

SNOHOMISH RIVER NATURAL COHO

DRAFT 6_OCTOBER 2018

SALMON REBUILDING PLAN, ENVIRONMENTAL ASSESSMENT, MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ANALYSIS, REGULATORY IMPACT REVIEW, AND INITIAL REGULATORY FLEXIBILITY ANALYSIS

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LIST OF ACRONYMS AND ABBREVIATIONS

ABC	acceptable biological catch
ACL	annual catch limit
BY	brood year
CDFW	California Department of Fish and Wildlife
CoTC	Coho Technical Committee (of the PSC)
Council	Pacific Fishery Management Council
CWT	coded-wire tag
EA	Environmental Assessment
EEZ	exclusive economic zone (from 3-200 miles from shore)
EIS	Environmental Impact Statement
ESA	Endangered Species Act
ESU	evolutionarily significant unit
F_{ABC}	exploitation rate associated with ABC
F_{ACL}	exploitation rate associated with ACL ($= F_{ABC}$)
FMP	fishery management plan
F_{MSY}	maximum sustainable yield exploitation rate
F_{OFL}	exploitation rate associated with the overfishing limit ($= F_{MSY}$, MFMT)
FONSI	Finding of No Significant Impacts
FRAM	Fishery Regulatory Assessment Model
GAM	generalized additive models
ISBM	individual stock-based management
KMZ	Klamath management zone (ocean zone between Humbug Mountain and Horse Mountain)
KOHM	Klamath Ocean Harvest Model
KRFC	Klamath River fall Chinook
MFMT	maximum fishing mortality threshold
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSM	mixed stock model
MSST	minimum stock size threshold
MSY	maximum sustainable yield
NA	not available
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NPGO	North Pacific Gyre Oscillation
NSIG	National Standard 1 Guidelines
ODFW	Oregon Department of Fish and Wildlife
OFL	overfishing limit
OY	Optimum Yield
PDO	Pacific Decadal Oscillation
PFMC	Pacific Fishery Management Council (Council)
PSC	Pacific Salmon Commission
PST	Pacific Salmon Treaty
RER	rebuilding exploitation rate
S_{ABC}	spawning escapement associated with ABC
S_{ACL}	spawning escapement associated with ACL ($= S_{ABC}$)
SHM	Sacramento Harvest Model
SI	Sacramento Index
S_{MSY}	MSY spawning escapement
S_{OFL}	spawning escapement associated with the overfishing limit ($= S_{MSY}$)

LIST OF ACRONYMS AND ABBREVIATIONS (*continued*)

SRFC	Sacramento River fall Chinook
SRWC	Sacramento River winter Chinook
STT	Salmon Technical Team (formerly the Salmon Plan Development Team)
VSI	visual stock identification
WDFW	Washington Department of Fish and Wildlife
QIN	Quinault Indian Nation

DRAFT 6

1.0 EXECUTIVE SUMMARY

To be developed for final Rebuilding Plan.

2.0 INTRODUCTION

In 2018, Snohomish River natural coho salmon (Snohomish coho) met the criteria for overfished status as defined in section 3.1 of the Pacific Coast Salmon Fishery Management Plan (FMP; PFMC 2016). In response, the Pacific Fishery Management Council (Council) directed the Salmon Technical Team (STT) to propose a rebuilding plan for Council consideration within one year. The FMP, and the Magnuson-Stevens Fishery Management and Conservation Management Act (MSA), requires that a rebuilding plan must be developed and implemented within two years of the formal notification from National Marine Fisheries Service (NMFS) to the Council of the overfished status. Excerpts from the FMP relevant to status determinations and rebuilding plans are provided in Appendix A.

The Council's criteria for overfished is met if the geometric mean of escapement, computed over the most recent three years, falls below the Minimum Stock Size Threshold (MSST) which is defined for applicable stocks in Table 3-1 of the FMP. For Snohomish coho, the number of adult spawners expected to produce maximum sustainable yield (MSY) is defined as 50,000 natural-area adult spawners, also known as S_{MSY} . The MSST for Snohomish coho is defined as 31,000 natural-area adult spawners, with $MSST = 0.62 S_{MSY}$. The geometric mean of Snohomish coho natural-area adult spawners over years 2014-2016 was 29,677, and thus in 2018 the stock met the criteria for overfished status. Table 2.0.a displays natural spawning escapement and the running three year geometric mean of escapement relative to S_{MSY} and the MSST. The FMP identifies the default criterion for achieving rebuilt status as attainment of a 3-year geometric mean of spawning escapement exceeding S_{MSY} .

Overfished status is defined by recent spawner escapement for salmon stocks, which is not necessarily the result of overfishing. Overfishing occurs when in any one year the exploitation rate on a stock exceeds the maximum fishing mortality threshold (MFMT), which for Snohomish coho is defined as the MSY fishing mortality rate (F_{MSY}) of 0.60. It is possible that this situation could represent normal variation, as has been seen in the past for several salmon stocks. However, the occurrence of reduced stock size or spawner escapements, depending on the magnitude of the short-fall, could signal the beginning of a critical downward trend. Imposing fisheries on top of already low abundances could further jeopardize the capacity of the stock to produce MSY over the long term if appropriate actions are not taken to ensure that conservation objectives are achieved.

In this rebuilding plan, we begin by providing an overview of the Snohomish coho stock, the physical setting of the Snohomish River watershed, and fisheries management. We then review the potential factors that may have contributed to the overfished status. Recommendations regarding alternative rebuilding actions are proposed, as are recommendations for actions outside of the management of salmon fisheries. We end with a socioeconomic analysis of the impact of the recommended rebuilding alternatives.

In 2015, natural spawner escapement was estimated to be the lowest on record at 12,804 adults (Figure 2.0.a). Preliminary data indicate that 2017 will be the second lowest escapement on record (18,195), which would further reduce the 3-year geometric mean.

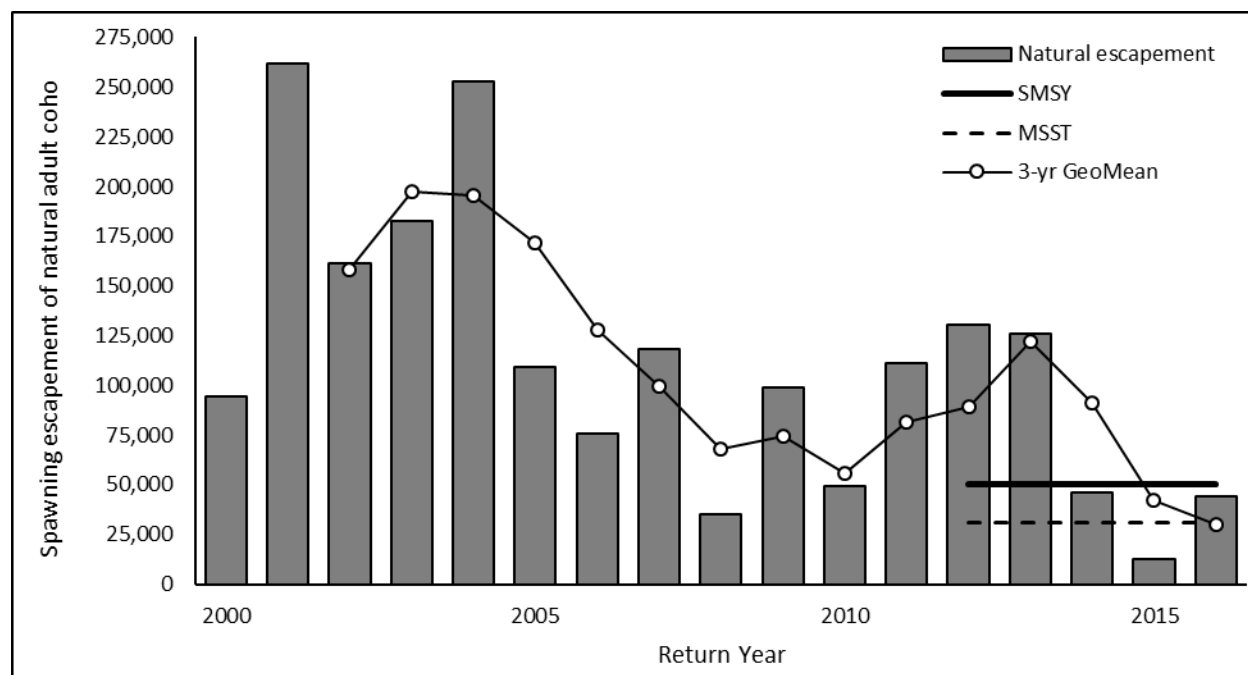


Figure 2.0.a. Spawning escapement of Snohomish River natural adult coho

2.1 National Environmental Policy Act

In addition to addressing the requirements of the FMP and MSA, this rebuilding plan document integrates the environmental assessment required under the National Environmental Policy Act (NEPA).

2.1.1 Proposed Action

The Proposed Action is for the Council to adopt and NMFS to approve a rebuilding plan for the Snohomish coho salmon stock, which has been determined by NMFS to be overfished under the MSA. The rebuilding plan must be consistent with the MSA and the provisions of the FMP; therefore, the plan shall include a control rule and a specified rebuilding period. The specified rebuilding period shall be as short as possible, taking into consideration the needs of the commercial, recreational and tribal fishing interests and coastal communities.

2.1.2 Purpose and Need

The purpose of the proposed action is to develop and implement a harvest control rule that will be applied to setting annual ocean salmon fishery management measures that impact Snohomish coho. This harvest control rule will be designed to attain a three-year geometric mean spawning escapement that meets the S_{MSY} specified for that stock in the FMP in the least amount of time possible while taking into account the biology of the stock, international agreements, and the needs of fishing communities, but not to exceed 10 years. The need for the proposed action is to rebuild Snohomish coho, which the NMFS determined, in 2018, to be overfished under the MSA.

2.2 Stock overview

Coho are distributed throughout all anadromous reaches of the Snohomish watershed (Figure 2.2.2.a), including the Snoqualmie and Skykomish River Basins. The majority of Snohomish adult coho return to the river as 3 year olds¹ between late August and late November with the peak occurring between the last week of September and first week of October². Coho have been observed as early as July 27 at the Sunset Falls trap-and-haul site on the South Fork Skykomish River, located approximately two miles above the confluence of the South and North Forks of the Skykomish River. Spawn timing occurs primarily November through January with access to spawning reaches being highly dependent on flow conditions. Preferred spawning habitat is small tributaries with extensive associated wetlands. Juveniles rear for over a year in freshwater before out-migrating as smolt from April through June with peak outmigration occurring late April to early May³.

Coded wire tag (CWT) recovery data from Wallace Hatchery fish indicates Snohomish coho migrate out of Puget Sound and northwards to the west coast of Vancouver Island, British Columbia (Weitkamp and Neely 2002). Snohomish coho production contributes to sport and commercial fisheries in southern British Columbia, the northern Washington coast, Strait of Juan de Fuca, Puget Sound, and in-river Snohomish fisheries.

2.2.1 Stock composition

All wild coho that originate from the Snohomish River Basin constitute a single management unit (MU) and are managed as a single stock. Snohomish River Coho Salmon belong to the larger Puget Sound/Strait of Georgia Coho Salmon evolutionarily significant unit (ESU)(Weitkamp et al. 1995). This ESU is currently a species of concern under the U.S. Endangered Species Act (NOAA Fisheries 2009). Co-managers are currently collecting genetic samples from coho in the Snohomish, Stillaguamish, and Skagit watersheds to determine genetic baselines and potentially determine within-basin population structure for these three coho stocks.

There are two hatchery programs considered to be part of the Snohomish system; WDFW's Wallace River Hatchery located at RM 4 on the Wallace River at the confluence with May Creek, and the Tulalip Tribes Bernie Kai-Kai Gobin Hatchery located at the juncture of the east and west Forks of Tulalip Creek (Figure 2.2.2.a). Eggs for both programs are collected at the Wallace Hatchery and are integrated with Snohomish wild broodstock. The Wallace Hatchery has been in operation since the early 1900s, and the Bernie Kai-Kai Gobin Hatchery since 1983.

The Bernie Kai-Kai Gobin Hatchery coho program is an isolated program and the purpose of this program is to provide coho salmon for harvest by Tulalip Tribal members in a terminal area fishery. Production from this program is also available for harvest by the non- Indian sport and commercial fisheries, and contributes to other directed and incidental harvest of coho salmon in other pre-terminal fisheries.

¹ The Wallace Hatchery has on average less than 1 percent coho returning as 2 year old jacks. CWT data has rarely recorded a 4 year old coho in the Snohomish River.

² WDFW Snohomish River in-river sport catch record card data.

³ 2000-2012 Skykomish and Snoqualmie Rivers Chinook and Coho Salmon Out-migration Study, Tulalip Tribes

The Wallace River Hatchery coho program is an integrated program (broodstock is genetically integrated with the local natural population) with the goal of providing fish for harvest opportunity. Adults are collected at the following two collection facilities: 1) an in-stream trap located on May Creek; and 2) a weir placed across the Wallace River from June until October 1. Returns to this hatchery are provided in Table 2.2.1.a.

Table 2.2.1.a. Wallace Hatchery coho returns.

Brood Year	Fish Returned	Males	Females	Jacks	% Female	% Jacks	Fecundity
2003	13,262	7,441	5,606	215	42%	1.60%	3,195
2004	13,880	7,259	6,576	45	47%	0.30%	3,244
2005	13,304	7,346	5,938	20	45%	0.20%	2,749
2006	6,145	3,034	3,100	11	50%	0.20%	3,054
2007	7,228	3,875	3,341	12	46%	0.20%	3,025
2008	3,316	1,813	1,490	13	45%	0.40%	3,409
2009	8,237	4,756	3,484	0	42%	0.00%	3,504
2010	4,338	2,002	2,318	20	53%	0.50%	3,424
2011	7,801	4,064	3,697	44	47%	0.60%	3,119
2012	10,475	5,202	5,240	33	50%	0.30%	2,875
2013	9,232	4,533	4,662	37	50%	0.40%	2,665
2014	7,764	4,060	3,658	46	47%	0.60%	2,706
2015	2,391	1,276	1,036	79	43%	3.30%	1,717
2016	8,384	4,161	4,147	76	49%	0.90%	2,820
2017	4,726	2,225	2,451	50	52%	1.10%	2,937
<i>Average</i>	<i>8,032</i>				<i>47%</i>	<i>0.70%</i>	<i>2,963</i>

2.2.2 Location and geography

The Snohomish River Basin is in Washington State and includes two major tributaries; the Skykomish and Snoqualmie Rivers.

The Snohomish River basin is 1,780 mi² [2,865 km²] in size, draining the Cascade Mountains to the east of Everett and Seattle, and entering Puget Sound at Everett. This area has extensive moderate to high quality juvenile coho spawning and rearing habitat, due the large number of low gradient tributaries. The main tributaries directly draining the Cascades tend to have two periods of peak flow, first during winter flood events and the second during peak snow runoff in spring and early summer. The smaller tributaries are largely rain-fed, and have peak flows during the winter rain season.

A significant increase in available natural coho production habitat in the Snohomish River Basin occurred in 1958 when the Sunset Falls trap-and-haul site became operational. Fish are trapped and trucked above a series of three anadromous barrier waterfalls to provide access to additional habitat for spawning and rearing. The drainage area of the South Fork Skykomish River above Sunset Falls is approximately 362 mi² [938 km²], representing approximately 20 percent of the entire drainage area of the Snohomish River basin (Zimmerman 2014).

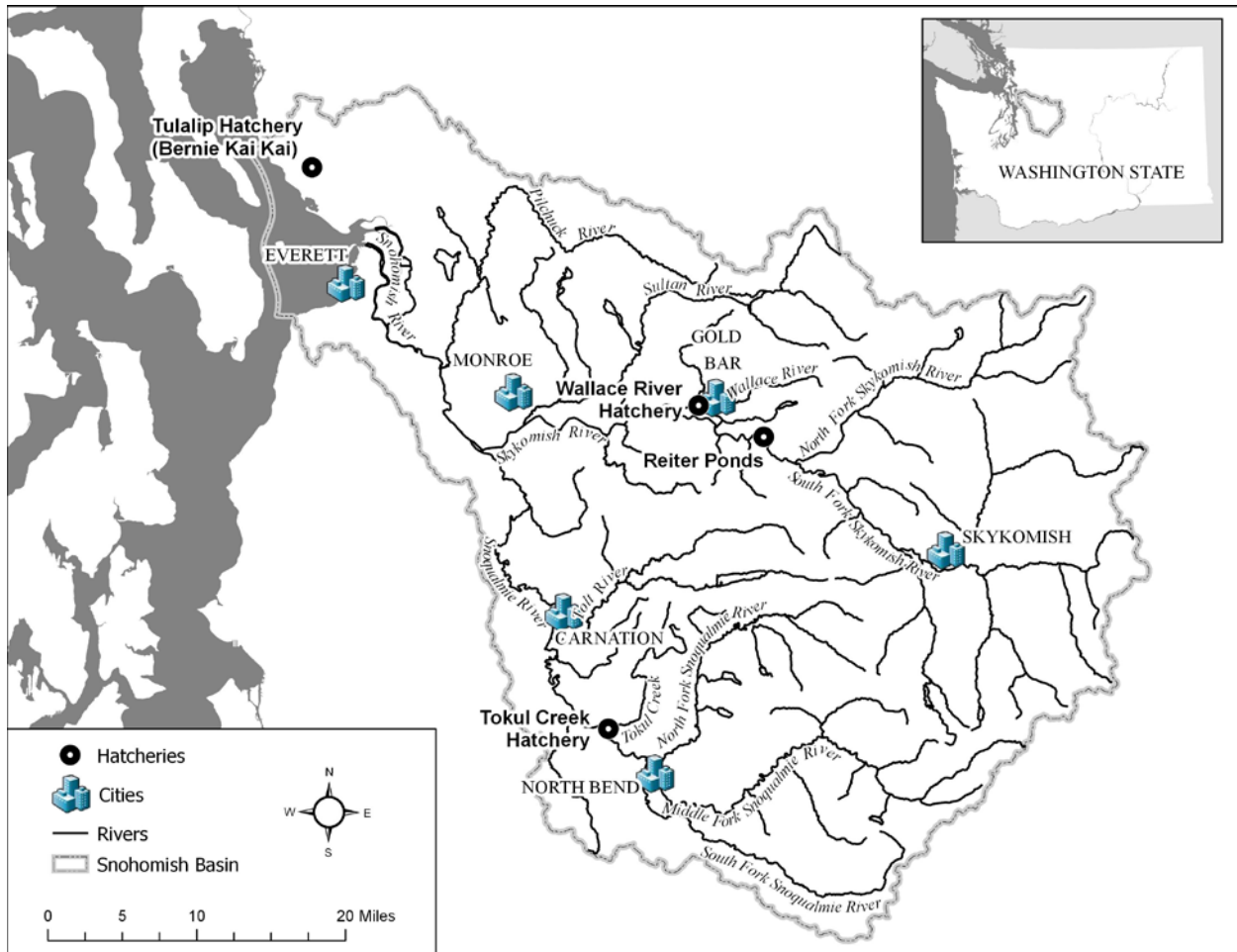


Figure 2.2.2.a. Map of the Snohomish River Basin.

2.3 Management Overview

Snohomish natural coho are one of five Puget Sound coho management units included in the coho chapter of the Pacific Salmon Treaty (PST). Under the PST, Puget Sound management units are managed under a tiered, abundance-based management regime. Each year, the management units are classified as “low” abundance, “moderate” abundance, or “abundant” based on the forecast ocean abundance of age-3 fish (CoTC 2013). The maximum allowable exploitation rate (ER) is determined by the abundance category (Table 2.3.a).

Table 2.3.a. Pacific Salmon Treaty-defined total exploitation rate ceilings by PSC status categories

Snohomish natural coho		
Status (PSC/Council)	Ocean Age-3 Abundance Reference Point	Total Exploitation Rate
Low	< 51,667	Up to 20%
Moderate	51,667 – 125,000	21% – 40%
Abundant	> 125,000	41% – 60%

2.3.1 Conservation objectives

The abundance-based stepped harvest rates of the PST management regime were adopted as conservation objectives for Puget Sound coho MUs by the Council in November 2009 (Bowhay and Pattillo 2009), and implemented in the 2010 preseason planning process. When the Council adopted Amendment 16 in 2011, the spawning escapements associated with the ocean abundance breakpoints and allowable exploitation rates were adopted as status determination criteria (SDC). The spawning escapement associated with the Low/Moderate breakpoint and 40 percent exploitation rate allowed when the MU is classified as of moderate abundance (31,000) was adopted as MSST, and the spawning escapement associated with the moderate/abundant breakpoint, the 60 percent exploitation rate allowed when the MU is abundant (50,000) was adopted as S_{MSY} , and the maximum allowable total exploitation rate (60 percent) was adopted as the maximum fishing mortality threshold (MFMT). A stock is considered to be subject to overfishing if the total fishing mortality exceeds the MFMT, and is considered to be overfished if the 3-yr geometric mean falls below the MSST. Amendment 16 to the FMP was implemented starting with the 2012 preseason planning process.

2.3.2 Management strategy

The tiered harvest rates with abundance breakpoints define a control rule that limits the allowable fishery impacts on Snohomish natural coho depending on the abundance. However, fisheries impacting Snohomish coho are also constrained by impacts on other coho management units identified in the Pacific Salmon Treaty, impacts on discrete population segments listed under the U.S. Endangered Species Act, harvest sharing obligations adjudicated by the Boldt decision (under the determinations of the U.S. District Court in *U.S. v. Washington*), and impacts on other salmon stocks identified in the FMP. Each year proposed management measures are modeled using the coho Fishery Regulation Assessment Model (FRAM) parameterized with the current year's stock abundance forecasts. Final management measures adopted by the Council need to meet all the constraints on stocks and fisheries. Usually, constraints on fishery impacts to other stocks are more constraining than those on Snohomish natural coho. Postseason, when actual catch and spawning escapement data can be used to parameterize the coho FRAM, management measures are assessed to determine whether conservation objectives and status determination criteria were met.

3.0 REVIEW OF POTENTIAL FACTORS LEADING TO OVERFISHED STATUS

A number of factors may contribute to a stock falling below the MSST and becoming classified as overfished. Fishing mortality may be higher than was expected when management measures were adopted, or the abundance may be less than forecast. Abundance may be less than forecast because low freshwater survival resulted in fewer smolts than expected, or because low marine survival resulted in fewer adult returns than expected. Freshwater and/or marine survival may be low enough, that even if anticipated, there will simply be too few adults produced to prevent the stock from falling below the MSST, even in the absence of fishing. The FMP specifies that the roles of freshwater survival, marine survival, and fishing should be considered in any rebuilding plan.

3.1 Freshwater survival

3.1.1 Review of freshwater conditions

In the 2018 Wild Coho Forecasts for Puget Sound, Washington Coast, and Lower Columbia, Mara Zimmerman states; “In most watersheds, overall production of juvenile coho (juveniles/female * number females) is rarely limited by spawner abundance, and the majority of variation in juvenile production is the result of environmental conditions (Bradford et al. 2000). Summer rearing flows are a key environmental variable affecting the freshwater survival and production of Puget Sound coho (Smoker 1955; Mathews and Olson 1980), although extreme flow events in the overwinter rearing period (Kinsel et al. 2009) and local habitat condition influenced by wood cover and channel complexity, fish passage, road densities, and water quality are also likely to influence smolt production (Quinn and Peterson 1996; Sharma and Hilborn 2001).”

The Snohomish watershed has been experiencing higher and more frequent fall flooding and lower and warmer summer flows than have been experienced historically. A cohesive temperature data set is lacking for the Snohomish, but for example in the summer of 2015, temperatures as high as 25.5 °C in the mainstem Snoqualmie River and 26.7 °C in the Raging River were observed. These temperatures are potentially lethal to salmonids (see Figures 3.1.1.a and 3.1.1.b, data from Kubo and LeDoux, 2016). “Salmonids in the Snoqualmie River watershed were subjected to both acute lethal and sub-lethal temperatures during the warm-dry summer of 2015. The impacts of these warm temperatures likely affected both juvenile salmonids rearing in the watershed over the summer as well as the adults that were holding or which returned later in the year” (Kubo, LeDoux *ibid*). This was followed by several flood stage high flows in October and November of 2015 (Figure 3.1.1.c and 3.1.1.d, USGS flow data: <https://nwis.waterdata.usgs.gov/nwis/>).

Figure 32. Mainstem Snoqualmie 7DADMAX range and WA Ecology thresholds for designated uses. State Standards after Sept. 15 specific for spawning and egg incubation.

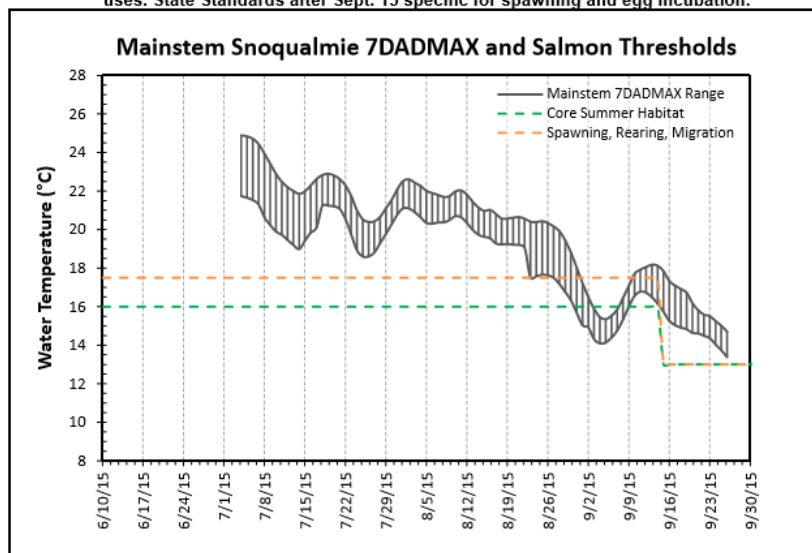


Figure 3.1.1.a. 2015 Snoqualmie River water temperatures, with thresholds for spawning and egg incubation shown.

Figure 33. Mainstem Snoqualmie 1DMAX range and WA Ecology thresholds for barrier to migration and acute lethality.

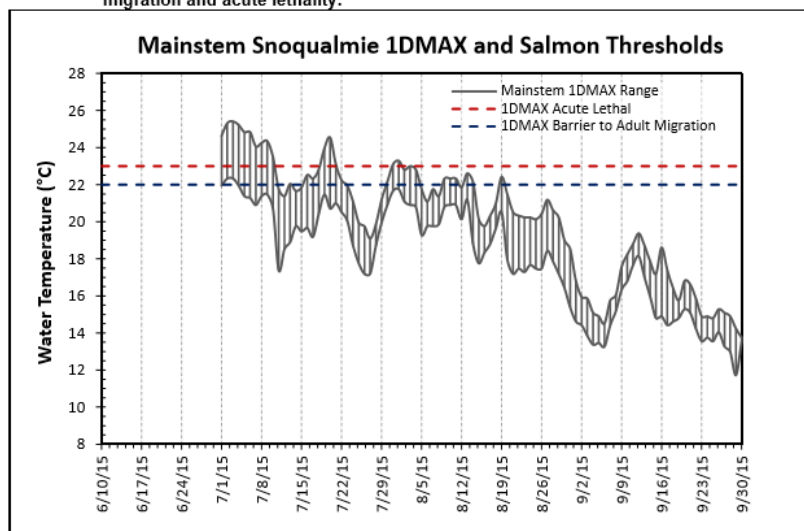


Figure 3.1.1.b. 2015 Snoqualmie River water temperatures, with thresholds for acute lethal and adult migration shown.

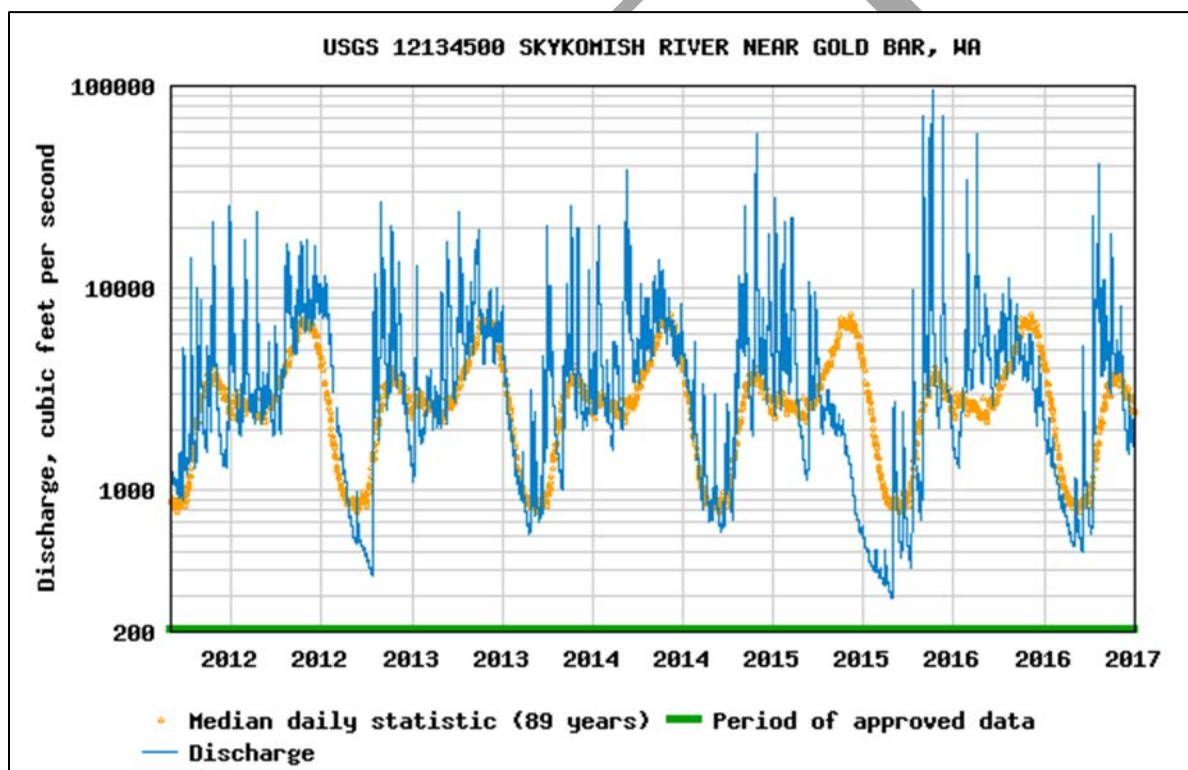


Figure 3.1.1.c. Skykomish River conditions (September 1, 2011-December 31, 2016).

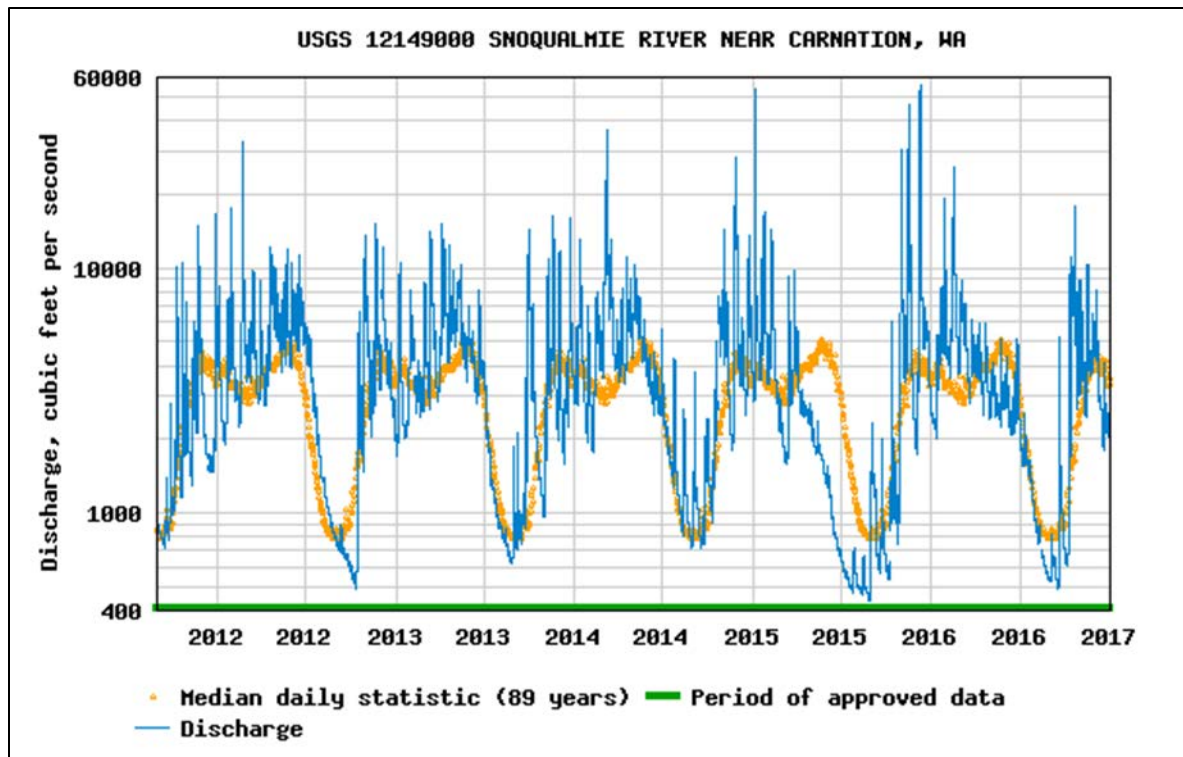


Figure 3.1.1.d. Snoqualmie River conditions (September 1, 2011-December 31, 2016).

3.1.2 Juvenile Production Estimates

Juvenile natural coho (yearlings) production in the Snohomish system is based on counts of unmarked yearling coho from two rotary screw traps operating in the Skykomish River (RM 26.5 from 2008 to present; RM 23 from 2001 to 2007) and Snoqualmie River (RM 12.2 from 2002 to present; RM 16.5 in 2001). These sites were selected for their water velocities ($> 3\text{ft/sec}$), a constricted channel, adequate access to samplers, and in a location low enough in the watershed to capture a significant fraction of the Chinook and coho juvenile production (Kubo et al. 2012). Approximately 72 percent of the coho-producing habitat in the watershed is upstream from the traps (based on Zillges, 1977 potential rearing habitat analysis).

The sampling regime of the traps is designed to maximize effort during nighttime hours, when catch rates are considerable higher. Table 3.1.1.a shows the total hours of operation by trap and year, coho catches, and CPUE. Catch is expanded to account for the time when the trap is not fishing, the estimated efficiency of the traps ($\sim 1\%$ and 0.6% for the Skykomish and Snoqualmie respectively), and for the fraction of the coho produced in habitat not sampled (downstream) by the trap.

Table 3.1.2.a. Total effort, catch, and CPUE of unmarked smolt coho for the Skykomish and Snoqualmie traps (Data source: M. Pouley, Tulalip NRD).

Year	Skykomish			Snoqualmie		
	Effort (Hours)	1+ Coho	CPUE	Effort (Hours)	1+ Coho	CPUE
2001	309	5,972	19.36	509	553	1.09
2002	901	5,512	6.12	780	1,894	2.43
2003	672	8,851	13.18	946	1,305	1.38
2004	992	8,713	8.78	1,056	1,127	1.07
2005	1,071	13,949	13.02	1,018	1,187	1.17
2006	944	3,082	3.26	992	2,023	2.04
2007	1,125	6,218	5.53	510	615	1.21
2008	447	3,882	8.69	318	587	1.85
2009	687	1,410	2.05	632	754	1.19
2010	1,046	1,245	1.19	1,158	1,149	0.99
2011	667	1,798	2.70	501	1,662	3.32
2012	1,016	3,005	2.96	847	1,384	1.63
2013	1,218	4,443	3.65	1,218	1,718	1.41
2014	888	2,625	2.96	797	1,084	1.36
2015	1,079	1,596	1.48	1,017	678	0.67
2016	1,032	2,137	2.07	1,112	809	0.73
2017	843	2,154	2.55	1,155	925	0.80

Most of the coho smolt have passed the trap by week 20-21 in the Skykomish River (Figure 3.1.2.a), although in some years (e.g. 2015) migration was completed a month earlier. In the Snoqualmie River (Figure 3.1.2.b), the inter-annual variation in the timing of the outmigration is comparable to the Skykomish River (e.g. being earlier in 2015 and 2016 compared to 2013 and 2014), yet in the Snoqualmie River, the number of coho smolts migrating can increase greatly in some weeks, as estimated during week 12 and 18 in 2015 and 2013 respectively).

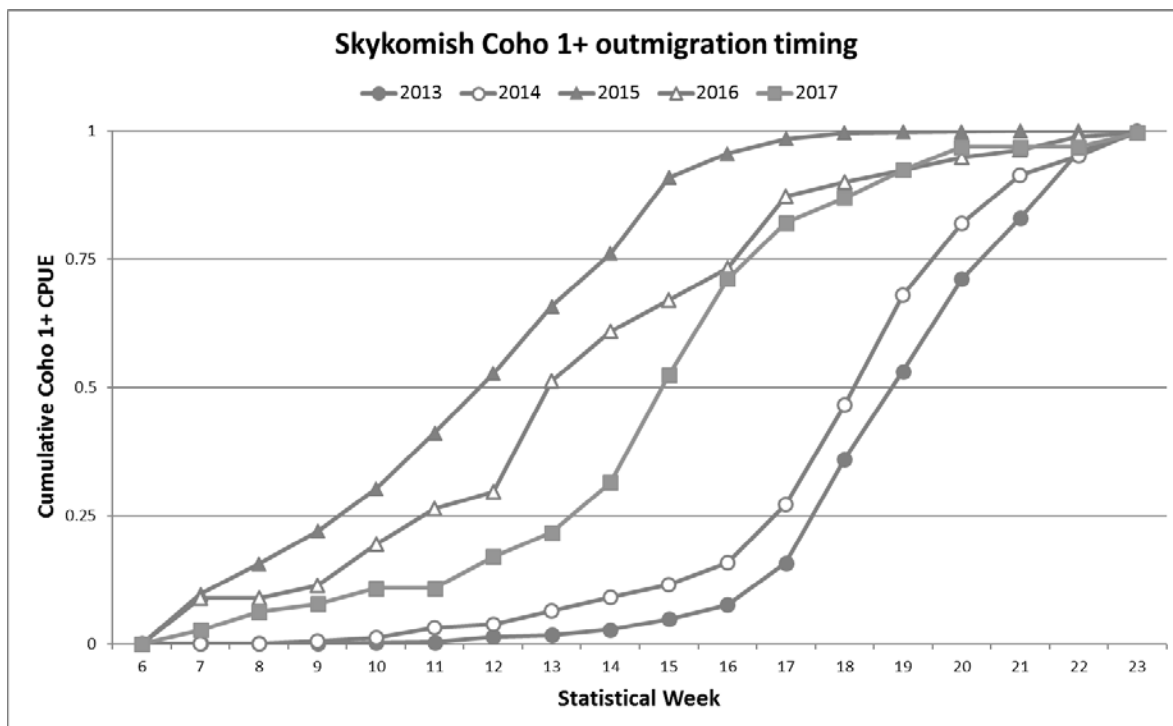


Figure 3.1.2.a. Cumulative season CPUE curves for unmarked smolt coho in the Skykomish (estimated from the trap counts). (Data source: M. Pouley, Tulalip NRD).

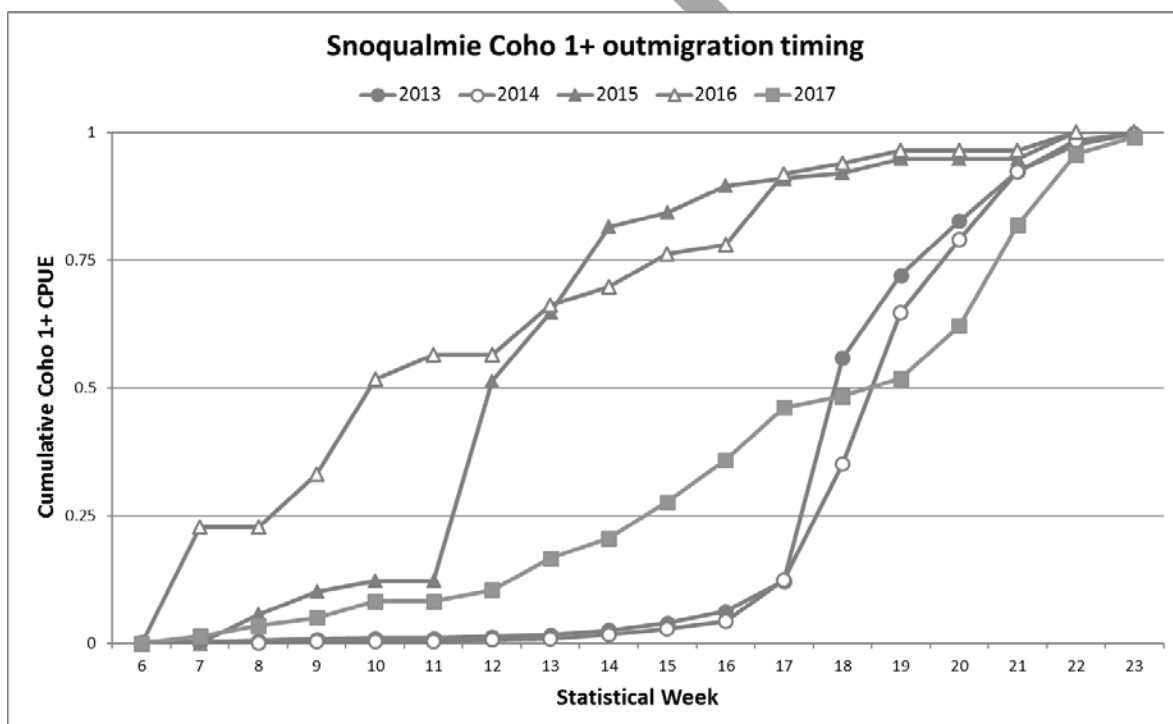


Figure 3.1.2.b. Cumulative season CPUE curves for unmarked smolt coho in the Snoqualmie estimated from the trap counts. (Data source: M. Pouley, Tulalip NRD).

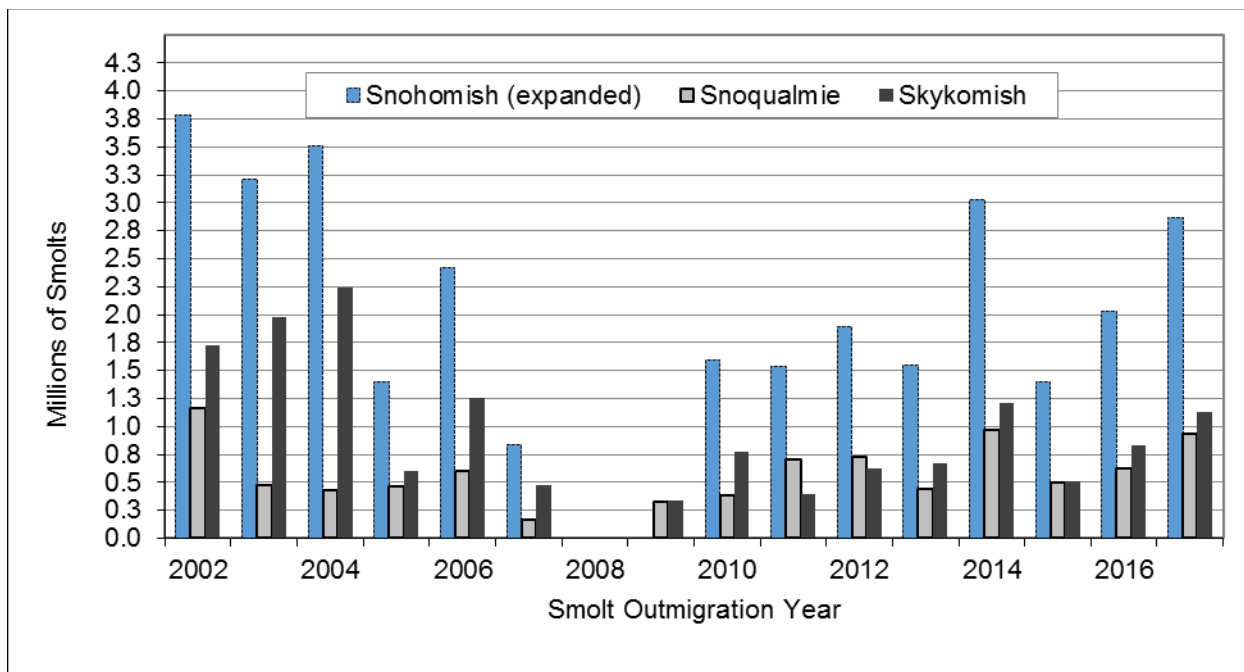


Figure 3.1.2.c. Coho smolt natural production estimates for the Snohomish Basin. Derived from data collected in area above traps on the Snoqualmie and Skykomish rivers, and expanded to whole basin production.

3.2 Marine Survival

3.2.1 Review of ocean conditions

While the marine environment affects the survival of coho salmon during their entire marine residence, the most critical time period is shortly after they emigrate from fresh water as smolts.

Coho smolts from the Snohomish River enter saltwater inside Puget Sound where they encounter a very different environment than those entering saltwater on the open coast; however, conditions inside Puget Sound are influenced by similar basin-wide climatic processes that drive the circulation patterns in the open ocean. In addition, many of the coho salmon from inside Puget Sound migrate outside the sound and rear in the California Current ecosystem where they experience the same ocean conditions as coastal stocks.

Ecosystem indicators that have been associated with early marine survival of Chinook and coho salmon are displayed in Figure 3.2.1.a (Peterson et al. 2017). These indicators were selected based primarily on correlations with survival of Columbia River stocks, but are generally indicative of basin-wide marine conditions. Indicators related the early marine survival of coho are generally related to adult coho abundance in the following year, so the years from 2013-2015 are associated with adult returns in 2014-2016. The mean ranks of indicators were generally neutral, but declining in 2013 and 2014, and have been negative since then. One noteworthy indicator is the catches of juvenile coho in September oceans surveys. These were highly correlated with coho returns in the following year, but the September surveys were discontinued in 2013, and are thus omitted from the mean ranks.

Ecosystem Indicators	Year																		
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
PDO (Sum Dec-March)	16	6	3	12	7	18	11	15	13	9	5	1	14	4	2	8	10	19	17
PDO (Sum May-Sept)	10	4	6	5	11	15	14	16	12	13	2	9	7	3	1	8	17	19	18
ONI (Average Jan-June)	18	1	1	6	12	14	13	15	8	11	3	10	16	4	5	7	9	17	19
46050 SST (°C; May-Sept)	15	8	3	4	1	7	19	14	5	16	2	9	6	10	11	12	13	18	17
Upper 20 m T (°C; Nov-Mar)	18	11	8	10	6	14	15	12	13	5	1	9	16	4	3	7	2	19	17
Upper 20 m T (°C; May-Sept)	15	11	13	4	1	3	19	17	7	8	2	5	12	10	6	16	18	9	14
Deep temperature (°C; May-Sept)	19	6	8	4	1	10	12	16	11	5	2	7	14	9	3	15	18	17	13
Deep salinity (May-Sept)	18	3	8	4	5	15	16	9	6	1	2	13	17	12	11	10	19	14	7
Copepod richness anom. (no. species; May-Sept)	17	2	1	7	6	13	12	16	14	10	8	9	15	4	5	3	11	18	19
N. copepod biomass anom. (mg C m ⁻³ ; May-Sept)	17	13	9	10	3	15	12	18	14	11	6	8	7	1	2	4	5	16	19
S. copepod biomass anom. (mg C m ⁻³ ; May-Sept)	19	2	5	4	3	13	14	18	12	10	1	7	15	9	8	6	11	16	17
Biological transition (day of year)	17	11	6	7	8	12	10	16	15	3	1	2	14	4	9	5	13	19	19
Ichthyoplankton biomass (log(mg C 1000 m ⁻³); Jan-Mar)	19	10	2	6	8	17	16	12	15	14	1	11	3	13	9	7	18	4	5
Ichthyoplankton community index (PCO axis 1 scores; Jan-Mar)	9	13	1	6	4	10	18	16	3	12	2	14	15	11	5	7	8	17	19
Chinook salmon juvenile catches (no. km ⁻³ ; June)	18	4	5	16	10	13	17	19	12	8	1	6	7	15	3	2	9	14	11
Coho salmon juvenile catches (no. km ⁻³ ; June)	18	7	12	5	6	2	15	19	16	3	4	9	10	14	17	1	11	8	13
Mean of ranks	16.4	7.0	5.7	6.9	5.8	11.9	14.6	15.5	11.0	8.7	2.7	8.1	11.8	7.9	6.3	7.4	12.0	15.3	15.3
Rank of the mean rank	19	6	2	5	3	13	15	18	11	10	1	9	12	8	4	7	14	16	16
Ecosystem Indicators not included in the mean of ranks or statistical analyses																			
Physical Spring Trans. UI based (day of year)	3	7	18	15	4	12	14	19	12	1	6	2	8	11	16	9	17	10	5
Physical Spring Trans. Hydrographic (day of year)	18	3	13	8	5	12	14	19	6	9	1	9	17	3	11	2	15	7	16
Upwelling Anomaly (April-May)	9	3	16	5	8	13	12	19	9	4	6	7	14	16	14	11	18	1	2
Length of Upwelling Season UI based (days)	6	2	17	11	1	12	9	19	5	3	8	3	14	16	14	13	18	10	7
SST NH-5 (°C; May-Sept)	8	6	5	4	1	3	19	15	9	17	2	18	10	7	13	12	14	11	16
Copepod Community Index (MDS axis 1 scores)	18	5	4	8	1	13	14	16	15	10	2	6	12	9	7	3	11	17	19
Coho Juv Catches (no. fish km ⁻³ ; Sept)	11	2	1	4	3	6	12	14	8	9	7	15	13	5	10	NA	NA	NA	NA

Figure 3.2.1.a. Summary of marine indicators from 1998-2017. The top block is basin-wide climate indices, the second block is specific physical oceanographic indicators, and the third block is biological indicators. Numbers inside each block are rank value of that indicator across all years with one being the best and 19 the worst. Color coding is used to reflect ocean conditions for salmon growth and survival (green=good, yellow=intermediate, red=poor). The bottom block is indicators not included in the mean ranks.

In 2013, there were mixed ocean conditions. The climate-indicators, such as Pacific Decadal Oscillation (PDO) and El Niño, were 'neutral'. However, sea surface temperatures were warmer than usual, and the majority of the upwelling occurred over a short period of time (i.e. July) with the upwelling 'season' ultimately ending much earlier than usual. The biological indicators pointed to good ocean conditions, with a high abundance of large, lipid-rich zooplankton, a moderate abundance of winter fish larvae that develop into salmon prey in the spring, and catches of juvenile spring Chinook salmon during the June survey off Washington and Oregon that were the second highest in 16 years. Overall, juvenile salmon entering the ocean in 2013 encountered average to above average ocean conditions off Oregon and Washington.

In 2014, many of the ecosystem indicators pointed towards a relatively poor year for salmon survival. The summer PDO values were strongly positive (warm), coinciding with a ‘warm blob’ of water centered in the Gulf of Alaska. El Niño conditions were ‘neutral’, sea surface temperatures were warmer than usual, and the upwelling season started late and ended early. The biological indicators featured a high abundance of large, lipid-rich zooplankton, but a low abundance of winter fish larvae that develop into salmon prey in the spring, and moderate catches of juvenile spring Chinook salmon during the June survey off Washington and Oregon. Overall, juvenile salmon entering the ocean in 2014 encountered below average ocean conditions off Oregon and Washington likely leading to below average returns of adult coho salmon in 2015.

In 2015, many of the ocean ecosystem indicators suggested a relatively poor year for juvenile salmon survival. The PDO was strongly positive (warm) throughout 2015, coinciding with anomalously warm ocean conditions in the NE Pacific called “The Blob” that began in the fall of 2013 and persisted through 2015. El Niño conditions also turned positive in April 2015 and remained strongly positive, signaling a strong El Niño at the equator. Despite the strongest upwelling observed since 1998, sea surface and deep water temperatures off Newport Oregon remained warmer than usual (+2°C) throughout most of 2015. During the strongest upwelling period in June, shelf waters did cool and were salty, but returned to positive temperature anomalies quickly from July onward. The zooplankton community remained in a lipid-depleted state throughout 2015, and was dominated by small tropical and sub-tropical copepods and gelatinous zooplankton that generally indicate poor feeding conditions for small fishes upon which juvenile salmon feed. Krill biomass was also among the lowest in 20 years. On the other hand, the biomass of larval fish species that are common in salmon diets in spring was above average this year, however, there were also high concentrations of larval rockfish and Northern anchovy which are generally indicators of poor feeding conditions for salmon. There were also many new copepod species encountered that had never been seen off Newport since sampling began in 1969.

3.2.2 Early life survival rates

The marine survival for the South Fork Skykomish River was directly estimated using coded-wire tags for ocean entry year 1978 through 1986. Starting in ocean entry year 1987, marine survival has been derived using the historical average smolt production above Sunset Falls (276,000 smolts), adult coho escapement at the Sunset Falls trap, and exploitation rates calculated from Wallace hatchery coho coded-wire tag groups (CWT/non-mark since 1996). This estimate assumes that average smolt production above Sunset Falls has not changed and that harvest rates of hatchery and wild coho are comparable (unmarked hatchery coho since 1996 (Zimmerman, 2018)).

For the entire Snohomish system, recent marine survival was estimated using reconstructed ocean recruit coho (postseason FRAM validation runs) and smolt trap estimates. Estimates of marine survival are available for the South Fork Skykomish River going back to 1979, and for the Snohomish River back to 2003 with the exceptions of 2009 and 2010. Recent year data (2004-2016) is shown in Figure 3.2.2.a. The broods returning in 2014-2016 experienced some of the lowest marine survival on record. Salmon from the South Fork Skykomish River have experienced low marine survival before, but not for consecutive years. The salmon returns in 2014-2016 all experienced low survival. For the Snohomish River, marine survival was low in all three years, but in 2015 survival was the lowest on record (at only 1 percent).

Zimmerman (2018) compared various preseason forecast models for Snohomish coho ocean abundance and found the best model included the North Pacific Gyre Oscillation (NPGO) index May to September of ocean entry and local marine water clarity (light transmissivity) in May of ocean entry in the top 20 meters of depth (assumed to be a proxy for plankton biomass) in Port Gardner. Holmgren (pers. comm. 2018) tested a model including an index of *Pseudocalanus* diversity (derived from PCA analysis during 2003-2016 and NPGO) and it performed very similar to the model described above. This suggests that bottom up processes in Puget Sound and in the ocean can explain some of the variability in early marine survival for Snohomish coho better than other environmental variables.

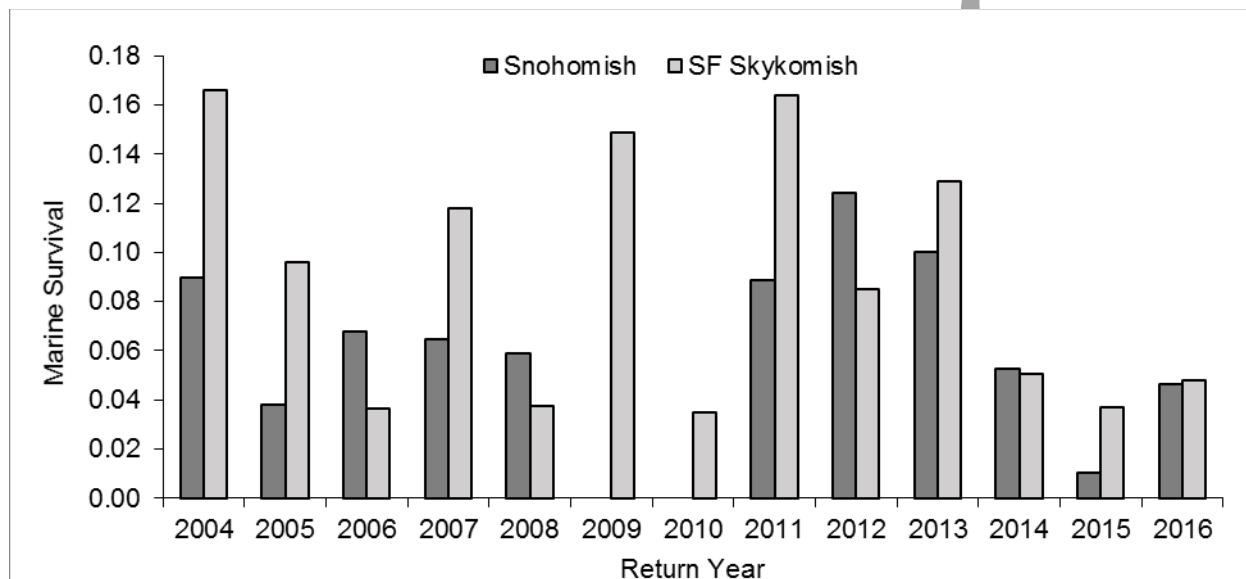


Figure 3.2.2.a. Estimated marine survival of Snohomish River and South Fork Skykomish River natural adult coho. For South Fork Skykomish wild coho (see Zimmerman 2018) and Snohomish (Pouley and Holmgren, pers. comm. 2018)

3.3 Harvest Impacts

3.3.1 Ocean fisheries

Season Descriptions

Harvest of Snohomish River natural coho occur in U.S. and Canadian marine sport and commercial fisheries in southern British Columbia, the northern Washington coast, Strait of Juan de Fuca, and Puget Sound. Terminal tribal and non-tribal drift and set net coho fisheries occur in commercial Marine Management Area (MMA) 8A (Port Susan/Possession Sound) and 8D (Tulalip Bay). These fisheries are directed at coho returning to hatchery production programs in Tulalip Bay and the Snohomish River Basin. There have been no directed commercial salmon fisheries in the Snohomish River, although there are periodically tribal ceremonial and subsistence fisheries. Moderate-sized coho sport fisheries occur in sport MMA 8.2 (Port Susan/Possession Sound), and the Snohomish River Basin. The terminal fishery co-managers are WDFW and the Tulalip Tribes.

Commercial Ocean Seasons

Council area commercial troll fisheries south of Cape Falcon typically do not allow retention of coho. North of Cape Falcon, the non-Indian and Treaty Indian troll (treaty troll) regulations

typically allow coho retention from July through September. In 2014 and 2015, coho retention in the non-Indian commercial troll fishery was limited to adipose-marked coho through August; non-selective coho fisheries occurred in September. In 2016, the non-Indian commercial troll fishery was limited to 30 total fishing days in July and August; September was closed to all troll fishing. Coho retention was not allowed in the fishery in 2016.

The Treaty Indian troll fishery was open from July through mid-September in 2014 and 2015 for all salmon species, and was limited to July and August in 2016 with no coho retention. Table 3.3.1.a shows coho quotas and catch by fishery during 2014, 2015, and 2016. The treaty troll fishery operates largely in ocean waters, however there is directed harvest in the Strait of Juan de Fuca (Area 4B). Area 4B is considered an 'ocean' fishery during the summer treaty troll season and harvest is deducted from the allowable ocean treaty troll coho quota.

Recreational Ocean Seasons

North of Cape Falcon, the all-species recreational salmon fisheries were open from mid-June through late September in 2014 and 2015. In both years, coho retention was limited to adipose-marked coho through August, and unmarked coho retention was allowed in September. In 2016, the recreational fishery was limited to July 1 through August 27. Coho retention was not allowed north of Leadbetter Point in 2016.

South of Cape Falcon, coho retention was allowed from late June through early August in 2014, 2015, and 2016 with retention limited to adipose-marked coho. Unmarked coho retention was allowed each year in September.

Ocean Harvest

Ocean harvest of coho during 2014-2016 were within the allowable quotas or guidelines. In 2016, the north of Cape Falcon coho harvest was severely restricted, if not prohibited, due to the low forecasted returns. In the area North of Cape Falcon, Council-area fisheries harvested 78 percent of the 282,500 coho quota in 2014, 42 percent of the 216,770 fish quota in 2015, and 85 percent of the very low quota of 18,900 in 2016. Table 3.3.1.a shows coho quotas and catch by fishery during 2014, 2015, and 2016.

Table 3.3.1.a. Coho harvest quotas for Council managed fisheries compared with actual harvest by management area and fishery.

Fishery Governed by Quota or Guideline	2014			2015			2016		
	Quota	Catch	Catch/ Quota	Quota	Catch	Catch/ Quota	Quota	Catch	Catch/ Quota
NORTH OF CAPE FALCON									
TREATY INDIAN COMMERCIAL TROLL	62,500	55,897	89%	42,500	3,983	9%	-	-	-
NON-INDIAN COMMERCIAL TROLL	35,200	23,141	66%	19,200	5,059	26%	-	-	-
RECREATIONAL	184,800	140,450	76%	155,070	82,986	54%	18,900	16,059	85%
TOTAL NORTH OF CAPE FALCON	282,500	219,488	78%	216,770	92,028	42%	18,900	16,059	85%
SOUTH OF CAPE FALCON									
RECREATIONAL									
Coho mark-selective	80,000	48,530	61%	55,000	14,896	27%	26,000	1,547	6%
Coho non-mark-selective	35,000	34,267	98%	20,700	4,445	21%	7,500	4,170	56%
TOTAL SOUTH OF CAPE FALCON	115,000	82,797	72%	75,700	19,341	26%	33,500	5,717	17%
GRAND TOTAL COUNCIL AREA	397,500	302,285	76%	292,470	111,369	38%	52,400	21,776	42%

Source: PFMC Review of Ocean Fisheries, Table I-6, Feb 2015, Feb 2016, Feb 2017

3.3.2 *Puget Sound fisheries*

Tribal Fisheries

Strait of Juan de Fuca (Area 5) is predominantly gillnet harvest during July-August, and then switches to set net harvest in October. Harvest in Areas 6 and 6C are modest.

In Central Puget Sound, harvest is largely from Area 10, in similar proportions for the month of September, October, and for gillnet and purse seine gears. Tribes have very limited fisheries in Area 9.

Harvest in terminal areas 8A and 8D are much larger in comparison to those in the Strait of Juan de Fuca and the Central Sound. During 2009-2016, total coho harvest amounted to 291,959 fish in Areas 8A and 8D (73,364 and 218,595 respectively). Most of the catch in both areas, occur in September, by gillnet in 8A and set net in 8D. Incidental coho catches during pink salmon fisheries (odd-years; calendar weeks 33-35) are very limited, and no coho catches have occurred in recent years past the coho management period, as chum fisheries have remained closed. The 8D fisheries target Tulalip hatchery origin salmon (coho, chum and Chinook) on average the proportion of non-Tulalip Hatchery coho (~15 percent) in the tribal net coho catch is significantly less in the inside part of Tulalip Bay (where set net gear is allowed) than in the outside portion (“the Bubble”, where other gears operate) at around 30 percent.

Coho tribal fisheries catches (all stocks) in the Strait of Juan de Fuca (Areas 5, 6, and 6C), Central Sound, and Terminal areas (8A, 8D) for the period 2004-2016 are summarized in Table 3.3.2.a.

Non-Indian Commercial seasons

The number of non-Indian commercial fisheries targeting coho within Puget Sound are limited in time and area. Within Puget Sound, non-Indian and Treaty Indian regulations typically allow coho retention from September through mid-October. In 2014 and 2015, coho retention in the non-Indian commercial Gillnet, Purse Seine, and Beach Seine Fisheries was limited to Quilcene Bay, Port Gamble Bay, Bellingham Bay, Dungeness Bay, Tulalip Bay and the waters through Possession Sound Northward to Camano Head. In 2016, the non-Indian commercial fishery targeting coho was not planned in the Tulalip Bay and Possession Sound areas, but was offered in all other areas.

Recreational seasons

Recreational fishing seasons in the marine catch areas of Puget Sound (Areas 5-13; see map in Appendix B, Table B.1) allowed some coho retention in most areas during the 2014-15 and 2015-16 seasons, via non-selective (NSF) or mark-selective (MSF) coho fisheries as specified in Table B.1. The standard daily bag limit in these fisheries was generally 2 salmon – up to 2 hatchery marked (adipose fin-clipped) coho in MSFs, and up to 2 coho (either marked or unmarked) in NSFs. Additionally, in 2015, as is typical for odd-year regulations, a pink salmon bonus limit (2 pink salmon in addition to the standard 2 salmon limit) was allowed in all Puget Sound marine areas except Areas 8-1 and 8-2. In contrast, coho retention was not allowed in most Puget Sound marine areas during the 2016-17 season due to relatively low run size forecasts for most Puget Sound coho stocks, with the exception of Hood Canal (Area 12; see further detail in Appendix B).

Puget Sound marine area harvest

Table 3.3.2.a. Coho harvest in Puget Sound marine fisheries^{a/b/}.

Year	Treaty Indian	Non-Indian Commercial	Recreational ^{c/}
2004	533,188	39,481	83,708
2005	287,037	19,694	58,309
2006	259,779	9,827	26,688
2007	209,137	13,435	65,306
2008	227,273	6,464	21,400
2009	259,528	20,091	75,719
2010	153,683	18,220	20,290
2011	223,800	28,821	56,775
2012	355,839	35,628	169,884
2013	298,503	29,577	115,934
2014	192,561	11,815	124,185
2015	47,263	4,777	142,669
2016	259,930	14,486	4,983
2017	191,726	11,763	NA
2004-13 Ave.	280,777	22,124	69,401

Source: PFMC Review of 2017 Ocean Fisheries, Tables B-39 and B-40

a/ Data do not reflect treaty Indian allocations. Includes U.S. and Canadian-origin salmon and fish caught in test fisheries.

b/ Commercial and Treaty Indian data are preliminary. Sport data are preliminary in 2016 and 2017.

c/ Recreational catches include WDFW Statistical Areas 5 through 13, which include the Strait of Juan de Fuca, San Juan Islands, and inner Puget Sound.

3.3.3 Recreational fisheries in the Snohomish River system

Seasons

The standard freshwater sport fishery salmon regulations in the Snohomish River Basin has allowed for an even-year fishing season in the Snohomish, Skykomish, and Snoqualmie rivers of September 1 through December 31, and in the Wallace River a season of September 16 through November 30. The standard odd-year season starts August 1 on the Snoqualmie River below Highway 9 to allow for harvest of the pink run and opens progressively as pink salmon move higher in the system. Even-year limits are generally 3 coho only and odd-year bag limits are 3 salmon plus one additional pink, release Chinook and chum. The 2012 through 2017 preseason agreed to in-river sport seasons followed this standard with the exception of 2016 which had a forecast below escapement goals and no preseason agreed to in-river sport harvest. See Appendix C, Table C.1.

Inseason changes that deviated from the preseason agreements were implemented in 2015, 2016 and 2017. These changes reduced the in-river sport fishing season in 2015 and 2017, and provided for some opportunity in 2016. See Appendix C, Table C.2.

In 2015, the beginning of sport seasons were truncated by drought closures implemented July 17 (during gamefish seasons) and lifted between September 2 and September 30 on different sections of the rivers. A run size update on October 1 indicated a much lower than predicted run size, and

the season ended October 21 through emergency regulation. In 2016, preseason forecasts allowed for no freshwater sport coho seasons, but when inseason updates indicated a run size larger than forecasted, a limited season of October 11 through October 31 was implemented. There were also two 4-day openings on the Snohomish mainstem, September 29 through October 2, and October 6 through October 9. In 2017, the Wallace River delayed opening until September 30 due to concerns about Chinook broodstock numbers, pink salmon retention closed throughout the Snohomish watershed on September 22 due to concerns over low pink returns, and the entire Snohomish watershed closed on October 28 to the retention of all salmon except hatchery coho.

Harvest

Snohomish in-river coho catch 2012 through 2016 ranged from 1,194 fish in 2016 which had a very limited season to 16,295 in 2013 (Table 3.3.3.a.).

Table 3.3.3.a. Recreational coho catch in the Snohomish River system

	2012	2013	2014	2015	2016
Skykomish River	1,472	3,068	1,177	995	714
Snohomish River	4,823	12,555	1,277	2,607	480
Snoqualmie River	606	672	85	115	-
Wallace River				125	253
Snohomish total	6,901	16,295	2,539	3,717	1,194

Wallace River separated from Skykomish River beginning in 2015

3.3.4 Total exploitation rates

Exploitation rates on Snohomish River coho returning in 2014-2106 were high compared to other recent years. The exploitation rates in 2015 and 2014 were the highest and second highest since at least 2004. This was largely a result of anomalously high exploitation rates in Puget Sound sport fisheries (labeled as 'Other Preterminal' in Figure 3.3.4.a; Table 3.3.4.a). Even though abundance was much lower in 2015, the fish were very vulnerable to sport fisheries in Puget Sound. In 2016, preseason forecasts for abundance were very low, and preterminal fisheries were severely restricted. Inseason, when the run size appeared to be greater than expected, terminal fisheries were liberalized. This resulted in most of the harvest being taken in terminal fisheries. Council area fisheries have minor impacts on Snohomish coho, and the postseason estimates of total impacts of Council area fisheries in 2014-2016 were less than 2 percent in all years (Table 3.3.4.a)

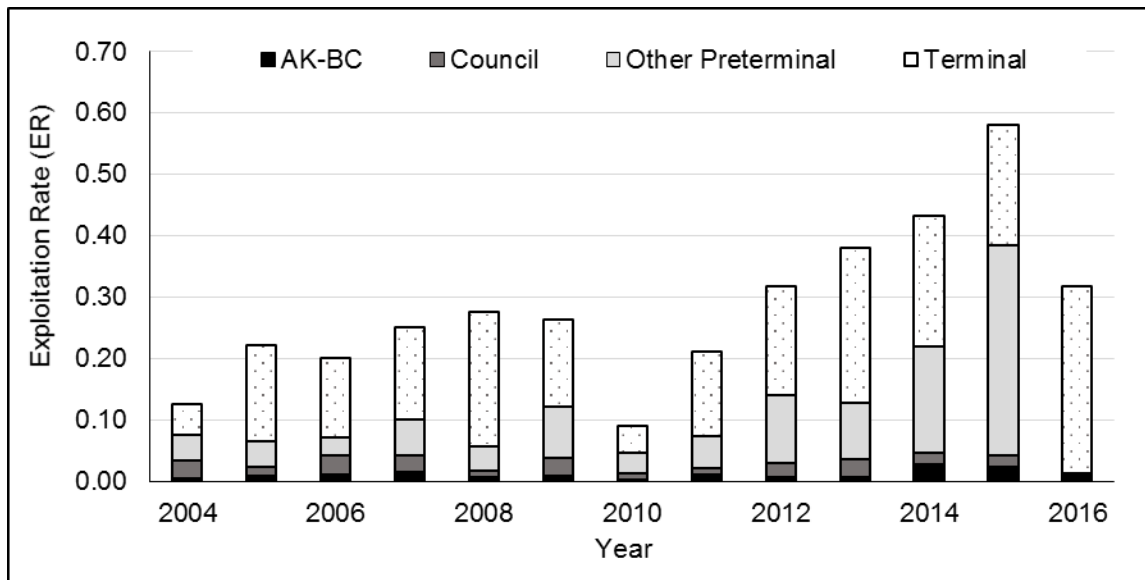


Figure 3.3.4.a. Postseason total exploitation rate by major fishery group on Snohomish natural coho from FRAM estimates generated by the PSC CoTC.

Table 3.3.4.a. Ocean age 3 abundance and escapement and exploitation rates for Snohomish natural coho from postseason FRAM estimates generated by the PSC CoTC.

Strata	2004	2005	2006	2007	2008	2009	2010
Ocean Age 3 Abundance	289,505	133,924	94,754	157,393	49,412	134,407	53,931
Escapement	252,787	104,149	75,626	117,737	35,816	98,950	49,104
Alaska-Canada	0.4%	0.8%	1.0%	1.5%	0.7%	1.0%	0.3%
NOF - Treaty Troll	2.1%	1.1%	2.5%	2.1%	0.8%	2.2%	0.5%
NOF - Nontreaty Troll	0.3%	0.2%	0.3%	0.2%	0.1%	0.3%	0.2%
NOF - Sport	0.5%	0.3%	0.3%	0.4%	0.1%	0.4%	0.2%
SOF all	0.1%	0.0%	0.0%	0.1%	0.0%	0.1%	0.0%
Preterminal Other	4.3%	4.2%	3.0%	5.7%	4.0%	8.2%	3.3%
Terminal Sport	0.0%	3.5%	1.5%	3.7%	3.6%	0.1%	2.8%
Terminal Net	5.1%	12.1%	11.5%	11.5%	18.2%	14.2%	1.5%
Total ER	12.7%	22.2%	20.2%	25.2%	27.5%	26.4%	9.0%
Strata	2011	2012	2013	2014	2015	2016	
Ocean Age 3 Abundance	141,943	191,762	188,878	81,348	30,502	64,697	
Escapement	112,076	130,639	117,216	46,244	12,806	44,138	
Alaska-Canada	1.1%	0.6%	0.7%	2.8%	2.4%	0.8%	
NOF - Treaty Troll	0.6%	1.6%	2.0%	1.3%	0.5%	0.0%	
NOF - Nontreaty Troll	0.2%	0.4%	0.5%	0.1%	0.4%	0.1%	
NOF - Sport	0.2%	0.3%	0.3%	0.2%	0.9%	0.1%	
SOF all	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	
Preterminal Other	5.4%	11.1%	9.3%	17.4%	34.2%	0.3%	
Terminal Sport	5.2%	4.0%	8.3%	2.8%	10.4%	1.3%	
Terminal Net	8.4%	13.9%	16.8%	18.4%	9.1%	29.1%	
Total ER	21.0%	31.9%	37.9%	43.2%	58.0%	31.8%	

3.4 Assessment and management

3.4.1 Abundance forecast errors

The age-3 ocean abundance forecast of Snohomish natural coho in each of the years from 2014-2016 was based on the estimated smolt production from the basin, multiplied by an expectation of the marine survival rate. Among the local and regional variables that may influence marine survival of wild coho salmon, two variables are particularly informative for the Snohomish MU – North Pacific Gyre Oscillation (NPGO) index May to September of ocean entry and local marine water clarity (light transmissivity) in May of ocean entry. Higher survival is associated with higher NPGO index values and higher light transmissivity (Zimmerman, 2018).

In 2014, and especially 2015, abundance was over-forecasted (Figures 3.4.1.a and 3.4.1.b). In 2016, abundance was substantially under-forecast, not just for the Snohomish coho, but for other coho stocks as well. Fisheries may not always be able to respond appropriately inseason to forecasting errors; this could cause ER caps to be exceeded (if over-forecast), or result in foregone opportunities for harvest (if under-forecast).

In 2016, fishery co-managers (tribal and WDFW) agreed to more conservative forecasts in response to the unexpected low returns in the previous year, and continuing observed poor ocean conditions (i.e., warmer temperatures, lower upwelling intensity, and lower prey abundance). The management response was to correlate fewer years of data (i.e. to reflect more recent conditions) in the forecast models and lower predicted marine survival.

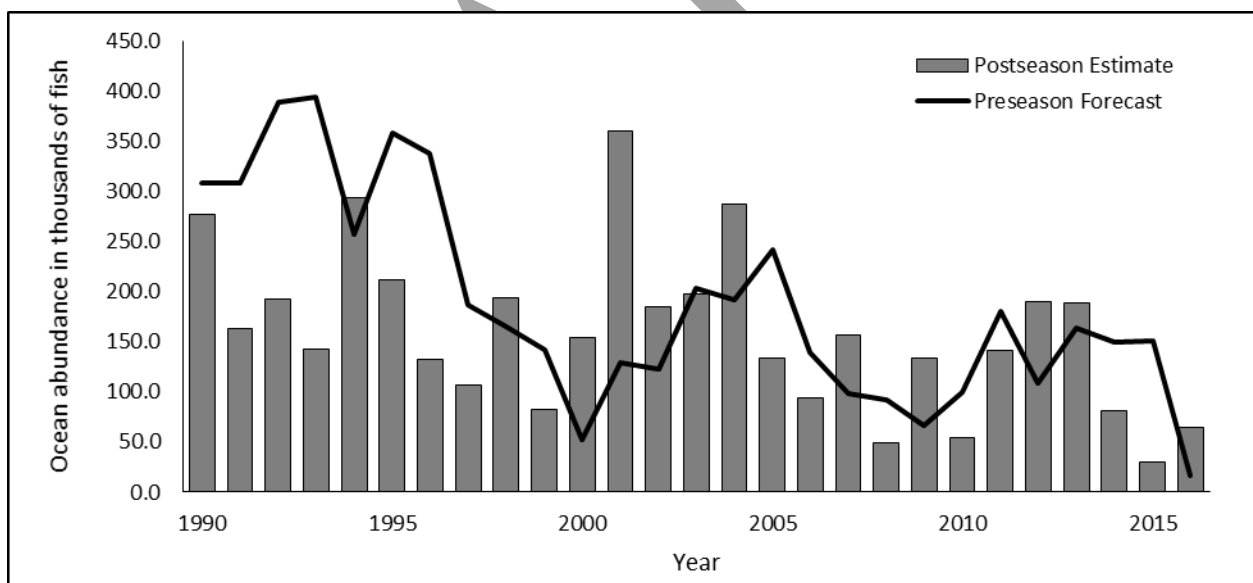


Figure 3.4.1.a. Preseason forecasts and postseason FRAM estimates of ocean age 3 abundance of Snohomish River natural coho. Preseason forecasts are generated by salmon co-managers and postseason FRAM estimates are generated by the PSC CoTC.

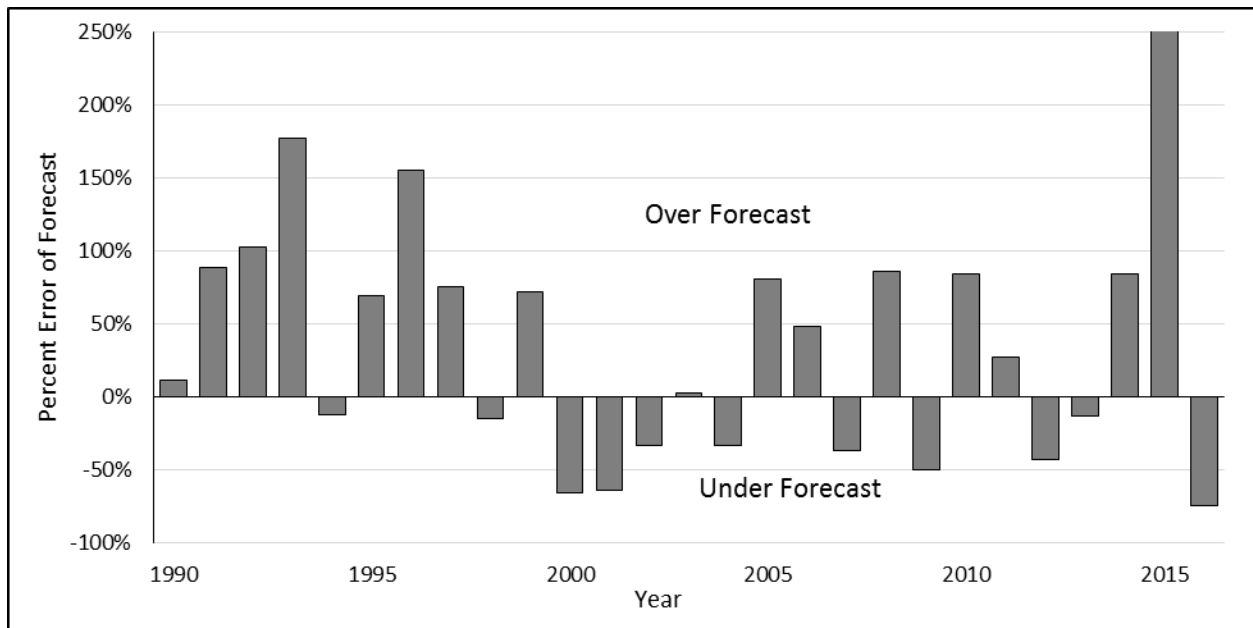


Figure 3.4.1.b. Preseason forecast error when compared to postseason estimates of ocean age 3 abundance of Snohomish River natural coho. Preseason forecasts are generated by salmon co-managers and postseason FRAM estimates are generated by the PSC CoTC

3.4.2 Exploitation rate forecast errors

The escapement years that contributed to the overfished determination for Snohomish coho were 2014 through 2016.

In 2014 and 2015, abundance was over-forecasted which caused the stock to be inappropriately categorized when determining the preseason maximum ER allowed, or 'ER Cap'. The over-forecasts of 2014 and 2015 also contributed to ERs that exceeded preseason projections. The combination of higher ERs than projected and preseason ER caps that were set too high (based on postseason estimates) resulted in postseason ER estimates that exceeded the postseason ER caps. (Table 3.4.2.a.).

In 2016, abundance was under-forecast which caused the stock to be inappropriately categorized when determining the preseason ER Cap. Inseason, information indicated actual abundance was greater than the preseason forecast. Pre-terminal area fisheries were able to respond to the abundance updates and provide additional opportunity inseason. As a result, the postseason ER was greater than preseason projections. Postseason ER estimates were less than the postseason cap, which was increased based on the postseason abundance estimates (Table 3.4.2.a.).

A summary of preseason projected and postseason estimated total exploitation rates, compared to those allowed (cap) since 2010 is provided in Table 3.4.2.a. This helps illustrate the change in preseason/postseason exploitation rates, and also the change in the ER Cap. Table 3.4.2.b details the pre- and postseason fishery mortalities and resulting exploitation rates by fishery aggregate for each of the three years that led to the overfished status. For Council fisheries, the postseason ERs were less than those predicted preseason in all three years.

Table 3.4.2.a. Preseason and postseason total exploitation rates for Snohomish natural coho generated in FRAM modeling conducted by the PFMC Salmon Technical Team (preseason) and the PSC CoTC (postseason).

Year	Exploitation Rate			
	Preseason		Postseason	
	Projected	ER Cap ^{a/}	Estimated	ER Cap ^{a/}
2010	32%	40%	9%	40%
2011	26%	60%	21%	60%
2012	28%	40%	32%	60%
2013	25%	60%	38%	60%
2014	30%	60%	43%	40%
2015	33%	60%	58%	20%
2016	7%	20%	32%	40%
Average	26%	40%	33%	40%

a/ See CoTC 2013 for information on determination of ER caps.

Table 3.4.2.b. Preseason forecast and postseason estimates of escapement, total mortality, and exploitation rate by fishery for Snohomish natural coho during years that contributed to the overfished classification. Data Sources: preseason forecasts generated by salmon co-managers, preseason exploitation rates from FRAM modeling by the PFMC STT, and postseason FRAM estimates generated by the PSC CoTC.

FISHERY COMPONENT	2014		2015		2016	
	Preseason	Postseason	Preseason	Postseason	Preseason	Postseason
Ocean Age 3 Abundance	150,477	81,348	152,091	30,502	16,772	64,697
FMP Smsy	50,000	50,000	50,000	50,000	50,000	50,000
Escapement after all fisheries	104,765	46,244	102,365	12,806	15,666	44,138
Alaska-Canada	802	2,315	2,396	747	199	495
Council North of Falcon						
Treaty Troll	3,407	1,087	2,582	140	5	11
Nontreaty Troll	559	119	553	123	27	66
Sport	854	164	868	288	59	87
Council South of Falcon	151	37	151	23	14	23
Council Subtotal	4,971	1,407	4,154	574	105	187
Preterminal Other						
Troll	55	36	107	85	4	-
Net	15,534	4,088	14,206	828	75	123
Sport	8,612	10,021	10,826	9,521	60	78
Terminal Net and Sport	15,738	17,237	18,037	5,941	663	19,676
Total Fishing Mortality	45,712	35,104	49,726	17,696	1,106	20,559
Alaska-Canada	0.5%	2.8%	1.6%	2.4%	1.2%	0.8%
Council North of Falcon						
Treaty Troll	2.3%	1.3%	1.7%	0.5%	0.0%	0.0%
Nontreaty Troll	0.4%	0.1%	0.4%	0.4%	0.2%	0.1%
Sport	0.6%	0.2%	0.6%	0.9%	0.4%	0.1%
Council South of Falcon	0.1%	0.0%	0.1%	0.1%	0.1%	0.0%
Council Subtotal	3.3%	1.7%	2.7%	1.9%	0.6%	0.3%
Preterminal Other						
Troll	0.0%	0.0%	0.1%	0.3%	0.0%	0.0%
Net	10.3%	5.0%	9.3%	2.7%	0.4%	0.2%
Sport	5.7%	12.3%	7.1%	31.2%	0.4%	0.1%
Terminal Net and Sport	10.5%	21.2%	11.9%	19.5%	4.0%	30.4%
Total Exploitation Rate	30.4%	43.2%	32.7%	58.0%	6.6%	31.8%

3.5 Summary of contributing factors

Freshwater productivity of the Snohomish River system does not appear to be a major contributing factor. The Snohomish system has produced large runs in the past, and estimated smolt production in 2013, 2014, and 2015, although less than some years, was not abnormally low.

Marine survival has fluctuated, but was low for all of the broods that returned in 2014, 2015, and 2016, especially for salmon returning in 2015. Lower marine survival in 2015 is attributed to poor ocean conditions and lack of available prey. In 2015, Snohomish coho returned in much lower numbers than forecasted preseason. The fish were also much smaller in both weight and length than normal, resulting in less fecundity per returning adult. This had a compounding effect on the resource, resulting in both low escapement and low spawning potential for those adult salmon that did return.

Exploitation rates on Snohomish coho are typically constrained by impacts of fisheries on other stocks. In the years from 2010 to 2016, the projected preseason ERs have averaged 53% of the allowable ER caps, and the postseason rates have averaged 73% of the allowable caps. However, the only two years in this time frame in which the postseason estimates exceeded what should have been allowed were 2014 and 2015. In 2014, harvest exceeded the allowable ER caps mainly due to forecast error, whereas in 2015 it was due to a combination of forecast error and a delayed in-season reduction to the sport fisheries in terminal waters. In 2016, despite a forecast error, harvest remained within the postseason ER cap, although both the postseason estimated ER and ER cap were higher than projected preseason.

4.0 RECOMMENDATIONS FOR ACTION

4.1 Recommendation 1: Rebuilt Criterion

Consider the Snohomish coho stock to be rebuilt when the 3-year geometric mean of natural-area adult escapement meets or exceeds S_{MSY} . This is the default rebuilt criterion in the FMP.

4.2 Recommendation 2: Management Strategy Alternatives

Recommend the Council adopt a management strategy (control rule) that will be used to guide management of fisheries that impact Snohomish coho until rebuilt status is achieved. We offer three alternative management strategies for consideration. The rebuilding time frame under each of the three Alternatives are not expected to exceed 10 years. The probability of achieving rebuilt status for years 1 through 10 are projected for Alternatives I and III in Section 4.3. *Analysis of Management Strategy Alternatives*.

The description of Alternatives may include references intended to meet NEPA or MSA criteria. Guidelines suggest that alternatives are identified as either an ‘action’ or a no-action’ alternative, and that the minimum time (T_{MIN}) and maximum time (T_{MAX}) estimated to achieve rebuilt status is acknowledged within the suite of alternatives.

Alternative I: Status quo control rule. During the rebuilding period continue to use the current management framework and reference points, as defined in the FMP and the PST, to set maximum allowable exploitation rates on an annual basis. Projected rebuilding time

is two years (see Section 4.3). This is considered a ‘no-action’ alternative, and represents T_{MAX} .

Alternative II: Reduced Coho Harvest. The Council will plan ocean fisheries to limit impacts on the rebuilding stock consistent with escapement thresholds and exploitation rate limits identified by the Washington co-managers, and consistent with the FMP. The co-managers may adjust escapement thresholds and exploitation rate limits annually, as described in the FMP, to promote rebuilding of the stock while allowing limited fisheries to occur. The state and tribal co-managers will plan inside fisheries during the North of Falcon preseason process that, when combined with PFMC fisheries, will meet the applicable escapement and exploitation rate objectives.

Alternative III: Suspend all salmon-directed ocean and in-river fisheries from the U.S/Canada border to Cape Falcon until rebuilt status is achieved. Projected rebuilding time is two years (see Section 4.3). This is considered an ‘action’ alternative, and represents T_{MIN} .

Alternative III includes fisheries that the Council does not have jurisdiction over. It also does not meet the purpose and need because it would restrict tribal fisheries in a manner that is inconsistent with their treaty right. Alternative III is provided solely to serve as a bookend in the analysis of rebuilding probabilities over a ten year period when assuming an exploitation rate of zero. This Alternative fulfills the requirement of National Standard 1 in calculating the minimum time (T_{MIN}) estimated to achieve rebuilt status.

4.3 Analysis of Alternatives

The STT has developed a simple model to assess the probability of a stock achieving rebuilt status in each year following the overfished declaration. Future abundance is based on observed past abundance levels for the stock. Realistic levels of error in abundance forecasts, escapement estimates, and exploitation rate implementation contribute to the projected adult spawner escapement. Replicate simulations are performed to allow for computation of the probability of rebuilt status by year. The model framework allows for evaluation of alternative rebuilding plans by specifying the rebuilding plans as alternative harvest control rules. The tool has some elements of a management strategy evaluation (MSE), but lacks an explicit biological operating model. This simplification is necessary because for many stocks data limitations do not allow for the development of full population dynamics models. Model structure, parameterization, and additional results are presented in Appendix D.

Figure 4.3.a. displays the projected probability of achieving rebuilt status in year one through 10 of the rebuilding period for status quo (Alternative I) and no directed salmon fishery impacts (Alternative III). Year one is assumed to be the year following the stock meeting the criteria for overfished status. Thus, year one in Figure 4.3.a represents year 2018. Under each of the alternatives the probability of achieving rebuilt status in year one is low. The probability of achieving rebuilt status by year two is greater than 0.50 for both Alternatives I and III, and greater than 0.90 by year 5, with the probabilities converging around years 6 or 7.

The projected rebuilding time is defined as the number of years needed for the probability of achieving rebuilt status to exceed 0.50. Rebuilding times are projected to be two years for Alternative I, and two years for Alternative III.

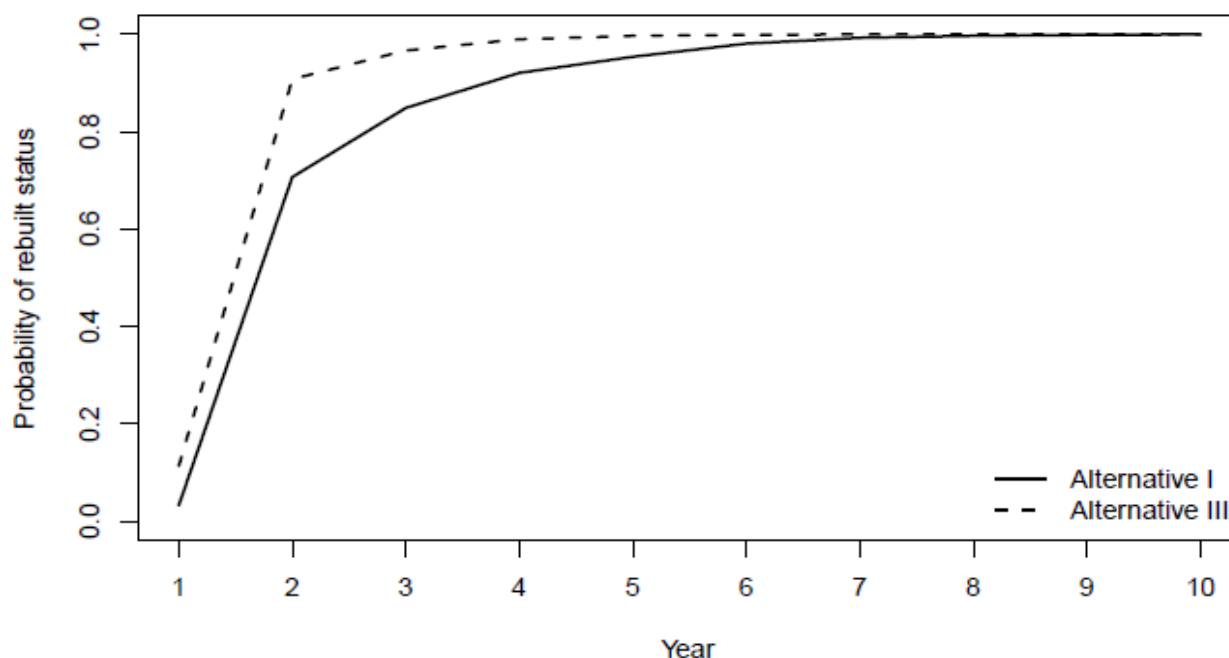


Figure 4.3.a. Projected probability of achieving rebuilt status by year under two alternative rebuilding plans:

4.4 Additional recommendations for consideration

Successful co-management is one essential component to rebuilding Snohomish coho stocks and this should continue. In response to over forecasting of Snohomish coho ocean abundances in 2014 and 2015 co-managers adjusted the 2016, 2017, and 2018 forecasts by using conservative marine survival in the calculations of adult recruits. In addition, the smolt production estimate used in the forecast of adult recruits in 2018 was lowered substantially (lower 95% confidence interval bound), to minimize the risk of over forecasting. Co-managers have been very conservative in setting fishing schedules for the seasons 2016-2018. In 2018 for example, tribal and sport fisheries were curtailed early in the season (end of September), resulting in a more conservative fishing schedule than what inseason updates to the terminal abundance would have allowed. Co-managers are taking a cautious approach because there is uncertainty in the estimates (smolt production, marine survival, and exploitation rates), and because of the need to recover the Snohomish coho stock to escapement levels to the “moderate” category.

5.0 SOCIOECONOMIC IMPACT OF MANAGEMENT STRATEGY ALTERNATIVES

5.1 Alternative 1

Current management framework and reference points, as defined in the FMP and the PST, to set maximum allowable exploitation rates on an annual basis would remain in place. Domestic ocean fisheries impacting Snohomish River coho occur mainly in Washington state and north of Cape Falcon, Oregon.

For purposes of describing the status quo economic situation, data for port areas in coastal Washington and Oregon north of Cape Falcon during 2004 to 2016 are used, since that period is representative of possible outcomes under the current status quo control rule. Estimates of total coastal community personal income impacts during 2004-2016 in affected port areas for the non-tribal commercial ocean troll salmon fishery averaged approximately \$3.4 million (in inflation-adjusted 2016 dollars), ranging from \$1.6 million in 2008 to \$5.6 million in 2015, and for the ocean recreational salmon fishery averaged approximately \$9.9 million, ranging from \$4 million in 2008 to \$16 million in 2014. Total community personal income impacts in affected areas from the combined non-tribal commercial troll and recreational salmon fisheries conducted in ocean areas averaged approximately \$13.3 million during 2004-2016, ranging from \$5.6 million in 2008 to \$21.3 million in 2014.⁴

For the individual port areas, inflation-adjusted personal income impacts during the period from combined ocean non-tribal commercial troll and recreational salmon fisheries averaged approximately \$1.3 million in Neah Bay, ranging from \$0.4 million in 2008 to \$2.2 million in 2004; \$0.7 million in La Push, ranging from \$0.3 million in 2016 to \$1 million in 2015; \$6.7 million in Westport, ranging from \$3 million in 2008 to \$10.2 million in 2015; \$3.3 million in Ilwaco, ranging from \$1.2 million in 2008 to \$5.8 million in 2014; and \$1.5 million in Astoria, ranging from \$0.7 million in 2008 to \$3.1 million in 2014.

2008 was the lowest year for combined non-tribal ocean salmon fishery inflation-adjusted personal income impacts during the period overall and for three of the five affected port areas: Neah Bay, Westport and Ilwaco, while 2016 was the lowest year for La Push and Astoria. 2014 had the highest inflation-adjusted combined salmon fishery personal income impacts during the period overall and also for two port areas: Ilwaco and Astoria. The highest years for the remaining three port areas were 2004 for Neah Bay, and 2015 for both La Push and Westport.

Although not included in these economic impact estimates, Snohomish River coho are also taken in commercial and tribal net fisheries and recreational fisheries in Puget Sound and its tributaries. During 2004-2016, commercial net harvests of adult Snohomish River coho in the Puget Sound region averaged 10,772 fish, ranging from 25,004 fish in 2009 to 2,261 fish in 2007.⁵

Provided that a sufficient likelihood of rebuilding is achieved during the allowable 10-year period under Status Quo (Alternative I), economic impacts under the two action alternatives (Alternatives II and III) are measured relative to the Status Quo fishery. The estimated timeframe needed to achieve rebuilt status (with a probability of at least 50 percent) under Status Quo conditions is two years, during which time it is assumed the 2004-2016 inflation-adjusted average of \$13.3 million per year in income from combined ocean commercial and recreational salmon fisheries would accrue in the affected communities north of Cape Falcon. By definition there would be no direct or indirect economic impact from the rebuilding plan under the Status Quo (no action) alternative.

⁴ It is important to note that income impact estimates for the two sectors (commercial and recreational) cannot be directly compared because they are derived using different methodologies.

⁵ Puget Sound catch data from *Review of 2017 Ocean Salmon Fisheries: Stock Assessment and Fishery Evaluation Document for the Pacific Coast Salmon Fishery Management Plan*. Table B-42.

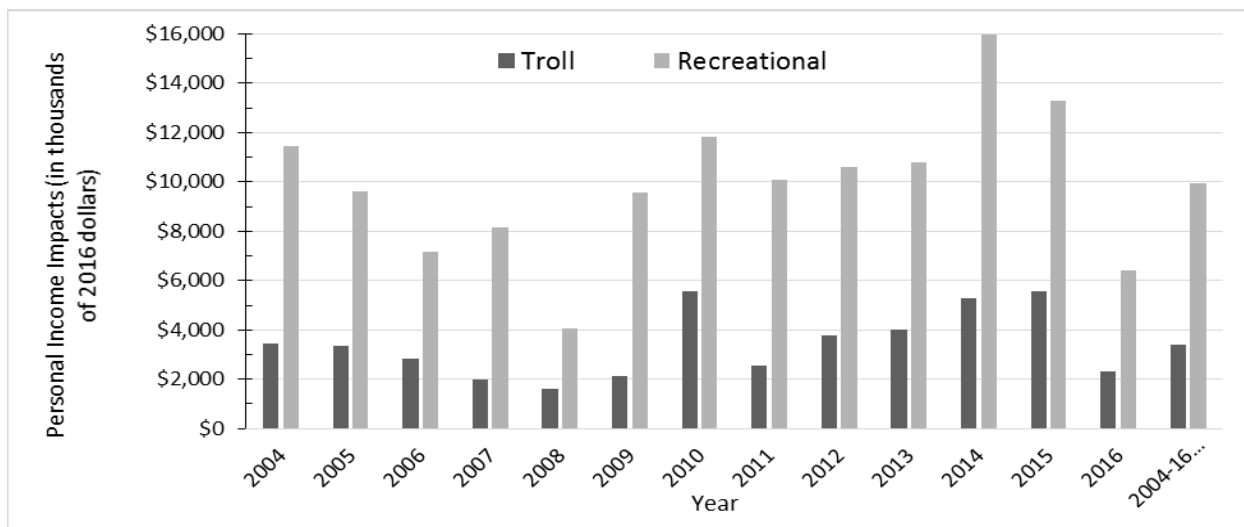


Figure 5.1.a. Estimates of total, aggregated personal income impacts in affected coastal communities in Washington and Oregon north of Cape Falcon in thousands of real (inflation adjusted, 2016) dollars for the non-tribal commercial ocean troll and ocean recreational salmon fisheries.

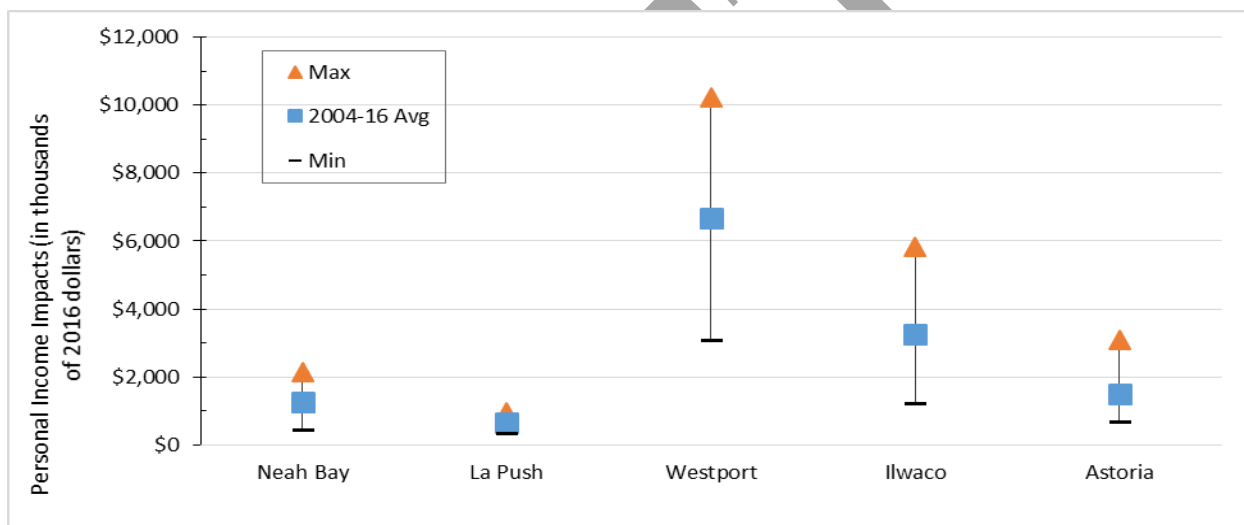


Figure 5.1.b. Estimates of personal income impacts by coastal community in thousands of real (inflation adjusted, 2016) dollars for the combined non-tribal commercial ocean troll and ocean recreational salmon fisheries in Washington and Oregon north of Cape Falcon.

Table 5.1.a. Estimates of personal income impacts by coastal community in thousands of real (inflation adjusted, 2016) dollars for the non-tribal commercial ocean troll and ocean recreational salmon fisheries for major Washington and Oregon port areas north of Cape Falcon.

OCEAN TROLL	Neah Bay	La Push	Westport	Ilwaco	Astoria	Total
2004	928	293	1,154	113	969	3,457
2005	761	454	1,170	144	803	3,333
2006	566	459	440	295	1,050	2,811
2007	250	254	1,038	129	310	1,981
2008	163	216	616	164	442	1,601
2009	331	342	1,192	83	180	2,128
2010	251	403	3,843	95	972	5,563
2011	575	228	1,407	96	244	2,551
2012	862	501	1,467	234	723	3,788
2013	485	448	2,674	74	354	4,035
2014	385	445	1,528	1,108	1,840	5,305
2015	315	641	3,021	420	1,171	5,568
2016	206	204	1,386	219	305	2,321
2004-16 Avg	468	376	1,611	244	720	3,419
Max	928	641	3,843	1,108	1,840	5,568
Min	163	204	440	74	180	1,601
RECREATIONAL	Neah Bay	La Push	Westport	Ilwaco	Astoria	Total
2004	1,228	260	5,332	3,494	1,151	11,465
2005	842	263	4,866	2,829	835	9,636
2006	552	231	3,593	2,200	600	7,176
2007	563	180	3,687	2,875	842	8,146
2008	244	108	2,425	1,024	242	4,043
2009	657	288	4,626	3,166	848	9,586
2010	777	332	6,312	3,422	976	11,819
2011	758	363	5,180	3,033	756	10,089
2012	944	343	5,848	2,853	606	10,594
2013	1,088	368	5,679	2,987	687	10,810
2014	1,190	484	8,315	4,731	1,242	15,962
2015	1,059	334	7,203	3,793	909	13,298
2016	595	112	2,746	2,604	352	6,410
2004-16 Avg	807	282	5,062	3,001	773	9,926
Max	1,228	484	8,315	4,731	1,242	15,962
Min	244	108	2,425	1,024	242	4,043
Combined	Neah Bay	La Push	Westport	Ilwaco	Astoria	Total
2004	2,156	553	6,486	3,607	2,120	14,922
2005	1,603	718	6,036	2,974	1,638	12,969
2006	1,118	690	4,033	2,495	1,649	9,986
2007	813	434	4,725	3,004	1,151	10,127
2008	407	324	3,041	1,189	683	5,644
2009	989	630	5,819	3,249	1,029	11,715
2010	1,028	735	10,155	3,517	1,948	17,382
2011	1,333	590	6,587	3,129	1,001	12,640
2012	1,806	845	7,315	3,087	1,329	14,382
2013	1,573	816	8,353	3,061	1,041	14,844
2014	1,576	928	9,842	5,839	3,082	21,268
2015	1,374	975	10,223	4,213	2,080	18,866
2016	800	316	4,132	2,824	658	8,730
2004-16 Avg	1,275	658	6,673	3,245	1,493	13,344
Max	2,156	975	10,223	5,839	3,082	21,268
Min	407	316	3,041	1,189	658	5,644

Income impact estimates from *Review of 2017 Ocean Salmon Fisheries: Stock Assessment and Fishery Evaluation Document for the Pacific Coast Salmon Fishery Management Plan*. Tables IV-17 and IV-18

5.2 Alternative II

Pending

5.3 Alternative III

Under Alternative III, rebuilding is estimated to occur after two years assuming an exploitation rate of zero during that time. Compared to the ‘no-action’ or Status Quo management strategy of Alternative I, this would result in an overall income impact of negative (-) \$13.3 million per year in coastal communities in the affected region over the two years it would take to rebuild under Status Quo.

5.4 Note on Economic Impacts

These estimates should be considered upper bounds on the magnitude of economic effect under the action alternatives because it is assumed that equal, proportional management measures would be put in place for all ocean commercial and recreational fisheries in all affected areas along the coast, whereas past experience has shown that overall economic impacts may be mitigated in many cases by using an approach in which areas in the affected region are managed differentially depending on the degree of interaction between fisheries and stocks of concern in each area.

6.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL EFFECTS OF MANAGEMENT STRATEGY ALTERNATIVES CONSIDERED

6.1 Introduction

This chapter will analyze the environmental impacts of the alternatives on the resources that would be more than minimally affected by the proposed action. This is a required component to adopt this integrated document as an environmental assessment under NEPA. The action area for the proposed action is the exclusive economic zone (EEZ), from three to 200 miles offshore of the coasts of Washington and Oregon, from the U.S./Canada border to Cape Falcon, Oregon. In this document, the action area and the analysis area are largely synonymous, exceptions are noted below.

6.2 Target Salmon Stocks

6.2.1 Affected Environment

Ocean salmon fisheries in the analysis area target Chinook and coho salmon.

The Council manages several stocks of Chinook salmon under the FMP (PFMC 2016a). In the ocean, stocks of salmon comingle which results in mixed-stock fisheries. Non-target stocks, including ESA-listed stocks, will be encountered in mixed-stock fisheries. The Council’s Salmon Technical Team (STT) models the degree to which target and non-target stocks are impacted by proposed fisheries, and the Council uses tools such as harvest restrictions, time and area closures, and mark-selective fisheries to limit impacts to non-target stocks (PFMC and NMFS 2017).

In the analysis area, the primary management tools are time and area closures and recreational bag limits; some fisheries also have quotas. The primary salmon stocks targeted in the analysis area are: Lower Columbia River hatchery fall-run Chinook salmon, Columbia River Spring Creek

Hatchery fall-run Chinook salmon, and Columbia River late hatchery coho stocks. Coastal coho stocks also contribute to fisheries in the analysis area, but individual stock contributions are minor. Fisheries in the analysis area are managed to meet FMP conservation objectives for these stocks, and to comply with ESA consultation requirements for any ESA-listed salmon stocks that are affected by salmon fisheries in the analysis area.

Detailed information on spawning escapement and fisheries impacts on salmon stocks are reported in the Council's annual Stock Assessment and Fishery Evaluation (SAFE) document, known as the Annual Review of Ocean Salmon Fisheries. These documents are available on the Council's website (www.pcouncil.org/salmon/stock-assessment-and-fishery-evaluation-safe-documents/).

6.2.2 Environmental Consequences of Alternatives on Target Salmon Stocks

Analysis pending

6.3 Marine Mammals

6.3.1 Affected environment

A number of non-ESA-listed marine mammal species occur in the analysis area. The non-ESA-listed marine mammal species that are known to interact with ocean salmon fisheries are California sea lion (*Zalophus californianus*) and harbor seals (*Phoca vitulina*), both species will feed on salmon, when available, and have been documented preying on hooked salmon in commercial and recreational fisheries (e.g., Weise and Harvey 1999). All marine mammals are protected under the Marine Mammal Protection Act (MMPA). Ocean salmon fisheries employ hook-and-line gear and are classified under NMFS' MMPA List of Fisheries as Category III (83 FR 5349, February 7, 2018), indicating there is no record of substantive impacts to marine mammals from these fisheries (MMPA 118(c)(1)).

ESA-listed marine mammal species that co-occur with Council-managed salmon fisheries include Guadalupe fur seal, southern sea otter, northern sea otter, and Southern Resident killer whale (SRKW). Among the ESA-listed marine mammals, only the SRKW is known to interact with Pacific salmon or salmon fisheries, in that SRKW are known to prey on salmon. The range of SRKW in spring, summer, and fall includes the inland waterways of Washington State and the transboundary waters between the United States and Canada. In recent years, SRKW have been regularly spotted as far south as central California during the winter months (<http://www.nmfs.noaa.gov/pr/species/mammals/whales/killerwhale.html>) and their range is currently defined as extending as far south as Point Sur, California (Teresa Mongillo, pers. comm.⁶). In 2009 NMFS consulted on the effects of the ocean salmon fisheries on the SRKW and concluded that Council-managed salmon fisheries were not likely to jeopardize these whales. In the time since that consultation, there has been additional research on SRKW life history, feeding habits, fecundity, and mortality rates. This new information indicates that prey base, environmental contaminants, and disturbance by vessel traffic are among the factors that may affect the recovery of SRKW. NMFS is working with researchers from the U.S. and Canada to evaluate impacts of various human activities, including salmon fisheries, on the survival and recovery of SRKW. Until such time as sufficient information is developed to inform a new ESA consultation on the impacts of salmon fisheries on the survival and recovery of SRKW, NMFS is

⁶ Personal communication from T. Mongillo (NMFS) to P. Mundy (NMFS), email dated September 28, 2017.

working on identifying and developing short-term management actions to improve Chinook salmon availability and reducing acoustic and vessel disturbance in key SRKW foraging areas.

6.3.2 Environmental Consequences of the Alternatives on Marine Mammals

Analysis pending

6.4 ESA listed Salmon Stocks

6.4.1 Affected environment

Several ESUs of Pacific salmon that are ESA-listed as threatened or endangered occur in the areas where Council-managed ocean salmon fisheries occur. As stated above, the only salmon species encountered in fisheries in the action area are Chinook and coho salmon. ESA-listed Chinook and coho salmon ESUs that occur within the analysis area are listed in Table 6.4.1a.

Table 6.4.1.a. ESA-listed Chinook and coho salmon ESUs that occur within the analysis area.

ESA-listed ESUs	Status	Most recent citation
Chinook (<i>Oncorhynchus tshawytscha</i>)		
Snake River Fall-run	Threatened	70 FR 37160 (June 28, 2005)
Snake River Spring/Summer-run	Threatened	70 FR 37160 (June 28, 2005)
Puget Sound	Threatened	70 FR 37160 (June 28, 2005)
Lower Columbia River	Threatened	70 FR 37160 (June 28, 2005)
Upper Willamette River	Threatened	70 FR 37160 (June 28, 2005)
Upper Columbia River Spring-run	Endangered	70 FR 37160 (June 28, 2005)
Coho (<i>Oncorhynchus kisutch</i>)		
Oregon Coastal	Threatened	76 FR 35755 (June 20, 2011)
Lower Columbia River	Threatened	70 FR 37160 (June 28, 2005)

NMFS has issued biological opinions on the impacts of Council-managed salmon fisheries on ESA-listed salmon. Based on those biological opinions, NMFS provides guidance to the Council during the preseason planning process for setting annual management measures for ocean salmon fisheries based on the coming year's abundance projections. This guidance addresses allowable impacts on ESA-listed salmon. The Council structures fisheries to not exceed those allowable impacts.

NMFS has previously consulted on the effects of Council-area salmon fisheries on the ESA-listed salmon ESUs in the analysis area, and has produced the biological opinions listed in Table 6.4.1.b.

Table 6.4.1.b. NMFS biological opinions regarding ESA-listed salmon ESUs likely to be affected by Council-area ocean salmon fisheries in the analysis area.

Date	Duration	Citation	Species Considered
8-Mar-96	Until reinitiated	NMFS 1996	Snake River spring/summer and fall Chinook (and sockeye)
28-Apr-99	Until reinitiated	NMFS 1999	Oregon Coast coho (S. Oregon/N. California Coast coho, and Central California Coast coho)
30-Apr-01	Until reinitiated	NMFS 2001	Upper Willamette Chinook, Upper Columbia River spring-run Chinook (Lake Ozette sockeye, Columbia River chum, and 10 steelhead ESUs)
30-Apr-04	Until reinitiated	NMFS 2004	Puget Sound Chinook
26-Apr-12	Until reinitiated	NMFS 2012	Lower Columbia River Chinook
9-Apr-15	Until reinitiated	NMFS 2015	Lower Columbia River coho

6.4.2 Environmental Consequences of the Alternatives on ESA-Listed Salmon Stocks

Analysis pending

6.5 Non-target Fish Species

6.5.1 Affected environment

Pacific halibut, and Pacific halibut fisheries, occur north of Point Arena, California. Halibut allocations are established annually in the International Pacific Halibut Commission's (IPHC) regulations and the PFMC's Area 2A Catch Sharing Plan (e.g., 82 FR 18581, April 20, 2017). Allocation of halibut quota to fisheries in the analysis area would not be affected by the Proposed Action, as the IPHC's halibut quota for the U.S. West Coast and the sub-area allocations set forth in the Catch Sharing Plan are set annually under separate processes from setting the annual salmon management measures.

Fisheries for coastal pelagic species (e.g., northern anchovy, market squid, Pacific sardine, Pacific mackerel, and jack mackerel), Dungeness crab, shrimp/prawns, and sea cucumbers occur in the analysis area and are managed by either NMFS and the PFMC (coastal pelagics) or the states (crab, shrimp/prawns, and sea cucumbers). The species targeted in these fisheries are not encountered in ocean salmon fisheries. It is possible that reductions in salmon fishing opportunities could result in a shift of effort toward these other species; however, we could not find any documentation to support this.

Fishermen that participate in salmon fisheries, both commercial and recreational, may also fish for groundfish (i.e., species such as rockfish and flatfish that live on or near the bottom of the ocean). Groundfish fisheries are managed under the Council's Groundfish FMP. Commercial salmon trollers that retain groundfish are considered to be participating in the open access groundfish fishery with non-trawl gear; therefore, they must comply with the regulations for the open access groundfish fishery. Likewise, recreational fishers that retain groundfish, must comply with recreational groundfish regulations. As fishery impacts to groundfish are managed under the Groundfish FMP and regulations, there would be no measurable effect on these species from the proposed action.

Albacore (*Thunnus alalunga*) is harvested on the West Coast, including the analysis area, by many of the same commercial and recreational fishermen that fish for salmon. Fishery impacts to

albacore are managed under the Council's Highly Migratory Species FMP. Commercial and recreational fishers shift effort between salmon and albacore in response to available fishing opportunities, catch limits, angler demand (recreational fisheries), and changing prices for the species being harvested (commercial fisheries). As fishery impacts to albacore are managed under the Highly Migratory Species FMP and regulations, there would be no measurable effect on these species from the proposed action.

6.5.2 Environmental Consequences of the Alternatives on non-target Fish Species *Analysis pending*

6.6 Seabirds

6.6.1 Affected environment

Numerous seabird species, as well as raptors, are protected under the Migratory Bird Treaty Act, including several species that are present in areas coincident with Pacific salmon. These seabirds include grebes, loons, petrels, albatrosses, pelicans, double-crested cormorants, gulls, terns, auks, and auklets (PFMC 2013c). ESA-listed seabird species include short-tailed albatross (endangered) and marbled murrelet (threatened). Interactions with the Pacific salmon fishery typically occur in two ways: when seabirds feed on outmigrating juvenile salmon, and when seabirds are entangled or otherwise interact with fishing gear or activities. Predation on juvenile salmon by seabirds is known to occur in estuarine environments, such as the lower Columbia River, as salmon smolts migrate downstream and into marine waters. We do not know the extent to which seabirds in the analysis area depend upon juvenile salmonids as prey. Council-managed ocean salmon fisheries are limited to hook-and-line tackle. Interactions with seabirds are uncommon in these fisheries.

6.6.2 Environmental Consequences of the Alternatives on Seabirds *Analysis pending*

6.7 Ocean and Coastal Habitats and Ecosystem Function

6.7.1 Affected environment

Salmon FMP stocks interact with a number of ecosystems along the Pacific Coast, including the California Current Ecosystem (CCE), numerous estuary and freshwater areas and associated riparian habitats. Salmon contribute to ecosystem function as predators on lower trophic level species, as prey for higher trophic level species, and as nutrient transportation from marine ecosystems to inland ecosystems. Because of their wide distribution in both the freshwater and marine environments, Pacific salmon interact with a great variety of habitats and other species of fish, mammals, and birds. The analysis area for the Proposed Action is dominated by the CCE. An extensive description of the CCE can be found in chapter three of the Council's Pacific Coast Fishery Ecosystem Plan (PFMC 2013c). Council managed salmon fisheries use hook and line gear, exclusively. This gear does not touch the ocean floor and does not disturb any habitat features. Therefore, salmon fisheries have no physical impact on habitat.

6.7.2 Environmental Consequences of the Alternatives on Habitat and Ecosystem Function *Analysis pending*

6.8 Cultural resources

6.8.1 Affected environment

Analysis pending

6.8.2 Environmental Consequences of the Alternatives on Cultural Resources

Analysis pending

6.9 Cumulative Impacts

Analysis pending

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APPENDIX A. STATUS DETERMINATION CRITERIA

The following is an excerpt from the Salmon Fishery Management Plan

3.1 STATUS DETERMINATION CRITERIA

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

NSIGs (600.310 (e)(2)(i)(E))

In establishing criteria by which to determine the status of salmon stocks, the Council must consider the uncertainty and theoretical aspects of MSY as well as the complexity and variability unique to naturally producing salmon populations. These unique aspects include the interaction of a short-lived species with frequent, sometimes protracted, and often major variations in both the freshwater and marine environments. These variations may act in unison or in opposition to affect salmon productivity in both positive and negative ways. In addition, variations in natural populations may sometimes be difficult to measure due to masking by hatchery produced salmon.

3.1.1 General Application to Salmon Fisheries

In establishing criteria from which to judge the conservation status of salmon stocks, the unique life history of salmon must be considered. Chinook, coho, and pink salmon are short-lived species (generally two to six years) that reproduce only once shortly before dying. Spawning escapements of coho and pink salmon are dominated by a single year-class and Chinook spawning escapements may be dominated by no more than one or two year-classes. The abundance of year-classes can fluctuate dramatically with combinations of natural and human-caused environmental variation. Therefore, it is not unusual for a healthy and relatively abundant salmon stock to produce occasional spawning escapements which, even with little or no fishing impacts, may be significantly below the long-term average associated with the production of MSY.

Numerous West Coast salmon stocks have suffered, and continue to suffer, from nonfishing activities that severely reduce natural survival by such actions as the elimination or degradation of freshwater spawning and rearing habitat. The consequence of this man-caused, habitat-based variation is twofold. First, these habitat changes increase large scale variations in stock productivity and associated stock abundances, which in turn complicate the overall determination of MSY and the specific assessment of whether a stock is producing at or below that level. Second, as the productivity of the freshwater habitat is diminished, the benefit of further reductions in fishing mortality to improve stock abundance decreases. Clearly, the failure of several stocks managed under this FMP to produce at an historical or consistent MSY level has little to do with current fishing impacts and often cannot be rectified with the cessation of all fishing.

To address the requirements of the MSA, the Council has established criteria based on biological reference points associated with MSY exploitation rate and MSY spawning escapement. The criteria are based on the unique life history of salmon and the large variations in annual stock abundance due to numerous environmental variables. They also take into account the uncertainty and imprecision surrounding the estimates of MSY, fishery impacts, and spawner escapements. In recognition of the unique salmon life history, the criteria differ somewhat from the general guidance in the NS1 Guidelines (§600.310).

3.1.4 Overfished

“For a fishery that is overfished, any fishery management plan, amendment, or proposed regulations... for such fishery shall (A) specify a time period for ending overfishing and rebuilding the fishery that shall:(i) be as short as possible, taking into account the status and biology of any overfished stocks of fish, the needs of the fishing communities, recommendations by international organizations in which the United States participates, and the interaction of the overfished stock within the marine ecosystem; and (ii) not exceed 10 years, except in cases where the biology of the stock of fish, other environmental conditions, or management measures under an international agreement in which the United States participates dictate otherwise....”

Magnuson-Stevens Act, §304(e)(4)

A stock will be considered overfished if the 3-year geometric mean of annual spawning escapements falls below the MSST, where MSST is generally defined as $0.5 \cdot S_{MSY}$ or $0.75 \cdot S_{MSY}$, although there are some exceptions (Table 3-1). Overfished determinations will be made annually using the three most recently available postseason estimates of spawning escapement.

3.1.4.1 Council Action

When the overfished status determination criteria set forth in this FMP have been triggered, the Council shall:

- 1) notify the NMFS NWR administrator of this situation;
- 2) notify pertinent management entities;
- 3) structure Council area fisheries to reduce the likelihood of the stock remaining overfished and to mitigate the effects on stock status;
- 4) direct the STT to propose a rebuilding plan for Council consideration within one year.

Upon formal notification from NMFS to the Council of the overfished status of a stock, a rebuilding plan must be developed and implemented within two years.

The STT's proposed rebuilding plan shall include:

- 1) an evaluation of the roles of fishing, marine and freshwater survival in the overfished determination;
- 2) any modifications to the criteria set forth in section 3.1.6 below for determining when the stock has rebuilt,
- 3) recommendations for actions the Council could take to rebuild the stock to S_{MSY} , including modification of control rules if appropriate, and;
- 4) a specified rebuilding period.

In addition, the STT may consider and make recommendations to the Council or other management entities for reevaluating the current estimate of S_{MSY} , modifying methods used to forecast stock abundance or fishing impacts, improving sampling and monitoring programs, or changing hatchery practices.

Based on the results of the STT's recommended rebuilding plan, the Council will adopt a rebuilding plan for recommendation to the Secretary. Adoption of a rebuilding plan will require implementation either through an FMP amendment or notice and comment rule-making process. Subject to Secretarial approval, the Council will implement the rebuilding plan with appropriate actions to ensure the stock is rebuilt in as short a time as possible based on the biology of the stock but not to exceed ten years, while taking into consideration the needs of the commercial,

recreational and tribal fishing interests and coastal communities. The existing control rules provide a default rebuilding plan that targets spawning escapement at or above MSY, provided sufficient recruits are available, and targets a rebuilding period of one generation (two years for pink salmon, three years for coho, and five years for Chinook). If sufficient recruits are not available to achieve spawning escapement at or above MSY in a particular year, the control rules provide for the potential use of *de minimis* exploitation rates that allow continued participation of fishing communities while minimizing risk of overfishing. However, the Council should consider the specific circumstances surrounding an overfished determination and ensure that the adopted rebuilding plan addresses all relevant issues.

Even if fishing is not the primary factor in the depression of the stock, the Council must act to limit the exploitation rate of fisheries within its jurisdiction so as not to limit rebuilding of the stock or fisheries. In cases where no action within Council authority can be identified which has a reasonable expectation of contributing to the rebuilding of the stock in question, the Council will identify the actions required by other entities to recover the depressed stock. Due to a lack of data for some stocks, environmental variation, economic and social impacts, and habitat losses or problems beyond the control or management authority of the Council, it is possible that rebuilding of depressed stocks in some cases could take much longer than ten years. The Council may change analytical or procedural methodologies to improve the accuracy of estimates for abundance, harvest impacts, and MSY escapement levels, and/or reduce ocean harvest impacts when it may be effective in stock recovery. For those causes beyond Council control or expertise, the Council may make recommendations to those entities which have the authority and expertise to change preseason prediction methodology, improve habitat, modify enhancement activities, and re-evaluate management and conservation objectives for potential modification through the appropriate Council process.

In addition to the STT assessment, the Council may direct its Habitat Committee (HC) to work with federal, state, local, and tribal habitat experts to review the status of the essential fish habitat affecting the overfished stock and, as appropriate, provide recommendations to the Council for restoration and enhancement measures within a suitable time frame. However, this action would be a priority only if the STT evaluation concluded that freshwater survival was a significant factor leading to the overfished determination. Upon review of the report from the HC, the Council will consider appropriate actions to promote any solutions to the identified habitat problems.

3.1.5 Not Overfished-Rebuilding

After an overfished status determination has been triggered, once the stock's 3-year geometric mean of spawning escapement exceeds the MSST, but remains below S_{MSY} , or other identified rebuilding criteria, the stock status will be recognized as "not overfished-rebuilding". This status level requires no Council action, but rather is used to indicate that stock's status has improved from the overfished level but the stock has not yet rebuilt.

3.1.6 Rebuilt

The default criterion for determining that an overfished stock is rebuilt is when the 3-year geometric mean spawning escapement exceeds S_{MSY} ; the Council may consider additional criteria for rebuilt status when developing a rebuilding plan and recommend such criteria, to be implemented subject to Secretarial approval.

Because abundance of salmon populations can be highly variable, it is possible for a stock to rebuild from an overfished condition to the default rebuilding criterion in as little as one year, before a proposed rebuilding plan could be brought before the Council.

In some cases it may be important to consider other factors in determining rebuilt status, such as population structure within the stock designation. The Council may also want to specify particular strategies or priorities to achieve rebuilding objectives. Specific objectives, priorities, and implementation strategies should be detailed in the rebuilding plan.

3.1.6.1 Council Action

When a stock is determined to be rebuilt, the Council shall:

- 1) notify the NMFS NWR administrator of its finding, and;
- 2) notify pertinent management entities.

3.1.7 Changes or Additions to Status Determination Criteria

Status determination criteria are defined in terms of quantifiable, biologically-based reference points, or population parameters, specifically, S_{MSY} , $MFMT (F_{MSY})$, and $MSST$. These reference points are generally regarded as fixed quantities and are also the basis for the harvest control rules, which provide the operative guidance for the annual preseason planning process used to establish salmon fishing seasons that achieve OY and are used for status determinations as described above. Changes to how these status determination criteria are defined, such as $MSST = 0.50 * S_{MSY}$, must be made through a plan amendment. However, if a comprehensive technical review of the best scientific information available provides evidence that, in the view of the STT, SSC, and the Council, justifies a modification of the estimated values of these reference points, changes to the values may be made without a plan amendment. Insofar as possible, proposed reference point changes for natural stocks will only be reviewed and approved within the schedule established for salmon methodology reviews and completed at the November meeting prior to the year in which the proposed changes would be effective and apart from the preseason planning process. SDC reference points that may be changed without an FMP amendment include: reference point objectives for hatchery stocks upon the recommendation of the pertinent federal, state, and tribal management entities; and Federal court-ordered changes. All modifications would be documented through the salmon methodology review process, and/or the Council's preseason planning process.

APPENDIX B. PUGET SOUND RECREATIONAL FISHERY REGULATIONS

Puget Sound Recreational Fisheries

Provided below are descriptions of recreational fishing seasons for coho as planned preseason during the state-tribal North of Falcon process, for each of the Puget Sound marine areas during the 2014-15, 2015-16, and 2016-17 seasons (the period from July 1, 2014 through June 30, 2017). Recreational fisheries were implemented as planned preseason unless specified otherwise via footnotes in Table B.1.

Areas 5 and 6

In the Strait of Juan de Fuca, both Area 5 (Sekiu and Pillar Point) and Area 6 (East Juan de Fuca Strait) were open to mark-selective coho fishing during the summer of 2014 and 2015 from July 1-September 30. In Area 5 only, non-selective coho fishing was allowed from September 19-25 during 2014, and on the specific dates of September 12-14, 19-21, and 26-27 in 2015. Additionally, Area 5 was open during October 1-31 for mark-selective coho fishing in 2014 and for non-selective coho fishing in 2015. In Area 6, non-selective coho fishing was open in the month of October in both 2014 and 2015. During the winter and spring seasons, Area 5 was open for non-selective coho fishing from February 16 - April 10 in 2015, and from February 16 - April 30 in 2016. During the 2016-17 season, there were no fisheries allowing coho salmon retention in Areas 5 and 6.

Area 7

In Area 7 (San Juan Islands area north to Point Roberts), non-selective coho fishing was open from July 1-31 in both the 2014 and 2015 summer seasons. Additionally, mark-selective coho fishing was open from August 1 – October 31 in 2014, and from August 1 – September 30 in 2015. The month of October in 2015 was open to non-selective coho fishing in Area 7. During the winter-spring of 2014-15 and 2015-16, Area 7 was open for non-selective fishing from December 1 through April 30. However, during the 2016-17 season, there were no fisheries allowing coho salmon retention in Area 7.

Areas 8-1 and 8-2

In Area 8-1 (Deception Pass, Hope Island, and Skagit Bay) and Area 8-2 (Port Susan and Port Gardner), non-selective coho fishing was open from August 1 through April 30 during both the 2014-15 and 2015-16 seasons; otherwise these areas were closed to salmon fishing. During the 2016-17 season, there were no fisheries allowing coho salmon retention in Areas 8-1 and 8-2, with the exception of the Tulalip Bay terminal area in which non-selective coho fishing was allowed from September 10-25 on Saturdays and Sundays only.

Area 9

In Area 9 (Admiralty Inlet), non-selective coho fishing was open from July 1 through November 30, and again from January 16 through April 15, in both the 2014-15 and 2015-16 seasons. In contrast, during the 2016-17 season, there were no fisheries allowing coho salmon retention in Area 9.

Area 10

In Area 10 (Seattle/Bremerton area), non-selective coho fishing was open from July 1 through January 31 in both the 2014-15 and 2015-16 seasons. In contrast, during the 2016-17 season, there were no fisheries allowing coho salmon retention in Area 10. The Elliott Bay terminal area near

Seattle was closed for all salmon retention during summer 2014 and 2016 but open in 2015 for non-selective coho and pink salmon fishing from August 14-31 (Fridays through Sundays only) in 2015.

Area 11

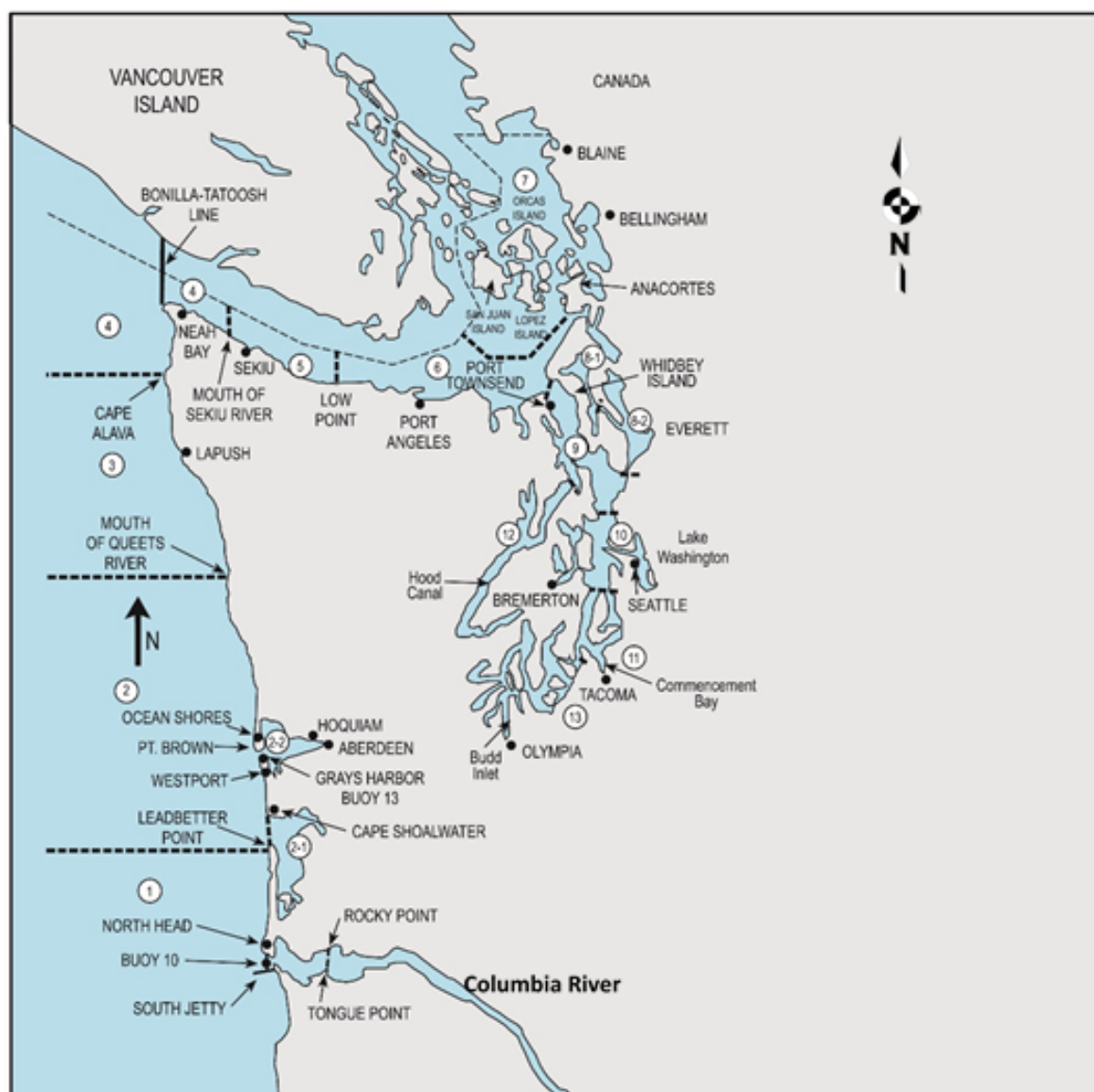
In Area 11 (Tacoma – Vashon Island), non-selective coho fishing was open from June 1 through December 31, and again from February 1 through April 30, in both the 2014-15 and 2015-16 seasons. In contrast, during the 2016-17 season, there were no fisheries allowing coho salmon retention in Area 11.

Area 12

Area 12 (Hood Canal) was open for non-selective coho fishing from July 1 through December 31 in both 2014 and 2015. However, the portion of Area 12 North of Point Ayock opened two months later (on September 1) during 2014. The whole area was open for non-selective coho fishing from February 1 through April 30 in the spring seasons of 2015 and 2016. During summer 2016, the area South of Point Ayock was open for non-selective coho fishing from July 1 – September 30, whereas the area North of Point Ayock opened starting 1 ½ months later, with a season from August 16 – September 30. All of Area 12 was open for non-selective coho fishing from October 1, 2016 through April 30, 2017.

Area 13

In Area 13 (South Puget Sound), mark-selective coho fishing was open from July 1 through October 31 during the summer seasons of 2014 and 2015. During the winter-spring period, non-selective coho fishing was open from November 1 through June 30 during both the 2014-15 and 2015-16 seasons. In contrast, during the 2016-17 season, there were no fisheries allowing coho salmon retention in Area 13.



Map of Western Washington, showing the Marine Catch Areas of Puget Sound (Areas 5 through 13) and the Washington coast (Areas 1 through 4).

Appendix Table B.1. Recreational Coho Fishing Seasons in Puget Sound Marine Areas 5 through 13 during the period from July 1, 2014 through June 30, 2017. Recreational fisheries were implemented as planned preseason unless noted otherwise below via footnotes (a/ through l/).

Area	Fishery Type ^{1/}	Dates of Season, by Fishery Year (July 1 - June 30)		
		2014-15	2015-16	2016-17
5	NR	n/a	n/a	July 1-Aug 15; Feb 16-Apr 30
	NSF	Sept 19-25; Feb 16-Apr 10	Sept 12-14, 19-21, 26-27; Oct 1-31; Feb 16-Apr 30	n/a
	MSF	July 1-Sept 18; Sept 26-30; Oct 1-31	July 1-Sept 11; Sept 15-18, 22-25, 28-30	n/a
	Closed	Nov 1-Feb 15; Apr 11-June 30	Nov 1 - Feb 15; May 1-June 30	Aug 16-Feb 15; May 1-June 30
6	NR	n/a	n/a	July 1-Aug 15; Dec 1-Apr 30
	NSF	Oct 1-31; Dec 1-Apr 10	Oct 1-31; Dec 1-Apr 10 ^{d/}	n/a
	MSF	July 1-Sept 30	July 1-Sept 30	n/a
	Closed	Nov 1-30; Apr 11-June 30	Nov 1-30; Apr 11-June 30	Aug 16-Nov 30; May 1-June 30
7	NR	n/a	n/a	July 1-Oct 31; Dec 1-Apr 30 ^{k/}
	NSF	July 1-31; Dec 1-Apr 30 ^{a/}	July 1-31; Oct 1-31; Dec 1-Apr 30 ^{e/}	n/a
	MSF	Aug 1 - Oct 31	Aug 1 -Sept 30	n/a
	Closed	Nov 1-30; May 1-June 30	Nov 1-30; May 1-June 30	Nov 1-30; May 1-June 30
8-1	NR	n/a	n/a	Nov 1 - Apr 30
	NSF	Aug 1-Apr 30	Aug 1-Apr 30 ^{f/}	n/a
	MSF	n/a	n/a	n/a
	Closed	July 1-31; May 1-June 30	July 1-31; May 1-June 30	July 1-Oct 31; May 1-June 30
8-2	NR	n/a	n/a	Nov 1 - Apr 30
	NSF	Aug 1-Apr 30	Aug 1-Apr 30 ^{f/}	n/a
	MSF	n/a	n/a	n/a
	Closed	July 1-31; May 1-June 30	July 1-31; May 1-June 30	July 1-Oct 31; May 1-June 30
Tulalip Bay	NR	n/a	n/a	July 1-Sept 5; May 26-June 30 (Fri-Mon only); otherwise same as Area 8-2
	NSF	May 29-June 29 (Fri-Mon only); Sept 6-21 (open Sat, Sun only); otherwise same as Area 8-2	July 1-Sept 7; May 27-June 30 ^{h/} (Fri-Mon only); Sept 12-27 (open Sat, Sun only); otherwise same as Area 8-2	Sept 10-25 (open Sat, Sun only); otherwise same as Area 8-2
	MSF	n/a	n/a	n/a
	Closed	Same as Area 8-2	Same as Area 8-2	Same as Area 8-2
9	NR	n/a	n/a	July 1-Aug 15; Nov 1-30; Jan 16-Apr 15
	NSF	July 1-Nov 30; Jan 16-Apr 15	July 1-Nov 30 ^{b/} ; Jan 16-Apr 15 ^{g/}	n/a
	MSF	n/a	n/a	n/a
	Closed	Dec 1-Jan 15; April 16-June 30	Dec 1-Jan 15; April 16-June 30	Aug 16-Oct 31; Dec 1-Jan 15; May 1-June 30

Area	Fishery Type ^{1/}	Dates of Season, by Fishery Year (July 1 - June 30)		
		2014-15	2015-16	2016-17
10	NR	June 1-30	June 1-30	July 1-Aug 15; Nov 1-Feb 28 ^{1/2} ; June 1-30
	NSF	July 1 - Jan 31	July 1 - Jan 31 ^{a/}	n/a
	MSF	n/a	n/a	n/a
	Closed	Feb 1 - May 31	Feb 1 - May 31	Aug 16-Oct 31; Mar 1-May 30
Elliott Bay	NR	n/a	n/a	n/a
	NSF	n/a	Aug 14-31 (Fri-Sun only)	n/a
	MSF	n/a	n/a	n/a
	Closed	July 1-Aug 31, otherwise same as Area 10	July 1-Aug 31, except as above for NSF; otherwise same as Area 10	July 1-Aug 31, otherwise same as Area 10
11	NR	n/a	June 1-30 ^{h/}	July 1 - Aug 31 ^{1/2} ; Feb 1-Apr 30
	NSF	June 1, 2014-Dec 31; Feb 1-Apr 30, 2015; June 1-30, 2015	July 1-Dec 31; Feb 1-Apr 30	n/a
	MSF	n/a	n/a	n/a
	Closed	Jan 1-31; May 1-31	Jan 1-31; May 1-31	Sept 1-Jan 31; May 1-31
12	NR	n/a	n/a	n/a
	NSF	<u>So. of Ayock</u> : July 1-Dec 31; <u>N. of Ayock</u> : Sept 1-Dec 31; <u>whole area</u> : Feb 1-Apr 30	<u>whole area</u> : July 1-Dec 31; Feb 1-Apr 30	<u>So. of Ayock</u> : July 1-Sept 30; <u>N. of Ayock</u> : Aug 16-Sept 30; <u>whole area</u> : Oct 1 - Apr 30
	MSF	n/a	n/a	n/a
	Closed	<u>whole area</u> : Jan 1-31; May 1-June 30; <u>N. of Ayock</u> : July 1-Aug 31	<u>whole area</u> : Jan 1-31; May 1-June 30	<u>So. of Ayock</u> : May 1-June 30; <u>N. of Ayock</u> : July 1-Aug 15; May 1-June 30
13	NR	n/a	n/a	July 1-Aug 31; Oct 1 ^{1/2} -June 30
	NSF	Nov 1-June 30	Nov 1-June 30 ^{h/}	n/a
	MSF	July 1-Oct 31	July 1-Oct 31	n/a
	Closed	n/a	n/a	Sept 1-30

^{1/} Definitions of fishery types:

NR= Non-retention regulation for coho salmon. Anglers may fish for other salmon or bottomfish species, but may not retain coho salmon.

NSF = Non-selective fishery for coho salmon. Anglers may keep either hatchery marked (adipose fin-clipped) or unmarked (adipose fin intact) coho. Daily bag limit is typically 2 salmon (at most 2 coho).

MSF = Mark-selective fishery for coho salmon. Anglers may keep hatchery marked (adipose fin-clipped) coho but must release unmarked (adipose fin intact) coho. Daily bag limit is typically 2 hatchery coho.

Closed = Closed for coho and all other salmon species.

Inseason changes:

^{a/} Area 7, winter-spring 2015:

Effective January 12 through April 30, 2015, the daily limit for salmon was reduced from 2 to 1 (anglers required to release unmarked Chinook). Starting January 29, Area 7 was closed for salmon fishing except on Fridays, Saturdays, and Sundays. Effective February 16 through April 30, 2015, Area 7 was closed to salmon fishing. Reason for these inseason changes: to ensure compliance with conservation objectives and agreed-to management plans for the Area 7 Chinook mark-selective fishery.

b/ Area 9, summer 2015:

Effective August 6, 2015, the sub-area in northern Hood Canal (from south and west of a line from Foulweather Bluff to Olele Point to the Hood Canal Bridge) was closed to salmon fishing, except angling for salmon from shore was permissible, from the Hood Canal Bridge to the northern boundary of Salsbury Point Park. Daily limit was 2 salmon plus 2 additional pink salmon. Reason for inseason change: to protect mid-Hood Canal Chinook per state-tribal management plans agreed to during the North of Falcon preseason process.

Effective November 1 through November 30, 2015, Area 9 closed for Chinook and coho salmon retention. Reason for inseason change: Area 9 winter mark-selective Chinook fishery had higher than expected sublegal-size Chinook encounters. Puget Sound coho run sizes were below preseason forecasts; therefore, non-retention of coho was required beginning November 1, 2015.

c/ Area 10, winter 2015-16:

Effective October 19, 2015, Area 10 closed for salmon fishing. Area 10 opened again on October 28 for chum salmon retention only -- coho and Chinook still had to be released. Effective December 1, 2015 through January 31, 2016, Area 10 closed again for salmon fishing. Reason for inseason changes: Chinook encounters in the Area 10 winter Chinook MSF had reached preseason expectations; needed to ensure compliance with conservation objectives and agreed-to management plans.

d/ Area 6, spring 2016:

Area 6 closed for salmon fishing effective February 22 through April 10, 2016 to slow down the number of Chinook encounters in the Area 6 Chinook MSF and comply with agreed-to management plans. From March 12 through March 18, however, the area opened again for a short time with a daily limit of 2 salmon, no more than 1 hatchery Chinook (release wild Chinook) for limited fishing opportunity.

e/ Area 7, spring 2016:

Area 7 closed to salmon fishing effective March 14 through April 30. Reason for inseason change: encounters of Chinook in the Area 7 Chinook MSF had reached preseason expectations; needed to ensure compliance with conservation objectives and agreed-to management plans.

f/ Areas 8-1 & 8-2, spring 2016:

Areas 8-1 and 8-2 closed to salmon fishing effective April 4 through April 30, 2016. Reason for inseason change: encounters of Chinook in the Area 8-1 and 8-2 Chinook MSFs had reached preseason expectations; needed to ensure compliance with conservation objectives and agreed-to management plans.

g/ Area 9, spring 2016:

Area 9 closed to salmon fishing effective April 11 through April 15, 2016. Reason for inseason change: encounters of Chinook in the Area 9 Chinook MSF had reached preseason expectations; needed to ensure compliance with conservation objectives and agreed-to management plans.

h/ Multiple Areas, spring 2016

Effective May 1 through June 24, 2016, the following areas were closed to salmon fishing (changed from coho non-retention to closed): Marine Area 8-2 (including Tulalip Terminal Area Fishery), Marine Area 11, Marine Area 13, and year-round piers (Marine Areas 9, 10, 11, and 13). Reason for change: State-tribal co-managers were delayed in coming to agreement during the 2016 North of Falcon process. Endangered Species Act (ESA) coverage for Chinook and steelhead impacts expired April 30, 2016; therefore, starting May 1, 2016, scheduled fisheries did not have the needed federal ESA permit and could not be implemented. Effective June 24, 2016, these areas opened to salmon fishing per permanent rules due to receiving the federal ESA permit.

i/ Area 11, summer 2016:

Area 11 closed to salmon fishing effective August 20, 2016 (except for piers) – changed from coho non-retention to closed for all salmon. Reason for inseason change: legal-sized encounters of Chinook in the Area 11 Chinook MSF had reached preseason expectations; needed to ensure compliance with conservation objectives and agreed-to management plans.

j/ Area 13, fall 2016:

A portion of Area 13 opened for hatchery coho salmon starting on October 1, 2016, and then the whole area opened for hatchery coho retention effective October 22, 2016. The daily bag limit was 2 salmon (release wild Chinook and wild coho). Reason for inseason change: the state-tribal co-managers agreed there were sufficient numbers of coho returning to southern Puget Sound to allow the retention of hatchery coho.

^{k/} Area 7, winter-spring 2017:

Closed to salmon fishing effective February 11 through March 24, 2017. Re-opened March 25 with a daily limit of 2 salmon, no more than 1 hatchery Chinook (release coho and wild Chinook). The Area 7 Chinook MSF was closed again on April 22 through April 30, 2017. Reasons for inseason changes: modified the Area 7 Chinook MSF to stay within the preseason agreed-to number of Chinook encounters and increase the possibility of providing season-long angling opportunity. The April 22 closure was needed due to encounters of Chinook reaching preseason expectations; needed to ensure compliance with conservation objectives and agreed-to management plans.

^{l/} Area 10, winter-spring 2017:

Area 10 closed to salmon fishing effective January 23, 2017 through February, 28, 2017 (changed from coho non-retention to closed), except for year-round piers. Reason for inseason change: encounters of Chinook reached preseason expectations in the Area 10 Chinook MSF; needed to ensure compliance with conservation objectives and agreed-to management plans.

APPENDIX C. RECREATIONAL SEASONS IN THE SNOHOMISH RIVER SYSTEM

Table C.1. Preseason agreed to freshwater sport coho fishing seasons in the Snohomish system

	2012	2013	2014	2015	2016	2017
Snohomish (mouth to Hwy 9 bridge)	Sept 1-Dec 31	Aug 1-Dec 31	Sept 1-Dec 31	Aug 1-Dec 31	Closed	Aug 1-Dec 31
Snohomish (Hwy 9 bridge to forks)	Sept 1-Dec 31	Aug 16-Dec 31	Sept 1-Dec 31	Aug 16-Dec 31	Closed	Aug 16-Dec 31
Skykomish (mouth to Lewis Street Bridge)	Sept 1-Dec 31	Aug 16-Dec 31	Sept 1-Dec 31	Aug 16-Dec 31	Closed	Aug 16-Dec 31
Skykomish (Lewis Street Bridge to confluence with NF and SF)	Sept 1-Dec 31	Sept 1-Dec 31	Sept 1-Dec 31	Sept 1-Dec 31	Closed	Sept 1-Dec 31
Snoqualmie (mouth to falls)	Sept 1-Dec 31	Sept 1-Dec 31	Sept 1-Dec 31	Sept 1-Dec 31	Closed	Sept 1-Dec 31
Wallace (mouth to hatchery intake)	Sept 16-Nov 30	Sept 16-Nov 30	Sept 16-Nov 30	Sept 16-Nov 30	Closed	Sept 16-Nov 30
All other rivers and creeks	Closed	Closed	Closed	Closed	Closed	Closed
Daily limit (release Chinook and chum)	3	3 + 1 pink	3	3 + 1 pink	0	3

Table C.2. Actual freshwater sport coho fishing seasons with inseason management in the Snohomish system.

	2015	2016	2017
Snohomish (mouth to Hwy 9 bridge)	Aug 1-Oct 21	Sept 29-Oct 2 Oct 6- 9 Oct 11-31	Aug 1-Oct 28
Snohomish (Hwy 9 bridge to forks)	Aug 16-Oct 21	Sept 29-Oct 2 Oct 6- 9 Oct 11-31	Aug 16-Oct 28
Skykomish (mouth to Lewis Street Bridge)	Sept 2-Oct 21	Oct 11-31	Aug 16-Oct 28
Skykomish (Lewis Street Bridge to mouth of the Sultan)	Sept 2-Oct 21	Oct 11-31	Sept 1-Oct 28
Skykomish (mouth of the Sultan to mouth of the Wallace)	Sept 2-Oct 21	Oct 11-31	
Skykomish (mouth of the Wallace to confluence with NF and SF)	Sept 11-Oct 21	Closed	Sept 1-Oct 28
Snoqualmie (mouth to falls)	Sept 1-Oct 21	Closed	Sept 1-Oct 28
Wallace (mouth to hatchery intake)	Sept 30-Oct 21	Oct 11-31	Sept 30-Oct 28
All other rivers and creeks	Closed	Closed	Closed

APPENDIX D. MODEL DESCRIPTION

Introduction

Salmon rebuilding plans must include, among other requirements, a specified rebuilding period. In addition, the National Environmental Policy Act (NEPA) analysis of rebuilding plans requires the development of rebuilding plan alternatives. In past assessments, the rebuilding period and alternative rebuilding plans were developed using expert knowledge, with no particular quantitative assessment. In 2018 the Salmon Technical Team (STT) developed a simple tool to assess the probability of a stock achieving rebuilt status in each year following an overfished declaration. Here we describe this model and provide additional results for the Snohomish coho salmon stock.

Methods

The methods described here are for a single replicate in one year.

The “known”, true abundance (N) is determined by a random draw from the set of past abundance estimates. For Snohomish coho, N is pre-fishery ocean age-3 abundance, defined as the sum of all fishery impacts and spawning escapement.

The forecast abundance (\hat{N}) is drawn from a lognormal distribution,

$$\hat{N} \sim \text{Lognormal}[\log(N) - 0.5\sigma_{\log(\hat{N})}, \sigma_{\log(\hat{N})}] \quad (1)$$

with the bias corrected mean and standard deviation specified on the log scale. The log-scale standard deviation is

$$\sigma_{\log(\hat{N})} = \sqrt{\log(1 + CV_{\hat{N}}^2)} \quad (2)$$

with $CV_{\hat{N}}$ representing the coefficient of variation for the abundance forecast. $CV_{\hat{N}}$ is a model parameter that defines the degree of abundance forecast error.

The forecast abundance \hat{N} is applied to the harvest control rule to determine the allowable exploitation rate, \hat{F} . However, for Snohomish coho, where the abundance or status of other stocks in the fishery determine the exploitation rate in most fisheries, including Council-area fisheries, the use of an abundance-based control rule would poorly describe the degree of exploitation on this stock. As a result, \hat{F} was determined by randomly drawing from postseason exploitation rates, estimated using backwards FRAM, from the 2004-2016 set of years.

Projected natural-area adult spawner escapement E is thus

$$E = N \times (1 - F) \quad (3)$$

where N is the “true” abundance and F is the realized exploitation rate. The realized exploitation rate is a random draw from the beta distribution

$$F \sim \text{Beta}(\alpha, \beta) \quad (4)$$

with parameters

$$\alpha = \frac{1 - \hat{F}(1 + CV_F^2)}{CV_F^2} \quad (5)$$

and

$$\beta = \frac{\frac{1}{\hat{F}} - 2 + \hat{F} + (\hat{F} - 1)CV_F^2}{CV_F^2}. \quad (6)$$

The coefficient of variation for the exploitation rate implementation error, CV_F , is a model parameter that determines the degree of error between the target and realized exploitation rates.

Because escapement is estimated with error, escapement estimates \hat{E} are drawn from a lognormal distribution,

$$\hat{E} \sim \text{Lognormal}[\log(E) - 0.5\sigma_{\log(\hat{E})}, \sigma_{\log(\hat{E})}] \quad (7)$$

where the bias corrected mean and standard deviation are specified on the log scale. The log-scale standard deviation is computed in the same manner as Equation (2).

The procedure described above is repeated for each year (years 1 through 10 following the overfished status determination), and each replicate.

A stock is assumed to be rebuilt when the geometric mean of \hat{E} computed over the previous three years exceed the maximum sustainable yield spawner escapement, S_{MSY} . The probability of achieving rebuilt status in year t is the cumulative probability of achieving a 3-year geometric mean greater than or equal to S_{MSY} by year t .

Results

Results for Snohomish coho presented here are the product of 1000 replicates in each of 10 years. The probability of being rebuilt in year $t = 1$ is the proportion of the 1000 replicates that resulted in the geometric mean of the estimated Snohomish coho escapement in $t-2$ (12,806: the 2015 adult escapement), the estimated escapement in $t-1$ (44,138: the 2016 adult escapement), and the simulated escapement estimate in year t (2017) exceeding S_{MSY} . For $t = 2$, the probability of being rebuilt is the probability that the stock was rebuilt in either $t = 1$ or $t = 2$.

Figure 4.3.a in the body of the report displays the probability of achieving rebuilt status under two management strategies: (1) the status quo control rule and (2) no fishing. For these simulations the following parameter values were assumed: $CV_N = 0.2$, $CV_E = 0.2$, and $CV_F = 0.1$. The parameter values were chosen because they produce reasonable levels of abundance forecast error, escapement estimation error, and implementation error for realized exploitation rates.

Rebuilding probabilities were also computed for the status quo control rule under an increased CV of the abundance forecast error ($CV_N = 0.6$), the escapement estimation error CV ($CV_E = 0.5$), and the CV of the exploitation rate implementation error ($CV_F = 0.2$). Figure (1) displays results for these alternative scenarios. Overall, the probability of achieving rebuilt status by year, for the status quo scenario, is relatively insensitive to increased values of these parameters.

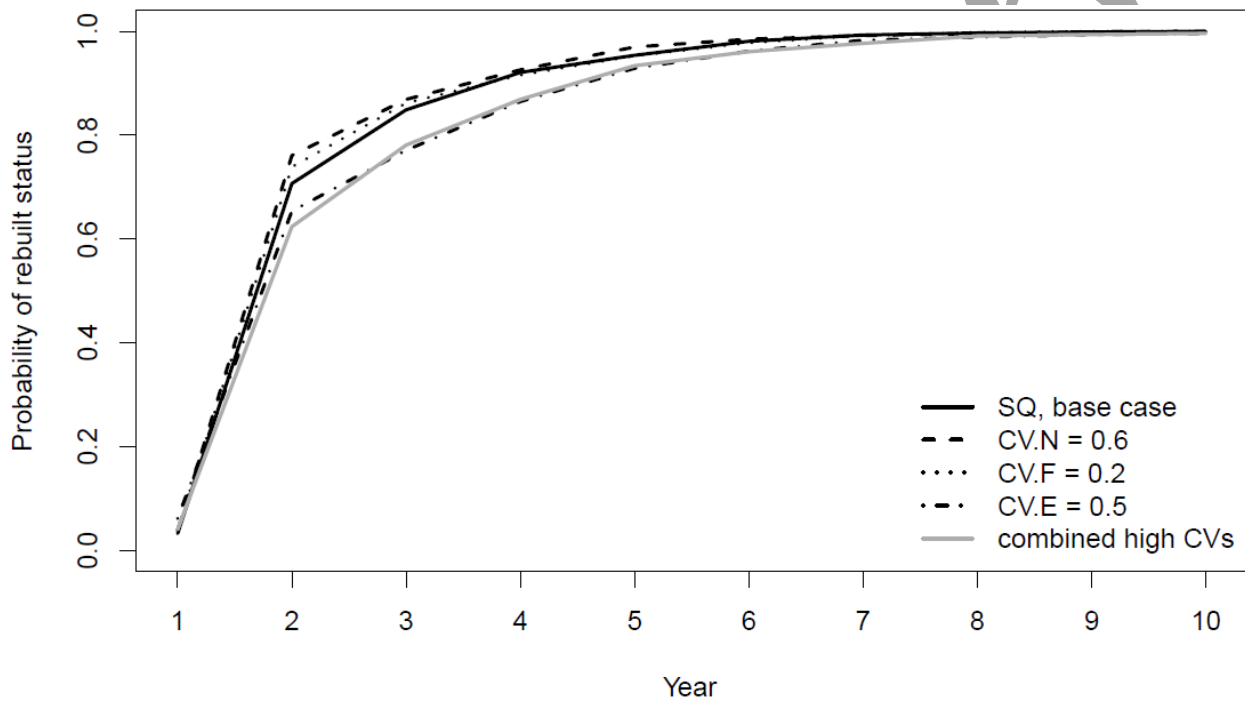


Figure 1. Probability of achieving rebuilt status in years 1 through 10, under the status quo control rule (Alternative 1) and under different parameter values.

Simulations were also performed assuming potentially biased abundance forecasts. Bias was incorporated by modifying the log-scale mean term in Equation (1) by adding the log of the observed ratio of the preseason forecast of the abundance to the postseason estimate of abundance. Thus, the mean term in Equation (1) becomes $\log(N) - 0.5\sigma_{\log(N)} + \log(r)$, where r is a drawn (with replacement) from the set of 13 ratios of forecast to observed Snohomish coho abundance. On the arithmetic scale this ratio ranged from 4.97 to 0.26 and the average of these ratios was 1.43. Figure (2) displays the effect of including these ratios, given management under the status quo control rule. Because in this analysis the abundance forecast does not affect the allowable exploitation rate (as exploitation rates are drawn randomly from the set of past exploitation rates), there is no effect on the probability of achieving rebuilt status

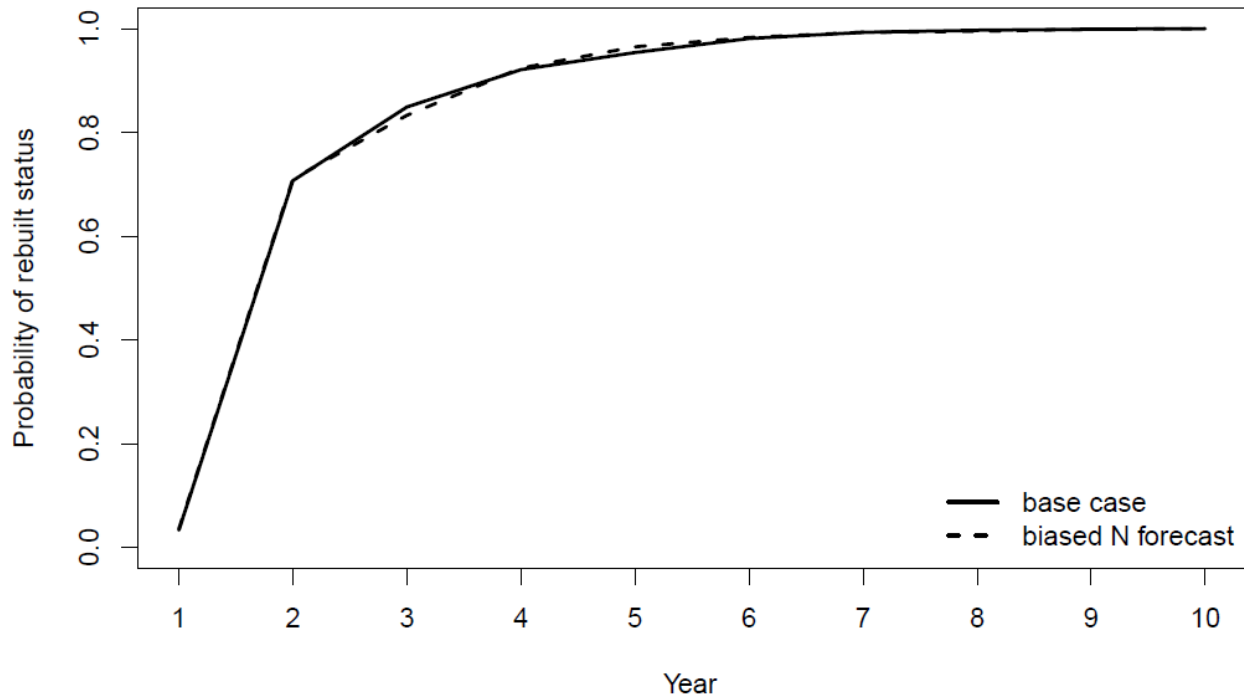


Figure 2. Probability of achieving rebuilt status under unbiased abundance forecasts and abundance forecasts that could potentially be biased.

Discussion

This model was created to allow for a quantitative assessment of alternative rebuilding plans. It shares some attributes with MSE approaches, but lacks some important features.

The model relies on random draws from past estimates of abundance to characterize future abundance. As such, autocorrelation in abundance is not modeled and there is no explicit population dynamics. Thus the model fails to capture multi-year increases or declines in abundance exhibited by many salmon stocks. Data limitations and the short time frame for development of rebuilding plans did not allow constructing a more detailed operating model.

The probability of achieving rebuilt status each year within a 10 year window for alternative rebuilding plans is the core result of this analysis. The results for particular alternatives should be interpreted in a relative rather than absolute sense. Rebuilding periods could be much shorter or longer than these results suggest due to the vagaries of future production and fisheries.

APPENDIX E. DRAFT FINDING OF NO SIGNIFICANT IMPACT

Pending

APPENDIX F. PAST, PRESENT AND REASONABLY FORESEEABLE FUTURE IMPACTS

Pending

APPENDIX G. LIST OF AGENCIES AND PERSONS CONSULTED

Pending, incomplete

The following public meetings were held as part of the salmon management process (Council-sponsored meetings in bold):

March 2018

April 2018

May 17, 2018

June, 2018:

August 2018

September 2018

The following organizations were consulted and/or participated in preparation of supporting documents:

California Department of Fish and Wildlife
Oregon Department of Fish and Wildlife
Washington Department of Fish and Wildlife

National Marine Fisheries Service, West Coast Region, Sustainable Fisheries Division
National Marine Fisheries Service, Northwest Fisheries Science Center
National Marine Fisheries Service, Southwest Fisheries Science Center
U.S. Fish and Wildlife Service, Columbia River Fisheries Program Office
United States Coast Guard

Northwest Indian Fisheries Commission
Columbia River Intertribal Fish Commission
West Coast Indian Tribes

APPENDIX H. REGULATORY IMPACT REVIEW

Pending

APPENDIX I. INITIAL REGULATORY FLEXIBILITY ANALYSIS

Pending

APPENDIX J. NATIONAL STANDARDS ANALYSIS

Pending

APPENDIX K. CONSISTENCY WITH OTHER APPLICABLE LAWS ANALYSIS

Pending, incomplete

- MSA
- CZMA
- ESA
- MMPA
- MBTA

- PRA
- EO 12898 Environmental Justice
- EO 13132 Federalism
- EO 13175 Tribal Consultation and Coordination
- Regulatory Flexibility Act
- EO 12866 Regulatory Planning and Review
- EO 13771 Reducing Regulation and Controlling Regulatory Costs

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