be implemented to diffuse this effluent.
- Avoid the use of biocides (e.g., aluminum, copper, chlorine compounds) to prevent fouling where possible. The least damaging antifouling alternatives should be implemented.

Desalination

Global population growth continues to place high demand on available supplies of potable water, and areas with limited supplies of this essential resource are turning to desalination (Roberts et al. 2010). Recent estimates suggest that up to 24 million cubic meters of desalinated water are produced daily (Latterman and Hoepner 2008). Expansion of desalination capacity can be found in the U.S., Europe, China, and Australia. California is leading the way in the U.S., with projections indicating that up to 20 new desalination plants, with a capacity of 2 million cubic meters per day, will be constructed by 2030. Desalination plants have a strong potential to detrimentally impact the ecology of marine habitats through water extraction and discharge of effluent. The following discussion is taken, unless otherwise cited, from a recent critical review by Roberts et al. (2010) of the available, peer-reviewed literature on the effects of effluent discharge.

Desalination of seawater to produce potable water uses one of two basic processes: thermal distillation such as multi-stage flash (MSF) distillation, and reverse osmosis (RO). Both of these methods have a saltwater intake and an effluent discharge. The effluent is water remaining after desalination and the concentrated salts from the seawater, commonly referred to as "brine." The brine also may contain various chemicals used in the desalination process, heavy metals from the machinery, and concentrated contaminants that were in the seawater. Reverse osmosis plants are increasingly common compared to the MSF plants.

Potential Adverse Effects

The potential effects are largely concerned with intake of seawater, which can entrain and impinge marine organisms, and discharge of the brine, which can affect the physiochemistry and, therefore, the ecology at the discharge site and beyond. The effects from intake of seawater at desalination plants are expected to be similar to those described under Power Plant Intakes, and will not be discussed here.

The discharge of brine can affect the salinity, temperature, and contaminant loading of the receiving body. Changes to salinity have been the most studied of these potential effects. Depending on the desalination method used, the design of the plant, and the salinity of the intake water, the salinity of the brine can range from as low as 37.3 parts per thousand (ppt) to as high as 75 ppt. In general, for an RO plant, the salinity of the brine will be roughly double that of the intake water. Published research shows that the extent of the brine plume (the area where the salinity is elevated) varies greatly, from 10s of meters, to 100s of meters, or in extreme cases, to several kilometers from the discharge point. The extent of the plume depends on a variety of factors, including the capacity of the plant, the salinity of the brine, the location of the discharge, the design of the diffuser, and local hydrologic conditions. However, in most cases studied, the intensity of the plume diminishes rapidly with distance from the outfall and is usually no greater than 2 ppt above background salinity within 20 m of the outlet.

Brine is usually denser than seawater and will, therefore, sink to the bottom and extend farther along the seafloor than at the surface. Where prevailing currents carry the plume further alongshore than offshore, the coastal fringe may be especially susceptible to impacts. During times of high tide, the brine may be concentrated around outfalls. Thus, the area impacted by the plume is likely to be both spatially and temporally variable.

A number of studies have shown that discharge of brine can lead to detectable ecological impacts to seagrass habitats, as well as phytoplankton, invertebrate and fish communities. The effects to seagrasses are the most widely studied. However, the results of these studies are highly variable. Several studies on the Mediterranean seagrass, *Posidonia oceana,* showed clear adverse effects, with significant increases in mortality and leaf necrosis at increases of only 1-2 ppt. Others found no significant effects, even six years after plant operations began. A study on eelgrass (*Zoster marina*) from marine and estuarine waters of the Netherlands found increased mortality at salinities 30 ppt and 25 ppt respectively, which are at the upper end of the salinity range in these habitats (van Katwijk et al. 1999). This suggests that eelgrass, a species of particular importance to Pacific Coast salmon (Fresh 2007), is sensitive to salinity changes and could be at risk if exposed to a brine plume.

Infaunal and epifaunal invertebrate communities were found to be impacted by the brine plume in several studies. Close to the outfall, nematodes dominated the community and reduced diversity of other taxa up to 400 meters from the outfall. The diversity and abundance of benthic diatoms may also be reduced near the outfall. These communities are an important part of the food web upon which juvenile and adult salmon depend, and could be at risk from exposure to brine plumes. In contrast, other studies found no change in the macrobenthic organisms where the brine dissipated within 10 m from the outfall. Some of the studies that showed changes to the benthic community were associated with older plants that discharged excessive levels of copper, an issue that is largely avoidable.

Salinities of 55 ppt or higher were found to be acutely toxic to juvenile sea bream and larval flounder. The implications of this for Pacific Coast salmon are not clear, but brine discharge could affect their survival, depending on the location of the outfall. Salmon entering the estuarine and marine environment are undergoing smoltification, the adaptation to saltwater. During this time, they gradually adapt to full-strength seawater, and are under considerable physiological stress. Exposure to a concentrated brine plume at this sensitive life stage could increase this already high level of physiological stress and reduce their chances of survival.

Depending on the design of the plant, the brine may be warmer than the receiving waters. This is primarily limited to MSF plants, while RO plants tend to result in plumes that are near ambient temperature. Because RO plants are becoming more common, relative to the MSF plants, this is a lesser problem than in the past. MSF plants can produce brines that are 10-15° C warmer than the receiving waters. However, most studies have found that the thermal impacts dissipate quickly, typically diminishing to background levels within tens of meters of the outfalls. The extent and severity of the thermal plume is dependent upon a variety of factors, such as the temperature of the discharge and receiving waters, the plant capacity, and local hydrologic conditions. Given the potentially high water temperatures in the immediate vicinity of the plume, there is a potential for salmon, particularly juveniles, to be affected. Mesa et al. (2002) found that exposure to increased temperature did not increase mortality or predation in juvenile Chinook salmon, but there was clear evidence of increased physiological stress.

Desalination can clearly impact the ecology of the receiving waters, but the extent of those effects depend on a variety of factors, such as plant capacity, discharge location and design, temperature and salinity differences between effluent and receiving water, and hydrologic conditions at the discharge site. Such variables should be considered when assessing the effects of these plants.

Power Plant Intakes

The withdrawal of water for power plant cooling purposes is termed once-through cooling (OTC). Withdrawal of cooling water removes billions of aquatic organisms every year (CEC 2005). Discharges of heated and/or chemically-treated discharge water may also occur. Adverse impacts to EFH from OTC

and subsequent discharges may adversely affect EFH in the source or receiving waters via 1) entrainment, 2) impingement, 3) discharge, 4) operation and maintenance, and 5) construction-related impacts.

Potential Adverse Effects

Entrainment is the withdrawal of aquatic organisms along with the cooling water into the cooling system. OTC indiscriminately entrains phytoplankton, zooplankton, and the eggs and larval stages of fish and shellfish. These entrained organisms are subjected to mechanical stress, heated water, and occasionally biocides. Of primary concern is the entrainment of early life history stages of fish and shellfish. Entrainment of larval stages can have a greater on fish and shellfish species than to phytoplankton or zooplankton due to a shorter spawning season, a more restricted habitat range, and greater likelihood of mortality. Long-term water withdrawal may adversely affect fish and shellfish populations by adding another source of mortality to the early life stage, which often determines recruitment and year-class strength (Travnichek et al. 1993). OTC units utilizing estuarine or marine waters are unlikely to entrain larval Chinook salmon or coho salmon given that spawning and larval development for these species occur in freshwater environments. Pink salmon are likely to be more susceptible to impingement and entrainment than the other two species because they typically enter the estuarine and marine habitats immediately after emergence and are, therefore, much smaller. Entrainment studies at power plants located in coastal lagoons and embayments have demonstrated that a large percentage of entrained larvae are composed of resident fishes that serve as a forage base for other species (EPRI 2007). Thus, entrainment may reduce the forage base for salmon species that may utilize the various coastal lagoons and embayments in which OTC units operate. Power plants utilizing OTC in open coastal environments have far less potential for population-level effects on fish populations than power plants located in coastal lagoons and embayments (EPRI 2007). However, localized reductions in forage opportunities may still occur near open coast OTC units.

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 (Grimes 1975; Hanson et al. 1977; Langord et al. 1978; Moazzam and Rizvi 1980; Helvey 1985; Helvey and Dorn 1987). The organisms cannot escape due to the water flow that either pushes them against the screen or prevents them from exiting the intake tunnel. Similar to entrainment, the withdrawal of water can entrapped particular species especially when visibility is reduced (Helvey 1985). This condition reduces the suitability of the source waters to provide normal EFH functions necessary for subadult and adult life stages of salmon and/or their prey. Population level impacts have not been observed for individual species

The ecological implications of entrainment and impingement are complex and difficult to assess. Although population level impacts are not consistently observed, the use of OTC may significantly decrease biological productivity in estuarine and marine systems. With modern entrainment sampling and analyses, a more scientifically robust method of determining appropriate compensation may be done through the use of habitat production foregone analyses. A combined habitat foregone estimate for 13 power plants using OTC in California bays and estuaries was approximately 10,800 acres of wetlands (CEC 2005).

Thermal effluents in inshore habitat may alter the benthic community or kill marine organisms, especially larval fish. Temperature influences biochemical processes of the environment and the behavior (e.g., migration) and physiology (e.g., metabolism) of marine organisms (Blaxter 1969). Thermal impacts are generally site-specific and depend upon the type of habitat and circulation at the discharge site. The thermal impacts of some West Coast plants have been large when discharge occurs either into bays and estuaries with reduced mixing or into the open coast where heated water quickly

contacts rocky habitats (Duke 2004a; Schiel et al. 2004; Foster 2005). Significant impacts to sensitive habitats, such as eelgrass and kelp, have been observed with some California power plants. However, heated water discharged offshore on the open coast experiences rapid mixing before touching benthic habitat, which likely results in little impact (CEC 2005). The water clarity of the receiving waters may also be diminished if the intake water is more turbid than that around the discharge structure. Water clarity and quality may also be altered by the increased dead organic matter in the discharge, as well as by scour if discharge occurs on shore (CEC 2005).

Other impacts to aquatic habitats may result from construction related activities, such as dewatering or dredging, as well as routine operation and maintenance activities. The effects of some of these activities are discussed elsewhere. 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 may cause turbidity, degraded water quality, noise, and substrate alterations. Power plants using once-through cooling may also periodically use biocides such as sodium hypochlorite and sodium bisulfate to clean the intake and discharge structures. Chlorine is extremely toxic to aquatic life. In addition, heat treatments are frequently used to control fouling organisms in the forebay area of OTC units. This kills the fish that remain in the forebay and the fouling invertebrate organisms along the tunnels and racks.

Potential Conservation Measures

- To the extent feasible, power plants should utilize cooling alternatives that avoid or minimize the use of river, estuary, or ocean water for cooling purposes. Alternatives such as dry cooling, closed-cycle wet cooling, utilizing recycled water for cooling water are more benign to EFH.
- 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.
- 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.
- 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 that 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.
- Regulate discharge temperatures (both heated and cooled effluent) such that they do not appreciably alter the temperature in a way that could cause a change in species assemblages and ecosystem function in the receiving waters. Strategies should be implemented to diffuse the heated effluent.
- Avoid the use of biocides (e.g., chlorine) to prevent fouling where possible. The least damaging antifouling alternatives should be implemented.
- 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. A habitat production foregone approach or equivalent habitat equivalency analysis should be used for determining mitigation.

- 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.

Pesticide use

Pesticides are a diverse group of chemicals that are broadly used to control unwanted organisms in agriculture and a range of non-agricultural uses (e.g., forestry, rights-of-way, horticulture, outdoor solid waste containers, irrigation ditches, stagnant water, households and domestic dwellings). They include fungicides, herbicides, insecticides, nematicides, molluscicides, rodenticides, fumigants, disinfectants, repellents, wood preservatives, and antifoulants among others. In Willapa Bay and Grays Harbor, two estuaries in Washington State, the insecticide carbaryl is often sprayed into the aquatic habitat to control burrowing shrimps that interfere with shellfish culture. Given this wide-spread use, pesticides are ubiquitous contaminants in the aquatic environment, and are known to adversely affect many types of organisms, including salmonids by either injuring or killing them, or by degrading the habitats upon which they depend.

Pesticides contain "active" ingredients that kill or otherwise affect targeted organisms (listed on the label). There are more than 900 active ingredients, and they must be registered under the Federal Insecticide, Fungicide, and Rodenticide Act. Registered pesticide products, known as formulations, typically contain active ingredients and a variety of "inert" or other ingredients which are generally not assessed for toxicity, although they are released into the environment. Examples may include chemical adjuvants to make pesticide products more efficacious, surfactants to reduce the interfacial, surface tension and increase uptake by the target, solvents, or other chemicals. Many of these ingredients have their own toxic properties that may result in adverse effects to salmon or their prey. Beginning in 2008, NMFS has issued three Opinions (NMFS 2008b; 2009b; 2010a) to the Environmental Protection Agency (EPA) on the registration of 18 pesticides, and is scheduled to complete consultation on 19 others by 2012. These Opinions determined that when applied according to the label instructions, many of these pesticides can have severe effects to individual and populations of threatened and endangered Pacific salmonids under NMFS' jurisdiction. The Opinions concluded that many of the pesticides analyzed present a limiting factor to the recovery of at least some of the 27 ESUs of Pacific Coast salmonids, and that application according to the labels would jeopardize the continued existence as well as adversely modify designated critical habitats of many of them. The following summary is drawn from the first two Opinions (NMFS 2008b; 2009b), which covered a total of six of the pesticides: chlorpyrifos, diazinon, malathion, carbaryl, carbofuran, and methomyl.

The risk analyses in the Opinions used existing literature to evaluate the effects of these pesticides on a number of important endpoints (survival, growth, reproduction, swimming, olfactory-mediated behaviors, and prey survival) and found strong evidence of adverse responses at concentrations that would be expected to occur in the habitats used by salmon. In off-channel habitats that are very important to juvenile salmonids, estimates of pesticide concentrations appeared to be especially high. The Opinions concluded the following:

- Direct, acute exposure to pesticides can kill salmonids. Monitoring data and modeling estimates show that some pesticides can reach lethal concentrations in some of the habitats used by salmon, especially in off-channel habitats.

- Acute or chronic exposure to sublethal concentrations of some active ingredients can lead to lower feeding success and likely results in reduced growth. Survival of juvenile salmonids has been correlated with growth rates, where lower growth rates result in lower survival.

- Salmonid prey are highly sensitive and affected by real-world exposures to many of the pesticides and mixtures of pesticides, particularly, neurotoxic insecticides. Aquatic habitats that are routinely exposed to certain pesticides showed reductions in the abundance and species diversity of the prey community, and reduced growth rates in juvenile salmon have been associated with low prey abundance.

- Exposure to real-world sublethal concentrations of some pesticides has been shown to impair swimming behavior in salmonids. Swimming speed, distance swam, and acceleration can be reduced after such exposure. The ecological consequences of aberrant swimming behavior are impaired feeding that translates into reduced growth, interrupted migratory patterns, survival, and reproduction.

- Definitive evidence supports that olfaction can be impaired by some pesticides at concentrations that are expected to occur in salmon habitats. Juveniles with impaired olfactory functions have been shown to more susceptible to predation, while adult spawning migration and mate detection can be affected by impaired olfaction.

- Mixtures of pesticides, including the ”inert/other” ingredients, can act in combination to increase the potential adverse effects to salmon and salmon habitat compared to exposure to a single ingredient

It is important to note that the potential for pesticides to adversely affect EFH depends on a variety of factors, and not every application will result in an adverse effect. The specific pesticide being applied, the application method and concentration, the distance from salmon habitat that the pesticide is applied, and the general pattern of pesticide use in the area will all affect the pesticide concentrations in the aquatic habitat. In addition the time of year and the species and life stages present are important considerations.

Potential conservation measures will vary depending on the specific pesticide being applied, the species and life stage in the area, and the time of year. In general, they include:

- Avoid the use of pesticides near aquatic habitats, if possible.
- Implement measures that reduce the need to apply pesticides, such as planting pest-resistant crops.
- Use less toxic alternatives to pesticides.
- Establish a minimum no-application buffer width.
- Install or establish a minimum non-crop vegetative buffer where no pesticides are applied.
- Maintain healthy riparian zones alongside salmon-bearing waters.
- Restrict applications under certain environmental conditions, such as during periods of high wind, rain, or wet soils.

Flood Control Maintenance

The protection of riverine and estuarine communities from flooding events can result in varying degrees of change in the physical, chemical, and biological characteristics of existing shoreline and riparian habitat. Land surrounding rivers is in high demand for agricultural and developmental purposes, prompting creation of artificial structures that improve flood control (SRSRB 2006). These structures include levees, weirs, channels, and dikes.

Potential Adverse Effects

Managing flood flows with these structures can disconnect a river from its floodplain eliminating off-channel habitat important for salmon (WSCC 2001b) Floodplains serve as a natural buffer to changes in water flow: they retain water during periods of higher flow and release it from the water table during reduced flows (Ziemer and Lisle 2001). These areas are typically well vegetated, lowering water temperatures, regulating nutrient flow and removing toxins. Juvenile salmon use these off channel areas because their reduced flows, greater habitat complexity and shelter from predators may increase growth rates and their chance of survival.

Artificial flood control structures have similar effects on aquatic habitat, as do bank stabilization efforts and woody debris removal. Riverbanks are artificially steepened, eliminating much of the inshore, shallow-water habitat used by larval and juvenile salmonids. Channel complexity is also lost, reducing naturally formed pool-riffle sequences (NMFS 2008c). Pools provide deepwater habitat for larger fish, as well as thermal and spatial refugia during low flow periods. Riffles support benthic invertebrates and juvenile fishes (Thompson 2002). The woody debris that provides shelter and helps structure heterogeneous flows is also lost (USFWS 2000). As a result, water moves at a uniform, increased rate, thereby decreasing spawning habitat and altering sediment dynamics. Sediment size distribution is important for providing habitat to salmonid prey items such as stoneflies and mayflies (NMFS 2009z). In addition, the routing of water through specific flood channels may isolate or strand migrating salmon. Earthen levees can be prone to failure due to cracks caused by rooting plants, and may thus be periodically cleared or stripped of vegetation, leaving denuded banks and barren riparian zones. This leads to decreased shading, higher water temperatures, less large woody debris recruitment, reduced filtering of overland nutrients, sediment, and toxics, and a loss of bank stability.

The use of dikes and berms can also have long-term adverse effects in tidal marsh and estuarine habitats. 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, 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.

Potential Conservation Measures

- Minimize the loss of riparian habitats as much as possible.
- The diking and draining of tidal marshlands and estuaries should not be undertaken unless a satisfactory compensatory mitigation plan is in effect and monitored.
- Wherever possible, “soft” approaches (such as beach nourishment, vegetative plantings, and placement of large woody debris) to shoreline modifications should be utilized.

- 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.
- Construct a low-flow channel to facilitate fish passage and help maintain water temperature in reaches where water velocities require armoring of the riverbed.
- Replace in-stream fish habitat by providing rootwads, deflector logs, boulders, and rock weirs and by planting shaded riverine aquatic cover vegetation.
- Use an adaptive management plan with ecological indicators to oversee monitoring and ensure mitigation objectives are met. Take corrective action as needed.
- Retain trees and other shaded vegetation along earthen levees.
- Screen inappropriate flood control channels.
- Ensure adequate inundation time for floodplain habitat that activates and enhances near-shore habitat for juvenile salmon.
- Ramp and convey flood flows appropriately to reduce stranding events.
- Reconnect wetlands and floodplains to channel/tides.

Culvert construction

Culvert construction, maintenance, and replacement are common activities occurring in Pacific Coast salmon habitat, typically—but not always—associated with roads. Culverts convey water from upslope portions of terrain to downslope areas, thereby minimizing the risk of flooding, erosion, and undesired impacts to infrastructure and habitat. In the past, however, many culverts were constructed too small to convey large flow events, too steep to allow adequate fish passage, or without other physical characteristics to avoid the impacts to habitat and species that are now recognized to be significant problems.

Regulatory requirements under the ESA and MSA, as well as best practices developed by states, counties, tribes, and federal agencies, have established a suite of construction, maintenance, and replacement actions to minimize adverse impacts to habitats and species. Habitat restoration programs have provided support for installation of "fish friendly" culverts, and the state of the art culvert is typically an open-bottom arched culvert that is designed to better mimic a natural stream bed.

Amendment 14 includes culvert construction and maintenance under the Road Building and Maintenance section. However, the effects and conservation recommendations are cursory. Any revisions to Pacific Coast salmon EFH would benefit from an updated stand-alone section on culvert effects and conservation recommendations.

Potential Adverse Effects

The physical and chemical components to culvert construction that lead to potential adverse habitat impacts include slope, jump height, lack of instream structure, contaminants, and water velocity. These can lead to compromised fish passage, lethal and sublethal effects to individuals, and loss of ecological connectivity (Castro 2003; NMFS 2008b). Culverts may pose significant barriers to migration in salmon habitat. Road crossings are a common bottleneck to migrating adult salmon, as many employ faulty or poorly designed culverts (Chestnut 2002). For example, if a culvert is too small compared to the surrounding river, water velocities will increase rapidly via a Venturi effect. Debris will not readily flow through the culvert, eventually clogging it and making fish passage even more difficult. This blockage also prevents woody debris from reaching lower stretches of the stream, removing valuable fish habitat.

The slope of a culvert can affect fish passage directly by providing conditions that lead to excessive water velocity. This can create a passage barrier to upstream migrating fish. Velocities greater than one

foot per second (fps) can create a barrier for juvenile salmon, regardless of the culvert length. For adult passage, velocities can range between two and six fps, depending on culvert length (NMFS 2001).

Excessive water velocity also can cause scouring at the downstream end of a culvert leading to a "perched" culvert requiring migrating fish to jump just to access the culvert. A perched situation can also occur when a culvert is simply placed too high and dries out during periods of low flow, or is placed too far above the stream at the outflow, thereby preventing fish from accessing it or safely exiting (Sylte 2002; Flanders 2000). NMFS (2008a) states that there should ideally be no difference in water height between water inside a culvert and water in the adjacent stream; and offers criteria for maximum jump heights.

Culverts can also impact a stream's geomorphology by trapping sediment above the culvert and increasing erosion below through a process called downcutting (Castro 2003; Wheeler et al. 2005). Downstream scour of stream bed and banks often occurs when large flow events through inadequately-sized culverts create a fire hose effect, mobilizing sediment and potentially eroding stream banks. This situation not only introduces excess sediment into the stream (potentially smothering redds), but also can remove riparian vegetation, a vital component of salmonid habitat. These physical changes can impact the entire lotic system, particularly harming macroinvertebrates that are prey for salmon (Vaughan 2002).

Numerous other effects resulting from the presence of culverts have been identified. These include loss of ecological connectivity, loss of (or excessive) transport of sediment and woody debris downstream, loss of spawning or rearing habitat, and effects to benthic invertebrates and aquatic vegetation (. et al 2003). It is important to remember that various culvert characteristics can act synergistically, even when one factor alone isn't enough to adversely affect habitat. For example, a too-steep slope can be mitigated by the presence of instream structure that allows for resting pockets and serves to slow water velocity. However, a too-steep slope plus lack of instream structure can make a culvert less passable for fish than if only one of those conditions existed.

The cumulative effects of multiple culverts in a stream system and multiple adverse elements associated with each culvert can increase the physiological stress of migrating salmon and may lower the probability of successful passage and subsequent adult spawning.

Potential Conservation Recommendations

NMFS (2001), Bates et al. (2003), and NMFS (2008a) offer design criteria that address the effects listed above. These criteria are often incorporated into conservation recommendations for individual projects, in ESA and EFH consultations, and could be used to develop a general suite of conservation recommendations germane to culvert construction.

- In instances where culverts are used to bridge stream crossings, specific engineering care should be given to maintain the stream's ecological function including use of alternative designs such as Active Channel Design, Stream Simulation Design and Hydraulic Design.
- Where applicable, baffles, weirs, and resting pools should be established to create hydraulic refuges for upstream migrating fish.
- Water velocities and jump heights should not exceed the swimming performance of critical life stages for Pacific salmon (adult or juvenile) or be increased beyond NMFS's culvert specific passage criteria.
- Regular maintenance should be conducted to ensure culverts remain clear of debris, operable, and have suitable hydraulic conditions.
- Where applicable, alternatives to culverts (such as bridges) should be explored.

Climate change

Human activities that emit greenhouse gases (GHG) such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases contribute to a changing climate. Global climate change is correlated to the residence time of these compounds in the atmosphere and their ability to warm the planet. Examples of human activities that contribute to GHG emissions include burning fossil fuels, deforestation, and land development. While climate change remains controversial and future conditions rely on mathematical models, strong evidence suggests the direction climate change will take and the effects it can have on Pacific salmon species (Zabel et al. 2006; ISAB 2007).

Pacific Northwest temperatures have increased by about 0.8° C, and models project warming of 2.0° C by the 2040s and 3.3° C by the 2080s (Mote and Salathé 2009). Precipitation is also projected to increase with a more intense seasonal cycle - autumns and winters may become wetter and summers may become drier. Regional climate models indicate that overall extreme precipitation in western Washington will increase and the snowpack in the Cascades will decrease (Mote and Salathé 2009).

These climate changes will likely have widespread impacts on Pacific salmon throughout their native range (Battin et al. 2007; ISAB 2007). Decreased summer precipitation could reduce spawning habitat for salmon populations that have already experienced habitat loss from impassable barriers. Winter precipitation increases causing a higher frequency of flooding that would scour eggs and larvae from the riverbed. Adult salmon that prefer slow moving pools would also see a decrease in this type of habitat. High winter flows may also degrade valuable estuarine zones through pollution, variable freshwater influx and physical disturbance. As the climate warms and regional snowpacks would reduced, snow fed streams would become more reliant on rainfall, and cold water flows that support salmonid growth and survival, freshwater ecosystems and human water supplies would be affected (Mote et al. 2003; Climate Impacts Group 2004). Warmer temperatures will likely also melt snow packs earlier and would change the timing of juvenile emigration from freshwater habitats (ISAB 2007). Changes in snowpack would further alter flow patterns leading to intensified summer droughts and reduced habitat for rearing and migrating juvenile salmon (Battin et al. 2007; Luce and Holden 2009).

Regional models also predict increase water temperatures throughout salmon habitats (ISAB 2007). Warmer water may cause salmon to experience direct mortality, become more susceptible to disease and contaminants or encounter decreased populations of freshwater prey items. Existing impassable barriers prevent salmon from reaching cool water spawning areas found at higher elevations. This problem would be exacerbated if the limited number of currently accessible cold-water spawning habitat areas were eliminated due to increased temperatures. Additionally, water temperature increases would also affect water chemistry by reducing dissolved oxygen levels. In the marine environment, increased water temperatures would promote stratification between warmer surface waters and cooler, nutrient rich deep waters. The resulting thermocline could prevent nutrient cycling between regions diminishing growth of phytoplankton that form the base of marine food webs (Climate Impacts Group 2004; Scheuerell and Williams 2005). Without this food source, fewer juvenile salmon would be able to reach maturity.

The ocean is a major sink for atmospheric CO_2, and changes in atmospheric concentrations will affect oceanic conditions. Specifically, as the level of CO_2 in the atmosphere increases, it will dissolve more readily in the ocean, increasing the concentration of carbonic acid and lowering the pH of seawater. This change may not directly harm salmon, as they are able to survive lower pH in freshwater habitat, but their ecosystem may be far less productive. Planktonic organisms that form the base of many marine food webs secrete $CaCO_3$ shells necessary for survival. Lower pH will dissolve or prevent the formation of these shells causing mortality (Orr et al. 2005). Juvenile salmon rely on plankton as a food

source and decreased plankton abundance could affect salmon growth and survival. Changing ocean temperatures may later salmon behavior, distribution and migrations (ISAB 2007).

Future climate scenarios predict increased fire frequency and intensity in western North America (ISAB 2007). Drought, and hot, dry weather will result in an increase in outbreaks of insects, which will affect forest and watershed health. Finally, climate change is expected to increase the demand placed on already-limited sources of water, increasing the conflict between meeting the needs of humans and those of salmon (Miles et al. 2000). Streams may be diverted more frequently for drinking, irrigation, frost protection or other purposes as human populations continue to increase along the Pacific Coast (Vicuna et al. 2007).

Recommendation

The Panel recommends that the Council give further consideration to updating the non-fishing threats to EFH contained in Amendment 14, adding the newly identified threats described above, and developing conservation recommendations for each threat.

5. INFORMATION AND RESEARCH NEEDS

This report and Amendment 14 identified the following information and research needs:

1. Improve fine scale mapping of salmon distribution to inform future reviews of EFH for Pacific Coast salmon and aid in more precise and accurate designation of EFH and the consultation process. Potential approaches include, but are not limited to:

    a. Develop distribution data at the 5th or 6th HUs, across the geographic range of these species.

    b. Develop habitat models that can be used to predict suitable habitat, both current and historical, across the geographic range of these species.

    c. Develop seasonal distribution data at a 1:24,000 or finer scale.

2. Improve data on habitat conditions across the geographic range of Pacific Coast salmon to help refine EFH in future reviews.

3. Improve data on marine distribution of Pacific Coast salmon, and develop models to predict marine distribution to inform revisions to EFH in future reviews.

4. Improve data on the potential adverse effects of fishing gear on the EFH of Pacific Coast salmon.

5. Advance the understanding of how a changing climate, can affect Pacific Coast salmon.

Recommendation

The Panel recommends further consideration of the information and research needs for refining EFH during the next review, based on the data gaps identified in this review and Amendment 14.

6. 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.

Abbott, R. and E. Bing-Sawyer. 2002. Assessment of pile driving impacts on the Sacramento blackfish (*Othodon microlepidotus*). Draft report prepared for Caltrans District 4.

Able, K.W., J.P. Manderson, and A.L. Studholme. 1998. The distribution of shallow water juvenile fishes in an urban estuary: the effects of man-made structures in the lower Hudson River. Estuaries 21:731-744.

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.

Bates, K., B. Barnard, B. Heiner, J.P. Klavas, and P.D. Powers. 2003. Design of road culverts for fish passage. Washington Department of Fish and Wildlife, Olympia, WA. 112pp.

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(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., E. Beamer, and L. Wasserman. 1994. Estimating coho salmon rearing habitat and smolt production losses in a large river basin, and implications for restoration. North American Journal of Fisheries Management 14:797-811.

Beechie, T.J., B.D. Collins, and G.R. Pess. 2001. Holocene and recent geomorphic processes, land use, and fish habitat in two Puget Sound watersheds. 37-54 *In* J.M. Dorova, D.R. Montgomery, B. Palcsak, and F. Fitzpatrick, editors. Geomorphic processes and riverine habitat. American Geophysical Union, Washington, D.C.

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.

Bellinger, Renee M. 2009. Mixed stock analysis of salmon in Pacific whiting (hake) bycatch collected shoreside in Newport, Oregon, preliminary report. Coastal Oregon Marine Experiment Station. Newport, Oregon.

Bergman, P. S. 2010. Annotated bibliography for 2010 Essential Fish Habitat update. Cramer Fish Sciences. Auburn, CA.

Bi, H., R.E. Ruppel, W.T. Peterson, and E.Casillas. 2008. Spatial distribution of ocean habitat of yearling Chinook (Oncorhynchus tshawytscha) and coho (Oncorhynchus kisutch) salmon off Washington and Oregon, USA. Fisheries Oceanography 17: 463–476.

Bilby, R.E., and P.A. Bisson. 1998. Function and distribution of large woody debris in streams. Pages 324-346 *in* R.J. Naiman and Bilby R.E., editors. River ecology and management: lessons from the Pacific Coastal Ecoregion. Springer-Verlag, New York.

Blackmon, D., T. Wyllie-Echeverria, and D.J. Shafer. 2006. The role of seagrasses and kelps in marine fish support. Wetlands Regulatory Assistance Program ERDC TNWRAP-06-1. February 2006.

Blaxter, J.H.S. 1969. Development: Eggs and larvae. p. 177-252 *In:* W.S. Hoar, Randall, D.J., Conte, F.P., eds. Fish Physiology. New York, NY: Academic Press, Inc.

Boehlert, G. W, G. R. McMurray, and C. E. Tortorici (editors). 2008. Ecological effects of wave energy in the Pacific Northwest. U.S. Dept. Commerce, NOAA Tech. Memo. NMFS-F/SPO-92, 174 p.

Boehlert, G.W. and A.B. Gill. 2010. Environmental and ecological effects of ocean renewable energy development: a current synthesis. Oceanography 23(2) 68-81.

BOR (Bureau of Reclamation). 2007. Letter from Preston Sleeger, Regional Environmental Officer, to NMFS transmitting comments on Federal Register notice on the proposed rule for essential fish habitat descriptions for Pacific salmon (FR 72 19862 April 20, 2007). June 19, 2007.

BOR and WDOE (Washington Department of Ecology). 2010. Draft environmental impact statement: Cle Elum Dam fish passage facilities and fish reintroduction project. Washington Ecology Publication No. 09-12-018. Available at: http://www.usbr.gov/pn/programs/eis/cle-elum/cle-elum-draft-eis.pdf.

BOR. 2008. Cle Elum and Bumping Lake Dams fish passage facilities planning report – draft. Storage dams fish passage study Yakima Project, Washington. Pacific Northwest Region. September 2008. Available at: http://www.usbr.gov/pn/programs/ucao_misc/fishpassage/planningreports/draftplanningreport.pdf.

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.

Brandes, P.L. and J S. McLain. 2001. Juvenile Chinook salmon abundance, distribution, and survival in the Sacramento-San Joaquin Estuary. California Fish and Game 179:39-136.

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. Transactions of the American Fisheries Society 117: 546-551.

Bulleri, F. and M.G. Chapman. 2010. The introduction of coastal infrastructure as a driver of change in marine environments. *Journal of Applied Ecology* 47: 26-53.

Burdick, D. M. and Short, F.T. 1999. The effects of boat docks on eelgrass beds in coastal waters of Massachusetts. Environmental Management 23(2): 231-240.

Bustard, D.R. and D.W. Narver. 1975. Aspects of the winter ecology of juvenile coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*Salmo gairdneri*). Journal of the Fisheries Research Board of Canada 32:667-680.

Callahan Grant, M. 2008. Personal communication regarding NOAA Restoration Center derelict net removal activities on the Columbia River, Oregon.

Caltrans. 2001. Fisheries impact assessment, pile installation demonstration project for the San Francisco - Oakland Bay Bridge, east span seismic safety project. 59 p

Carter, L., Burnett, D., Drew, S., Marle, G., Hagadorn, L., Bartlett-McNeil, D., and Irvine, N. 2009. Submarine cables and the oceans-connecting the world. The United Nations Environment Programme World Conservation Monitoring Centre (UNEP_WCMC) Biodiversity Series No. 31. 64p.

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.

CDFG. 1998. A status review of the spring-run Chinook salmon (*Oncorhynchus tshawytscha*) in the Sacramento River drainage. Candidate Species Report 98-01.

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 at: http://www.dfg.ca.gov/nafwb.cohorecovery. (December 2009).

CEC (California Energy Commission). 2005. Issues and Environmental Impacts Associated with Once-Through Cooling at California's Coastal Power Plants. Staff Report in support of the 2005 Environmental Performance Report and 2005 Integrated Energy Policy Report.

Cederholm, C.J. and W.J. Scarlett. 1982. Seasonal immigration of juvenile salmonids into four small tributaries of the Clearwater rivers, Washington, 1977-1981. Pages 98-110 *in* E.L. Brannon and E.O. Salo, editors. Salmon and trout migratory behavior symposium, June 3-5, 1981. University of Washington, Seattle, WA.

Chapman, D.W. and E. Knudsen. 1980. Channelization and livestock impacts on salmonid habitat and biomass in western Washington. Transactions of the American Fisheries Society 109: 357-363.

Chestnut, T. J. 2002. A review of closed bottom stream crossing structures (culverts) in fish-bearing streams in the Kamloops Forest District, June 2001. Canadian Manuscript Report of Fisheries and Aquatic Science 2602.

Climate Impacts Group. 2004. Overview of Climate Change Impacts in the U.S. Pacific Northwest. University of Washington. Seattle,WA

Cohen, A.N., Calder, D.R., Carlton, J.T., Chapman, J.W., Harris, L.H., Kitayama, T., Lambert, C.C., C. Piotrowski, M. Shouse, and L.A. Solorzano. 2005. Rapid assessment shore survey for exotic species in San Francisco Bay-May 2004. Final Report for the California State Coastal Conservancy, Association of Bay Area Governments/San Francisco Bay-Delta Science Consortium, National Geographic Society and Rose Foundation. San Francisco Estuary Institute, Oakland, CA.

Collins, B. D., D. R. Montgomery, and A. J. Sheikh. 2003. Reconstructing the historical riverine landscape of the Puget lowland. Pages 79-128 *in* D. R. Montgomery, S. Bolton, D. B. Booth, and L. Wall, editors. Restoration of Puget Sound Rivers. University of Washington Press, Seattle, WA.

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.

Cowardin, L. M., V. Carter, F. C. Golet, E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U. S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/1998/classwet/classwet.htm (Version 04DEC98).

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. North American Journal of Fisheries Management 13: 96-102.

Dethier, M. N. 1990. A marine and estuarine habitat classification system for Washington State. Washington Natural Heritage Program, Department of Natural Resources, Olympia, Washington.

Drucker, E.G. 2006. Skykomish River braided reach restoration assessment: fish use analysis. Draft final report, June 28, 2006, prepared by Washington Trout for Snohomish County Surface Water Management, Everett, WA.

Duffy-Anderson, J.T. and 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. (http://link.springer.de/link/service/journals/00227/index.htm)

Duke (Duke Energy South Bay, LLC). 2004a. Duke Energy South Bay Power Plant - SBPP cooling water system effects on San Diego Bay Volume I: Compliance with Section 316(a) of the Clean Water Act for the South Bay Power Plant. Duke Energy South Bay, LLC, Chula Vista.

Ebersole, J. L., W.J. Liss, and C. A. Frissell, 2003. Cold water patches in warm streams: Physicochemical characteristics and the Influence of shading. Journal of the American Water Resources Association 39(2):355-368.

Ebersole, J.L., Colvin, M.E., Wigington, P.J., Leibowitz, S.G., Baker, J.P., Church, M.R., Compton, J.E., Cairns, M.A. 2009. Hierarchical modeling of late-summer weight and summer abundance of juvenile coho salmon across a stream network. Transactions of the American Fisheries Society 138(5): 1138–1156.

Ebersole, J.L., Wigington, P.J., Baker, J.P., Cairns, M.A., Church, M.R., Hansen, B.P., Miller, B.A., LaVigne, H.R., Compton, J.E., Leibowitz, and S.G. 2006. Juvenile coho salmon growth and survival across stream network seasonal habitats. Transactions of the American Fisheries Society 135(6): 1681–1697.

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.

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.

EPRI (Electric Power Research Institute). 2007. Assessment of cooling water intake structure impacts to California coastal fisheries. EPRI, Palo Alto, CA.

Ettlinger, E., D. Morrell, A. Wolf, and G.M. Andrew. 2010. Lagunitas Creek salmon spawner survey report 2009-2010. Marin Municipal Water District, Corte Madera, CA.

Feist, B. E., J.J. Anderson, and R. Miyamota. 1992. Potential impacts of pile driving on juvenile pink *(Oncorhynchus gorbuscha)* and chum *(O. keta)* salmon behavior and distribution. Fisheries Research Institute, School of Fisheries, University of Washington. Seattle, Washington.

FERC. 2010. Biological assessment and essential fish habitat assessment for the Oregon LNG terminal and pipeline project. October, 2010. Office of Energy Projects, Washington, DC.

FHWG (Fisheries Hydroacoustic Working Group). 2008. Agreement in principal for interim criteria for injury to fish from pile driving activities. Memorandum of agreement between NOAA Fisheries' Northwest and Southwest Regions; USFWS Regions 1 and 8; California, Washington, and Oregon Departments of Transportation; California Department of Fish and Game; and Federal Highways Administration. June 12, 2008.

Flanders, L.S. and 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.

Foster, M. 2005. An assessment of the studies used to detect impacts to marine environments by California's coastal power plants using once-through cooling: A plant by plant review. Prepared for the California Energy Commission.

Foster, M. S. and D. R. Schiel. 1985. The ecology of giant kelp forests in California: A community profile, U. S. Fish Wildlife Service Biological Report 85(7.2).

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.

Francisco, M.D. 1995. Propeller scour and sediment remediation at the Seattle waterfront. M.S. thesis, University of Washington, Seattle, Washington.

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.

Gill, A.B. 2005. Offshore renewable energy: ecological implications of generating electricity in the coastal zone. Journal of Applied Ecology 42: 605-615

Glasby, T.M. 1999a. Differences between subtidal epibiota on pier pilings and rocky reefs at marinas in Sydney, Australia. Estuarine, Coastal, and Shelf Science. 48: 281-290.

Glasby, T.M. 1999b. Effects of shading on subtidal epibiotic assemblages. Journal of Exp. Mar. Biol. and Ecol. 234:275-290.

Goniea, T.M., Keefer, M.L., Bjornn, T.C., Peery, C.A., Bennett, D.H., Stuehrenberg, and L.C. 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(2): 408-419.

Good, J.W. 2000. Summary and current status of Oregon's estuarine ecosystems. Section 3.3, Estuarine Ecosystems. Oregon Progress Board, Salem. Available at: http://egov.oregon.gov/DAS/OPB/docs/SOER2000/Ch3_3a.pdf

Gresh, T., J. Lichatowich, and P. Schoonmaker. 2000. An estimation of historic and current levels of salmon production in the Northeast Pacific ecosystem: evidence of a nutrient deficit in the freshwater systems of the Pacific Northwest. Fisheries 25(1):15-21.

Grimes, C.B. 1975. Entrapment of fishes on intake water screens at a steam electric generating station. Chesapeake Science 16: 172-177.

Haas, M.A., C.A. Simenstad, Jr., J.R. Cordell, D.A. Beauchamp, and 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).

Haertel, L. and C. Osterberg. 1967. Ecology of zooplankton, benthos and fishers in the Columbia River Estuary. Ecology 48(3):459-472.

Hanson, C.H., J.R. White, and H.W. Li. 1977. Entrapment and impingement of fishes by power plant cooling water intakes: an overview. Marine Fisheries Review 39:7-17.

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.

Hastings, K., P. Hesp, and G.A. Kendrick. 1995. Seagrass loss associated with boat moorings at Rottnest Island, Western Australia. Ocean and Coastal Management 26:225-246.

Hastings, M. C., and A. N. Popper. 2005. Effects of sound on fish. Prepared for Jones & Stokes under California Department of Transportation Contract No. 43A0139. Sacramento, CA.

Helfman, G.S. 1981. T he advantage to fish of hovering in shade. Copeia(2):392-400.

Helvey, M. 1985. Behavioral factors influencing fish entrapment at offshore cooling-water intakestructures in southern California. Marine Fisheries Review 47:18-26.

Helvey, M. and P.B. Dorn. 1987. Selective removal of reef fish associated with an offshore cooling-water intake structure. Journal of Applied ecology 24:1-12.

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.

Hightower, M. M., L. Gritzo, A. Luketa-Hanlin, J. Covan, S. Tieszen, G. Wellman, M. Irwin, M. Kaneshige, B. Melof, and C. Morrow. 2004. Guidance on risk analysis and safety Implications of a large liquefied natural gas (LNG) spill over water. SAND2004-6258. Sandia National Laboratories, Albuquerque, NM. December 2004.

Horton, G. 1994. Effects of jet boats on salmonid reproduction in Alaskan streams. Master's thesis. University of Alaska, Fairbanks, Alaska.

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.

ISAB (Independent Scientific Advisory Board). 2007. Climate change impacts on Columbia River basin fish and wildlife. ISAB, Report 2007-2, Portland, Oregon. Available online at: http://www.nwcouncil.org/library/isab/ISAB%202007-2%20Climate%20Change.pdf.

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 Fish 85: 119-125.

Jay, D.A. and C.A. Simenstad. 1996. Downstream Effects of Water Withdrawal in a Small, High-Gradient Basin: Erosion and Deposition on the Skokomish River Delta. Estuaries 19:501-517.

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.

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.

Johnson, L., S.Y. Sol, G.M. Ylitalo, T. Hom, B. French, O.P. Olson, and T.K. Collier. 1999. Reproductive Injury in English Sole (*Pleuronectes vetulus*) from the Hylebos Waterway, Commencement Bay, Washington. Journal of Aquatic Ecosystems Stress and Recovery 6:289-310.

Johnston, C.A. 1994. Cumulative impacts to wetlands. Wetlands 14(1):49-55.

Kahler, T., M. Grassley, and 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. Available at: kitsapgov.com/dcd/lu_env/cao/bas/wetlands/bellevue_bas.pdf. (January 2010).

Koski, K. V. 2009. The fate of coho salmon nomads: the story of an estuarine-rearing strategy promoting resilience. Ecology and Society 14: 4.

Kramer, S., M.Previsic, P. Nelson, and S.Woo. 2010. Re Vision DE-003: Deployment effects of marine renewable energy technologies-framework for identifying key environmental concerns in marine renewable energy projects. U.S. Department of Energy, Advanced Waterpower Program. 93p.

Langford, T.E., N.J. Utting, R.H.A. Holmes. 1978. Factors affecting the impingement of fishes on power station cooling-water intake screens. Pages 281-288 *in* D.S. McLusky, Berry, A.J., editors. Physiology and Behaviour of Marine Organisms. Pergamon Press. New York, NY.

Leidy, R.A. 2007. Ecology, assemblage structure, distribution, and status of fishes in streams tributary to the San Francisco Estuary, California. San Francisco Estuary Institute, Contribution No. 530. Oakland, CA.

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.

Longmuir, C. and T. Lively. 2001. Bubble curtain systems for use during marine pile driving. Report by Fraser River Pile and Dredge Ltd. New Westminister, British Columbia.

Luce, C. H.,and Z. A. Holden (2009), Declining annual streamflow distributions in the Pacific Northwest United States, 1948–2006, *Geophys. Res. Lett.*, 36, L16401, doi:10.1029/2009GL039407.

Luketa, A., M.M. Hightower, and S. Attaway. 2008. Breach and safety analysis of spills over waters from large liquefied natural gas carriers. SAND2008-3153. Sandia National Labortory, Albuquerque, NM. May 2008.

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 (*Oncorhynchus tshawytscha*). Canadian Journal of Fisheries and Aquatic Sciences 45: 1366-1377.

Magnusson, A. and 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.

Merz, J. 2001. Association of fall-run Chinook salmon redds with woody debris in the Lower Mokelumne River, Califronia. California Fish and Game 87:51-60.

Mesa, M.G., L.K. Weiland, and P. Wagner. 2002. Effects of acute thermal stress on survival, predator avoidance, and physiology of juvenile fall Chinook salmon. Northwest Science 76(2): 118-128.

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 the American Water Resources Association 36:399-420.

Miller, B.A. and S. Sadro. 2003. Residence time and seasonal movements of juvenile coho salmon in the ecotone and lower estuary of Winchester Creek, South Slough, Oregon. Transactions of the American Fisheries Society, 132(3): 546-559.

Moazzam, M. and S.H.N. Rizvi. 1980. Fish entrapment in the seawater intake of a power plant at Karachi coast. Environmental Biology of Fish 5:49-57.

Montgomery, D.R., and J.M. Buffington. 1998. Channel processes, classification, and response. Pages 13-42 *in* B.E. Bilby and R.J. Naiman, editors. River ecology and management: lessons from the Pacific coastal ecoregion. Springer-Verlag, New York.

Montgomery, D.R., E.M. Beamer, G. Pess, and T.P. Quinn. 1999. Channel type and salmonid spawning distribution and abundance. Canadian Journal of Fisheries and Aquatic Sciences 56: 377-387.

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.

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.

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.

Mote, P.W. and E.P. Salathé , Jr. 2009. Future climate in the Pacific Northwest. P. 21-43. In: The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate. Climate Impacts Group, University of Washington, Seattle.

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.

Nelson P.A., D. Behrens, J. Castle, G. Crawford, R.N. Gaddam, .SC. Hackett, J. Largier, D.P. Lohse, K.L. Mills, P.T. Raimondi, M. Robart, W.J. Sydeman, S.A. Thompson, and S. Woo. 2008. Developing Wave Energy In Coastal California: Potential Socio-Economic And Environmental Effects. California Energy Commission, PIER Energy-Related Environmental Research Program & California Ocean Protection Council CEC-500-2008-083. 165 p.

Nightingale, B. and 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.

NMFS. 2006. Guidance to refine the description and identification of essential fish habitat. Memo to NMFS Regional Administrators, from Pat Montanio, Director, Office of Habitat Conservation to NMFS Regional Administrators. October 30, 2006.

NMFS. 2007a. 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, and CA. 48 pp. Available: http://swr.nmfs.noaa.gov/salmon/MSRA_RecoveryPlan_FINAL.pdf.

NMFS. 2007b. Letter from Rodney McInnis, Regional Administrator, NMFS Southwest Region, to FERC transmitting NMFS' modified prescriptions for pishways and alternatives analysis for the Klamath Hydroelectric Project (FERC Project No. 2082). January 26, 2007.

NMFS. 2008a. Anadromous salmonid passage facility design. NMFS, Northwest Region, Portland, Oregon. NMFS. 2008a

NMFS. 2008b. Endangered Species Act section 7 consultation: biological opinion on Environmental Protection Agency registration of pesticides containing chlorpyrifos, diazinon, and malathion (Biological Opinion). Silver Spring, Maryland. U.S. Department of Commerce. NMFS. 2008b

NMFS. 2008c. Endangered Species Act section 7 consultation: biological opinion on the Federal Columbia River power system biological opinion. Portland, Oregon. U.S. Department of Commerce. Available: http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/final-BOs.cfm. NMFS. 2008b

NMFS. 2008d. Endangered Species Act section 7 consultation: biological opinion on theFederal Columbia River power system. Available at: http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/final-BOs.cfm .

NMFS. 2008d. Impacts to marine fish habitat from nonfishing activities in the northeastern United States. NOAA Technical Memorandum NMFS-NE-209. U.S. Department of Commerce, Gloucester, MA. NMFS. 2008

NMFS. 2009 b. Endangered Species Act section 7 consultation: biological opinion on Environmental Protection Agency registration of pesticides containing carbaryl, carbofuran, and methomyl. (Biological Opinon). Silver Spring, Maryland. U.S. Department of Commerce.

NMFS. 2009a. Endangered Species Act section 7 consultation: biological opinion and conference opinion on the long-term operations of the Central Valley Project and State Water Project. Sacramento, California. U.S. Department of Commerce.

NMFS. 2009c. 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).

NMFS. 2010a. Endangered Species Act section 7 consultation: biological opinion on Environmental Protection Agency registration of pesticides containing azinphos methyl, bensulide, dimethoate, disulfoton, ethoprop, fenamiphos, naled, methamidophos, methidathion, methyl parathion, phorate and phosmet. Silver Spring, Maryland. U.S. Department of Commerce.

NMFS. 2 010b. Endangered Species Act section 7 consultation: biological opinion on the Operation of the Klamath Project between 2010 and 2018. National Marine Fisheries Service, Southwest Region. March 2010.

NMFS. 2005b. Pacific Coast Groundfish management plan essential fish habitat designation and minimization of adverse impacts. Final Environmental Impact Statement. National Marine Fisheries Service Northwest Region. 7600 Sand Point Way NE, Seattle Washington. December 2005.

NMFSa. 2005. Designation of critical habitat for West Coast salmon and steelhead Final 4(b)(2) report. August 2005. Available at: http://www.nwr.noaa.gov/1salmon/salmesa/crithab/CHsite.htm

NRC (National Research Council). 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. National Academy Press. Washington, D.C.

NWF (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.

NWFSC. 2009. Northwest Fisheries Center. Data report and summary analyses of the U.S. West Coast non-nearshore fixed gear groundfish fishery. West Coast Groundfish Observer Program. NWFSC, 2725 Montlake Blvd E., Seattle, WA 98112.

NWSI (Northwest Straits Initiative). 2010. Northwest Straits Initiative derelict gear removal program. Online at: http://www.derelictgear.org/, and http://www.derelictgear.org/Progress/ARRA-Project.aspx

Olson, A.M., Visconty, S.V., Witherspoon, B.W. (II), Sweeny, K., Thom, R.M., Shreffler, D.K. 1997. Light environment and eelgrass shading around three WSDOT ferry terminals. Pp.52-74 in Simenstad, C.A.,

Orr, J.C., V.J. Fabry, and O. Aumont, 2005. Anthropogenic ocean acidification over the twenty-first century and its impact on calcifying organisms. Nature 437: 681-686.

Pess, G., D.R. Montgomery, T.J. Beechie, and L. Holsinger. 2003. Anthropogenic alterations the biogeography of Puget Sound salmon. Pages 129-154 *in* D.R. Montgomery, S. Bolton, D.B. Booth, and L. Wall, editors. Restoration of Puget Sound rivers. University of Washington Press. Seattle, WA.

Pess, G.R., D.R. Montgomery, E.A. Steel, R.E. Bilby, B.E. Feist, and H.M. Greenberg. 2002. Landscape characteristics, land use, and coho salmon (*Oncorhynchus kisutch*) abundance, Snohomish River, Wash., U.S.A. Canadian Journal of Fisheries and Aquatic Sciences 59:613-623.

Peterson, N. P. 1982. Immigration of juvenile coho salmon (*Oncorhynchus kisutch*) into riverine ponds. Canadian Journal of Fisheries and Aquatic Sciences 39:1308-1310

Peterson, W.T., C.A. Morgan, J.P. Fisher, and E. Casillas. 2010. Ocean distribution and habitat associations of yearling coho (*Oncorhynchus kisutch*) and Chinook (*O. tshawytscha*) salmon in the northern California Current. Fisheries Oceanography 19: 508-525.

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. Newport, OR: Northwest Fisheries Science Center, Newport Research Station. Available at: *http://www.nwfsc.noaa.gov/research/divisions/fed/ecosysrep.pdf*.

PFMC (Pacific Fishery Management Council). 1999. Identification and description of essential fish habitat, adverse impacts, and recommended conservation measures for salmon. Appendix A to Amendment 14, Pacific Coast salmon fishery management plan. Available at: http://www.pcouncil.org/salmon/fishery-management-plan/adoptedapproved-amendments/amendment-14-to-the-pacific-coast-salmon-plan-1997/.

PFMC. 2005. Amendment 19 (essential fish habitat) to the Pacific Coast groundfish fishery management plan for the California, Oregon, and Washington groundfish fishery. Available at: http://www.pcouncil.org/wp-content/uploads/A18-19Final.pdf.

PFMC. 2008. Pacific Coast Groundfish Fishery Management Plan, as amended through Amendment 19. Pacific Fishery Management Council, Portland, Oregon. Available at: http://www.pcouncil.org/wp-content/uploads/fmpthru19.pdf.

Pilati, DA. 1976. Cold shock: biological implications and a method for approximating transient environmental temperatures in the near-field region of a thermal discharge. Science of the Total Environment 6(3):227-37.

Pool, S., M.S. Douglas, D.C. Reese, and R.D., Brodeur. (in prep). Defining marine habitat of juvenile Chinook salmon, *Oncorhynchus tshawytscha*, and coho salmon, *O. kisutch*, in the northern California Current System.

Poston, T. 2001. Treated wood issues associated with overwater structures in marine and freshwater environments. White paper submitted to Washington Department of Fish and Wildlife, Washington Department of Ecology and Washington Department of Transportation by Batelle. Available at http://www.wa.gov/wdfw/hab/ahg/finaltw.pdf.

Previsic, M. 2010. RE Vision DE-001: Deployment effects of marine renewable energy technologies. Wave energy scenarios. U.S. Department of Energy, Advanced Waterpower Program. 106p.

Quinn, T.P. 2005. The behavior and ecology of Pacific salmon and trout. University of Washington Press. Seattle, WA.

Riley, W.D., D.L. Maxwell, M.G. Pawson, and 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.

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, abundance, and feeding ecology of juvenile salmon. Marine Ecology Progress Series 299:33-44.

Roberts, D.A., E.L. Johnston, and N.A. Knott. 2010. Impacts of desalination plant discharges on the marine environment: A critical review of published studies. Water Resources 44:5117-5128.

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.

Rogers, CA. 1976. Effects of temperature and salinity on the survival of winter flounder embryos. Fisheries Bulletin 74(1):52-8.

Rogers, P. H. and M. Cox. 1988. Underwater sound as a biological stimulus. p. 131-149 *In:* J. Atema, Fay, R. R., Popper, A. N., Tavolga, W. N., eds. Sensory biology of aquatic animals. New York: Springer-Verlag.

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.

Ruggerone, G. T., S. Goodman, and R. Miner. 2008. Behavioral response and survival of juvenile coho salmon exposed to pile driving sounds. Prepared for the Port of Seattle by Natural Resource Consultants, Inc. Seattle, WA.

Sargent, F. J., T. J. Leary, D.W. Crewz, and C.R. Kruer. 1995. Scarring of Florida's Seagrasses: Assessment and Management Options. St. Petersburg, FL, Florida Department of Environmental Protection.

Satterwaithe, T. 1995. Effects of boat traffic on juvenile salmonids in the Rogue River. Oregon Department of Fish and Wildlife. Portland, Oregon.

Scheuerell, M.D. and J.G. Williams. 2005. Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook salmon (I). Fisheries Oceanography 14(6):448-457.

Scheuerell, M.D. and 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, M.D., P.S. Levin, R.W. Zabel, J.G. Williams, and B.L. Sanderson. 2005. A new perspective on the importance of marine-derived nutrients to threatened stocks of Pacific salmon (Oncorhynchus spp.) Canadian Journal of Fisheries and Aquatic Sciences. 62(5): 961–964.

Schiel, D.R., J.R. Steinbeck, and M.S. Foster. 2004. Ten years of induced ocean warming causes comprehensive changes in marine benthic communities. Ecology 85:1833-1839.

Semmens, B. X. 2008. Acoustically derived fine-scale behaviors of juvenile Chinook salmon (I) associated with intertidal benthic habitats in an estuary. Canadian Journal of Fisheries and Aquatic Sciences 65:2053-2062.

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.

Shared Strategy (Shared Strategy for Puget Sound). 2007. Puget Sound salmon recovery plan. Prepared by Shared Strategy Development Committee, Seattle, Washington. Available at: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/PS-Chinook-Plan.cfm

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.

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

Short, F.T., E.W. Koch, J.C. Creed, K.M. Magalhaes, E. Fernandez, and J.L. Gaeckle. 2006. SeagrassNet monitoring across the Americas: case studies of seagrass decline. Marine Ecology 27: 277-289.

Shreffler, D.K. and Gardiner, W.M. 1999. Preliminary findings of diving and lights surveys. in Simenstad, C.A., Thom, R.M., and Olson, A.M. (eds.). 1997. Mitigation between regional transportation needs and preservation of eelgrass beds. Research report, vol. 1. Washington State Transportation Commission/USDOT. 103 pp.

SNSRB (Snake River Salmon Recovery Board). 2006. Snake River salmon recovery plan for Southeast Washington. Available at: http://www.snakeriverboard.org/resources/library.htm.

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.

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).

SRSRB (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)

Stadler, J. H. 2002. Personal communication on observations of fishes killed during pile driving. October 7, 2002. Fish Biologist, DOC/NOAA/National Marine Fisheries Service/HCD, Lacey, WA.

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.

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.

Stotz, T., J. Colby. 2001. January 2001 dive report for Mukilteo wingwall replacement project. Washington State Ferries Memorandum.

Sutherland, A. and D. Ogle. 1975. Effect of jet boats on salmon eggs. New Zealand Journal of Marine and Freshwater Research 9(3) 273-282.

Sutton, R., M. 2007. Klamath River thermal refugia study, 2006. U.S. Bureau of Reclamation Technical Memorandum 86-68290-01-07.

Swales, S. and C.D. Levings. 1989. Role of off-channel ponds in the life cycle of coho salmon (*Oncorhynchus kisutch*) and other juvenile salmonids in the Coldwater River, British Columbia. Canadian Journal of Fisheries and Aquatic Sciences 46:232-242.

Swales, S., R.B. Lauzier, and C.D. Levings. 1986. Winter habitat preferences of juvenile salmonids in two interior rivers in British Columbia. Canadian Journal of Zoology 64:1506-1514.

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 Society138: 1252-1265.

Sylte, T.E. 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.

Thompson, D.M. 2002. Long-term effect of instream habitat-improvement structures on channel morphology along the Blackledge and Salmon Rivers, Connecticut, USA. Environmental Management 29(1): 250-265.

Torgensen, 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.

Travnichek, V.H., A.V. Zale, and W.L. Fisher. 1993. Entrainment of ichthyoplankton by a warmwater hydroelectric facility. Transactions of the American Fisheries Society 122(5):709-716.

UCSRB (Upper Columbia Salmon Recovery Board). 2007. Upper Columbia spring Chinook salmon and steelhead recovery plan. Available at: http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Interior-Columbia/Upper-Columbia/upload/UC_Plan.pdf.

USDOE (U.S. Department of Energy). 2009. Report to Congress on the potential environmental effects of marine and hydrokinetic energy technologies. Prepared in response to the Energy Independence and Security Act of 2007, section 633(B). December, 2009. 143 p.

USFWS (U.S. Fish and Wildlife Service). 2000. Impacts of riprapping to ecosystem functioning, lower Sacramento River, California. U.S. Fish and Wildlife Service, Sacramento, CA. Prepared for the US Army Corps of Engineers, Sacramento District.

van Katwijk, M.M., G.H.W. Schmitz, A.P. Gasseling, and P.H. van Avesaanth. 1999. Effects of salinity and nutrient load and their interaction on Zostera marina. Mar. Ecol. Prog. Ser. 190: 155-165.

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, Oregon.

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.

Vronskiy, B. B. 1972. Reproductive biology of the Kamchatka River Chinook salmon (*Oncorhynchus tshawytscha* (Walbaum)). Journal of Ichthyology 12(2):259-273.

Walker, D.I., R.J. Lukatelich, G. Bastyan, and A.J. McComb. 1989. Effect of boat moorings on seagrass beds near Perth, Western Australia. Aquatic Botany 36:69-77.

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, 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.

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.

WSCC (Washington State Conservation Commission). 2002. Salmonid habitat limiting factors water resource inventory areas 33 (lower) and 35 (middle) Snake watersheds, and lower six miles of the Palouse River. Available: http://www.scc.wa.gov/index.php/288-WRIA-33-34-35-Snake-River-Watershed/View-category.html.

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.

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.

Ziemer, R. R. and T. E. Lisle. 2001. Hydrology. In River Ecology and Management, Lessons from the Pacific Coastal Ecoregion. Pages 43-68 *in* R.J. Naiman, and R. E. Bilby. Springer- Verlag New York, New York, NY.

APPENDIX A: ANNOTATED BIBLIOGRAPHY FOR 2010 ESSENTIAL FISH HABITAT REVIEW

Summary of Conclusions and Recommendations – Pacific Salmon EFH Review

This table displays the major recommendations made by the Salmon EFH Oversight Panel. The Council may choose to move forward in all, some, or none of these major areas. Any changes to EFH extent will require an FMP amendment.

Subject	Recommendation
Chinook EFH	Update Chinook EFH based on new distribution data and new Hydrologic Unit data (pg 19)
Coho EFH	Update coho EFH based on new distribution data and new Hydrologic Unit data (pg 23)
Puget Sound Pink EFH	Update PS pink EFH based on new distribution data and new Hydrologic Unit data (pg 24)
Impassible barriers	Update the list of impassible dams that mark the upstream extent of EFH (pg 36)
Marine EFH	Update marine EFH and better definition of the FMU for coho salmon and PS pink salmon (pg 43)
EFH descriptions	Update descriptions of EFH and components (pg 47)
New information	Incorporate the new information into the annotated bibliography (pg 47)
Habitat Areas of Particular Concern (HAPC)	Consider HAPCs of channels and floodplains; thermal refugia; spawning habitat; estuaries; and marine and estuarine submerged aquatic vegetation (pg 54)
Fishing threats	Consider newly-identified fishing activities that may adversely affect EFH; consider measures to minimize impacts to EFH (pg 59)
Non-fishing threats	Consider updating the non-fishing threats, adding the newly identified threats and developing conservation recommendations (pg 80)
Information and research needs	Consider information and research needs for future refining of EFH, based on the data gaps identified in this review and Amendment 14.

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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

Approach 1
Task 2. Impassable man-made barriers 1
Task 3. Threats to salmon EFH 1
Task 4. Salmon life history 2
Table of Contents 3
Task 2. Impassable man-made barriers 6
Gorge Lake Dam 6
Masonry Dam (Cedar Falls Dam) 6
Tolt Dam 7
Keechelus Dam 7
Kachess Dam 8
Cle Elum Dam 8
Rimrock Dam 9
Chief Joseph Dam 9
Dworshak Dam 10
Hells Canyon Complex 10
Opal Springs Dam 11
Big Cliff Dam 11
Cougar Dam 12
Dexter Dam 12
Dorena Dam 13
Soda Springs Dam 13
Lost Creek Dam 14
Applegate Dam 14
City of Portland #2 (Bull Run River) 15
Oak Grove Dam 15
Iron Gate Dam 16
Lewiston Dam 16
Dwinnell Dam (Shasta River Dam) 17
Robert W. Mathews Dam 17
Coyote Valley Dam 17
Warm Springs Dam 18
Scott Dam 18
Keswick Dam 18
Oroville Dam 19

Black Butte Dam 19
Whiskeytown Dam 20
Camp Far West Dam 20
Nimbus Dam 20
Friant Dam 21
Camanche Dam 21
New Hogan Dam 21
Crocker-Huffman Dam 22
Goodwin Dam 22
La Grange Dam 22
Nicasio Dam 23
Peters Dam 23
San Pablo Dam 24
Anderson Dam 24
Newell Dam 25
Task 3. Threats to Salmon EFH 25
Agriculture 25
Artificial Propogation 29
Bank Stabilization 36
Beaver Removal 39
Urbanization 41
Dams 45
Dredging 53
Estuarine Alteration 56
Forestry 61
Grazing 64
Irrigation 72
Mineral Mining 75
Nonnative Species 77
Offshore Drilling 80
Road Building 84
Sand Gravel Mining 88
Vessel Operation 91
Wastewater/Pollutants 93
Wetland Alteration 96
Woody Debris Removal 98
Pile-Driving 102
Over-water Structures 109
Alternative Energy 113
LNG Facilities 115
Desalination 116
Power Plant Intakes 116

Pesticides **119**
Flood Control **122**
Culvert Construction **126**
Climate Change **130**
Task 4. Salmon Life History **136**
Chinook Salmon **136**
Eggs and Spawning *136*
Juveniles(Freshwater) *138*
Juveniles (Estuarine) *143*
Juveniles (Marine) *146*
Adults *148*
Coho Salmon **151**
Eggs and Spawning *151*
Juveniles(Freshwater) *151*
Juveniles (Estuarine) *153*
Juveniles (Marine) *153*
Adults *155*
Pink Salmon **155**
Eggs and Spawning *155*
Juveniles(Freshwater) *156*
Juveniles (Estuarine) *156*
Juveniles (Marine) *157*
Adults *158*
Salmon (General) **158**
Eggs and Spawning *159*
Juveniles(Freshwater) *159*
Juveniles (Estuarine) *159*
Juveniles (Marine) *160*
Adults *164*

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 artificial, 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.

Bulleri, F. and M.G. Chapman. 2010. The introduction of coastal infrastructure as a driver of change in marine environments. *Journal of Applied Ecology* 47: 26-53.

- Coastal landscapes are being transformed as a consequence of the increasing demand for urban infrastructure to sustain commercial, residential and tourist activities. A variety of man-made structures, such as breakwaters, jetties and seawalls have thus become ubiquitous features of intertidal and shallow subtidal habitats. This transformation will accelerate in response to the exponential growth of human populations and to global changes, such as sea-level rise and increased frequency of extreme meteorological events (e.g. storms).
- Urban infrastructure supports different epibiota and associated assemblages and does not function as surrogate of natural rocky habitats. Its introduction in the intertidal zone or in nearshore waters can cause fragmentation and loss of natural habitats.
- The provision of novel habitat (hard substrata) along sedimentary shores can alter local and regional biodiversity by modifying natural patterns of dispersal of species, or by facilitating the and spread of exotic species
- Incorporating natural elements of habitat (e.g. wetland vegetation; seagrass) into shoreline stabilization can reduce ecological impacts, without impinging on its efficacy in halting erosion.
- Improving the ecological value of artificial structures by adding features of habitat that are missing from such structures (e.g. rock-pools) can contribute to mitigation of the detrimental effects of urbanization on biodiversity.

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.

Cohen, A.N., Calder, D.R., Carlton, J.T., Chapman, J.W., Harris, L.H., Kitayama, T., Lambert, C.C., Piotrowski, C., Shouse, M., Solorzano, L.A. 2005. Rapid assessment shore survey for exotic species in San Francisco Bay-May 2004. Final Report for the California State Coastal Conservancy, Association of Bay Area Governments/San Francisco Bay-Delta Science Consortium, National Geographic Society and Rose Foundation. San Francisco Estuary Institute, Oakland, CA.

- The Smithsonian Institute conducts Rapid Assessment Surveys in the San Francisco Estuary to determine exotic species distribution on overwater structures 896 records of 294 distinct taxa have been observed, with 60% represented on floating docks, 20% on intertidal benthos, and 13% from benthic grabs

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.

Burdick, D. M., Short, F.T. 1999. The effects of boat docks on eelgrass beds in coastal waters of Massachusetts. Environmental Management 23(2): 231-240

- Seagrass decreases are typically linked to pollution or disease, but docks, piers and boats can have a detrimental effect that is not often considered. The authors examine the impacts of these structures on eelgrass in New England estuaries.
- Height above the water is the most important variable in determining eelgrass health underneath docks. The greater the height, the more sunlight can diffuse underneath.
- Impacts to eelgrass were much greater than dock acreage because shading impacts areas adjacent to docks and associated boating activity can damage eelgrass.
- North-south orientation is more important than width in minimizing eelgrass impacts.

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°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°F and 51°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°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°F and 60°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°F to 56°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°F, and fish can become stressed as temperatures approach 70°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°F and 60°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



Pacific Coast Salmon 5-Year Review of Essential Fish Habitat

Final Report to the Pacific Fishery Management Council

PFMC Meeting
San Mateo, CA
April 12, 2011

What is the Report?

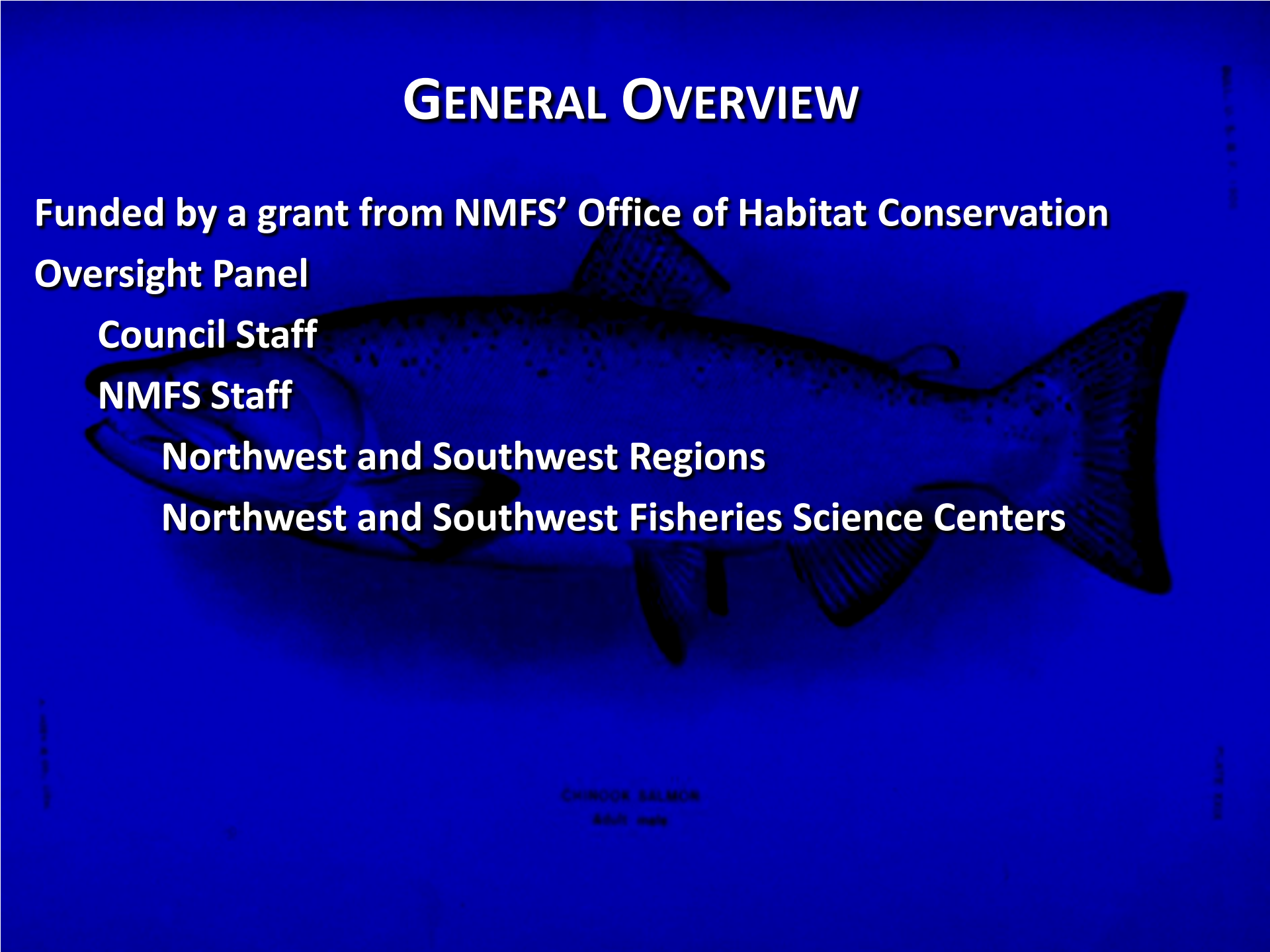
- It presents the results of the 5-year review
- It *is not* an amendment to the FMP
- It *is* intended to inform the Council's decision process on refining EFH for Pacific Coast salmon
- It *is not* an assessment of existing habitat conditions

General Overview

Funded by a grant from NMFS' Office of Habitat Conservation

Oversight Panel

- Council Staff
- NMFS Staff
  - Northwest and Southwest Regions
  - Northwest and Southwest Fisheries Science Centers



5-Year Review of EFH

- Annotated bibliography – Cramer Fish Sciences
- Compared current distribution data to existing EFH
- Evaluated the dams currently designated as the upstream extent of EFH
- Developed potential HAPCs
- Evaluated the threats to EFH from fishing and non-fishing related activities
- Identified information and research needs

Amendment 14 EFH Definition of EFH

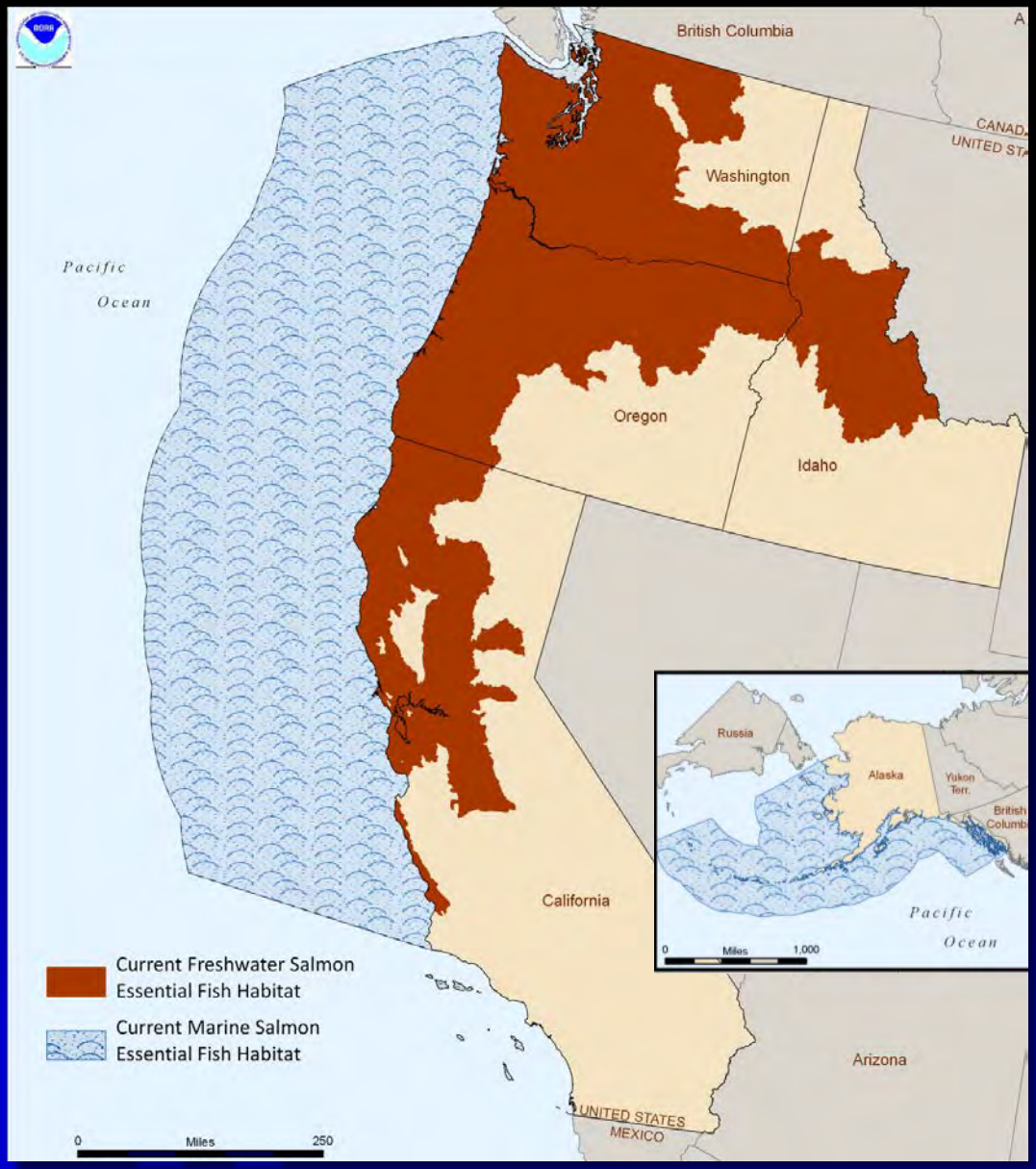
Freshwater

- All those streams, lakes, ponds, wetlands, and other currently viable water bodies and most of the habitat historically accessible to salmon in Washington, Oregon, Idaho, and California.

Estuarine and marine areas

- From the nearshore and tidal submerged environments within state territorial waters out to the full extent of the EEZ (370.4 km) offshore of Washington, Oregon, and California north of Point Conception.
- Includes the marine areas off Alaska designated as salmon EFH by the North Pacific Fishery Management Council.

Current EFH for Pacific Coast Salmon



Chinook salmon
Oncorhynchus tshawytscha

Coho salmon
O. kisutch

Puget Sound Pink Salmon
O. gorbuscha

EFH is designated at the 4th Field Hydrologic Unit

Is a smaller HU possible?



54% of 6th Field HUs with distribution data

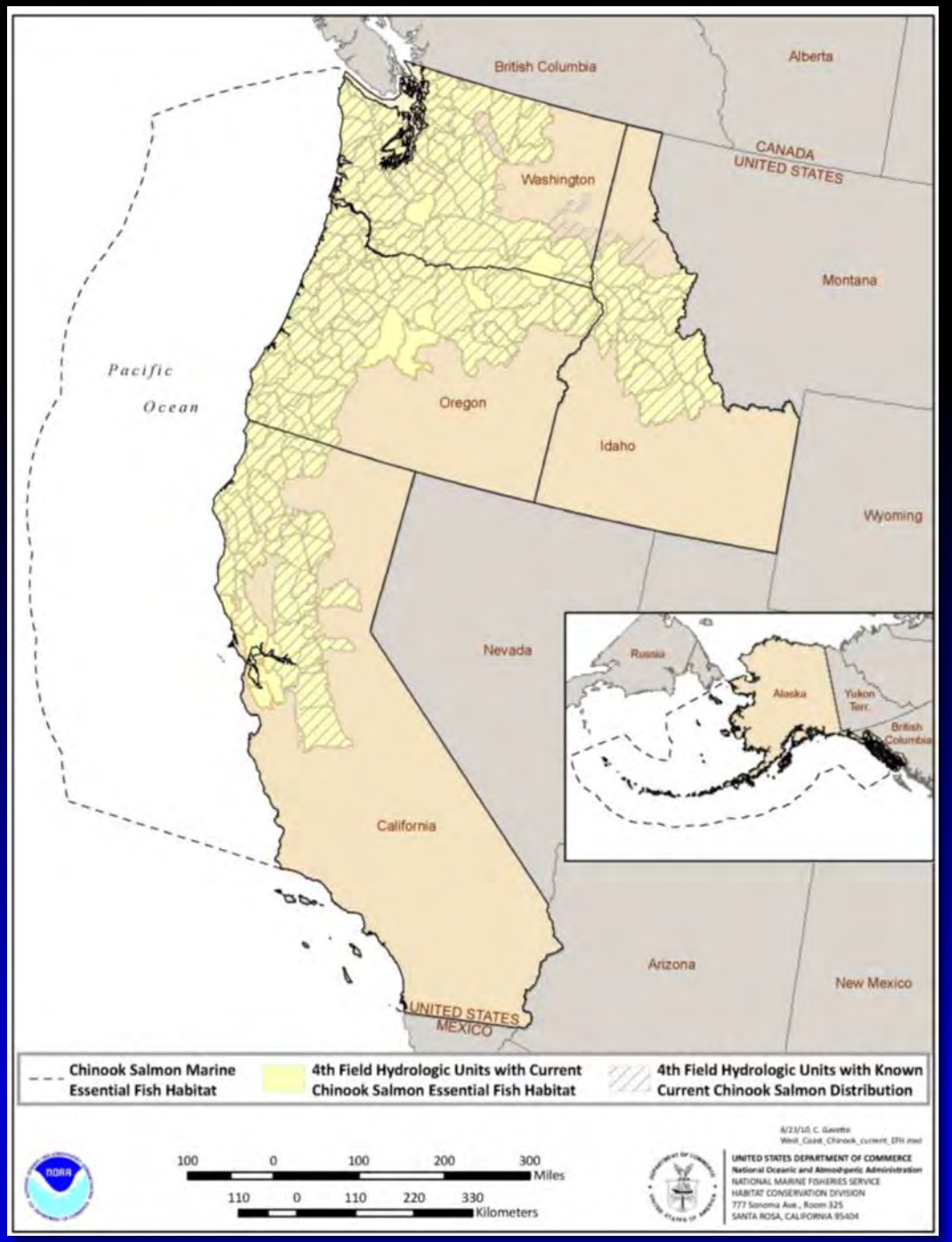
77% of 5th Field HUs with distribution data

Chinook Salmon

Existing EFH

vs

Current and Historic Data



Central Valley HU Changes

- Boundaries
- Codes
- Names



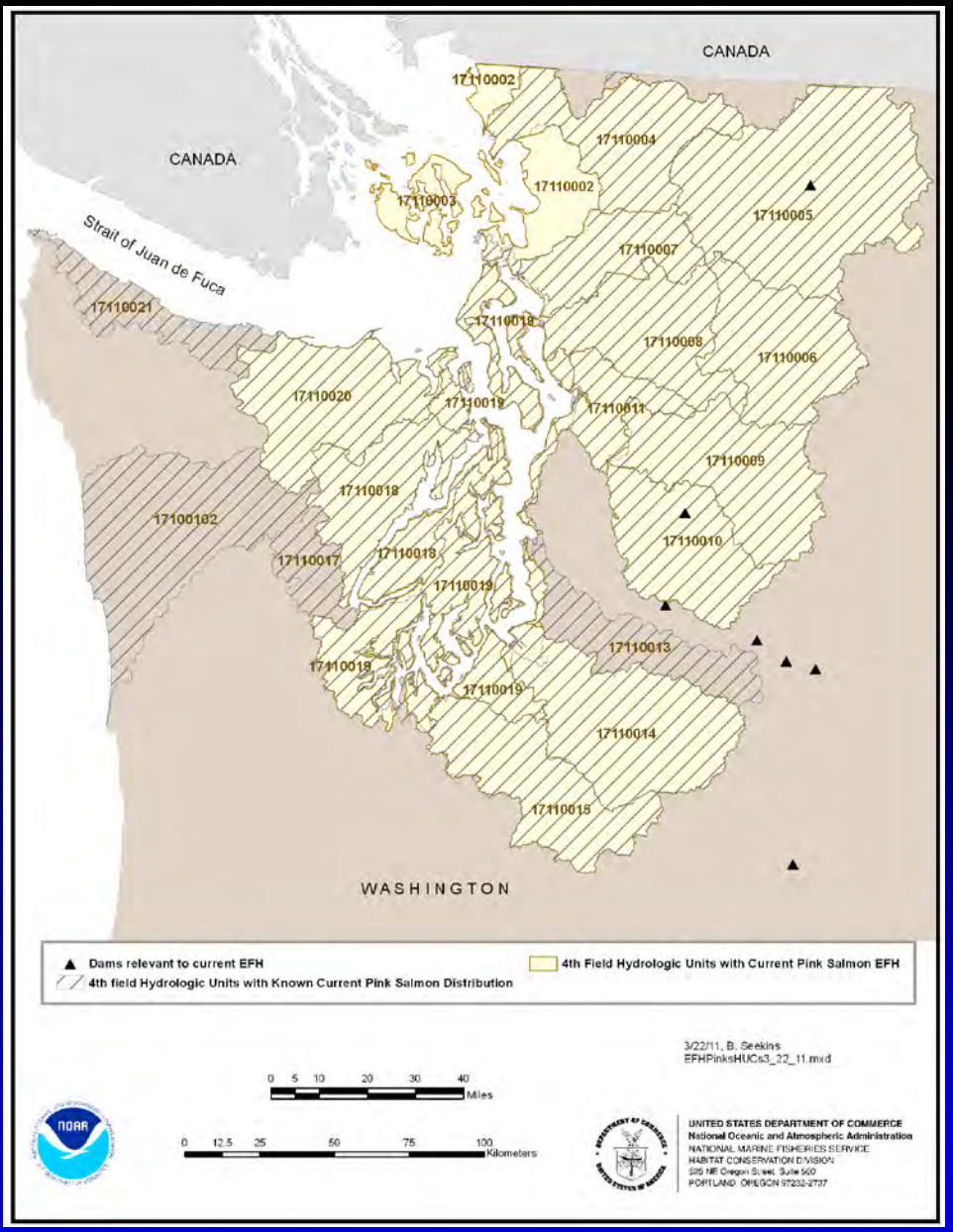


Coho Salmon

Existing EFH

vs

Current and Historic Data



Puget Sound Pink Salmon
Existing EFH
Vs
Current and Historic Data

4 HUs not EFH but with
PS pink salmon data

Green-Duwamish – recent high returns
Skokomish River
Hoko-Crescent
Queets-Quinault

Where is the FMU?

Intrinsic Potential Modeling

- Predicts the historical potential for a given stream reach to develop suitable habitat characteristics
- Based on a limited set of geomorphic and hydrologic characteristics
- Has been done for a limited number of ESUs
- Models are specific to the geographic area
- Insufficient coverage to use for designating EFH at this time

Impassible Dams Forming Upstream Extent of EFH

Re-evaluated the dams listed in the 2008 Final Rule using the criteria established in Amendment 14

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?**
   - ***Panel: must be identified as such in a document such as a Biological Opinion, Critical Habitat Designation, Recovery Plan, etc.***

Table 6. Potential Changes to Upstream Extent

Correct errors and omissions

Delete dam from list because it is upstream of another dam

Brownlee Dam and Oxbow Dam

Designate a dam as the upstream extent of EFH

McKay Dam and Emigrant Dam

Designate EFH above dams:

- that now have passage
- where passage is being constructed or planned
- where passage is being "considered"
- where habitat has been identified as "essential" to conservation of the species

Council Considerations on Upstream Extent of EFH

- How should the criteria be interpreted?
  - What is the definition of "passage being considered"?
  - Should habitat that "may be essential" to the conservation of a species be designated as EFH?
- If the habitat above a dam is designated as EFH, are there dams upstream that meet the criteria?
- Expansion of EFH means EFH consultations in new areas

Marine EFH

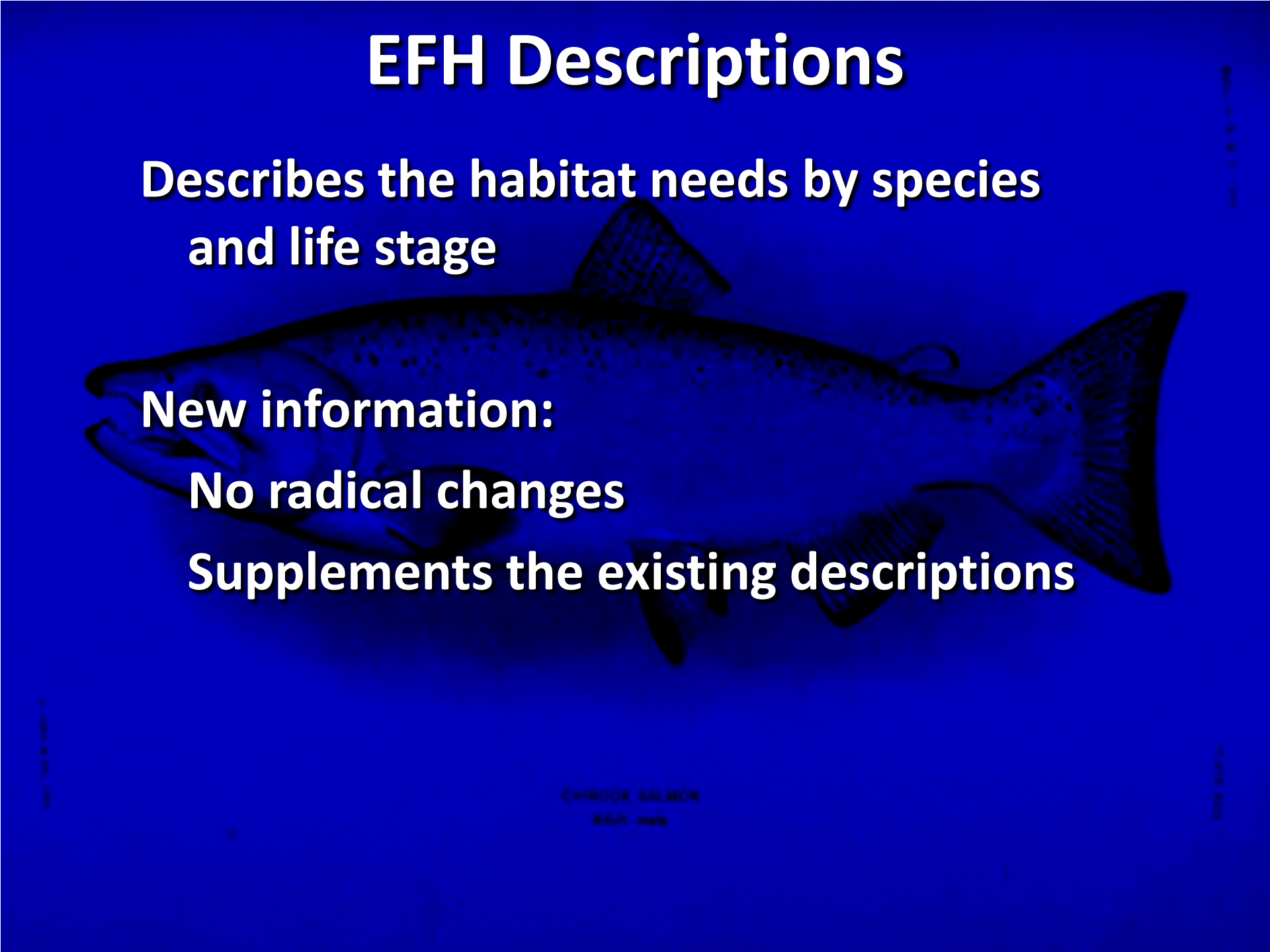
- Chinook salmon and coho salmon – entire EEZ north of Pt. Conception, including Alaskan EEZ
- PS pink salmon – limited
- Alaskan waters
  - EFH designated by NPFMC
  - Entire EEZ of Alaska
- NMFS Alaska Region and NPFMC
  - Developing models to predict marine distribution
  - All 5 species and marine life stages
  - Expected to be complete by end of 2011
  - Can be used as a model by the Council during next review

EFH Descriptions

Describes the habitat needs by species and life stage

New information:

- No radical changes
- Supplements the existing descriptions



Habitat Areas of Particular Concern

- A subset of EFH
- No additional regulatory burden
- Provides focus for conservation efforts
- Considerations for designating HAPCs
  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
  4. The rarity of the habitat type

Potential HAPCs

- Complex channel and floodplain habitat
- Thermal refugia
- Spawning habitat
- Estuaries – spatially explicit
- Marine and estuarine SAV
- *Migration corridors*

Rejected because it includes all EFH

Threats to EFH

- Fishing Gear and Activities
- Non-fishing activities



Fishing Gear and Activities

- Various types of gear
- Harvest of prey species
- Loss of salmon carcasses
- Derelict gear
  - Habitat modification
  - Entanglement
- Recreational fisheries

Non-Fishing Threats to EFH Identified in Amendment 14

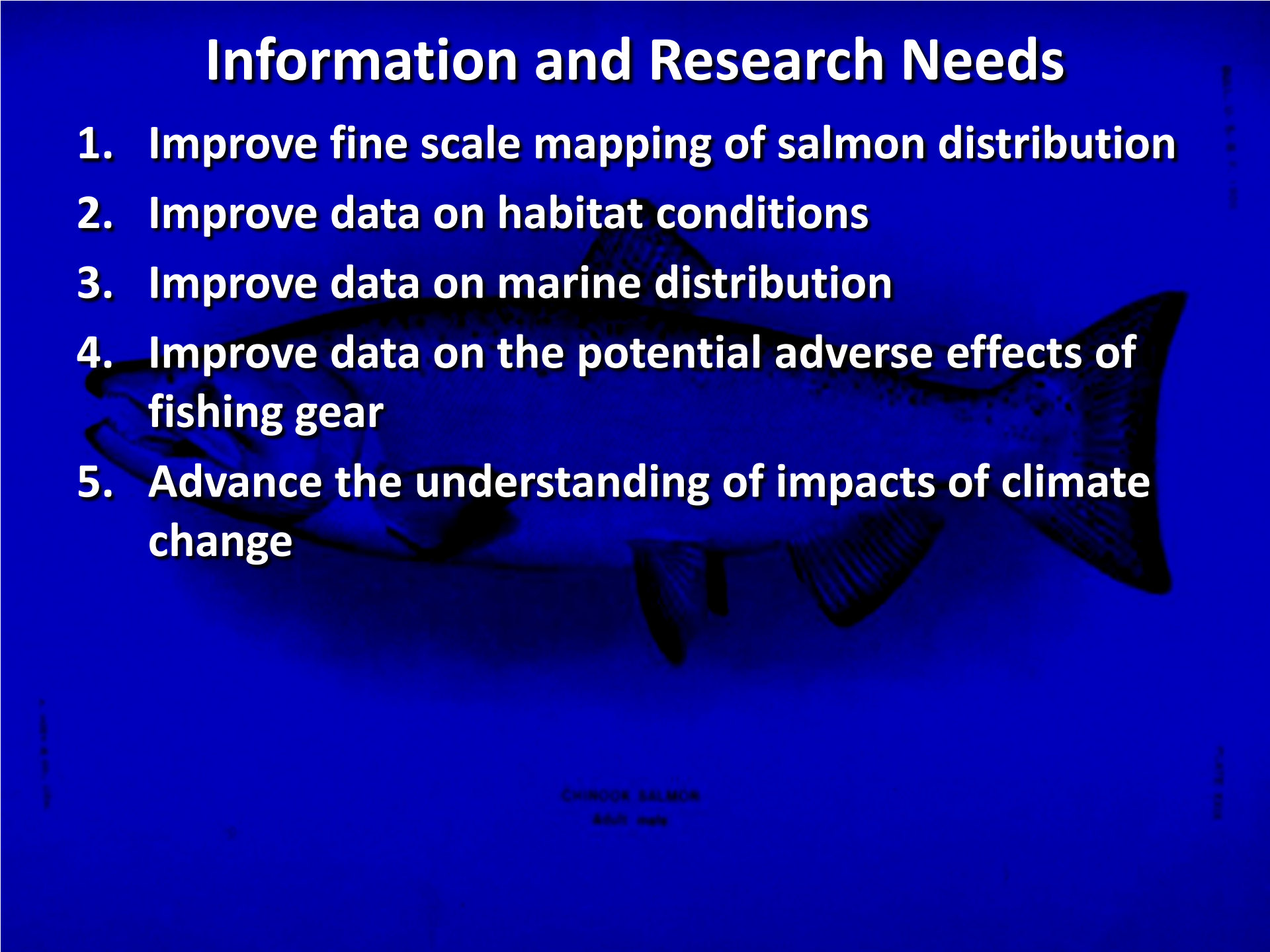
- Agriculture
- Artificial Propagation of Fish and Shellfish
- Bank Stabilization
- Beaver Removal
- Construction/Urbanization
- Dam Construction/Operation
- Dredging and Spoil Disposal
- Estuarine Alteration
- Forestry
- Grazing
- Habitat Restoration Projects
- Irrigation/Water Management
- Mineral Mining
- Introduction 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

Newly Identified Threats

- **Pile driving**
- **Over-water structures**
- **Alternative energy development**
- **Liquefied natural gas projects**
- **Desalination**
- **Power plant intakes**
- **Pesticide use**
- **Flood control maintenance**
- **Culvert construction**
- **Climate change**

Information and Research Needs

1. Improve fine scale mapping of salmon distribution
2. Improve data on habitat conditions
3. Improve data on marine distribution
4. Improve data on the potential adverse effects of fishing gear
5. Advance the understanding of impacts of climate change



Summary of the 5-Year Review

The review found:

- New distribution data for all three species of salmon
- Changes in the 4th field HUs in the Central Valley
- Changes in the status of some dams that are currently designated as the upstream extent of EFH
- New information on the habitat needs of Pacific Coast salmon

The review identified:

- Five potential HAPCs
- 10 threats to EFH that were not considered in Amendment 14
- Information and research needs

HABITAT COMMITTEE REPORT ON SALMON ESSENTIAL FISH HABITAT (EFH) REVIEW FINAL REPORT

The Habitat Committee (HC) heard a synopsis of the Salmon Essential Fish Habitat (EFH) Review from Eric Chavez, HC member and co-author of the report. The HC is supportive of the final report and recommends adoption by the Council. We offer more specific recommendations, pending adoption of the final report by the Council.

In considering the three options in the report presented for the Council, the HC suggests further consideration of all major recommendations presented in the table (Agenda Item G.5.b) through the fishery management plan (FMP) amendment process.

Changing the upstream extent of EFH would require an FMP amendment. If the FMP is updated, the Council could include a statement to allow for technical adjustments to handle small changes.

The HC appreciates the review panel's efforts to examine higher resolution models to inform freshwater salmon EFH designations, and acknowledges the sparseness of comprehensive data. The HC suggests that the Intrinsic Potential models, in particular, show great potential value in defining EFH. Attempts to develop them consistently across the geographic extent of EFH should continue to be pursued.

The HC notes that the report reflects limited new information on salmon distribution in the marine environments. However, the HC believes that more comprehensive information on juvenile salmon distribution is available, and looks forward to participating in the next phase of the EFH review, should the Council proceed with an EFH amendment. The HC agrees with the panel in the potential utility of the North Pacific Fishery Management Council model in refining marine EFH designations.

The HC agrees with the consideration of habitat areas of particular concern in the EFH report. These represent a new and important aspect to defining and protecting salmon EFH.

The HC was concerned about the reference to gillnets on page 58 because it focused solely on the lower Columbia River. Gillnets are used in many other places. The report should include additional information on derelict fishing gear rather than relying on a personal communication reference on the lower Columbia River.

The panel developed descriptions of non-fishing activities (p. 59) that may affect EFH (see also 2004 report). The HC agrees with the Oversight Panel that all of these activities warrant Council consideration. The HC acknowledges that conservation measures were not fully developed in the final report, but agrees with the panel that these can be more fully developed in the next phase if the Council adopts the major recommendations presented in Agenda Item G.5.b.

Lastly, the HC suggests that the annotated bibliography (Agenda Item G.5.b, Attachment. 3) should be updated to include all supporting and relevant literature obtained during the review process.

PFMC
04/09/11

SALMON ADVISORY SUBPANEL REPORT ON SALMON ESSENTIAL FISH HABITAT (EFH) REVIEW FINAL REPORT

The Salmon Advisory Subpanel (SAS) supports the adoption of the Pacific Coast Salmon Five-Year Review of Essential Fish Habitat, Final Report to the Pacific Fishery Management Council.

The SAS notes in the Recreational Fishing section that the study on wader caused mortality on alevins (page 58 Roberts and White, 1992) is not listed in the references and the discussion is primarily anecdotal. The SAS recommends adding an errata sheet to include this reference and other possible omissions and corrections.

The SAS points out that in the Derelict Gear section of the EFH Review, page 58, the issue of ghost nets on the Lower Columbia is referenced only by a "personal communications" with Callahan Grant, 2008. No additional documentation is provided for this statement and the SAS recommends the Council not accept this statement with the review.

Page 49, paragraph 3; add "of" in the second sentence "removal <u>of</u> dikes and levees."

PFMC
04/11/11

Agenda Item G.5.c
Supplemental SSC Report
April 2011

SCIENTIFIC AND STATISTICAL COMMITTEE REPORT ON SALMON ESSENTIAL FISH HABITAT (EFH) REVIEW FINAL REPORT

Mr. Kerry Griffin provided the Scientific and Statistical Committee (SSC) with an overview of the final report on the 5 year review of Essential Fish Habitat (EFH). The SSC reviewed an earlier version of this document in September 2010. The Oversight Panel has addressed most of the SSC concerns: The five potential habitat areas of particular concern (HAPCs) are now each evaluated in terms of the four defining criteria. Threats which have been added to the list are fully described and documented.

The report highlights several areas of the existing EFH designation that need to be updated:

- New information on the range of salmon is not consistent with current designations.
- Some habitat units have been redefined, and EFH designations in these areas need to be reexamined.
- The status of some dams and other impassable barriers has changed, or errors have been identified.

The SSC notes a few shortcomings of the Final Report:

- In the current document there is an imbalance in the level of detail for fishery-related and non-fishery-related threats. Descriptions of fishery-related threats should be more fully developed.
- Criteria for designation of EFH above impassable barriers needs to be clarified.

The Final Report is a thorough and detailed document that highlights a number of discrepancies in the current EFH designation, provides descriptions of potential HAPCs, expands and documents the list of threats, and identifies (but does not solve) the problem of defining EFH above impassable barriers. It could serve as a solid basis for the process of implementing a new FMP amendment.

PFMC
04/11/11

SALMON TECHNICAL TEAM REPORT
ON SALMON ESSENTIAL FISH HABITAT (EFH) REVIEW FINAL REPORT

The Salmon Technical Team (STT) recommends that the Council accept the final report on the 5-year review of salmon essential fish habitat (EFH). The STT notes that the updated distribution information brought to light some discrepancies between the currently designated EFH and the distribution of salmon included in the fishery management plan (FMP). Amendment 16 may remove Mid-Columbia Spring Chinook from the FMP or designate them as ecosystem components. This would further affect the discrepancies between the distribution of stocks managed under the FMP and the current designation of EFH. The Council will need to consider future action to reconcile these differences.

PFMC
4/11/2011

**TESTIMONY OF THE COLUMBIA RIVER TREATY TRIBES
BEFORE THE PACIFIC FISHERIES MANAGEMENT COUNCIL
San Mateo, CA
April 12, 2011**

Agenda Item G.5. Salmon Essential Fish Habitat Review Final Report

Good day, Mr. Chairman and members of the Council. My name is Wilbur Slockish Jr. and I am presenting testimony on behalf of the four Columbia River Treaty Tribes.

We would like to comment on two aspects of the Salmon Essential Fish Habitat Review Final Report. First on Table 6 on Page 37 there is an incorrect reference to the Umatilla River. The Umatilla River is in Oregon, not Washington. While McKay Dam is an impassable dam, it is on McKay Creek which is a tributary of the Umatilla River south of the city of Pendleton. It would be correct to state that McKay Dam is the upstream extent of salmon EFH in McKay Creek, it is certainly not the upstream extent of salmon EFH in the Umatilla River. Salmon inhabit wide areas of the Umatilla River and its tributaries upstream from McKay Creek. The document should make this clear.

Second, on page 58 in the section on derelict gear, we have comments relative to salmon gill nets. In the document, there is a sentence, "In the Columbia River, derelict salmon gillnets continue to ghost fish for salmon, sturgeon, and other species (Callahan Grant, personal communication, 2008). We do not know Ms. Callahan Grant nor are we aware of her expertise on salmon gillnets if any. However this statement is misleading and should not have been included in the document. Lost nets will behave differently in a large river like the Columbia than they would in either small rivers or in marine areas like Puget Sound or the Ocean. Nets in the river are not the same as large ocean drift nets that people have seen pictures of. We are only aware of one study on lost fishing nets in the Zone 6 area between Bonneville and McNary dams where the tribes fish. The study is titled: "Ghost Net Recovery Project – A Feasibility Study." It was a report to the Bonneville Power Administration in 2004. This study did find some lost nets in Zone 6, but the only species found in any of the nets recovered were sturgeon. There was no evidence at all that salmon were impacted from lost fishing nets and it was not possible to determine the significance of the sturgeon impact given the modest number of nets found.

Salmon fishermen actually loose very few nets. A salmon gillnet fully rigged and ready to fish is worth over $1000. Salmon fishers will expend significant effort to recover any net that they might loose. Losing a net not only costs money to replace, but the cost in lost fishing time is also significant. Our fishermen do occasionally loose a net due to weather or if a net is run over by a boat or barge. Our fishermen work very hard to avoid this loss. The effects of lost gear is actually much less significant on the fish than many people presume.

We also believe that because of the way drift nets are used in the lower, river it is unlikely there are many lost nets in the lower river either.

We think the document should have simply said that there are no data on the number of lost nets in the Columbia River. The tribes believe the number of lost nets in Zone 6 is small. There is also no evidence that lost gillnets have any significant adverse effect on salmon or salmon EFH in the Columbia River.

The Council should not accept mere conjecture of possible adverse effects from fishing gear as proof that there actually are any adverse effects from salmon fishing gear.

We do wish, that in the future, when NMFS is writing documents that are concerned with Columbia River fisheries and fish runs, that they would consult the tribes in order to get better information.

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April 1, 2011

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

RE: Agenda Item G.5. Salmon Essential Fish Habitat Review

Dear Mr. Cedergreen and Council Members:

Oceana is writing to request that select important Pacific salmon prey species be designated as Essential Fish Habitat under the Pacific Coast Salmon Fishery Management Plan. As you are aware, Essential Fish Habitat (EFH) means those waters and substrate necessary to fish for spawning, breeding, *feeding*, or growth to maturity.[1]

Prey species are addressed as a component of the Magnuson Stevens Act (MSA) provision to minimize adverse impacts to Essential Fish Habitat.[2] The 2002 EFH Final Rule recognizes that prey can be a vital component of EFH for managed species.[3] The EFH final rule states that "adverse effects may include . . . loss of, or injury to . . . prey species and their habitat. . ."[4] This final rule explains in detail that loss of prey is a critical concern and that management plans should pay special attention to both the predator-prey relationship and the location of prey species' habitat.[5] In the final rule, NMFS further reinforces this by including harvest limits on the take of prey species as one of the methods that managers can employ to meet the MSA requirements to minimize the adverse effects of fishing on EFH.[6]

Pacific salmon prey species are an associated biological community that constitute 'feeding' habitat and are 'necessary' to support a sustainable salmon fishery and the species' contribution to a healthy ecosystem. As such, salmon prey species should be designated EFH for Pacific salmon managed under the Salmon Fishery Management Plan (FMP), including chinook (*Oncorhynchus tshawytscha*), coho (*O. kisutch*), and Puget Sound pink (*O. gorbuscha*). Amendment 14 to the Pacific Coast Salmon FMP recognizes that "adequate prey species and forage base" are important elements of marine EFH for chinook, coho, and Puget Sound pink salmon.[7] The Final Rule that codifies Amendment 14, however, does not specify or designate prey in general, or any specific prey species, as EFH for Pacific Coast Salmon.[8]

Importantly, designating prey species as EFH for Pacific salmon would give the National Marine Fisheries Service (NMFS) additional authority to take management actions to minimize adverse effects to prey species, initiate consultation for non-fishing impacts, and provide EFH conservation

[1] 67 Fed Reg. 2343, 2375 (January 17, 2002), emphasis added.
[2] 16 U.S.C. 1853 § 303(a)(7).
[3] Id, at 2347 and 2378.
[4] 50 C.F.R. § 600.810(a).
[5] 50 C.F.R. § 600.815(a)(7).
[6] 50 C.F.R. § 600.815(2)(C)(iii).
[7] PFMC. 2000. Amendment 14 to the Pacific Coast Salmon Plan, at A-24, A-25 and A-42.
[8] 73 Fed Reg. 60987 (October 15, 2008).

recommendations to appropriate state fishery management agencies. In order to do this, prey species must be designated as EFH. We believe that there are impacts to salmon prey that must be objectively evaluated, such as the direct harvest and bycatch of salmon prey in other managed fisheries.

Salmon prey species including Pacific herring (*Clupea pallasii*), northern anchovy (*Engraulis mordax*), Pacific sardine (*Sardinops sagax*), juvenile midwater rockfish (*Sebastes spp*.), and krill (Euphausiacea) play a fundamental role as forage in the California Current marine ecosystem. A study from 1957 reported that juvenile shortbelly rockfish were an important prey for chinook salmon along the central California coast in late spring and summer, accounting for more than 60% of their prey identified to the species level.[9] More recently, juvenile rockfishes and northern anchovy are the two most important prey items for chinook salmon in the San Francisco Bay region.[10] Northern anchovy, Pacific sardine and krill are managed under the Coastal Pelagic Species FMP, and Pacific herring are scheduled to be included in the plan as an Ecosystem Component species through Amendment 13 to the CPS FMP. Rockfish including shortbelly rockfish are managed under the Groundfish FMP. Pacific salmon species prey on other important forage species such as Pacific sand lance, smelts (e.g. eulachon), squid, and small invertebrates.[11] A recent NOAA Technical Memorandum assessed the diet composition of chinook salmon (see table 1 below).[12] As small planktivores, krill, and juvenile rockfish make up the top 90%, by weight of the diet of chinook salmon, these species clearly constitute key prey items for Pacific salmon species, and we ask that you designate these species as EFH. In addition to this list, we ask thatyou're you request NMFS evaluate other key salmon prey species such as Pacific sand lance, eulachon, and others documented in the referenced literature.

For federally managed prey species, including those in the PFMC FMPs (e.g. Pacific herring, northern anchovy, Pacific sardine, and juvenile rockfish), we ask that you evaluate management actions to mitigate adverse effects from the reduction in availability of these major salmon prey species caused by fishing. While the PFMC has undertaken positive steps to protect krill, coastwide overfishing is occurring on Pacific sardine and the biomass level is well below Bmsy.[13] What is more, there is increasing fishing pressure on northern anchovy, without any recent stock assessments or a control rule for determining when the northern population is overfished.[14] Another example of a federally managed species is Pacific eulachon, which were listed as threatened under the Endangered Species Act in March 2010. Climate change and bycatch in the trawl pink shrimp fishery have been identified as the greatest impediments to the recovery of this threatened forage species.[15]

We hope you will fully consider and forward this recommendation to amend the Pacific Coast Salmon FMP to designate Pacific herring, northern anchovy, Pacific sardine, juvenile rockfish, krill, and other key

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[9] Merkel, T.J. 1957. Food habits of the king salmon, *Oncorhynchus tshawytscha* (Walbaum), in the vicinity of San Francisco, California. Calif. Dept. Fish and Game 43: 249-270.

[10] Healey, M. C. 1991. Life history of chinook salmon. *In* C. Groot and L. Margolis, (eds.), Pacific salmon life histories, p. 311–393. Univ. British Columbia Press, Vancouver, Canada, 564 p.

[11] Brodeur, R.D. 1990. A synthesis of the food habits and feeding ecology of salmonids in marine waters of the North Pacific. (INPFC Doc.) FRI-UW-9016. Fish. Res. Inst., Univ. Washington, Seattle. 38 pp.

[12] Dufault, A.M., K. Marshall, and I.C. Kaplan. 2009. A synthesis of diets and trophic overlap of marine species in the California Current. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-103, 81 p.

[13] PFMC 2010. Assessment of the Pacific sardine in 2010 for use in management in 2011. Agenda Item I.2.b. November 2010.

[14] In November 2011 the PFMC voted to set catch levels for the northern subpopulation of northern anchovy five times higher than recent landing, without any consideration of ecological impacts and without all legally required Status Determination Criteria.

[15] Eulachon Biological Review Team. Status Review Update for Eulachon in Washington, Oregon and California. 20 Jan 2010.

prey documented in the referenced studies as EFH, and consider appropriate management measures to mitigate adverse impacts to salmon prey availability by Council-managed fisheries, as required by law. Given the importance of adequate and abundant prey to salmon species, we expect that this designation will ultimately help better manage and protect Pacific salmon species, their essential habitat, and the long-term health and biodiversity of the California Current marine ecosystem.

Sincerely,



Ben Enticknap
Pacific Project Manager

Prey	Percent
Small planktivores	0.4840
Large zooplankton	0.2603
Juv. midwater rockfish	0.0704
Juv. deep small rockfish	0.0584
Cephalopods	0.0534
Juv. megazoobenthos	0.0262
Juv. deep large rockfish	0.0214
Juv. shallow large rockfish	0.0107
Juv. shallow small rockfish	0.0083
Deep vertical migrators	0.0025
Pacific hake	0.0020
Misc. nearshore fish	0.0008
Small flatfish	0.0006
Benthic herbivorous grazers	0.0003
Deposit feeders	0.0002
Gelatinous zooplankton	0.0002
Shallow macrozoobenthos	0.0001
Shrimp	0.0001

Table 1. Diet composition by weight for chinook salmon. Small planktivores are Pacific herring, Pacific sardine and northern anchovy. Large zooplankton are predominately krill (Euphasiids).[16]

[16] supra note 12, at 70.

FINAL ACTION ON 2011 MANAGEMENT MEASURES

The Salmon Technical Team (STT) will briefly review its analysis of the tentative management measures and answer Council questions. Final adoption of management measures will follow the comments of the advisors, tribes, agencies, and public.

Any season structure considered for adoption that deviates from Salmon Fishery Management Plan (FMP) objectives will require implementation by emergency rule. If an emergency rule appears to be necessary, the Council must clearly identify and justify the need for such an action consistent with emergency criteria established by the Council (Agenda Item G.2.a, Attachment 1) and National Marine Fisheries Service (Agenda Item G.2.a, Attachment 2).

This action is for submission to the U.S. Secretary of Commerce, and the final motions must be visible in writing. To avoid unnecessary delay and confusion in proposing final regulations, minor edits may be made to the STT analysis and other documents provided by staff. If major deviations from existing documents are anticipated, Council members should be prepared to provide a written motion that can be projected on a screen or quickly photocopied. Please prepare your motion documents or advise Council staff of the need for, or existence of, additional working documents as early as possible before the final vote.

Council Action:

1. **Adopt final treaty Indian troll, non-Indian commercial and recreational ocean salmon fishery management measures for submission to the U.S. Secretary of Commerce.**
2. **If necessary, identify and justify any regulations requiring implementation by emergency rule.**

Reference Materials:

1. Agenda Item G.6.b, Supplemental STT Report: STT Analysis of Tentative 2011 Ocean Salmon Fishery Management Measures.

Agenda Order:

a. Agenda Item Overview — Chuck Tracy
b. Reports and Comments of Management Entities and Advisory Bodies
c. Public Comment
d. **Council Action:** Adopt Final Management Measures for 2011 Ocean Salmon Fisheries

PFMC
03/17/11

CALIFORNIA DEPARTMENT OF FISH AND GAME SUPPLEMENTAL REPORT ON COMMERCIAL SALMON SAMPLING GOALS, COSTS AND FUNDING SOURCES

Commercial landings of salmon must be sampled by CDFG at minimum levels to meet federal ocean salmon management data requirements for actively managed salmon stocks. All west coast recovery agencies, including California, strive to randomly sample at least 20 percent of commercial and sport landings to have a statistically acceptable estimate of total tag recoveries for a given area-time stratum. This ensures the recovery of coded-wire tags (CWTs) from rare salmon stocks, including ESA-listed Chinook salmon and other stocks of special concern in California's commercial fisheries. The Department has found it must schedule its sampling activities somewhat above the 20 percent minimum in each time-area strata to ensure that 20 percent of the fish taken in the fishery are ultimately sampled. For quota fisheries, the Department's dockside sampling efforts need to be substantially higher since real-time catch and effort data are generally needed daily in order to track and close these fisheries within 24 hours.

In California, approximately 20 ports spanning about 600 miles of coastline from Avila (San Luis Obispo County) to the California-Oregon border are sampled throughout the salmon season in accordance with these goals. Each salmon is examined during the commercial salmon offloading process and the heads are collected from all adipose fin-clipped salmon. All heads are transported to the Department's Santa Rosa Coded Wire Tag (CWT) lab for processing. The dockside sample data combined with the CWT data allows CDFG to determine the commercial fishery catch and effort information by species, time, and area, and allows the contribution of various stocks to the fishery to be determined at relatively fine scales as required for management. The information must be tabulated and analyzed by January of each year for use by the Council as part of the annual season setting process.

Table 1 provides a summary of the number of fish landed, the number of fish sampled, the number of heads collected, and the number of CWTs read each year from the California commercial fishery since 2003. Table 1 also provides information on the state and federal funds used to support these data collection efforts. Although federal funding for commercial salmon sampling was reduced to $0 in 2008 due to the loss of Anadromous Fisheries Act (AFA) monies, sampling costs were not incurred due to a complete closure of the commercial fishery in that year, or subsequently in 2009. Although some federal funds were provided to sample the state's limited 2010 commercial fisheries, no federal funds have been made available for 2011. Meanwhile, CDFG anticipates a significant increase over prior years in the number of commercial fish landed that will need to be sampled due to increased CWT tagging rates. In 2006, state and federal salmon hatcheries began a Constant Fractional Marking (CFM) program which increased mark rates to at least 25 percent. In 2011, most salmon that will be contacted in California ocean fisheries were produced under the CFM program, and

consequently, CDFG expects at least a threefold increase in the number of recovered heads over previous years.

CDFG recognizes that when commercial salmon opportunities are provided, revenue is generated to CDFG's Preservation Fund from landings taxes and the sale of commercial fishing licenses, vessel licenses, salmon vessel permits, and stamps. However, these funds are not earmarked to support only commercial sampling, as several other CDFG salmon programs including recreational fishery monitoring programs, enforcement of sport and commercial fisheries, licensing programs, and salmon habitat and restoration efforts are funded at least in part by these same preservation fund dollars.

While CDFG is fully supportive of providing fishing opportunities in accordance with conservation goals, we are mindful that as the number of open seasons and areas increase, sampling costs likewise increase. Sampling of fall or other credit card fisheries, which take place during a time in the year when little information is available on the size of the stock being fished, is particularly important. Sampling any fisheries open during these times should not be compromised due to funding or other limitations.

Table 1. CDFG Ocean Salmon Project's ocean salmon commercial fishery monitoring and CWT processing statistics, including Federal and State funding amounts, 2003-2011.

Year	# salmon landed	# salmon sampled	% salmon sampled	# days fished	# days open	# salmon heads collected	% salmon ad-clipped	Federal funding	Federal funding source	State funding
2003	491,894	114,639	23%	15,941	620	10,060	9%	$67,900	AFA	$251,200
2004	502,110	116,374	23%	21,733	562	12,192	10%	$64,500	AFA	$251,500
2005	340,862	113,005	33%	17,018	412	4,512	4%	$63,800	AFA	$253,000
2006	69,728	27,192	39%	8,259	333	1,072	4%	$65,000	AFA	$381,000
2007	113,406	40,932	36%	10,577	474	2,273	6%	$64,000	AFA	$427,200
2008	closed	--		--	--	--	--	$0	--	--
2009	closed	--		--	--	--	--	$0	--	--
2010	15,098	9,336	62%	1,979	54	1,257	13%	$88,000	PacFIN	$478,500
2011*	365,000	90,000	25%	16,700	373	**22,500**	25%	$0	--	$532,000

* Information for 2011 is projected based on an anticipated 2011 CA commercial harvest that would result from the season structure proposed to PFMC (Agenda item G.6 April 13 2011). Number of fish sampled would result from continuing at a 25 percent CDFG ocean fishery sample rate and encountering 25 percent of fish with adipose fin clips, corresponding to the CFM mark rate. If no fall fisheries were prosecuted in 2011, the catch is anticipated to be approximately 12 percent less than under the proposed season structure; resulting in 320,000 fish landed and 20,000 heads collected.

SALMON TECHNICAL TEAM

ANALYSIS OF TENTATIVE 2011 OCEAN SALMON FISHERY MANAGEMENT MEASURES

April 13, 2011

TABLE 1. Commercial troll management measures analyzed by the STT for non-Indian ocean salmon fisheries, 2011.4/13/11 08:37
(Page 1 of 5)

A. SEASON DESCRIPTIONS

North of Cape Falcon

Supplemental Management Information

1. Overall non-Indian TAC: 64,600 (non-mark-selective equivalent of 61,800) Chinook and 80,000 coho marked with a healed adipose fin clip (marked).
2. Non-Indian commercial troll TAC: 30,900 Chinook and 12,800 marked coho.
3. No preseason trade of Chinook or coho between non-Indian commercial and recreational fisheries.

U.S./Canada Border to Cape Falcon

- May 1 through earlier of June 30 or 20,600 Chinook quota.

Seven days per week (C.1). All salmon except coho (C.7). Cape Flattery, Mandatory Yelloweye Rockfish Conservation Area, and Columbia Control Zones closed (C.5). See gear restrictions and definitions (C.2, C.3).
An inseason conference call will occur when it is projected that 13,700 Chinook have been landed to consider modifying the open period to five days per week and adding landing and possession limits to ensure the guideline is not exceeded.

U.S./Canada Border to Cape Falcon

- July 1 through earlier of September 15 or 10,300 preseason Chinook guideline (C.8) or a 12,800 marked coho quota (C.8.d).

Friday through Tuesday; landing and possession limit of 50 Chinook and 50 coho per vessel per open period north of Leadbetter Point or 50 Chinook and 50 coho south of Leadbetter Point (C.1). All Salmon except no chum retention north of Cape Alava, Washington in August and September (C.7). All coho must be marked (C.8.d). See gear restrictions and definitions (C.2, C.3). Cape Flattery, Mandatory Yelloweye Rockfish Conservation Area, and Columbia Control Zones closed; Grays Harbor Control Zone closed in August and September (C.5).

Vessels must land and deliver their fish within 24 hours of any closure of this fishery. Under state law, vessels must report their catch on a state fish receiving ticket. Vessels fishing or in possession of salmon while fishing north of Leadbetter Point must land and deliver their fish within the area and north of Leadbetter Point. Vessels fishing or in possession of salmon while fishing south of Leadbetter Point must land and deliver their fish within the area and south of Leadbetter Point, except that Oregon permitted vessels may also land their fish in Garibaldi, Oregon. Oregon State regulations require all fishers landing salmon into Oregon from any fishery between Leadbetter Point, Washington and Cape Falcon, Oregon must notify ODFW within one hour of delivery or prior to transport away from the port of landing by either calling 541-867-0300 Ext. 271 or sending notification via e-mail to nfalcon.trollreport@state.or.us. Notification shall include vessel name and number, number of salmon by species, port of landing and location of delivery, and estimated time of delivery. Inseason actions may modify harvest guidelines in later fisheries to achieve or prevent exceeding the overall allowable troll harvest impacts (C.8).

TABLE 1. Commercial troll management measures analyzed by the STT for non-Indian ocean salmon fisheries, 2011. 4/13/11 08:37 (Page 2 of 5)

A. SEASON DESCRIPTIONS

South of Cape Falcon

Supplemental Management Information

1. Sacramento River Basin recreational fishery catch assumption: 61,400 adult Sacramento River fall Chinook.
2. Sacramento River fall Chinook spawning escapement of 377,000 adults.
3. Klamath River recreational fishery allocation: 7,900 adult Klamath River fall Chinook.
4. Klamath tribal allocation: 34,800 adult Klamath River fall Chinook.

Cape Falcon to Humbug Mt.

- April 15 through July 9, July 17 through August 31, October 1-31. (C.9).

Seven days per week. All salmon except coho; landing and possession limit of 50 Chinook per vessel per calendar week in October (C.7). All vessels fishing in the area must land their fish in the State of Oregon. See gear restrictions and definitions (C.2, C.3) and Oregon State regulations for a description of special regulations at the mouth of Tillamook Bay.

In 2012, the season will open March 15 for all salmon except coho. This opening could be modified following Council review at its March 2012 meeting.

Humbug Mt. to OR/CA Border (Oregon KMZ)

- May 1-31;
- June 1 through earlier of June 30, or a 1,500 Chinook quota;
- July 1 through earlier of July 31, or a 1,200 Chinook quota;
- Aug. 1 through earlier of Aug. 31, or a 1,000 Chinook quota (C.9).

Seven days per week. All salmon except coho (C.7). Chinook 28 inch total length minimum size limit (B). June 1 through August 31, landing and possession limit of 30 Chinook per vessel per day. Any remaining portion of the June and/or July Chinook quotas may be transferred inseason on an impact neutral basis to the next open quota period (C.8). All vessels fishing in this area must land and deliver all fish within this area or Port Orford, within 24 hours of any closure in this fishery, and prior to fishing outside of this area (C.1, C.6). Oregon State regulations require all fishers landing salmon from any quota managed season within this area to notify Oregon Dept. of Fish and Wildlife (ODFW) within 1 hour of delivery or prior to transport away from the port of landing by either calling (541) 867-0300 ext. 252 or sending notification via e-mail to KMZOR.trollreport@state.or.us. Notification shall include vessel name and number, number of salmon by species, port of landing and location of delivery, and estimated time of delivery. See gear restrictions and definitions (C.2, C.3).

In 2012, the season will open March 15 for all salmon except coho, with a 28 inch Chinook minimum size limit. This opening could be modified following Council review at its March 2012 meeting.

OR/CA Border to Humboldt South Jetty (California KMZ)

- July 2 through the earlier of July 20 or a 1,400 Chinook quota, Saturday to Wednesday;
- Aug. 1 through earlier of Aug. 15 or a 1,000 Chinook quota, seven days per week;
- Sept. 15 through earlier of Sept 30, or a 2,000 Chinook quota, seven days per week (C.9).

All salmon except coho (C.7). Chinook 27 inch total length minimum size limit (B). Landing and possession limit of 15 Chinook per vessel. Any remaining portion of the July Chinook quota may be transferred inseason on an impact neutral basis to the August quota (C.8) All vessels fishing in this area must land and deliver all fish within this area, within 24 hours of any closure in this fishery, and prior to fishing outside of this area (C.1, C.6). See compliance requirements (C.1) and gear restrictions and definitions (C.2, C.3). Klamath Control Zone closed (C.5.e). See California State regulations for additional closures adjacent to the Smith and Klamath rivers. When the fishery is closed between the OR/CA border and Humbug Mt. and open to the south, vessels with fish on board caught in the open area off California may seek temporary mooring in Brookings, Oregon prior to landing in California only if such vessels first notify the Chetco River Coast Guard Station via VHF channel 22A between the hours of 0500 and 2200 and provide the vessel name, number of fish on board, and estimated time of arrival.

Humboldt South Jetty to Horse Mt.

Closed.

California State regulations require all salmon be made available to a CDFG representative for sampling immediately at port of landing. Any person in possession of a salmon with a missing adipose fin, upon request by an authorized agent or employee of the CDFG, shall immediately relinquish the head of the salmon to the state. (California Fish and Game Code §8226)

TABLE 1. Commercial troll management measures analyzed by the STT for non-Indian ocean salmon fisheries, 2011. 4/13/11 08:37 (Page 3 of 5)

A. SEASON DESCRIPTIONS

South of Cape Falcon

Horse Mt. to Point Arena (Fort Bragg)

- July 23-27
- July 29 through Aug. 29;
- Sept. 1-30 (C.9).

Seven days per week. All salmon except coho (C.7). Chinook 27 inch total length minimum size limit (B). All fish caught in the area when the KMZ quota fisheries are open must be landed south of Horse Mt.; all fish must be landed in California and offloaded within 24 hours of the August 29 closure (C.1, C.6). See gear restrictions and definitions (C.2, C.3).

Pt. Arena to Pigeon Pt. (San Francisco)

- May 1-31 seven days per week
- June 25 through July 5 seven days per week
- July 9-27 Saturday through Wednesday
- July 29 through Aug. 29 seven days per week
- September 1-30 seven days per week (C.9).

All salmon except coho (C.7). Chinook minimum size limit of 27 inches total length (B). All fish must be landed in California and offloaded within 24 hours of the August 29 closure. All fish caught in the area when the KMZ quota fisheries are open must be landed south of Horse Mt. (C.1, C.6). See gear restrictions and definitions (C.2, C.3).

Pt. Reyes to Pt. San Pedro (Fall Area Target Zone)

- October 3-14

Monday through Friday. All salmon except coho (C.1). Chinook minimum size limit 27 inches total length (B). All vessels fishing in this area must land and deliver all fish between Point Arena and Pigeon Point (C.1, C.6). See gear restrictions and definitions (C.2, C.3).

Pigeon Pt. to Pt. Sur (Monterey)

Same as Pt. Arena to Pigeon Pt.

Pt. Sur to U.S./Mexico Border (Monterey south)

- May 1 through July 5 seven days per week
- July 9-27 Saturday through Wednesday
- July 29 through Aug. 29 seven days per week
- September 1-30 seven days per week (C.9).

All salmon except coho (C.7). Chinook minimum size limit of 27 inches total length (B). All fish must be landed in California; all fish caught in the area June 1-24 must be landed south of Pt. San Pedro; all fish caught in the area when the KMZ quota fisheries are open must be landed south of Horse Mt. (C.1, C.6). See gear restrictions and definitions (C.2, C.3).

California State regulations require all salmon be made available to a CDFG representative for sampling immediately at port of landing. Any person in possession of a salmon with a missing adipose fin, upon request by an authorized agent or employee of the CDFG, shall immediately relinquish the head of the salmon to the state. (California Fish and Game Code §8226)

B. MINIMUM SIZE (Inches) (See C.1)

	Chinook		Coho		
Area (when open)	Total Length	Head-off	Total Length	Head-off	Pink
North of Cape Falcon	28.0	21.5	16.0	12.0	None
Cape Falcon to OR/CA Border	28.0	21.5	-	-	None
OR/CA Border to U.S./Mexico Border	27.0	20.5	-	-	None

C. REQUIREMENTS, DEFINITIONS, RESTRICTIONS, OR EXCEPTIONS

C.1. Compliance with Minimum Size or Other Special Restrictions: All salmon on board a vessel must meet the minimum size, landing/possession limit, or other special requirements for the area being fished and the area in which they are landed if the area is open. Salmon may be landed in an area that has been closed more than 96 hours only if they meet the minimum size, landing/possession limit, or other special requirements for the area in which they were caught. Salmon may be landed in an area that has been closed less than 96 hours only if they meet the minimum size, landing/possession limit, or other special requirements for the areas in which they were caught and landed.

States may require fish landing/receiving tickets be kept on board the vessel for 90 days after landing to account for all previous salmon landings.

C. REQUIREMENTS, DEFINITIONS, RESTRICTIONS, OR EXCEPTIONS (continued)

C.2. Gear Restrictions:

a. Salmon may be taken only by hook and line using single point, single shank, barbless hooks.
b. Cape Falcon, Oregon, to the OR/CA border: No more than 4 spreads are allowed per line.
c. OR/CA border to U.S./Mexico border: No more than 6 lines are allowed per vessel, and barbless circle hooks are required when fishing with bait by any means other than trolling.C.3. Gear Definitions:

Trolling defined: Fishing from a boat or floating device that is making way by means of a source of power, other than drifting by means of the prevailing water current or weather conditions.

Troll fishing gear defined: One or more lines that drag hooks behind a moving fishing vessel. In that portion of the fishery management area (FMA) off Oregon and Washington, the line or lines must be affixed to the vessel and must not be intentionally disengaged from the vessel at any time during the fishing operation.

Spread defined: A single leader connected to an individual lure and/or bait.

Circle hook defined: A hook with a generally circular shape and a point which turns inward, pointing directly to the shank at a 90º angle.

C.4. Transit Through Closed Areas with Salmon on Board: It is unlawful for a vessel to have troll or recreational gear in the water while transiting any area closed to fishing for a certain species of salmon, while possessing that species of salmon; however, fishing for species other than salmon is not prohibited if the area is open for such species, and no salmon are in possession.

C.5. Control Zone Definitions:

a. *Cape Flattery Control Zone* - The area from Cape Flattery (48º23'00" N. lat.) to the northern boundary of the U.S. EEZ; and the area from Cape Flattery south to Cape Alava (48º10'00" N. lat.) and east of 125º05'00" W. long.
b. *Mandatory Yelloweye Rockfish Conservation Area* – The area in Washington Marine Catch Area 3 from 48°00.00' N. lat.; 125°14.00' W. long. to 48°02.00' N. lat.; 125°14.00' W. long. to 48°02.00' N. lat.; 125°16.50' W. long. to 48°00.00' N. lat.; 125°16.50' W. long. and connecting back to 48°00.00' N. lat.; 125°14.00' W. long.
c. *Grays Harbor Control Zone* - The area defined by a line drawn from the Westport Lighthouse (46° 53'18" N. lat., 124° 07'01" W. long.) to Buoy #2 (46° 52'42" N. lat., 124°12'42" W. long.) to Buoy #3 (46° 55'00" N. lat., 124°14'48" W. long.) to the Grays Harbor north jetty (46° 36'00" N. lat., 124°10'51" W. long.).
d. *Columbia Control Zone* - An area at the Columbia River mouth, bounded on the west by a line running northeast/southwest between the red lighted Buoy #4 (46°13'35" N. lat., 124°06'50" W. long.) and the green lighted Buoy #7 (46°15'09' N. lat., 124°06'16" W. long.); on the east, by the Buoy #10 line which bears north/south at 357° true from the south jetty at 46°14'00" N. lat.,124°03'07" W. long. to its intersection with the north jetty; on the north, by a line running northeast/southwest between the green lighted Buoy #7 to the tip of the north jetty (46°15'48" N. lat., 124°05'20" W. long.), and then along the north jetty to the point of intersection with the Buoy #10 line; and, on the south, by a line running northeast/southwest between the red lighted Buoy #4 and tip of the south jetty (46°14'03" N. lat., 124°04'05" W. long.), and then along the south jetty to the point of intersection with the Buoy #10 line.
e. *Klamath Control Zone* - The ocean area at the Klamath River mouth bounded on the north by 41°38'48" N. lat. (approximately six nautical miles north of the Klamath River mouth); on the west, by 124°23'00" W. long. (approximately 12 nautical miles off shore); and on the south, by 41°26'48" N. lat. (approximately six nautical miles south of the Klamath River mouth).

C.6. Notification When Unsafe Conditions Prevent Compliance with Regulations: If prevented by unsafe weather conditions or mechanical problems from meeting special management area landing restrictions, vessels must notify the U.S. Coast Guard and receive acknowledgment of such notification prior to leaving the area. This notification shall include the name of the vessel, port where delivery will be made, approximate amount of salmon (by species) on board, the estimated time of arrival, and the specific reason the vessel is not able to meet special management area landing restrictions.

In addition to contacting the U.S. Coast Guard, vessels fishing south of the Oregon/California border must notify CDFG within one hour of leaving the management area by calling 800-889-8346 and providing the same information as reported to the U.S. Coast Guard. All salmon must be offloaded within 24 hours of reaching port.

C. REQUIREMENTS, DEFINITIONS, RESTRICTIONS, OR EXCEPTIONS (continued)

C.7. Incidental Halibut Harvest: During authorized periods, the operator of a vessel that has been issued an incidental halibut harvest license may retain Pacific halibut caught incidentally in Area 2A while trolling for salmon. Halibut retained must be no less than 32 inches in total length, measured from the tip of the lower jaw with the mouth closed to the extreme end of the middle of the tail, and must be landed with the head on. License applications for incidental harvest must be obtained from the International Pacific Halibut Commission (phone: 206-634-1838). Applicants must apply prior to April 1 of each year. Incidental harvest is authorized only during May and June troll seasons and after June 30 if quota remains and if announced on the NMFS hotline (phone: 800-662-9825). ODFW and Washington Department of Fish and Wildlife (WDFW) will monitor landings. If the landings are projected to exceed the 28,126 pound preseason allocation or the total Area 2A non-Indian commercial halibut allocation, NMFS will take inseason action to prohibit retention of halibut in the non-Indian salmon troll fishery.

Beginning May 1, license holders may land no more than one Pacific halibut per each 3 Chinook, except one Pacific halibut may be landed without meeting the ratio requirement, and no more than 35 halibut may be landed per trip. Pacific halibut retained must be no less than 32 inches in total length (with head on).

A "C-shaped" yelloweye rockfish conservation area is an area to be voluntarily avoided for salmon trolling. NMFS and the Council request salmon trollers voluntarily avoid this area in order to protect yelloweye rockfish. The area is defined in the Pacific Council Halibut Catch Sharing Plan in the North Coast subarea (Washington marine area 3), with the following coordinates in the order listed:

48°18' N. lat.; 125°18' W. long.;
48°18' N. lat.; 124°59' W. long.;
48°11' N. lat.; 124°59' W. long.;
48°11' N. lat.; 125°11' W. long.;
48°04' N. lat.; 125°11' W. long.;
48°04' N. lat.; 124°59' W. long.;
48°00' N. lat.; 124°59' W. long.;
48°00' N. lat.; 125°18' W. long.;
and connecting back to 48°18' N. lat.; 125°18' W. long.

C.8. Inseason Management: In addition to standard inseason actions or modifications already noted under the season description, the following inseason guidance is provided to NMFS:

a. Chinook remaining from the May through June non-Indian commercial troll harvest guideline north of Cape Falcon may be transferred to the July through September harvest guideline on a fishery impact equivalent basis.
b. Chinook remaining from the June and/or July non-Indian commercial troll quotas in the Oregon KMZ may be transferred to the Chinook quota for the next open period on a fishery impact equivalent basis.
c. Chinook remaining from the July non-Indian commercial troll quota in the California KMZ area may be transferred to the August quota on a fishery impact equivalent basis.
d. NMFS may transfer fish between the recreational and commercial fisheries north of Cape Falcon on a fishery impact equivalent basis if there is agreement among the areas' representatives on the Salmon Advisory Subpanel (SAS).
e. At the March 2012 meeting, the Council will consider inseason recommendations for special regulations for any experimental fisheries (proposals must meet Council protocol and be received in November 2011).
f. If retention of unmarked coho is permitted by inseason action, the allowable coho quota will be adjusted to ensure preseason projected mortality of critical stocks is not exceeded.
g. Landing limits may be modified inseason to sustain season length and keep harvest within overall quotas.

C.9. State Waters Fisheries: Consistent with Council management objectives:

a. The State of Oregon may establish additional late-season fisheries in state waters.
b. The State of California may establish limited fisheries in selected state waters.

Check state regulations for details.

C.10. For the purposes of California Department of Fish and Game (CDFG) Code, Section 8232.5, the definition of the Klamath Management Zone (KMZ) for the ocean salmon season shall be that area from Humbug Mt., Oregon, to Horse Mt., California.

TABLE 2. Recreational management measures analyzed by the STT for non-Indian ocean salmon fisheries, 2011. (Page 1 of 4)
4/13/11 08:38

A. SEASON DESCRIPTIONS

North of Cape Falcon

Supplemental Management Information

1. Overall non-Indian TAC: 64,600 (non-mark-selective equivalent of 61,800) Chinook and 80,000 coho marked with a healed adipose fin clip (marked).
2. Recreational TAC: 33,700 (non-mark selective equivalent of 30,900) Chinook and 67,200 marked coho; all retained coho must be marked.
3. No preseason trade of Chinook or coho between non-Indian commercial and recreational fisheries.
4. No Area 4B add-on fishery.
5. Buoy 10 fishery opens Aug. 1 with an expected landed catch of 7,000 marked coho in August and September.

U.S./Canada Border to Cape Falcon

- June 18 through earlier of June 25 or a coastwide **marked Chinook quota of 4,800** (C.5).

Seven days per week. Two fish per day, all salmon except coho, **all Chinook must be marked with a healed adipose fin clip (C.1)**. Chinook 24-inch total length minimum size limit (B). See gear restrictions (C.2). Inseason management may be used to sustain season length and keep harvest within the overall Chinook recreational TAC for north of Cape Falcon (C.5).

U.S./Canada Border to Cape Alava (Neah Bay)

- June 26 through earlier of September 18 or 6,990 marked coho subarea quota with a subarea guideline of 3,200 Chinook. (C.5).

Seven days per week. All salmon except no chum beginning August 1; two fish per day, no more than one of which can be a Chinook, plus one additional pink salmon. All coho must be marked (C.1). See gear restrictions (C.2). Beginning August 1, Chinook non-retention east of the Bonilla-Tatoosh line (C.4.a) during Council managed ocean fishery. Inseason management may be used to sustain season length and keep harvest within the overall Chinook and coho recreational TACs for north of Cape Falcon (C.5).

Cape Alava to Queets River (La Push Subarea)

- June 26 through earlier of September 18 or 1,700 marked coho subarea quota with a subarea guideline of 1,350 Chinook. (C.5).
- September 24 through earlier of October 9 or 50 marked coho quota or 50 Chinook quota (C.5) in the area north of 47°50'00 N. lat. and south of 48°00'00" N. lat.

Seven days per week. All salmon; two fish per day, no more than one of which can be a Chinook, plus one additional pink salmon. All coho must be marked (C.1). See gear restrictions (C.2). Inseason management may be used to sustain season length and keep harvest within the overall Chinook and coho recreational TACs for north of Cape Falcon (C.5).

Queets River to Leadbetter Point (Westport Subarea)

- June 26 through earlier of September 18 or 24,860 marked coho subarea quota with a subarea guideline of 16,900 Chinook (C.5).

Sunday through Thursday. All salmon; two fish per day, no more than one of which can be a Chinook. All coho must be marked (C.1). See gear restrictions and definitions (C.2, C.3). Grays Harbor Control Zone closed beginning August 1 (C.4). Inseason management may be used to sustain season length and keep harvest within the overall Chinook and coho recreational TACs for north of Cape Falcon (C.5).

Leadbetter Point to Cape Falcon (Columbia River Subarea)

- June 26 through earlier of September 30 or 33,600 marked coho subarea quota with a subarea guideline of 7,400 Chinook (C.5).

Seven days per week. All salmon; two fish per day, no more than one of which can be a Chinook. All coho must be marked (C.1). See gear restrictions and definitions (C.2, C.3). Columbia Control Zone closed (C.4.c). Inseason management may be used to sustain season length and keep harvest within the overall Chinook and coho recreational TACs for north of Cape Falcon (C.5).

TABLE 2. Recreational management measures analyzed by the STT for non-Indian ocean salmon fisheries, 2011. (Page 2 of 4)
4/13/11 08:38

A. SEASON DESCRIPTIONS

South of Cape Falcon

Supplemental Management Information

1. Sacramento River Basin recreational fishery catch assumption: 61,400 adult Sacramento River fall Chinook.
2. Sacramento River fall Chinook spawning escapement of 377,000 adults.
3. Klamath River recreational fishery allocation: 7,900 adult Klamath River fall Chinook.
4. Klamath tribal allocation: 34,800 adult Klamath River fall Chinook.
5. Overall recreational TAC: 15,000 marked coho and 3,000 unmarked coho.

Cape Falcon to Humbug Mt.

- Except as provided below during the all-salmon mark-selective **and non-mark-selective coho fisheries**, the season will be March 15 through September 30 (C.6).

All salmon except coho; two fish per day (C.1). See gear restrictions and definitions (C.2, C.3).

- Cape Falcon to Humbug Mt. all-salmon mark-selective coho fishery: July 2 through earlier of August 13 or a landed catch of 15,000 marked coho.

Seven days per week. All salmon, two fish per day. All retained coho must be marked (C.1). Any remainder of the mark selective coho quota will be transferred on an impact neutral basis to the September non-selective coho quota listed below. The all salmon except coho season reopens the earlier of August 14 or attainment of the coho quota, through August 31.

- Cape Falcon to Humbug Mt. **non-mark-selective coho fishery**: September 1 through the earlier of September 10 or a landed catch of 3,000 **non-mark-selective coho quota (C.5)**.

Thursday through Saturday **all salmon**, two fish per day;
Sunday through Wednesday, **all salmon except coho**, two fish per day.

The all salmon except coho season reopens the earlier of September 11 or attainment of the coho quota (C.5). Open days may be adjusted inseason to utilize the available coho quota (C.5).

Fishing in the Stonewall Bank yelloweye rockfish conservation area restricted to trolling only on days the all depth recreational halibut fishery is open (call the halibut fishing hotline 1-800-662-9825 for specific dates) (C.3.b, C.4.d).

In 2012, the season between Cape Falcon and Humbug Mt. will open March 15 for all salmon except coho, two fish per day (B, C.1, C.2, C.3).

Humbug Mt. to OR/CA Border. (Oregon KMZ)

- May 14 through September 5 (C.6).

Seven days per week. All salmon except coho, two fish per day (C.1). Chinook minimum size limit of 24 inches total length (B). See gear restrictions and definitions (C.2, C.3).

OR/CA Border to Horse Mt. (California KMZ)

- May 14 through September 5 (C.6).

Seven days per week. All salmon except coho, two fish per day (C.1). Chinook minimum size limit of 24 inches total length (B). See gear restrictions and definitions (C.2, C.3). Klamath Control Zone closed in August (C.4.e). See California State regulations for additional closures adjacent to the Smith, Eel, and Klamath rivers.

Horse Mt. to Point Arena (Fort Bragg)

- April 2 through November 13.

Seven days per week. All salmon except coho, two fish per day (C.1). Chinook minimum size limit of 24 inches total length (B). See gear restrictions and definitions (C.2, C.3).

In 2012, season opens February 18 for all salmon except coho, two fish per day (C.1). Chinook minimum size limit of 24 inches total length (B); and the same gear restrictions as in 2011 (C.2, C.3).

Point Arena to Pigeon Pt. (San Francisco)

- April 2 through November 13.

Seven days per week. All salmon except coho, two fish per day (C.1). Chinook minimum size limit of 24 inches total length (B). See gear restrictions and definitions (C.2, C.3).

In 2012, season opens April 7 for all salmon except coho, two fish per day (C.1). Chinook minimum size limit of 24 inches total length (B); and the same gear restrictions as in 2011 (C.2, C.3).

TABLE 2. Recreational management measures analyzed by the STT for non-Indian ocean salmon fisheries, 2011. (Page 3 of 4)
4/13/11 08:38

A. SEASON DESCRIPTIONS

South of Cape Falcon

Pigeon Point to U.S./Mexico Border (Monterey South)

- April 2 through October 2.

Seven days per week. All salmon except coho, two fish per day (C.1). Chinook minimum size limit of 24 inches total length (B). See gear restrictions and definitions (C.2, C.3).

In 2012, season opens April 7 for all salmon except coho, two fish per day (C.1). Chinook minimum size limit of 24 inches total length (B); and the same gear restrictions as in 2011 (C.2, C.3).

California State regulations require all salmon be made available to a CDFG representative for sampling immediately at port of landing. Any person in possession of a salmon with a missing adipose fin, upon request by an authorized agent or employee of the CDFG, shall immediately relinquish the head of the salmon to the state. (California Fish and Game Code §8226)

B. MINIMUM SIZE (Inches) (See C.1)

Area (when open)	Chinook	Coho	Pink
North of Cape Falcon	24.0	16.0	None
Cape Falcon to OR/CA Border	24.0	16.0	None
OR/CA Border to U.S./Mexico Border	24.0	-	24.0

C. REQUIREMENTS, DEFINITIONS, RESTRICTIONS, OR EXCEPTIONS

C.1. Compliance with Minimum Size and Other Special Restrictions: All salmon on board a vessel must meet the minimum size or other special requirements for the area being fished and the area in which they are landed if that area is open. Salmon may be landed in an area that is closed only if they meet the minimum size or other special requirements for the area in which they were caught.

Ocean Boat Limits: Off the coast of Washington, Oregon, and California, each fisher aboard a vessel may continue to use angling gear until the combined daily limits of salmon for all licensed and juvenile anglers aboard has been attained (additional state restrictions may apply).

C.2. Gear Restrictions: Salmon may be taken only by hook and line using barbless hooks. All persons fishing for salmon, and all persons fishing from a boat with salmon on board, must meet the gear restrictions listed below for specific areas or seasons.

a. *U.S./Canada Border to Point Conception, California*: No more than one rod may be used per angler; and no more than two single point, single shank barbless hooks are required for all fishing gear. [Note: ODFW regulations in the state-water fishery off Tillamook Bay may allow the use of barbed hooks to be consistent with inside regulations.]

b. *Horse Mt., California, to Point Conception, California*: Single point, single shank, barbless circle hooks (see gear definitions below) are required when fishing with bait by any means other than trolling, and no more than two such hooks shall be used. When angling with two hooks, the distance between the hooks must not exceed five inches when measured from the top of the eye of the top hook to the inner base of the curve of the lower hook, and both hooks must be permanently tied in place (hard tied). Circle hooks are not required when artificial lures are used without bait.

C.3. Gear Definitions:

a. *Recreational fishing gear defined*: Angling tackle consisting of a line with no more than one artificial lure and/or natural bait attached. Off Oregon and Washington, the line must be attached to a rod and reel held by hand or closely attended; the rod and reel must be held by hand while playing a hooked fish. No person may use more than one rod and line while fishing off Oregon or Washington. Off California, the line must be attached to a rod and reel held by hand or closely attended; weights directly attached to a line may not exceed four pounds (1.8 kg). While fishing off California north of Point Conception, no person fishing for salmon, and no person fishing from a boat with salmon on board, may use more than one rod and line. Fishing includes any activity which can reasonably be expected to result in the catching, taking, or harvesting of fish.

b. *Trolling defined*: Angling from a boat or floating device that is making way by means of a source of power, other than drifting by means of the prevailing water current or weather conditions.

c. *Circle hook defined*: A hook with a generally circular shape and a point which turns inward, pointing directly to the shank at a 90° angle.

TABLE 2. Recreational management measures analyzed by the STT for non-Indian ocean salmon fisheries, 2011. (Page 3 of 4) 4/13/11 08:38

C. REQUIREMENTS, DEFINITIONS, RESTRICTIONS, OR EXCEPTIONS

C.4. Control Zone Definitions:

a. *The Bonilla-Tatoosh Line*: A line running from the western end of Cape Flattery to Tatoosh Island Lighthouse (48°23'30" N. lat., 124°44'12" W. long.) to the buoy adjacent to Duntze Rock (48°28'00" N. lat., 124°45'00" W. long.), then in a straight line to Bonilla Point (48°35'30" N. lat., 124°43'00" W. long.) on Vancouver Island, British Columbia.

b. *Grays Harbor Control Zone* - The area defined by a line drawn from the Westport Lighthouse (46° 53'18" N. lat., 124° 07'01" W. long.) to Buoy #2 (46° 52'42" N. lat., 124°12'42" W. long.) to Buoy #3 (46° 55'00" N. lat., 124°14'48" W. long.) to the Grays Harbor north jetty (46° 36'00" N. lat., 124°10'51" W. long.).

c. *Columbia Control Zone*: An area at the Columbia River mouth, bounded on the west by a line running northeast/southwest between the red lighted Buoy #4 (46°13'35" N. lat., 124°06'50" W. long.) and the green lighted Buoy #7 (46°15'09' N. lat., 124°06'16" W. long.); on the east, by the Buoy #10 line which bears north/south at 357° true from the south jetty at 46°14'00" N. lat., 124°03'07" W. long. to its intersection with the north jetty; on the north, by a line running northeast/southwest between the green lighted Buoy #7 to the tip of the north jetty (46°15'48" N. lat., 124°05'20" W. long. and then along the north jetty to the point of intersection with the Buoy #10 line; and on the south, by a line running northeast/southwest between the red lighted Buoy #4 and tip of the south jetty (46°14'03" N. lat., 124°04'05" W. long.), and then along the south jetty to the point of intersection with the Buoy #10 line.

d. *Stonewall Bank Yelloweye Rockfish Conservation Area*: The area defined by the following coordinates in the order listed:
   44°37.46' N. lat.; 124°24.92' W. long.;
   44°37.46' N. lat.; 124°23.63' W. long.;
   44°28.71' N. lat.; 124°21.80' W. long.;
   44°28.71' N. lat.; 124°24.10' W. long.;
   44°31.42' N. lat.; 124°25.47' W. long.;
   and connecting back to 44°37.46' N. lat.; 124°24.92' W. long.

e. *Klamath Control Zone*: The ocean area at the Klamath River mouth bounded on the north by 41°38'48" N. lat. (approximately six nautical miles north of the Klamath River mouth); on the west, by 124°23'00" W. long. (approximately 12 nautical miles off shore); and, on the south, by 41°26'48" N. lat. (approximately 6 nautical miles south of the Klamath River mouth).

C.5. Inseason Management: Regulatory modifications may become necessary inseason to meet preseason management objectives such as quotas, harvest guidelines, and season duration. In addition to standard inseason actions or modifications already noted under the season description, the following inseason guidance is provided to NMFS:

a. Actions could include modifications to bag limits, or days open to fishing, and extensions or reductions in areas open to fishing.

b. Coho may be transferred inseason among recreational subareas north of Cape Falcon on a fishery impact equivalent basis to help meet the recreational season duration objectives (for each subarea) after conferring with representatives of the affected ports and the Council's SAS recreational representatives north of Cape Falcon.

c. Chinook and coho may be transferred between the recreational and commercial fisheries north of Cape Falcon on a fishery impact equivalent basis if there is agreement among the representatives of the Salmon Advisory Subpanel (SAS).

d. If retention of unmarked coho is permitted in the area from the U.S./Canada border to Cape Falcon, Oregon, by inseason action, the allowable coho quota will be adjusted to ensure preseason projected mortality of critical stocks is not exceeded.

e. Marked coho remaining from the June/July through August Cape Falcon to OR/CA border recreational coho quota may be transferred inseason to the September Cape Falcon to Humbug Mt. non-mark-selective recreational fishery on a fishery impact equivalent basis.

C.6. Additional Seasons in State Territorial Waters: Consistent with Council management objectives, the States of Washington, Oregon, and California may establish limited seasons in state waters. Check state regulations for details.

TABLE 3. Treaty Indian ocean troll management measures analyzed by the STT for ocean salmon fisheries, 2011. 4/13/2011 8:38 AM
(Page 1 of 1)

A. SEASON DESCRIPTIONS

Supplemental Management Information

1. Overall Treaty-Indian TAC: 41,000 Chinook and 42,000 coho.

May 1 through the earlier of June 30 or 19,750 Chinook quota.
All salmon except coho. If the Chinook quota for the May-June fishery is not fully utilized, the excess fish cannot be transferred into the later all-salmon season. If the Chinook quota is exceeded, the excess will be deducted from the later all-salmon season. See size limit (B) and other restrictions (C).

• July 1 through the earlier of September 15, or 21,250 preseason Chinook quota, or 42,000 coho quota.
All salmon. See size limit (B) and other restrictions (C).

B. MINIMUM SIZE (Inches)

	Chinook		Coho		
Area (when open)	Total Length	Head-off	Total Length	Head-off	Pink
North of Cape Falcon	24.0 (61.0 cm)	18.0 (45.7 cm)	16.0 (40.6 cm)	12.0 (30.5 cm)	None

C. REQUIREMENTS, DEFINITIONS, RESTRICTIONS, OR EXCEPTIONS

C.1. Tribe and Area Boundaries. All boundaries may be changed to include such other areas as may hereafter be authorized by a Federal court for that tribe's treaty fishery.

S'KLALLAM - Washington State Statistical Area 4B (All).

MAKAH - Washington State Statistical Area 4B and that portion of the FMA north of 48°02'15" N. lat. (Norwegian Memorial) and east of 125°44'00" W. long.

QUILEUTE - That portion of the FMA between 48°07'36" N. lat. (Sand Pt.) and 47°31'42" N. lat. (Queets River) and east of 125°44'00" W. long.

HOH - That portion of the FMA between 47°54'18" N. lat. (Quillayute River) and 47°21'00" N. lat. (Quinault River) and east of 125°44'00" W. long.

QUINAULT - That portion of the FMA between 47°40'06" N. lat. (Destruction Island) and 46°53'18"N. lat. (Point Chehalis) and east of 125°44'00" W. long.

C.2. Gear restrictions
- a. Single point, single shank, barbless hooks are required in all fisheries.
- b. No more than eight fixed lines per boat.
- c. No more than four hand held lines per person in the Makah area fishery (Washington State Statistical Area 4B and that portion of the FMA north of 48°02'15" N. lat. (Norwegian Memorial) and east of 125°44'00" W. long.)

C.3. Quotas
- a. The quotas include troll catches by the S'Klallam and Makah tribes in Washington State Statistical Area 4B from May 1 through September 15.
- b. The Quileute Tribe will continue a ceremonial and subsistence fishery during the time frame of September 15 through October 15 in the same manner as in 2004-2010. Fish taken during this fishery are to be counted against treaty troll quotas established for the 2011 season (estimated harvest during the October ceremonial and subsistence fishery: 100 Chinook; 200 coho).

C.4. Area Closures
- a. The area within a six nautical mile radius of the mouths of the Queets River (47°31'42" N. lat.) and the Hoh River (47°45'12" N. lat.) will be closed to commercial fishing.
- b. A closure within two nautical miles of the mouth of the Quinault River (47°21'00" N. lat.) may be enacted by the Quinault Nation and/or the State of Washington and will not adversely affect the Secretary of Commerce's management regime.

TABLE 4. Chinook and coho harvest quotas and guidelines (*) for 2011 ocean salmon fishery management measures analyzed by the STT.

Fishery or Quota Designation	Chinook	Coho
NORTH OF CAPE FALCON		
TREATY INDIAN OCEAN TROLL		
U.S./Canada Border to Cape Falcon (All Except Coho)	19,750	-
U.S./Canada Border to Cape Falcon (All Species)	21,250	42,000
Subtotal Treaty Indian Ocean Troll	41,000	42,000
NON-INDIAN COMMERCIAL TROLL [a/]		
U.S./Canada Border to Cape Falcon (All Except Coho)	20,600	-
U.S./Canada Border to Cape Falcon (All Species)	10,300	12,800
Subtotal Non-Indian Commercial Troll	30,900	12,800
RECREATIONAL[a/]		
U.S./Canada Border to Cape Falcon (All Except Coho)	4,800 [b/]	-
U.S./Canada Border to Cape Alava	3,200 *	6,990
Cape Alava to Queets River	1,400 *	1,750
Queets River to Leadbetter Pt.	16,900 *	24,860
Leadbetter Pt. to Cape Falcon[c/]	7,400 *	33,600
Subtotal Recreational	33,700	67,200
TOTAL NORTH OF CAPE FALCON	105,600	122,000
SOUTH OF CAPE FALCON		
COMMERCIAL TROLL		
Humbug Mt. to OR/CA Border	3,700	-
OR/CA Border to Humboldt South Jetty	4,400	-
Subtotal Troll	8,100	-
RECREATIONAL[d/]		
Cape Falcon to OR/CA Border	-	18,000
TOTAL SOUTH OF CAPE FALCON	8,100	18,000

a/ The coho quota is a landed catch of coho marked with a healed adipose fin clip (marked).

b/ The Chinook quota is a landed catch of Chinook marked with a healed adipose fin clip (marked) and is equivalent to a non-mark-selective quota of about 2,800.

c/ Does not include Buoy 10 fishery (7,000 marked coho).

d/ The coho quota includes landed catch of 15,000 marked-selective and 3,000 non-mark selective quotas.

TABLE 5. Projected key stock escapements (thousands of fish) or management criteria for 2011 ocean fishery management measures analyzed by the STT.a/ (Page 1 of 3)

Key Stock/Criteria	Projected Ocean Escapement[b/] or Other Criteria (Council Area Fisheries)	Spawner Objective or Other Comparative Standard as Noted
		CHINOOK
PUGET SOUND:		
Elwha Summer/Fall	3.9%	≤ 10.0% Southern U.S. Rebuilding Exploitation Rate (NMFS ESA consultation standard)
Dungeness Spring	4.0%	≤ 10.0% Southern U.S. Rebuilding Exploitation Rate (NMFS ESA consultation standard)
Mid-Hood Canal Summer/Fall	11.8%	≤ 15.0% Preterminal Southern U.S. CERC (NMFS ESA consultation standard)
Skokomish Summer/Fall	50.0%	≤ 50.0% Total Rebuilding Exploitation Rate (NMFS ESA consultation standard)
Nooksack Spring	7.9%	≤ 7.0% Southern U.S. CERC, not to exceed in four out of five years (NMFS ESA consultation standard)
	41.0%	≤ 60.0% ISBM Index (PSC general obligation)
Skagit Summer/Fall	49.9%	≤ 50.0% Total Rebuilding Exploitation Rate (NMFS ESA consultation standard)
	54.0%	≤ 60.0% ISBM Index (PSC general obligation)
Skagit Spring	28.5%	≤ 38.0% Total Rebuilding Exploitation Rate (NMFS ESA consultation standard)
	44.0%	≤ 60.0% ISBM Index (PSC general obligation)
Stillaguamish Summer/Fall	23.4%	≤ 25.0% Total Rebuilding Exploitation Rate (NMFS ESA consultation standard)
	36.0%	≤ 60.0% ISBM Index (PSC general obligation)
Snohomish Summer/Fall	10.7%	≤ 15.0% Southern U.S. Rebuilding Exploitation Rate (NMFS ESA consultation standard)
	28.0%	≤ 60.0% ISBM Index (PSC general obligation)
Lake Washington Summer/Fall	15.8%	≤ 20.0% Southern U.S. Rebuilding Exploitation Rate (NMFS ESA consultation standard)
	57.0%	≤ 60.0% ISBM Index (PSC general obligation)
Green River Summer/Fall	8.4%	≤ 15.0% Preterminal Southern U.S. Rebuilding Exploitation Rate and
	5.3[c/]	≥ 5.800 Natural spawning escapement (NMFS ESA consultation standard)
	35.0%	≤ 60.0% ISBM Index (PSC general obligation)
White River Spring	19.4%	≤ 20.0% Total Rebuilding Exploitation Rate (NMFS ESA consultation standard)
Puyallup Summer/Fall	48.3%	≤ 50.0% Total Rebuilding Exploitation Rate (NMFS ESA consultation standard)
Nisqually River Summer/Fall	64.8%	≤ 65.0% Total Rebuilding Exploitation Rate (NMFS ESA consultation standard)
WASHINGTON COAST:		
Hoko Fall	41.9%	≤ 60.0% ISBM Index (PSC general obligation)
Quillayute Fall	105.8%	≤ 60.0% ISBM Index (PSC general obligation) not applicable for 2011 because escapement objective met
Hoh Fall	76.0%	≤ 60.0% ISBM Index (PSC general obligation) not applicable for 2011 because escapement objective met
Queets Fall	32.7%	≤ 60.0% ISBM Index (PSC general obligation)
Grays Harbor Fall	55.0%	≤ 60.0% ISBM Index (PSC general obligation)

TABLE 5. Projected key stock escapements (thousands of fish) or management criteria for 2011 ocean fishery management measures analyzed by the STT.a/ (Page 2 of 3)

Key Stock/Criteria	Projected Ocean Escapement[b/] or Other Criteria (Council Area Fisheries)	Spawner Objective or Other Comparative Standard as Noted
		CHINOOK
COLUMBIA RIVER		
Columbia Upriver Brights	399.5	74.0 Minimum ocean escapement to attain 60.0 adults over McNary Dam, with normal distribution and no mainstem harvest.
	84.1%	≤ 60.0% ISBM Index (PSC general obligation) not applicable for 2011 because escapement objective met
Deschutes Upriver Brights	104.4%	≤ 60.0% ISBM Index (PSC general obligation) not applicable for 2011 because escapement objective met
Snake River Fall (threatened) SRFI	50.5%	≤ 70.0% Of 1988-1993 base period exploitation rate for all ocean fisheries (NMFS ESA consultation standard).
Mid-Columbia Brights	100.4	11.0 Minimum ocean escapement to attain 4.7 adults for Bonneville Hatchery and 2.0 for Little White Salmon Hatchery egg-take, assuming average conversion and no mainstem harvest.
Columbia Lower River Hatchery Tules	128.6	23.8 Minimum ocean escapement to attain 12.6 adults for hatchery egg-take, with average conversion and no lower river mainstem or tributary harvest.
Columbia Lower River Natural Tules (threatened)	37.0%	≤ 37.0% Total adult equivalent fishery exploitation rate; 2011 ESA guidance (NMFS ESA consultation standard).
Columbia Lower River Wild[d/] (threatened)	13.1	6.9 Minimum ocean escapement to attain MSY spawner goal of 5.7 for N. Lewis River fall Chinook (NMFS ESA consultation standard).
	35.0%	≤ 60.0% ISBM Index (PSC general obligation)
Spring Creek Hatchery Tules	116.4	8.2 Minimum ocean escapement to attain 7.0 adults for Spring Creek Hatchery egg-take, assuming average conversion and no mainstem harvest.
Upriver Summer	39.8%	≤ 60.0% ISBM Index (PSC general obligation)
OREGON COAST:		
Nehalem Fall	214.6%	≤ 60.0% ISBM Index (PSC general obligation) not applicable for 2011 because escapement objective met
Siletz Fall	64.3%	≤ 60.0% ISBM Index (PSC general obligation) not applicable for 2011 because escapement objective met
Siuslaw Fall	122.7%	≤ 60.0% ISBM Index (PSC general obligation) not applicable for 2011 because escapement objective met
CALIFORNIA		
Klamath River Fall	35.0	35.0 Minimum number of adult spawners to natural spawning areas; FMP.
Federally recognized tribal harvest	50.0%	50.0% Equals 34.8 (thousand) adult fish for Yurok and Hoopa tribal fisheries.
Spawner Reduction Rate	53.8%	≤ 66.7% Equals 40.8 (thousand) fewer natural adult spawners due to fishing.
Adult river mouth return	101.5	NA Natural and hatchery adults.
Age-4 ocean harvest rate	16.0%	≤ 16.0% NMFS ESA consultation standard for threatened California Coastal Chinook.
KMZ sport fishery share	12.8%	No Council guidance for 2011.
River recreational fishery share	22.8%	≥ 15% 2011 Council Guidance. Equals 7.9 (thousand) adult fish for recreational inriver fisheries.
Sacramento River Winter (endangered)	Met	Recreational seasons: Point Arena to Pigeon Point between the first Saturday in April and the second Sunday in November; Pigeon Point to the U.S./Mexico Border between the first Saturday in April and the first Sunday in October. Minimum size limit ≥ 20 inches total length. In addition, for 2011, fisheries south of Pt. Arena must have either a minimum size limit ≥ 24 inches total length, or be closed for two consecutive months between May 1 and August 31. Commercial seasons: Point Arena to the U.S./Mexico border between May 1 and September 30, except Point Reyes to Point San Pedro between October 1 and 15. Minimum size limit ≥ 26 inches total length. (NMFS ESA Guidance for 2011).
Sacramento River Fall	377.0	180.0 2011 Council and NMFS guidance for natural and hatchery adult spawners.
Ocean commercial impacts	190.3	Include fall (Sept-Dec) 2010 impacts; equals 0 SRFC.
Ocean recreational impacts	101.3	Include fall (Sept. -Dec.) 2010 impacts (76 SRFC).
River recreational impacts	61.4	No guidance in 2011.
Hatchery spawner goal	≥ 22.0	22.0 Aggregate number of adults to meet egg take goals at Coleman, Feather River and Nimbus hatcheries.

TABLE 5. Projected key stock escapements (thousands of fish) or management criteria for 2011 ocean fishery management measures analyzed by the STT.a/ (Page 3 of 3)

Key Stock/Criteria	Projected Ocean Escapement[b/] or Other Criteria (Council Area Fisheries)	Spawner Objective or Other Comparative Standard as Noted	
		COHO	
Interior Fraser (Thompson River)	10.0%(4.1%)	≤ 10.0%	2011 Southern U.S. exploitation rate ceiling; 2002 PSC coho agreement.
Skagit	35.3%(3.7%)	≤ 60.0%	2011 total exploitation rate ceiling; FMP matrix[e/]
Stillaguamish	25.9%(2.6%)	≤ 50.0%	2011 total exploitation rate ceiling; FMP matrix[e/]
Snohomish	25.8%(2.6%)	≤ 60.0%	2011 total exploitation rate ceiling; FMP matrix[e/]
Hood Canal	40.0%(3.8%)	≤ 65.0%	2011 total exploitation rate ceiling; FMP matrix[e/]
Strait of Juan de Fuca	10.8%(3.1%)	≤ 40.0%	2011 total exploitation rate ceiling; FMP matrix[e/]
Quillayute Fall	26.6	6.3-15.8	FMP objective MSY adult spawner range[e/]
Hoh	10.0	2.0-5.0	FMP objective MSY adult spawner range[e/]
Queets Wild	10.5	5.8-14.5	FMP objective MSY adult spawner range[e/]
Grays Harbor	81.4	35.4	FMP objective MSY adult spawner range[e/]
Lower Columbia River Natural (threatened)	15.0%	≤ 15.0%	Total marine and mainstem Columbia River fishery exploitation rate (NMFS ESA consultation standard).
Upper Columbia	74.0%	≥ 50%	Minimum percentage of the run to Bonneville Dam.
Columbia River Hatchery Early	162.0	36.7	Minimum ocean escapement to attain hatchery egg-take goal of 14.2 early adult coho, with average conversion and no mainstem or tributary fisheries.
Columbia River Hatchery Late	101.0	9.6	Minimum ocean escapement to attain hatchery egg-take goal of 6.2 late adult coho, with average conversion and no mainstem or tributary fisheries.
Oregon Coastal Natural	13.2%	≤ 15.0%	Marine and freshwater fishery exploitation rate.
Northern California (threatened)	8.4%	≤ 13.0%	Marine fishery exploitation rate for R/K hatchery coho (NMFS ESA consultation standard).

a/ Assumptions for Canadian and Southeast Alaska Chinook fisheries operating under aggregate abundance based management (AABM) regimes are based on allowable catch levels determined under the 2009 PST Chinook agreement and the 2011 calibration of the PSC Chinook Model. The allowable catch levels are for an Alaska all-gear catch of 294,800, a Northern BC troll and Queen Charolette Islands catch of 182,400, and a WCVI troll and outside sport catch of 196,800.

b/ Ocean escapement is the number of salmon escaping ocean fisheries and entering freshwater with the following clarifications. Ocean escapement for Puget Sound stocks is the estimated number of salmon entering Area 4B that are available to U.S. net fisheries in Puget Sound and spawner escapement after impacts from the Canadian, U.S. ocean, and Puget Sound troll and recreational fisheries have been deducted. Numbers in parentheses represent Council area exploitation rates for Puget sound coho stocks. For Columbia River early and late coho stocks, ocean escapement represents the number of coho after the Buoy 10 fishery. Exploitation rates for LCN coho include all marine impacts prior to the Buoy 10 fishery. Exploitation rates for OCN coho include impacts of freshwater fisheries.

c/ Abundance in 2011 is such that the escapement goal in not achievable; however, the exploitation rate meets the NMFS RER harvest standard of 46.0%.

d/ Includes minor contributions from East Fork Lewis River and Sandy River.

e/ Annual management objectives may be different than FMP goals, and are subject to agreement between WDFW and the treaty tribes under U.S. District Court orders. Total exploitation rate includes Alaskan, Canadian, Council area, Puget Sound, and freshwater fisheries and is calculated as total fishing mortality divided by total fishing mortality plus spawning escapement.

TABLE 7. Expected coastwide lower Columbia Natural (LCN) Oregon coastal natural (OCN) and Rogue/Klamath (RK) coho, and Lower Columbia River (LCR) tule Chinook exploitation rates by fishery for 2011 ocean fisheries management measures analyzed by the STT.

	Exploitation Rate (Percent)			
Fishery	LCN Coho	OCN Coho	RK Coho	LCR Tule
SOUTHEAST ALASKA	0.0%	0.0%	0.0%	2.7%
BRITISH COLUMBIA	0.1%	0.3%	0.2%	16.2%
PUGET SOUND/STRAIT/WA COAST BAYS	0.2%	0.1%	0.0%	0.5%
NORTH OF CAPE FALCON				
Treaty Indian Ocean Troll	2.1%	0.5%	0.0%	3.9%
Recreational	4.4%	0.8%	0.0%	2.3%
Non-Indian Troll	1.4%	0.4%	0.0%	3.9%
SOUTH OF CAPE FALCON				
Recreational:				0.1%
Cape Falcon to Humbug Mt.	1.2%	2.5%	0.2%	
Humbug Mt. OR/CA border (KMZ)	0.1%	0.4%	0.8%	
OR/CA border to Horse Mt. (KMZ)	0.1%	0.7%	3.5%	
Fort Bragg	0.0%	0.5%	1.3%	
South of Pt. Arena	0.0%	0.4%	1.0%	
Troll:				1.9%
Cape Falcon to Humbug Mt.	0.8%	1.0%	0.1%	
Humbug Mt. OR/CA border (KMZ)	0.0%	0.0%	0.1%	
OR/CA border to Horse Mt. (KMZ)	0.0%	0.1%	0.4%	
Fort Bragg	0.0%	0.2%	0.5%	
South of Pt. Arena	0.0%	0.4%	0.3%	
BUOY 10	0.6%	0.0%	0.0%	5.6%
ESTUARY/FRESHWATER	3.8%	4.8%	0.2%	
TOTAL[a/]	15.0%	13.2%	8.4%	37.0%

a/ Totals do not include estuary/freshwater or Buoy 10 for RK coho.

**TESTIMONY OF THE COLUMBIA RIVER TREATY TRIBES
BEFORE THE PACIFIC FISHERIES MANAGEMENT COUNCIL
San Mateo, CA**

April 13, 2011

Good day, Mr. Chairman and members of the Council. My name is Herb Jackson. I am a member of the Fish and Wildlife Committee of the Nez Perce Tribe. I am here with Wilbur Slockish Jr., Chris Williams, and Bruce Jim to provide testimony on behalf of the four Columbia River treaty tribes: the Yakama, Warm Springs, Umatilla and Nez Perce tribes.

I am here to present testimony relative to the final 2011 ocean salmon fishery recommendations.

With the ocean fisheries being so constrained due to impacts on stocks such as lower Columbia River tules, it should cause us to think about the real reasons that many stocks are depressed and the kinds of things that could be done to solve the problem.

One thing that we believe could be done that would benefit lower river tules as well as virtually all other stocks in the Columbia would be to address the bird predation problem in the lower Columbia River. The Columbia River tribes have been concerned for years about the level of predation by birds in the Columbia River. Bird predation, primarily by Caspian terns and cormorants, is causing enormous losses of numerous stocks of salmon in the Columbia River. Seagulls are also important predators especially in the upper river near dams. None of the important bird predators are endangered. Bird predation occurs throughout the Columbia. But predation in the estuary is a significant problem for all stocks. A high proportion of the predation is associated with the nesting periods of these birds. Instead spending endless years and countless dollars studying birds, we could actually take any number of relatively simple actions that would likely have significant impacts on birds and their ability to nest and feed in the estuary. The types of things that could be done include things like planting vegetation, hazing birds during nesting, putting up structures to attract hawks and eagles, allowing predators such as mink or raccoons access to islands when bird are nesting. Encouraging appropriate levels of natural predation on bird eggs would be a good thing. Simply allowing members of the public to exercise their dogs on the nesting islands would be useful. There are many other cost effective things that could be done as well.

Bird predation is a problem throughout the Columbia Basin. There are significant hot spots for bird predation on islands in the mainstem, near the mouth of the Snake River, on islands upstream of Wanapum Dam, and at various dams in tributaries.

Excessive bird predation is highly correlated with areas where people have modified habitat. The birds are able to take advantage of modified and damaged fish habitat in ways that are harmful to fish. Therefore, it is appropriate for people to take action to control both bird populations and bird predation activity.

By taking fairly simple actions to help control birds in the Columbia, we can expect significant benefits to fish populations. We expect that this would make planning fisheries much easier for both Indian and non-Indian fishers.

There are numerous other things that we should also be working on together to address the lack of productivity of many of our salmon stocks.

Thank you

MOTION
For The Ocean Treaty Troll Fishery

For the 2011 salmon fishery in the area from the U.S./Canada border to Cape Falcon, Oregon, I move the following management structure be adopted by the Council for the Treaty Indian ocean salmon troll fisheries:

The Treaty Indian ocean troll fishery would have a quota of:

- 41,000 Chinook and
- 42,000 coho.

The overall chinook quota would be divided into a 19,750-Chinook sub-quota for the May 1 through June 30 chinook only fishery and a 21,250-Chinook sub-quota for the all species fishery in the time period of July 1 through September 15.

The Treaty troll fishery would close upon the projected attainment of either of the Chinook or coho quota. Other applicable regulations are shown in Table 3 of STT Report Preliminary Analysis of Tentative 2011 Ocean Salmon Fishery Management Measures – Agenda Item H.5.b.