Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion

Reinitiation of Section 7 Consultation Regarding the Pacific Fisheries Management Council's Groundfish Fishery Management Plan

NMFS Consultation Number: F/WCR-2017-7552

Prepared by

National Marine Fisheries Service, West Coast Region

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NMFS Consultation Number: F/WCR-2017-7552

Action Agency: National Marine Fisheries Service (NMFS)

Affected Species and NMFS' Determinations:

Endangered Species Act (ESA)-listed Species	Status	Is action likely to adversely affect species?	Is action likely to jeopardize the species?	Is action likely to adversely affect critical habitat?	Is action likely to destroy or adversely modify critical habitat?
Puget Sound Chinook Salmon (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	No	No
Lower Columbia River Chinook Salmon (*Oncorhynchus tshawytscha*)	Threatened			No	No
Upper Willamette River Chinook Salmon (*Oncorhynchus tshawytscha*)	Threatened			No	No
Upper Columbia River spring Chinook salmon (*Oncorhynchus tshawytscha*)	Endangered			No	No
Snake River Spring/Summer Chinook Salmon (*Oncorhynchus tshawytscha*)	Threatened			No	No
Snake River Fall Chinook Salmon (*Oncorhynchus tshawytscha*)	Threatened			No	No
California Coastal Chinook Salmon (*Oncorhynchus tshawytscha*)	Threatened			No	No
Lower Columbia River coho	Threatened			No	No
Oregon Coast coho	Threatened			No	No
Southern Oregon/Northern California coho	Threatened			No	No
Central California Coast coho	Endangered			No	No

Consultation conducted by National Marine Fisheries Service, West Coast Region.

Issued by: ______________________

FOR Barry A. Thom
Regional Administrator

Date: ___ 12/11/2017_____________ (***Date expires:*** Until reinitiated)

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LIST OF ACRONYMS

ACL	Annual catch limit
AEQ	Adult equivalent
A/P	Abundance and productivity
BRA	Bycatch Reduction Area
BRT	Biological Review Team
CC	California coastal
CCA	Cowcod Conservation Area
CCC	Central California Coast [ESU]
CCF	Clatsop County Fisheries
CDFW	California Department of Fish and Wildlife
CFR	Code of Federal Regulations
Council	Pacific Fishery Management Council
CWT	Coded wire tag
DFO	Department of Fisheries and Oceans Canada
DPS	Distinct population segment
DQA	Data Quality Act
EA	Environmental assessment
ECE	Extreme catch event
EEZ	Exclusive Economic Zone
EFH	Essential fish habitat
EFHCA	Essential Fish Habitat Conservation Area
EFP	Exempted fishing permit
ER	Exploitation rate
ESA	Endangered Species Act
ESU	Evolutionarily significant unit

fm	Fathom
FMP	Fishery Management Plan
FRAM	Fishery Regulation and Assessment Model
GAPS	Genetic Analysis of Pacific Salmon
GCA	Groundfish Conservation Area
GMT	Groundfish Management Team
GSI	Genetic stock identification
HG	Harvest guideline
HR	Harvest rate
ICTRT	Interior Columbia Technical Recovery Team
IFQ	Individual fishing quota
IPHC	International Pacific Halibut Commission
ISAB	Independent Science Advisory Board
ITS	Incidental take statement
lb	Pound
LCFRB	Lower Columbia River Fish Recovery Board
LCR	Lower Columbia River
LE	Limited entry
LEFG	Limited entry fixed gear
LGR	Lower Granite River
mt	Metric ton
MPG	Major Population Group
MSY	Maximum sustainable yield
NFH	National Fish Hatchery
nm	Nautical mile
NMFS	National Marine Fisheries Service

NWR	Northwest Region (NMFS)
OA	Open access
OAFC	Open access fixed gear
Oregon Coast	Oregon Coast
ODFW	Oregon Department of Fish and Wildlife
PCE(s)	Primary constituent element(s)
PBF(s)	Physical or biological feature(s)
PBT	Parental-based genetic tagging
pHOS	Proportion of hatchery-origin spawners
POP	Pacific Ocean perch
PRA	Population recovery approach
PSIT	Puget Sound Indian Tribes
PSTIT	Puget Sound Treaty Indian Tribes
PSTRT	Puget Sound Technical Recovery Team
PWCC	Pacific Whiting Conservation Cooperative
RCA	Rockfish Conservation Area
RMP(s)	Resource management plan(s)
RPA	Reasonable and prudent alternative
SBT	Shoshone-Bannock Tribe
SFFT	Selective flatfish trawl
SONCC	Southern Oregon/Northern California Coast
SS/D	Spatial structure/diversity
SSPS	Shared Strategy of Puget Sound
TAC	Total allowable catch
TRT	Technical Recovery Team
U&A	Usual and accustomed

UCR	Upper Columbia River
U.S.C.	United States Code
USFWS	U.S. Fish and Wildlife Service
UWR	Upper Willamette River
VSP	Viable salmonid populations
WCGOP	West Coast Groundfish Observer Program
WCR	West Coast Region (NMFS)
WDFW	Washington Department of Fish and Wildlife
WLC	Willamette/Lower Columbia River

1 INTRODUCTION

This introduction section provides information relevant to the other sections of this document and is incorporated by reference into Section 2 and Section 3 below.

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973, as amended (16 United States Code [U.S.C.] 1531 et seq.), and implementing regulations at 50 Code of Federal Regulations (CFR) 402.

NMFS completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available through NMFS' Public Consultation Tracking System https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts. A complete record of this consultation is on file at the Seattle NMFS West Coast Regional office.

This document constitutes NMFS' biological opinion under section 7 of the ESA for a federal action NMFS proposed. The federal action is continued implementation of the Pacific Coast Groundfish Management Plan (FMP) as described in Section 1.2.

1.2 Consultation History

This opinion considers impacts of the proposed action on seven listed Chinook Salmon Evolutionarily Significant Units (ESUs): Puget Sound Chinook, Snake River Fall Chinook, Lower Columbia River (LCR) Chinook, Upper Willamette River (UWR) Chinook, Snake River Spring/summer Chinook, California Coastal (CC) Chinook, LCR Coho, Oregon Coast Coho, Southern Oregon/Northern California Coho, and Central California Coast (CCC) Coho Salmon. Other listed species occurring in the action area and affected by the proposed action are covered under an existing, long-term ESA opinion or NMFS has determined that the proposed action is not likely to adversely affect the species (NMFS 2012c).

NMFS has considered the impacts on ESA-listed salmon species resulting from implementation of the FMP in several previous biological opinions. The sequence of previous consultation activities related to the FMP is summarized in **Table 1-1**. In each determination, NMFS concluded that the proposed actions were not likely to jeopardize the continued existence of any of the listed species. NMFS also concluded that the actions were not likely to destroy or adversely modify designated critical habitat for any of the listed species. The most recent consultation on effects on ESA-listed salmonids was completed in 2006, and it remains current until completion of this opinion (NMFS 2006b). That consultation affirmed the incidental take limits and provisions of the 1999 opinion (NMFS 1999).

In January 2013, NMFS reinitiated section 7 consultation for listed salmonids to address changes in the groundfish fishery, including the trawl rationalization program and the emerging midwater trawl fishery targeting species other than Pacific whiting. In October 2014, before the consultation was complete, the whiting fishery exceeded its incidental take limit, tripping a second trigger for reinitiation. To better understand the implications of the changes in management framework and the effects on listed salmonids of all fishing under the FMP in the reinitiated consultation, NMFS conferred with the Pacific Fishery Management Council (Council), its advisory bodies, and the public over the next few years. The results are summarized below:

April 2015: NMFS staff provided the Council, its advisory bodies, and the public with an initial briefing on the agency's reinitiatation of ESA section 7 consultation on the effects of the groundfish fisheries on listed Chinook salmon stocks. The Council asked that NMFS return to a future Council meeting with additional information and analysis, including the basis of the current consultation standards, a summary of Chinook bycatch by fishery sector, and past and present stock composition estimates for Chinook taken in the fishery.

June 2015: NMFS staff reported back to the Council with the information requested in April 2015. After receiving comments from its advisory bodies and the public, the Council endorsed a NMFS proposal to convene a July 2015 workshop to brief stakeholders on the consultation for ESA-listed Chinook salmon stocks caught in the Pacific coast groundfish fishery and to obtain input from stakeholders on realistic bycatch estimates in existing and future groundfish fisheries and on potential measures to reduce Chinook salmon bycatch. For its September 2015 meeting, the Council asked that NMFS to report back on the workshop's outcomes, so that the Council could use its September 2015 meeting time to develop estimates of incidental bycatch levels for various groundfish fisheries, to inform the reinitiated ESA section 7 consultation.

July to August 2015: On July 29, 2015, NMFS held a public workshop to engage stakeholders on the re-initiated ESA consultation. The workshop was well attended by groundfish fishery management entities, generating ideas and comments from groundfish participants, including Council advisory body members, state and tribal agency staff, stakeholders, and other members of the public. NMFS posted a video recording of the workshop online and provided a public comment period through August 7, 2015. NMFS summarized the comments it received during this period for the Council at its September 2015 meeting.

September 2015: In addition to reporting on the July 2015 public workshop and subsequent public input on this issue, NMFS reported the following items to the Council in September 2015:

- Draft proposals for managing salmon bycatch in the groundfish fisheries
- An analysis of the Chinook catch-per-unit effort for the bottom trawl and non-whiting midwater trawl fisheries
- The Chinook bycatch in the at-sea sectors of the Pacific whiting fishery
- A summary of the Chinook genetic stock composition estimates from that fishery's bycatch

After reviewing the NMFS reports and comments from its advisory bodies and the public, the Council adopted a motion to provide guidance to NMFS for analysis of a range of alternatives to assess Chinook bycatch against proposed thresholds under different groundfish management strategies to inform development of the proposed action.

March 2017: NMFS presented its analysis of the September 2015 Council-recommended alternatives at the March 2017 Council meeting. NMFS also received feedback on its methodology and analysis from various advisory bodies to the Council and the California Department of Fish and Wildlife (CDFW). The Council requested that NMFS, in collaboration with the Groundfish Management Team (GMT) do the following:

(1) Evaluate the effect on estimated Chinook bycatch with and without use of selective flatfish trawl nets for each of the non-whiting alternative fishing scenarios described in NMFS Report 1 because removal of the current requirement for the gear shoreward of the Rockfish Conservation Area (RCA) was under consideration by the Council.

(2) Update the description of each fishery included in the main analytical document, including the management measures and regulations applicable to each sector for inclusion in the biological opinion.

April 2017: The Council adopted its recommendations for the proposed action for the consultation on salmon impacts in the fisheries managed under the FMP. In recommending the proposed action to NMFS for consultation, the Council considered the results of the analyses requested during the March meeting. The Council also recommended that NMFS consider the discussions, reports, and recommendations related to its proposed action when considering issuance of a midwater non-whiting trawl exempted fishing permit (EFP) in 2018.

This consultation request relies on, as its basis, the letter from NMFS requesting consultation (Lockhart

2013), the information discussed with Council described above, the Council motion of April 2017 that recommended NMFS include certain elements in its proposed action for the consultation (PFMC 2017a), and statements and reports provided by the Council advisory bodies, and the West Coast Groundfish Observer Program (WCGOP), discussions with coastal tribal, Washington Department of Fish and Wildlife (WDFW), Oregon Department of Fish and Wildlife (ODFW), and CDFW staff, published and unpublished scientific information on the biology and ecology of the listed species in the action area, and other sources of information.

Table 1-1. ESA section 7 consultation activities related to the Pacific Coast Groundfish FMP.

Date	Citation	ESU considered or circumstances
August 10, 1990	**(NMFS 1990)**	**Sacramento River winter-run Chinook salmon, marine mammals, and turtles**
November 26, 1991	**(NMFS 1991)**	**Sacramento River winter-run Chinook salmon and Snake River sockeye salmon**
August 28, 1992	**(NMFS 1992)**	**Sacramento River winter-run Chinook salmon, Snake River sockeye salmon, Snake River spring/summer Chinook salmon, and Snake River fall Chinook salmon**
September 27, 1993	**(NMFS 1993)**	**High bycatch of pink salmon, ITS revised**
May 14, 1996	**(NMFS 1996)**	**Bycatch exceedance of take limit of Chinook in the 1995 whiting fishery (14,557)**
December 15, 1999	**(NMFS 1999)**	**Consultation on the effects of the FMP on 22 newly listed ESUs and Snake River fall Chinook**
April 25, 2002	**(Robinson 2002)**	**Bycatch exceedance of take limit of Chinook in the 2000 whiting fishery (11,513)**
March 11, 2006	**(NMFS 2006b)**	**Bycatch exceedance of take limit of Chinook in the 2000 and 2004 trawl fishery and the 2005 whiting fishery; reconsideration of Puget Sound, LCR, Snake River fall, UWR Chinook; addition of Sacramento River winter-run, CC, and Central Valley spring-run Chinook**
December 7, 2012	**(NMFS 2012c)**	**Green sturgeon, eulachon, humpback whales, Stellar sea lions, and leatherback sea turtles**

1.3 Proposed Federal Action

“Action” means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.2). These actions require consultation with NMFS because it is authorizing actions that may adversely affect listed species (section 7(a)(2) of the ESA).

"Interrelated" actions are those that are part of a larger action and depend on the larger action for their justification. "Interdependent" actions are those that have no independent utility apart from the action under consideration. There are no interrelated or interdependent actions of the proposed action.

The action proposed here is the continuing implementation of the Pacific Coast Groundfish FMP consistent with the recommendations the Council made in April 2017 regarding the proposed action (Appendix 1). The FMP governs fishing in the Exclusive Economic Zone (EEZ) with respect to species listed in Section 3.1 of the FMP. The fisheries managed under the FMP are expected to change in the near future because several species in the fishery that were previously designated as overfished have been rebuilt; and because the Council is making adjustments to the trawl rationalization program it adopted and NMFS implemented recently. To address some of the actions the Council has recently taken but have not yet been fully implemented, actions the Council is currently considering, and changes that are expected in the fishery independent of Council or NMFS' actions, the Council developed a set of assumptions that it recommended to NMFS as part of the proposed action for this consultation at its April 2017 meeting. These assumptions are listed in Table 1.2.1 below, and are described in further detail in Appendix 1.The duration of the consultation is the foreseeable future.

The following discussion describes all the groundfish fisheries governed by the FMP that are the subject of this consultation. It provides an overview of all components of the groundfish fishery that provides context for understanding how the fisheries operate and for assessing the direct and indirect effects of the Federal actions covered by this consultation. The overview also provides historical information to provide a perspective on the expected changes in the fishery included in the proposed action. In addition, components of the Council's recommendations are both included in Table 1-2 below and discussed in sections of the overview to which they are relevant. The discussion focuses on those attributes of the Pacific Coast groundfish fishery that influence the exposure of listed species to the fishery and potential outcomes including the following:

- Gear Type and Target Species—Configuration of gear and anticipated catch levels of target species, including the potential for direct interaction with listed species
- Seasonality and Geographic Extent—When and where the gear is deployed for comparison with the distribution of listed species and the intensity of effort
- Catch—Indirect effects of fishery catch and bycatch on listed salmon species

Additional consideration is given to monitoring strategies, data sources, and management jurisdiction.

Table 1-2. Summary of Council motion from April 2017 Council meeting (Agenda Item F.3, Council Action, April 2017). Scenarios 1A and 2B(1) were provided at the March 2017 Council meeting (NMFS 2017d).

Description of fisheries	**Whiting: consistent with scenario 1A** **(NMFS 2017d)**	**Recent conditions will continue, including historical geographic footprint of the fisheries.** **Includes a more substantial tribal fishery than observed in recent years with broader participation.**
	Non-Whiting: consistent with scenario 2B(1) **(NMFS 2017d)**	**Rockfish Conservation Area (RCA) is open to trawl fishing (see RCA definition below).** **Geographic distribution of the fleet/harvest is similar to that prior to trawl rationalization and reflects recent bycatch rates** **Midwater yellowtail/widow rockfish fishery is conducted in a manner similar to historical patterns when such a fishery took place.** **Retain selective flatfish trawl gear (SFFT) requirements shoreward of the RCA in 2017.**
RCA	**RCA is consistent with the Council's preliminary preferred alternative (November 2016 Council Meeting) (see Geographic Extent in Overview).**	
Estimated Harvest Level/Model Threshold	**Whiting: Total U.S. total allowable catch (TAC) achieved; up to 500k metric tons (mt) of TAC into the future.**	
	At-sea: total allocations and set-aside harvested.	
	Individual fishing quota (IFQ): Allocations for sablefish, petrale, lingcod, shortspine and longspine, and overfished rockfish species fully harvested.	
	IFQ: Other stocks which had 75% or more attainment in 2014 to 2016 will be achieved.	
Estimated Harvest Levels	**IFQ: The 2014 to 2016 harvest levels for canary, widow, yellowtail, and chilipepper will be taken by shoreside whiting and bottom trawl; the remainder will be harvested in the midwater non-whiting trawl.**	
	IFQ: All other groundfish stocks, harvest levels for 2014 to 2016 will continue.	
	Limited entry fixed gear (LEFG), open access (OA) fixed gear (OAFG), recreational fishery allocations, harvest guidelines (HGs), and harvest levels will likely continue.	
Chinook Bycatch Management Guidelines	**Whiting: 11,000 Chinook salmon**	**Bottom trawl, midwater non-whiting, LEFG, OAFG, and recreational: 5,500 Chinook salmon**
Chinook Bycatch Reserve	**3,500 Chinook bycatch** **Assess three possible scenarios of maximum effect for the purposes of assessing the impact of the Reserve on listed salmon:** **Assume Reserve taken entirely by whiting.** **Assume Reserve taken entirely by non-whiting bottom trawl.** **Assume Reserve taken by entirely non-whiting midwater trawl.**	
Exempted Fishing Permit	**2017:**	

Table 1-2. Summary of Council motion from April 2017 Council meeting (Agenda Item F.3, Council Action, April 2017). Scenarios 1A and 2B(1) were provided at the March 2017 Council meeting (NMFS 2017d). (continued)

	Bottom trawl[1] north of 42° N. latitude **No minimum mesh size requirement for bottom trawl vessels** **SFFT gear not required shoreward of the RCA.** **Chinook bycatch HG of 3,500 Chinook (counted towards the 5,500 threshold above) [1]** **EFP terminated if 3,500 HG (or 800 prior to May 15th) attained so that participating vessels would have to comply with SFFT gear requirement.**
	2018: Considered the advisory body comments, reports, and discussions occurring on this issue in April 2017 (see Appendix B). [The Chinook bycatch would be counted toward the 5,500 threshold above.]

The Council recommended that NMFS consider the Reserve not as an entitlement or a de facto increase in the bycatch threshold; but rather, as a safety net to minimize disruption to the fishery where actions that were already actively being taken to reduce bycatch were insufficient. Depending on the results of this opinion, the Council could consider maintaining the concept of the Reserve and limiting Reserve portions to specific sectors, or eliminating the Reserve. However, for purposes of this analysis, NMFS assumes the Reserve will be implemented as the Council has recommended.

For 2019 and 2020, and beyond, using the biennial groundfish harvest specifications and management process, the Council will develop and consider a range of alternatives for management measures to address the bycatch of salmon in groundfish fisheries. Such measures may include: sector-specific catch limits, bycatch thresholds, HGs, time and area closures, and gear restrictions. These measures may be implemented preseason or inseason, and they may be described as NMFS automatic actions or Council actions.

1.3.1 Overview of the Components and Operation of the Groundfish Fishery

The Pacific coast groundfish fishery is a year-round, multi-species fishery occurring off the coasts of Washington, Oregon, and California. The groundfish fishery includes vessels that use a variety of gear types to harvest groundfish directly or to land groundfish incidentally caught while targeting non-

[1] The motion refers to a midwater non-whiting trawl fishery EFP, but the description actually refers to the EFP for bottom-trawl vessels only in place at the time. The EFP also includes a sub-guideline of only 800 Chinook salmon allowed to be taken prior to May 15th.

groundfish species. These gear types have a potential for direct interaction with listed salmonids. The seasonality and geographic extent, including fishing depth and north/south distribution of the different target strategies and gear types, result in different direct effects on different ESUs of salmonids. This section presents an overview of the groundfish species, the management structure, gear types used to harvest groundfish, seasonality and geographic extent of the fishery, and catch monitoring. Additional detail on these elements can be found in NMFS (2017b).

Fisheries that impact groundfish but that are not directly regulated through the FMP are managed by the coastal states. These include state-managed nearshore fisheries which target some of the same species included in the FMP fisheries and that target species not included in the FMP and that incidentally catch species in the FMP. Examples of the latter include the California halibut fishery and the pink shrimp fishery.

The FMP and its implementing regulations do limit the retention of groundfish in these fisheries, and they require observer coverage to enforce those limits, but they do not directly regulate the harvest of the target species. Most nearshore fixed gear fishing regulated by the states occurs between 0 and 3 miles offshore. These state-managed fisheries are not part of this proposed action, as they are not directly managed under the FMP. In addition, they are neither interrelated nor interdependent with the federally managed groundfish fisheries covered by the FMP. They have independent utility, and they do not depend on the federally managed fisheries for their justification. Therefore, this consultation does not address the effects of these fisheries on listed species, nor does it provide incidental take coverage for them. Their effects are addressed in the Environmental Baseline and Cumulative Effects sections (Section 2.4 and Section 2.5, respectively).

1.3.1.1 **Groundfish Species**

The FMP includes more than 90 species. Commercial and recreational fisheries targeting Pacific whiting, sablefish, lingcod, rockfish, and flatfish species encounter salmon. **Table 1-3** shows total commercial groundfish catch mortality in metric tons by species and species groupings in recent years compared with anticipated harvest levels under the proposed action. These estimates are based on the Council's recommendations regarding what proportion of historical allowed catch levels may be taken in future fisheries. For species in the groundfish fishery other than whiting, annual catch limits (ACLs) are set and allocated to sectors of the fishery through a biennial process. An annual catch level for whiting is set through an international process under the Whiting Treaty between the US and Canada. A few target stocks are typically caught nearly up to their ACLs, but many species in the fishery are caught at levels significantly below their ACLs. Thus, the Council included in its recommendations assumptions about what proportion of ACLs for various species might be taken in future fisheries (Table 1-2). These recommendations are part of this proposed action. Under the proposed action, harvest levels would increase for the majority of these species from those observed over the past 15 years.

Different species of groundfish inhabit different habitats defined by substrate, depth, and other environmental characteristics (NMFS 2017b; PFMC 2014a). The distribution of the fishing fleets is the result of a combination of factors; in general, however, it reflects the distribution of the species targeted by each fishery, as well as the regulatory constraints in place to manage those fisheries.

Table 1-3. Groundfish mortality by species and species groups, commercial and recreational fisheries by year, including the estimated level of catch associated with the proposed action (Bellman et al. 2008; Bellman et al. 2009; Bellman et al. 2010' Bellman et al. 2011; Bellman et al. 2012; Bellman et al. 2013; Somers et al. 2014; Somers et al. 2015a; Somers et al. 2016; PFMC 2017a).[a/]

Species and Species Groups		Fishing Year												
		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Proposed Action[d/]
Roundfish	Cabezon [b/]	--	133	106	42	39	105	108	98	121	103	109	118	
	California scorpionfish	--	--	--	68	65	70	67	104	120	115	125	84	
	Lingcod	588	890	952	706	574	581	450	852	1,068	1,294	1,298	1,489	1,770
	Pacific cod	--	864	385	101	39	248	347	607	634	391	440	775	305
	Pacific whiting	226,615	261,212	267,707	215,340	250,205	122,165	165,717	231,996	160,706	234,499	265,120	155,559	500,000
	Sablefish	6,235	6,543	6,470	5,545	6,078	7,400	7,205	6,582	5,406	4,193	4,518	5,183	2,742
Flatfish	Arrowtooth	5,668	3,706	3,105	3,099	3,409	5,443	4,090	2,666	2,508	2,510	1,844	1,771	5,464
	Dover sole	7,213	7,507	7,730	10,227	11,820	12,546	10,952	7,927	7,175	8,081	6,566	6,328	8,955
	English sole	1,229	1,222	1,336	914	436	501	311	205	224	357	306	386	320
	Petrale sole	2,119	2,766	2,723	2,340	2,260	1,978	936	953	1,111	2,265	2,439	2,670	2,629
	Starry flounder	--	--	--	30	21	28	38	24	17	9	28	29	9
	All other flatfish	1,889	1,965	1,962	1,649	1,040	1,565	1,144	921	897	1,080	1,106	1,087	942
Rockfish	Bocaccio	105	97	61	67	47	70.6	72	112	140	149	119	138	283
	Canary	48	49	57	46	41	38	43	52	45	43	46	79	1,014
	Chilipepper	153	97	126	128	151	311	376	329	302	404	334	199	1,846

Table 1-3. Groundfish mortality by species and species groups, commercial and recreational fisheries by year, including the estimated level of catch associated with the proposed action (Bellman et al. 2008; Bellman et al. 2009; Bellman et al. 2010’ Bellman et al. 2011; Bellman et al. 2012; Bellman et al. 2013; Somers et al. 2014; Somers et al. 2015a; Somers et al. 2016; PFMC 2017a).[a/](continued)

Species and Species Groups		Fishing Year												
		2004	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**Proposed Action[d/]**
	Cowcod	**2**	**2**	**1**	**3**	**1**	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**1**
	Darkblotched	**231**	**124**	**193**	**285**	**253**	**301**	**332**	**133**	**105**	**133**	**140**	**117**	**518**
	POP	**152**	**76**	**80**	**157**	**131**	**181**	**159**	**62**	**56**	**58**	**56**	**41**	**198**
	Thornyheads	**1,562**	**1,546**	**1,707**	**2,114**	**2,972**	**3,377**	**3,263**	**2,001**	**1,861**	**2,171**	**1,822**	**1,654**	**2,432**
	Widow	**119**	**199**	**214**	**259**	**238**	**195**	**173**	**216**	**278**	**499**	**748**	**375**	**10,662**
	Yelloweye	**16**	**16**	**12**	**19**	**12**	**11**	**8**	**9**	**12**	**11**	**9**	**11**	**>1**
	Yellowtail	**739**	**935**	**493**	**389**	**476**	**751**	**955**	**1,352**	**1,570**	**1,424**	**1,462**	**1,386**	**4,075**
	Nearshore unspecified [c/]	**--**	**1,527**	**1,703**	**1,436**	**1,240**	**1,442**	**1,308**	**1,266**	**1,353**	**1,667**	**655**	**739**	
	Shelf, unspecified [c/]	**--**	**501**	**230**	**519**	**296**	**352**	**335**	**433**	**499**	**521**	**513**	**608**	**61**
	Slope, unspecified [c/]	**1,754**	**672**	**701**	**814**	**850**	**951**	**884**	**574**	**772**	**552**	**508**	**337**	**311**
Other	**Kelp greenling**	**--**	**35**	**48**	**53**	**57**	**63**	**59**	**75**	**65**	**70**	**54**	**57**	
	Grenadiers, unspecified	**--**	**--**	**--**	**414**	**379**	**248**	**365**	**240**	**201**	**318**	**156**	**303**	

Species and Species Groups		Fishing Year												
		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Proposed Action[d/]
	Spiny dogfish	--	2,044	1,407	1,504	2,497	1,207	1,215	1,662	831	652	625	457	
	Skates, unspecified	--	1,920	1,029	2,192	2,314	2,186	1,723	1,555	1,396	1,178	1,414	1,406	
	All other groundfish	--	2,425	1,015	414	277	212	215	122	209	145	125	123	

[a/] Included small amounts of research catch.

[b/] 2007-2008 includes only California catch; 2009 to 2013 includes both California and Oregon catch.

[c/] These are an aggregation of species specific to this report and combined species managed individually with species managed in complexes.

[d/] Estimated as per direction in Appendix 1. These estimates are provided to estimate salmon bycatch; they are not intended to represent actual management quotas.

1.3.1.2 Current Management Structure and Fishing Gears

The groundfish fishery includes commercial, treaty tribal, and recreational gear components. The commercial groundfish fishery includes a limited entry (LE) permit program for a commercial non-tribal fleet that was established in 1994 for trawl, longline, and trap (or pot) gears and an OA fishery. The LE fleet takes the majority of the commercial groundfish harvest. The OA fishery takes groundfish incidentally or in small amounts. The OA fishery participants may use, but are not limited to longline, vertical hook-and-line, pot, setnet, trammel net, and non-groundfish trawl gear. There is also a commercial tribal fishery off the Washington Coast. Participants in the tribal fishery use gear similar to that used in the non-tribal fisheries. The groundfish fisheries can be divided into the groups shown in **Table 1-4**, based on permitting requirements, gear, and target strategy.

Table 1-4. Summary of gear and components by fishery managed under the FMP.

Fishery	Gear	Components
LE vessels registered to Federal LE groundfish permits (non-tribal)	Trawl—At-sea Pacific whiting cooperatives	Catcher/processor cooperative Mothership sector cooperative
	Trawl—Shorebased IIFQ program	Pacific whiting midwater trawl Non-whiting midwater trawl Bottom trawl Fixed gear (gear switching)
	Fixed gear	Sablefish tier limit fishery LEFG trip limit fishery
Open access	See text for description.	Directed OA Incidental OA
Tribal	Gear similar to LE fishery	Pacific whiting midwater trawl Non-whiting midwater trawl Bottom trawl Fixed gear
Recreational	Hook-and-line Spear	Commercial passenger vessels and private party vessels

In 2017, 340 LE harvesting vessels were managed under the FMP. The harvesting vessels include vessels that harvest catch and deliver it to land based processing facilities and vessels that both harvest and process catch (catcher-processors). In addition, there are six mothership processors which receive whiting from catcher vessels and process them at sea. The number of vessels in the LE fisheries varies between years based on permits being transferred to multiple vessels, vessels in the sablefish tier fishery stacking[2] or unstacking permits, and permit owners removing their permits from vessels so that the permits are unused for some period (i.e., unidentified status). Each permit is endorsed for a particular gear type, and that endorsement cannot be changed. Therefore, the distribution of permits between LE trawl and fixed gears is fairly stable. The overall number of permits is reduced when multiple permits are combined to create a new permit with a longer vessel length endorsement. The distribution of permits often shifts among the three states. Effort in the fishery has declined significantly since the mid-1990s (**Figure 1-1**).

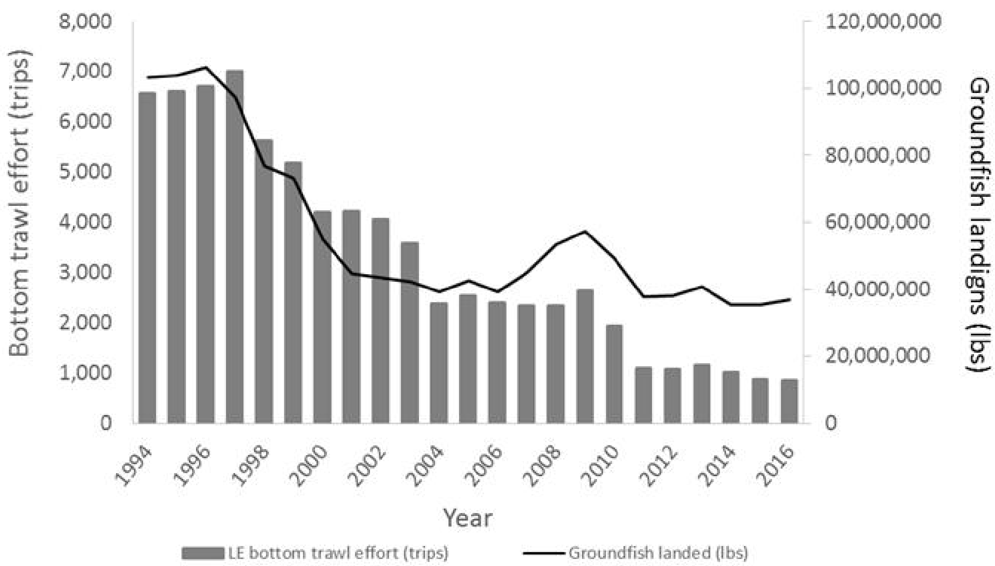

Figure 1-1. Non-whiting LE trawl trips (number) and groundfish landings by year.

An important reason for identifying fishery sectors relates to allocation of catch opportunity. Harvest levels or specifications for various groundfish stocks and stock complexes are referred to as annual catch limits (ACLs) and HGs. These may be coastwide specifications, or they may be subdivided geographically. Most of the ACLs are allocated to specific sectors of the fishery as described in the FMP.

Allocations may be “formal” or “informal.” Formal allocations are generally established to ensure that a sector can catch its portion of the ACL. Informal allocations are a function of particular management

[2] Stacking is the practice of registering more than one LE permit for use with a single vessel.

measures that constrain catch opportunities. In addition to allocations, managers also consider “set-asides”, portions of particular species’ ACLs that are set aside to prevent annual catch from exceeding the ACLs. Set-asides are established for research catch, incidental fisheries, tribal fisheries, and EFPs.

Overview of Trawl Fisheries

Beginning in 2011, West Coast groundfish fisheries have been managed under a catch share program that constrains both the number of vessels participating in the fishery and the amount of catch permitted by participationg vessels. Catch shares consist of an IFQ program for the shorebased trawl fleet and harvester cooperatives for the at-sea mothership and catcher-processor fleets. The catch shares system divides the portion of the ACL allocated to the trawl fishery into shares controlled by individual fishermen or groups of fishermen (coops). The shares can be harvested largely at the fishermen's discretion. IFQ species and Pacific halibut catch are deducted from the fisherman's personal quota or the pooled quota (coops). Under catch shares, some management measures from the previous management structure remain in place; these measures include trip limits for non-IFQ species, size limits, and area restrictions.

The trawl fishery is divided into a number of sectors for management purposes. A portion of the fishery targets Pacific whiting, a midwater species. This portion of the fishery is divided into vessels that deliver to onshore processors (shoreside) and vessels that process at sea or deliver to vessels that process at sea (at-sea). Another portion of the fishery targest bottom-dwelling groundfish species (bottom trawl). Finally, there is a developing fishery for non-whiting midwater groundfish species. This latter fishery is expected to expand in the future as restrictions put in place to allow formerly overfished species to rebuild are lifted.

For the whiting fishery, the Council recommended that NMFS assume that the fishery will continue much as it has in recent years, with the same geographical footprint. However, the Council recommended that NMFS assume that the annual whiting total allowable catch (TAC) could go up to 500,000 metric tons, as the TAC has been trending higher in recent years, and that this TAC will be fully harvested.

For the non-whiting fishery, the Council recommended that NMFS assume the geographic distribution of the fleet and harvest levels will be similar to patterns prior to the implementation of the trawl rationalization program. For the non-whiting mid-water trawl fishery, the Council recommended that NMFS assume fishing patterns will be similar to those that occurred prior to species that had been targeted in those fisheries being designated as overfished species. As some species have been rebuilt, fishing in the future is expected to resemble those historical patterns more closely than recent patterns which reflect restrictions on fishing necessary for rebuilding the overfished species.

At-Sea Pacific Whiting Cooperatives - From May 15 to December 31 (the primary whiting season), midwater trawl gear is used to target Pacific whiting in the at-sea sectors (mothership and catcher-processor cooperatives). Catcher/processors both harvest and process catch while mothership vessels process catch received from catcher vessels.

In 2017, there are 10 permitted catcher-processors (nine of which are registered to vessels), 6 permitted mothership vessels, and 34 LE catcher permits with mothership endorsements (mothership catcher vessel permits, 31 of which are registered to vessels to participate in the fishery).[3] The at-sea fleet has the mobility to follow the movement of Pacific whiting. The catcher-processors are large vessels that have the capacity to target Pacific whiting at deeper depths than some of the smaller catcher vessels that harvest in the mothership or shoreside IFQ sectors. At times, the at-sea fleet has fished at depths greater than 200 fathoms, which may limit salmon bycatch (**Figure 1-2**). Since 1992, the at-sea fleet has been restricted from processing its catch south of 42° N. latitude (57 FR 14663).

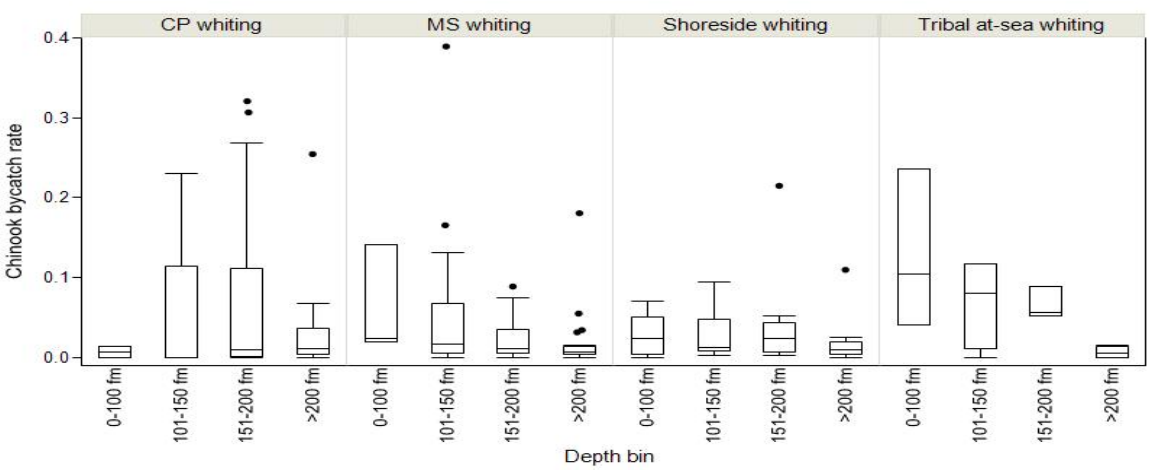

Figure 1-2. Box plot of Chinook bycatch rates (count per mt retained whiting), and retained whiting catch by depth strata for whiting sectors. Data are based on 2009 to 2015 for at-sea sectors, and 2011 to 2014 data for shorebased sectors. The chart follows standard box-plot convention: midline = median, box ends = first and third quartiles, whiskers = 1.5*interquartile range, dots = outliers beyond whiskers. (NMFS 2017b).

[3] When the trawl individual quota program was initiated, there were 10 CP permits, 6 MS permits, and 37 MS/CV endorsements with assigned catch histories. Currently, 3 of the 34 vessels have two endorsements and catch histories assigned to them. These data come from the NMFS West Coast Region Pacific Coast Fisheries Permit System, which was queried on March 20, 2017.

Prior to 2009, the whiting sectors (including shoreside) operated without bycatch limits (1990 to 2006) for overfished species, or a whiting sector combined bycatch limit for overfished species (2007 to 2008). This led to a race for Pacific whiting until the allocation was reached, or until a bycatch cap for an overfished groundfish species resulted in closing the sectors to fishing. In 2009, sector-specific bycatch caps for overfished species were established, leading to sectors individually managing their fishing activity. From 1997 to 2010, the catcher-processor fleet operated under a voluntary coop program through the Pacific Whiting Conservation Cooperative (PWCC). After 2011, the program became a mandatory catch share cooperative. In 2011, the mothership sector began operating under a single coop agreement under the new catch share program.

With implementation of the catch share program under Amendment 20 in 2011, there were few changes to the management of the PWCC. Regulations at 660.160(h) were enacted so that if the coop dissolves, the quota would be apportioned equally among current member vessels. For the mothership sector, the catch share program provided the opportunity for owners of mothership catcher vessel permits to form harvester coops. Each year, owners of such permits must choose whether to participate in a catcher vessel coop and, if they reach that decision, they must identify the mothership to which they commit their deliveries. To date, the mothership catcher vessel permit holders have chosen to form a single coop, and all have chosen to join that coop. If the catcher vessels do not choose a coop, they can participate in a non-coop fishery, and they receive their respective allocations. However, a vessel with a mothership catcher vessel endorsed permit may not fish in both the coop and non-coop fisheries in the same year.

Under the typical coop agreements, the primary goal is to minimize bycatch of all constraining species, with each fleet using real time monitoring to track location and catch amounts. For the mothership coop, there are specific criteria in the coop agreements for avoiding high bycatch, including area restrictions and moving protocols when specific base rates are exceeded. There are two stages of Chinook salmon base rates for the mothership sector. The base rates are flagged that indicate additional actions may be taken to reduce bycatch:

a) A rate of 0.04 Chinook/mt is the base rate for fleets that have taken more than their pro-rata share of Chinook salmon relative to whiting harvested.

b) A rate of 0.06 Chinook/mt is the base rate for fleets that have taken less than their pro-rata share of Chinook salmon relative to whiting harvested (Council, Agenda Item H.9.b, Public Comment, September 2015).

Once a seasonal pool has taken 50 percent of its pro-rata share of Chinook salmon, then vessels may be forced to move fishing effort based on varying levels of bycatch. Vessels may move earlier due to other constraining species base rates. There are fewer vessels for the catcher-processor sector and companies participating within the coop; therefore, no pools or specific base rates are stated explicitly within the agreement. However, vessel reports are looked at frequently (hourly to daily), and if bycatch rates are above acceptable levels, PWCC discusses what actions should be taken with the vessels

Both the mothership and catcher processor sectors use a private contracting service called Seastate for their data collection. Seastate uses electronically submitted observer data to calculate bycatch rates and provides the data back to the fleet within 24 hours to be used for bycatch avoidance. The Seastate service allows for information quick turnaround; it provides an avenue for vessels to work together to reduce bycatch, and it allows sharing of otherwise confidential data.

A number of non-whiting species are caught in this fishery. Bycatch of non-whiting species during this period largely consisted of spiny dogfish, yellowtail rockfish, widow rockfish, minor slope rockfish, thornyheads, sablefish, darkblotched rockfish, Pacific Ocean perch (POP), and arrowtooth flounder. Annual set-asides of the overall trawl allocations are established for most incidentally caught groundfish.

Shorebased IFQ Trawl Fishery—The IFQ fishery consists of permit owners who are issued quota pounds for most groundfish stocks and stock complexes, vessel owners who register their vessels to LE trawl permits, and shorebased IFQ first receivers. The fishery includes vessels using midwater trawl gear to target Pacific whiting delivering to on-shore processors, vessels using bottom trawl gear to harvest non-whiting and minor levels of Pacific whiting, vessels using midwater trawl to target non-whiting groundfish, and vessels using fixed gears (gear switching) to harvest trawl IFQ. In 2017, 175 LE trawl permits were issued for the shorebased IFQ fishery (all gears). Vessels fished throughout the year in a wide range of depths, and they delivered catch to shoreside processors in Washington, Oregon and California ports.

Pacific Whiting Shoreside Fishery—Vessels participating in the Pacific whiting shoreside fishery use midwater trawl gear during the primary whiting season, May 15 to December 31. These vessels land their catch on shore and tend to fish in waters closer to shore than vessels in the at-sea fleet. Since implementation of the Shorebased IFQ program in 2011, the number of participating vessels in this sector has dropped from 36 vessels in 2010 to 23 vessels in 2016. These vessels may also deliver catch to the mothership sector if they have a mothership catcher vessel endorsed permit. Most shoreside Pacific whiting vessels also fish in Alaska fisheries.

Bottom Trawl Fishery—Bottom trawlers often target species assemblages, which can result in diverse catch. A single groundfish bottom trawl tow often includes 15 to 20 groundfish species. The following species account for the bulk of non-whiting landings, by weight: Dover sole, arrowtooth flounder, petrale sole, sablefish, longspine thornyhead and shortspine thornyhead, yellowtail rockfish, and skates/rays.

Bottom trawl gear includes small footrope that consists of selective flatfish trawl (less than 8-inch diameter) and large footrope (more than 8 inches and no larger than 19 inches in diameter) gear designed to remain in contact with the ocean floor and used to target species that reside along the ocean bottom. Fishers generally use small footrope trawl gear in areas with few rocks or outcroppings and more widely on the continental shelf than on the continental slope. Only small footrope gear is allowed in areas shallower than 100 fm. In nearshore areas, SFFT[4] trawl gear, a type of small footrope trawl, has been required north of 40°10' N. latitude.

In 2017, NMFS issued an EFP that provides vessels with an exemption to the requirement to use SFFT gear north of 42°N. latitude only, but only under a hard Chinook bycatch cap. Analysis indicates that SFFT gear can significantly reduce Chinook bycatch (PFMC 2017b, Agenda Item F.3.a, Supplemental GMT Report 2). Fishers most commonly use large footrope trawl gear in areas that have an irregular substrate, along the continental slope and in deeper water.

The continental shelf in the Eureka area is narrow, and the 100-fathom (fm) contour generally occurs 6 to 10 nautical miles (nm) offshore. Because higher salmon bycatch rates have been observed in the midwater trawl fishery inside the 100-fm contour in the Eureka management area, year-round trip limits for Pacific whiting have been in place for midwater trawl gear. There is a 20,000-pound- (lb) per-trip limit before the primary whiting season; during and after the primary season, no more than 10,000-lb/trip of Pacific whiting may be retained on a fishing trip limit (50 CFR 660 subpart D, Table 1).

***Midwater Non-whiting Trawl*—**Since 2011, midwater trawl vessels have increased targeting of widow and yellowtail rockfish with midwater trawl gear. In the 1980s and 1990s, midwater trawl gear was used to harvest large volumes of widow, yellowtail, and chilipepper rockfish. In 2001, widow rockfish was declared overfished, and targeting opportunities for widow and yellowtail rockfish were eliminated in 2002 (**Figure 1-3**). Retention was restricted to Pacific whiting trips with greater than 10,000 lbs of whiting. Trip limits for widow and yellowtail rockfish were reduced to accommodate incidental catch and prevent targeting on widow rockfish while fishing for Pacific whiting. Targeting opportunities for

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[4]Vessels fishing under EFPs in 2004 voluntarily used SFFT gear; it became a regulatory requirement in May 2005 for waters shoreward of the RCAs north of 40°10' N. latitude. Chinook salmon catch in the bottom trawl fishery has dropped significantly since early 2003.

chilipepper rockfish with midwater gear were eliminated in 2003, but larger limits (large enough to allow targeting) were reinstated seaward of the RCAs in 2005. With implementation of the shorebased IFQ program in 2011, in which catch of all IFQ species, including discards, is accounted for with quota pounds, the restrictive trip limits that allowed widow and yellowtail rockfish retention only by vessels harvesting Pacific whiting during the primary fishery were eliminated.

Widow rockfish was considered rebuilt in 2012, and canary rockfish, a co-occurring species that can constrain midwater trawl activity, was declared rebuilt in 2015. With the ACLs for these midwater species increasing, an upsurge in the targeting of rockfish such as yellowtail rockfish, widow, and chilipepper is anticipated. The current midwater non-whiting trawl fishery occurs during the dates of the Pacific whiting primary season north of 40°10' N. latitude or seaward of the RCAs south of 40°10' N. latitude. As part of the proposed action, the Council has recommended an EFP to examine the effects of a year-round, coastwide midwater non-whiting trawl fishery in the future (see EFP description below).

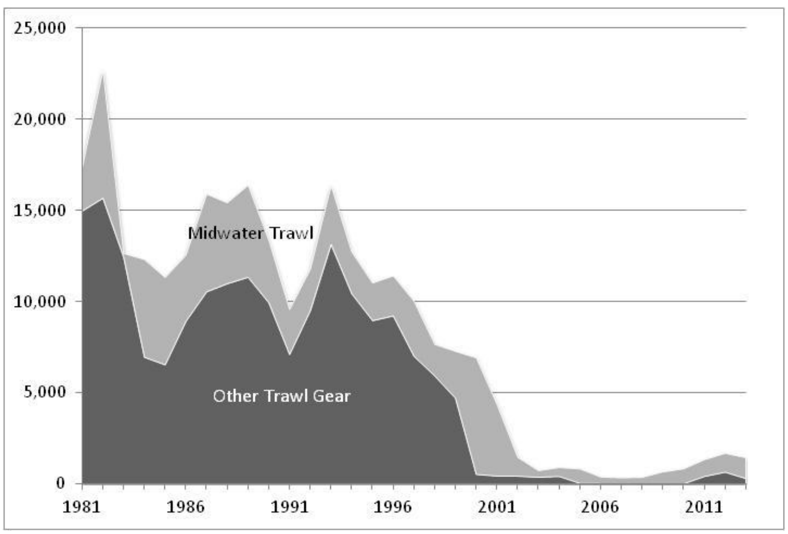

Figure 1-3. Landings of widow and yellowtail rockfish by trawl gear type, 1981 to 2013 (PFMC 2015).

IFQ Gear Switching—The Shorebased IFQ program allows LE trawl permit holders to switch from trawl to fixed gears (longline and pot gear) to fish their individual quota. In 2014, 21 fixed gear vessels caught sablefish allocated to the trawl fishery. Fixed gears targeting sablefish are more selective than trawl gear and have less potential impact to benthic habitat. Sablefish are caught, in deeper water, unlike nearshore groundfish species. The use of gear switching specific to sablefish is not based on regulation, but is facilitated because of where sablefish are caught.

Overview of Fixed Gear Fisheries

In 2005, LEFG fishing opportunity was constrained by measures needed to reduce the catch of overfished species, including canary rockfish coastwide, yelloweye rockfish north of 40°10′ N, latitude, and bocaccio and cowcod south of 40°10’ N. latitude. Landing limits for the LEFG fleet north of 40°10’ N. latitude provided vessels with access to continental slope and nearshore species and less access to continental shelf species. For waters south of 40°10′ N. latitude, landings limits were intended to draw vessels away from continental shelf species. Non-trawl RCAs are closed areas used to move fixed gear effort away from areas with higher yelloweye and canary rockfish abundance. The Cowcod Conservation Areas (CCAs) off the Southern California Bight were closed to commercial groundfish fishing to prevent vessels from fishing in areas of higher cowcod abundance.

Although the OA non-trawl fishery is managed separately from the LEFG fishery, overfished species protection measures are similar for both sectors. The non-trawl RCA boundaries that apply to the LEFG fleet also apply to the OA non-trawl fleet, as do the CCAs. Also, similar to the LE fleet, greater landings limits are provided for continental slope and nearshore species, with closed seasons and lower limits for continental shelf species, including the same closed periods for lingcod as in the LEFG fisheries.

Limited Entry Fixed Gear—Fixed gear vessels primarily target high-value sablefish with most landings historically occurring in Oregon and Washington. However, landings of sablefish vary depending on environmental conditions, and they have recently shown a southerly trend. California ports have had the greatest amount of LE, daily-trip-limit landings of sablefish in recent years, while Oregon have had the most primary landings. In 2017, there were 234 fixed gear permits, including 168 sablefish-endorsed and 66 non-sablefish endorsed permits. In addition, all LE fixed gear permits have gear endorsements (longline, pot/trap, or both). Of the sablefish endorsed permits, 135 were associated with longline gear, 29 were associated with pot/trap gear, and 4 were associated with both longline and pot/trap gear. The remaining 66 non-sablefish-endorsed permits were associated with longline gear.[5]

The LE fixed gear groundfish fishery consists of vessels fishing in the sablefish-endorsed tier fishery and the trip-limit fishery targeting nearshore species and non-nearshore species, including the daily trip limit fishery for sablefish. In the sablefish tier fishery, the permit holder of a sablefish-endorsed permit receives an annual share of the sablefish catch or “tier limits.” Regulations allow for up to three sablefish-endorsed permits to be stacked on a single vessel. Vessels that are sablefish-endorsed generally fish deeper than

[5] NMFS West Coast Region Pacific Coast Fisheries Permit System, queried March 27, 2017.

80 fathoms, and they land catch composed mostly of sablefish, with groundfish bycatch consisting primarily of spiny dogfish shark, Pacific halibut, rockfish species, and skates.

Vessels fishing under trip limits generally target sablefish, thornyheads, and other groundfish species. These vessels primarily fish out of California ports. Fixed gear vessels are more prone to catch yelloweye rockfish, an overfished species, than trawl vessels, and, therefore, they have greater fishing restrictions on the continental shelf. LE, fixed-gear vessels may also participate in OA fisheries or in the LE trawl fishery. Like the LE trawl fleet, LE, fixed-gear vessels deliver their catch to ports along the Washington, Oregon, and California coasts.

OA Fixed Gear—The OA sector consists of vessels that do not hold a Federal groundfish LE permit. They target groundfish (OA directed fisheries) or catch them incidentally (OA incidental fisheries) using a variety of gears. Vessels in this sector may hold Federal or state permits for non-groundfish fisheries. OA vessels must comply with cumulative trip limits established for the OA sector, and they are subject to the other operational restrictions imposed in the regulations, including general compliance with RCA restrictions.

Fishers use various non-trawl gears (including longline, trap or pot, setnet, stationary hook-and-line, vertical hook-and-line, and troll) to target particular groundfish species or species groups. Longline and hook and line gear are the most common OA gear types used by vessels directly targeting groundfish, and they are generally used to target sablefish, rockfish, and lingcod. Pot gear is used for targeting sablefish, thornyheads, and rockfish. The directed OA fishery is further grouped into the “dead” and/or “live” fish fisheries. In the live-fish fishery, groundfish are primarily caught with hook-and-line gear (rod-and-reel), LE longline gear, and a variety of other hook gears (e.g., stick gear). The fish are kept alive in a seawater tank onboard the vessel. Groundfish delivered live are primarily nearshore rockfish, but they also include thornyheads, sablefish, and lingcod.

For vessels targeting non-groundfish species, the groundfish catch is incidental to the target species. Only the groundfish catch is regulated under the Groundfish FMP. Incidental catch occurs in the following state-managed, non-groundfish trawl fisheries: California halibut, pink shrimp, ridgeback prawn, sea cucumber, and spot prawn. The fixed gear fisheries that take incidental amounts of groundfish include the following fisheries managed by the states (not part of the proposed action) or under other Federal FMPs: California halibut, coastal pelagic species, crab pot, fish pot, highly migratory species, Pacific halibut, salmon, sea urchin, and set net fisheries.

OA groundfish landings vary according to which non-groundfish fisheries are landing groundfish as bycatch. The number of OA boats that land groundfish also varies with the changes in the non-groundfish fisheries and participation varies between years. For the directed OA fisheries, participation from 2008 to 2012 in the nearshore fixed gear fishery had approximately 597 unique vessels (216 from Oregon and 282 from California), and the non-fixed gears had approximately 150 unique vessels (18 from Washington, 44 from Oregon, and 88 from California) (PFMC 2014a). For the incidental OA fisheries, there were approximately 604 unique vessels from 2008 to 2012 (46 from Washington, 200 from Oregon, and 367 from California) (PFMC 2014a). There is limited information on the distribution of effort by OA vessels. The OA sector is made up of many different gear types involved in directed and incidental catch, which makes it difficult to discern the location of effort. However, based on the diversity of this sector, it is reasonable to assume that effort is widespread across the West Coast.

Tribal Groundfish Fisheries**—**Washington coastal tribes (Makah, Quileute, Hoh, and Quinault) possess treaty rights to harvest federally managed groundfish in their usual and accustomed fishing areas (U&As) within the EEZ, as described in decisions in *United States v. Washington* and associated cases. Under treaty arrangements, each tribe manages the fisheries prosecuted by its members. The FMP and its implementing regulations provide for allocations or set-asides of specific amounts of some species for the tribal fisheries to ensure implementation of treaty fishing rights. Those allocations and set-asides are developed annually or biennially (depending on the species) in consultation with the tribes.

The individual tribes manage their fisheries, coordinating with NMFS and the Council. Treaty tribes participating in the groundfish fishery off Washington State have formal allocations for sablefish, black rockfish, and Pacific whiting established through the Council. For other groundfish species without formal allocations, the tribes propose trip limits to the Council. The Council tries to accommodate the requested trip limits, while ensuring that catch limits for all groundfish species are not exceeded.

All four tribes have longline vessels in their fleets; only the Makah Tribe has trawlers. The Makah trawl vessels use both midwater and bottom trawl gear to target groundfish. The Makah Tribe also has the most longline vessels, followed by the Quinault, Quileute, and Hoh Tribes. Since 1996, a portion of the U.S. Pacific whiting TAC has been allocated to the West Coast treaty tribes fishing in the groundfish fishery. Tribal allocations have been based on discussions with the tribes regarding their intent for a specific fishing year. From 2007 to 2016 the tribal allocation has ranged from 13 to 37 percent of the U.S. Pacific whiting TAC.

The tribal whiting annual allocations are interim allocations not intended to set precedent for future allocations. Although the Quinault, Quileute, and Makah Tribes have expressed interest in the whiting fishery, to date, only the Makah Tribe has participated in the Pacific whiting fishery. Since 2012, whiting migration patterns have resulted in minimal tribal fisheries, in part because whiting distribution has been south of tribal U&A areas. If a more robust tribal fishery were to resume, and participation were to widen, it could incur additional Chinook impacts. To accommodate this potential within this consultation, the proposed action assumes an increase in tribal participation from the Quileute and Quinault Tribes. Discussions with tribal representatives and staff indicate that the expected catch could be approximately 8,000 mt of whiting per year for each tribe, and that their strategy would resemble a mothership operation, but the fishery would likely be prosecuted with small vessels, operating in relatively shallow bottom depths. However, examination of the boundaries of the relevant U&A fishing areas (81 FR 36806, June 8, 2016) indicate access by both tribes to a substantial area with deeper bottom depths (greater than 200 fm). These conditions could enable more typical mothership operation of the fishery which tends to show lower bycatch rates than the shorebased fleet.

In addition to its participation in the whiting fishery, the Makah Tribe has a midwater trawl fishery that primarily targets yellowtail rockfish and a bottom trawl fishery that targets petrale sole. In developing its trawl fisheries, the Makah Tribe has implemented management practices that include test fishing to show tribal managers that the fishery can be conducted with gear and in areas without harming existing tribal fisheries. In the Makah bottom trawl fishery, the Tribe adopted small footrope to reduce rockfish bycatch and avoid areas where higher numbers of rockfish occur. In addition, the bottom trawl fishery is limited by overall footrope length to conduct a more controlled fishery. Harvest is restricted by time and area to focus on harvestable species while avoiding bycatch of other species. If bycatch of rockfish is above a set amount, the fishery is modified to stay within the bycatch limit. The midwater trawl fishery has similar control measures. A trawl area must first be tested to determine the incidence of overfished rockfish species before opening the area to harvest. Vessels receive guidelines for fishing techniques and operation of their net. Observers monitor fishing effort, and changes or restrictions are implemented, as needed, to stay within the bycatch limits.

Approximately one-third of the tribal sablefish allocation is taken during an open competition fishery, where vessels from all the four tribes have access to the overall tribal sablefish allocation. The open competition portion of the fishery tends to be taken during the same period as the main tribal commercial Pacific halibut fisheries in March and April. The remaining two-thirds of the tribal sablefish allocation are split between the tribes according to a mutually agreed-upon allocation scheme. Specific sablefish allocations are managed by the individual tribes. Participants in the halibut and sablefish fisheries tend to use hook and line gear, as required by the International Pacific Halibut Commission (IPHC).

Recreational

The states primarily manage recreational fisheries, with a distinction made between charter vessels (commercial passenger fishing vessels) and private party recreational vessels (individuals fishing from their own or rented boats). Federal and state management measures have been designed to limit catch of overfished species and provide fishing opportunity for anglers targeting nearshore groundfish species. The primary management tools have been seasons, bag limits, and closed areas. Gears used in the recreational fisheries include dip nets, throw nets, hook-and-line, dive/spears, and pots. In Oregon, starting in 2017, a longleader gear opportunity will be made available. Longleader gear has a minimum of 30 feet between the weight and the lowest hook. The gear is designed to target midwater rockfish species such as yellowtail and widow rockfish to move fishing pressure off nearshore rockfish species and to provide increased recreational fishing opportunities.

Changes to Gear Limitations

In March 2016 the PFMC recommended a suite of regulatory changes to the bottom trawl fishing gear restrictions that may affect how the fishery is operated in coming years ("gear package").. NMFS is in the process of implementing the regulatory changes. The proposed changes include: 1) removing all mesh size restrictions on trawl nets[6], 2) updating methods for measuring minimum mesh size, 3) removing restrictions requiring the use of single walled codends, 4) removing the prohibition on using chafing gear to create the effect of a double walled codend, 5) removing chafing gear restrictions, 6) removing the required use of selective flatfish trawl requirement north of 40°10' N. latitude and allow any type of small footrope trawl to be used shoreward of the RCAs, 7) removing restrictions that prohibit the carrying and use of multiple types of trawl gear (i.e., bottom and midwater trawl) on a single trip, and 8) removing restrictions on bringing more than a single haul on board at a time. These changes will likely affect salmon bycatch, however, to date, these actions remain under consideration and so are not explicitly part of the proposed action. Prior to further action on these changes, the effect on listed salmon ESUs will be assessed for consistency with the impact analysis in this biological opinion).

Rather, based on the Council's recommendations the proposed action includes some components of these changes. In June 2016, the PFMC recommended removing restrictions that prohibit fishing in multiple

[6] For midwater trawl nets, at least 20 ft immediately behind the footrope or headrope, bare ropes or mesh of 16-inch minimum mesh size must completely encircle the net.

IFQ management areas on a single trip – this change is included in the proposed action. The Council also recommended that NMFS include in the proposed action its preliminary preferred alternative for modifying the RCA boundaries and removing the area and season restrictions for midwater non-whiting IFQ and allowing the fishery to operate year round either north of 40°10' N. latitude or coastwide. Participants in 2017 and 2018 EFPs designed to collect data on the effects of some of the components of the gear package are exempt from certain current gear restrictions, and these EFPs are included in the proposed action. (Section 1.2.1).

As mentioned above, two EFPs, that include portions of the gear changes under consideration, are specifically included under the proposed action. The first EFP, also known as the 2017 trawl gear EFP, was implemented in February of 2017. This EFP was open to bottom trawl vessels. The purpose of the study was to test gear configurations to better target pelagic rockfish species and to collect information on the nature and extent of bycatch that results. Vessels operating under this EFP are exempt from the requirements to use SFFT inshore of the RCA and north of 42°N latitude and the minimum mesh size of 4.5 inches, provided they follow all protocols and terms and conditions of the permit (NMFS 2017e) which included an overall HG (HG) of 3,547 Chinook, only 800 of which could be taken prior to May 15, and monitoring requirements. If the cumulative take of Chinook salmon reaches the 800 HG before May 15th, the EFP would be closed until May 15th. This EFP expires at the end of 2017 so will not be considered further.

In September 2017, the Council recommended that the 2017 trawl gear EFP be continued in 2018 with modifications to expand the times and areas in which midwater trawl gear can be used to target non-whiting species. The Council recommended specific EFP provisions and a process for moving forward with a trawl gear and non-whiting midwater trawl EFP (or EFPs) for 2018 (Agenda Item E.4.d, Supplemental Staff Report 1). The Council's recommendation would expand the opportunity to use midwater gear to target non-whiting species would be expanded from beyond the current regulations as follows: prior to May 15, north of 40° 10 N. latitude in all depths (within, seaward, and shoreward of the RCA), and year-round within the RCA south of 40° 10'N. latitude. All midwater trawling would still be prohibited shoreward of the RCA in the area south of 40°10'N. latitude. Further, pending a review of the salmon preseason forecasts (available annually in late February/early March) for 2018 to determine the adequacy of salmon stock conditions in the southern area, the southern boundary of the bottom trawl gear EFP provisions, which includes an exemption to the requirement to use selective flatfish trawl shoreward of the RCA, would be extended south from 42°N. latitude to 40°10'N. latitude through the remainder of the year or the remainder of the EFP, whichever comes first. With respect to EFP fishing south of 42°, all fishing activities covered by the EFP would be subject to an 80 Chinook bycatch limit for the entire year, or until the current regulations apply. This EFP would be subject to the same overall and pre-May 15th HGs as the first EFP. Permit conditions would also include provisions for monitoring and reporting bycatch.

The Council's recommendations for the 2018 trawl gear EFP include several general terms and conditions that would be required of the participants. Participants would be required to abide by several gear restrictions, including use of gear that met the definition of bottom trawl and small footrope bottom trawl, as well as to comply with other bottom trawl restrictions. Participants would also be prohibited from fishing in the Columbia River Salmon Conservation Zone and the Klamath Conservation Zone. Participants would be required to abide by all declaration and logbook requirements. Finally, EFP participants who elect to fish multiple gears during the same trip (i.e., midwater and bottom trawl) would be required to (a) declare the gear change while at sea prior to making the next set and (b) sort and stow the catch separately by gear type.NMFS is reviewing the Council's EFP recommendations and may issue EFPs in 2018. For the purposes of this opinion we assume that the EFPs will be issued, so as to better account for the potential overall effect of the groundfish fisheries on Chinook salmon.

1.3.1.3 **Seasonality**

At-sea Pacific Whiting Cooperative fishery—The Pacific whiting primary season for the at-sea sectors begins on May 15 and continues to December 31, until the sector allocations are taken. Allocations remaining on December 31 are not carried into the new fishing year. Because many of the vessels are also used in the Alaska groundfish fishery and participate in the pollock B-season (June to October), much of the participation in the Pacific whiting fishery occurs before the Alaska pollock fishery and then again after the Alaska fishery. Since 2011, most of the catcher-processor activity has occurred from mid-May to early June and from late September to late November, and most of the mothership activity has occurred from mid-May to early June and from mid-September to mid-November. Generally, there is little or no fishing activity in the Pacific whiting at-sea fishery during July and August.

Shorebased IFQ Trawl fishery seasonality—Like the at-sea sectors, the Pacific whiting shorebased IFQ fishery has a specified start date for the primary season. Since 1997, a framework has been used for setting Pacific whiting fishery season dates for the area north of 40°30 N. latitude. Under the framework, the fishery opened north of 42° N. latitude on June 15; between 42°and 40°30' N. latitude, the season opened April 1; south of 40°30' N. latitude, the season opened April 15. The Pacific whiting shorebased IFQ fishery primary season start dates changed in 2015 to allow the midwater fishery north of 40°30 N. latitude to open coastwide on May 15 and south of 40°30' N. latitude to open April 15. Since 2011, the Pacific whiting shorebased IFQ fishery has harvested most of its Pacific whiting from mid-June through

September, with smaller amounts being taken after September. Changing the season start date aligned the Pacific whiting shorebased IFQ fishery with the at-sea sector start date to allow access to non-whiting species one month earlier and equal access between the sectors to other midwater species such as widow rockfish.

The bottom trawl fishery is a year-round fishery in which vessels fish in a wide range of depths and deliver catch to shore-side processors. Since 2011, the peak of non-whiting groundfish catch (all gears) has occurred in the spring, in either March or April; with a secondary, lower peak happening in October. Two important and valuable species in this fishery are sablefish and petrale sole. Sablefish catch peaks in the fall, during September and October, and petrale sole catch peaks in the winter during December and January. January catch of Petrale sole has been rising each year since 2011.

The non-whiting midwater trawl fishery currently has the same season start date as the Pacific whiting shorebased IFQ fishery (May 15th). To date the non-whiting midwater trawl fishery has not yet established a clear seasonality.

IFQ vessels also use non-trawl gears (gear switching). Non-trawl gears are primarily used to target sablefish. Gear switching is allowed year-round. Given the gear switching provision, most fish landed with fixed gear and attributed to the shorebased trawl IFQ program are sablefish, and the seasonality is the same as IFQ fisheries in general.

Fixed Gear Fisheries Seasonality

Sablefish tier limit fishery**—**LE, sablefish-endorsed primary season fishing takes place from April 1 to October 31. The seven-month season was first implemented in 2002. Permit holders land their tier limits at any time during the seven-month season. Once the primary season opens, all sablefish landed by a sablefish-endorsed permit is counted toward attainment of its tier limit.

LEFG trip limit fishery**—**The non-IFQ fixed gear fishery operates year-round (January to December) with most fishing activity occurring in the summer months. Landings have been highest from August through October, followed by the April to July period. The lowest number of landings occur between December and March. The LEFG trip limit vessels primarily fish out of California ports.

Open Access fisheries**—**The fishery operates year-round (January to December). Assuming that landed catch represents directed OA, and that landed catch is a function of effort, then more OAS-related fishing activity occurs during the spring, summer, and fall months than during winter months, although seasonal patterns have varied considerably among years, especially since 2011. In previous years, there was a more pronounced peak in effort and landings during August and September. Incidental fisheries vary with fishing seasons for the intended target species.

Tribal fisheries**—**The tribal non-whiting groundfish fishery shows a dome-shaped seasonal pattern from 2011 through 2014; generally peaking between May and September. Historically the Pacific whiting tribal fishery tended to occur between June and September. However, there has been little activity in the tribal Pacific whiting fishery since 2011 so the pattern in recent years may not reflect what would occur under broader tribal participation as envisioned in the proposed action.

Recreational Fisheries Seasonality

Recreational fisheries in Washington and California have shifted from year-round fisheries to seasonal fisheries with different open periods, depending on the target species. Recreational fishing in Oregon is open year-round, except for inseason closures, when needed. Coastwide, the number of marine angler trips peak in the July-to-August period, but seasonal concentrations are more pronounced in Oregon and Washington where weather is more variable. A more detailed summary of the history of fishing seasons is provided in NMFS (2017b).

***Washington* -** From 2005 to 2016, the Washington recreational season was year-round except for lingcod, which had a late-spring start. Beginning in 2017, the Washington recreational bottomfish fishery will close from mid-October to mid-March. Little fishing effort occurs in Marine Areas 1 to 4 from October through February. The primary purpose of the season change is to cap groundfish fishing effort at current levels and to minimize additional effort that could potentially develop in the future. In addition, the recreational rockfish bag limit will be reduced from 10 to 7 fish per day and the aggregate daily bottomfish bag limit will be reduced from 12 to 9 fish per day. Also beginning in 2017, the minimum size limit of 22 inches for lingcod will be removed. The daily-bag-limit changes are intended to keep mortality of black rockfish within allowable limits. The removal of the lingcod minimum size limit is intended to allow anglers to keep the first two lingcod encountered, and the action may reduce bycatch of rockfish, including yelloweye rockfish, if time on the water is reduced.

Oregon - The Oregon recreational fishery will continue to operate as a year-round season with bag limits and sub-bag limits. Closures will be made inseason, as necessary. The primary difference from prior years is that there will be a long-leader gear opportunity starting in late summer of 2017, but planned to occur between April and September in 2018 and beyond. Midwater long-leader gear is intended to provide access to more fishing grounds where healthy or underutilized midwater species may be caught, while minimizing impacts on deeper water species, such as yelloweye rockfish. Under current conditions, allowing fishing with the new gear is not expected to increase recreational effort for most ports in Oregon.

However, for ports without reefs in shallow depths such as Winchester Bay and Florence (less than 30 trips per year for both ports combined), the midwater long-leader fishery could provide new opportunities.

***California* -** California recreational fisheries will continue to be managed as five areas with their own season dates (Table 1-5). The seasons for each area have varied over the years; however, the opening dates have remained relatively similar. The southern fisheries have had earlier start dates, and the northern fisheries have had later start states. The summer months tend to be the most active months, and fishery mortality tends to accumulate more quickly during the summer. For 2017, a new inseason process is being implemented that will allow NMFS, in cooperation with CDFW, to adjust black rockfish, canary rockfish and yelloweye rockfish regulations for conservation reasons during periods between Council meetings.

Table 1-5. California recreational seasons and depth constraints for 2017-2018, by management area.

Management Area	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Northern	Closed				May 1 – Oct 31 <30fm						All Depth	
Mendocino	Closed				May 1 – Oct 31 <20fm						All Depth	
San Francisco	Closed				April 15 – Dec 31 <40fm							
Central	Closed			April 1 – Dec 31 <50fm								
Southern	Closed		Mar 1 – Dec 31 <60 fm									

1.3.1.4 Geographic Extent and Depth Distribution

The groundfish fisheries operate coastwide in state and Federal waters. Groundfish fisheries managed under the FMP occur in the EEZ. Figures 1-4 thru 1-9 depict the recent geographic pattern of fishing by fishery sector together with the pattern of Chinook bycatch in the fishery. The Council's recommendations in the proposed action regarding revisions to the RCA, coastwide fishing of the midwater non-whiting trawl fleet and increased access to previously overfished rockfish species will change this pattern to some extent.

Area closures have been a primary tool used in management of the fishery and have varied in number and size as management objectives evolve. Although most of the currently closed areas do not have non-groundfish bycatch reduction as an objective, an ancillary effect may be bycatch reduction. This section describes the various types of closed areas that apply to all of the groundfish fisheries, as well as fishery-specific closed areas. The Council is considering modifications to revise or remove certain area management restrictions, including revisions to Essential Fish Habitat Conservation Areas (EFHCAs) reducing or eliminating the trawl RCAs, removing closure of nearshore areas north of 40°10’ N. latitude, to trawl gear other than selective flatfish trawl gear, and the prohibition of commercial and recreational fixed gears in the area known as 60 Mile Bank off southern California. The Council recommended that only some of these actions be included in the proposed action. Actions included in the proposed action are the EFPs discussed above, (Section 1.2.1) and the Council’s Preliminary Preferred Alternative revision of the RCA.

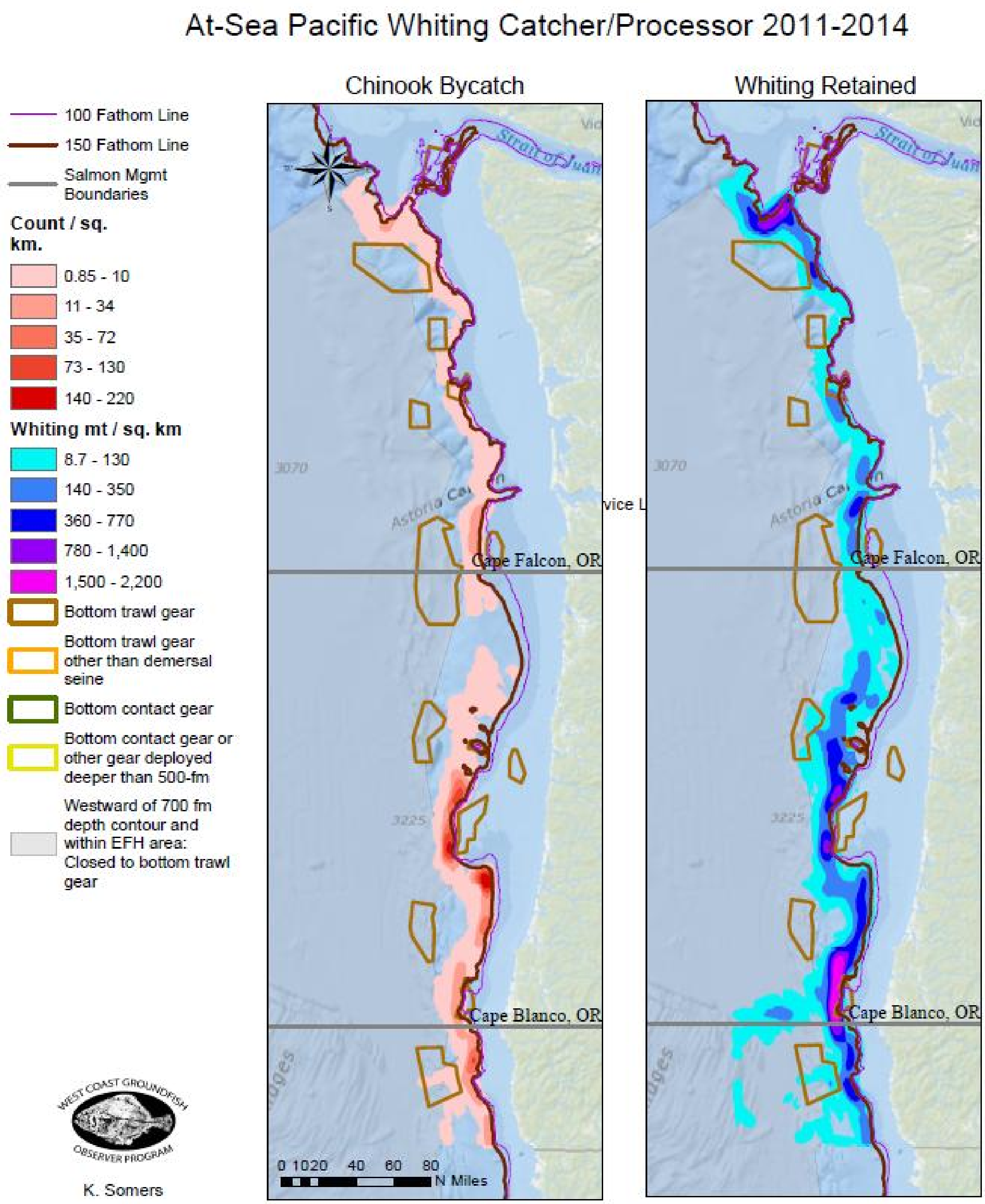

Figure 1-4. Catcher/processor sector Chinook and Pacific whiting catch coastwide, 2011-2014.

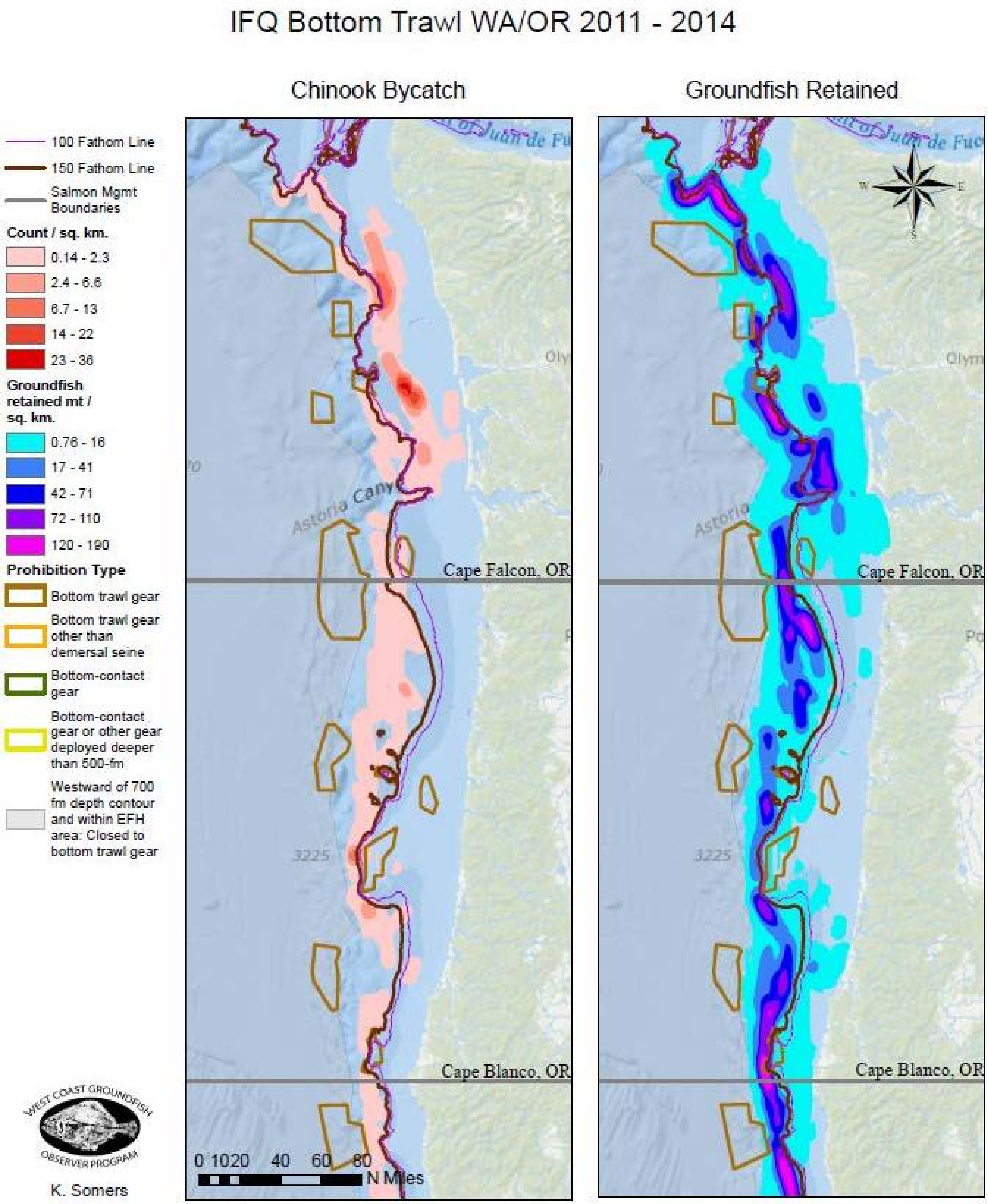

Figure 1-5. Shorebased IFQ Program bottom trawl Chinook and groundfish catch off Oregon and Washington, 2011-2014.

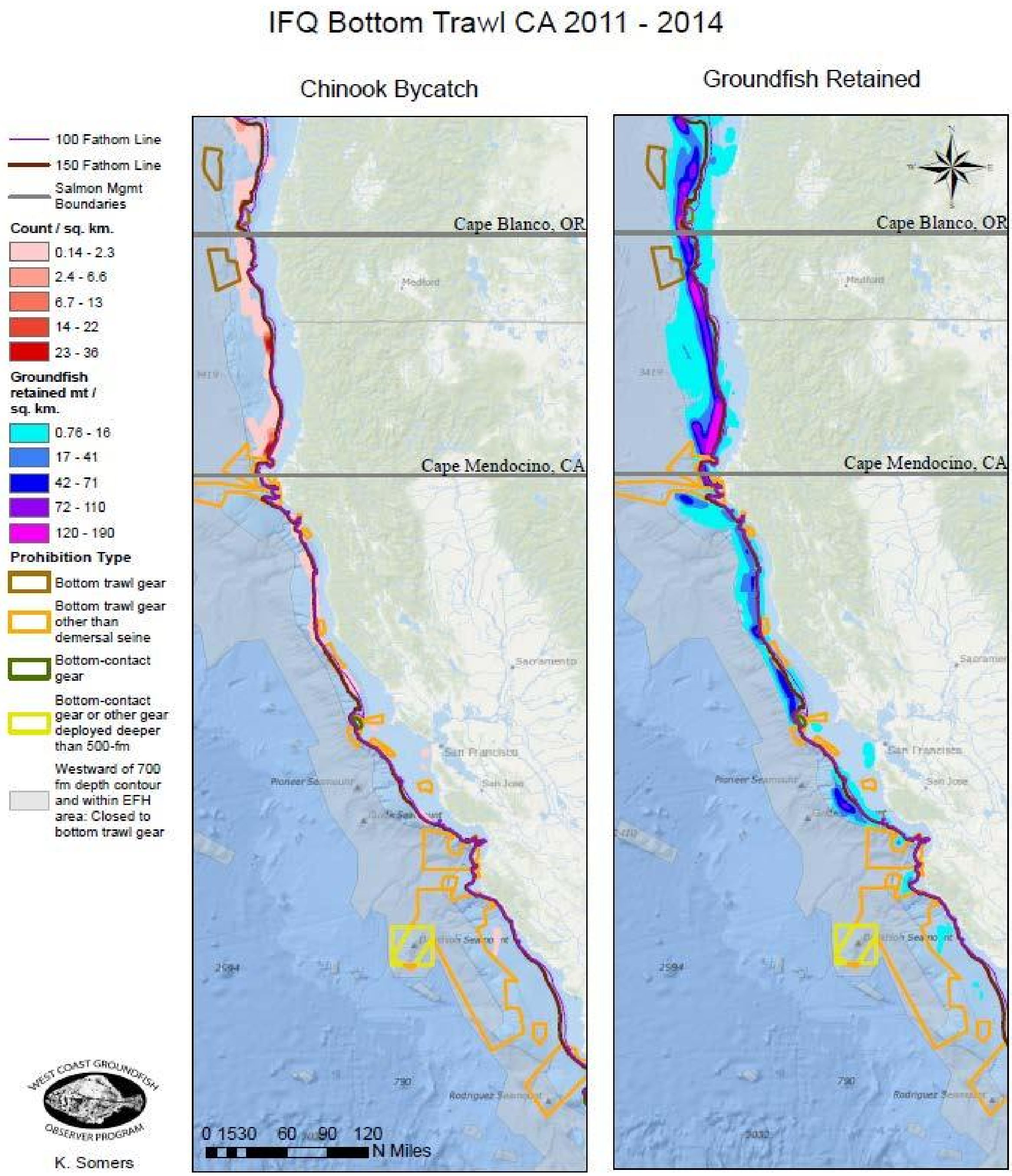

Figure 1-6. Shorebased IFQ Program bottom trawl Chinook and groundfish catch off California, 2011-2014.

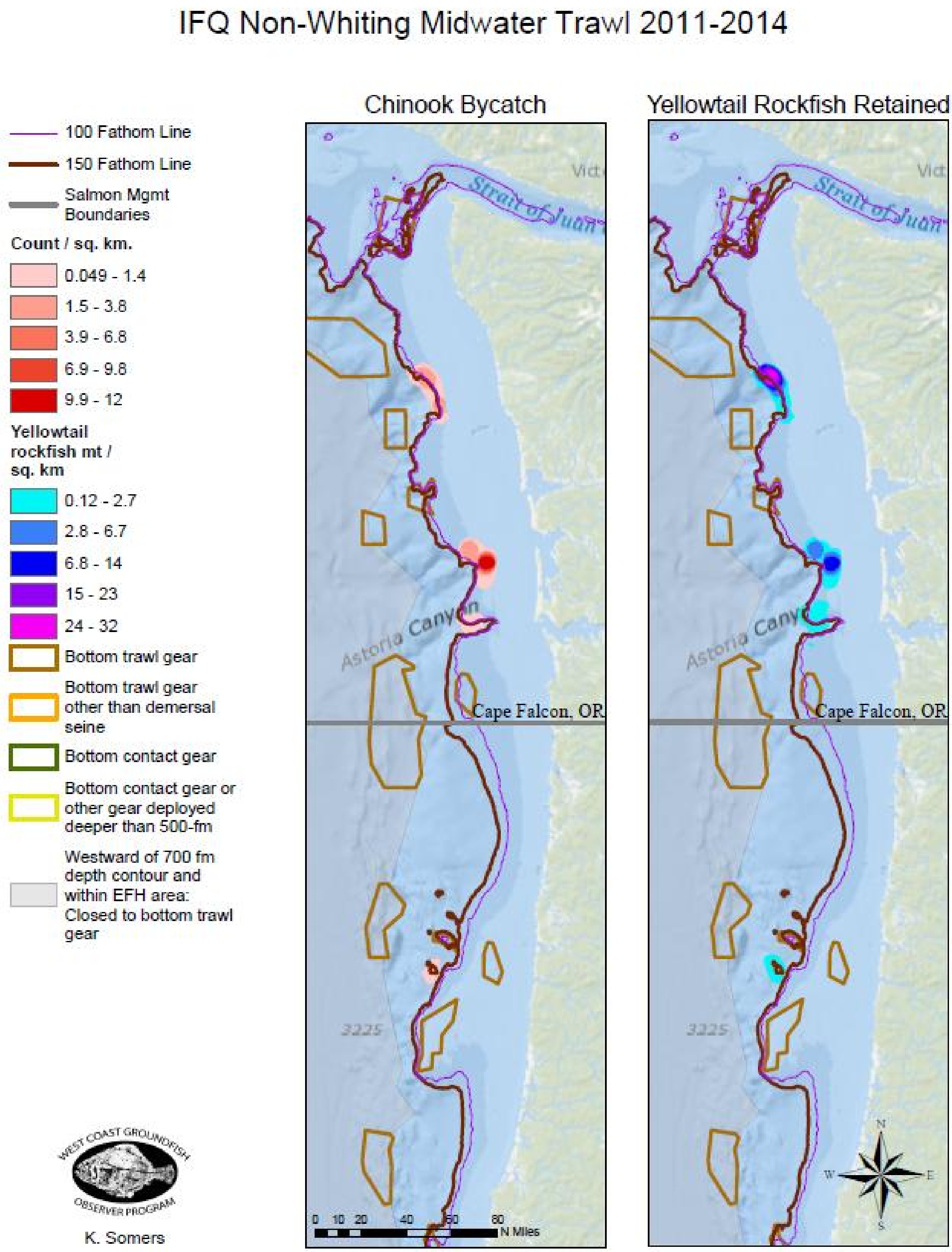

Figure 1-7. Shorebased IFQ Program non-whiting midwater trawl Chinook and groundfish catch coastwide, 2011-2014.

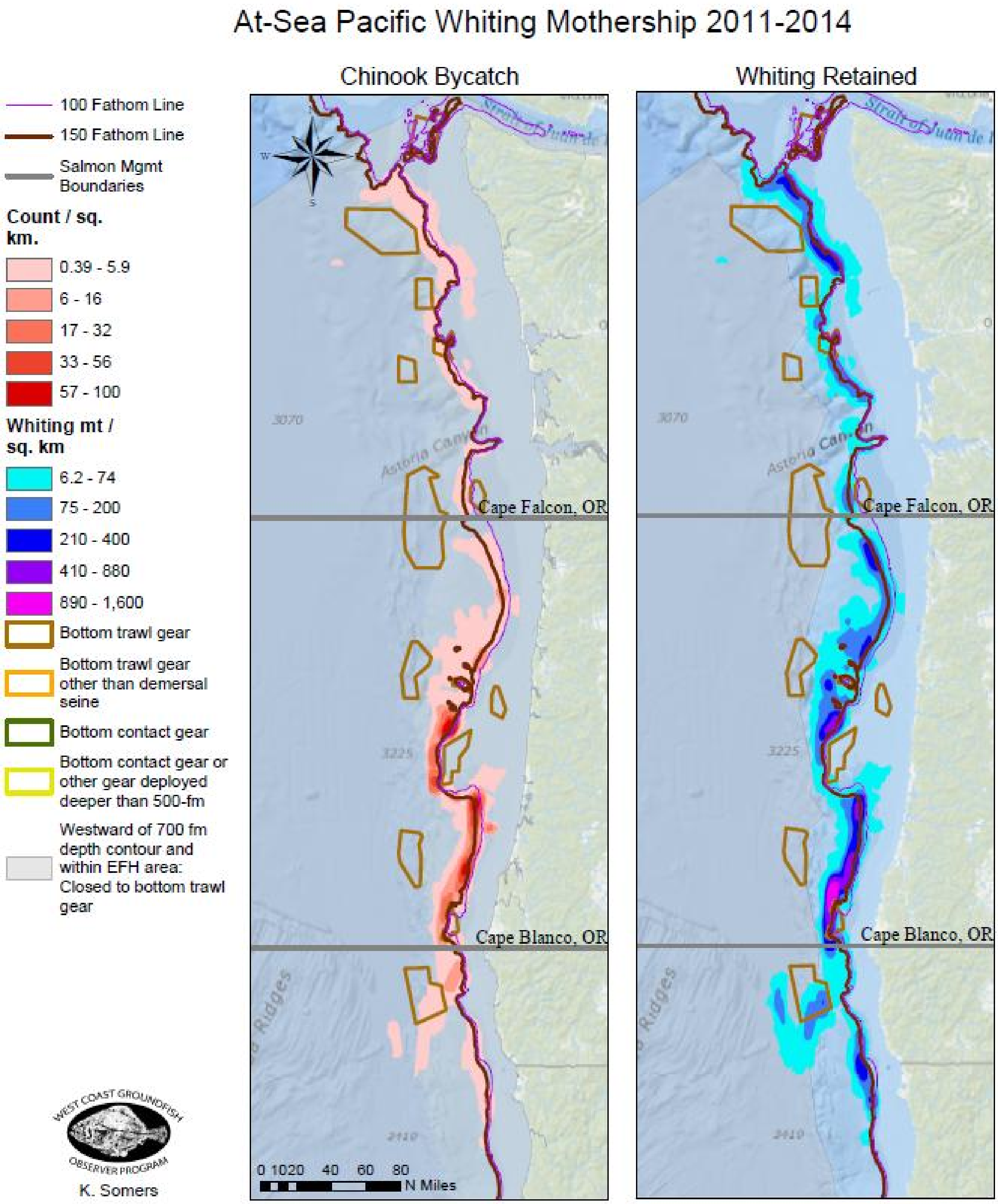

Figure 1-8. Mothership sector Chinook and Pacific whiting catch coastwide, 2011-2014.

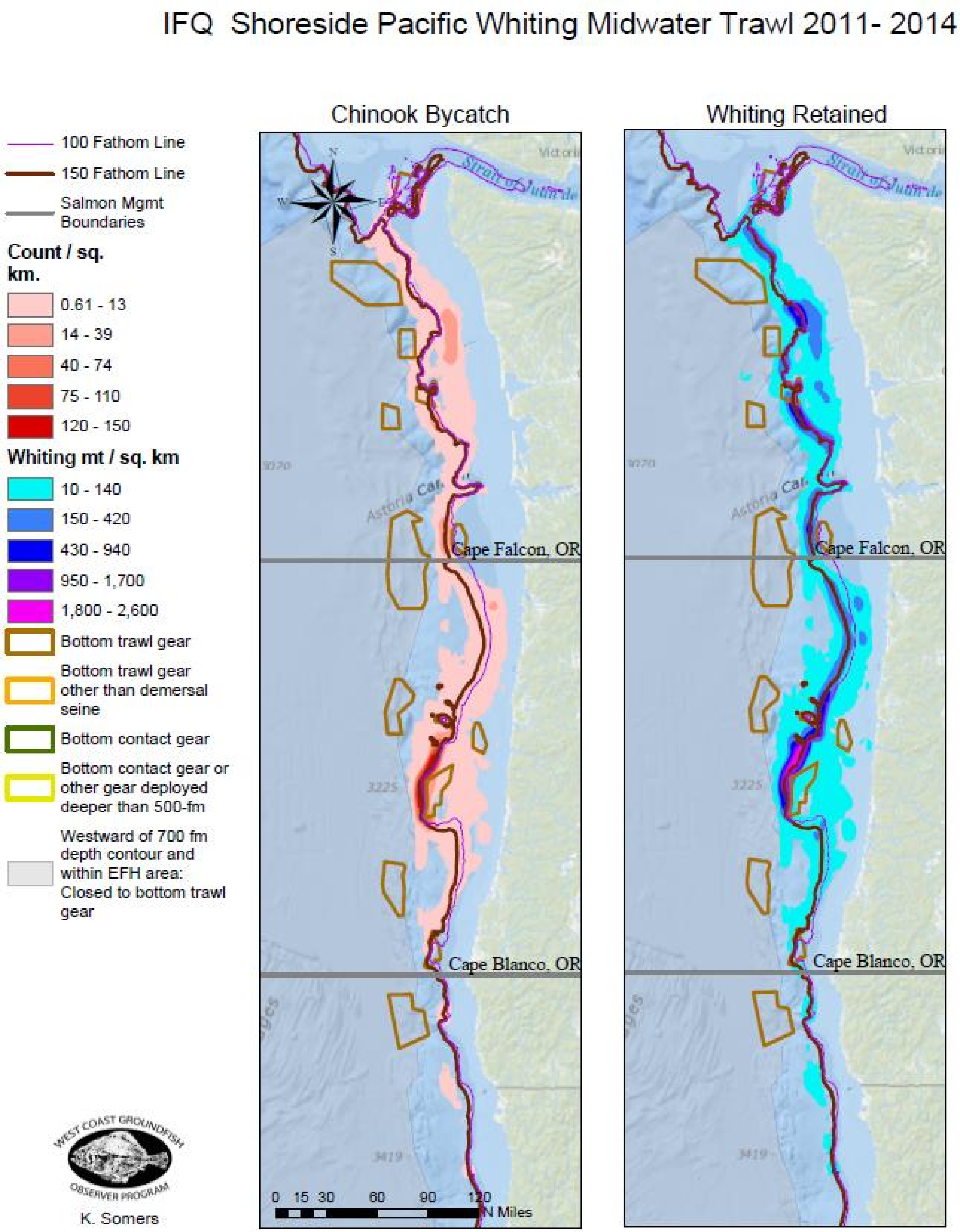

Figure 1-9. Shorebased IFQ Program Pacific whiting midwater trawl Chinook and Pacific whiting

catch coastwide, 2011-2014.

Closed areas that apply to all Groundfish Fisheries

Groundfish Conservation Areas (GCAs) - GCAs are depth based management areas closed to commercial and, in some cases, recreational vessels. The use of these areas applies to all groundfish fisheries. The GCAs are used to control catch of overfished groundfish species or protected species and prohibit fishing in areas where the catch is likely to be high for a particular gear type. The boundaries are defined by a series of latitude/longitude coordinates that are intended to approximate particular depth contours. Depth contours are a series of coordinates expressed in degrees of latitude and longitude. Federal regulations at 50 CFR 660.60 state that depth-based closed areas may be used: to protect and rebuild overfished stocks; to prevent the overfishing of any groundfish species by minimizing the direct or incidental catch of that species; to minimize the incidental harvest of any protected or prohibited species taken in the groundfish fishery; to extend the fishing season in areas outside the closed zones; to minimize disruption of traditional fishing and marketing patterns for the commercial fisheries; to spread the available catch over a large number of anglers for the recreational fisheries; to discourage target fishing while allowing small incidental catches to be landed; and to allow small fisheries to operate outside the normal season. Specific GCAs include: RCAs, CCAs, Yelloweye Rockfish Conservation Areas (YRCAs) and Bycatch Reduction Areas (BRAs). Off California, closed areas also encircle the Farallon Islands and the Cordell Banks, both of which lie within national marine sanctuary waters. For a detailed description of these areas, see NMFS 2017.

Rockfish Conservation Areas - RCAs are large-scale closed areas that extend along the entire length of the West Coast, from the Mexican border to the Canadian border. Commercial RCAs are specified for a particular gear group (trawl, non-trawl, and non-groundfish trawl) and can differ north and south of 40°10’ N. latitude. Recreational RCAs may either have boundaries defined by general depth contours or boundaries defined by specific latitude and longitude coordinates that are intended to approximate particular depth contours.

The Council recommended that NMFS assume RCAs going forward will be consistent with the Council’s Preliminary Preferred Alternative as described in November 2016 (PFMC 2016a). The trawl RCA off Oregon and California would be eliminated completely, and “block area closures” would be established, a series of areas that, taken together span the entire West Coast seaward of the state territorial seas out to 700 fm. The individual block areas, or groups of blocks, could be closed as needed, by the PFMC or NMFS, to protect PFMC-managed or other protected species including salmon (PFMC 2016a).

Cowcod Conservation Areas - The CCAs are two areas off of the southern California coast that are intended to reduce the catch of cowcod. These areas have been in place since 2001 and are expected to remain in effect in the near future. Fishing is prohibited in CCAs with the following exceptions: Fishing for “Other Flatfish” when using no more than 12 hooks, #2 or smaller and fishing for rockfish and lingcod shoreward of 20 fm. In general, these areas do not change between years.

***Essential Fish Habitat Conservation Area*s -** The EFHCAs are geographic areas defined by coordinates expressed in degrees latitude and longitude, wherein fishing by a particular gear type or types may be prohibited. EFHCAs are created and enforced for the purpose of contributing to the protection of West Coast groundfish essential fish habitat (EFH). The EFHCAs include the closure of waters deeper than 700 fm to bottom trawl; the prohibition of large footrope trawl shoreward of the 100 fm depth contour; and the specification of closed areas where bottom trawl gear and bottom contact gears are prohibited.

The Council recommended (see Table 1.2.1) that NMFS assume RCAs going forward will be consistent with the Council’s Preliminary Preferred Alternative as described in November 2016 (PFMC 2016a). The Council’s preliminary preferred alternative for the EFH/RCA action would maintain the existing configuration of EFHCAs coastwide? and trawl RCAs off the coast of Washington. (Council, Agenda Item F.3, Council Action, April 2017).

Closed areas that apply only to trawl fisheries

Closed areas that apply to the trawl fisheries differ for bottom trawl and midwater trawl. Midwater trawl is generally less geographically restricted than bottom trawl. In addition, vessels targeting Pacific whiting have fishery-specific area restrictions and practical constraints related to fishery operation. Vessels delivering catch to first receivers tend to fish in waters closer to the ports where first receivers are located. Figure 1-10, compares the depth distribution of the Pacific whiting IFQ vessels to the at-sea fleet. Fifty percent of all shoreside hauls have occurred within 120 fathoms or shallower, compared to 140 fathoms in the mothership sector and 175 fathoms in the catcher processor sector.

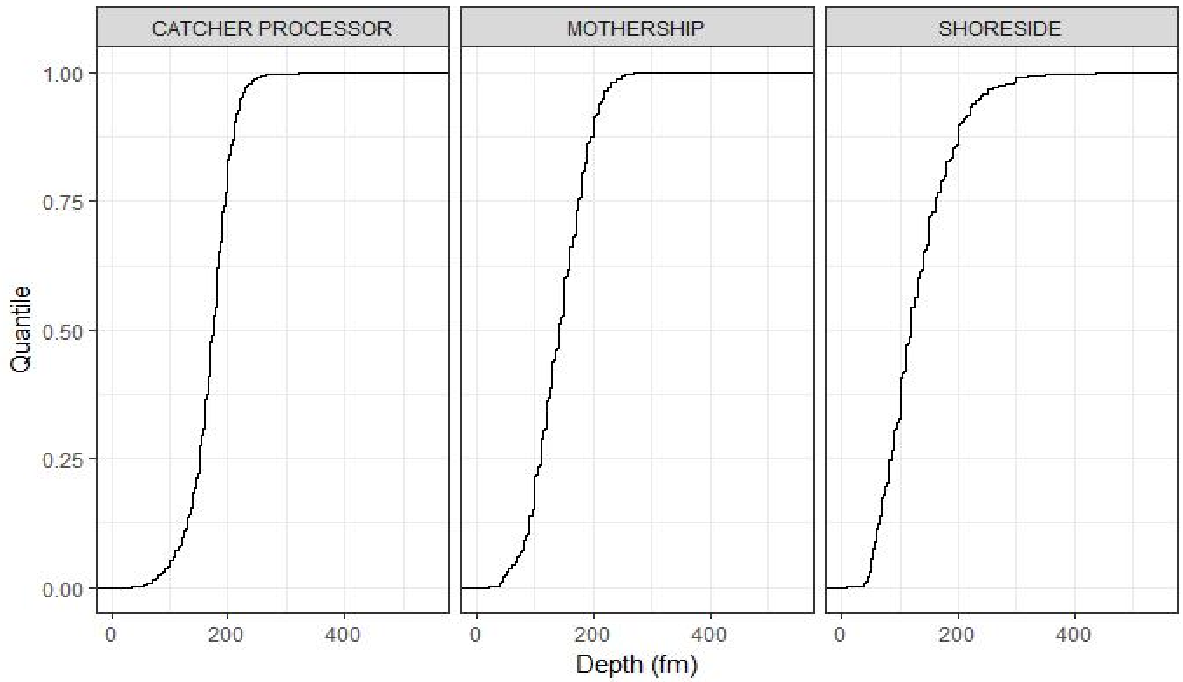

Figure 1-10. Distribution of hauls by depth for all three whiting sectors from 2011-2015, with average depth of haul in fathoms on the x-axis, and the quantile on the right axis.

Trawl Rockfish Conservation Areas - The operation of a vessel with bottom trawl gear onboard is currently prohibited in a trawl RCA, except for the purpose of continuous transiting. Fishing with midwater trawl gear within the RCAs north of 40°10' N. latitude is allowed during the Pacific whiting season. Since 2005, midwater trawling has been allowed in the area south of 40°10' N. latitude for all groundfish species when fishing seaward of the trawl RCA. The type of trawl gear type can be restricted within the RCA. For a detailed description of RCA trawl boundaries from 2006 to 2014, see NMFS 2017b.

For the proposed action, as recommended by the Council, RCA boundaries would be consistent with the Council's preliminary preferred alternative as described in November 2016 (PFMC 2016a). The trawl RCA off Oregon and California would be eliminated completely, and "block area closures" would be established, a series of areas that, taken together span the entire West Coast seaward of the state territorial seas out to 700 fm. NMFS could close the individual block areas, or a group of block areas, as needed, to protect Council-managed or other protected species including salmon (PFMC 2016a). The trawl RCA off Washington would remain in place.

Bycatch Reduction Areas – Federal regulations at 50 CFR § 660.131 for the Pacific whiting fishery include closed areas referred to as BRAs. BRAs may be implemented inseason under automatic action authority when NMFS projects that a whiting sector will exceed an allocation for a non-whiting groundfish species specified for that sector before the sector's whiting allocation is projected to be reached. The BRAs are depth closures that use the 75-fm (137-m), 100-fm (183-m) or 150-fm (274-m) depth contours to shift the Pacific whiting fishery into deeper waters. Because the Pacific whiting fishery is exempt from the RCA restrictions north of 40°10' N. latitude, the BRAs allow depth based management in the Pacific whiting fishery when needed (§ 660.11). Like RCAs, the BRAs are areas closed to fishing by particular gear types, bounded by lines approximating particular depth contours (660.11). Federal regulations at §660.55 (c)(3)(i) continue to allow BRAs to be implemented through automatic action to prevent a Pacific whiting sector allocation from being exceeded. BRAs can also be implemented through routine inseason action to address broader conservation concerns.

Salmon Conservation Zones - Closed Areas Specific to the Pacific Whiting Fisheries

Vessels fishing in the Pacific whiting primary seasons for the Shorebased IFQ Program, Mothership Cooperative Program, or Catcher/Processor Cooperative Program are prohibited from targeting Pacific whiting in the following areas in order to reduce salmon bycatch:

Klamath River Salmon Conservation Zone - The targeting of Pacific whiting with midwater trawl is prohibited in the ocean area surrounding the Klamath River mouth bounded on the north by 41°38.80′ N. latitude (approximately 6 nautical miles (nm) north of the Klamath River mouth), on the west by 124°23′ W. longitude (approximately 12 nm from shore), and on the south by 41°26.80′ N. latitude (approximately 6 nm south of the Klamath River mouth). The Klamath River conservation zone was established in 1993 because of the concentrations of Chinook salmon in the area.

Columbia River Salmon Conservation Zone - The targeting of Pacific whiting with midwater trawl is prohibited in the ocean area surrounding the Columbia River mouth bounded by a line extending for 6 nm due west from North Head along 46°18′ N. latitude to 124°13.30′ W. longitude, then southerly along a line of 167 True to 46°11.10′ N. latitude and 124°11′ W. longitude (Columbia River Buoy), then northeast along Red Buoy Line to the tip of the south jetty. The Columbia River conservation zone was established in 1993 because of the concentrations of Chinook salmon in the area.

Ocean Salmon Conservation Zone (OSCZ) - The OSCZ is a mitigation measure that may be implemented when the current 11,000 Chinook bycatch threshold for the whiting fishery has been exceeded (71 FR 78638, December 29, 2006). The intent of the closed area was to moved whiting fishing (targeting of whiting) offshore of a boundary line approximating the 100-fm (183-m) depth contour to reduce the Chinook salmon bycatch rates. The data available in 2005 indicated that incidental catch rates of Chinook salmon by vessels targeting Pacific whiting tended to be higher in the nearshore areas.

Eureka Area 100 fm Limit - Regulations at 50 CFR § 660.131 for the Pacific whiting fishery (any vessels with a valid "Limited entry midwater trawl, Pacific whiting shorebased IFQ fishing" declaration) **s**tate that unless otherwise specified, no more than 10,000-lb of whiting may be taken and retained, possessed, or landed by a vessel that, at any time during a fishing trip, fished in the fishery management area shoreward of the 100 fm contour in the Eureka management area. In 1992, this was one of several management actions taken to limit salmon bycatch. The continental shelf in the Eureka area is narrow and the 100 fathom contour generally occurs 6 to 10 nm offshore. Because a depth effect with higher salmon bycatch rates had also been observed in the bottom trawl fishery in the Eureka area, a year round trip limit for Pacific whiting taken with bottom trawl was also established. Before the primary whiting season, there is a 20,000 lb/trip limit and during and after the primary season there is a 10,000 lb/trip limit.

At-sea Processing South of 42° N. Latitude - Since 1992, catcher/processors and mothership processing vessels have been prohibited from processing south of 42° N. latitude in order to reduce salmon interception in those sectors (PFMC 1997). Therefore, no at-sea sector catch has occurred south of 40°10' N. latitude in recent years.

Closed areas that apply to the LEFG and OA Fixed gear Fisheries

This section discusses closed areas that apply to the non-trawl gears which include: LE or OA longline and pot or trap, OA hook-and-line, pot or trap, gillnet, set net, trammel net and spear fishing for groundfish. Fixed gear vessels may use one or more of these gears on a single fishing trip.

Non-trawl Rockfish Conservation Areas - Fishing with non-trawl gear is prohibited within the non-trawl gear RCA. It is unlawful to take and retain, possess, or land groundfish taken with non-trawl gear in the non-trawl gear RCA. LE fixed gear and OA non-trawl gear vessels may transit through the non-trawl gear RCA, with or without groundfish on board. These restrictions do not apply to vessels fishing for species other than groundfish with non-trawl gear (i.e. Dungeness crab). If a vessel fishes in an RCA, it may not participate in any fishing on that trip that is inconsistent with the restrictions that apply within the RCA. For a detailed description of RCA non-trawl boundaries from 2006 to 2014, see NMFS2017b.

In recent years, non-trawl RCAs have been established for a particular latitude and have not varied throughout the year. In earlier years non-trawl RCAs were used to reduce the catch of lingcod. Lingcod, which are predominately found on the shelf, and were declared overfished in 1999 and rebuilt in 2006. Non-trawl RCAs were used to reduce the catch of lingcod during winter spawning and nesting seasons, resulting in more variation in non-trawl RCAs than has been observed in recent years.

Closed Areas That Apply to Recreational Fisheries

This section describes closed areas that apply to the recreational fisheries. Like the commercial fisheries GCAs, RCAs, CCAs and YRCAs have been used to control fishing effort in the recreational fishery.

***Recreational Rockfish Conservation Areas* -** Unlike the commercial fisheries the recreational RCAs have been defined by a seaward boundary with shoreward areas being open. Each state has used recreational RCAs for all or a portion of the year to limite catch of overfished groundfish species. The RCAs have remained relatively stable in recent years in all three states (NMFS 2017). Starting summer 2017, midwater long-leader gear will be allowed in waters seaward of 40fm off the coast of Oregon during months in which fishing deeper than 40fm is currently prohibited. The recreational groundfish fishery off Oregon is currently restricted to fishing shoreward of the 30fm curve from April 1 through September 30.

Recreational Yelloweye Rockfish Conservation Areas - YRCAs are a type of GCA that are intended to reduce the catch of yelloweye rockfish. A detailed description of the YRCAs can be found in NMFS 2017b.

Chinook Bycatch Management

As part of the proposed action, the Council recommended that NMFS include specific measures to limit Chinook bycatch in the groundfish fisheries. As described in Table 1.2.1, the whiting fishery would be managed to stay within an annual 11,000 Chinook bycatch guideline; and the bottom trawl, non-whiting midwater trawl, fixed gear and recreational fisheries combined would be managed to stay within an annual 5,500 Chinook bycatch guideline. The Council also requested that NMFS include in the proposed action a potential Reserve of 3,500 Chinook, and that NMFS assess the effects on Chinook if the Reserve were taken each year by each of the three trawl fisheries (whiting, non-whiting midwater, or bottom trawl). In practice, the Reserve would be available to both the whiting and non-whiting sectors including the fixed gear and recreational gears; but the sectors could not exceed the Reserve of 3,500 in total.

1.3.2 Catch Monitoring

Vessel monitoring systems that automatically transmit hourly position reports to NMFS are the primary management tool used to monitor commercial vessel compliance with time and area restrictions. All non-tribal commercial vessels are required to have an operational vessel monitoring system to fish in the groundfish fishery. In addition, each vessel operator is required to submit declaration reports to the Office for Law Enforcement that allows the vessel's position data to be linked to the type(s) of fishing gear and in some cases a target strategy[7]. For the Shorebased IFQ Program in 2017 and beyond, vessels using midwater trawl gear may declare either "LE midwater trawl, non-whiting shorebased IFQ" or "LE midwater trawl, Pacific whiting shorebased IFQ". Table 1-6 summarizes the type and level of monitoring by fishery sector.

The monitoring of fishing mortality varies widely between sectors. The greatest amount of monitoring occurs in the trawl fisheries and the least in the incidental OA and recreational fisheries (Table 1-6). In the at-sea Pacific whiting sectors, catch composition is closely monitored through an on-board observer program on processing vessels and electronic monitoring (video) or observers on mothership sector catcher vessels. [8] Each processing vessel 125 ft and longer must carry two observers that subsample close to 100 percent of all hauls. Processing vessels under 125 ft must carry one observer. Currently, there are no processing vessels under 125 ft. Since 2011, each mothership catcher vessel has carried one observer to account for discards or have used electronic video monitoring to verify full retention of catch. Prior to 2011, mothership catcher vessels were not monitored. Observers on the processing vessels subsample the catch to collect data used to estimate catch composition. In addition, the observers collect biological data from groundfish, protected species, and prohibited species. Catch data by species, groundfish and non-groundfish, are generally available and will continue to be available into the future for use in management decisions within 24 hours during the season. Stock specific information on Chinook salmon is not available until the following year. Samples collected from the fishery bycatch including salmon are also used to train observers (Wulff 2017).

Implementation of the Shorebased IFQ program included an increase in observer coverage for all vessels fishing on IFQ quota pounds. This was an increase in coverage from approximately 25 percent pre-IFQ to nearly 100 percent of all groundfish landings with IFQ. With on board observers close to 100 percent of the hauls are sampled with discards being accounted for at the haul level. The exception is in the Pacific whiting Shorebased IFQ fishery where most vessels retain nearly all their catch and do not sort at sea. In the Pacific whiting Shorebased IFQ fishery observers primarily monitor the retention of catch. Catch composition data are gathered on shore by catch monitors. Pacific whiting vessels may voluntarily use electronic monitoring to monitor catch retention. Observers collect valuable fisheries data, including

[7] The Council has recommended changes to gear restrictions that would allow vessels in the shorebased IFQ program to declare multiple trawl gears which would reduce the ability to determine fishing strategy.

[8] Preliminary investigations on the use of electronic monitoring have been conducted under exempted fishing permits. Regulations are expected to be available in regulation in 2017 to monitor mothership catcher vessels and Pacific whiting Shorebased IFQ vessels in lieu of the 100 percent observer coverage requirement.

fishing effort and location, estimates of retained and discarded catch, species composition, biological data, and protected species interactions. Stock specific information on Chinook salmon is not available until the following year. The data informs fisheries managers and stock assessment scientists, as well as other fisheries researchers. Observer catch data informs the vessel accounting system used for quota management.

Shorebased IFQ vessels are required to land catch at IFQ first receivers where the landed catch is sorted and weighed. Catch monitors are individuals who collect data to verify that the catch is correctly sorted, weighed and reported. Landings data and at-sea discards are later combined for total catch estimation. Prohibited species catch data for the IFQ fishery, including salmonids, is available to fishery participants inseason. However, the full dataset at the haul level for all species is not available until the summer of the following year. Total catch data for groundfish species are available approximately 11-12 months following the end of the fishing year.

The WCGOP provides observer coverage for the LE fixed gear fisheries (Table 6). Observers collect discard data at sea as well as biological data from groundfish, protected, and prohibited species. Stock specific information on Chinook salmon is not available until the following year. Prohibited species catch data are not available inseason. Groundfish total catch data are available approximately 11-12 months following the end of the fishing year after sample data are extrapolated and combined with landings data. In 2016, 43 percent of the sablefish tier fishery and 5 percent of the non-sablefish landings were monitored by observers (www.nwfsc.noaa.gov/research/divisions/fram/observation/data_products/sector_products.cfm).

The WCGOP also provides coverage for the OA fishery. In 2016, seven percent of the OA fixed gear fishery for sablefish and eight percent of the nearshore OA fishery landings were monitored by observers (www.nwfsc.noaa.gov/research/divisions/fram/observation/data_products/sector_products.cfm). Similar to LE fixed gear, prohibited species catch data are not available inseason. Groundfish total catch data are available approximately 11-12 months following the end of the fishing year after sample data are extrapolated and combined with landings data.

Tribal-directed groundfish fisheries are subject to full rockfish retention. Shorebased sampling, and observer coverage are also used to monitor the fisheries. Information on current coverage levels and protocols were not available.

Recreational catch is generally monitored by the states as it is landed in port. However, there may also be on the water effort estimates as well. These data are compiled by the Pacific States Marine Fisheries Commission (PSMFC) in the Recreational Fisheries Information Network (RecFIN) database. The types of data compiled in RecFIN include sampled biological data, estimates of landed catch plus discards, and economic data. Data are generally available within 3 months. Descriptions of the RecFIN program, state recreational fishery sampling programs and the most recent data available to managers, assessment scientists, and the general public can be found on the PSMFC web site at http://www.psmfc.org/program/prog-3

Monitoring within the ongoing 2017 trawl gear EFP and the upcoming 2018 trawl gear EFPs will closely mirror those requirements in current regulations. All EFP vessels will require 100 percent monitoring either through observer coverage or electronic monitoring. Additionally, all salmon caught on EFP trips is required to be separated by haul so that observes onboard and catch monitors onshore are able to identify the time and place that particular salmon was caught and align it with the biological samples taken.

Table 1-6. Type and level of monitoring by fishery sector

Fishing Sector	Time Area Monitoring	Catch and Discard Monitoring	
	VMS Coverage	Observer Coverage (2013)	Other Coverage
Trawl IFQ	Vessel registered to LE permits must operate VMS 24 hours a day throughout the fishing year	1 observer per harvesting vessel, 1 catch monitor at first receivers.	Optional electronic monitoring.
Trawl at-sea whiting		2 observers per processor 125 ft and over, 1 per processor under 125 ft. 1 observe per mothership harvesting vessel	Mothership harvesting vessels - optional electronic monitoring under EFPs.
LEFG sablefish tier limit fishery		Observer coverage of all groundfish landings was 33% of the longline and 71% of pot gear landings	
LEFG trip limit fishery		Observer coverage coastwide was 5% of all groundfish.	
OA directed	Any vessel that takes, and retains, or possess groundfish in the EEZ must operate VMS 24 hours a day throughout the fishing year	Observer coverage coastwide was: 7% of all groundfish landings in non-nearshore 8% for all nearshore landings	
OA incidental	Any vessel that takes, and retains, or possess groundfish in the EEZ and any vessel that uses non-groundfish trawl gear to fish in the EEZ must operate VMS 24 hours a day throughout the fishing year		
Tribal	Not required, unless vessel is registered to non-tribal groundfish permit	Observer coverage and shore-based sampling of groundfish directed fishing.	
Recreational			State surveys - may include, catch data and estimates from private, rental and charter vessels, beach and private access effort, and effort based on license data. Coverage varies
Trawl Gear EFPs	Same requirement as that for all LE vessels	Vessels may use EM or observers. Observers will take samples by haul on observed vessels and then	EM vessels are exempt from the prohibition on retaining prohibited species and are

		all prohibited species must be discarded.	required to retain all salmon by haul for shoreside sampling.

2 ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, Federal agencies must ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS, and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an opinion stating how the agencies' actions would affect listed species and their critical habitat. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RMPs) and terms and conditions to minimize such impacts.

This opinion considers impacts of the proposed actions under the ESA on Puget Sound Chinook (PS), Snake River Fall Chinook (SRF), LCR Chinook, Upper Willamette River Chinook (UWR), Upper Columbia spring, Snake River spring/summer Chinook, California Coastal Chinook (CC), LCR coho, Oregon Coast coho, Southern Oregon/Northern California coho (SO/NOC) and CCC coho salmon ESUs. Available data show no impacts on Sacramento winter-run and Central Valley spring-run Chinook salmon; thus, we are concluding that the proposed action is not likely to adversely affect these two ESUs. Those findings are documented in the "Not Likely to Adversely Affect" Determinations section (Section 2.11). We have determined that the proposed action is likely to have no effect on designated critical habitat for any salmonid species. Critical habitat does not include the offshore marine areas that comprise the action area for the proposed action.

Of the listed salmon species, the bycatch of salmonids in the whiting fishery is almost exclusively Chinook salmon, with low or no bycatch of coho, chum, sockeye, or steelhead. For coho and chum, estimates of bycatch averaged 227 and 82 fish, respectively, per year coastwide, since 2002, across all groundfish fishery sectors. Most are caught north of Cape Blanco (WCGOP unpublished). The vast majority of these would be unlisted hatchery fish or from unlisted ESUs. Table 2-2 summarizes mortality by salmon species and fishing sector, 2002-2015. Available information indicates harvest of listed coho would be less than 80 fish on average per year from the four coho ESUs. The effects on these ESUs are discussed further in this section. Bycatch of listed chum would be rare. Steelhead and sockeye individuals are occasionally observed, but estimates of bycatch in most years are zero. The effects on listed sockeye and chum salmon ESUs, and steelhead distinct population segments (DPSs) would be negligible.

2.1 Analytical Approach

This biological opinion includes both a jeopardy analysis and/or an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of a listed species," which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological opinion relies on the definition of "destruction or adverse modification," which means "a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (81 FR 7214).

The designation(s) of critical habitat for (species) use(s) the term primary constituent element (PCE) or essential features. The new critical habitat regulations (81 FR 7414) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a ''destruction or adverse modification'' analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

Identify the range-wide status of the species and critical habitat likely to be adversely affected by the proposed action. Section 2.2 describes the current status of each listed species and its critical habitat relative to the conditions needed for recovery. For listed salmon and steelhead, NMFS has developed specific guidance for analyzing the status of the listed species' component populations in a viable salmonid populations (VSP) paper (McElhany et al. 2000). Similar criteria are used to analyze the status of ESA-listed rockfish because these parameters are applicable for a wide variety of species.

The VSP approach considers the abundance, productivity, spatial structure, and diversity of each population as part of the overall review of a species' status. For listed salmon and steelhead, the VSP criteria, therefore, encompass the species' "reproduction, numbers, or distribution" (50 CFR 402.02). In describing the range-wide status of listed species, NMFS relies on viability assessments and criteria in technical recovery team documents and recovery plans, as well as other available information sources that describe how VSP criteria are applied to specific populations, major population groups (MPGs), and species. NMFS determines the range-wide status of critical habitat by examining the condition of its physical or biological features, which were identified when the critical habitat was designated.

Describe the environmental baseline in the action area. The environmental baseline (Section 2.3) includes the past and present impacts of Federal, state, or private actions and other human activities in the action area. It includes the anticipated impacts of proposed Federal projects that have already undergone formal or early section 7 consultation and the impacts of state or private actions that are contemporaneous with the consultation in process.

- *Analyze the effects of the proposed action on both species and their habitat using an "exposure-response-risk" approach.* In this step (Section 2.4), NMFS considers how the proposed action would affect the species' reproduction, numbers, and distribution or, in the case of salmon and steelhead, their VSP and other relevant characteristics. NMFS also evaluates the proposed action's effects on critical habitat features.
- *Describe any cumulative effects in the action area.* Cumulative effects (Section 2.6), as defined in our implementing regulations (50 CFR 402.02), are the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area. Future Federal actions that are unrelated to the proposed action are not considered because they require separate section 7 consultation.
- *Integrate and synthesize the above factors* by (1) reviewing the status of the species and critical habitat and (2) adding the effects of the action, the environmental baseline, and cumulative effects to assess the risk that the proposed action poses to species and critical habitat. (Section 2.6).
- *Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified.* These conclusions (Section 2.8) flow from the logic and rationale presented in the Integration and Synthesis section (2.7).
- *If necessary, define a reasonable and prudent alternative to the proposed action.* If, in completing the last step in the analysis, we determine that the action under consultation is likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat, we must identify a reasonable and prudent alternative (RPA) to the action in Section 2.8. The RPA must not be likely to jeopardize the continued existence of listed species nor adversely modify their designated critical habitat and it must meet other regulatory requirements.

2.2 Rangewide Status of the Species

This opinion examines the status of each species that would be affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, listing decisions, and other relevant information. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02.

2.2.1 Status of Listed Species

For Pacific salmon, NMFS commonly uses four parameters to assess the viability of the populations that, together, constitute the species: spatial structure, diversity, abundance, and productivity (McElhany et al. 2000). These VSP criteria, therefore, encompass the species' "reproduction, numbers, or distribution," as described in 50 CFR 402.02. When these parameters are collectively at appropriate levels, they maintain a population's capacity to adapt to various environmental conditions and allow it to sustain itself in the natural environment. These attributes are influenced by survival, behavior, and experiences throughout a species' entire life cycle, and these characteristics, in turn, are influenced by habitat and other environmental conditions.

"Spatial structure" refers both to the spatial distributions of individuals in the population and the processes that generate that distribution. A population's spatial structure depends fundamentally on habitat quality and spatial configuration and the dynamics and dispersal characteristics of individuals in the population.

"Diversity" refers to the distribution of traits within and among populations. These range in scale from DNA sequence variation at single genes to complex life history traits (McElhany et al. 2000). Genetic resources that represent the ecological and genetic diversity of a species can reside in a hatchery program. "Hatchery programs with a level of genetic divergence relative to the local natural population(s) that is no more than what occurs within the ESU are considered part of the ESU an will be incuded in any listing of the ESU" (NMFS 2005). (For a detailed description of how NMFS evaluates and determines whether to include hatchery fish in an ESU or DPS, see NMFS (2005)).

"Abundance" generally refers to the number of naturally produced adults (i.e., the progeny of naturally spawning parents) in the natural environment (e.g., on spawning grounds).

"Productivity," as applied to viability factors, refers to the entire life cycle or portions of a life cycle; i.e., the number of progeny or naturally spawning adults produced per parent. When progeny replace or exceed the number of parents, a population is stable or increasing. When progeny fail to replace the number of parents, the population is declining. McElhany et al. (2000) use the terms "population growth rate" and "productivity" interchangeably when referring to production over the entire life cycle. They also refer to "trend in abundance," which is the manifestation of long-term population growth rate.

For species with multiple populations, once the biological status of a species' populations has been determined, NMFS assesses the status of the entire species using criteria for groups of populations, as described in recovery plans and in guidance documents from technical recovery teams, and regional guidance. Considerations for species viability include having multiple populations that are viable, ensuring that populations with unique life histories and phenotypes are viable, and that some viable populations are both widespread to avoid concurrent extinctions from mass catastrophes and spatially close to allow functioning as metapopulations (McElhany et al. 2000).

Climate change and other ecosystem effects

Changes in climate and ocean conditions happen on several different time scales and have had a profound influence on distribution and abundance of marine and anadromous fishes. Salmon throughout Washington are also likely affected by climate change. Several studies have revealed that climate change has the potential to affect ecosystems in nearly all tributaries throughout the West Coast (Battin et al. 2007; Independent Science Advisory Board [ISAB] 2007). While the intensity of effects will vary by region (ISAB 2007), climate change is generally expected to alter aquatic habitat (water yield, peak flows, and stream temperature). As climate change alters the structure and distribution of rainfall, snowpack, and glaciation, each factor will in turn alter riverine hydrographs. Given the increasing certainty that climate change is occurring and is accelerating (Battin et al. 2007), NMFS anticipates that salmonid habitats will be affected; this, in turn, will likely affect the distribution and productivity of salmon populations in the region (Beechie et al. 2006, Lindley et al. 2007). Climate and hydrology models project significant reductions in both total snow pack and low-elevation snow pack in the Pacific Northwest over the next 50 years (Mote and Salathé 2009). These changes will shrink the extent of the snowmelt-dominated habitat available to salmon. Such changes may restrict NMFS' ability to conserve diverse salmon and steelhead life histories, and they may make recovery targets for these salmon populations more difficult to achieve.

Climate change is a major factor affecting the range-wide status of the threatened and endangered anadromous Chinook and coho salmon ESUs that are subject of this opinion). Climate change has negative implications for designated critical habitats in the Pacific Northwest and California (CIG 2004; Scheuerell and Williams 2005; Zabel et al. 2006; ISAB 2007, Lindley et al. 2007). Average annual Northwest air temperatures have increased by approximately 1ºC since 1900, or about 50 percent more than the global average over the same period (ISAB 2007). According to the ISAB, these effects pose the following impacts over the next 40 years:

- Warmer air temperatures will result in diminished snowpacks and a shift to more winter/spring rain and runoff, rather than snow that is stored until the spring/summer melt season.
- With a smaller snowpack, these watersheds will see their runoff diminished earlier in the season, resulting in lower stream-flows in the June through September period. River flows in general and peak river flows are likely to increase during the winter due to more precipitation falling as rain rather than snow.
- Water temperatures are expected to rise, especially during the summer months when lower stream-flows co-occur with warmer air temperatures.

These changes will not be spatially homogeneous across the entire Pacific Coast. Low-lying areas are likely to be more affected. Climate change may have long-term effects that include, but are not limited to, depletion of important cold water habitat, variation in quality and quantity of tributary rearing habitat, alterations to migration patterns, accelerated embryo development, premature emergence of fry, and increased competition among species (ISAB 2007).

Higher water temperatures and lower spawning flows, together with increased magnitude of winter peak flows will all likely increase salmonid mortality. The largest driver of climate-induced decline in salmon and populations is projected to be the impact of increased winter peak flows, which scour the streambed and destroy salmonid eggs (Battin et al. 2007; Mantua et al. 2009). Higher ambient air temperatures will likely cause water temperatures to rise (ISAB 2007). Salmonids require cold water for spawning and incubation. As climate change progresses, and stream temperatures warm, thermal refugia will be essential to persistence of many salmonid populations. Thermal refugia are important for providing salmonids with patches of suitable habitat while allowing them to undertake migrations through or to make foraging forays into areas with higher than optimal temperatures. To avoid waters above summer maximum temperatures, juvenile rearing increasingly may occur only in the confluence of colder tributaries or other areas of cold water refugia (Mantua et al. 2009).

Once salmon leave fresh water they are subject to a highly variable and dynamic ocean environment that is also subject to climatic impacts. There is evidence that salmon abundance is linked to variation in climate effects on the marine environment. It is widely understood that variations in marine survival of salmon correspond with periods of cold and warm ocean conditions, with cold regimes being generally favorable for salmon survival and warm ones unfavorable (Fletcher et al 2015, Behrenfeld *et al.* 2006, Wells *et al.* 2006). Both short term, Ocean Nino Index (ONI) and longer term climate variability, (PDO), appear to play a part in salmon survival and abundance. An evaluation of conditions in the California Current since the late 1970s reveals a generally warm, unproductive regime that persisted until the late 1990s. This regime has been followed by a period of high variability that began with colder, more productive conditions lasting from 1999 to 2002. In general, salmon populations increased substantially during this period. However, this brief cold cycle was immediately succeeded by a 4-year period of predominantly warm ocean conditions beginning in late 2002, which appeared to have negatively impacted salmon populations in the California Current (Peterson *et al*. 2006). 2006 through 2013 had generally favorable PDO and ONI rankings with the exception of 2010 and conditions have been intermediate or unfavorable since 2013(https://www.nwfsc.noaa.gov/research/divisions/fe/estuarine/oeip/g-forecast.cfm). Evidence suggests these regime shifts follow a more or less linear pattern beginning with the amount and timing of nutrients provided by upwelling and passing "up" the food chain from plankton to forage fish and eventually, salmon. There are also indications that these same regime shifts affect the migration patterns of larger animals that prey on salmon (*e.g*., Pacific hake, sea birds) resulting in a "top-down" effect as well (Peterson *et al*. 2006). Fishing records indicate that in the past, these shifts in temperature and consequent salmon abundance, appear to last several decades (Mantua *et al.* 1997). However, the long term viability of salmon cannot be dependent on periods of good ocean conditions alone, as the relative importance of good ocean conditions is difficult to quantify (McClure *et al*. 2003) and it is quite possible that the climate patterns observed in the 20th century may not repeat in the 21st century due to long term climate change (Mantua and Francis 2004; IPCC 2001)

In summary, observed and predicted climate change effects are generally detrimental to all of the Chinook species along the West Coast, so unless offset by improvements in other factors, the status of the species and critical habitat is likely to decline over time. The climate change projections referenced above cover the time period between the present and approximately 2100. While there is uncertainty associated with projections, which increase over time, the direction of change is relatively certain (McClure et al. 2013).

In addition to climate change effects, variation in fish populations along the West Coast may reflect broad-scale shifts in natural limiting conditions, such as predator abundances and food resources in ocean rearing areas. NMFS has noted that predation by marine mammals has increased as marine mammal numbers, especially harbor seals (*Phoca vitulina*) and California sea lions (*Zalophus californianus*), increase on the Pacific Coast (Myers et al. 1998; Jeffries et al. 2003; Pitcher et al. 2007; DFO 2010; Jeffries 2011, Chasco et al. 2017). In addition to predation by marine mammals, Fresh (1997) reported that 33 fish species and 13 bird species are predators of juvenile and adult salmon, particularly during freshwater rearing and migration stages.

2.2.1.1 Status of Puget Sound Chinook

This ESU was listed as a threatened species in 1999; its threatened status was reaffirmed June 28, 2005 (70 FR 37160). NMFS issued results of a five-year review on May 26, 2016 (81 FR 33469) and concluded that this species should remain listed as threatened. As part of the review, NOAA's NWFSC evaluated the viability of the listed species undergoing five-year reviews and issued a status review providing updated information and analysis of the biological status of the listed species (NWFSC 2015). The status review incorporated the findings of the NWFSC's report, summarized new information concerning delineation of the ESU and inclusion of closely related salmonid hatchery programs, and included an evaluation of the listing factors (NMFS 2017a). Where possible, particularly as new material becomes available, the NWFSC supplements the status review information with more recent information and other population-specific data that may not have been considered during the status review so that NMFS uses the best available information. Critical habitat for the Puget Sound Chinook ESU was designated on September 2, 2005 (70 FR 52630).

NMFS adopted the recovery plan for Puget Sound Chinook on January 19, 2007 (72 FR 2493). The recovery plan consists of two documents: the Puget Sound Salmon Recovery Plan, prepared by the Shared Strategy for Puget Sound, and NMFS' Final Supplement to the Shared Strategy Plan (SSPS 2005b, SSPS 2007). The recovery plan adopts ESU and population level viability criteria recommended by the Puget Sound Technical Recovery Team (PSTRT) (Ruckelshaus et al. 2002). The PSTRT's biological recovery criteria will be met when the following conditions are achieved:

1. All watersheds improve from current conditions, resulting in improved status for the species.
2. At least two to four Chinook salmon populations in each of the five biogeographical regions of Puget Sound attain a low risk status over the longterm.[9]
3. At least one or more populations from major diversity groups historically present in each of the five Puget Sound regions attain a low risk status..

[9] The number of populations required depends on the number of diversity groups in the region. For example, three of the regions have only two populations, generally of one diversity type; the Central Sound Region has two major diversity groups; the Whidbey/Main Region has four major diversity groups.

4. Tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations are functioning in a manner that is sufficient to support an ESU-wide recovery scenario..
5. Production of Chinook salmon from tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations occurs in a manner consistent with ESU recovery.

Abundance, Productivity, Spatial Structure, and Diversity:

Status of the species is determined based on the abundance, productivity, spatial structure, and diversity of its constituent natural populations. The PSTRT determined that 22 historical populations currently contain Chinook salmon and grouped them into five major geographic regions, based on consideration of historical distribution, geographic isolation, dispersal rates, genetic data, life history information, population dynamics, and environmental and ecological diversity (**Table 2-1**). Based on genetic and historical evidence reported in the literature, the PSTRT also determined that there were 16 additional spawning aggregations or populations in the Puget Sound Chinook Salmon ESU that are now putatively extinct10 (Ruckelhaus et al. 2006). This ESU includes all naturally spawned Chinook salmon originating from rivers flowing into Puget Sound from the Elwha River (inclusive) eastward, including rivers in Hood Canal, South Sound, North Sound, and the Strait of Georgia. The ESU also includes Chinook salmon from 26 artificial propagation programs: the Kendall Creek Hatchery Program, Marblemount Hatchery Program (spring subyearlings and summer-run), Harvey Creek Hatchery Program (summer-run and fall-run), Whitehorse Springs Pond Program, Wallace River Hatchery Program (yearlings and subyearlings), Tulalip Bay Program, Issaquah Hatchery Program, Soos Creek Hatchery Program, Icy Creek Hatchery Program, Keta Creek Hatchery Program, White River Hatchery Program, White Acclimation Pond Program, Hupp Springs Hatchery Program, Voights Creek Hatchery Program, Diru Creek Program, Clear Creek Program, Kalama Creek Program. George Adams Hatchery Program, Rick's Pond Hatchery Program, Hamma Hamma Hatchery Program, Dungeness/Hurd Creek Hatchery Program, Elwha Channel Hatchery Program, and the Skookum Creek Hatchery Spring-run Program (79 FR 20802).

Three of the five regions (Strait of Juan de Fuca, Georgia Basin, and Hood Canal) contain only two populations, both of which must be recovered to viability to recover the ESU (NMFS 2006c). Under the

[10] In most cases, the PSTRT could not determine whether these Chinook salmon spawning groups historically represented independent populations, or were distinct spawning aggregations within larger populations.

Puget Sound Salmon Recovery Plan, the Suiattle and one each of the early, moderately early, and late run-timing populations in the Whidbey Basin Region, as well as the White and Nisqually (or other late-timed) populations in the Central/South Sound Region must also achieve viability (NMFS 2006c). The PSTRT did not define the relative roles of the remaining populations in the Whidbey and Central/South Sound Basins to ESU viability.

Table 2-1. Extant Puget Sound Chinook salmon populations in each geographic region (Ruckelshaus et al. 2006).

Geographic Region	Population (Watershed)
Strait of Georgia	**North Fork Nooksack River**
	South Fork Nooksack River
Strait of Juan de Fuca	**Elwha River**
	Dungeness River
Hood Canal	**Skokomish River**
	Mid Hood Canal River
Whidbey Basin	Skykomish River (late)
	Snoqualmie River (late)
	North Fork Stillaguamish River (early)
	South Fork Stillaguamish River (moderately early)
	Upper Skagit River (moderately early)
	Lower Skagit River (late)
	Upper Sauk River (early)
	Lower Sauk River (moderately early)
	Suiattle River (very early)
	Cascade River (moderately early)
Central/South Puget Sound Basin	Cedar River
	North Lake Washington/Sammamish River
	Green/Duwamish River
	Puyallup River
	White River
	Nisqually River

Note: NMFS has determined that the bolded populations, in particular, are essential to recovery of the Puget Sound ESU. In addition, at least one other population within the Whidbey Basin and Central/South Puget Sound Basin Regions would have to be viable for recovery of the ESU. The PSTRT noted that the Nisqually watershed is in comparatively good condition; thus, the certainty that the population could be recovered is among the highest in the Central/South Region. NMFS concluded in its supplement to the Puget Sound Salmon Recovery Plan that protecting the existing habitat and working toward a viable population in the Nisqually watershed would help to buffer the entire region against further risk (NMFS 2006c).

Therefore, NMFS developed additional guidance that considers distinctions in genetic legacy and watershed condition, among other factors, in assessing the risks to survival and recovery of the listed species by the proposed actions across all populations within the Puget Sound Chinook ESU. In doing so, it is important to consider whether the genetic legacy of the population is intact, or whether it is no longer distinct. Populations are defined by both their relative isolation from each other and the unique genetic characteristics that evolve because of that isolation to adapt to their specific habitats. If these are populations that still retain their historic genetic legacy, then the appropriate course to ensure their survival and recovery is to preserve that genetic legacy and rebuild those populations. Preserving that legacy requires both a sense of urgency and the actions necessary and appropriate to preserve the legacy that remains. If the genetic legacy is gone, however, then the appropriate course is to recover the populations using the individuals that best approximate the genetic legacy of the original population, reduce the effects of the factors that have limited their production, and provide the opportunity for them to readapt to the existing conditions.

In keeping with this approach, NMFS further classified Puget Sound Chinook populations into three tiers based on a systematic framework that considers the population's life history and production and watershed characteristics (Puget Sound Domain Team 2010) (**Figure 2-1**). This framework, termed the *Population Recovery Approach*, carries forward the biological viability and delisting criteria described in the Supplement to the Puget Sound Salmon Recovery Plan

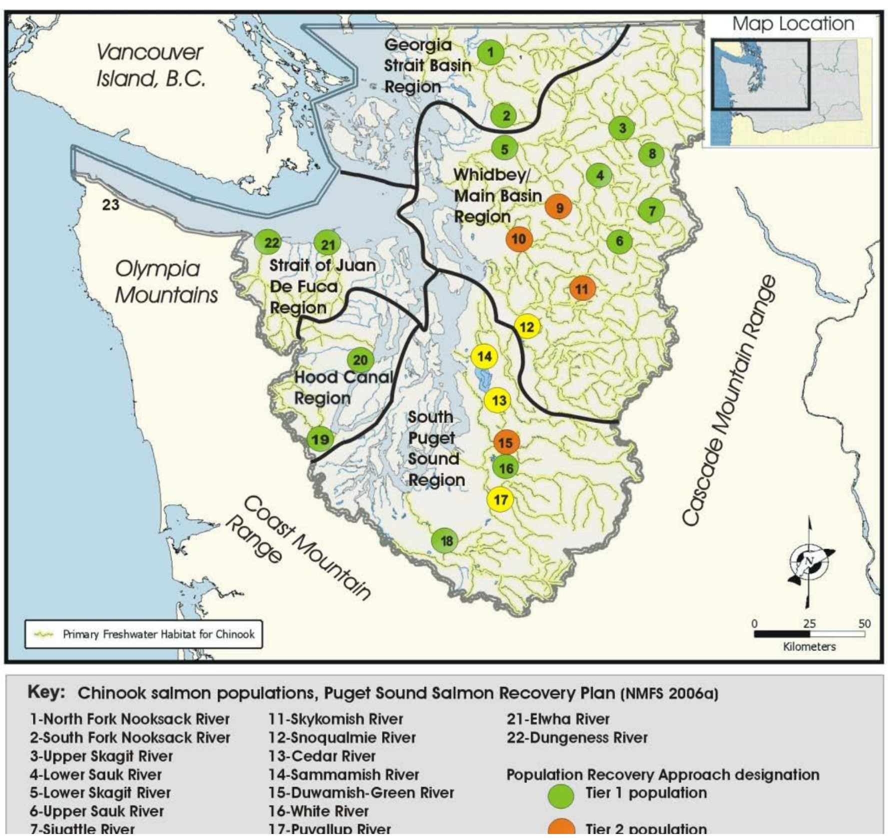

Figure 2-1. Puget Sound Chinook populations

(Ruckelshaus et al. 2002; NMFS 2006c). The assigned tier indicates the relative role of each of the 22 populations comprising the ESU in the viability of the ESU and its recovery. Tier 1 populations are most important for preservation, restoration, and ESU recovery. Tier 2 populations play a less important role in recovery of the ESU. Tier 3 populations play the least important role. When we analyze proposed actions, we evaluate impacts at the individual population scale for their effects on the viability of the ESU. We expect that impacts on Tier 1 populations would be more likely to affect the viability of the ESU as a whole than similar impacts on Tier 2 or 3 populations because of the relatively greater importance of Tier 1 populations to overall ESU viability. NMFS has incorporated this and similar approaches in previous ESA section 4(d) determinations and opinions on Puget Sound salmon fisheries and regional recovery planning (NMFS 2005d; 2005h; 2008c; 2008e; 2010; 2011b; 2013b; 2014c; 2015b; 2016g).

Indices of spatial distribution and diversity have not been developed at the population level, though diversity at the ESU level is declining. Abundance is becoming more concentrated in fewer populations and regions within the ESU. The Whidbey Basin Region is the only region with consistently high-fraction, natural-origin spawner abundance in 6 of the 10 populations within the region. All other regions have moderate to high proportions of hatchery-origin spawners (**Table 2-2**).

In general, the Strait of Juan de Fuca, Georgia Basin, and Hood Canal Regions are at greater risk than the other regions due to critically low natural abundance and/or declining growth rates of the populations in these regions. In addition, spatial structure, or geographic distribution, of the White, Skagit, Elwha, and Skokomish populations has been substantially reduced or impeded by the loss of access to the upper portions of those tributary basins due to flood control activities and hydropower development. Habitat conditions conducive to salmon survival in most other watersheds have been reduced significantly by the effects of land use, including urbanization, forestry, agriculture, and development (NMFS 2005a; 2006c; 2008b; 2008c; SSPS 2007). It is likely that genetic diversity has also been reduced by this habitat loss.

Most Puget Sound Chinook populations are well below escapement levels identified as required for recovery to low extinction risk (**Table 2-2**). All populations are consistently below productivity goals identified in the recovery plan (**Table 2-2**). Although trends vary for individual populations across the ESU, most populations exhibit a stable or increasing trend in natural escapement (**Table 2-3**). However, natural-origin abundance across the Puget Sound ESU has generally decreased since the last status review, with only 6 of 22 populations (Cascade, Suiattle, Upper Sauk, Cedar, Mid-Hood Canal, and Nisqually) showing a positive change in the 5-year, geometric mean, natural-origin spawner abundances since the prior status review (NWFSC 2015). While the previous status review in 2010 (Ford 2011) indicated that there was no obvious trend for the total ESU, addition of the data to 2014 now shows widespread negative trends in natural-origin Chinook salmon spawner population abundances (NWFSC 2015).[11]

Natural-origin escapements for eight populations are at or below their critical thresholds.[12] Both populations in three of the five biogeographical regions are below or near their critical threshold: Georgia Strait, Hood Canal, and the Strait of Juan de Fuca (**Table 2-2**). When hatchery spawners are included, aggregate average escapement exceeds 1,000 for one of the two populations in each of these three regions. Four populations are above their rebuilding thresholds; three of them are in the Whidbey/Main Basin Region.

Trends in growth rate of natural-origin escapement are generally higher than growth rate of natural-origin recruitment (i.e., abundance prior to fishing), indicating some stabilizing influence on escapement possibly from past reductions in fishing-related mortality (**Table 2-3**). Since 1990, nine populations show productivity above replacement for natural-origin escapement, including populations in all regions. Only six populations in three of the five regions demonstrate positive growth rates in natural-origin recruitment (**Table 2-2**). Survival and recovery of the Puget Sound Chinook Salmon ESU will depend, over the long term, on remedial actions related to all harvest-, hatchery-, and habitat-related activities. Many of the habitat and hatchery actions identified in the Puget Sound Salmon Recovery Plan are likely to take years or decades to be implemented and to produce significant improvements in natural population attributes, and current trends are consistent with these expectations (NWFSC 2015).

[11] This is a synopsis of information provided in the recent five-year status review and supplemental data and complementary analysis from other sources. Differences in results reported in **Table 3** and **Table 4** from those in the status review are related to the data source, method, and time period analyzed (e.g., 15 versus 25 years).

[12] After considering uncertainty, the critical threshold is defined as a point below which (1) depensatory processes are likely to reduce the population below replacement, (2) the population is at risk from inbreeding depression or fixation of deleterious mutations. or (3) productivity variation due to demographic stochasticity becomes a substantial source of risk (NMFS 2000b). The rebuilding threshold is defined as the escapement that will achieve maximum sustainable yield (MSY) under current environmental and habitat conditions (NMFS 2000b). Thresholds were based on population-specific data where available.

Table 2-2. Estimates of escapement and productivity (recruits/spawner) for Puget Sound Chinook populations. Natural-origin escapement information is provided where available. Populations below their critical escapement threshold are bolded. For several populations, hatchery contribution to natural spawning data are limited or unavailable.

Region	Population	1999 to 2015 Geometric mean Escapement (Spawners)		NMFS Escapement Thresholds		Recovery Planning Abundance Target in Spawners (productivity)[2]	Average % hatchery fish in escapement 1999 to 2015 (minimum to maximum)[5]
		Natural [1]	Natural-origin (Productivity[2])	Critical[3]	Rebuilding[4]		
Georgia Basin	Nooksack MU	2,233	262	400	500		
	NF Nooksack	1,804	205[8] (0.4)	*200[6]*	-	3,800 (3.4)	85 (63-94)
	SF Nooksack	61	43[8] (1.0)	*200[6]*	-	2,000 (3.6)	85 (62-96)
Whidbey/Main Basin	Skagit Summer/Fall MU						
	Upper Skagit River	10,167	8,887[8] (1.7)	967	7,454	5,380 (3.8)	3 (1-8)
	Lower Sauk River	620	588[8] (1.5)	*200[6]*	681	1,400 (3.0)	1 (0-10)
	Lower Skagit River	2,276	2,046[8] (1.6)	251	2,182	3,900 (3.0)	4 (2-8)
	Skagit Spring MU						
	Upper Sauk River	655	640[8] (2.4)	130	330	750 (3.0)	2 (0-5)
	Suiattle River	373	365[8] (2.0)	170	400	160 (3.2)	2 (0-7)
	Upper Cascade River	326	294[8] (1.5)	170	*1,250[6]*	290 (3.0)	10 (0-50)
	Stillaguamish MU						
	NF Stillaguamish River	1,227	644 (0.8)	300	550	4,000 (3.4)	37 (8-62)
	SF Stillaguamish River	151	146 (1.1)	*200[6]*	300	3,600 (3.3)	6 (0-39)
	Snohomish MU						
	Skykomish River	3,338	1,944[8] (1.3)	1,650	3,500	8,700 (3.4)	35 (15-62)
	Snoqualmie River	1,524	1,088[8] (1.3)	400	*1,250[6]*	5,500 (3.6)	20 (8-35)
Central/South Sound	Cedar River	882	816[8] (1.9)	*200[6]*	*1,250[6]*	2,000 (3.1)	24 (10-36)
	Sammamish River	1,159	184[8] (0.7)	*200[6]*	*1,250[6]*	1,000 (3.0)	84 (66-95)
	Duwamish-Green Rivers	3,591	1,235[8] (1.0)	835	5,523	-	55 (20-79)
	White River[9]	1,223	515[8] (0.8)	*200[6]*	1,100[7]	-	53 (27-87)
	Puyallup River[10]	1,596	747[8] (1.1)	*200[6]*	522[7]	5,300 (2.3)	48 (18-76)
	Nisqually River	1,641	526[8] (1.6)	*200[6]*	1,200[7]	3,400 (3.0)	69 (53-85)

Table 2-2. Estimates of escapement and productivity (recruits/spawner) for Puget Sound Chinook populations. Natural-origin escapement information is provided where available. Populations below their critical escapement threshold are bolded. For several populations, hatchery contribution to natural spawning data are limited or unavailable. (continued)

Region	**Population**	**1999 to 2015 Geometric mean Escapement (Spawners)**		**NMFS Escapement Thresholds**		**Recovery Planning Abundance Target in Spawners (productivity)[2]**	**Average % hatchery fish in escapement 1999 to 2015 (minimum to maximum)[5]**
		Natural [1]	**Natural-origin (Productivity[2])**	**Critical[3]**	**Rebuilding[4]**		
Hood Canal	Skokomish River	1,223	317 (0.9)	452	1,160	-	67 (7-95)
	Mid-Hood Canal Rivers[11]	179		*200[6]*	*1,250[6]*	1,300 (3.0)	48 (5-90)
Strait of Juan de Fuca	Dungeness River	350	103[8] (0.6)	*200[6]*	925[7]	1,200 (3.0)	69 (39-96)
	Elwha River[12]	1,521	116[8]	*200[6]*	*1,250[6]*	6,900 (4.6)	90 (82-98)

[1] Includes naturally spawning hatchery fish.

[2] Source productivity is Abundance and Productivity Tables from NWFSC database, measured as the mean of observed recruits/observed spawners. The Sammamish productivity estimate has not been revised to include Issaquah Creek. The source for the recovery planning productivity target is the final supplement to the Puget Sound Salmon Recovery Plan (NMFS 2006c); measured as recruits/spawner associated with the number of spawners at MSY under recovered conditions.

[3] Critical natural-origin escapement thresholds under current habitat and environmental conditions (McElhany et al. 2000; NMFS 2000b).

[4] Rebuilding natural-origin escapement thresholds under current habitat and environmental conditions (McElhany et al. 2000; NMFS 2000b).

[5] Estimates of the fraction of hatchery fish in natural spawning escapements are from the Abundance and Productivity Tables and co-manager postseason reports on the Puget Sound Chinook Harvest Management Plan (Puget Sound Indian Tribes [PSIT] and WDFW 2013, WDFW and PSTIT 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016) and the 2010-2014 Puget Sound Chinook Harvest Management Plan (PSIT and WDFW 2010).

[6] Based on generic VSP guidance (McElhany et al. 2000; NMFS 2000b).

[7] Based on alternative habitat assessment.

[8] Estimates of natural-origin escapement for Nooksack available only for 1999 to 2015, Skagit Springs, Skagit Falls, and Skokomish available only for 1999 to 2015. Snohomish for 1999 to 2001 and 2005 to 2015, Lake Washington for 2003 to 2015, White River 2005 to 2015, Puyallup for 2002 to 2015, Nisqually for 2005 to 2015, Dungeness for 2001 to 2015, and Elwha for 2010 to 2015.

[9] Captive broodstock program for early run Chinook salmon ended in 2000; estimates of natural spawning escapement include an unknown fraction of naturally spawning hatchery-origin fish from late-run and early-run hatchery programs in the White and Puyallup River Basins.

[10] The South Prairie index area provides a more accurate trend in the escapement for the Puyallup River because it is the only area in the Puyallup River in which spawners or redds can be consistently counted (PSIT and WDFW 2010).

[11] The Puget Sound TRT considers Chinook salmon spawning in the Dosewallips, Duckabush, and Hamma Hamma Rivers to be subpopulations of the same historically independent population; annual counts in those three streams are variable due to inconsistent visibility during spawning ground surveys. Data on the contribution of hatchery fish are limited; primarily based on returns to the Hamma Hamma River.

[12] Estimates of natural escapement do not include volitional returns to the hatchery or those fish gaffed or seined from spawning grounds for broodstock collection.

Table 2-3. Long-term trends in abundance and productivity (A/P) for Puget Sound Chinook populations. Long-term, reliable data series for natural-origin contribution to escapement are limited in many areas.

Region	Population	Natural Escapement Trend[1] (1990 to 2015)		Growth Rate[2] (1990 to 2013)	
		NMFS		Recruitment (Recruits)	Escapement (Spawners)
Georgia Basin	NF Nooksack (early)	1.12	increasing	1.04	1.00
	SF Nooksack (early)	1.03	stable	1.04	1.01
Whidbey/Main Basin	Upper Skagit River (moderately early)	1.02	stable	0.98	1.01
	Lower Sauk River (moderately early)	1.00	stable	0.97	0.98
	Lower Skagit River (late)	1.01	stable	0.97	0.99
	Upper Sauk River (early)	1.04	increasing	0.99	1.03
	Suiattle River (very early)	1.00	stable	0.97	1.00
	Upper Cascade River (moderately early)	1.02	increasing	0.99	1.03
	NF Stillaguamish River (early)	1.00	stable	0.97	1.00
	SF Stillaguamish River[3] (moderately early)	0.95	declining	0.94	0.97
	Skykomish River (late)	1.00	stable	0.93	1.00
	Snoqualmie River (late)	1.00	stable	0.97	0.99
Central/South Sound	Cedar River (late)	1.04	increasing	1.02	1.04
	Sammamish River[4] (late)	1.01	stable	1.04	1.07
	Duwamish-Green River (late)	0.95	declining	0.95	0.98
	White River[5] (early)	1.10	increasing	1.02	1.05
	Puyallup River (late)	0.97	declining	0.93	0.95
	Nisqually River (late)	1.05	increasing	0.93	1.00

Table 2-3. Long-term trends in abundance and productivity (A/P) for Puget Sound Chinook populations. Long-term, reliable data series for natural-origin contribution to escapement are limited in many areas. (continued)

Region	Population	Natural Escapement Trend[1] (1990 to 2015)		Growth Rate[2] (1990 to 2013)	
		NMFS		Recruitment (Recruits)	Escapement (Spawners)
Hood Canal	Skokomish River (late)	1.00	stable	0.90	0.96
	Mid-Hood Canal Rivers[3] (late)	1.03	stable	0.95	1.03
Strait of Juan de Fuca	Dungeness River (early)	1.05	stable	1.04	1.08
	Elwha River[3] (late)	1.03	stable	0.91	0.94

[1] The escapement trend is calculated based on all spawners (i.e., including both natural-origin spawners and hatchery-origin fish spawning naturally) to assess the total number of spawners passed through the fishery to the spawning ground. Directions of trends are defined by statistical tests.

[2] Median growth rate (λ) is calculated based on natural-origin production. It is calculated assuming the reproductive success of naturally spawning hatchery fish is equivalent to that of natural-origin fish (for those populations where information on the fraction of hatchery fish in natural spawning abundance is available). Source: Abundance and Productivity Tables from NWFSC database.

[3] Estimate of the fraction of hatchery fish in time series is not available for use in λ calculation, so trend represents that in hatchery-origin + natural-origin spawners.

[4] Median growth rate estimates for Sammamish have not been revised to include escapement in Issaquah Creek.

[5] Natural spawning escapement includes an unknown percentage of naturally spawning hatchery-origin fish from late- and early run hatchery programs in the White/Puyallup River Basin.

Limiting Factors and Threats:

Limiting factors described in SSPS (2007) and reiterated in NMFS (2017a) include the following:

- Degraded nearshore and estuarine habitat: Residential and commercial development has reduced the amount of functioning nearshore and estuarine habitat available for salmon rearing and migration. The loss of mudflats, eelgrass meadows, and macroalgae further limits salmon foraging and rearing opportunities in nearshore and estuarine areas.

- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and large wood supply, stream substrate, impaired passage conditions and water quality have been degraded for adult spawning, embryo incubation, and rearing as a result of cumulative impacts of agriculture, forestry, and development. Some improvements have occurred over the last decade for water quality and removal of forest road barriers.

- Anadromous salmonid hatchery programs: Salmon and steelhead released from Puget Sound hatcheries operated for harvest augmentation purposes pose ecological, genetic, and demographic risks to natural-origin Chinook salmon populations. The risk to the species' persistence that may be attributable to hatchery-related effects has decreased since the last status review, based on hatchery risk reduction measures that have been implemented and new scientific information regarding genetic effects noted above (NWFSC 2015). Improvements in hatchery operations associated with ongoing ESA review and determination processes are expected to further reduce hatchery-related risks.

- Salmon harvest management: Total fishery exploitation rates (ERs) have decreased substantially since the late 1990s when compared to years prior to listing (average reduction = -35percent, range =
  -18 percent to -58 percent), but weak, natural-origin Chinook salmon populations in Puget Sound still require enhanced protective measures to reduce the risk of overharvest. The risk to the species' persistence because of harvest remains the same since the last status review for all three species. Increased harvest from the Canadian West Coast Vancouver Island fisheries has impacted most Puget Sound populations. Further, there is greater uncertainty associated with this threat due to shorter term harvest plans and exceedance of management objectives for some Chinook salmon populations essential to recovery.

- Concerns regarding existing regulatory mechanisms: lack of documentation or analysis of the effectiveness of land-use regulatory mechanisms and land-use management plans, lack of reporting and enforcement for some regulatory programs, and certain Federal, state, and local land and water use decisions continue to occur without the benefit of ESA review. State and local decisions have no Federal nexus to trigger the ESA Section 7 consultation requirement; thus, certain permitting actions allow direct and indirect species take and/or adverse habitat effects.

2.2.1.2 Status of Lower Columbia River Fall Chinook Salmon

On March 24, 1999, NMFS listed the LCR Chinook Salmon ESU as a threatened species (64 FR 14308). The threatened status was reaffirmed on April 14, 2014. Critical Habitat for LCR Chinook salmon was designated on September 2, 2005 (70 FR 52706). NMFS adopted a recovery plan for the LCR Chinook Salmon ESU in 2013 (NMFS 2013). Aspects of the recovery plan including recovery criteria are discussed in the following status section.

Within the geographic range of this ESU, 27 Chinook salmon hatchery programs are currently operational. Fourteen of these hatchery programs are included in the ESU (**Table 2-4.**), while the remaining 13 programs are excluded (Jones 2015). Willamette River Chinook salmon are listed within the Willamette River Chinook Salmon ESU, but they are not listed within the LCR Chinook Salmon ESU.

Table 2-4. LCR Chinook Salmon ESU description and MPGs (NMFS 2013b; Jones 2015; NWFSC 2015).

ESU Description[1]	
Threatened	Listed under ESA in 1999; updated in 2014.
Six major population groups	32 historical populations
Major Population Group	***Populations***
Cascade Spring	Upper Cowlitz (C, G), Cispus (C), Tilton, Toutle, Kalama, NF Lewis (C), Sandy (C, G)
Gorge Spring	(Big) White Salmon (C), Hood
Coast Fall	Grays/Chinook, Elochoman (C), Mill Creek, Youngs Bay, Big Creek (C), Clatskanie, Scappoose
Cascade Fall	Lower Cowlitz (C), Upper Cowlitz, Toutle (C), Coweeman (G), Kalama, EF Lewis (G), Salmon Creek, Washougal, Clackamas (C), Sandy River early
Gorge Fall	Lower Gorge, Upper Gorge (C), (Big) White Salmon (C), Hood
Cascade Late Fall	North Fork Lewis (C, G), Sandy (C, G)

ESU Description[1]	
Artificial production	
Hatchery programs included in ESU (14)	Big Creek Tule Fall Chinook, Astoria High School (Salmon and Trout Enhancement Program), Tule Fall Chinook, Warrenton High School (Salmon and Trout Enhancement Program), Tule Fall Chinook, Cowlitz Tule Fall Chinook Salmon Program, North Fork Toutle Tule Fall Chinook, Kalama Tule Fall Chinook, Washougal River Tule Fall Chinook, Spring Creek National Fish Hatchery (NFH) Tule Chinook, Cowlitz Spring Chinook Salmon (two programs), Friends of Cowlitz spring Chinook, Kalama River Spring Chinook, Lewis River Spring Chinook, Fish First Spring Chinook, Sandy River Hatchery Spring Chinook Salmon (ODFW stock #11)
Hatchery programs not included in ESU (13)	Deep River Net-Pens Spring Chinook, Clatsop County Fisheries (CCF) Select Area Brights Program Fall Chinook, CCF Spring Chinook Salmon Program, Carson NFH Spring Chinook Salmon Program, Little White Salmon NFH Tule Fall Chinook Salmon Program, Bonneville Hatchery Tule Fall Chinook Salmon Program, Hood River Spring Chinook Salmon Program, Deep River Net Pens Tule Fall Chinook, Klaskanine Hatchery Tule Fall Chinook, Bonneville Hatchery Fall Chinook, Little White Salmon NFH Tule Fall Chinook, Cathlamet Channel Net Pens Spring Chinook, and Little White Salmon NFH Spring Chinook

[1] The designations "(C)" and "(G)" identify core and genetic legacy populations, respectively.[13]

Thirty-two historical populations within six Major Population Groups (MPGs) comprise the LCR Chinook Salmon ESU. The populations are distributed through three ecological zones.[14] A combination of life-history types based on run timing and the ecological zones result in the six MPGs, some of which are considered extirpated or nearly so (**Table 2-5).** The run timing distributions across the 32 historical populations are 9 spring populations, 21 early-fall populations, and 2 late-fall populations (**Figure 2-2**).

[13] Core populations are defined as those that, historically, represented a substantial portion of the species abundance. Genetic legacy populations are defined as those that have had minimal influence from nonendemic fish due to artificial propagation activities, or that may exhibit important life history characteristics no longer found throughout the ESU (WLC-TRT 2003).

[14] There are many ways to classify freshwater, terrestrial, and climatic regions. The WLC TRT used the term ‘ecological zone’ as a reference, in combination with an understanding of the ecological features relevant to salmon, to designate four ecological areas in the domain: (1) Coast Range zone, (2) Cascade zone, (3) Columbia Gorge zone, and (4) Willamette zone. This concept provides geographic structure to ESUs in the domain. Maintaining each life-history type across the ecological zones reduces the probability of shared catastrophic risks. Additionally, ecological differences among zones reduce the impact of climate events across entire ESUs (Myers et al. 2003).

Table 2-5. Current status for LCR Chinook salmon populations and recommended status under the recovery scenario (NMFS 2013b).

Major Population Group	Population (State)	Status Assessment		Recovery Scenario	
		Baseline Persistence Probability[1]	Contribution[2]	Target Persistence Probability	Abundance Target[3]
Cascade Spring	Upper Cowlitz (WA)	VL	Primary	H+	1,800
	Cispus (WA)	VL	Primary	H+	1,800
	Tilton (WA)	VL	Stabilizing	VL	100
	Toutle (WA)	VL	Contributing	M	1,100
	Kalama (WA)	VL	Contributing	L	300
	North Fork Lewis (WA)	VL	Primary	H	1,500
	Sandy (OR)	M	Primary	H	1,230
Gorge Spring	White Salmon (WA)	VL	Contributing	L+	500
	Hood (OR)	VL	Primary[4]	VH[4]	1,493
Coast Fall	Youngs Bay (OR)	L	Stabilizing	L	505
	Grays/Chinook (WA)	VL	Contributing	M+	1,000
	Big Creek (OR)	VL	Contributing	L	577
	Elochoman/Skamokawa (WA)	VL	Primary	H	1,500
	Clatskanie (OR)	VL	Primary	H	1,277
	Mill/Aber/Germ (WA)	VL	Primary	H	900
	Scappoose (OR)	L	Primary	H	1,222
Cascade Fall	Lower Cowlitz (WA)	VL	Contributing	M+	3,000
	Upper Cowlitz (WA)	VL	Stabilizing	VL	--
	Toutle (WA)	VL	Primary	H+	4,000
	Coweeman (WA)	VL	Primary	H+	900
	Kalama (WA)	VL	Contributing	M	500
	Lewis (WA)	VL	Primary	H+	1,500
	Salmon (WA)	VL	Stabilizing	VL	--
	Clackamas (OR)	VL	Contributing	M	1,551
	Sandy (OR)	VL	Contributing	M	1,031
	Washougal (WA)	VL	Primary	H+	1,200
Gorge Fall	Lower Gorge (WA/OR)	VL	Contributing	M	1,200
	Upper Gorge (WA/OR)	VL	Contributing	M	1,200
	White Salmon (WA)	VL	Contributing	M	500
	Hood (OR)	VL	Primary[4]	H[4]	1,245

Major Population Group	Population (State)	Status Assessment		Recovery Scenario	
		Baseline Persistence Probability[1]	Contribution[2]	Target Persistence Probability	Abundance Target[3]
Cascade Late Fall	North Fork Lewis (WA)	VH	Primary	VH	7,300
	Sandy (OR)	H	Primary	VH	3,561

[1] The Lower Columbia River Fish Recovery Board (LCFRB) (2010) used the late 1990s as a baseline period for evaluating status; ODFW (2010) assumed average environmental conditions of the period 1974 to 2004. VL = very low, L = low, M = moderate, H = high, VH = very high. These are adopted in the recovery plan (NMFS 2013b).

[2]Primary, contributing, and stabilizing designations reflect the relative contribution of a population to recovery goals and delisting criteria. Primary populations are targeted for restoration to a high or very high persistence probability. Contributing populations are targeted for medium or medium-plus viability. Stabilizing populations are those that will be maintained at current levels (generally low to very low viability), which is likely to require substantive recovery actions to avoid further degradation.

[3]Abundance objectives account for related goals for productivity (NMFS 2013b).

[4]Oregon analysis indicates a low probability of meeting the delisting objectives for these populations.

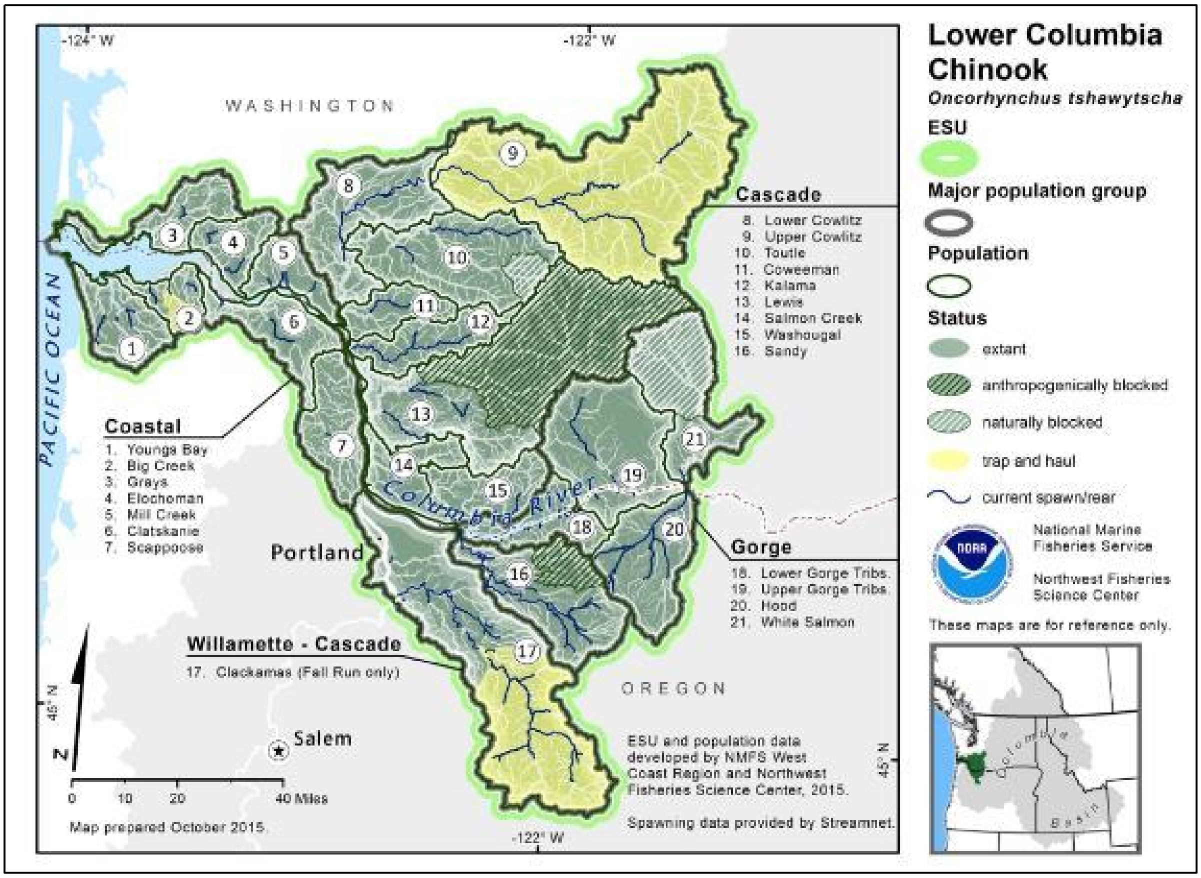

Figure 2-2. Map of the LCR Chinook Salmon ESU's spawning and rearing areas, illustrating populations and MPGs. Several watersheds contain or historically contained both fall and spring runs; only the fall-run populations are illustrated here (NWFSC 2015).

Chinook salmon have a wide variety of life-history patterns that include the following: variation in age at seaward migration; length of freshwater, estuarine, and oceanic residence; ocean distribution; ocean migratory patterns; and age and season of spawning migration. Two distinct races of Chinook salmon are generally recognized: "stream-type" and "ocean-type" (Healey 1991; Myers et al. 1998). The proposed action affects both types of Chinook salmon. Ocean-type Chinook salmon reside in coastal ocean waters for three to four years before returning to freshwater, They exhibit extensive offshore ocean migrations, compared to stream-type Chinook salmon that spend two to three years in coastal ocean waters. The ocean-type Chinook also enter freshwater to return for spawning later (May and June) than the stream-type (February through April). Ocean-type Chinook salmon use different areas in the river; they spawn and rear in lower-elevation, mainstem rivers, and they typically reside in fresh water for no more than three months, compared to stream-type Chinook salmon that spawn and rear high in the watershed and reside in freshwater for a year.

LCR Chinook salmon are classified into three life-history types including spring runs, early-fall runs ("tules," pronounced (too-lees)), and late-fall runs ("brights") based on when adults return to freshwater (**Table 2-6**). LCR spring Chinook salmon are stream-type, while LCR early-fall and late-fall Chinook salmon are ocean-type. Other life-history differences among run types include the timing of spawning, incubation, emergence in freshwater, migration to the ocean, maturation, and return to freshwater. This life-history diversity allows different runs of Chinook salmon to use streams as small as 10 feet wide (3 m) and rivers as large as the mainstem Columbia (NMFS 2013b). Stream characteristics determine run type distribution among LCR streams. Depending on run type, Chinook salmon may rear for a few months to a year or more in freshwater streams, rivers, or the estuary before migrating to the ocean in spring, summer, or fall. All runs migrate far into the north Pacific on a multi-year journey along the continental shelf to Alaska before circling back to their river of origin. The spawning run typically includes three or more age classes. Adult Chinook salmon are the largest of the salmon species, and LCR fish occasionally reach sizes up to 25 kilograms (55 lbs). Chinook salmon require clean gravels for spawning and pool and side-channel habitats for rearing. All Chinook salmon die after spawning once (NMFS 2013b).

Table 2-6. Life-history and population characteristics of LCR Chinook salmon.

	Life-History Features		
Characteristic	**Spring**	**Early-fall (tule)**	**Late-fall (bright)**
Number of extant population	9	21	2
Life-history type	Stream	Ocean	Ocean
River entry timing	March-June	August-September	August-October
Spawn timing	August-September	September-November	November-January
Spawning habitat type	Headwater large tributaries	Main stem large tributaries	Main stem large tributaries
Emergence timing	December-January	January-April	March-May
Duration in freshwater	Usually 12-14 months	1-4 months, a few up to 12 months	1-4 months, a few up to 12 months
Rearing habitat	Tributaries and main stem	Main stem, tributaries, sloughs, estuary	Main stem, tributaries, sloughs, estuary
Estuarine use	A few days to weeks	Several weeks up to several months	Several weeks up to several months
Ocean migration	As far north as Alaska	As far north as Alaska	As far north as Alaska
Age at return	4-5 years	3-5 years	3-5 years
Recent natural spawners	800	6,500	9,000
Recent hatchery adults	12,600 (1999-2000)	37,000 (1991-1995)	NA

All LCR Chinook salmon runs have been designated as part of an LCR Chinook Salmon ESU that includes natural populations in Oregon and Washington from the ocean upstream to and including the

White Salmon River in Washington and the Hood River in Oregon. Fall Chinook salmon (tules and brights) historically were found throughout the entire range, while spring Chinook salmon historically were only found in the upper portions of basins with snowmelt driven flow regimes (western Cascade Crest and Columbia Gorge tributaries) (LCFRB 2010). Bright Chinook salmon were identified in only two basins in the western Cascade Crest tributaries. In general, bright Chinook salmon mature at an older average age than either LCR spring or tule Chinook salmon, and they have a more northerly oceanic distribution. Currently, the abundance of all fall Chinook salmon greatly exceeds that of the spring component (NWFSC 2015).

Abundance, Productivity, Spatial Structure and Diversity:

Status of the species is determined based on the abundance, productivity, spatial structure, and diversity of its constituent natural populations. Best available information indicates that the species, in this case the LCR Chinook Salmon ESU, is at high risk and remains at threatened status. Each LCR Chinook salmon natural population baseline and target persistence probability level is summarized in **Table 2-5**, along with target abundance for each population that would be consistent with delisting. Persistence probability is measured over a 100-year time period and ranges from very low (probability less than 40 percent) to very high (more than 99 percent) probability.

NMFS (2013b) commented on the uncertainties and practical limits to achieving high viability for the spring and tule populations in the Gorge MPGs. Recovery opportunities in the Gorge were limited by the small numbers of natural populations and the high uncertainty related to restoration because of Bonneville Dam passage and inundation of historically productive habitats. NMFS also recognized the uncertainty regarding the TRT's MPG delineations between the Gorge and Cascade MPG populations and that several Chinook salmon populations downstream from Bonneville Dam may be quite similar to those upstream of Bonneville Dam. As a result, the recovery plan recommends that additional natural populations in the Coast and Cascade MPGs achieve recovery status to provide a safety factor to offset the anticipated shortcomings for the Gorge MPGs. This was considered a more precautionary approach to recovery than merely assuming that efforts related to the Gorge MPG would be successful.

Based on the information provided by the Willamette/Lower Columbia River (WLC) TRT and the management unit recovery planners, NMFS concluded in the recovery plan that the recovery scenario in **Table 2-5** represents one of multiple possible scenarios that would meet biological criteria for delisting. The similarities between the Gorge and Cascade MPGs, coupled with compensation in the other strata for not meeting TRT criteria in the Gorge stratum, would provide an ESU no longer likely to become endangered.

Cascade Spring MPG

LCR spring Chinook salmon natural populations occur in both the Gorge and Cascade MPGs (**Table 2-7**). There are seven LCR spring Chinook salmon populations in the Cascade MPG. The most recent estimates of minimum in-river run size and escapement totals for LCR spring Chinook salmon is provided in **Table 2-7**. The combined hatchery-origin and natural-origin LCR spring Chinook salmon run sizes for the Cowlitz, Kalama, and Sandy River populations have all numbered in the thousands in recent years (**Table 2-7**). The Cowlitz and Lewis populations are currently managed for hatchery production since most of the historical spawning habitat has been inaccessible due to hydro development in the upper basin (LCFRB 2010). Cowlitz and Kalama river hatcheries' escapement objectives have been met in recent years with few exceptions (**Table 2-7**).

Table 2-7. Total tributary returns for LCR spring Chinook along with hatchery escapement and natural spawning estimates (TAC 2017, Table 2.1.10).

	Cowlitz			Kalama			Lewis			Sandy		
Year	**Total Tributary Return**	**Hatchery Escapement (rack return goal: 1,337)[1]**	**Natural-origin Spawners**	**Total Tributary Return**	**Hatchery Escapement (rack return goal: 300)[2]**	**Natural-origin Spawners**	**Total Tributary Return**	**Hatchery Escapement (rack return goal: 1,380)[3]**	**Natural-origin Spawners**	**Total Tributary Return**	**Hatchery Escapement**	**Natural-origin Spawners**
1997	1,877	1,298	437	505	576	39	2,196	2,245	410	4,410	na	na
1998	1,055	812	262	407	408	42	1,611	1,148	211	3,577	na	na
1999	2,069	1,321	235	977	794	215	1,753	845	241	3,585	na	na
2000	2,199	1,408	264	1,418	1,256	33	2,515	776	473	3,641	na	na
2001	1,609	1,306	315	1,796	952	555	3,777	1,193	678	5,329	na	na
2002	5,152	2,713	781	2,912	1,374	886	3,514	1,865	493	5,905	na	1,445
2003	15,954	10,481	2,485	4,556	3,802	766	5,040	3,056	679	5,615	na	968
2004	16,511	12,596	2,048	4,286	3,421	352	7,475	4,235	494	12,680	2,950	4,010
2005	9,379	7,503	539	3,367	2,825	380	3,512	2,219	116	7,668	1,830	2,305
2006	6,963	5,379	816	5,458	4,313	292	7,301	4,130	847	4,382	981	2,280
2007	3,975	3,089	144	8,030	4,748	2,146	7,596	3,897	264	2,813	28	1,418
2008	2,986	1,895	484	1,623	940	362	2,215	1,386	25	5,994	163	6,610
2009	6,034	3,604	819	404	170	26	1,493	1,068	58	2,429	261	2,623
2010	8,585	5,920	286	977	467	0	2,347	1,896	157	7,652	652	8,215
2011	5,308	1,992	191	776	275	200	1,310	1,101	90	5,721	635	2,640
2012	12,144	5,589	321	889	285	28	1,895	1,294	190	5,038	424	2,735
2013	8,157	3,762	409	1,014	732	158	1,570	1,785	60	5,700	730	2,413
2014	8,310	4,591	227	1,013	709	187	1,396	1,009	403	5,971	1,016	1,658
2015	23,596	17,600	na	3,149	2,642	na	1,006	908	147	4,657	365	2,023
2016	22,478	na	na	3,980	na	na	473	na	na	4,151	123	3,590

Hatchery and natural spawners will not add to total due to sport harvest that is not included.

1. Cowlitz River Spring Chinook salmon brood origin hatchery returns are collected on-station at the Cowlitz Salmon Hatchery.
2. Kalama River Spring Chinook salmon brood origin hatchery returns are collected on-station at the Kalama Falls Hatchery.
3. Lewis River Spring Chinook salmon brood origin hatchery returns are collected at the Merwin Dam Fish Collection Facility, and on-station at the Lewis River Hatchery.

A reintroduction program now being implemented on the Cowlitz River involves trap and haul of adults and juveniles. The reintroduction program for the upper Cowlitz and Cispus Rivers above Cowlitz Falls Dam is consistent with the recommendations of the recovery plan and constitutes the initial steps in a more comprehensive recovery strategy. However, the program is currently limited by low collection efficiency of out-migrating juveniles at Cowlitz Falls Dam and by lack of productivity in the Tilton Basin because of relatively poor habitat quality. Some unmarked adults, meaning unknown origin (hatchery or natural), return voluntarily to the hatchery intake, but, for the time being, the reintroduction program relies primarily on the use of surplus hatchery adults. Information on the hatchery program and the associated Settlement Agreement with Tacoma Power can be found at the following site: *https://www.mytpu.org/tacomapower/fish-wildlife-environment/cowlitz-river-project/cowlitz-fisheries-programs/*. The reintroduction program facilitates the use of otherwise vacant habitat, but cannot be self-sustaining until low juvenile collection problems are solved, and other limiting factors are addressed. Efforts are underway to improve juvenile collection facilities. Given the current circumstances, NMFS's first priority is to manage populations to achieve the hatchery escapement goals and thereby preserve the genetic heritage of the population. Preservation of genetic heritage reduces the extinction risk of the population, should passage problems continue, and acts as a safety valve for the eventual recovery of the Cowlitz population.

A reintroduction program is also in place for the Lewis River as described in the Lewis River Hatchery and Supplementation Plan (Jones & Stokes Associates 2009). Out-planting of hatchery spring Chinook salmon adults began in 2012 after completion of downstream passage facilities.

While the Cowlitz and Kalama River systems have all met their hatcheries escapement objectives in recent years, with few exceptions, based on the goals established in their respective HGMPs (**Table 2-7**), more recently, the Lewis River system has not met its goals. Meeting these escapement objectives at least ensures that what remains of the genetic legacy of these natural populations is preserved and can be used to advance recovery. The existence of these hatchery programs reduces extinction risk, in the short term.

The historical significance of the Kalama population to the overall LCR Chinook Salmon ESU was likely limited because habitat there was probably not as productive for spring Chinook salmon compared to the other spring Chinook salmon populations in the ESU (NMFS 2013). In the recovery scenario, the Kalama spring Chinook salmon population is designated as a contributing population targeted for a relatively lower persistence probability, because habitat there was not as historically productive for spring Chinook salmon (**Table 2-5**) (NMFS 2013).

Legacy effects of the 1980 Mount St. Helens eruption are still a fundamental limiting factor for the Toutle River spring Chinook salmon natural population (NMFS 2013). The North Fork Toutle River was the area most affected by the blast and resulting sedimentation from the eruption. Because of the eruption, a sediment retention structure (SRS) was constructed to manage the ongoing input of fine sediments into the lower river. Nonetheless, the SRS is a continuing source of fine sediments and blocks passage to the upper river. A trap and haul system was implemented and operates annually from September to May to transport adult fish above the SRS. The transport program provides access to 50 miles of anadromous fish habitat located above the structure (NMFS 2013) but that habitat is still in very poor condition. There is relatively little known about current natural spring Chinook salmon production in this basin. The Toutle River population has been designated a contributing population targeted for medium persistence probability under the recovery scenario (**Table 2-5**).

The baseline persistence probability of the Sandy River spring natural population is currently medium. This population is designated as a primary population targeted for high persistence probability and, thus, is likely to be important to the overall recovery of the ESU (Table 10). Marmot Dam in the upper Sandy watershed was used as a counting and sorting site in prior years, but the Dam was removed in October 2007. The abundance component of the persistence probability goal for Sandy River spring Chinook salmon is 1,230 natural-origin fish (**Table 2-5**), and the return of natural-origin fish has exceeded this goal in recent years. The total return of spring Chinook salmon to the Sandy River, including ESA-listed hatchery fish, has averaged more than 5,500 since 2000 (**Table 2-5**). Although the abundance criterion has been exceeded in recent years, other aspects of the VSP criteria would have to improve for the population to achieve the higher persistence probability level that is targeted.

Gorge Spring MPG

The Hood River and White Salmon natural populations are the only populations in the Gorge Spring MPG. The 2005 Biological Review Team (BRT) described the Hood River spring run as “extirpated or nearly so” (Good et al. 2005), and the 2005 ODFW Native Fish Status report describes the population as extinct (ODFW 2005). NMFS reaffirmed its conclusion that Hood River spring Chinook salmon are in the Gorge Spring MPG in the most recent status review (NWFSC 2015). Additionally, the White Salmon River population is considered extirpated (NMFS 2013, Appendix C).

Most of the habitat that was historically available to spring Chinook salmon in the Hood River is still accessible. Because of the apparent extirpation of the population, Oregon initiated a reintroduction program using spring Chinook salmon from the Deschutes River. The nearest natural population of spring Chinook salmon is the Deschutes River population, but the population is part of a different ESU, the

MCR Chinook Salmon ESU. Although the reintroduction program has been underway since the mid-90s, it has not met its original goals for smolt-to-adult survival rates. Deficiencies are attributed to production practices (ISRP 2008; CTWSR 2009; NMFS 2013). The delisting persistence probability target is listed as very high, but NMFS (2013) believes that the prospects for meeting that target are uncertain. The estimates of spring Chinook salmon returning to the Hood River are in **Table 2-8**.

Table 2-8. Total, hatchery, and natural-origin Spring Chinook returns to the Hood River (TAC 2017, Table 2.1.11).

Year	Total Run Size [1]	Clipped Hatchery Run Size	Unclipped Presumed Natural-origin Run Size	Proportion Presumed Natural-origin
2001	602	560	42	7.0%
2002	170	101	69	40.6%
2003	400	338	62	15.5%
2004	242	98	144	59.5%
2005	696	589	107	15.4%
2006	1,236	939	297	24.0%
2007	460	327	133	28.9%
2008	997	936	61	6.1%
2009	1,314	1,248	66	5.0%
2010	635	507	128	20.2%
2011	1,377	1,377	na	na
2012	1,114	1,114	na	na
2013	860	820	40	4.7%
2014	1,111	1,086	25	2.3%
2015	2,331	2,223	108	4.6%
2016	1,996	1,846	150	7.5%
5 yr avg	1,482	1,418	81	3.8%

1. Run size from ODFW. Powerdale dam counts prior to 2010.

The White Salmon River natural population is also considered extirpated. Condit Dam was completed in 1913 with no juvenile or adult fish passage, thus precluding access to all essential habitat. The breaching of Condit Dam in 2011 provided an option for recovery planning in the White Salmon River. The recovery plan calls for monitoring escapement into the basin for four to five years to see if natural recolonization occurs (abundance estimates prior to 2012 reflected fish spawning below Condit Dam during the spring run temporal spawning window) (NWFSC 2015). Sometime during or at the end of the interim monitoring program, a decision will be made about whether to proceed with a reintroduction program using hatchery fish; however, there are not enough data available yet to evaluate that action. The recovery scenario described in the recovery plan identifies the White Salmon spring population as a contributing population with a low plus persistence probability target (**Table 2-9**).

Coast Fall MPG

There are seven natural populations in the Coast Fall Chinook salmon MPG. None is considered a genetic legacy population. The baseline persistence probability of five of the seven populations in this MPG is listed as very low, whereas the remaining two populations are listed as low (Youngs Bay and Scappoose) (**Table 2-5**). All of the populations are targeted for improved persistence probability in the recovery scenario. The Elochoman/Skamokawa, Clatskanie, Mill/Abernathy/Germany (M/A/G), and Scappoose populations are targeted for high persistence, while the Grays River population is targeted for medium plus persistence probability. The Big Creek and Youngs Bay populations are targeted for low persistence probability (**Table 2-5**).

Populations in this MPG are subject to significant levels of hatchery straying (Beamesderfer et al. 2011). There was a Chinook salmon hatchery on the Grays River, but that program was closed in 1997, with the last hatchery returns to the river in 2002. A temporary weir was installed on the Grays River for the first time in 2008 to quantify escapement and to help control the number of hatchery strays, from hatchery programs outside the Grays River. As it turns out, a large number of out-of-ESU Rogue River "brights" from the Youngs Bay net pen programs were observed at the weir; by 2010, the weir was functionally able to begin removing hatchery strays. The escapement data reported in **Table 2-9** have been updated through 2015 relative to those reported in the 2010 status review (Ford 2011). More recent information is reported in WDFW's Salmon Conservation and Reporting Engine online system (see **Table 2-9** citations).

The Elochoman had an in-basin fall Chinook salmon hatchery production program that released 2,000,000 fingerlings annually. That program was closed in 2009 (NMFS 2013). The last returns of these hatchery fish were probably in 2014. Closure of the hatchery program is consistent with the overall transition and hatchery reform strategy for tule Chinook salmon. The number of spawners in the Elochoman has ranged from several hundred to several thousand in recent years (**Table 2-9)** with most being hatchery-origin spawners (Beamesderfer et al. 2011). The M/A/G population does not have an in-basin hatchery program, but it still has several hundred hatchery spawners each year. Numbers have, however, decreased slightly in the most recent years (**Table 2-9**).

Table 2-9. Early-fall (tule) Chinook salmon (in Coast MPG) total natural spawner abundance estimates (natural- and hatchery-origin fish combined) and the proportion of hatchery-origin fish (pHOS[1]) on the spawning grounds for the Coast Fall MPG populations, 1997 to 2015 (from WDFW SCoRE[2]).

Year	Clatskanie[3]	pHOS	Grays	pHOS	Elochoman[4]	pHOS	M/A/G[4]	pHOS	Youngs Bay[3]	pHOS
1997	7	na	12	na	2,137	na	595	na	na	na
1998	9	na	93	na	358	na	353	na	na	na
1999	10	na	303	na	957	na	575	na	na	na
2000	26	90%	89	na	146	na	370	na	na	na
2001	26	90%	241	na	2,806	na	3,860	na	na	na
2002	39	90%	78	na	7,893	na	3,299	na	na	na
2003	48	90%	373	na	7,384	na	3,792	na	na	na
2004	11	90%	726	na	6,880	na	4,611	na	na	na
2005	10	90%	122	na	2,699	na	2,066	na	na	na
2006	4	90%	383	na	324	na	622	na	na	na
2007	9	90%	96	na	168	na	335	na	na	na
2008	9	90%	33	65%	1,320	na	780	na	na	na
2009	94	44%	210	62%	1,467	na	604	na	na	na
2010	12	88%	70	55%	154	88%	194	93%	1,152	0%
2011	12	100%	70	83%	59	95%	111	93%	1,584	61%
2012	6	92%	43	79%	64	73%	23	88%	170	97%
2013	3	92%	189	91%	187	71%	207	80%	409	95%
2014	7	91%	322	56%	192	78%	65	90%	119	95%
2015	6	91%	156	85%	313	68%	92	91%	382	81%

[1] Proportion of hatchery-origin spawners (pHOS): hatchery fish escaping to the spawning grounds. For example, Clatskanie in 2007 had nine natural-origin spawners and 90 percent hatchery spawners. To calculate hatchery-origin numbers, multiply (9/ (1-.90))-9 = 81 hatchery-origin spawners.

[2] Online at https://fortress.wa.gov/dfw/score/score/recovery/recovery.jsp#score Date Accessed: April 15, 2016.

[3] Clatskanie and Youngs Bay estimates are from http://odfwrecoverytracker.org/explorer/species/Chinook/run/fall/esu/241/244/, 2012 Youngs Bay estimate is from http://odfw.forestry.oregonstate.edu/spawn/pdf%20files/reports/2012-13LCTuleSummary%20.pdf Date accessed: May 19, 2016.

[4] Elochoman and M/A/G estimates from 1997 to 2009 are considered a proportion on the WDFW SCORE website. Elochoman estimates include the Skamokawa Creek Fall Chinook Spawners (proportion).

ODFW reported that hatchery strays contributed approximately 90 percent of the fall Chinook salmon spawners in both the Clatskanie River and Scappoose Creek over the last 30 years (ODFW 2010). New information was considered when developing the status of the Clatskanie and Scappoose natural populations. Problems with the previous Clatskanie estimates are summarized in Dygert (2011). Escapement estimates for Clatskanie from 1974 to 2006 were based on expanded index counts, meaning if index counts were less than five, they were replaced with values based on averages of neighboring years. This occurred for 11 of the 33 years in the data set. From 2004 to 2006, there was also computational error in the data reported, resulting in estimates that were approximately twice as high as they should have been. Index counts in the Clatskanie River since 2006 (i.e., not using the expanded index counts) continue to show few natural spawners.

Surveys were conducted in Scappoose Creek for the first time from 2008 to 2010; two spawning adults were observed in 2008, but none was seen in 2009 or 2010. All of the information above suggests that there are significant problems with the historical time series for the Clatskanie River used in the past and that there is currently very little spawning activity in either the Clatskanie River or Scappoose Creek.

Apparent problems with these escapement estimates have implications for earlier analyses that relied on those data. The Clatskanie data were used in life-cycle modeling analysis done by the NWFSC (2010). The Clatskanie data were also used indirectly for the modeling analysis of the Scappoose natural population. Because there were no direct estimates of abundance for the Scappoose, the data from the Clatskanie were rescaled to account for difference in subbasin size and then used in the life-cycle analysis for the Scappoose population. Results from the life-cycle analysis indicated that spawners in both locations were supported largely by hatchery strays and that juvenile survival rates were inexplicably low relative to the generic survival rates used in the analysis. The general conclusion of the life-cycle analysis was that the populations were unproductive and not viable under current conditions. If there are substantive flaws in the escapement data, then results from the life-cycle analysis are also flawed. The general conclusion of the life-cycle analysis is still probably correct—the populations are not viable. But recent data suggest that there are, in fact, few hatchery strays and little or no natural production in the Clatskanie River or Scappoose Creek, and the natural populations may be extirpated or nearly so. Confirmation of these tentative conclusions will depend on more monitoring.

The Big Creek and Youngs Bay natural populations are both proximate to large net pen rearing and release programs designed to provide for a localized, terminal fishery in Youngs Bay. ODFW estimates that 90 percent of the fish that spawn in these areas are hatchery strays (**Table 14)**. The number of fish released at the Big Creek hatchery has been reduced, with additional changes in hatchery practices to help reduce straying into the Clatskanie and other neighboring systems. These are examples of actions the states have taken as part of a comprehensive program of hatchery reform to address the effects of hatcheries. The nature and scale of the reform actions were described in more detail in Frazier (2011) and Stahl (2011).

Cascade Fall MPG

There are ten natural populations of fall Chinook salmon in the Cascade MPG. Of these, only the Coweeman and East Fork Lewis are considered genetic legacy populations. The baseline persistence probability of all of these populations is very low (**Table 2-5**). These determinations were generally based on assessments of status at the time of listing. The Lower Cowlitz, Kalama, Clackamas, and Sandy populations are targeted for medium persistence probability and Toutle, Coweeman, Lewis, and Washougal populations are targeted for high-plus persistence probability in the ESA recovery plan. The target persistence probability for the other two populations is very low: Salmon Creek, a population within a highly urbanized subbasin with limited habitat recovery potential, and Upper Cowlitz, a population with reintroduction of spring Chinook salmon as the main recovery effort (NMFS 2013) (**Table 2-5**).

Total escapements (natural-origin and hatchery fish combined) to the Coweeman and East Fork Lewis have averaged 735 and 612, respectively, over the last 18 years (**Table 2-10**) The recovery abundance target for the Coweeman population is 900 natural-origin fish and 1,500 natural-origin fish for the East Fork Lewis population (**Table 2-5**). The historical contribution of hatchery spawners to the Coweeman and East Fork Lewis populations is relatively low compared to that of other populations (Beamesderfer et al. 2011). The Kalama, Washougal, Toutle, and Lower Cowlitz natural populations are all associated with significant in-basin hatchery production and are subject to large numbers of hatchery strays (Beamesderfer et al. 2011). NMFS has less information on returns to the Clackamas and Sandy Rivers, but ODFW indicated that 90 percent of the spawners for both are likely hatchery strays from as many as three adjacent hatchery programs (NMFS 2013, Appendix A).

The Coweeman and Lewis populations do not have in-basin hatchery programs, and they are generally subject to less straying. Broodstock management practices for hatcheries are being revised to reduce the level of straying and the resulting effects when straying occurs. Weirs are being operated on the Kalama River to assist with brood stock management, and on the Coweeman and Washougal Rivers to further assess and control hatchery straying in each system. These are examples of actions the states have taken as part of a comprehensive program of hatchery reform to address the effects of hatcheries. The nature and scale of the reform actions were described in more detail in Frazier (2011) and Stahl (2011).

Table 2-10. LCR tule Chinook salmon total natural spawner escapement (natural-origin and hatchery fish combined) and the proportion of hatchery-origin fish (pHOS[1]) on the spawning grounds for Cascade Fall MPG populations, 1997 to 2015 (from WDFW SCoRE[2])*.

Year	Coweeman	pHOS	Washougal	pHOS	Kalama	pHOS	EF Lewis	pHOS	Upper Cowlitz[3]	pHOS	Lower Cowlitz	pHOS	Toutle[4]	pHOS
1997	689	na	4,529	na	3,539	na	307	na	27	na	2,710	na	na	na
1998	491	na	2,971	na	4,318	na	104	na	257	na	2,108	na	1,353	na
1999	299	na	3,105	na	2,617	na	217	na	1	na	997	na	720	na
2000	290	na	2,088	na	1,420	na	304	na	1	na	2,363	na	879	na
2001	802	na	3,836	na	3,613	na	526	na	3,646	na	4,652	na	4,971	na
2002	877	na	5,725	na	18,809	na	1,296	na	6,113	na	13,514	na	7,896	na
2003	1,106	na	3,440	na	24,710	na	714	na	4,165	na	10,048	na	13,943	na
2004	1,503	na	10,404	na	6,612	na	886	na	2,145	na	4,466	na	4,711	na
2005	853	na	2,671	na	9,168	na	598	na	2,901	na	2,870	na	3,303	na
2006	566	na	2,600	na	10,386	na	427	na	1,782	na	2,944	na	5,752	na
2007	251	na	1,528	na	3,296	na	237	na	1,325	na	1,847	na	1,149	na
2008	424	na	2,491	na	3,734	na	379	na	1,845	na	1,828	na	1,725	na
2009	783	na	2,741	na	7,546	na	596	na	7,491	na	2,602	na	539	na
2010	446	30%	833	86%	832	88%	378	64%	3,700	62%	3,169	29%	275	87%
2011	500	12%	842	82%	599	93%	827	71%	5,029	62%	2,782	25%	338	79%
2012	412	11%	305	72%	517	93%	601	52%	1,951	68%	1,946	29%	259	73%
2013	1,398	31%	3,018	58%	1,037	91%	1,441	85%	3,287	55%	3,593	19%	950	58%
2014	857	4%	1,362	33%	1,029	91%	856	57%	na	na	na	na	371	50%
2015	1,430	1%	1,703	57%	3,598	50%	947	50%	na	na	na	na	440	39%

[1] Proportion of hatchery-origin spawners (pHOS): hatchery fish escaping to the spawning grounds. [1] For example, Coweeman in 2013 had 1,398 natural-origin spawners and 31 percent hatchery spawners. To calculate hatchery-origin numbers, multiply (1,398/ (1-.31))-1,398 = 628 hatchery-origin spawners.

[2] Online at https://fortress.wa.gov/dfw/score/score/recovery/recovery.jsp#score.

* Date Accessed: April 18, 2016.

[3] Upper Cowlitz includes the Cispus portions of the Cowlitz River. Only natural spawner abundance estimates are shown. No data exist for 2014-2015 as of date of website access.

[4] Toutle River numbers include both the North Fork Toutle (Green River) and South Fork Toutle River fall (tule) Chinook salmon.

Gorge Fall MPG

There are four natural populations of tule Chinook salmon in the Gorge Fall Chinook salmon MPG: Lower Gorge, Upper Gorge, White Salmon, and Hood. The baseline persistence probability for all these populations is very low (**Table 2-5**). The recovery plan targets the White Salmon and Lower and Upper Gorge populations for medium persistence probability, and the Hood River population for high persistence although, as discussed earlier in this subsection, it is unlikely that the high viability objective can be met (**Table 2-5**). There is some uncertainty regarding the historical role of the Gorge populations in the ESU and whether they truly functioned historically as demographically independent populations (NMFS 2013). This is accounted for in the recovery scenario presented in the recovery plan.

Natural populations in the Gorge Fall MPG have been subject to the effects of a high incidence of hatchery fish straying and spawning naturally. The White Salmon population, for example, was limited by Condit Dam, as discussed above regarding Gorge Spring MPG, and natural spawning occurred in the river below the dam (NMFS 2013, Appendix C). The number of fall Chinook salmon spawners in the White Salmon increased from low levels in the early 2000s to an average of 1,086 for the period from 2010 to 2015 (**Table 2-10**). However, spawning is dominated by tule Chinook salmon strays from the neighboring Spring Creek Hatchery and upriver bright Chinook salmon from the production program in the adjoining Little White Salmon River, which are not part of the LCR Chinook ESU. The Spring Creek Hatchery, which is located immediately downstream from the Little White Salmon River mouth, is the largest tule Chinook salmon production program in the Columbia Basin, releasing approximately 10 million smolts annually. The White Salmon River was the original source for the hatchery brood stock, so whatever remains of the genetic heritage of the population is contained in the mix of hatchery and natural spawners. There is relatively little known about current natural-origin fall Chinook salmon production in this basin, but it is presumed to be low.

The breaching of Condit Dam is likely to add silt to the lower reaches of the White Salmon utilized for spawning. The White Salmon Working Group, consisting of staff from the U.S. Fish and Wildlife Service (USFWS), Yakama Nation, WDFW, NMFS, PacifiCorp, and U.S. Geological Survey, out-planted adult fall Chinook salmon upstream of Condit Dam in 2011 prior to the breaching, in lieu of adult collection and subsequent propagation. This was a one-time conservation measure to mitigate for the impacts of the expected sediment released downstream. As part of this measure, the White Salmon Working Group collected 552 natural-origin and 127 hatchery-origin returning Chinook salmon (of which 299 were females) at the White Salmon weir located adjacent to the White Salmon hatchery ponds at river mile 1.4 and transported them upstream of Northwestern Lake reservoir (NMFS 2012). No additional trap and haul operations are planned at this time. Natural escapement and production will be monitored for the next four to five years. Thereafter, a decision will be made about the role of hatchery propagation in future plans for recovery (NMFS 2013).

There is relatively little specific or recent information on the abundance of tule Chinook salmon for the other natural populations in the Gorge Fall MPG (**Table 2-10**). Stray hatchery fish are presumed to be decreasing contributors towards the spawning populations in these tributaries due to recent reductions in overall Gorge MPG hatchery releases, including the recent discontinuation of tule Chinook salmon releases from the Little White Salmon Hatchery. Hatchery strays still contribute to the escapement to the Lower Gorge, Upper Gorge, and Hood River populations on the Oregon side of the river (NMFS 2013, Appendix A). These populations are mostly influenced by hatchery strays from the Bonneville Hatchery located immediately below Bonneville Dam, and the Spring Creek Hatchery located just above Bonneville Dam. The natural-origin abundance of returning Chinook salmon on the Washington side of the Lower and Upper Gorge populations has been steadily increasing in recent years (**Table 2-10**). The tributaries in the Gorge on the Washington side of the river are similarly affected by hatchery strays, which the recent past five years of monitoring show stable pHOS levels (**Table 2-10**). As a consequence, hatchery-origin fish contribute at varying degrees to spawning levels in all of the Gorge area tributaries, but actual estimates are unknown for areas like Eagle Creek, Tanner Creek, and Herman Creek.

Table 2-11. LCR tule Chinook salmon total natural-origin spawner abundance estimates in Gorge Fall Strata populations, 2005 *to* 2015.

Year	Upper Gorge (WA estimates only) White Salmon[1,3]		White Salmon[1]		Hood River[2]	
	Natural-Origin Spawners	pHOS[2]	Natural-Origin Spawners	pHOS[2]	Natural-Origin Spawners	pHOS[2]
2005	452	na	1,448	na	42	14%
2006	235	na	755	na	49	11%
2007	263	na	898	na	45	0%
2008	181	na	770	na	21	22%
2009	343	na	964	na	57	12%
2010	334	22%	1,097	27%	na	na
2011	581	68%	335	12%	na	na
2012	286	68%	517	7%	na	na
2013	816	72%	829	32%	na	na
2014	779	71%	1,304	23%	na	na
2015	1,833	67%	557	52%	na	na

[1] Online at https://fortress.wa.gov/dfw/score/score/recovery/recovery.jsp#score
Date Accessed: April 18, 2016.

[2] For example, Hood River in 2005 had 42 natural-origin spawners and 14 percent hatchery spawners. To calculate hatchery-origin numbers, multiply (42/ (1-.14))-42 = ~7 hatchery-origin spawners.

[3] Upper Gorge natural-origin spawner abundance numbers include Little White Salmon and Wind River spawners.

Cascade Late Fall MPG

There are two late fall, “bright” Chinook salmon natural populations in the LCR Chinook Salmon ESU in the Sandy and Lewis Rivers. Both populations are in the Cascade MPG (**Table 2-4**). The baseline persistence probability of the Lewis and Sandy populations is very high and high, respectively; both populations are targeted for very high persistence probability under the recovery scenario (**Table 2-5**).

The Technical Advisory Committee (TAC) designated for the 2018 to 2027 *United States v. Oregon* Management Agreement provided estimates of the escapement of bright Chinook salmon to the Sandy River (**Table 2-12**). These estimates of spawning escapement are based on estimates of peak redd counts obtained from direct surveys in a 16-km index area that is expanded to estimates of spawning escapement by multiplying by a factor of 2.5 (TAC 2017). The recovery plan includes an appendix that describes how index counts are expanded to estimates of total abundance (ODFW 2010, Appendix C). There are some minor differences between the values reported in Appendix C and those shown in **Table 2-11** that reflect updates or revisions in prior index area estimates. The abundance target for delisting is 3,747 natural-origin fish (**Table 2-5**), and escapements have averaged about 3,000 natural-origin fish since 1995 (**Table 2-12**).

The Lewis River population is the principal indicator stock for management within the Cascade Late Fall MPG. It is a natural-origin population with little or no hatchery influence. The escapement goal, based on estimates of MSY, is 5,700. The escapement has averaged 9,000 over the last 10 years and has generally exceeded the goal by a wide margin since at least 1980. Escapement was below-goal from 2006 through 2008 (**Table 2-12**). The shortfall is consistent with a pattern of low escapements for other far-north migrating stocks in the region and can likely be attributed to poor ocean conditions. Escapement improved in 2009 and has been well above goal since (**Table 2-12**). NMFS (2013) identifies an abundance target under the recovery scenario of 7,300 natural-origin fish (**Table 2-5**), which is 1,600 more fish than the current escapement goal. The recovery target abundance is estimated from population viability simulations and is assessed as a median abundance over any successive 12-year period. The median escapement over the last 12 years is 8,580 fish, which exceeds the abundance objective (**Table 2-12**). Escapement to the Lewis River is expected to vary from year-to-year as it has in the past, but generally to remain high relative to the population’s escapement objectives, which suggests that the population is near capacity (NWFSC 2015).

Table 2-12. Annual escapement of natural-origin LCR bright Chinook salmon from 1995 to 2016.

Year	Lewis River[1, 2]	Sandy River
1995	9,718	1,036
1996	12,700	505
1997	8,168	2,001
1998	5,167	773
1999	2,639	447
2000	8,727	84
2001	11,267	824
2002	13,284	1,275
2003	12,816	619
2004	12,926	601
2005	9,775	770
2006	5,066	1,130
2007	3,708	171
2008	5,485	602
2009	6,281	318
2010	9,294	373
2011	8,205	1,019
2012	8,143	62
2013	15,197	1,253
2014	20,808	436
2015	23,631	1,274
2016	8,957	451

[1] Online at https://fortress.wa.gov/dfw/score/score/recovery/recovery.jsp#score.

* Date Accessed: August 21, 2016.

[2] Data are total spawner estimates of wild late fall (bright) Chinook.

Summary

Spatial structure and diversity are VSP attributes that are evaluated for the LCR Chinook Salmon ESU using a mix of qualitative and quantitative metrics. Spatial structure has been substantially reduced in many populations within the ESU (NMFS 2013). The estimated changes in VSP status for LCR Chinook salmon populations in **Table 2-13** indicate that a total of 7 of 32 populations are at or near their recovery viability goals, although under the recovery plan scenario only two of these populations had scores above 3.0, indicating these two are at a moderate level of viability. The remaining 25 populations generally require a higher level of viability, and most require substantial improvements to reach their viability goals

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(NWFSC 2015). The natural populations that did meet their recovery goals were able to do so because the goals were set at status quo levels.

Table 2-13. Summary of VSP scores and recovery goals for LCR Chinook salmon populations (NWFSC 2015).

MPG	State	Population	Total VSP Score	Recovery Goal
Cascade Spring	WA	Upper Cowlitz	0.5	3.5
	WA	Cispus	0.5	0.5
	WA	Tilton	0.5	2.0
	WA	Toutle	0.5	3.5
	WA	Kalama	0.5	1.0
	WA	NF Lewis	0.5	3.0
	OR	Sandy	2.0	3.0
Gorge Spring	WA	White Salmon	0.5	1.5
	OR	Hood	0	4.0
Coast Fall	OR	Youngs Bay	1.0	1.0
	WA	Grays/Chinook	0.5	2.5
	OR	Big Creek	0	1.0
	WA	Elochoman/Skamokawa	0.5	3.0
	OR	Clatskanie	0	3.0
	WA	Mill/Aber/Ger	0.5	3.0
	OR	Scappoose	1.0	3.0
Cascade Fall	WA	Lower Cowlitz	0.5	2.5
	WA	Upper Cowlitz	0.5	1.0
	WA	Toutle	0.5	3.5
	WA	Coweeman	0.5	3.5
	WA	Kalama	0.5	2.0
	WA	Lewis	4.0	4.0
	WA	Salmon	0.5	0.5
	OR	Clackamas	0	2.0
	OR	Sandy	0	2.0
	WA	Washougal	0.5	3.5
Gorge Fall	WA/OR	Lower Gorge	0.5	2.0
	WA/OR	Upper Gorge	0.5	2.0
	WA	White Salmon	0.5	2.0
	OR	Hood	0	3.0
Cascade Late Fall	WA	NF Lewis	0.5	3.5
	OR	Sandy	3.0	4.0

Notes: Summaries are taken directly from Figures 60 and 61, in NWFSC (2015). All are on a 4-point scale, with 4 being the lowest risk and 0 being the highest risk. VSP scores represent a combined assessment of population A/P spatial structure and diversity (McElhany et al. 2006). A VSP score of 3.0 represents a population with a 5 percent risk of extinction within a 100-year period.

Table 2-14 provides recently updated information about the A/P, spatial structure, diversity, and overall persistence probability for each population within the LCR Chinook Salmon ESU. Spatial structure has been substantially reduced in several populations. Low abundance, past broodstock transfers, other legacy hatchery effects, and ongoing hatchery straying may have reduced genetic diversity within and among LCR Chinook salmon populations. Hatchery-origin fish spawning naturally may also have reduced population productivity (NMFS 2016c).

Out of the 32 populations that make up this ESU, only the two late-fall "bright" runs—the North Fork Lewis and Sandy—are considered viable. Most populations (26 out of 32) have a very low probability of persistence over the next 100 years (and some are extirpated or nearly so; NMFS 2016c). Five of the six strata fall significantly short of the WLCTRT criteria for viability; one stratum, Cascade late-fall, meets the WLC TRT criteria (NMFS 2013; 2016).

A/P ratings for LCR Chinook salmon populations are currently low to very low for most populations, except for spring Chinook salmon in the Sandy River (moderate) and late-fall Chinook salmon in North Fork Lewis River and Sandy River (very high for both) (Table (NMFS 2016c). For some of these populations with low or very low A/P ratings, low abundance of natural-origin spawners (100 fish or fewer) has increased genetic and demographic risks. Other LCR Chinook salmon populations have higher total abundance, but several of these also have high proportions of hatchery-origin spawners. For tule fall Chinook salmon populations, poor data quality prevents precise quantification of population abundance and productivity; data quality has been poor because of inadequate spawning surveys and the presence of unmarked hatchery-origin spawners (NMFS 2016c).

Table 2-14. LCR Chinook Salmon ESU MPG, ecological sub-regions, run timing, populations, and scores for the key elements (A/P, spatial structure, and diversity) used to determine overall net persistence probability of the population (NMFS 2013).[1]

MPG		Spawning Population (Watershed)	A/P	Spatial Structure	Diversity	Overall Persistence Probability
Ecological Subregion	**Run Timing**					
Cascade Range	Spring	Upper Cowlitz River (WA)	VL	L	M	VL
		Cispus River (WA)	VL	L	M	VL
		Tilton River (WA)	VL	VL	VL	VL
		Toutle River (WA)	VL	H	L	VL
		Kalama River (WA)	VL	H	L	VL
		North Fork Lewis (WA)	VL	L	M	VL
		Sandy River (OR)	M	M	M	M
	Fall	Lower Cowlitz River (WA)	VL	H	M	VL
		Upper Cowlitz River (WA)	VL	VL	M	VL
		Toutle River (WA)	VL	H	M	VL
		Coweeman River (WA)	L	H	H	L
		Kalama River (WA)	VL	H	M	VL

Table 2-14. LCR Chinook Salmon ESU MPG, ecological sub-regions, run timing, populations, and scores for the key elements (A/P, spatial structure, and diversity) used to determine overall net persistence probability of the population (NMFS 2013).[1] (continued)

MPG						
Ecological Subregion	**Run Timing**	**Spawning Population (Watershed)**	**A/P**	**Spatial Structure**	**Diversity**	**Overall Persistence Probability**
		Lewis River (WA)	VL	H	H	VL
		Salmon Creek (WA)	VL	H	M	VL
		Clackamas River (OR)	VL	VH	L	VL
		Sandy River (OR)	VL	M	L	VL
		Washougal River (WA)	VL	H	M	VL
	Late Fall	North Fork Lewis (WA)	VH	H	H	VH
		Sandy River (OR)	VH	M	M	VH
Columbia Gorge	Spring	White Salmon River (WA)	VL	VL	VL	VL
		Hood River (OR)	VL	VH	VL	VL
	Fall	Lower Gorge (WA & OR)	VL	M	L	VL
		Upper Gorge (WA & OR)	VL	M	L	VL
		White Salmon River (WA)	VL	L	L	VL
		Hood River (OR)	VL	VH	L	VL
Coast Range	Fall	Young Bay (OR)	L	VH	L	L
		Grays/Chinook rivers (WA)	VL	H	VL	VL
		Big Creek (OR)	VL	H	L	VL
		Elochoman/Skamokawa creeks (WA)	VL	H	L	VL
		Clatskanie River (OR)	VL	VH	L	VL
		Mill, Germany, and Abernathy creeks (WA)	VL	H	L	VL
		Scappoose River (OR)	L	H	L	L

[1] Persistence probability ratings and key element scores range from very low (VL), low (L), moderate (M), high (H), to very high (VH) (NMFS 2016c).

Figure 2-3 displays the extinction risk ratings for all four VSP parameters, including spatial structure and diversity attributes, for natural populations of LCR Chinook salmon in Oregon (Ford 2011). The results indicate low to moderate spatial structure risk for most populations, but high diversity risk for all but two populations; the Sandy River bright and spring Chinook salmon populations. The assessments of spatial structure and diversity are combined with those of A/P to give an assessment of the overall status of LCR Chinook salmon natural populations in Oregon. Risk is characterized as high or very high for all populations except the Sandy River late fall and spring populations (**Figure 2-3)**. Relative to baseline VSP levels identified in the recovery plan (NMFS 2013), there has been an overall improvement in the status of a number of fall-run populations, although most are still far from the recovery plan goals (NWFSC 2015).

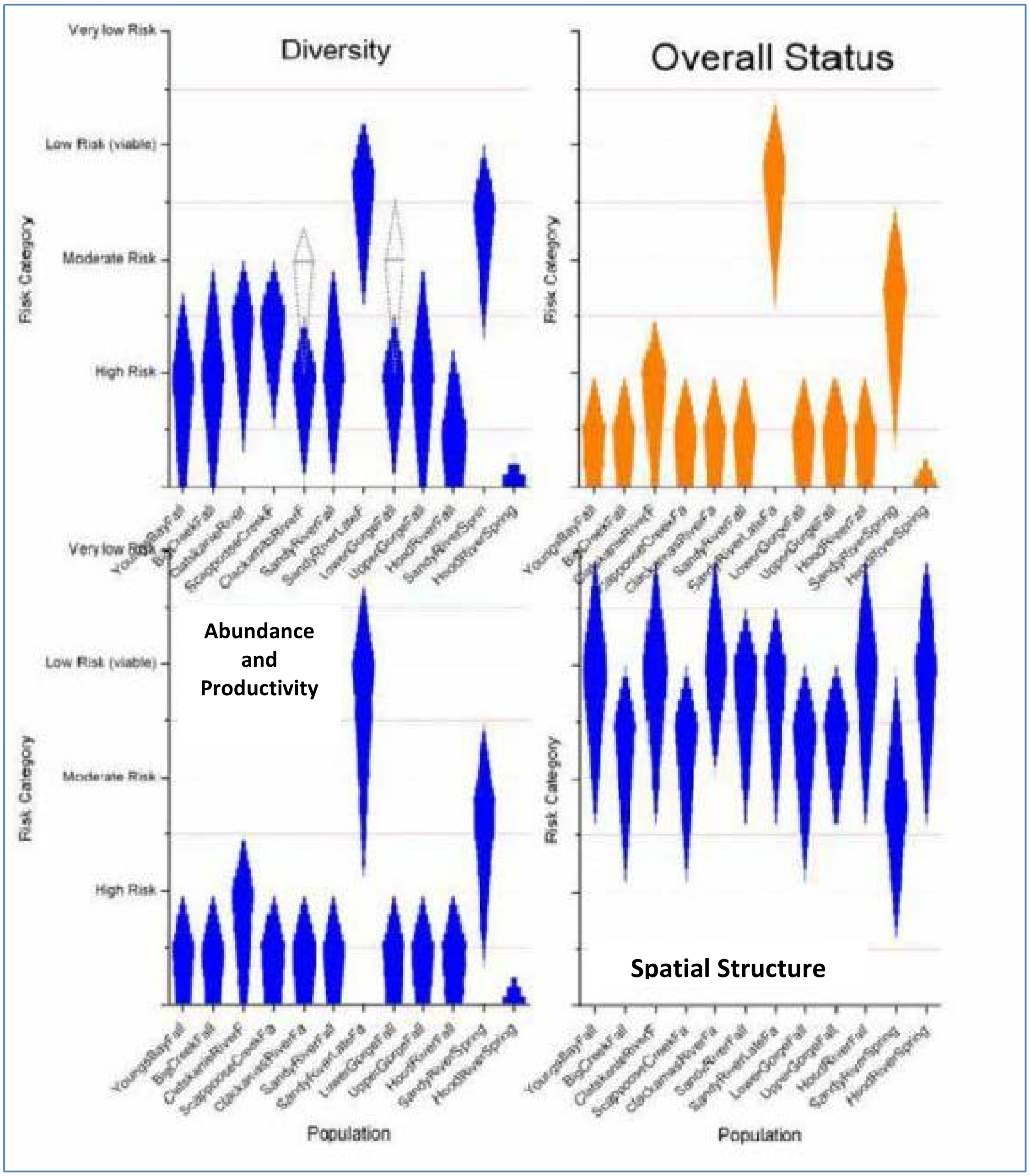

Figure 2-3. Extinction risk ratings for LCR Chinook salmon natural populations in Oregon for the assessment attributes abundance/productivity, diversity, and spatial structure, as well as overall ratings for populations that combine the three attributes (Ford 2011).

The recent status review (NWFSC 2015) concluded that there has been little change since the last status review (Ford 2011) in the biological status of Chinook salmon natural populations in the LCR Chinook Salmon ESU, though there are some positive trends. For example, increases in abundance were observed in about 70 percent of the fall-run populations, and decreases in the hatchery contribution were noted for several populations. The improved fall-run VSP scores reflect both changes in biological status and improved monitoring. However, most populations in this ESU remain at high risk, with low natural-origin abundance levels, especially the spring-run Chinook population in this ESU (NWFSC 2015). Hatchery contributions remain high for a number of populations, especially in the Coast Fall MPG, and it is likely that many returning unmarked adults are the progeny of hatchery-origin parents, which contributes to the high risk. Moreover, hatchery-produced fish still represent a majority of the fish returning to the ESU, even though hatchery production has been reduced (NWFSC 2015). Because spring-run Chinook salmon populations have generally low abundance levels from hydroelectric dams cutting off access to essential spawning habitat, it is unlikely that there will be significant improvements in the status of the ESU until efforts to improve juvenile passage systems are in place and proven successful (NWFSC 2015).

Limiting Factors and Threats:

Many factors affect the abundance, productivity, spatial structure, and diversity of the LCR Chinook Salmon ESU. Understanding the factors that limit the ESU provides important information and perspective regarding the status of a species. One of the necessary steps in recovery and consideration for delisting is to ensure that the underlying limiting factors and threats have been addressed. LCR Chinook salmon populations began to decline by the early 1900s because of habitat alterations and harvest rates (HRs) that were unsustainable, particularly given these changing habitat conditions. Human impacts and limiting factors come from multiple sources, including hydropower development on the Columbia River and its tributaries, habitat degradation, hatchery effects, fishery management and harvest decisions, and ecological factors that include predation and environmental variability. The recovery plan consolidates available information regarding limiting factors and threats for the LCR Chinook Salmon ESU (NMFS 2013b).

The recovery plan provides a detailed discussion of limiting factors and threats and describes strategies for addressing each of them. Chapter 4 of the recovery plan (NMFS 2013b) describes limiting factors on a regional scale and describes how they apply to the four ESA-listed species from the LCR considered in the plan, including the LCR Chinook Salmon ESU. Chapter 4 (NMFS 2013b) includes details on large scale issues, including the following:

- Ecological interactions
- Climate change
- Human population growth

Chapter 7 of the recovery plan discusses the limiting factors that pertain to LCR Chinook salmon spring, fall, and late fall natural populations and the MPGs in which they reside. Rather than repeating this extensive discussion from the recovery plan, it is incorporated here by reference. The discussion of limiting factors in Chapter 7 (NMFS 2013b) is organized to address the following:

- Tributary habitat
- Estuary habitat
- Hydropower
- Hatcheries
- Harvest
- Predation

Naturally spawning spring Chinook salmon are made up of anywhere from 34 percent to 90 percent hatchery-origin fish, depending on the population (LCFRB 2010a, Table 3-8; ODFW 2010, Table 4-8). Hatchery straying, combined with past stock transfers, has likely altered the genetics of LCR spring Chinook salmon population structure and diversity and reduced the productivity as a result of this influence. However, high proportions of hatchery-origin fish in spawning populations have been purposeful in some areas, e.g., for reintroduction purposes in the Hood, Cowlitz, and Lewis subbasins.

Most fall Chinook salmon currently returning to Lower Columbia tributaries are produced in hatcheries operated to produce fish for harvest. The fish from these programs are not intended to spawn naturally. Hatchery production has declined from its peak in the late 1980s, but it continues to threaten the productivity of LCR fall Chinook salmon natural populations (NMFS 2013b). Out-of-ESU Rogue River bright fall Chinook salmon released into Youngs Bay to support terminal harvest have been recovered in the Grays River, potentially affecting genetics and diversity within the Grays River population. Similar to spring Chinook populations, genetic stock integrity and productivity for fall Chinook salmon in the LCR Chinook Salmon ESU have likely declined as a result of the influence of hatchery-origin fish contributing to natural spawning.

Some scientists suspect that closely spaced releases of hatchery fish from all Columbia Basin hatcheries may lead to increased competition with natural-origin fish for food and habitat space in the estuary. NMFS (2006a) and the Lower Columbia Fishery Recovery Board (LCFRB 2010a) identified competition for food and space among hatchery and natural-origin juveniles in the estuary as a critical uncertainty that may affect recovery in unknown ways. ODFW (2010) acknowledged that uncertainty, but listed competition for food and space as a secondary limiting factor for juveniles of all populations. The NMFS

West Coast Region (WCR) and Northwest and Southwest Fisheries Science Centers are working to better define and describe the scientific uncertainty associated with ecological interactions between hatchery-origin and natural-origin salmon in freshwater, estuarine, and nearshore ocean habitats.

2.2.1.3 Status of Snake River Fall Chinook Salmon

On June 3, 1992, NMFS listed the Snake River fall-run Chinook Salmon ESU as a threatened species (57 FR 23458). More recently, the threatened status was reaffirmed on June 28, 2005, (70 FR 37160) and on April 14, 2014 (79 FR 20802). Critical habitat was designated on December 28, 1993 (58 FR 68543).

The Snake River fall-run Chinook Salmon ESU includes naturally spawned fish in the lower mainstem of the Snake River and the lower reaches of several of the associated major tributaries, including the Tucannon, the Grande Ronde, Clearwater, Salmon, and Imnaha Rivers, along with four artificial propagation programs (Jones 2015; NWFSC 2015). None of the hatchery programs is excluded from the ESU. **Table 2-15** lists the natural and hatchery populations included in the ESU.

Table 2-15. Snake River Fall-Run Chinook Salmon ESU description and MPGs (Jones 2015; NWFSC 2015).

ESU Description	
Threatened	Listed under ESA in 1992; updated in 2014
One major population group	Two historical populations (one extirpated)
Major Population Group	***Population***
Snake River	Lower Mainstem Fall-run
Artificial production	
Hatchery programs included in ESU (4)	Lyons Ferry NFH fall, Acclimation Ponds Program fall, Nez Perce Tribal Hatchery fall, Idaho Power fall.
Hatchery programs not included in ESU (0)	n/a

Two historical populations (one extirpated) within one MPG comprise the Snake River Fall-run Chinook Salmon ESU. The extant natural population spawns and rears in the mainstem Snake River and its tributaries below Hells Canyon Dam. **Figure 2-4** shows a map of the ESU area. The decline of this ESU was due to heavy fishing pressure beginning in the 1890s and loss of habitat with the construction of Swan Falls Dam in 1901 and the Hells Canyon Complex from 1958 to 1967, which extirpated one of the historical populations. Hatcheries mitigating for losses caused by the dams have played a major role in the production of Snake River fall-run Chinook salmon since the 1980s (NMFS 2012a). Since the species were originally listed in 1992, fishery impacts have been reduced in both ocean and river fisheries. The total ER has been relatively stable in the range of 40 percent to 50 percent since the mid-1990s (NWFSC 2015).

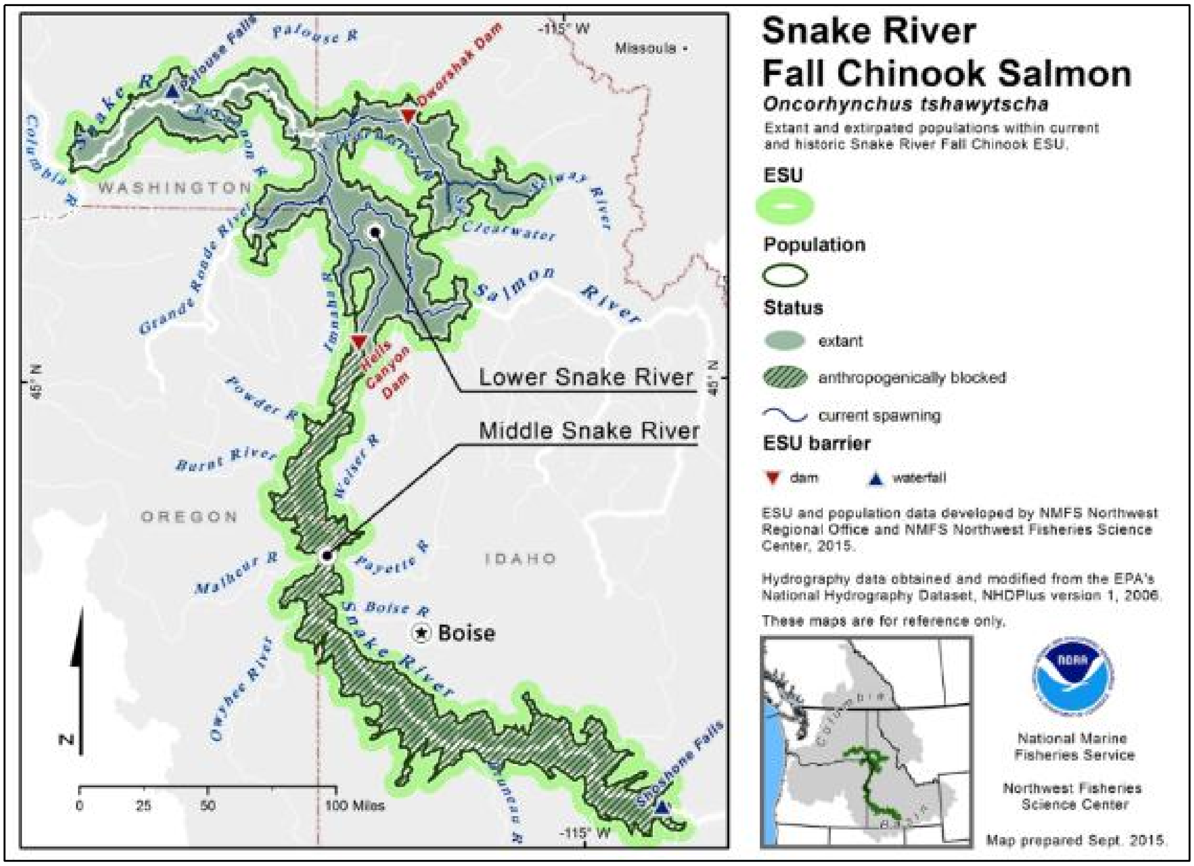

Figure 2-4. Map of the Snake River Fall-Run Chinook Salmon ESU's spawning and rearing areas, illustrating populations and MPGs (NWFSC 2015).

Snake River fall-run Chinook salmon spawning and rearing occurs primarily in larger mainstem rivers, such as the Salmon, Snake, and Clearwater Rivers. Historically, the primary fall-run Chinook salmon spawning areas were located on the upper mainstem Snake River (Connor et al. 2005). Now, a series of Snake River mainstem dams block access to the Upper Snake River and about 85 percent of the ESU's spawning and rearing habitat. Swan Falls Dam, constructed in 1901, was the first barrier to upstream migration in the Snake River, followed by the Hells Canyon Complex, beginning with Brownlee Dam in 1958, Oxbow Dam in 1961, and Hells Canyon Dam in 1967. Natural spawning is currently limited to the Snake River from the upper end of the Lower Granite Dam (Lower Granite River [LGR]) to Hells Canyon Dam; the lower reaches of the Imnaha, Grande Ronde, Clearwater, Salmon, and Tucannon Rivers; and small areas in the tailraces of the Lower Snake River hydroelectric dams (Good et al. 2005).

Some fall-run Chinook salmon also spawn in smaller streams such as the Potlatch River, and Asotin and Alpowa Creeks, and they may be spawning elsewhere. The vast majority of spawning today occurs upstream of LGR, with the largest concentration of spawning sites in the mainstem Snake River (about 60 percent) and in the Clearwater River, downstream from Lolo Creek (about 30 percent) (NMFS 2012a).

Due to losing access to historic spawning and rearing sites heavily influenced by the influx of groundwater in the Upper Snake River and the effects of dams on downstream water temperatures, Snake River fall-run Chinook salmon now reside in waters that may have thermal regimes that differ from those that historically existed. In addition, alteration of the Lower Snake River by hydroelectric dams has created a series of low-velocity pools that did not exist historically. Both habitat alterations have created obstacles to Snake River fall-run Chinook salmon survival. Before alteration of the Snake River Basin by dams, Snake River fall-run Chinook salmon exhibited a largely ocean-type life-history, where they migrated downstream during their first year. Today, fall-run Chinook salmon in the Snake River Basin exhibit one of two life histories that Connor et al. (2005) have called ocean-type and reservoir-type. Juveniles exhibiting the reservoir-type life-history overwinter in the pools created by the dams before migrating out of the Snake River. The reservoir-type life-history is likely a response to early development in cooler temperatures, which prevents juveniles from reaching a suitable size to migrate out of the Snake River and on to the ocean.

Snake River fall Chinook salmon also spawned historically in the lower mainstems of the Clearwater, Grande Ronde, Salmon, Imnaha, and Tucannon River systems. At least some of these areas probably supported production, but at much lower levels than in the mainstem Snake River. Smaller portions of habitat in the Imnaha and Salmon Rivers have supported Snake River fall-run Chinook salmon. Some limited spawning occurs in all these areas, although returns to the Tucannon River are predominantly releases and strays from the Lyons Ferry Hatchery program (NMFS 2012a).

Abundance, Productivity, Spatial Structure, and Diversity:

Species status is determined based on the abundance, productivity, spatial structure, and diversity of its constituent natural populations. Best available information indicates that the species, in this case the Snake River fall-run Chinook Salmon ESU, remains at threatened status, which is based on a low-risk rating for abundance/productivity and a moderate-risk rating for spatial structure/diversity (SS/D) (NWFSC 2015).

Spawner abundance, productivity, and proportion of natural-origin fish abundance estimates for the Lower Mainstem Snake River population are based on counts and sampling at Lower Granite Dam. Separate estimates of the numbers of adult (age 4 and older) and jack (age 3) fall Chinook salmon passing over Lower Granite Dam are derived using ladder counts and the results of sampling a portion of each year's run using a trap associated with the ladder. A portion of the fish sampled at the trap are retained and used as hatchery broodstock. The data from trap sampling, including the coded wire tag (CWT) recovery results, passive integrated transponder tag detections, and the incidence of fish with adipose-fin clips, are used to construct daily estimates of hatchery proportions in the run (NWFSC 2015).

At present, estimates of natural-origin returns are made by subtracting estimated hatchery-origin returns from the total run estimates (Young et al. 2012). In the near future, returns from a parental-based genetic tagging (PBT)[15] program will allow for a comprehensive assessment of hatchery contributions and, therefore, a more direct assessment of natural returns and ESU abundance risk (NWFSC 2015).

Sampling methods and statistical procedures used in generating the estimated escapements have improved substantially over the past 10 to 15 years. Beginning with the 2005 return, estimates are available for the total run apportioned into natural and hatchery returns by age (and hatchery-origin) with standard errors and confidence limits (e.g., Young et al. 2012). Current estimates of escapement over Lower Granite Dam for return years prior to 2005 were also based on adult dam counts and trap sampling (**Table 2-16**). In recent years, naturally spawning fall-run Chinook salmon in the lower Snake River have included both returns originating from naturally spawning parents and from returning hatchery releases (NWFSC 2015). Hatchery-origin fall-run Chinook salmon escaping upstream above Lower Granite Dam to spawn naturally are now predominantly returns from hatchery supplementation program juvenile releases in reaches above Lower Granite Dam and from releases at Lyons Ferry Hatchery that have dispersed upstream.

[15] PBT is a method whereby each parent in a hatchery program, both male and female, are genotyped for polymorphic molecular markers. By genotyping each parent, all of their offspring are effectively identifiable, and the method requires no juvenile handling. This allows for assignments back to individual parents when the hatchery releases return as adults wherever they are found, so long as they are genetically sampled.

Table 2-16. Escapement data for Snake River fall-run Chinook natural-origin salmon returning to LGR, from 2000-2016 (TAC 2017).

Year	Total Unique adult fish Arriving at Lower Granite	Hatchery Adult Sized Fish Arriving at Granite	Natural-origin Adult Sized Fish arriving at Granite
2000	4,036	2,888	1,148
2001	12,793	7,630	5,163
2002	12,297	10,181	2,116
2003	13,963	9,706	4,257
2004	14,984	11,655	3,329
2005	11,670	6,493	5,177
2006	7,807	3,138	4,669
2007	11,186	7,444	3,742
2008	16,200	12,271	3,930
2009	25,262	20,285	4,977
2010	45,335	37,340	7,995
2011	27,714	18,936	8,778
2012	36,338	23,541	12,797
2013	55,624	34,500	21,124
2014	59,747	45,575	14,172
2015	58,363	42,151	16,212
2016	37,401	27,629	9,772

Recent years corrected for fallback

Productivity, defined in the Interior Columbia Technical Recovery Team (ICTRT) viability criteria as the expected replacement rate at low to moderate abundance relative to a population's minimum abundance threshold, is a key measure of the potential resilience of a natural population to annual environmentally driven fluctuations in survival. The ICTRT Viability Report (ICTRT 2007) provided a simple method for estimating population productivity based on return-per-spawner estimates for the most recent 20 years. To ensure that all sources of mortality are considered, the ICTRT recommended that productivities used in Interior Columbia River viability assessments be expressed in terms of returns to the spawning grounds. Other management applications express productivities in terms of pre-harvest recruits. Pre-harvest recruit estimates are also available for Snake River fall-run Chinook salmon (NWFSC 2015).

The recently released Proposed NMFS Snake River Fall Chinook Recovery Plan (NMFS 2015c) indicates that a single population viability scenario could be possible, given the unique spatial complexity of the Lower Mainstem Snake River fall-run Chinook salmon population; the recovery plan notes that such a scenario could be possible if major spawning areas supporting the bulk of natural returns are operating consistent with long-term diversity objectives in the proposed plan. Under this single population scenario, the requirements for a sufficient combination of natural A/P could be based on a combination of total population natural abundance and relatively high production from one or more major spawning areas with relatively low hatchery contributions to spawning, i.e., low hatchery influence for at least one major natural spawning production area. According to the most recent information available (i.e., redd counts through 2016 (**Table 2-17**), there is no indication of a strong differential distribution of hatchery returns among major spawning areas, given the widespread distribution of hatchery releases and the lack of direct sampling of reach-specific spawner compositions.

Table 2-17. Fall Chinook redd counts in the Snake River Basin from 2000 *to* 2016 (TAC 2017).

Year	Snake River	Clearwater Basin	Asotin Creek[1]	Imnaha River	Grande Ronde River	Salmon River	Total
2000	346	180		9	8	0	543
2001	709	336		38	197	22	1,302
2002	1,113	527		72	111	31	1,854
2003	1,524	571	2	41	91	18	2,247
2004	1,709	631	4	35	161	17	2,557
2005	1,442	487	6	36	129	27	2,127
2006	1,025	526	0	36	42	9	1,638
2007	1,117	718	0	17	81	18	1,951
2008	1,819	965	3	68	186	14	3,055
2009	2,095	1,198	0	36	104	34	3,467
2010	2,944	1,924	35	132	263	8	5,306
2011	2,837	1,621	2	24	154	60	4,698
2012	1,828	1,958	30	85	313	34	4,248
2013	2,667	2,956	53	38	255	31	6,000
2014	2,808	3,118		103	342	42	6,413
2015	3,155	5,082		83	378	142	8,840
2016	1,972	3,731		29	415	35	6,182

[1]Blank cells indicate no survey

In terms of spatial structure and diversity, the Lower Mainstem Snake River fall-run Chinook salmon population was rated at low risk for Goal A (allowing natural rates and levels of spatially mediated processes) and moderate risk for Goal B (maintaining natural levels of variation) in the status review update (NWFSC 2015), resulting in an overall spatial structure and diversity rating of moderate risk (**Table 2-18**). The moderate risk rating was driven by changes in major life-history patterns, shifts in phenotypic traits, and high levels of genetic homogeneity in samples from natural-origin returns. In addition, risk associated with indirect factors (e.g., the high levels of hatchery spawners in natural spawning areas, the potential for selective pressure imposed by current hydropower operations, and cumulative harvest impacts) contribute to the current rating level.

The overall current risk rating for the Lower Mainstem Snake River fall Chinook salmon population is viable (**Table 2-18**). The single population delisting options provided in the draft Snake River Fall Chinook Recovery Plan would require the population to meet or exceed minimum requirements for highly viable (green-shaded combinations) with a high degree of certainty.

The current rating described above is based on evaluating current status against the criteria for the aggregate population. The overall risk rating is based on a low risk rating for A/P and a moderate risk rating for SS/D. For abundance/productivity, the rating reflects remaining uncertainty that current increases in abundance can be sustained over the long run. The geometric mean natural-origin fish abundance obtained from the most recent 10 years of annual spawner escapement estimates is 6,418 fish. The most recent status review used the ICTRT simple 20-year recruits per spawner method to estimate the current productivity for this population (1990 to 2009 brood years) and determined it was 1.5. Given remaining uncertainty and the current level of variability, the point estimate of current productivity would have to meet or exceed 1.70, which is the present potential metric for the population to be rated at very low risk. While natural-origin spawning levels are above the minimum abundance threshold of 4,200, and estimated productivity is also high, neither measure is high enough to achieve the very low risk rating necessary to buffer against significant remaining uncertainty (NWFSC 2015).

Table 2-18. Lower Mainstem Snake River fall Chinook salmon population risk ratings integrated across the four VSP metrics.[1]

		Spatial Structure/Diversity Risk			
		Very Low	Low	Moderate	High
Abundance/ Productivity Risk	Very Low (<1%)	**HV**	**HV**	V	M
	Low (1-5%)	V	V	V Lower Main. Snake	M
	Moderate (6 – 25%)	M	M	M	HR
	High (>25%)	HR	HR	HR	HR

[1] Viability Key: HV-Highly Viable; V-Viable; M-Maintained; HR-High Risk; HV cell—meets criteria for Highly Viable; Gray shaded M and HR cells—does not meet viability criteria (darkest cells are at greatest risk) (NWFSC 2015).

For SS/D, the moderate risk rating was driven by changes in major life-history patterns, shifts in phenotypic traits, and high levels of genetic homogeneity detected in samples from natural-origin returns. In particular, the rating reflects the relatively high proportion of within-population hatchery spawners in all major spawning areas and the lingering effects of previous high levels of out-of-ESU strays. In addition, the potential for selective pressure imposed by current hydropower operations and cumulative harvest impacts contribute to the current rating level (NWFSC 2015).

Considering the most recent information available, an increase in estimated productivity (or a decrease in the year-to-year variability associated with the estimate) would be required to achieve delisting status, assuming that natural-origin abundance of the single extant Snake River fall-run Chinook salmon population remains relatively high. An increase in productivity could occur with a further reduction in mortalities across life stages. Such an increase could be generated by actions such as a reduction in harvest impacts (particularly when natural-origin spawner return levels are below the minimum abundance threshold) and/or further improvements in juvenile survivals during downstream migration. It is also possible that survival improvements resulting from various actions (e.g., improved flow-related conditions affecting spawning and rearing, expanded spill programs that increased passage survivals) in recent years have increased productivity, but that increase is effectively masked due to relatively high spawning levels in recent years. A third possibility is that productivity levels may decrease over time due to negative impacts of chronically high hatchery proportions across natural spawning areas. Such a decrease would also be largely masked by the high annual spawning levels (NWFSC 2015).

Limiting Factors and Threats:

Understanding the limiting factors and threats that affect the Snake River fall-run Chinook Salmon ESU provides important information and perspective regarding the status of a species. One of the necessary steps in recovery and consideration for delisting is to ensure that the underlying limiting factors and threats have been addressed. This ESU has been reduced to a single-remnant population with a narrow range of available habitat. However, the overall adult abundance has been increasing from the mid-1990s, with substantial growth since 2000 (NMFS 2012a).

There are many factors that affect the abundance, productivity, spatial structure, and diversity of the Snake River Fall-run Chinook Salmon ESU. Factors that limit the ESU have been, and continue to be, hydropower projects, predation, harvest, degraded estuary habitat, and degraded mainstem and tributary habitat (Ford 2011). Ocean conditions have also affected the status of this ESU. Ocean conditions affecting the survival of Snake River fall-run Chinook salmon were generally poor during the early part of the last 20 years (NMFS 2012a).

The draft recovery plan (NMFS 2015c) provides a detailed discussion of limiting factors and threats and describes strategies for addressing each of them. Rather than repeating this extensive discussion from the recovery plan, it is incorporated here by reference. Section 3.3 of the plan provides criteria for addressing the underlying causes of decline. Section 4.1.2 B.4. of the plan (NMFS 2015c) describes the changes in current impacts on Snake River fall Chinook salmon. These changes include the following:

- Hydropower systems
- Juvenile migration timing
- Adult migration timing
- Harvest
- Age-at-return
- Selection caused by non-random removals of fish for hatchery broodstock
- Habitat

Overall, the status of Snake River fall-run Chinook salmon has clearly improved compared to the time of listing and since the time of prior status reviews. The single extant population in the ESU is currently meeting the criteria for a rating of viable developed by the ICTRT, but the ESU as a whole is not meeting the recovery goals described in the draft recovery plan for the species, which require the single population to be "highly viable with high certainty" and/or will require reintroduction of a viable population above the Hells Canyon Dam complex (NWFSC 2015).

2.2.1.4 Status of Snake River Spring-Summer Chinook Salmon

On June 3, 1992, NMFS listed the Snake River Spring/summer-run Chinook Salmon ESU as a threatened species (57 FR 23458). More recently, the threatened status was reaffirmed on June 28, 2005 (70 FR 37160) and on April 14, 2014 (79 FR 20802). Critical habitat was originally designated on December 28, 1993, (58 FR 68543) but was updated most recently on October 25, 1999 (65 FR 57399).

The Snake River Spring/summer-run Chinook Salmon ESU includes all naturally spawned populations of spring/summer-run Chinook salmon in the mainstem Snake River and the Tucannon River, Grande Ronde River, Imnaha River, and Salmon River subbasins, as well as 11 artificial propagation programs (Jones 2015; NWFSC 2015). However, inside the geographic range of the ESU, 19 hatchery spring/summer-run Chinook salmon programs are currently operating (Jones 2015). **Table 2-19** lists the natural and hatchery populations included (or excluded) in the ESU.

Table 2-19. Snake River Spring/summer-Run Chinook Salmon ESU description and MPGs (Jones 2015; NWFSC 2015).

ESU Description	
Threatened	Listed under ESA in 1992; updated in 2014.
Five major population groups	28 historical populations (4 extant)
Major Population Group	***Populations***
Lower Snake River	Tucannon River
Grande Ronde/Imnaha River	Wenaha, Lostine/Wallowa, Minam, Catherine Creek, Upper Grande Ronde, Imnaha
South Fork Salmon River	Secesh, East Fork/Johnson Creek, South Fork Salmon River Mainstem, Little Salmon River
Middle Fork Salmon River	Bear Valley, Marsh Creek, Sulphur Creek, Loon Creek, Camas Creek, Big Creek, Chamberlain Creek, Lower Middle Fork Salmon, Upper Middle Fork Salmon
Upper Salmon River	Lower Salmon Mainstem, Lemhi River, Pahsimeroi River, Upper Salmon Mainstem, East Fork Salmon, Valley Creek, Yankee Fork, North Fork Salmon
Artificial production	
Hatchery programs included in ESU (11)	Tucannon River Spr/Sum, Lostine River Spr/Sum, Catherine Creek Spr/Sum, Looking glass Hatchery Reintroduction Spr/Sum, Upper Grande Ronde Spr/Sum, Imnaha River Spr/Sum, Big Sheep Creek-Adult Spr/Sum out-planting from Imnaha program, McCall Hatchery summer, Johnson Creek Artificial Propagation Enhancement summer, Pahsimeroi Hatchery summer, Sawtooth Hatchery spring
Hatchery programs not included in ESU (8)	Dollar Creek Shoshone-Bannock Tribe (SBT) spring, Panther Creek summer, Yankee Fork SBT spring, Rapid River Hatchery spring, Dworshak NFH spring, Kooskia spring, Clearwater Hatchery spring, Nez Perce Tribal Hatchery spring

Twenty-eight historical populations (four extirpated) within five MPGs comprise the Snake River Spring/summer-run Chinook Salmon ESU. The natural populations are aggregated into the five extant MPGs based on genetic, environmental, and life-history characteristics. **Figure 2-5** shows a map of the current ESU and the MPGs within the ESU.

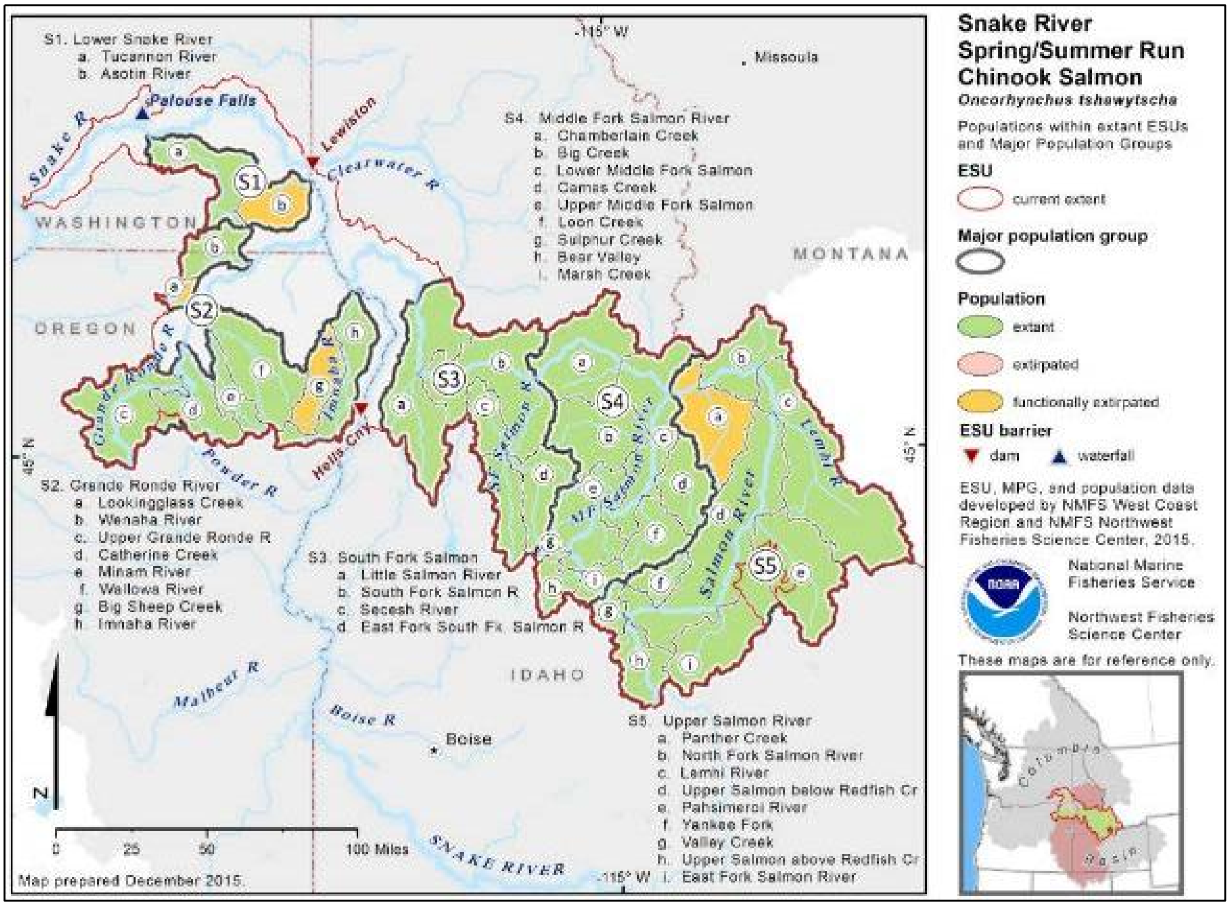

Figure 2-5. Snake River Spring/Summer-Run Chinook Salmon ESU spawning and rearing areas, illustrating natural populations and MPGs (NWFSC 2015).

Chinook salmon have a wide variety of life-history patterns, including variation in age at seaward migration; length of freshwater, estuarine, and oceanic residence; ocean distribution; ocean migratory patterns; and age and season of spawning migration. The Snake River Spring/Summer Chinook Salmon ESU consists of stream-type Chinook salmon, which spend two to three years in ocean waters and exhibit extensive offshore ocean migrations (Myers et al. 1998). For a general review of stream-type Chinook salmon see the LCR Chinook Salmon ESU life-history and status description. In general, Chinook salmon tend to occupy streams with lower gradients than steelhead, but there is considerable overlap between the distributions of the two species (NMFS 2012a).

Historically, the Snake River drainage is thought to have produced more than 1.5 million adult spring/summer-run Chinook salmon in some years during the late 1800s (Matthews and Waples 1991). By the 1950s, the abundance of spring/summer-run Chinook salmon had declined to an annual average of 125,000 adults, and numbers continued to decline through the 1970s. In 1995, only 1,797 spring/summer-run Chinook salmon adults returned (hatchery and wild fish combined). Returns at LGR (hatchery and wild fish combined) dramatically increased after 2000, with 185,693 adults returning in 2001. The large increase in 2001 was due primarily to hatchery returns, with only 10 percent of the returns from fish of natural-origin spawners (NMFS 2012a).

The causes of oscillations in abundance are uncertain, but likely are due to a combination of factors. Over the long term, population size is affected by a variety of factors, including ocean conditions, harvest, increased predation in riverine and estuarine environments, and construction and continued operation of Snake and Columbia River Dams; increased smolt mortality from poor downstream passage conditions; competition with hatchery fish; and widespread alteration of spawning and rearing habits. Spawning and rearing habits are commonly impaired in places from factors such as agricultural tilling, water withdrawals, sediment from unpaved roads, timber harvest, grazing, mining, and alteration of floodplains and riparian vegetation. Climate change is also recognized as a possible factor in Snake River salmon declines (Tolimieri and Levin 2004; Scheuerell and Williams 2005; NMFS 2012a).

Abundance, Productivity, Spatial Structure, and Diversity:

Species status determinations are based on the abundance, productivity, spatial structure, and diversity of its constituent natural populations. Best available information indicates that the species, in this case, the Snake River Spring/summer-run Chinook Salmon ESU, remains at high overall risk, with the exception of one population (Chamberlain Creek in the Middle Fork Snake River MPG). NMFS has initiated recovery planning for the Snake River drainage, organized around a subset of management unit plans corresponding to state boundaries.

NMFS accepted a tributary recovery plan for one of the major management units, the Lower Snake River tributaries within Washington state boundaries in 2005. The plan developed under the auspices of the Lower Snake River Recovery Board. The Lower Snake Recovery Board Plan provides recovery criteria, targets, and tributary habitat action plans for the two populations of the spring/summer Chinook salmon in the Lower Snake MPG in addition to the populations in the Touchet River (Mid-Columbia Steelhead DPS) and the Washington sections of the Grande Ronde River (NWFSC 2015).

The recovery plans being synthesized and developed by NMFS will incorporate viability criteria recommended by the ICTRT. The ICTRT recovery criteria are hierarchical in nature, with ESU/DPS level criteria being based on the status of natural-origin Chinook salmon assessed at the population level. The population level assessments are based on a set of metrics designed to evaluate risk across the four VSP elements—abundance, productivity, spatial structure, and diversity (McElhany et al. 2000). The ICTRT approach calls for comparing estimates of current natural-origin A/P against predefined viability curves (NWFSC 2015). Achieving recovery (i.e., delisting the species) of each ESU via sufficient improvement in the abundance, productivity, spatial structure, and diversity is the longer-term goal of the recovery plan. **Table 2-20** shows the most recent metrics for the Snake River Spring/summer-run Chinook Salmon ESU.

Most natural populations in the Snake River Spring/summer-run Chinook Salmon ESU remain at high risk overall, with one population (Chamberlain Creek in the Snake River Middle Fork MPG) improving to an overall rating of maintained due to an increase in abundance (**Table 2-21**). Natural-origin abundance has increased over the levels reported in the prior review (Ford 2011) for most populations in this ESU, although the increases were not substantial enough to change viability ratings. Relatively high ocean survivals in recent years were a major factor in recent abundance patterns. Ten natural populations increased in both A/P, seven increased in abundance while their updated productivity estimates decreased, and two populations decreased in abundance and increased in productivity. One population, Loon Creek in the Snake River Middle Fork MPG, decreased in both A/P. Overall, all but one population in this ESU remains at high risk for A/P, and there is a considerable range in the relative improvements to life cycle survivals or limiting life stage capacities required to attain viable status. In general, populations within the South Fork grouping had the lowest gaps among MPGs. The other multiple population MPGs each have a range of relative gaps (NWFSC 2015).

Spatial structure ratings remain unchanged or stable with low or moderate risk levels for most of the populations in the ESU (**Table 2-22**). Four populations from three MPGs (Catherine Creek and Upper Grande Ronde of the Grande Ronde/Imnaha MPG, Lemhi River of the Upper Salmon River MPG, and Lower Middle Fork Mainstem of the Middle Fork MPG) remain at high risk for spatial structure loss. Three of the four extant MPGs in this ESU have populations that are undergoing active supplementation with local broodstock hatchery programs. In most cases, those programs evolved from mitigation efforts and they include some form of sliding-scale management guidelines that limit hatchery contribution to natural spawning based on the abundance of natural-origin fish returning to spawn—the more natural-origin fish that return, the fewer hatchery fish that are needed to spawn naturally. Sliding-scale management is designed to maximize hatchery benefits in low abundance years and reduce hatchery risks at higher spawning levels. Efforts to evaluate key assumptions and impacts are underway for several programs (NWFSC 2015).

Table 2-20. Measures of viability and overall viability rating for Snake River spring/summer-run Chinook salmon populations.[1]

Population	Abundance/Productivity Metrics				Spatial Structure and Diversity Metrics			Overall Viability Rating
	ICTRT Minimum Threshold	Natural Spawning Abundance	ICTRT Productivity	Integrated A/P Risk	Natural Processes Risk	Diversity Risk	Integrated SS/D Risk	
Lower Snake River MPG								
Tucannon River	750	↑ 267 (.19	↓ .69 (.23)	High	Low	Moderate	Moderate	HIGH RISK
Asotin Creek	500	extirpated						extirpated
Grande Ronde/Imnaha MPG								
Wenaha River	750	↓ 399 (.12)	↑ .93 (.21)	High	Low	Moderate	Moderate	HIGH RISK
Lostine/Wallowa R.	1,000	↑ 332 (.24)	↑ .98 (.12)	High	Low	Moderate	Moderate	HIGH RISK
Lookingglass R. (ext)	500	extirpated						extirpated
Minam R.	750	↑ 475 (.12)	↑ .94 (18)	High(M)	Low	Moderate	Moderate	HIGH RISK
Catherine Creek	1,000	↑ 110 (.31)	↑ .95 (.15)	High	Moderate	Moderate	Moderate	HIGH RISK
Upper Gr. Ronde R.	1,000	↑ 43 (.26)	↑ .59 (.28)	High	High	Moderate	High	HIGH RISK
Imnaha River	750	↑ 328 (.21)	↑ 1.20 (.09)	High (M)	Low	Moderate	Moderate	HIGH RISK
South Fork MPG								
South Fork Mainstem	1,000	↑ 791 (.18)	↓ 1.21 (.20)	High (M)	Low	Moderate	Moderate	HIGH RISK
Secesh River	750	↑ 472 (.18)	○ 1.25 (.20	High(M)	Low	Low	Low	HIGH RISK
East F./Johnson Cr.	1,000	↑ 208 (.24)	↓ 1.15 (.20)	High	Low	Low	Low	HIGH RISK
Little Salmon River	750	Insf. data			Low	Low	Low	HIGH RISK
Middle Fork MPG								
Chamberlain Creek	750	↑ 641 (.17)	↓ 2.26 (.45)	Moderate	Low	Low	Low	Maintained
Big Creek	1,000	↑ 164 (.23)	↓ 1.10 (.21)	High	Very Low	Moderate	Moderate	HIGH RISK
Loon Creek	500	↓ 54 (.10)	↓ .98 (.40)	High	Low	Moderate	Moderate	HIGH RISK
Camas Creek	500	↑ 38 (.20)	↓ .80 (.29)	High	Low	Moderate	Moderate	HIGH RISK
Lower Mainstem MF	500	Insf. data	Insf.data	-	Moderate	Moderate	Moderate	HIGH RISK
Upper Mainstem MF	750	↑ 71 (.18)	↓ 0.50 (.72)	High	Low	Moderate	Moderate	HIGH RISK
Sulphur Creek	500	↑ 67 (.99)	↑ .92 (.26)	High	Low	Moderate	Moderate	HIGH RISK
Marsh Creek	500	↑ 253 (.27)	↓ 1.21 (.24)	High	Low	Low	Low	HIGH RISK
Bear Valley Creek	750	↑ 474 (.27	↓ 1.37 (.17)	High(M)	Very Low	Low	Low	HIGH RISK

Upper Salmon River MPG								
Salmon Lower Main	2,000	↓ 108 (.18)	↑ 1.18 (.17)	High	Low	Low	Low	HIGH RISK
Salmon Upper Main	1,000	↑ 411 (.14)	↑ 1.22 (.19)	High (M)	Low	Low	Low	HIGH RISK
Pahsimeroi River	1,000	↑ 267 (.16)	↑ 1.37 (.20)	High (M)	Moderate	High	High	HIGH RISK
Lemhi River	2,000	↑ 143 (.23)	↑ 1.30 (.23)	High	High	High	High	HIGH RISK
Valley Creek	500	↑ 121 (.20)	↑ 1.45 (.15)	High	Low	Moderate	Moderate	HIGH RISK
Salmon East Fork	1,000	↑ 347 (.22)	↑ 1.08 (.28)	High	Low	High	high	HIGH RISK
Yankee Fork	500	↑ 44 (.45)	↓ .72 (.39)	High	Moderate	High	High	HIGH RISK
North Fork	500	Insf. data	Insf. data		Low	Low	Low	HIGH RISK
Panther Creek (ext)	750	Insf. data	Insf. data					extirpated

[1]Comparison of updated status summary vs. draft recovery plan viability objectives; upwards arrow=improved since prior review. Downwards arrow=decreased since prior review. Oval=no change. Shaded populations are the most likely combinations within each MPG to be improved to viable status. Current A/P estimates are expressed as geometric means (standard error). Extirpated populations were not evaluated as indicated by the blank cells (NWFSC 2015).

Table 2-21. Natural-origin spring Chinook salmon spawner estimates (Identified by common spring or summer timing categories) (TAC 2017, Table 2.1.25).

	Idaho Populations							**Oregon Populations**						
Year	**Bear Valley Creek spring**	**Big Creek spring**	**Marsh Creek spring**	**Sulphur Creek Spring**	**Pahsimeroi River summer**	**SF Salmon River Mainstem summer**	**Total Idaho**	**Minam spring**	**Wenaha spring**	**Catherine Cr. Spring**	**Lostine spring**	**UPR Grand Ronde Spring**	**Imnaha summer**	**Total Oregon**
1997	234	160	161	36	54	432	1,077	208	313	82	130	68	185	986
1998	391	73	229	101	56	695	1,545	233	286	101	156	92	267	1,135
1999	81	48	0	0	72	485	686	166	93	88	68	4	428	847
2000	325	63	94	10	68	609	1,169	512	523	55	223	53	442	1,808
2001	740	682	508	86	175	984	3,175	676	999	410	484	77	2375	5,020
2002	1,177	551	484	201	169	885	3,467	737	761	252	358	107	1359	3,575
2003	1,315	438	872	190	354	1,797	4,966	621	601	252	368	230	1577	3,648
2004	342	243	94	15	215	870	1,779	548	751	53	197	43	525	2,117
2005	306	68	65	28	353	551	1,371	387	532	46	146	22	328	1,460
2006	158	43	125	54	104	628	1,112	498	398	113	182	54	294	1,539
2007	312	97	130	56	148	672	1,415	348	326	74	150	36	198	1,132
2008	437	204	177	71	224	691	1,804	485	342	89	382	64	262	1,624
2009	501	448	167	49	324	607	2,096	765	348	125	482	100	444	2,264
2010	791	224	632	112	308	1,585	3,652	865	593	476	733	136	752	3,555
2011	757	297	674	171	423	1,314	3,636	697	592	413	583	129	896	3,310
2012	940	385	411	41	234	828	2,839	584	563	392	744	241	766	3,290
2013	505	195	375	110	354	421	1,960	409	282	247	319	352	277	1,886
2014	993	287	861	203	559	920	3,823	926	606	610	1019	742	825	4,728
2015	594	253	586	119	368	329	2,249	555	609	293	467	395	633	2,952
2016	469	214	411	43	347	351	1,835	614	745	258	672	165	683	3,137
2008-2016 avg	665	279	477	102	349	783	2,655	656	520	323	600	258	615	2,972

Table 2-22. Snake River spring/summer-run Chinook salmon ecological subregions, populations, and scores for the key elements (A/P, diversity, and SS/D) used to determine current overall viability risk for Snake River spring/summer-run Chinook salmon (Ford 2011).1

Ecological Subregions	Spawning Populations (Watershed)	A/P	Diversity	Integrated SS/D	Overall Viability Risk
Lower Snake River	Tucannon River	H	M	M	H
	Asotin River				E
Grande Ronde and Imnaha rivers	Wenaha River	H	M	M	H
	Lostine/Wallowa River	H	M	M	H
	Minam River	H	M	M	H
	Catherine Creek	H	M	M	H
	Upper Grande Ronde R.	H	M	H	H
	Imnaha River	H	M	M	H
	Big Sheep Creek				E
	Lookingglass Creek				E
South Fork Salmon River	Little Salmon River	*	*	*	H
	South Fork mainstem	H	M	M	H
	Secesh River	H	L	L	H
	EF/Johnson Creek	H	L	L	H
Middle Fork Salmon River	Chamberlin Creek	H	L	L	H
	Big Creek	H	M	M	H
	Lower Middle Fork Salmon	H	M	M	H
	Camas Creek	H	M	M	H
	Loon Creek	H	M	M	H
	Upper Middle Fork Salmon	H	M	M	H
	Sulphur Creek	H	M	M	H
	Bear Valley Creek	H	L	L	H
	Marsh Creek	H	L	L	H
Upper Salmon River	N. Fork Salmon River	H	L	L	H
	Lemhi River	H	H	H	H
	Pahsimeroi River	H	H	H	H
	Upper Salmon-lower mainstem	H	L	L	H
	East Fork Salmon River	H	H	H	H
	Yankee Fork	H	H	H	H
	Valley Creek	H	M	M	H
	Upper Salmon main	H	M	M	H
	Panther Creek				E
* Insufficient data.					

[1] Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH), and extirpated (E). Extirpated populations were not evaluated as indicated by the blank cells (NMFS 2016c).

While there have been improvements in the abundance/productivity in several populations relative to prior reviews (Ford 2011), those changes have not been sufficient to warrant a change in ESU status (NWFSC 2015).

Limiting Factors and Threats:

Understanding the limiting factors and threats that affect the Snake River Spring/summer-run Chinook Salmon ESU provides important information and perspective regarding the status of a species. One of the necessary steps in recovery and consideration for delisting is to ensure that the underlying limiting factors and threats have been addressed. The abundance of spring/summer-run Chinook salmon had already begun to decline by the 1950s, and it continued declining through the 1970s. In 1995, only 1,797 spring/summer-run Chinook salmon total adults (both hatchery and natural-origins combined) returned to the Snake River (NMFS 2012c).

Many factors affect the abundance, productivity, spatial structure, and diversity of the Snake River Spring/summer-run Chinook Salmon ESU. Factors that limit the ESU have been, and continue to be, survival through the Federal Columbia River Power System; degradation and loss of estuarine areas that help fish survive the transition between fresh and marine waters; spawning and rearing areas that have lost deep pools, cover, side-channel refuge areas, and high-quality spawning gravels; and interbreeding and competition with hatchery fish that far outnumber natural-origin fish. Although the status of the ESU is improved relative to measures available at the time of listing, the ESU has remains at threatened status.

2.2.1.5 Status of Upper Willamette River Chinook Salmon

On March 24, 1999, NMFS listed the UWR Chinook Salmon ESU as a threatened species (64 FR 14308). The threatened status was reaffirmed on June 28, 2005 (70 FR 37160) and again on April 14, 2014 (79 FR 20802). Critical habitat was designated on June 28, 2005 (70 FR 37160).

The ESU includes all naturally spawned populations of spring-run Chinook salmon in the Clackamas River and in the Willamette River, and its tributaries, above Willamette Falls, Oregon, as well as several artificial propagation programs (**Figure 2-6**). The ESU contains seven historical populations, within a single MPG (western Cascade Range, **Table 2-23**).

Table 2-23. UWR Chinook Salmon ESU description and MPG (Jones 2015; NMFS 2016c).

ESU Description	
Threatened	Listed under ESA in 1999; updated in 2014.
One major population group	*Seven* historical populations
Major Population Group	**Populations**
Western Cascade Range	Clackamas River, Molalla River, North Santiam River, South Santiam River, Calapooia River, McKenzie River, Middle Fork Willamette River
Artificial production	
Hatchery programs included in ESU (6)	McKenzie River spring, North Santiam spring, Molalla spring, South Santiam spring, Middle Fork Willamette spring, Clackamas spring
Hatchery programs not included in ESU (0)	n/a

UWR Chinook salmon's genetics have been shown to be strongly differentiated from nearby populations, and they are considered one of the most genetically distinct groups of Chinook salmon in the Columbia River Basin (Waples et al. 2004; Beacham et al. 2006). For adult Chinook salmon, Willamette Falls historically acted as an intermittent physical barrier to upstream migration into the UWR Basin, where adult fish could only ascend the falls at high spring flows. It has been proposed that the falls served as an zoogeographic isolating mechanism for a considerable time (Waples et al. 2004), and this has led to, among other attributes, the unique early run timing of these populations relative to other LCR spring-run populations. Historically, the peak migration of adult salmon over the falls occurred in late May. Low flows during the summer and autumn months prevented fall-run salmon and coho salmon from reaching the UWR basin (ODFW and NMFS 2011).

The generalized life-history traits of UWR Chinook are summarized in **Table 2-24**. Today, adult UWR Chinook salmon begin appearing in the lower Willamette River in January, with fish entering the Clackamas River as early as March. Most of the run ascends Willamette Falls from late April through May, with the run extending into mid-August (Myers et al. 2006).

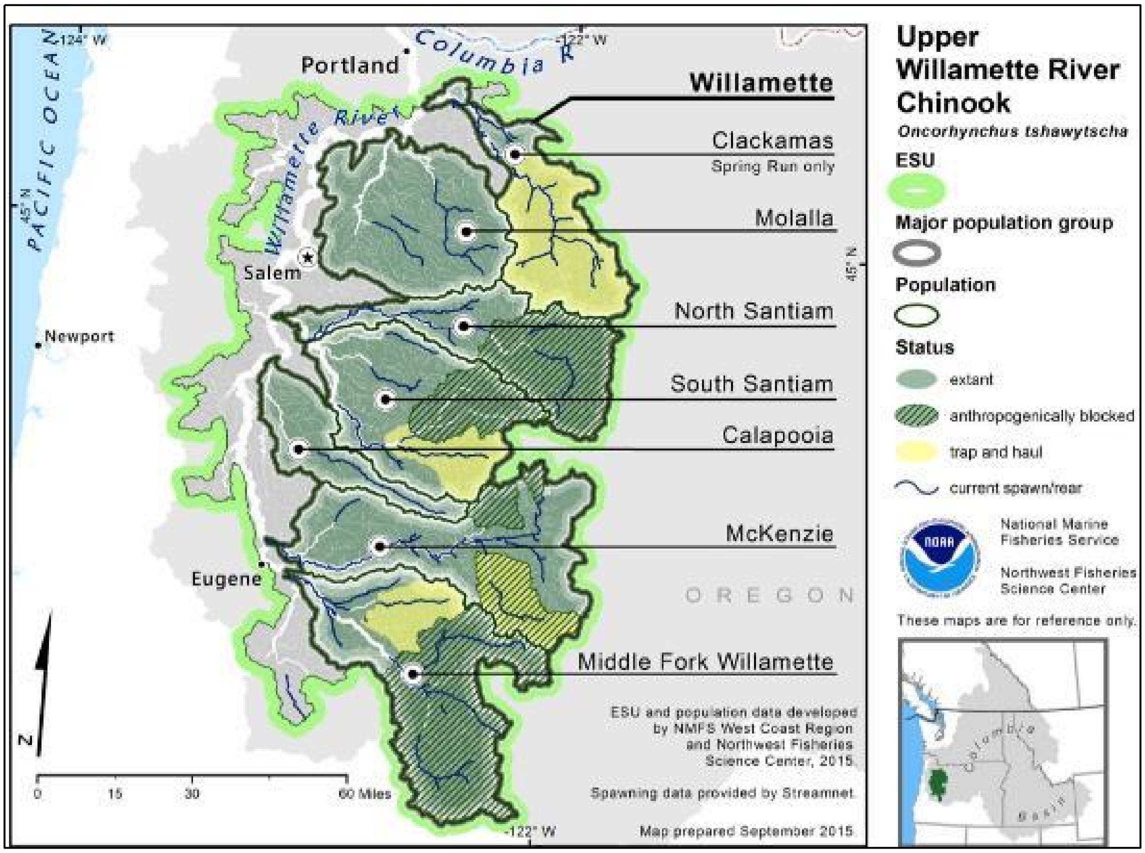

Figure 2-6. Map of the UWR Chinook Salmon ESU's spawning and rearing areas, illustrating populations and MPGs (NWFSC 2015).

Chinook migration past the falls generally coincides with a rise in river temperatures above 50°F (Mattson 1948; Howell et al. 1985; Nicholas 1995). Historically, passage over the falls may have been marginal in June because of diminishing flows, and only larger fish would have been able to ascend. Mattson (1963) discusses a late spring Chinook run that once ascended the falls in June. The disappearance of the June run in the 1920s and 1930s was associated with the dramatic decline in water quality in the lower Willamette River (Mattson 1963). This was also the period of heaviest dredging activity in the lower Willamette River. Dredge material was not only used to increase the size of Swan Island, but to fill floodplain areas like Guild's Lake. These activities were thought to influence the water quality heavily at the time. Chinook salmon now ascend the falls via a fish ladder at Willamette Falls.

Table 2-24. A summary of the general life-history characteristics and timing of UWR Chinook salmon.[1]

Life-history Trait	Characteristic
Willamette River entry timing	January-April; ascending Willamette Falls April-August
Spawn timing	August-October, peaking in September
Spawning habitat type	Larger headwater streams
Emergence timing	December-March
Rearing habitat	Rears in larger tributaries and mainstem Willamette
Duration in freshwater	12-14 months; rarely 2-5 months
Estuarine use	Days to several weeks
Life-history type	Stream
Ocean migration	Predominately north, as far as southeast Alaska
Age at return	3-6 years, primarily 4-5 years

[1] Data are from numerous sources (ODFW and NMFS 2011).

Abundance, Productivity, Spatial Structure, and Diversity:

Status of the species is determined based on the abundance, productivity, spatial structure, and diversity of its constituent natural populations. Best available information indicates that the species, in this case, the UWR Chinook Salmon ESU, is at moderate to high risk and remains at threatened status.

The Willamette Valley was not glaciated during the last epoch (McPhail and Lindsey 1970), and Willamette Falls likely served as a physical barrier for reproductive isolation of Chinook salmon populations. This isolation had the potential to produce local adaptation relative to other Columbia River populations (Myers et al. 2006).

Fish ladders were constructed at the falls in 1872 and again in 1971. It is unclear what role they may have played up to the present day in reducing localized adaptations in UWR fish populations.

Little information exists on the life-history characteristics of the historical UWR Chinook populations, especially since early fishery exploitation (starting in the mid-1880s), habitat degradation in the lower Willamette Valley (starting in the early 1800s), and pollution in the lower Willamette River (by early 1900s) likely altered life-history diversity before data collections began in the mid-1900s. Nevertheless, there is ample reason to believe that UWR Chinook salmon still contain a unique set of genetic resources compared to other Chinook salmon stocks in the WLC Domain (ODFW and NMFS 2011).

According to the most recent status review (NWFSC 2015), abundance levels for five of the seven natural populations in this ESU remain well below their recovery goals. Of these, the Calapooia River population may be functionally extinct, and the Molalla River population remains critically low (although perhaps only marginally better than the 0 VSP score estimated in the Recovery Plan). Abundance, in terms of adult returns, in the North and South Santiam Rivers has risen since the last review (Ford 2011), but still ranges only in the high hundreds of fish. Improvements in the status of the Middle Fork Willamette River population relates solely to the return of natural-origin adults to Fall Creek; however, the capacity of the Fall Creek Basin alone is insufficient to achieve the recovery goals for the Middle Fork Willamette River individual population. The status review incorporates valuable information from the Fall Creek program that is relevant to the use of reservoir drawdowns as a method of juvenile downstream passage. The proportion of natural-origin spawners has improved in the North and South Santiam Basins, but is still below identified recovery goals. The presence of juvenile (subyearling) Chinook salmon in the Molalla River suggests that there is some limited natural production there. Additionally, the Clackamas and McKenzie Rivers have previously been viewed as natural population strongholds, but both individual populations have experienced declines in abundance[16] (NWFSC 2015). All seven historical natural populations of UWR Chinook salmon identified by the WLCTRT occur within the action area and are contained within a single ecological subregion, the Western Cascade Range (Table 2-25).

Table 2-25. Scores for the key elements (A/P, diversity, and spatial structure) used to determine current overall viability risk for UWR Chinook salmon (ODFW and NMFS 2011; NWFSC 2015).[1]

Population (Watershed)	**A/P**	**Diversity**	**Spatial Structure**	**Overall Extinction Risk**
Clackamas River	M	M	L	M
Molalla River	VH	H	H	VH
North Santiam River	VH	H	H	VH
South Santiam River	VH	M	M	VH
Calapooia River	VH	H	VH	VH
McKenzie River	VL	M	M	L
Middle Fork Willamette River	VH	H	H	VH

[1] All populations are in the Western Cascade Range ecological subregion. Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH). All populations originate in the Action Area (NMFS 2016c).

The Clackamas and McKenzie River populations had the best overall risk ratings within the ESU for A/P,

[16]Spring-run Chinook salmon counts on the Clackamas River are taken at North Fork Dam, where only unmarked fish are passed above the dam presently. A small percentage of these unmarked fish are hatchery-origin. While there is some spawning below the dam, it is not clear whether any progeny from the downstream redds contribute to escapement.

spatial structure, and diversity, as of 2016. Data collected since the BRT status update in 2005 highlight the substantial risks associated with pre-spawning mortality. A recovery plan was finalized for this species on August 5, 2011 (ODFW and NMFS 2011). Although recovery plans are targeting key limiting factors for future actions, there have been no significant on-the-ground-actions since the 2011 status review to resolve the lack of access to historical habitat above dams nor substantial actions removing hatchery fish from the spawning grounds (NMFS 2016c). Furthermore, limited data are available for natural-origin spawner abundance for UWR Chinook salmon populations. **Table 2-26** includes the most up-to-date available data for natural-origin recruit Chinook salmon spawner estimates from UWR subbasins. The McKenzie subbasin has the largest amounts of natural-origin Chinook salmon spawners compared to the other surveyed subbasins.

Table 2-26. Estimated number of natural-origin spring Chinook salmon spawners in surveyed subbasins of the UWR from 2005 through 2015 (ODFW 2015).1

Run Year	North Santiam	South Santiam	McKenzie	Middle Fork Willamette
2005	247	268	2,135	139
2006	201	209	2,049	664
2007	309	245	2,562	69
2008	412	323	1,387	368
2009	358	913	1,193	110
2010	292	376	1,266	189
2011	553	756	2,511	181
2012	348	544	1,769	175
2013	405	631	1,202	59
2014	566	886	1,031	90
2015	431	629	1,571	139
2008 – 2015 average	421	632	1,491	161

[1]The data are a combination of estimates from spawning ground surveys (N. Santiam, S. Santiam, Lower McKenzie, and Middle Fork) and video counts (upper McKenzie). Estimates include natural-origin spawners transported above dams.

Population status is characterized relative to persistence (which combines the A/P criteria), spatial structure, and diversity, as well as habitat characteristics. The overview above for UWR Chinook salmon populations suggests that there has been relatively little net change in the VSP score for the ESU since the last review, so the ESU remains at moderate risk (**Table 2-27**) (NWFSC 2015).

Table 2-27. Summary of VSP scores and recovery goals for UWR Chinook salmon populations (NWFSC 2015).

MPG	State	Population	Total VSP Score	Recovery Goal
Western Cascade Range	OR	Clackamas River	2	4
	OR	Molalla River	0	1
	OR	North Santiam River	0	3
	OR	South Santiam River	0	2
	OR	Calapooia River	0	1
	OR	McKenzie River	3	4
	OR	Middle Fork Willamette River	0	3

Limiting Factors and Threats:

Understanding the limiting factors and threats that affect the UWR Chinook Salmon ESU provides important information and perspective regarding the status of the species. One of the necessary steps in recovery and consideration for delisting is to ensure that the underlying limiting factors and threats have been addressed.

UWR Chinook salmon are harvested in ocean fisheries, primarily in Canada and Alaska, but they are also taken in lower mainstem Columbia River commercial gillnet fisheries, in recreational fisheries in the mainstem Columbia and Willamette Rivers, and in tributary terminal areas. These fisheries in the Columbia and Willamette Rivers are now directed at hatchery-origin fish. However, hatchery fish could not be discriminated from natural-origin fish historically, and natural-origin fish were also retained in past fisheries.

In the late 1990s, ODFW began mass-marking the hatchery-origin fish, and recreational fisheries within the Willamette River started to retain marked fish only (i.e., hatchery-origin fish), with mandatory release of unmarked natural-origin fish. Overall ERs reflect this change in fisheries, with the rates dropping from the 50 percent to 60 percent range in the 1980s and early 1990s to around 30 percent since 2000, with differences observed in both ocean and freshwater fisheries. Post-release mortality from hooking are generally estimated at 10 percent in the Willamette River, although river temperatures likely influence this rate. Illegal take of unmarked fish is thought to be low (NWFSC 2015).

Many factors affect the abundance, productivity, spatial structure, and diversity of the UWR Chinook Salmon ESU. Factors that limit the ESU have been, and continue to be: dams that block access to major production areas, loss and degradation of accessible spawning and rearing habitat, and degraded water quality and increased water temperatures. Together, these factors have affected the populations of this ESU (NMFS 2016c).

The recovery plan for UWR Chinook salmon (ODFW and NMFS 2011) provides a detailed discussion of limiting factors and threats and describes strategies for addressing each of them (Chapter 5 in ODFW and NMFS 2011). Rather than repeating this extensive discussion from the recovery plan, it is incorporated here by reference.

Additionally, (NMFS 2016c) outlines additional limiting factors for the UWR Chinook Salmon ESU which include the following:

- Significantly reduced access to spawning and rearing habitat because of tributary dams
- Degraded freshwater habitat, especially floodplain connectivity and function, channel structure and complexity, and riparian areas and large wood recruitment as a result of cumulative impacts of agriculture, forestry, and development
- Degraded water quality and altered water temperatures as a result of both tributary dams and the cumulative impacts of agriculture, forestry, and urban development
- Hatchery-related effects
- Anthropogenic introductions of non-native species and out-of-ESU races of salmon or steelhead have increased predation on, and competition with, native UWR Chinook salmon
- Ocean HRs of approximately 30 percent

Although there has likely been an overall decrease in population VSP scores since the last review, the magnitude of this change is not sufficient to suggest a change in risk category for the ESU. Given current climate conditions and the prospect of long-term climate change, the inability of many populations to access historical headwater spawning and rearing areas may put this ESU at greater risk in the near future (NWFSC 2015).

2.2.1.6 Status of the Upper Columbia River Spring-Run Chinook Salmon ESU

On March 24, 1999, NMFS listed the Upper Columbia River (UCR) spring-run Chinook Salmon ESU as an endangered species (64 FR 14308). The endangered status was reaffirmed on June 28, 2005, (70 FR 37160) and most recently on April 14, 2014 (70 FR 20816). Critical habitat for the UCR spring-run Chinook salmon was designated on September 2, 2005 (70 FR 2732).

Inside the geographic range of this ESU, eight natural populations within three MPGS have historically comprised the UCR spring-run Chinook Salmon ESU, but the ESU is currently limited to one MPG (North Cascades MPG) and three extant populations (Wenatchee, Entiat, and Methow populations). Six hatchery spring Chinook salmon programs are currently operational, but only four are included in the ESU (Jones Jr. 2015). **Table 2-28** lists the hatchery and natural populations included (or excluded) in the ESU.

Table 2-28. UCR spring-run Chinook Salmon ESU description and MPG (Jones Jr. 2015; NWFSC 2015).

ESU Description	
Endangered	Listed under ESA in 1999; updated in 2014.
Three major population groups	Eight historical populations
Major Population Group	***Populations***
North Cascades	Wenatchee River, Entiat River, Methow River.
Artificial production	
Hatchery programs included in ESU (4)	Methow, Winthrop NFH, Chiwawa River, White River
Hatchery programs not included in ESU (2)	Nason Creek, Leavenworth NFH

Approximately half of the area that originally produced spring Chinook salmon in this ESU is now blocked by dams. What remains of the ESU includes all naturally spawned fish upstream of Rock Island Dam and downstream of Chief Joseph Dam in Washington State, excluding the Okanogan River (64 FR 14208, March 24, 1999). **Figure 2-7** shows the map of and specific basins within the current ESU.

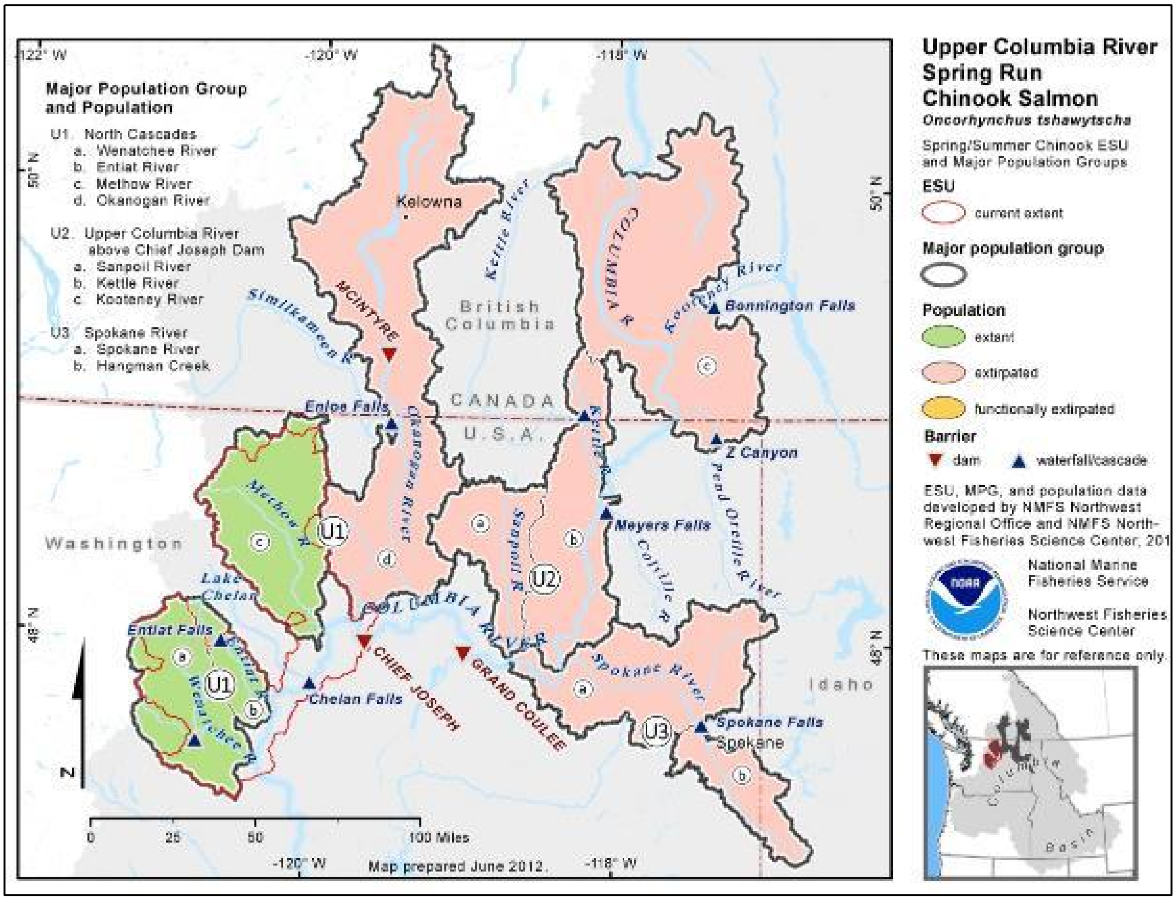

Figure 2-7. Map of the UCR spring-run Chinook Salmon ESU's spawning and rearing areas, illustrating populations and MPGs (NWFSC 2015).

Chinook salmon have a wide variety of life-history patterns, including variation in age at seaward migration; length of freshwater, estuarine, and oceanic residence; ocean distribution; ocean migratory patterns; and age and season of spawning migration. ESA-listed UCR spring Chinook salmon are known as stream-type; they spend two to three years in coastal ocean waters, whereas ocean-type Chinook salmon spend three to four years at sea and exhibit offshore ocean migrations. Ocean-type Chinook salmon also enter freshwater later to spawn (May and June) than stream type salmon (February through April). Ocean-type Chinook salmon also use different areas—they spawn and rear in lower elevation mainstem rivers, and they typically reside in fresh water for no more than three months compared to stream-type (including spring Chinook salmon) that spawn and rear high in the watershed and reside in freshwater for a year (NMFS 2014a).

Spring Chinook salmon begin returning from the ocean in the early spring, with the run into the Columbia River peaking in mid-May. Spring Chinook salmon enter the UCR tributaries from April through July, and they hold in freshwater tributaries after migration until they spawn in the late summer (peaking in mid to late August) (Upper Columbia Salmon Recovery Board [UCSRB] 2007). Juvenile spring Chinook salmon spend a year in freshwater before migration to salt water in the spring of their second year of life.

Abundance, Productivity, Spatial Structure, and Diversity

Species status is determined based on the abundance, productivity, spatial structure, and diversity of its constituent natural populations. Best available information indicates that the species, in this case the UCR Spring-run Chinook Salmon ESU, is at high risk and remains at endangered status (NWFSC 2015). The ESA Recovery Plan (UCSRB 2007) calls for improvement in each of the three extant spring-run Chinook salmon populations (no more than 5 percent risk of extinction in 100 years) and for a level of spatial structure and diversity that restores the distribution of natural populations to previously occupied areas and that allows natural patterns of genetic and phenotypic diversity to be expressed. This corresponds to a threshold of at least viable status for each of the three natural populations. None of the three populations is viable with respect to A/P, and they all have a greater than 25 percent chance of extinction in 100 years (**Figure 2-8**) (UCSRB 2007).

Risk Rating for Spatial Structure/Diversity

Risk Rating for Abundance/Productivity	Very Low	Low	Moderate	High
Very Low (<1%)	Highly Viable	Highly Viable	Viable	Maintained
Low (1-5%)	Viable	Viable	Viable	Maintained
Moderate (6-25%)	Maintained	Maintained	Maintained	High Risk
High (>25%)	High Risk	High Risk	High Risk	High Risk: Wenatchee R., Entiat R., Methow R.[1]

Figure 2-8. Matrix used to assess natural population status across VSP parameters or attributes for the UCR Spring-Run Chinook Salmon ESU. Percentages for A/P scores represent the probability of extinction in a 100-year time period (ICTRT 2007; Ford 2011; NMFS 2014a).

[1]The Wenatchee, Entiat, and Methow River populations are considered a high risk for both A/P and composite SS/D, as noted in the above.

In the 2005 status review, the BRT noted that the UCR spring-run Chinook salmon populations had "rebounded somewhat from the critically low levels" that were observed in the 1998 review. Although this was an encouraging sign, the BRT noted that this increase in population size was largely driven by returns in the two most recent spawning years available at the time of the review (NWFSC 2015). In the 2011 status review, Ford (2011) reported that the Upper Columbia Spring-run Chinook Salmon ESU was not currently meeting the viability criteria (adapted from the ICTRT)) in the Upper Columbia Recovery Plan. Increases in the natural-origin abundance relative to the extremely low spawning levels observed in the mid-1990s were encouraging; however, average productivity levels remained extremely low. Overall, the 2011 status report indicated that the viability of the UCR Spring-run Chinook Salmon ESU had likely improved somewhat since the 2005 review, but the ESU was still clearly at moderate-to-high risk of extinction (NWFSC 2015).

Achieving recovery (i.e., delisting the species) of each ESU via sufficient improvement in the abundance, productivity, spatial structure, and diversity is the longer-term goal of the UCSRB Plan. The plan calls for meeting or exceeding the same basic spatial structure and diversity criteria adopted from the ICTRT viability report for recovery (NWFSC 2015).

Table 2-29. UCR spring-run Chinook Salmon ESU population viability status summary.

Population	Abundance and productivity metrics[1]				Spatial structure and diversity metrics			Overall viability rating
	ICTRT minimum threshold	Natural Spawning Abundance	ICTRT Productivity	Integrated A/P Risk	Natural Processes Risk	Diversity Risk	Integrated SS/D Risk	
Wenatchee River 2005-2014	2,000	545 ↑ (311-1,030)	0.60 ↑ (0.27,15/20)	High	Low	High	High	High Risk
Entiat River 2005-2014	500	166 ↑ (78-354)	0.94 ↑ (0.18, 12/20)	High	Moderate	High	High	High Risk
Methow River 2005-2014	2,000	379 ↑ (189-929)	0.46 ○ (0.31, 16/20)	High	Low	High	High	High Risk

[1] Current A/P estimates are geometric means. The range in annual abundance, standard error, and number of qualifying estimates for production are in parentheses. Upward arrows = current estimates increased from prior review. Oval = no change since prior review (NWFSC 2015).

Overall A/P remains rated at high risk for each of the three extant populations in this MPG/ESU (**Table 2-30**) (NWFSC 2015). The 10-year geometric mean abundance of adult natural-origin spawners has increased for each population relative to the levels reported in the 2011 status review, but natural-origin escapements remain below the corresponding ICTRT thresholds. The combinations of current A/P for each population result in a high-risk rating when compared to the ICTRT viability curves (NWFSC 2015).

The composite SS/D risks for all three of the extant natural populations in this MPG are rated at high (**Table 2-30**). The natural processes component of the SS/D risk is low for the Wenatchee and Methow River populations and moderate for the Entiat River population. All three of the extant populations in this MPG are rated at high risk for diversity, driven primarily by chronically high proportions of hatchery-origin spawners in natural spawning areas and a lack of genetic diversity among the natural-origin spawners (ICTRT 2008; NWFSC 2015). Based on the combined ratings for A/P and SS/D, all three of the extant natural populations of UCR spring-run Chinook salmon remain rated at high overall risk (**Table 2-30, Table 2-31**).

Table 2-30 Scores for the key elements (abundance/productivity, diversity, and SS/D) used to determine current overall viability risk for spring-run UCR Chinook salmon (NWFSC 2015)[1]

Population	A/P	Diversity	Integrated SS/D	Overall Viability Risk
Wenatchee River	H	H	H	H
Entiat River	H	H	H	H
Methow River	H	H	H	H

[1] Risk ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH) and extirpated (E). Extirpated populations were not evaluated as indicated by the blank cells (NMFS 2016c).

In the 2015 status review, updated data series on spawner abundance, age structure, and hatchery/natural proportions were used to generate current assessments of A/P at the population level. Annual spawning escapements for all three of the extant UCR spring-run Chinook salmon populations showed steep declines beginning in the late 1980s, leading to extremely low abundance levels in the mid-1990s. The steep downward trend reflects the extremely low return rates for the natural population from the 1990 to 1994 brood years. Steeply declining trends across indices of total spawner abundance were a major consideration in the 1998 BRT risk assessment prior to listing of the ESU. Updating the series to include the 2009 to 2014 data shows that the short-term (e.g., 15-year) trend in wild spawners has been stable for the Wenatchee population and positive for the Entiat and Methow populations. In general, both total and natural-origin escapements for all three populations increased sharply from 1999 through 2002, and they have shown substantial year-to-year variations in the years following, with peaks around 2001 and 2010. Average natural-origin returns remain well below ICTRT minimum threshold levels.

Table 2-31 provides the most recent total natural spawner abundance information for UCR spring-run Chinook salmon. The proportions of natural-origin contributions to spawning in the Wenatchee and Methow populations have trended downward since 1990, reflecting the large increase in hatchery production and releases and subsequent returns from the directed supplementation program in those two drainages. There is no direct hatchery supplementation program in the Entiat River.

The Entiat NFH spring-run Chinook salmon release program was discontinued in 2007, and the upward trend in proportional natural-origin spawners since then can be attributed to that closure. Hatchery supplementation returns from the adjacent Wenatchee River program stray into the Entiat (Ford et al. 2015). The nearby Eastbank Hatchery facility is used for rearing the Wenatchee River supplementation stock prior to transfer to the Chiwawa acclimation pond. Some of the returns from that program may be homing on the Eastbank facility and then straying into the Entiat River, the closest spawning area (NWFSC 2015).

Table 2-31 UCR spring-run Chinook salmon total spawner escapement abundance estimates in UCR tributaries, 1997 to 2016 (TAC 2017).

	Wenatchee			Entiat			Methow		
Year	Total Spawning Escapement	Hatchery-origin Spawners	Natural-origin Spawners	Total Spawning Escapement	Hatchery-origin Spawners	Natural-origin Spawners	Total Spawning Escapement	Hatchery-origin Spawners	Natural-origin Spawners
1997	499	272	226	82	14	68	347	78	269
1998	221	68	153	53	11	42	41	21	20
1999	215	42	173	75	46	29	116	71	45
2000	1,174	523	651	175	121	54	979	862	117
2001	6,920	4,828	2,092	485	146	339	10,971	9,139	1,832
2002	3,007	1,938	1,069	370	126	244	2,636	2,291	345
2003	1,532	603	929	259	83	176	1,138	1,080	58
2004	2,386	1,472	914	302	157	145	1,496	1,008	488
2005	3,830	3,231	599	356	178	178	1,376	849	527
2006	2,263	1,690	573	257	146	111	1,748	1,420	328
2007	3,635	3,308	327	245	135	110	1,079	813	266
2008	6,211	5,574	637	278	142	136	1,002	704	298
2009	5,177	4,377	800	276	141	135	2,641	2,077	564
2010	5,682	4,802	880	490	122	368	2,369	1,768	601
2011	6,680	5,192	1,487	595	274	321	2,936	1,975	961
2012	7,375	4,810	2,565	566	192	374	1,298	1,098	200
2013	4,448	3,386	1,062	238	52	186	1,089	848	241
2014	4,187	2,826	1,361	245	20	225	2,063	1,555	508
2015	3,405	1,942	1,463	509	92	417	1,353	955	398
2016	2,364	1,427	937	334	53	281	1,339	726	613
2008-2016 avg	5,059	3,815	1,244	392	121	271	1,788	1,301	487

Limiting Factors and Threats

Understanding the limiting factors and threats that affect the UCR spring-run Chinook Salmon ESU provides important information and perspective regarding the status of the species. One of the necessary steps in recovery and consideration for delisting is for all involved parties to ensure that the underlying limiting factors and threats have been addressed. Natural populations of spring-run Chinook salmon within the UCR basin were first affected by intensive commercial fisheries in the LCR. These fisheries began in the late 1800s and continued into the 1900s, nearly eliminating many salmon stocks. With time, the construction of dams and diversions, some without passage, blocked salmon migrations and killed upstream and downstream migrating fish. Early hatcheries, constructed to mitigate for fish loss at dams and loss of habitat for spawning and rearing, were operated without a clear understanding of population genetics, and fish were transferred to hatcheries without consideration of their actual origin. Although hatcheries increased the total number of fish returning to the basin, there was no evidence that they were increasing the abundance of natural populations and it is considered likely that they were decreasing the diversity and productivity of populations they were intended to supplement (UCSRB 2007).

Concurrent with these historic activities, human population growth within the basin was increasing, and land uses (in many cases, encouraged and supported by government policy) in some areas were impacting salmon spawning and rearing habitat. In addition, non-native species (refer to the recovery plan for a list of non-native species) were introduced by both public and private interests throughout the region that directly or indirectly affected salmon and trout. These activities, in concert with natural disturbances, decreased the abundance, productivity, spatial structure, and diversity of spring-run Chinook salmon in the UCR Basin (UCSRB 2007).

Many factors affect the abundance, productivity, spatial structure, and diversity of the UCR Spring-run Chinook Salmon ESU. According to the recovery plan, factors that limit the ESU have been, and continue to be, destruction of habitat, overutilization for commercial/recreational/scientific/educational purposes, disease, predation, inadequacy of existing regulatory mechanisms, and other natural or human-made factors affecting the population's continued existence (UCSRB 2007).

The UCSRB (2007) provides a detailed discussion of limiting factors and threats and describes strategies for addressing each of them. Rather than repeating this extensive discussion from the recovery board, it is incorporated here by reference. Based on the information available from the 2015 status review, the risk category for the UCR Spring-run Chinook Salmon ESU remains unchanged from the prior review (Ford 2011). Although the status of the ESU is improved relative to measures available at the time of listing, all three populations remain at high risk.

2.2.1.7 Status of the California Coastal Chinook Salmon ESU

On September 16, 1999, NMFS listed the CC Chinook salmon as a threatened species (64 FR 50394). The ESU includes all naturally spawned populations of Chinook salmon in rivers and streams south of the Klamath River to the Russian River in California. Any Chinook salmon found in coastal basins south of this range are considered to be part of this ESU (Myers et al. 1998). The CC ESU constitutes the southernmost coastal portion of the species' range in North America (Bjorkstedt et al. 2005). Currently, no artificial propagation programs are part of this ESU (79 FR 20802). Critical habitat was designated on September 2, 2005 (70 FR 52488).

Only fall-run Chinook salmon currently occur in the CC Chinook ESU. Historically, spring-run Chinook existed in the Mad River and the north and middle forks of the Eel River (Myers et al. 1998; Moyle 2002). Low summer flows and high temperatures in many rivers result in seasonal physical and thermal barrier bars that block movement by anadromous fish. Sand bars at the mouths of streams in the southern part of the ESU often prevent access by Chinook until November or December. The ocean-type Chinook salmon in California tend to use estuaries and coastal areas for rearing more extensively than river-type Chinook salmon. The brackish water areas in estuaries provide rich sources of important lipids and moderate the physiological stress that occurs during parr-smolt transitions. CC Chinook generally remain in the ocean for two to five years (Healey 1991), and they tend to stay along the California and Oregon coasts.

The ESU historically included fall-run (28 populations) and spring-run (6 populations) Chinook salmon; however, NMFS currently lacks substantive information for either run (Bjorkstedt et al. 2005). Therefore, population structure analysis is constrained by the lack of data for this ESU. CC Chinook occur in four different diversity strata: North Coastal, North Mountain-Interior, North-Central Coastal, and Central Coastal. Each stratum is defined by its unique topography, climatic pattern, and stream dynamics. The North Coastal stratum is influenced strongly by coastal rainfall patterns, but it does have some higher inland areas. The North Mountain-Interior stratum is characterized by watersheds that penetrate far inland to higher elevations that contribute snowmelt to streamflow. The North-Central Coastal stratum is composed of small- to moderate-size, lower elevation watersheds. The Central Coastal stratum is drier and warmer than the stratums to the north. Spring-run Chinook historically occurred in only the North Mountain-Interior stratum, while fall-run Chinook occurred in all four (**Table 2-32**) (Bjorkstedt et al. 2005).

Table 2-32 Historical populations of the CC Chinook salmon ESU (Bjorkstedt et al. 2005).

Stratum	Run	Populatio
Northern Coastal	Fall	Redwood Creek, Little River, Mad River, Humboldt Bay, Lower Eel River, Bear River, Mattole River
Northern Mountain Interior	Fall	Upper Eel River
	Spring	Redwood Creek, Mad River, Van Duzen River, Upper Eel River, North Fork Eel River, Middle Fork Eel River
North-Central Coastal	Fall	Usal Creek, Cottaneva Creek, DeHaven Creek, Wages Creek, Ten Mile River, Pudding Creek, Noyo River, Hare Creek, Caspar Creek, Big River, Albion River
Central Coastal	Fall	Big Salmon Creek, Navarro River, Greenwood Creek, Elk Creek, Alder Creek, Brush Creek, Garcia River, Gualala River, Russian River

CC Chinook salmon populations remain widely distributed throughout much of the ESU (Bjorkstedt et al. 2005). Notable exceptions include the area between the Navarro River and Russian River and the area between the Mattole and Ten Mile River populations (Lost Coast area). The lack of Chinook salmon populations both north and south of the Russian River (the Russian River is at the southern end of the species' range) makes it one of the most isolated populations in the ESU. Myers et al. (1998) reports no viable populations of Chinook salmon south of San Francisco, California.

Abundance, Productivity, Spatial Structure, and Diversity:

Status of the species is determined based on the abundance, productivity, spatial structure, and diversity of its constituent natural populations. Historic CC Chinook salmon abundance is mostly unknown. In the mid-1960s, CDFW estimated CC Chinook salmon abundance at 72,550 fish (CDFG 1965; Good et al. 2005). The CDFW estimate, however, is just a midpoint number in the CC Chinook salmon's abundance decline, being a century into commercial harvest and coastal development.

By the mid-1980s, Wahle and Pearson (1987) estimated the ESU at 20,750 fish (Good et al. 2005). Coastal Chinook salmon depend highly on seasonal rainfall and stream flows in ascending tributaries to spawn; fish may spawn in the mainstems of rivers if they do not have access into tributaries. Chinook occur in relatively low numbers in northern streams, and their presence is sporadic in streams in the southern portion of the geographic region encompassing this ESU. Coastal California streams support small, sporadically monitored, populations of Chinook salmon; no estimates of absolute population abundance are available for most populations. Abundance estimates for CC Chinook salmon are only available for 12 of 28 fall-run populations; and from those data, the average abundance for CC Chinook salmon populations is 5,599 adult spawners (**Table 2-33**).

Table 2-33 Geometric mean abundances of CC Chinook salmon spawner escapements by population (Spence 2016).

Population	Location	Natural-origin Spawners[a]	Expected Number of Outmigrants[b]
Northern Coastal Stratum			
Redwood Creek	Redwood Creek	915	73,200
	Prairie Creek	190	15,200
Humboldt Bay	Humboldt Bay	2	160
	Freshwater Creek	8	640
Mattole River	Mattole River	219	17,520
Mad River	Cannon Creek	92	7,360
Lower Eel River	SF Eel River	585	46,800
	Sproul Creek	100	8,000
North Mountain Interior Stratum			
Upper Eel River	Tomki Creek	48	3,840
	Upper Eel River (Van Arsdale Station)	608	48,640
North- Central Coastal Stratum			
Ten Mile River	Ten Mile River	5	400
Noyo River	Noyo River	8	640
Big River	Big River	8	640
Central Coastal Stratum			
Navarro River	Navarro River	2	160
Garcia River	Garcia River	3	240
Russion River	Russion River	2,806	224,480
ESU Average		5,599	447,920

[a] Geometric mean of post-fishery spawners.

[b] Expected number of outmigrants=Total spawners*40 percent proportion of females*2,000 eggs per female*10 percent survival rate from egg to outmigrant

Of the 16 locations where abundances were estimated, short-term trends could be calculated for 12 locations and long-term trends for four locations (**Table 2-34**). For short-term trends, three of the 12 locations (Prairie Creek, Freshwater Creek, and Noyo River) had significantly negative population trends, while the other nine locations showed no significance. For long-term trends, one location has a significantly positive trend (Van Arsdale Station), while one location (Tomki Creek) had a significantly negative trend; both of these locations were from the Upper Eel River population (Spence 2016).

Table 2-34 Short- and long-term trends for CC Chinook salmon abundance. Trends in bold are significantly different from 0 at α=0.05 (Spence 2016).

Population/Location	Short-term		Long-term	
	Trend (95% CI)	# years	Trend (95% CI)	# years
Northern Coastal Stratum				
Prairie Creek	**-0.140 (-0.248, -0.032)**	14	-	-
Cannon Creek	-0.054 (-0.147, 0.039)	16	0.027 (-0.016, 0.069)	34
Freshwater Creek	**-0.240 (-0.349, -0.130)**	15	-	-
Sproul Creek	0.043 (-0.077. 0.453)	16	-0.025 (-0.060, 0.010)	39
North Mountain Interior Stratum				
Tomki Creek	0.013 (-0.125, 0.151)	16	**-0.100 (-0.152, -0.048)**	34
Upper Eel River (Van Arsdale Stn)	0.087 (-0.004, 0.179)	16	**0.078 (0.049, 0.108)**	63
North- Central Coastal Stratum				
Ten Mile River	-0.215 (-1.520, 1.091)	6	-	-
Noyo River	**-0.624 (-0.951, -0.296)**	6	-	-
Big River	-0.588 (-1.476, 0.300)	6	-	-
Central Coastal Stratum				
Navarro River	-0.274 (-1.110, 0.562)	6	-	-
Garcia River	0.048 (-0.888, 0.983)	6	-	-
Population/Location	**Short-term**		**Long-term**	
	Trend (95% CI)	**# years**	**Trend (95% CI)**	**# years**
Russian River	0.019 (-0.067, 0.104)	14	-	-

Limiting Factors and Threats:

At the ESU level, several areas of concern remain (Bjorkstedt et al. 2005). Within the North-Coastal and North Mountain Interior strata, all independent populations continue to persist, though there is high uncertainty about current abundance in all of these populations. The absence of the spring Chinook life-history type from these two strata represents a significant loss of diversity within the ESU. Additionally, the apparent extirpation of all populations south of the Mattole River to the Russian River (exclusive) means that one diversity stratum (North-Central Coastal) currently does not support any populations of Chinook salmon, and a second stratum (Central Coastal Stratum) contains only one extant population (Russian River) that, while it remains relatively abundant, has shown a declining trend since 2003. The significant gap in distribution diminishes connectivity among strata across the ESU. Additionally, CC Chinook salmon have been the subject of many artificial production efforts, including out-of-basin and out-of-ESU stock transfers (Bjorkstedt et al. 2005). It is, therefore, likely that CC Chinook salmon genetic diversity has been significantly adversely affected despite the relatively wide distribution of populations within the ESU. Concerning habitat, the following issues continue to impede CC Chinook salmon: water quality (i.e., pollution from agriculture, urban/suburban areas, industrial sites), instream flows (i.e., dams and reservoirs, blocked fish passage, diversions), agriculture (i.e., wine production, marijuana cultivation), and timber harvest (NMFS 2016a).

2.2.1.8 Lower Columbia River Coho

The Lower Columbia River (LCR) coho salmon ESU was first listed as threatened on June 28, 2005 (70 FR 37160). When NMFS reexamined the status of these fish in 2011 and 2016, it determined that they still warranted listing as threatened (76 FR 50448; 81 FR 33468). The listing includes all naturally spawned populations of coho salmon in the Columbia River and its tributaries in Washington and Oregon, from the mouth of the Columbia River, up to and including the Big White Salmon and Hood Rivers, as well as the Willamette River to Willamette Falls, Oregon. As shown in Table 2-37, twenty artificial propagation programs are part of the ESU and are also listed (79 FR 20802). Critical habitat was originally designated on February 22, 2016 (81 FR 9251).

Table 2-35. Hatchery Stocks Included in the LCR Coho Salmon ESU.

Artificial Propagation Program	Run	Location (State)
Grays River	Type-S	Grays River (Washington)
Peterson Coho Project	Type-S	Grays River (Washington)
Big Creek Hatchery (ODFW stock # 13)	n/a	Big Creek (Oregon)
Astoria High School (STEP) Coho Program	n/a	Youngs Bay (Oregon)
Warrenton High School (STEP) Coho Program	n/a	Youngs Bay (Oregon)
Cowlitz Type-N Coho Program	Type-N	Upper & Lower Cowlitz River (Washington)
Cowlitz Game and Anglers Coho Program	n/a	Lower Cowlitz River (Washington)
Friends of the Cowlitz Coho Program	n/a	Lower Cowlitz River (Washington)
North Fork Toutle River Hatchery	Type-S	Cowlitz River (Washington)
Kalama River Coho Program	Type-N	Kalama River (Washington)
Kalama River Coho Program	Type-S	Kalama River (Washington)
Lewis River Type-N Coho Program	Type-N	North Fork Lewis River (Washington)
Lewis River Type-S Coho Program	Type-S	North Fork Lewis River (Washington)
Fish First Wild Coho Program	n/a	North Fork Lewis River (Washington)
Fish First Type-N Coho Program	Type-N	North Fork Lewis River (Washington)
Syverson Project Type-N Coho Program	Type-N	Salmon River (Washington)
Washougal River Type-N Coho Program	Type-N	Washougal River (Washington
Eagle Creek National Fish Hatchery Program	n/a	Clackamas River (Oregon)
Sandy Hatchery (ODFW stock # 11)	Late	Sandy River (Oregon)
Bonneville/Cascade/Oxbow Complex (ODFW stock # 14)	n/a	LCR Gorge (Oregon)

Coho salmon is a widespread species of Pacific salmon that occurs in most major river basins around the Pacific Rim from Monterey Bay, California, north to Point Hope, Alaska, westward through the Aleutians, and in northeast Asia from the Anadyr River south to Korea and northern Hokkaido, Japan. From central British Columbia south, the vast majority of coho salmon adults are three-year-olds, having spent approximately 18 months in fresh water and 18 months in salt water.

Both early-and late- run stocks were present historically and still persist in the LCR. Type S coho is an early type that enters the river from mid-August to September, spawns in mid-October to early November, and generally spawns in higher tributaries. Ocean migration for these fish is in Washington, Oregon, and Northern California coastal (CC) waters.

Type N coho is a late type that enters the river from late September to December, spawns in November to January, and generally spawns in lower tributaries. Ocean migration for these fish is in British Columbia, Washington, and Oregon coastal waters.

The LCR coho salmon ESU includes 25 populations that historically existed in the Columbia River Basin from the Hood River downstream (**Table 2-36).** Until recently, Columbia River coho salmon were managed primarily as a hatchery stock. Coho were present in all LCR tributaries, but the run now consists of very few wild fish. Twenty-one of the 24 populations in the ESU are at a very high risk of extinction, see **Table 2-36**). Some native coho populations may now be extinct, but the presence of naturally spawning hatchery fish makes that difficult to ascertain. The strongest remaining populations occur in Oregon; they include the Clackamas River and Scappoose Creek, which are both at moderate risk of extinction.

Table 2-36 Historical Population Structure and Viability Status for LCR Coho Salmon (ODFW 2010; LCFRB 2010). Risk ratings range from very low viability (VL), low (L), moderate (M), high (H), to very high (VH). For example, a viability rating of VL suggests the population is at high risk for that VSP parameter.

Stratum	Population	Viability Status		
		A&P	Spatial	Diversity
Coastal	Grays/Chinook	VL	H	VL
	Elochoman/Skamokawa	VL	H	VL
	Mill/Abernathy/Germany	VL	H	L
	Youngs	VL	VH	VL
	Big Creek	VL	H	L
	Clatskanine	L	VH	M
	Scappoose	M	H	M
Cascade	Lower Cowlitz	VL	M	M
	Upper Cowlitz	VL	M	L
	Cispus	VL	M	L
	Tilton	VL	M	L
	South Fork Toutle	VL	H	M
	North Fork Toutle	VL	M	L
	Coweeman	VL	H	M
	Kalama	VL	H	L
	North Fork Lewis	VL	L	L
	East Fork Lewis	VL	H	M
	Salmon Creek	VL	M	VL
	Washougal	VL	H	L
	Clackamas	M	VH	H
	Sandy	VL	H	M
Gorge	Lower Gorge	VL	M	VL
	White Salmon	VL	M	VL
	Hood	VL	VH	L

For the spatial structure analysis, the Oregon and Washington recovery plans evaluated the proportion of stream miles currently accessible to the species relative to the historical accessible miles (ODFW 2010; LCFRB 2010). The recovery plans adjusted the rating downward if portions of the currently accessible habitat were qualitatively determined to be seriously degraded. The recovery plans also adjusted the rating downward if the portion of historical habitat lost was a key production area. The Oregon and Washington recovery plans rate spatial structure as moderate to very high viability status in nearly all populations of LCR coho. The populations that rate lowest have fish passage barriers.

Trap and haul operations on the Cowlitz River pass adults upriver, but downstream passage and survival of juvenile fish is very low. This problem also affects spatial structure in the Cispus and Tilton populations. Merwin Dam blocks access to most of the available spawning habitat in the North Fork Lewis populations. The relicensing agreement for Lewis River hydroelectric projects calls for reintroduction of coho salmon, but adequate passage through the system must be achieved to realize the habitat potential. Condit Dam on the White Salmon River blocked access to most of the historical spawning habitat, but it was removed in 2011. Thus, the LCR coho salmon spatial structure is less diverse now than times past, but management actions are underway to improve the situation.

The Oregon and Washington recovery plans (ODFW 2010; LCFRB 2010) rate diversity to be low to very low in most of the coho populations (**Table 2-36**). Pervasive hatchery effects and small population bottlenecks have greatly reduced the diversity of coho salmon populations (LCFRB 2010).

Hatchery-origin fish typically comprise a large fraction of the spawners in natural production areas. Widespread inter-basin (but within ESU) stock transfers have homogenized many populations. The Oregon and Washington recovery plans state that there were no observations of coho spawning in LCR tributaries during the 1980s and 1990s (ODFW 2010; LCFRB 2010). While historical population structure likely included significant genetic differences among populations in each watershed, NMFS can no longer distinguish genetic differences in natural populations of coho salmon in the LCR (excluding the Clackamas and Sandy rivers in Oregon).

Abundance and Productivity:

Wild coho in the Columbia Basin have been in decline for the last 50 years. The number of wild coho returning to the Columbia River historically was at least 600,000 fish (Chapman 1986). At a recent low point in 1996, the total return of wild fish may have been as few as 400 fish. Coinciding with this decline in total abundance has been a reduction in the number of self-sustaining wild populations. Of the 24 historical populations making up the LCR coho ESU, there is direct evidence of persistence during the adverse conditions of the 1990s only in the case of the Clackamas and Sandy Basins, with numbers of wild coho increasing in both since 2000. During this same period, naturally reproducing coho populations have become re-established in the Scappoose and Clatskanie Basins (ODFW 2010).

Table 2-37 displays the available information on abundance of naturally produced and hatchery LCR coho salmon. Based on the best available data and using a three-year average, the average number of LCR coho salmon spawning in the wild is 32,986 naturally produced fish and 23,082 hatchery produced fish.

Table 2-37 Estimated Abundance of Adult LCR Coho Spawners (ODFW 2016; WDFW 2016).

Stratum	Population	Years	Hatchery	Natural
Coastal	Grays/Chinook	2010-2012	2,155	445
	Elochoman/Skamokawa	2010-2012	1,185	730
	Mill/Abernathy/Germany	2010-2012	51	340
	Youngs	2010-2012	178	119
	Big Creek	2010-2012	136	283
	Clatskanine	2012-2014	250	1,396
	Scappoose	2010-2012	-	823
Cascade	Lower Cowlitz	2010-2012	711	4,834
	Upper Cowlitz/Cispus	2010-2012	9,543	4,015
	Tilton	2010-2012	4,936	1,418
	South Fork Toutle	2010-2012	296	1,357
	North Fork Toutle	2010-2012	467	360
	Coweeman	2010-2012	225	2,976
	Kalama	2010-2012	367	37
	North Fork Lewis	2010-2012	31	533
	East Fork Lewis	2010-2012	365	2,023
	Salmon Creek	2010-2012	426	1,573
	Washougal	2010-2012	253	629
	Clackamas	2012-2014	666	5,151
	Sandy	2012-2014	97	2,591
Gorge	Lower Gorge	2010-2012	269	882
	Upper Gorge/White Salmon	2011-2013		104
	Hood	2012-2014	477	367
	Total		23,082	32,986

Limiting Factors and Threats:

The status of LCR coho results from the combined effects of habitat degradation, dam building and operation, fishing, hatchery operations, ecological changes, and natural environmental fluctuations. Habitat for LCR coho has been adversely affected by changes in access, stream flow, water quality, sedimentation, habitat diversity, channel stability, riparian conditions, channel alternations, and floodplain interactions. These large-scale changes have altered habitat conditions and processes important to migratory and resident fish and wildlife. Additionally, habitat conditions have been fundamentally altered throughout the Columbia River Basin by construction and operation of a complex of tributary and mainstem dams and reservoirs for power generation, navigation, and flood control. LCR coho are adversely affected by hydrosystem-related flow and water quality effects, obstructed and/or delayed passage, and ecological changes in impoundments. Dams in many of the larger subbasins have blocked anadromous fishes' access to large areas of productive habitat.

Hatchery programs can harm salmonid viability in several ways: hatchery-induced genetic change can reduce fitness of wild fish; hatchery-induced ecological effects—such as increased competition for food and space—can reduce population productivity and abundance; hatchery imposed environmental changes can reduce a population's spatial structure by limiting access to historical habitat; hatchery-induced disease conveyance can reduce fish health. Practices that introduce native and non-native hatchery fish can increase predation on juvenile life stages. Hatchery practices that affect natural fish production include removal of adults for broodstock, breeding practices, rearing practices, release practices, number of fish released, reduced water quality, and blockage of access to habitat.

The primary fisheries targeting Columbia River hatchery coho salmon occur in West Coast ocean and Columbia River mainstem fisheries. Most of these fisheries have hatchery-selective harvest regulations or time and area strategies to limit impacts on wild coho.

The ER of coho prior to the 1990s fluctuated from approximately 60 percent to 90 percent, but now the aggregate annual ER of wild coho is about 20 percent or less, while the exploitation of hatchery coho is significantly greater because of mark-selective fisheries. It is unclear whether current ER limitations for wild coho provide adequate protection for the weak populations included in the aggregate. Wild coho are harvested in Washington, Oregon, California, and Canadian ocean commercial and sport fisheries (about 9 percent of the total run), and in Columbia River sport, commercial, and treaty Indian fisheries and tributary sport fisheries (about 9 percent more). Regulations in most fisheries specify the release of all wild (non-fin clipped) coho, but some coho are likely retained, and others die after release. Fishing-related threats to wild coho salmon escapements include the following:

- Ocean and in-river harvest
- Release mortalities from hatchery-selective fisheries
- Illegal harvest

2.2.1.9 **Oregon Coast Coho Salmon ESU**

Oregon Coast (Oregon Coast) coho salmon was first listed as threatened on August 10, 1998 (63 FR 42587). After a court decision and the delisting of the species, NMFS relisted Oregon Coast coho as threatened on February 11, 2008 (73 FR 7816). When NMFS re- examined the status of this species in 2011 and 2016, it determined that they still warranted listing as threatened (76 FR 35755; 81 FR 33468). The listing includes all naturally spawned populations of coho salmon in coastal streams south of the Columbia River and north of Cape Blanco. The listing also includes the Cow Creek hatchery coho stock, produced at the Rock Creek Hatchery. Critical habitat was originally designated on February 11, 2008 (73 FR 7816).

In contrast to the life history patterns of other anadromous salmonids, coho salmon generally exhibit a relatively short and fixed three-year life cycle. Juvenile life stages (i.e., eggs, alevins, fry, and parr) inhabit freshwater/riverine areas for up to 15 months. Parr typically undergo a smolt transformation in their second spring, at which time they migrate to the ocean. Subadults and adults forage in coastal and offshore waters of the North Pacific Ocean before returning to spawn in their natal streams. Adults typically begin their spawning migration in the late summer and fall, spawn by mid-winter, then die. Coho salmon typically spend two growing seasons in the ocean before returning to their natal stream to spawn as three-year-olds. Some precocious males, called “jacks,” return to spawn after only six months at sea (i.e., as twoyear-olds).

The Oregon/Northern California Coast TRT identified 56 historical coho populations for the Oregon Coast coho salmon ESU (Lawson et al. 2007). The Oregon/Northern California Coast TRT classified historical populations into three distinct groups: functionally independent, potentially independent, and dependent (**Table 2-38**). In general, Oregon Coast drainage basins of intermediate to large size may have supported a coho population capable of persisting indefinitely in isolation, though some of them may have been demographically influenced by adult coho straying into spawning areas from elsewhere in the ESU. Those persistent populations with minimal demographic influence from adjacent populations are classified as functionally independent (13 populations). Populations that appear to be capable of persisting in isolation but which are demographically influenced by adjacent populations, are classified as potentially independent (eight populations). Coho salmon populations in smaller coastal basins that may not have been able to maintain themselves continuously for periods as long as hundreds of years without the demographic boost provided by migrating spawners from other populations are classified as dependent (35 populations).

Table 2-38. Historical coho populations in the Oregon Coast ESU (Lawson et al. 2007).

Population	Population type	Population	Population type
Necanicum	Potentially independent	Alsea	Functionally independent
Ecola	Dependent	Big (near Alsea)	Dependent
Arch Cape	Dependent	Vingie	Dependent
Short Sands	Dependent	Yachats	Dependent
Nehalem	Functionally independent	Cummins	Dependent
Spring	Dependent	Bob	Dependent
Watseco	Dependent	Tenmile Creek	Dependent
Tillamook Bay	Functionally independent	Rock	Dependent
Netarts	Dependent	Big	Dependent
Rover	Dependent	China	Dependent
Sand	Dependent	Cape	Dependent
Nestucca	Functionally independent	Berry	Dependent
Neskowin	Dependent	Sutton (Mercer Lake)	Dependent
Salmon	Potentially independent	Siuslaw	Functionally independent
Devils Lake	Dependent	Siltcoos	Potentially independent
Siletz	Functionally independent	Tahkenitch	Potentially independent
Schoolhouse	Dependent	Threemile	Dependent
Fogarty	Dependent	Lower Umpqua	Functionally independent
Depoe Bay	Dependent	Middle Umpqua	Functionally independent
Rocky	Dependent	North Umpqua	Functionally independent
Spencer	Dependent	South Umpqua	Functionally independent
Wade	Dependent	Tenmile	Potentially independent
Coal	Dependent	Coos	Functionally independent
Moolack	Dependent	Coquille	Functionally independent
Big (near Yaquina)	Dependent	Johnson	Dependent
Yaquina	Functionally independent	Twomile	Dependent
Theil	Dependent	Floras/New	Potentially independent
Beaver	Potentially independent	Sixes	Potentially independent

Spatial structure was identified as a problem in the 1980s and 1990s, when it was observed that river systems on the North Coast had substantially lower spawner escapements than those on the South Coast (Stout et al. 2011). Causes of these disproportionately lower escapements were never clearly identified, but contributing factors may have included more intense fisheries north of Cape Falcon near the mouth of the Columbia River and high percentages of hatchery fish on the spawning grounds.

Harvest was generally reduced in 1994 (although not as severely north of Cape Falcon as south). Hatchery releases in the Nehalem and Trask Rivers have been reduced or eliminated so that the percentage of hatchery fish on the spawning grounds has declined from a high of 67 percent in 1996 to less than 5 percent in most recent years. Since about 1999, the north coast basins have had escapements more on a par with the rest of the ESU.

Current concerns for spatial structure focus on the Umpqua River (Stout et al. 2011). Of the four populations in the Umpqua stratum, two, the North Umpqua and South Umpqua, were of particular concern. The North Umpqua is controlled by Winchester Dam and has historically been dominated by hatchery fish. Hatchery influence has recently been reduced, but the natural productivity of this population remains to be demonstrated.

In the recent past, the effect of hatchery releases had a significant effect on life history diversity in the Oregon Coast coho salmon ESU (Stout et al. 2011). ODFW has significantly reduced hatchery releases of coho salmon; therefore, the effect of hatchery fish on native population diversity should be abating, although there is little information about the duration of hatchery genetic effects on naturally spawning populations. Because of significant reduction in hatchery releases of coho, the hatchery fraction of spawners observed on the spawning grounds has been substantially reduced (ODFW 2009). This should lead to improvement of diversity in naturally produced Oregon Coast coho salmon in those populations once dominated by hatchery fish.

Since 1990, there have been years with extremely low escapements in some systems. Many small systems have shown local extirpations, presumably reducing diversity due to loss of dependent populations. For example, Cummins Creek, on the central coast, had no spawners observed in 1998, indicating the potential loss of a brood cycle. These small systems are apt to be repopulated by stray spawners most likely from larger adjacent populations during periods of higher abundance (Lawson et al. 2007), and recent local extirpations may represent loss of genetic diversity in the context of normal metapopulation function.

Current status of diversity shows improvement through the waning effects of hatchery fish on populations of Oregon Coast coho salmon. In addition, recent efforts in several coastal estuaries to restore lost wetlands should be beneficial. However, the loss of diversity brought about by legacy effects of both freshwater and tidal habitat loss coupled with the restriction of diversity from very low returns over the past 20 years led NMFS to conclude that current diversity is lower than historical diversity.

Abundance and Productivity:

Based on historic commercial landing numbers and estimated ERs, coho salmon escapement to coastal Oregon rivers was estimated to fall between 1 million and 1.4 million fish in the early 1900s, and the harvest level at that time was nearly 400,000 fish (Mullen 1981; Lichatowich 1989). ODFW (1995) estimated coho salmon abundance at several points of time from 1900 to the present. These data show a decline of about 75 percent from 1900 to the 1950s and an additional 15 percent decline since the 1950s.

Spawning escapement estimates from the late 1990s using stratified random surveys give an annual average of 47,356 returning adults (Jacobs et al. 2002). Lichatowich (1989) attributed much of the species' overall decline to a nearly 50 percent reduction in habitat production capacity. While the contrasting methods of estimating total returns make it difficult to compare historical and recent escapements, these numbers suggest that current abundance of coho salmon on the Oregon coast may be less than 5 percent of what is was in the early 1900s.

Though the overall trend has been distinctly downward throughout the century, Oregon Coast coho salmon populations vary highly from year to year. From 1950 through 2009, the number of naturally produced adult coho (prior to harvest) has ranged from a high of 788,290 in 1951 to a low of 26,888 in 1997 (ODFW 2010). Over the past 10 years, abundance has been cyclical and the trend nearly flat. Since 2000, abundance twice fluctuated to fewer than 80,000 and then rose to nearly 300,000. Table 2-41 summarizes abundance of Oregon Coast coho over the most recent four years.

Table 2-39. Estimated Abundance of Hatchery and Naturally Produced Adult Oregon Coast Coho (ODFW 2016).

Population	Origin	2011	2012	2013	2014	Average
Necanicum R.	Hatchery	39	0	0	98	34
	Natural	2,120	902	798	5,727	2,387
Nehalem R.	Hatchery	64	0	0	764	207
	Natural	15,322	2,963	4,539	30,577	13,350
Tillamook Bay	Hatchery	0	0	304	460	191
	Natural	19,250	1,686	4,402	20,090	11,357
Nestucca R.	Hatchery	0	0	37	0	9
	Natural	7,857	1,751	946	6,369	4,231
NC Dependents	Hatchery	0	0	0	111	28
	Natural	1,341	218	271	4,607	1,609
Salmon R.	Hatchery	0	0	0	27	7
	Natural	3,636	297	1,165	3,680	2,195
Siletz R.	Hatchery	0	0	0	71	18
	Natural	33,094	4,495	7,660	19,496	16,186

Population	Origin	2011	2012	2013	2014	Average
Yaquina R.	Hatchery	0	0	0	0	0
	Natural	19,074	6,268	3,553	25,582	13,619
Beaver Cr.	Hatchery	0	0	0	0	0
	Natural	2,389	1,878	2,015	6,564	3,212
Alsea R.	Hatchery	81	0	0	0	20
	Natural	28,337	8,470	9,283	25,786	17,969
Siuslaw R.	Hatchery	803	314	0	0	279
	Natural	28,082	11,946	14,118	38,896	23,261
MC Dependents	Hatchery	0	0	0	118	30
	Natural	4,487	492	1,929	1,890	2,200
Lower Umpqua R.	Hatchery	0	0	0	0	0
	Natural	18,715	3,731	7,792	36,942	16,795
Middle Umpqua R.	Hatchery	71	0	0	0	18
	Natural	19,962	2,447	4,272	13,939	10,155
North Umpqua R.	Hatchery	335	669	622	105	433
	Natural	3,679	3,134	2,774	3,979	3,392
South Umpqua R.	Hatchery	1,130	0	193	1,022	586
	Natural	49,958	11,636	12,178	11,412	21,296
Coos R.	Hatchery	0	0	0	0	0
	Natural	10,999	9,414	6,884	38,880	16,544
Coquille R.	Hatchery	442	0	148	148	185
	Natural	55,667	5,911	23,637	41,660	31,719
Floras Cr.	Hatchery	0	0	0	0	0
	Natural	9,217	2,502	1,936	1,022	3,669
Sixes R.	Hatchery	0	3	0	0	1
	Natural	334	31	567	410	336
Siltcoos Lake	Hatchery	0	0	0	0	0
	Natural	6,352	3,945	3,797	7,178	5,318
Tahkenitch Lake	Hatchery	0	0	3	0	1
	Natural	6,665	5,675	3,413	3,691	4,861
Tenmile Lake	Hatchery	0	0	0	0	0
	Natural	7,284	9,302	6,449	11,141	8,544
Total	Hatchery	2,965	986	1,307	2,924	2,046
Natural		353,821	99,094	124,378	359,518	234,203

A review of ODFW's stratified random surveys from 1990 to 2002 shows positive trends for 11 major river systems (Good et al. 2005). The biggest increases (more than 10 percent per year) were found on the north coast (Necanicum, Nehalem, Tillamook, Nestucca), mid coast (Yaquina, Siuslaw), and the

Umpqua, while smaller increases were seen on the central (Siletz, Siuslaw) and south (Coos, Coquille) coasts. Thirteen-year trends in preharvest recruits show a less favorable picture. Necanicum, Nehalem, Tillamook, Nestucca, Yaquina, and Umpqua all showed positive trends of about 8 percent to 13 percent per year. Siletz, Alsea, and Coquille showed declines ranging from 1 percent to 4 percent per year.

Long-term (33-year) trends in spawner abundance for both the lakes and rivers have been relatively flat, with lakes increasing about 2 percent per year and rivers increasing about 1 percent per year. In both the lakes and rivers, long-term trends in recruits have declined about 5 percent per year since 1970. For the ESU as a whole, spawners and recruits have declined at a 5 percent rate over the past 33 years.

Stout et al. (2011) found that recruits from the return years 1997 to 1999 failed to replace parental spawners: a recruitment failure occurred in all three brood cycles even before accounting for harvest-related mortalities. This was the first time this had happened since data collection began in the 1950s. Ocean conditions improved for the 1998 brood year, and recruits since 2001 have returned to spawn in numbers higher than we have previously observed. However, in the return years of 2005, 2006, and 2007, recruits again failed to replace parental spawners.

Limiting Factors and Threats:

Some threats, in particular hatchery production and harvest, have been greatly reduced over the last decade and appear to have been largely eliminated as significant sources of risk. Other factors, such as habitat degradation and water quality, are considered to be ongoing threats that appear to have changed little over the last decade (NMFS 2011a). Changes in freshwater and marine habitat due to global climate change are also considered to be threats likely to become manifest in the future.

Historical HRs on Oregon Production Index area coho salmon were in the range of 60 percent to 90 percent from the 1960s into the 1980s (NMFS 2011a). Modest harvest reductions were achieved in the late 1980s, but rates remained high until a crisis was perceived, and most directed coho salmon harvest was prohibited in 1994. Subsequent fisheries have been severely restricted and most reported mortalities are estimates of indirect (noncatch) mortality in Chinook fisheries and selective fisheries for marked (hatchery) coho. Estimates of these indirect mortalities are somewhat speculative, and there is a risk of underestimation (PFMC 2009; Lawson and Sampson 1996). Freshwater fisheries have been allowed in recent years based on the provision in the salmon FMP that terminal fisheries can be allowed on strong populations as long as the overall ER for the ESU does not exceed the allowable rate, and population escapement is not reduced below full seeding of the best available habitat.

Hatchery production continues to be reduced with the cessation of releases in the North Umpqua River and Salmon River populations. The near-term ecological benefits from these reductions may result in improved natural production for these populations in future (NMFS 2011a). In addition, reductions in hatchery releases that have occurred over the past decade may continue to produce some positive effects on the survival of the ESU in the future, due to the time it may take for past genetic impacts on become attenuated.

ODFW has been monitoring freshwater rearing habitat for the Oregon Coast coho salmon ESU over the past decade (1998 to present), collecting data during the summer low-flow period (Anlauf et al., 2009). The goal of this program is to measure the status and trend of habitat conditions throughout the range of the ESU through variables related to the quality and quantity of aquatic habitat for coho salmon: stream morphology, substrate composition, instream roughness, riparian structure, and winter-rearing capacity (Moore, 2008). ODFW concluded that for the most part, at the ESU and strata scale, habitat for the Oregon Coast coho salmon has not changed significantly in the last decade. They did find some small but significant trends. For instance, the Mid-South Coast stratum did show a positive increase in winter rearing capacity.

In 2010, the BRT found that habitat complexity, for the most part, decreased across the ESU over the period of consideration (1998 to 2008) (Stout et al. 2011). The BRT noted that legacy effects of splash damming, log drives, and stream-cleaning activities still affect the amount and type of wood and gravel substrate available and, therefore, stream complexity across the ESU (Montgomery et al., 2003). Road densities remain high and affect stream quality through hydrologic effects like runoff and siltation and by providing access for human activities. Beaver (*Castor canadensis*) activities, which produce the most favorable coho salmon rearing habitat especially in lowland areas, appear to be reduced. Stream habitat restoration activities may be having a short-term positive effect in some areas, but the quantity of impaired habitat and the rate of continued disturbance outpace agencies' ability to conduct effective restoration.

2.2.1.9 Southern Oregon/Northern California Coast Coho Salmon ESU

The Southern Oregon/Northern California Coast's (SONCC) coho salmon was first listed as threatened on May 6, 1997. When we re-examined the status of these fish in 2005, 2011, and 2016, we determined that they still warranted listing as threatened (70 FR 37160; 76 FR 50447; 81 FR 33468). The listing includes all naturally spawned populations of coho salmon in coastal streams between Cape Blanco, Oregon, and Punta Gorda, California. The ESU includes coho salmon from three hatchery programs: the Cole Rivers Hatchery Program (ODFW Stock #52); Trinity River Hatchery Program; and the Iron Gate Hatchery Program (79 FR 20802).

Williams et al. (2006) characterized the SONCC ESU as three large populations that penetrate far inland (interior basins) and multiple smaller coastal populations (coastal basins). Populations that had minimal demographic influence from adjacent populations and were viable in isolation were classified as functionally independent populations. Populations that appeared to have been viable in isolation but were demographically influenced by adjacent populations were classified as potentially independent populations. Small populations that do not have a high likelihood of sustaining themselves more than 100 years in isolation and that receive sufficient immigration to alter their dynamics and extinction risk were classified as dependent. Ephemeral populations, the last category, do not have a high likelihood of sustaining themselves more than 100 years in isolation and do not receive sufficient immigration to affect this likelihood. The habitat supporting an ephemeral population is expected to be only rarely occupied.

The interior subbasin strata were divided into substrata representing the three major subbasins of the Rogue, Klamath, and Eel Basins (Table 2-40). However, sufficient geographical and environmental variability occurs within the Klamath Basin, therefore the Klamath Basin was split into sub-strata of the Klamath River (upstream of the confluence with the Trinity River) and the Trinity River. The lower portions of these three large basins were included in the coastal basins sub-strata because they are more similar to other coastal basins in terms of the environmental and ecological characteristics examined than interior portions of the large basins.

Table 2-40. Arrangement of historical populations of the Southern Oregon/Northern California Coast coho salmon ESU. Population types are functionally independent (F), potentially independent (P), dependent (D) and, ephemeral (E).

Diversity Stratum	Pop.	Population	Diversity Stratum	Pop.	Population
Northern Coastal	F	Elk River	Southern Coastal	F	Humboldt Bay tribs
	P	Lower Rogue River		F	Low. Eel/Van Duzen
	F	Chetco River		P	Bear River
	P	Winchuck River		F	Mattole River
	E	Hubbard Creek		D	Guthrie Creek
	E	Euchre Creek	Interior – Rogue	F	Illinois River
	D	Brush Creek		F	Mid. Rogue/Applegate
	D	Mussel Creek		F	Upper Rogue River
	D	Hunter Creek	Interior – Klamath	P	Middle Klamath River
	D	Pistol River		F	Upper Klamath River
Central Coastal	F	Smith River		P	Salmon River
	F	Lower Klamath River		F	Scott River
	F	Redwood Creek		F	Shasta River
	P	Maple Creek/Big	Interior – Trinity	F	South Fork Trinity
	P	Little River		P	Lower Trinity River
	F	Mad River		F	Upper Trinity River
	D	Elk Creek	Interior – Eel River	F	South Fork Eel River
	D	Wilson Creek		P	Mainstem Eel River
	D	Strawberry Creek		P	Mid. Fork Eel River
	D	Norton/Widow White		F	Mid. Mainstem Eel River
				P	Up. Mainstem Eel River

The TRT divided the coastal basins of the SONCC Coho Salmon ESU into three sub-strata to better take into account geographical and environmental variability. The northern sub-stratum includes basins from the Elk River to the Winchuck River, including the lower portion of the Rogue River. The central substratum includes coastal basins from the Smith River to the Mad River, including the lower portion of the Klamath River. The southern stratum includes the Humboldt Bay tributaries south to the Mattole River, including the lower Eel River and Van Duzen River.

The primary factors affecting the genetic and life history diversity of SONCC coho salmon appear to be low population abundance and the influence of hatcheries and out-of-basin introductions. Although the operation of a hatchery tends to increase the abundance of returning adults, the reproductive success of hatchery-born salmonids spawning in the wild can be less than that of naturally produced fish (Araki et al. 2007). As a result, the higher the proportion of hatchery-born spawners in a population, the greater the likelihood of lower overall productivity of the population, as demonstrated by Chilcote (2003).

Williams et al. (2008) considered a population to be at least at moderate risk of extinction if the contribution of hatchery coho salmon spawning in the wild exceeds 5 percent. Populations have a lower risk of extinction if no or negligible ecological or genetic effects resulting from past or current hatchery operations can be demonstrated. Because the main stocks in the SONCC coho salmon ESU (i.e., Rogue River, Klamath River, and Trinity River) remain heavily influenced by hatcheries and have little natural production in mainstem rivers (Weitkamp et al. 1995; Good et al. 2005), some of these populations are at high risk of extinction relative to the genetic diversity parameter. In addition, some populations are extirpated or nearly extirpated (i.e., Middle Fork Eel, Bear River, and Upper Mainstem Eel), and some brood years have low abundance or may even be absent in some areas (e.g., Shasta River, Scott River, Mattole River, and Mainstem Eel River), which further restricts the diversity present in the ESU. The ESU's current genetic variability and variation in life history likely contribute significantly to long-term risk of extinction. Given the recent trends in abundance across the ESU, the genetic and life history diversity of populations is likely very low and is inadequate to contribute to a viable ESU.

NMFS recognizes that artificial propagation can be used to help recover ESA-listed species, but it does not consider hatcheries to be a substitute for conserving the species in its natural habitat. Potential benefits of artificial propagation for natural populations include reducing the short-term risk of extinction, helping to maintain a population until the factors limiting recovery can be addressed, reseeding vacant habitat, and helping speed recovery. Artificial propagation could have negative effects on population diversity by altering life history characteristics such as smolt age and migration, as well as spawn timing.

Abundance and Productivity:

Although long-term data on coho abundance in the SONCC Coho Salmon ESU are scarce, all available evidence from shorter-term research and monitoring efforts indicate that conditions have worsened for populations in this ESU since the early 2000s (Williams et al. 2011). For all available time series (except the parietal counts from West Branch and East Fork of Mill Creek), recent population trends have been downward. The longest existing time series at the "population unit" scale is from the Shasta River, which indicates a significant negative trend. The two extensive time series from the Rogue Basin both have recent negative trends, although neither is statistically significant (Williams et al. 2011).

Good et al. (2005) noted that the 2001 brood year appeared to be the strongest of the last decade and that the Rogue River stock had an average increase in spawners over the last several years (as of the Good et al. 2005 review). In the 2011 status evaluation, none of the time series examined (other than West Branch and East Fork Mill Creek) had a positive short-term trend, and examination of these time series indicates that the strong 2001 brood year was followed by a decline across the entire ESU (Williams et al. 2011). The exception is the Rogue Basin estimate from Huntley Park that exhibited a strong return year in 2004, stronger than 2001, followed by a decline to 414 fish in 2008, the lowest estimate since 1993 and the second lowest going back to 1980 in the time series.

Counts of adult coho salmon at Huntley Park, about 8 miles from the mouth of the Rogue River, provide a view of this species' abundance over a 32-year period (ODFW 2016). The time series data from Huntley Park indicate that populations in the Rogue River have declined since the 2005 status review (Good et al. 2005; NMFS 2011c). The time series from the Rogue Basin show recent negative trends, although the trend is not considered to be statistically significant (NMFS 2011c).

Recent returns of naturally produced adults to the Rogue, Trinity, Shasta, and Scott Rivers have highly varied. Wild coho salmon estimates derived from the beach seine surveys at Huntley Park on the Rogue River ranged from 414 to 24,481 naturally produced adults between 2003 and 2012 (Table 2-43). Similar fluctuations have been noted in the Trinity, Shasta, and Scott River populations. Overall, the average annual abundance, for populations where NMFS has abundance data, is only 5,586 naturally produced fish. However, abundance data are lacking for the Eel, Smith, and Chetco Rivers, the other major populations in the ESU, as well as for the numerous smaller coastal populations. Actual abundance is, therefore, likely to be higher than this estimate.

Table 2-41. Estimates of the Natural and Hatchery Adult Coho Returning to the Rogue, Trinity, and Klamath rivers (ODFW 2016, Kier et al 2015, CDFW 2012).

Year	Rogue River		Trinity River		Klamath River		
					Shasta [a]	Scott [a]	Salmon
	Hatchery	Natural	Hatchery	Natural	Natural	Total	Natural
2008	158	414	3,851	944	30	62	
2009	518	2,566	2,439	542	9	81	
2010	753	3,073	2,863	658	44	927	
2011	1,156	3,917	9,009	1,178	62	355	
2012	1,423	5,440	8,662	1,761		201	
2013	1,999	11,210	11,177	4,097			
2014	829	2,409	8,712	917			
Average [b]	1,417	6,353	9,517	2,258	38	357	50 [c]

[a] Hatchery proportion unknown, but assumed to be low.

[b] Three-year average of most recent years of data.

[c] Annual returns of adults are likely less than 50 per year (NMFS 2012d).

The productivity of a population (i.e., production over the entire life cycle) can reflect conditions (e.g., environmental conditions) that influence the dynamics of a population and determine abundance. In turn, the productivity of a population allows an understanding of the performance of a population across the landscape and habitats in which it exists and its response to those habitats (McElhany et al. 2000). In general, declining productivity equates to declining population abundance. As discussed above in the population abundance section, available data indicate that many populations have declined, which reflects a declining productivity. For instance, the Shasta River population has declined in abundance by almost 50 percent from one generation to the next (Williams et al. 2011; NMFS 2012d). Two partial counts from Prairie Creek, a tributary of Redwood Creek, and Freshwater Creek, a tributary of Humboldt Bay, indicate a negative trend (NMFS 2012d). Data from the Rogue River Basin also show recent negative trends. In general, SONCC coho salmon have declined substantially from historic levels. Because productivity appears to be negative for most, if not all, SONCC coho salmon populations, this ESU is not currently viable in regard to population productivity.

Limiting Factors and Threats:

Harvest impacts include mark-selective (hatchery) coho fisheries and Chinook-directed fisheries in Oregon, as well as non-retention impacts in California. California has prohibited coho salmon-directed fisheries and coho salmon retention in the ocean since 1996.

The Rogue/Klamath coho salmon ocean ER averaged 6 percent from 2000 to 2007 before declining to 1 percent and 3 percent in 2008 and 2009, respectively, due to closure of nearly all salmon fisheries south of Cape Falcon, Oregon. For 2010, the forecasted rate was 10 percent (PFMC 2010), primarily due to the resumption of recreational fishing off California and Oregon.

Tribal harvest is not considered to be a major threat. Estimates of the HR for the Yurok fishery averaged 4 percent from 1992 to 2005 and 5 percent from 2006 to 2009 (Williams 2010). NMFS does not have HR estimates for the Hoopa Valley and Karuk tribal fisheries.

Recreational harvest of SONCC coho salmon has not been allowed since 1994, with the exception being a mark-selective recreational coho salmon fishery that has taken place in recent years in the Rogue River and Oregon coastal waters. The Council (2007) estimated that 3.3 percent of Rogue/Klamath coho salmon accidentally caught in this mark-selective fishery would die on release. However, no recent assessments of coho salmon bycatch have occurred in Oregon or California. Overall, the threat to the SONCC coho salmon ESU from recreational fishing is unknown, but is likely to be a factor for decline (NMFS 2011d).

Recent studies have raised concerns about the potential impacts of hatchery fish predation on natural coho salmon populations. Hatchery fish can exert predation pressure on juvenile coho salmon in certain watersheds. Released at larger sizes than naturally produced juveniles and in great quantity, hatchery-reared salmonids will often prey on naturally produced juvenile coho (Kostow 2009). Evidence indicates that predation by hatchery fish may result in the loss of tens of thousands of naturally produced coho salmon fry annually in some areas of the Trinity River (Naman 2008).

The ODFW Aquatic Inventories Project, started in 1990, and the Oregon Plan Habitat Survey, begun in 1998, randomly surveyed streams for both summer and winter habitat. In addition to characterizing a site's streamside and upland processes, the surveys detailed specific attributes such as large wood, pools, riparian structure, and substrate. It established the following benchmark thresholds as indicators of habitat quality:

(1) Pool area greater than 35 percent of total habitat area

(2) Fine sediments in riffle units less than 12 percent of all sediments

(3) Volume of large woody debris greater than 20-m^3 per 100-m stream length

(4) Shade greater than 70 percent

(5) Large riparian conifers more than 150 trees per 305-m stream length

For the combined 1998-to-2000 surveys in the Oregon portion of the SONCC ESU, 6 percent of sites surveyed met none of the benchmarks, 29 percent met one, 38 percent met two, 20 percent met three, 5 percent met four, and 2 percent met all five benchmarks. No trends in habitat condition can yet be assessed from these data, but they are being developed and will eventually be used to assess changes in habitat quality (Good et al. 2005). It is likely that human demands for natural resources in southern Oregon will increase and, thereby, continue to negatively affect SONCC coho critical habitat.

2.2.1.10 Central California Coast Coho Salmon ESU

The CCC Coho Salmon ESU includes all naturally spawned coho salmon originating from rivers south of Punta Gorda, California, to and including Aptos Creek, as well as coho salmon originating from tributaries to San Francisco Bay. The CCC Coho Salmon ESU was originally listed as threatened in 1996 (61 FR 56138). In 2005, following a reassessment of its status and after applying NMFS' hatchery listing policy, the ESU was reclassified as endangered, and several conservation hatchery programs were included in the listing of the ESU: Don Clausen Fish Hatchery Captive Broodstock Program; the Scott Creek/King Fisher Flats Conservation Program; and the Scott Creek

Captive Broodstock program (70 FR 37160). Critical habitat was originally designated on May 5, 1999 (64 FR 24049).

Historically, the CCC Coho Salmon ESU comprised approximately 76 coho salmon populations. Most of these were dependent populations that needed immigration from other nearby populations to ensure their long-term survival. Historically, there were 11 functionally independent populations and one potentially independent population of CCC coho salmon (Spence et al. 2008; Spence et al. 2012). In the mid-1990s, Adams et al. (1999) found that coho salmon were present in only 51 percent (98 of 191) of the streams in which they were historically present, although coho salmon were documented in 23 additional streams within the CCC Coho Salmon ESU for which there were no historical records. Recent genetic research by the SWFSC and the Bodega Marine Laboratory has documented a reduction in genetic diversity within subpopulations of the CCC Coho Salmon ESU (Bjorkstedt et al. 2005).

Abundance and Productivity:

Brown et al. (1994) estimated that annual spawning numbers of coho salmon in California ranged between 200,000 and 500,000 fish in the 1940s, with a decline to about 100,000 fish by the 1960s, followed by a further decline to about 31,000 fish by 1991. More recent abundance estimates vary from approximately 600 to 5,500 adults (Good et al. 2005). Recent status reviews (Good et al. 2005; Williams et al. 2011; NMFS 2016b) indicate that CCC coho salmon are likely continuing to decline in number, and many independent populations that supported the species' overall numbers and geographic distributions have been extirpated. The current average run size for the CCC Coho Salmon ESU is 1,621 fish (1,294 natural-origin and 327 hatchery-produced).

Threats and Limiting Factors:

Most of the populations in the CCC coho salmon ESU are currently doing poorly; due to low abundance, range constriction, fragmentation, and loss of genetic diversity. The near-term (10-to-20 year) viability of many of the extant independent CCC coho salmon populations is of serious concern. These populations may not have enough fish to survive additional natural and human caused environmental change.

NMFS has determined that currently depressed population conditions are, in part, the result of the following human-induced factors affecting critical habitat[17] logging, agriculture, mining, urbanization, stream channelization, dams, wetland loss, and water withdrawals (including unscreened diversions for

[17] The conservation value of a site depends upon "(1) the importance of the populations associated with a site to the ESU [or DPS] conservation, and (2) the contribution of that site to the conservation of the population through demonstrated or potential productivity of the area" (NMFS 2005e)

irrigation). Impacts of concern include altered stream bank and channel morphology, elevated water temperature, lost spawning and rearing habitat, habitat fragmentation, impaired gravel and wood recruitment from upstream sources, degraded water quality, lost riparian vegetation, and increased erosion into streams from upland areas (Weitkamp et al. 1995; Busby et al. 1996; 64 FR 24049; 70 FR 37160; 70 FR 52488). Diversion and storage of river and stream flow has dramatically altered the natural hydrologic cycle in many of the streams within the ESU.

2.3 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). For the Pacific Coast Groundfish Fishery, the action area includes the EEZ and state waters of the Pacific Ocean. Although the consulted-on action of the continued operations of the fishery NMFS regulates occurs only between 3 and 200 nautical miles off the coast, fishing vessels will transit through the coastal waters to reach the EEZ, and some species targeted by the groundfish fisheries straddle the state-federal marine waters boundary. Therefore, coastal waters are included in the action area (Figure 2-9).

2.4 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for the species affected by the proposed actions includes the effects of many activities that occur across the broad expanse of the action area considered in this opinion. The status of the species described in Section 2.2 of the biological opinion is a consequence of those effects.

NMFS recognizes the unique status of treaty Indian fisheries and their relation to the environmental baseline. Implementation of treaty Indian fishing rights involves, among other things, application of the sharing principles of *United States v. Washington*, annual calculation of allowable harvest levels and ERs, the application of the "conservation necessity principle" articulated in *United States v. Washington* to the regulation of treaty Indian fisheries, and an understanding of the interaction between treaty rights and the ESA on non-treaty allocations. ER calculations and harvest levels to which the sharing principles apply, in turn, are dependent upon various biological parameters, including the estimated run sizes for the particular year, the mix of stocks present, the allowable fisheries and the anticipated fishing effort. The treaty fishing right itself exists and must be accounted for in the environmental baseline, although the precise quantification of treaty Indian fishing rights during a particular fishing season cannot be established by a rigid formula.

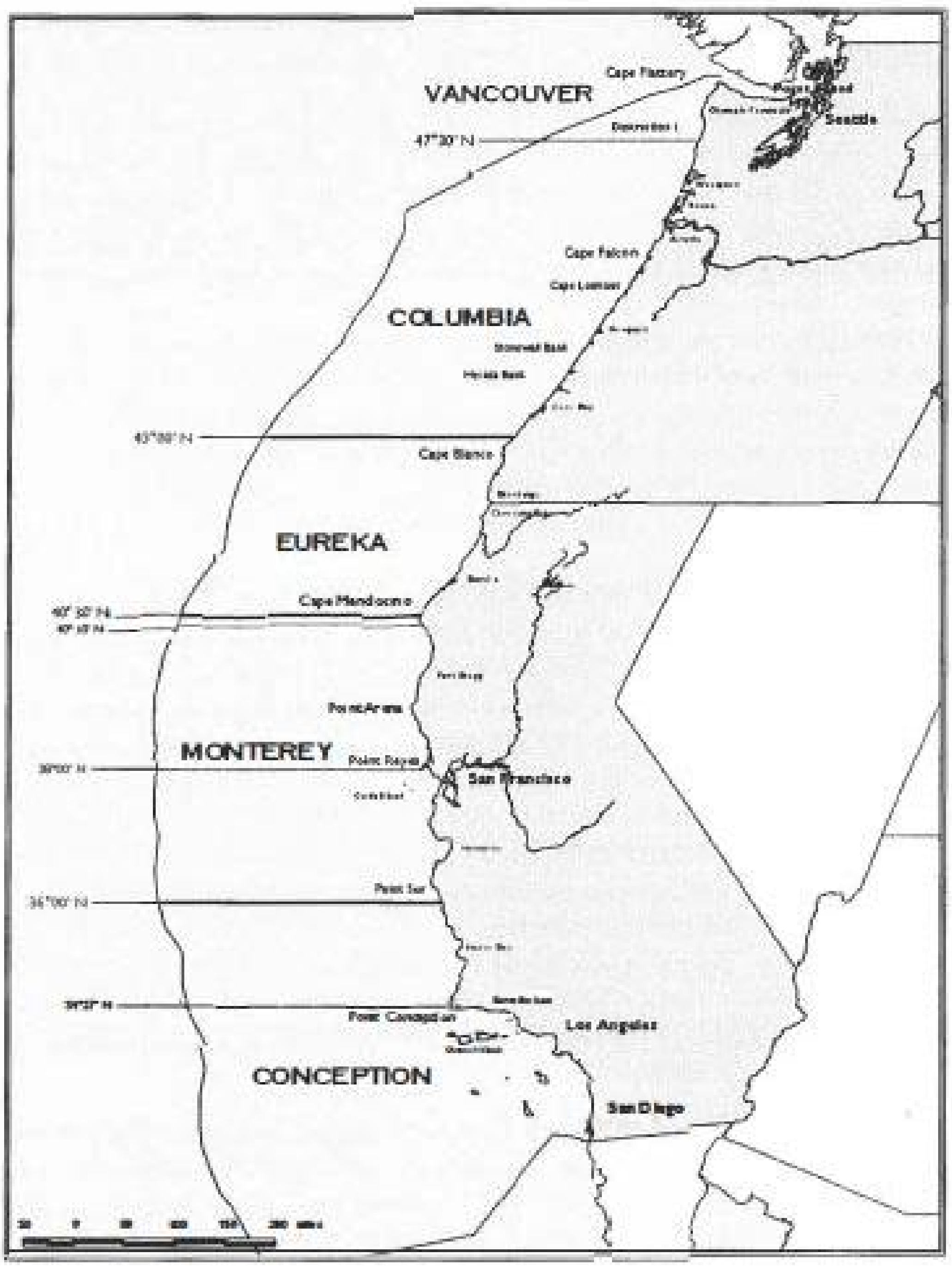

Figure 2-9. General map of the proposed action area; solid line west of the coast depicts the limit of the U.S. EEZ (PFMC 2016a).

If, after completing this ESA consultation, circumstances change, or unexpected consequences arise that necessitate additional Federal action to avoid jeopardy determinations for ESA listed species, such action will be taken in accordance with standards, principles, and guidelines established under *United States v. Washington*, Secretarial Order 3206, and other applicable laws and policies. The conservation principles of *United States v. Washington* will guide the determination of appropriate fishery responses if additional harvest constraints become necessary. Consistent with the September 23, 2004 Memorandum for the Heads of Executive Departments and Agencies pertaining to Government-to-Government Relationship with Tribal Governments and Executive Order 13175, Departmental and agency consultation policies guiding their implementation, and administrative guidelines developed to implement Secretarial Order 3206, these responses are to be developed through government-to-government discourse involving both technical and policy representatives of the WCR and affected Indian tribes prior to finalizing a proposed course of action.

2.4.1 Recovery Planning

NMFS has convened recovery planning efforts across the Pacific Northwest to identify what actions are needed to recover listed salmon and steelhead. Although these plans do not address actions within the action area of this opinion, the effect of actions implemented through the recovery plans are expected to improve baseline conditions. The recovery plans include exhaustive descriptions of the limiting factors listed in Section 2.2 above (Status of the Species) and recommendations of actions to address those factors. Table 2-42 lists the recovery plans of ESUs discussed in this opinion.

Table 2-42. Recovery plan citations by listed Chinook and coho ESU.

ESU	Recovery Plan
Puget Sound Chinook	Puget Sound Salmon Recovery Plan (SSPS 2007) http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/PS-Recovery-Plan.cfm Final Supplement to the Shared Strategy's Puget Sound Salmon Recovery Plan (NMFS 2006c) http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/upload/PS-Supplement.pdf)
LCR Chinook	ESA Recovery Plan for LCR Coho Salmon, LCR Chinook Salmon, Columbia River Chum Salmon, and LCR Steelhead (NMFS 2013b) http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/lower_columbia_river/lower_columbia_river_recovery_plan_for_salmon_steelhead.html
Upper Willamette River Chinook	Upper Willamette River Conservation & Recovery Plan for Chinook Salmon & Steelhead (ODFW and NMFS 2011) http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/willamette_river/upper_willamette_river_recovery_plan_for_chinook_salmon_steelhead.html

ESU	Recovery Plan
Snake River fall Chinook	Proposed ESA Recovery Plan for Snake River Fall Chinook Salmon (Oncorhynchus tshawytscha) (NMFS 2015c) http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/snake_river/snake_river_fall_chinook_recovery_plan.html
Snake River spring/summer Chinook	Proposed ESA Snake River spring/summer Chinook Salmon and Steelhead Recovery Plan (NMFS 2015c) http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/snake_river/snake_river_sp-su_chinook_steelhead.html
CC Chinook	Coastal Multispecies Final Recovery Plan: CC Chinook Salmon ESU, Northern California Steelhead DPS and Central California Coast Steelhead DPS (NMFS 2016e). http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/north_central_california_coast/coastal_multispecies_recovery_plan.html
LCR coho	ESA Recovery Plan for LCR Coho Salmon, LCR Chinook Salmon, Columbia River Chum Salmon, and LCR Steelhead (NMFS 2013b) http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/lower_columbia_river/lower_columbia_river_recovery_plan_f or_salmon_steelhead.html
Oregon Coast coho	Oregon Coast Coho Recovery Plan (NMFS 2016f) http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/oregon_coast/oregon_coast_recovery_plan.html. The Oregon Coast Coho Salmon Recovery Implementation Strategy is an on-going effort that is intended to supplement the broader recovery plan. The Strategy will add strategic action plans and other detailed information at the population level.
Southern Oregon/Northern California coho	Southern Oregon Northern California Coast Coho Salmon Recovery Plan (NMFS 2014b). http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/southern_oregon_northern_california_coast/SONCC_recovery_plan.html
Central California Coast coho	Central California Coast Coho Salmon Recovery Plan (NMFS 2012h). http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/north_central_california_coast/central_california_coast_coho_recovery_plan.html

2.4.2 Climate change and other ecosystem effects

Changes in climate and ocean conditions happen on several different time scales and have had a profound influence on distributions and abundances of marine and anadromous fishes. Evidence suggests that marine survival among salmonids fluctuates in response to 20- to 30-year cycles of climatic conditions and ocean productivity. The fluctuations in salmon survival that occur with these changes in climate conditions can also affect species that depend on salmon for prey such as Southern Resident killer whales.

More detailed discussions about the likely effects of large-scale environmental variation on salmonids, including climate change, are found in Section 2.2.1 of this opinion, and biological opinions on the 2008 Pacific Salmon Treaty Agreement (NMFS 2008f) and the Pacific Coast Salmon Plan effects on LCR Chinook (NMFS 2012b). The University of Washington Climate Impacts Group summarized the current state of knowledge of climate change and anticipated trends, including those that would affect salmon (Mauger et al. 2015). In addition to those described in Section 2.3 for freshwater environments, effects on salmon may occur in the marine ecosystem including warmer water temperatures, loss of coastal habitat due to sea level rise, ocean acidification, and changes in water quality and freshwater inputs (Mauger et al. 2015).

2.4.3 Harvest Actions

The harvest impacts on listed Chinook and coho salmon ESUs from salmon fisheries are described in some detail in the discussion of the status of the species that considers harvest in the context of limiting factors (Section 2.2.1). Some of that harvest occurs in the action area and has been consulted on previously; it is, therefore, formally part of the environmental baseline. Harvest in ocean fisheries in Alaska, Canada, and the Columbia River occurs outside the action area but has effects on the abundance of salmon in the action area. These effects are reflected in annual escapements listed in for each ESU in Section 2.2.1.

Council salmon fisheries

Council recreational and commercial salmon fisheries occur in the action area. The fisheries target coho and Chinook returning to watersheds along the southern U.S. West Coast, using troll and hook-and-line gears. Table 2-43 summarizes ERs of listed Chinook and coho salmon ESUs from these fisheries. Of the listed Chinook ESUs, UCR spring, Central Valley spring and Snake River spring/summer Chinook are rarely observed in Council managed salmon fisheries. Stocks returning to the Columbia River, Klamath River and Central Valley rivers are the primary Chinook contributors to the fishery. LCR Washington Coast and Oregon Coast coho are the primary contributing coho stocks. Directed fishing for coho and retention of coho in Chinook-directed fisheries is prohibited off California, which means that mortality in ocean fisheries is the result of incidental mortality in fisheries directed on Chinook or mark selective for coho in Oregon and generally very low (Spence 2016). CC Chinook and coho are not coded-wire tagged, so tagged Chinook from the Klamath system are used as the surrogate for CC Chinook salmon. Coho salmon from the Klamath and Rogue River systems are used as a surrogate for SONCC coho. The SONCC (Rogue/Klamath), natural-origin, coho salmon ocean ER provides the best available proxy measure of the CCC-coho salmon ocean ER (Williams et al. 2016).

Table 2-43. Average 2008 to 2014 total and southern U.S. adult equivalent ocean ERs for Chinook and coho salmon ESUs

Evolutionarily Significant Unit	Life History	Council Exploitation Rate	Total Exploitation Rate	ESA consultation standard
Puget Sound Chinook[a]	spring	<2%	16-54%	Various depending on population status
	fall	<5%	27-59%	
LCR fall Chinook[a]	spring	11%	27%	30-41% total adult equivalent (AEQ) ER depending on abundance and survival
	brights	8%	51%	
	fall	27%	11%`	
Upper Willamette River Chinook [a]	spring	2%	43%	
Snake River fall Chinook[a]	fall	11%	45%	30.0% reduction in age-3 and age-4 AEQ total ER relative to 1988-1993
CC Chinook[b]		11% age-4	Minor additional in-river impacts	16% ocean AEQ ER on age-4 Klamath fall Chinook
LCR coho			15%	10-30% total AEQ ER depending on survival and abundance
Oregon Coast coho			11%	Total AEQ ER depending on survival and abundance (e.g., ≤30%)
Southern Oregon/Northern California coho[c]		<13%	Additional in-river low impacts (<5%)	≤13% AEQ ocean ER
Central California Coast coho		<6%	Minor additional in-river impacts	No retention in CA salmon fisheries

[a] Data source: Chinook Technical Committee report.

[b] CC Chinook are not tagged, so the ESA consultation standard is the age-4 ocean HR on Klamath River Chinook (PFMC 2017c).

[c] The Rogue/Klamath coho hatchery stock is used as an indicator of fishery impacts on SONCC coho and provides the best available proxy measure of the CCC-coho salmon ocean ER.

Forty percent or more of the harvest of many of the populations within Chinook ESUs from the Columbia River and Puget Sound occurs in salmon fisheries outside the action area, primarily in Canadian waters. These fisheries are managed under the terms of the Pacific Salmon Treaty Agreement and the Pacific Fisheries Management Council. The effects of these fisheries were assessed in previous biological opinions (NMFS 2004; 2008f).

Halibut Fisheries

Commercial and recreational halibut fisheries occur within the action area. Salmon caught during coincident halibut/salmon openings are accounted for in existing biological opinions on those salmon fisheries. Commercial and tribal halibut fisheries occur in Washington and Oregon waters. In a recent biological opinion, NMFS concluded that salmon are not likely to be caught incidentally in the commercial or tribal halibut fisheries when using halibut gear (NMFS 2017c). Stock assessment surveys in the same general and adjacent areas and depths have no survey records of salmon bycatch in the action area (Leaman 2012; Leaman 2016). Halibut seasons are extremely short (i.e., often only a few days to a couple of weeks). Differences in depth and behavior between the species support the lack of observed salmon bycatch in commercial halibut fisheries (NMFS 2017c).

The non-retention mortality of Chinook salmon in the coastal halibut recreational fishery North of Cape Falcon when salmon fisheries did not occur during the analysis period was low, ranging from zero to seven and averaging two Chinook salmon, and ranging from zero to four and averaging two coho salmon per year (Table 2-44) (NMFS 2017c). All of the reported catch of the salmon in California halibut trips were coho (Yaremko 2016). From the available information, nearly all were caught and released during times when recreational halibut and salmon fisheries were open and are thus accounted for (Yaremko 2017). NMFS estimated the likely stock composition of the Chinook caught in the area by using the Fishery Regulation and Assessment Model (FRAM) that is used for estimating stock specific impacts in the salmon fishery. Of these, the estimated catch of listed fish (hatchery and wild) was less than two Puget Sound Chinook and less than one LCR Chinook per year. Listed coho will be commingled with non-listed coho from Puget Sound, the Washington coast, Canada, and the UCR. Therefore, the likelihood of take from one or more coho from a listed ESU is very low.

Table 2-44. Total mortality (landed and released) of salmon (number of fish) by year and area in targeted coastal recreational halibut fisheries. Does not include catch at times or areas when ocean salmon sport fishery is open concurrently.

Catch Year	Species	Neah Bay /LaPush	Westport	Columbia River	Oregon	Total
2013	Chinook	0	0	0	0	0
	Coho	0	0	0	0	0
2012	Chinook	0	1	0	0	1
	Coho	0	2	0	0	2
2011	Chinook	0	1	0	0	1
	Coho	0	0	0	0	0
2010	Chinook	3	2	2	0	7
	Coho	3	0	0	0	3
2009	Chinook	0	0	0	0	0
	Coho	2	2	0	0	4
Average	Chinook	1	1	0	0	2
	Coho	1	1	0	0	2

State managed nearshore fixed gear fisheries

The nearshore, fixed-gear fisheries occur between 0 to 3 miles offshore and are regulated by the states. These state-managed fisheries are not part of this proposed action, because they are not directly managed under the FMP. However, vessels participating in FMP fisheries transit areas in which these fisheries occur to reach the EEZ, so coastal waters are included in the action area, and the effects of salmon caught in state managed fisheries are reviewed here. While these fisheries primarily target species that are not managed under Federal FMPs, their incidental catch includes FMP managed species. Of the nearshore state-managed fisheries, the pink shrimp and California halibut trawl fisheries are the only fisheries that have recorded salmon bycatch. Pink shrimp are harvested with trawl gear from northern Washington to central California from 25 to 200 fm offshore. Most pink shrimp catch are taken off the coast of Oregon. From 2010 to 2015, bycatch occurred rarely, with two Chinook caught in 2012, and 27 coho caught in 2015 (WCGOP, unpub. Data 2017). The California halibut fishery primarily occurs in central and southern California. From 2010 to 2015, the fishery averaged 49 Chinook salmon per year and caught no coho salmon. The Chinook bycatch would be a mix of listed and unlisted ESUs.

Council groundfish fisheries

Historical salmon bycatch in the Council groundfish fisheries contributed to the current status of the species in the action area; they are, therefore, considered part of the environmental baseline. Table 52 summarizes the bycatch of salmon by species and fishery managed under the FMP from 2002 through 2015. Chinook salmon are the salmon species most typically taken as incidental catch by trawl fisheries. Chinook salmon bycatch ranged from 901 to 19,475 fish for non-tribal fisheries from 2002 to 2015. Coho and chum are caught in relatively low numbers, with an annual catch of tens to at most a few hundreds of fish over all fishery sectors coast-wide. Most of these fish will be unlisted natural-origin or hatchery fish. Pink salmon were caught sporadically. As noted earlier, sockeye and steelhead are rarely encountered in the groundfish fishery. Available information suggests several ESUs (Central Valley Spring, Sacramento Winter-run, Upper Columbia Spring, and Snake River Spring/summer Chinook) are not or have rarely been taken in the groundfish fisheries. During this period, Chinook were primarily caught in the at-sea and shorebased whiting fisheries. Bycatch across fisheries averaged just over 9,200 Chinook annually from 2002 to 2015. Bycatch consists of primarily subadult Chinook and coho (i.e., two- and three-year-olds), with coho averaging 2 percent percent of all salmon taken annually in the groundfish fisheries.

NMFS concluded in previous opinions that the effects on ESA-listed Chinook ESUs most likely to be subject to measurable impacts (Snake River fall Chinook, LCR Chinook, Upper Willamette Chinook, and Puget Sound Chinook) were very low. However, limited monitoring and low Chinook and coho bycatch levels constrained the feasibility of making quantitative assessments for individual ESUs. Qualitative characterizations of the impacts ranged from rare to ERs that ranged from a “small fraction of 1 percent per year” to “less than 1 percent per year,” depending on the ESU or populations being considered (NMFS 2006b, NMFS 1999). Since then, information regarding the stock composition of the Chinook salmon bycatch has become available from samples taken from 2009 to 2014 from the at-sea and shoreside sectors of the whiting fishery. Bycatch in other sectors has been very low, with insufficient samples for either genetic or CTW-based analysis. The samples were analyzed by using genetic stock identification (GSI) techniques. Although listed and unlisted ESUs contributed to bycatch, the major contributors to Chinook salmon bycatch in the at-sea sectorwere from unlisted ESUs. They contributed, on average, Klamath/Trinity Chinook (28 percent) followed by south Oregon/north California (25 percent), Oregon Coast (10 percent), and northern British Columbia (11 percent) Chinook. Samples from Chinook salmon bycatch in the shoreside whiting sector showed a contribution from Central Valley Chinook (13 percent), similar to the Oregon Coast and very low contribution from British Columbia

Chinook. The remainder of stocks which included contributions from listed ESUs contributed 5 percent or less of the Chinook bycatch in either fleet on average. In general, the shoreside fishery is focused closer to shore. It does not extend as far south as the at-sea fishery.

The results demonstrate a strong regional pattern in contribution of Chinook ESUs, with a greater proportion of southern Chinook stocks as bycatch when the fleets move south along the coast and similar patterns in the distribution of those stocks between the at-sea and shoreside fleets. Samples from years when fisheries had more southerly distribution include more southern stocks and vice versa. Moreover, some stocks fit this pattern more closely than others (e.g., Puget Sound, Central Valley) due to different migration patterns (tending to migrate differentially north or south). Columbia River Chinook stocks were dominant in the Columbia River area. Catches further north included Columbia River and increasing percentages of Puget Sound and Fraser River Chinook stocks.

These low contribution rates to bycatch from the listed Chinook ESUs (i.e., 5 percent or less) are consistent with the previous qualitative characterizations of likely ERs described above. These genetic sampling results provide more specific information regarding the stock composition of the Chinook salmon bycatch in the whiting fishery, but the results support the more qualitative expectations in the 2006 supplemental opinion that impacts to listed ESUs are very low; i.e., less than 1 percent mortality per year for the most affected ESUs (NMFS 2006c).

Table 2-45. Salmon mortality (number of fish) by species and fishing sector in Pacific Coast Groundfish Fisheries, 2002 to 2015.

Fishery	Species	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
At-Sea whiting	Chinook	1,663	2,617	803	3,958	1,192	1,317	718	318	714	3,989	4,209	3,739	6,695	1,806
	Coho	146	3	1	86	28	226	21	12	0	5	17	6	104	4
	Chum	24	11	55	20	87	169	60	41	10	46	53	26	4	5
	Pink	0	17	0	48	0	34	0	2	0	12	22	37	0	23
	Sockeye	0	0	0	0	0	0	2	0	2	0	0	0	0	0
Shorebased whiting	Chinook	1,062	425	4,206	4,018	839	2,462	1,962	279	2,997	3,722	2,359	1,263	6,898	2,002
	Coho	0	0	0	0	0	0	141	10	37	16	136	16	33	167
	Chum	0	0	0	0	0	0	113	8	2	8	42	3	7	4
	Pink	0	0	0	0	0	47	7	26	0	6,113	0	2	0	0
	Sockeye	0	0	0	0	0	0	0	0	0	2	0	0	1	0
Tribal whiting a/	Chinook	1,004	3,413	3,743	3,980	1,931	2,400	696	2,145	678	828	17	1,014	45	3
	Coho	23	191	207	344	3	107	21	57	5	28	0	78	0	0
	Chum	51	9	11	2	24	8	11	11	1	23	0	5	0	0
	Pink	0	3747	0	383	0	513	9	129	0	1087	0	5	0	0
	Sockeye	0	0	0	0	0	0	0	0	0	2	0	1	0	0
Bottom trawl	Chinook	14,501	16,433	1,758	808	67	194	449	304	282	175	304	323	984	996
	Coho	24	32	66	5	0	13	0	0	31	19	27	49	18	3
	Chum	14	38	4	0	0	0	0	0	0	0	0	0	0	0
	Pink	0	0	0	0	0	0	0	2	0	0	2	0	2	0
	Sockeye	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Midwater non-whiting	Chinook	--	--	--	--	--	--	--	--	--	--	12	71	661	482
	Coho	--	--	--	--	--	--	--	--	--	--	0	0	12	7
	Chum	--	--	--	--	--	--	--	--	--	--	0	1	0	5
	Pink	--	--	--	--	--	--	--	--	--	--	0	0	0	0
	Sockeye	--	--	--	--	--	--	--	--	--	--	0	0	0	0
Non-trawl gear b/	Chinook	22	72	43	32	20	0	0	22	16	8	63	124	36	40
	Coho	0	3	45	3	0	15	42	71	42	83	43	68	124	63
	Chum	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Pink	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Sockeye	0	0	0	0	0	0	0	0	0	0	0	0	0	0

a/ Includes only the Pacific whiting fishery. Tribal non-whiting fishery values were not available

b/ Includes bycatch by vessels fishing under EFPs not already included in a sector count. The added Chinook bycatch by year under EFPs was 2002-22, 2003-51, 2004-3, 2014-1

2.4.4 Hatcheries

Hatcheries can provide benefits to salmon populations by reducing demographic risks and preserving genetic traits for populations at low abundance in degraded habitats. Providing harvest opportunity is an important contributor to upholding the meaningful exercise of treaty rights for Pacific Northwest tribes. However, hatchery-origin fish may also pose risk through genetic, ecological, or harvest effects. Seven factors may pose positive, negligible, or negative effects to population viability of naturally produced salmon. These factors are listed below:

(1) Hatchery program that does or does not remove fish from the natural population and use them for hatchery broodstock;

(2) Hatchery fish and the progeny of naturally spawning hatchery fish on natural populations' spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities;

(3) Hatchery fish and the progeny of naturally spawning hatchery fish in natural populations' juvenile rearing areas;

(4) Hatchery fish and the progeny of naturally spawning hatchery fish in the natural populations' migration corridor, estuary, and ocean;

(5) Research, monitoring, and evaluation that exists because of the hatchery program;

(6) The operation, maintenance, and construction of hatchery facilities that exist because of the hatchery program;

(7) Fisheries that exist because of the hatchery program, including terminal fisheries intended to reduce the escapement of hatchery-origin fish to spawning grounds

Some historical hatchery management practices adversely impacted wild populations by producing large numbers of in some cases out-of-basin or out-of-ESU fish raised in an artificial environment that bred with wild populations thus affecting their genetics, and competed with wild fish for resources. Beginning in the 1990s, state and tribal comanagers took steps to reduce risks identified with hatchery programs as better information became available (PSTT and WDFW 2004), in response to reviews of hatchery programs (e.g., Busack and Currens 1995; HSRG 2000; HSRG 2002). The intent of hatchery reform is to reduce negative effects of artificial propagation on natural populations, while retaining proven production and potential conservation benefits. The goals of conservation programs are to restore and to maintain natural populations. Hatchery programs along the southern U.S. West Coast are phasing out use of dissimilar broodstocks, such as out-of-basin or out-of-ESU stocks, replacing them with fish derived from, or more compatible with, locally adapted populations. Producing fish that are better suited for survival in the wild is now an explicit objective of many salmon hatchery programs. Hatchery programs are also incorporating improved production techniques, such as NATURES-type rearing protocols[18] and limits on the duration of conservation hatchery programs. These changes are intended to ensure that existing natural salmonid populations are preserved and that hatchery-induced genetic and ecological effects on natural populations are minimized.

Many hatchery programs incorporate natural-origin Chinook salmon as broodstock for supportive breeding (conservation) or harvest augmentation purposes. Use of natural-origin fish as broodstock for conservation programs is intended to impart viability benefits to the total, aggregate population by bolstering total and naturally spawning fish abundance, preserving remaining diversity, or improving population spatial structure by extending natural spawning into unused areas.

Integration of natural-origin fish for harvest augmentation programs is intended to reduce genetic diversity reduction risks by producing fish that no more than moderately diverge from the associated, donor natural population. Incorporating natural-origin fish as broodstock for harvest programs produces hatchery fish that are genetically similar to natural-origin fish, reducing risks to the natural population that may result from unintended straying and spawning by unharvested hatchery-origin adults in natural spawning areas. To enable monitoring and evaluation of the performance and effects of programs incorporating natural-origin fish as broodstock, juvenile fish are marked with CWTs or with a clipped adipose fin prior to release so that they can be differentiated and accounted for separately from juvenile and returning adult natural-origin fish.

2.4.5 Habitat Disturbance

Several ocean-dredged material disposal sites have been designated along the coast. In recent years, NMFS has consulted with the Environmental Protection Agency on the proposed designation of several sites off the Oregon coast, off the mouths of the Rogue River, Umpqua River, and Yaquina River (NMFS 2009a, consultation #2009/05437; NMFS 2009b, consultation #2008/05438; NMFS 2012d, consultation #2011/06017). In 2012, NMFS also consulted on the use of four ocean disposal sites off the Columbia River, as part of the Columbia River Channel Operations and Maintenance Program (NMFS 2012e,

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[18] A fundamental assumption is that improved rearing technology will reduce environment-induced physiological and behavioral deficiencies presently associated with cultured salmonids. NATURES-type rearing protocols include a combination of underwater feed-delivery systems, submerged structure, overhead shade cover, and gravel substrates, which, in most studies, have been demonstrated to improve instream survival of Chinook salmon (*O. tshawytscha*) smolts during seaward migrations.

consultation #/2011/02095).

Increased suspended sediment and turbidity levels may also result from dredging and disposal activities, but the effects on water quality are expected to be short term and to have minimal impacts on salmon in the area. Other water quality effects could result from contaminants in the dredged material. However, existing statutes and regulations require dredged material to be tested and deemed "clean" prior to disposal, such that levels of compounds in the sediments are not expected to exceed concentrations harmful to salmon and other organisms occurring at the disposal sites.

In-water construction activities occur throughout the coast, including pile driving and removal activities and installation of renewable energy installations. In 2011, NMFS consulted on the proposed Columbia River Jetty System Rehabilitation Project at the mouth of the Columbia River (NMFS 2011b, consultation #2010/06104). NMFS has also consulted on proposed renewable ocean energy projects off the Oregon coast (NMFS 2012f, consultation #2010/06138; NMFS 2012g, consultation #2012/02531). Potential impacts from these projects include underwater noise and chemical contamination that could cause behavioral changes or physical injury to salmon in the area. In general, the sound levels generated by these projects are expected to be below estimated threshold levels that would result in injury to fish. In addition, the projects typically cover a small area, and the effects would be temporary and minimal. Additional studies are needed, however, to better understand the impacts of underwater noise on salmon. Such studies are included in the project monitoring.

In 2014, NMFS consulted on a project in Yaquina Bay (NMFS 2014b, consultation WCR-2013-9) that included dredging and riprap replacement. The project could impact salmon considered in this opinion through an increase in stormwater contaminants, reduction of forage in the dredging area, and physical injury from ocean disposal of dredged material. The number of salmon injured or killed by reduced forage, increased stormwater contaminants, and ocean disposal each year was estimated to be small due to the areal extent of the effects, the migratory nature of salmon, and the action occurring outside the species' spawning habitat. Abundance of forage for Oregon Coast coho salmon in the action area will be reduced for up to a year, but restoration efforts in the area would offset that reduction. Overall, inclusion of mitigation and monitoring measures resulted in only an anticipated take of a fraction of a percent on average of any of the Chinook or coho ESUs considered in this opinion from these projects.

Dredging activities, disposal of dredged material at ocean disposal sites, and management and operation of renewable ocean energy installations may affect benthic habitats and prey availability for salmon, primarily juvenile life stages, in marine waters by disturbing benthic habitats and injuring or burying prey resources. In general, effects are expected to be localized and insignificant relative to the abundance of prey available. Some of the actions would occur in areas of high-energy environments where benthic communities are affected by frequent disturbance and rapid recolonization.

2.4.6 Scientific Research

The listed salmon species in this opinion are the subject of scientific research and monitoring activities. Most biological opinions NMFS issues have conditions requiring specific monitoring, evaluation, and research projects to gather information to aid the preservation and recovery of listed species. The impacts of these research activities pose both benefits and risks. Research on the listed species in the Action Area is currently provided coverage under Section 10(a)(1)(A) permits, or included in the estimates of fishery mortality discussed in the Effects of the Proposed Action in this opinion.

While the following research is not intended to take ESA-listed marine fish, some may die as an inadvertent result of the activities. The Groundfish Bottom Trawl Survey, the Integrated Ecosystem and Pacific Hake Acoustic-Trawl Survey, the Investigations of Hake Ecology, Survey Methods, the California Current Ecosystem Study, and the Bycatch Reduction Research in West Coast Trawl Fisheries are expected to incidentally take ESA-listed marine fish in the course of this research. Since the research would take place along the entire U.S. West Coast from Mexico to Canada, the effects of that take cannot be examined at the salmon population level. Further, no individual population is likely to experience a disproportionate amount of these losses (NMFS 2016d). Table 2 displays the total take for the ongoing research authorized under ESA 10(a)(1)(A) for research conducted in the action area and affecting listed salmon ESUs considered in this opinion. Most of the salmon taken are subadults (i.e., two or three years old) for which abundance estimates are not available. Therefore, the proportion of the ESU killed was estimated as a proportion of adult spawners. Because additional mortality occurs between the subadult and adult phase, the abundance of subadult Chinook and coho would be greater than the abundance of spawning adults, resulting in an overestimate of the likely mortality.

Table 2-46. Annual take allotments for research on listed species in action area (NMFS 2016d).

ESU/DPS	Life Stage	Origin[a]	Requested Take	Percent of ESU killed
Puget Sound Chinook	Adult	LHAC	5	0.04%
	Adult	Natural	5	0.03%
Lower Columbia River Chinook	Adult	LHAC	11	0.03%
	Adult	Natural	6	0.02%
Snake River spring/summer Chinook	Adult	LHAC	4	0.07%
	Adult	Natural	4	0.04%
Snake River fall Chinook	Adult	LHAC	9	0.03%
	Adult	Natural	4	0.04%
Upper Columbia River spring Chinook	Adult	LHAC	4	0.14%
	Adult	Natural	4	0.27%
Upper Willamette spring Chinook	Adult	LHAC	10	0.03%
	Adult	Natural	4	0.03%
California Coastal Chinook	Adult	Natural	4	0.07%
Lower Columbia River coho	Adult	LHAC	32	0.14%
	Adult	Natural	4	0.01%
Southern Oregon/Northern California coho	Adult	LHAC	4	0.04%
	Adult	Natural	4	0.04%
Oregon Coast coho	Adult	LHAC	4	0.20%
	Adult	Natural	16	0.01%
Central California Coast coho	Adult	Natural	4	0.21%

a LHAC = Listed Hatchery Adipose Clipped

Actual take levels associated with these activities are almost certain to be substantially lower than the permitted levels. There are three reasons for this. First, most researchers do not handle the full number of individual fish they are allowed. Second, the estimates of mortality for each proposed study are purposefully inflated (the amount depends upon the species) to account for potential accidental deaths; it is, therefore, likely that fewer fish (in some cases many fewer), especially juveniles, than the researchers are allotted would be killed during any given research project. Finally, researchers are encouraged to collaborate on studies (i.e., share fish samples and biological data among permit holders) so that overall impacts on listed species are reduced.

2.5 Effects of the Action on Species

Under ESA, "effects of the action" mean the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed actions and are later in time, but still are reasonably certain to occur.

2.5.1 Assessment Approach

The effects analysis is conducted in four parts. This section 2.5.1 describes the general approach. Section 2.5.2 includes estimates of the overall Chinook and coho bycatch and spatial distribution of bycatch for the whiting and non-whiting fisheries assuming the guidelines provided in the proposed action with and without use of the Reserve. Section 2.5.3 discusses ESU-specific stock composition of that bycatch based on genetic stock information and Section 2.5.4 assesses those impacts against the status of the individual ESUs

2.5.1.1 Bycatch estimation

WCGOP provided the data used to develop the bycatch estimtes in this analysis, which included both total Chinook counts and total combined retained groundfish weights (round, mt). Projected salmon bycatch by non-trawl groundfish fisheries also relied on data from Washington, Oregon, and California state agency queries for recreational groundfish trips and from a draft environmental assessment (EA) that provided estimates of potential bycatch from a long-leader "midwater" recreational groundfish fishery that may occur off Oregon beginning 2018 (NMFS 2016c). More detail regarding these data sources is found in Matson and Erickson 2017; NMFS 2016; and online at the following web address: https://www.nwfsc.noaa.gov/research/divisions/fram/observation/data_products/index.cfm.

The bootstrap method of modelling used in the analysis is a non-parametric simulation approach that builds empirical distributions of one or more specified statistics by resampling actual data within stated parameters. The method uses samples from the observed data to describe the uncertainty, bias, variance and other characteristics of the data. This approach previously has been used within the Council process to estimate probabilities of exceeding bycatch and HG, to manage bycatch in the drift gill net fishery for swordfish, and to manage bycatch of rockfish in the whiting fishery (e.g., Agenda Item F.7.a, WDFW Report, September 2016). This method circumvents shortcomings of parametric simulation approaches (such as Monte Carlo) that result from non-standard distributions typically seen in fishery data. Forcing an assumption of a particular distribution upon an analysis that does not fit the data well can introduce error (not easily predicted or corrected), which can have important consequences on analytical conclusions and downstream decision making.

For the purposes of our effects analysis for the biological opinion, we assumed that the Council would manage Chinook bycatch to not exceed the bycatch guidelines and Reserve as indicated by the intent described in the proposed action. However, the guidelines in the proposed action were not described as hard limits to Chinook bycatch so we explored the likelihood that either sector would exceed its guideline without active management to remain within them. This information is useful in informing the provisions of the ITS. To this end, separate bycatch projections were made for each sector in the whiting and then the non-whiting fisheries. Our goal was to estimate distributions of bycatch counts of Chinook and their latitudinal distributions, coincident with simulated seasons with defined amounts of whiting catch. We simulated fishing seasons by randomly drawing many hauls with replacement (i.e., putting the sampled data back into the pool of available data). We built cumulative tallies of target species (retained groundfish) versus bycatch (counts of Chinook salmon), and we evaluated those tallies of Chinook bycatch against their respective guidelines. This process was repeated 10,000 times (for 10,000 simulated seasons), the results were aggregated into distributions, and the quantiles and measures of central tendency from those distributions were calculated.

We wanted to identify the range of Chinook bycatch that would occur in most cases under the proposed action considering the variability in fishery operation, environmental conditions and other factors that might affect bycatch. The quantiles can be used as reasonable approximations of probabilities, under the implicit and explicit conditions and assumptions of a model run, and the input data used (Davidson and Hinkley 1997). We calculated quantiles of the predicted distributions for each sector; then summed the same quantile across the sectors to estimate the bycatch in each of the whiting and non-whiting fisheries. That provided a series of bycatch levels and the likelihood that that level of bycatch would occur that could be compared against the guidelines in the proposed action. In general, for example, a bycatch of 4,500 Chinook at the 80^{th} quantile means that Chinook bycatch is likely to be at or below 4,500 Chinook 80 percent of the time (or greater than 4,500 20 percent of the time). If the guideline is 5,500, then the results would indicate that bycatch is likely to be below the guideline at least 80 percent of time.

The 80th percentile of the distribution of simulated catches was chosen to evaluate the guidelines in the proposed action. For assessing impacts on ESA-listed species, our goal was to assess the range of bycatch that would occur in most circumstances, rather than every eventuality; providing a robust but realistic assessment of the range of bycatch expected to occur in the fisheries.

The analysis indicates that the bycatch associated with the 80th percentile would encompass the range of bycatch that would occur under most situations, except those generally associated with uncommon extreme catch events (ECEs). The estimates reflect the pattern in the data for most hauls to either catch zero to a handful of Chinook, while a much smaller number of hauls catch an intermediate amount. Finally, a very small number of hauls and vessels catch a comparatively very large amount of Chinook, on the order of 100 or more fish, and these ECEs tend to occur as lightning strikes, once to a few times per year.

The selection of the 80th quantile as the upper end of a reasonable range of bycatch is supported by the data itself. Bycatch data show a break at approximately the 80th quantile for both fisheries, after which bycatch increases significantly over the last 20 percent of simulated bycatch. This pattern indicates the range defined by the 80th quantile describes the bycatch most likely to occur with the jump in bycatch at that point underscoring the influence of the ECEs (Figure 2-10).[19] The overall estimated bycatch associated with the 80th quantile was compared to bycatch guidelines for the whiting (11,000 Chinook) and non-whiting (5,500 Chinook) fisheries, consistent with the proposed action. In the case of the use of the Reserve, we analyzed the impacts to listed Chinook ESUs assuming full use of the Reserve by both the whiting and non-whiting sectors. For the non-whiting sector, we analyzed scenarios where the Reserve was fully used by the bottom trawl sector or by the midwater sector. Latitudinal distribution of the bycatch is characterized by the location of the hauls from the years used in the analysis.

[19] NMFS uses an 80 percent level of probability to assess ESA effects in other fishery-related actions, as well (NMFS 2000b).

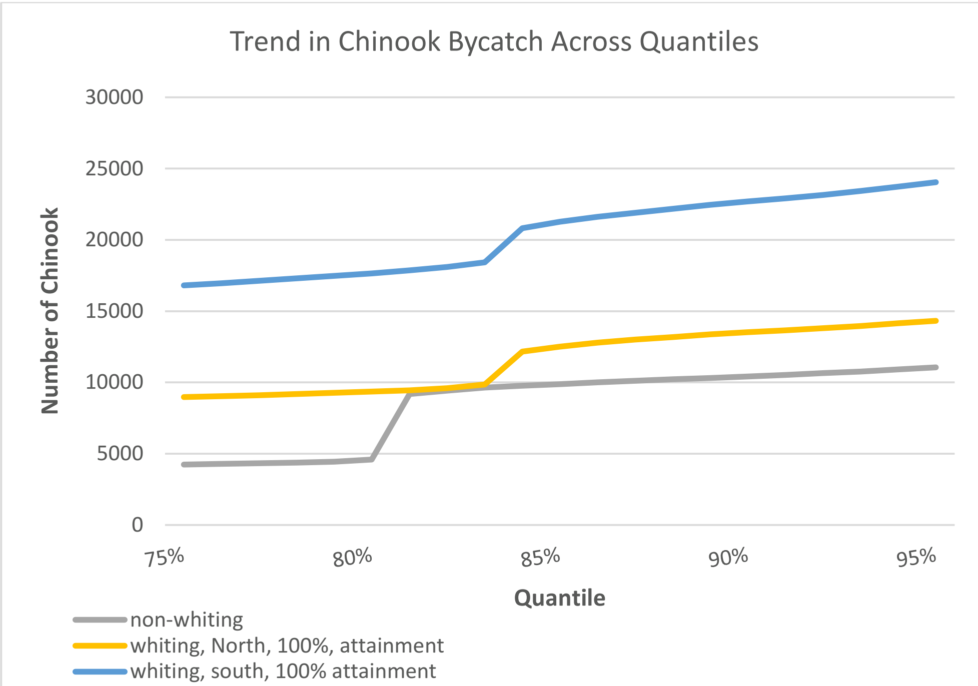

Figure 2-10. Pattern in Chinook bycatch over the 75th to 95th quantiles illustrating the break at approximately the 80th quantile.

2.5.1.2 Stock composition estimates

We used conditional maximum likelihood genetic mixture modeling based on the Genetic Analysis of Pacific Salmon (GAPS) Microsatellite Baseline (Seeb et al. 2007) to estimate the stock composition of observed Chinook bycatch in the whiting fishery. Baseline reference populations were aggregated into reporting groups according to membership (genetic affinity) in ESUs (Appendix 2). As described below, this information was also used to model the stock composition in the non-whiting fishery. Sampling protocols and more detailed explanations of the results are described in detail in several previous reports (Al-Humaidhi et al. 2012, Moran et al. 2009, Moran and Tuttle 2015, Somers et al. 2014).

The relationship between stock composition of Chinook ESUs, using the results of the conditional maximum likelihood genetic mixture modeling, and the latitudinal distribution of bycatch in the U.S. West Coast, at-sea Pacific whiting and non-whiting fisheries was used to determine the likely stock composition of Chinook bycatch under the proposed action (for a detailed explaination see Appendix 2). Estimated stock composition for the shoreside sector of the whiting fishery was based on observed stock composition among genetic samples taken in 2013 and 2014. Sample sizes were not adequate to assess stock composition by depth. This information could be used to predict stock composition at various latitudes associated with implementation of the proposed action.

Three different regression methods were evaluated by using independent cross validation, and the best predictor was used to model the relationship between mean latitude and proportional contribution of each ESU to coastwide bycatch in a given year, as described in detail in Appendix 2.[20] Stock composition by ESU (Table 54) was then applied to the coastwide bycatch estimates for each fishery sector and scenario (e.g., footprint, level of attainment, use of Reserve). Estimates were based on the 80th quantile of projected bycatch to determine the magnitude of impacts on individual Chinook ESUs. Finally, the results were combined into an aggregate estimate across sectors consistent with the scenarios.

Significant uncertainty exists in the magnitude of ESU-specific impacts for fisheries in locations or time periods outside the available data. Areas south of 42° N. latitude and during the January-to-May period have particularly limited information. For example, ESUs with early freshwater entry timing, like Upper Willamette spring and Snake River spring/summer stocks, may be underrepresented in the genetics data. These stocks are thought to be present in ocean areas in the winter period; however, whiting fisheries have not occurred in the January- to mid-May period since the mid-1990s. Historical CWT recoveries indicate that about one third of the recoveries for Upper Willamette Chinook were prior to the current May 15th start date for the fishery.

Table 2-47. Proportion of Chinook bycatch by ESU for each sector in the whiting and non-whiting fisheries. Stock composition for the bottom trawl fishery was used to estimate stock composition for the fixed gear sector as it has a more coastwide distribution as represented by the mean latitude than the non-whiting midwater trawl sector (NMFS 2017d).

Sector/Geartype	Mean Latitude	Central Valley Sp	Central Valley Fa	Sacramento Winter	California Coast	Klamath Trinity	S Oregon/N California	Oregon Coast	Washington Coast	L Columbia R	U Willamette R	Mid-Columbia R Sp	U Columbia R Sp	Deschutes R Su/Fa	U Columbia R Su/Fa	Snake R Sp/Su	Snake R Fa	Puget Sound	Southern BC	Centr
Bottom trawl	43.30071	0.000	0.033	0.000	0.057	0.421	0.341	0.127	0.000	0.000	0.000	0.000	0.000	0.004	0.009	0.000	0.005	0.000	0.000	0.001
Non-whiting MDT	46.67375	0.000	0.016	0.000	0.023	0.130	0.132	0.111	0.004	0.099	0.004	0.001	0.002	0.012	0.050	0.005	0.024	0.133	0.236	0.018
Northern at-sea whiting scenario																				
Catcher/Processor (CP)	46.00519	0.000	0.020	0.000	0.031	0.192	0.177	0.115	0.003	0.073	0.003	0.001	0.002	0.010	0.042	0.004	0.021	0.106	0.184	0.015
Mothership (MS)	46.09677	0.000	0.020	0.000	0.030	0.184	0.171	0.115	0.003	0.077	0.003	0.001	0.002	0.010	0.043	0.004	0.021	0.110	0.191	0.015
Shoreside whiting (SS)	45.27982	0.000	0.129	0.000	0.025	0.257	0.215	0.209	0.011	0.041	0.000	0.000	0.000	0.012	0.052	0.000	0.015	0.011	0.022	0.001
Southern at-sea whiting scenario																				
Catcher/Processor (CP)	43.77493	0.000	0.032	0.000	0.055	0.397	0.325	0.130	0.001	0.000	0.000	0.000	0.001	0.006	0.015	0.000	0.008	0.017	0.012	0.003
Mothership (MS)	44.06135	0.000	0.031	0.000	0.052	0.374	0.309	0.129	0.001	0.000	0.000	0.000	0.001	0.006	0.019	0.001	0.009	0.029	0.034	0.005
Shoreside whiting (SS)	45.27982	0.000	0.129	0.000	0.025	0.257	0.215	0.209	0.011	0.041	0.000	0.000	0.000	0.012	0.052	0.000	0.015	0.011	0.022	0.001

Genetic data are not yet available for any sectors of the non-whiting fishery, and CWT recoveries are insufficient, given the low salmon bycatch, to estimate stock composition independently for those sectors

[20] The linear regression models should not be applied to estimate stock composition outside the range of the observed data except in very limited circumstances, as described later in this document. This is particularly true for fisheries south of the observed data where the data from the whiting fishery used to develop the model is extremely limited (e.g., the southern-most mean value was at 43°55’ N. latitude).

(NMFS 2017b). Therefore, given the strong relationship between latitude and stock composition in the whiting fishery discussion above and in Appendix 2, we used the coerced linear regression model based on genetic data from the whiting fishery described in the previous paragraph to estimate stock composition in the non-whiting sectors. The range of latitude encompassed by the genetic data for the whiting fishery used to develop the coerced linear regression model is generally consistent with the latitudes at which the non-whiting fishery occurs. The latitudinal information from the haul-level information used to estimate Chinook bycatch in the non-whiting sectors described above was used in the coerced linear regression model to estimate stock composition in the non-whiting sectors. Differences among the whiting and non-whiting fisheries such as seasonality or fishing depth introduce uncertainty in the estimates. Given the lack of alternative data, however, this approach represents the best available data at this time. Given this uncertainty, the general magnitude of the impact is more important than the absolute number of estimated impacts. Improved data will be available over time as genetic and CWT information is collected from the non-whiting fishery. That information will be used to assess bycatch as it becomes available. Until that new information is available, estimates of ESU specific impacts remain uncertain.

To estimate the stock composition of the coho bycatch, we used the FRAM. The FRAM is used to assess impacts of proposed salmon regimes managed in waters under Council jurisdiction. Genetic information is unavailable, and CWT recoveries are scarce, given the generally low bycatch of coho in the groundfish fisheries (NMFS 2017b). Coho bycatch was summarized by management area, and the stock composition for those management areas was applied to the bycatch. FRAM uses CWTs recovered in past fisheries to represent catch composition in salmon fisheries within Council waters.

The latitudinal patterns in catch composition are consistent with what is known of salmon migratory patterns, so it is reasonable that coho caught in the same general area would have similar general stock composition across fisheries. However, the results discussed in the subsequent sections should be viewed as a coarse representation of impacts, given the difference in target fishing areas and other operational aspects between the groundfish and salmon fisheries. In addition, listed coho ESUs from California have less associated tagged hatchery production and, thus, may be underestimated in our analysis.

Finally, estimated impacts were calculated as a percentage of the average ocean abundance for each ESU from 2008 to 2016 (i.e., non-AEQ ER).[21] Derivation of the ER was based on a variety of sources of available information. Abundance information was available, either in terms of spawners or ocean escapement, for populations within the ESU. In some cases, abundance data were only available for some of the populations within the ESU for the 2008-to-2016 period (see Subsection 2.2, Rangewide Status of the Species and Critical Habitat). Data were summed across populations to derive a total spawner or ocean escapement estimate for the ESU by year where available. Spawner estimates were expanded by the total ER. Ocean escapement was expanded by ocean ERs to derive the total ocean abundance. Ocean abundance for the ESU was averaged across the 2008-to-2016 period. Estimated impacts by listed Chinook or coho salmon ESU by fishing sector were divided by ocean abundance to derive the ER.

2.5.2 Bycatch Estimates and Distribution

The analysis of bycatch estimates and distributions takes into account most components of the proposed action. However, the proposed action does not include any detail on how the Chinook bycatch guidelines or the Reserve are intended to be implemented. It is not clear, for example, if fisheries would be closed once the thresholds are reached or the Reserve is consumed. It is likewise unclear how access to the Reserve will be triggered, and how fisheries using the Reserve will be managed to keep bycatch within the combined amount of the applicable guideline plus the Reserve. However, the Council expressed its intent to manage to stay within the guidelines and Reserve within the language describing the proposed action. Therefore, for the purposes of our effects analysis for the biological opinion, we assumed that the Council will manage Chinook bycatch to not exceed the bycatch guidelines and Reserve consistent with this stated intent. However, as mentioned above, we also explored the likelihood that either the whiting or non-whiting sector would exceed its guideline or the Reserve without active management to remain within them. This information will be used to inform the provisions of the ITS.

As described in the proposed action, we assume that the whiting fishery will continue to operate as it

[21] These are non-AEQ (adult equivalent) rates, i.e., the proportion of the population that would have returned to spawn in the absence of fishing. Younger age fish (two to three years old) exhibit much higher natural mortality rates than do older age fish (three to five years old). Where information is available to do so, ERs are typically adjusted to account for this difference, i.e., ERs due to fishing are lower for younger age fish, because they more frequently die from other causes. Chinook encountered in the groundfish fishery are primarily two- and three-year-old fish. The degree to which ERs are adjusted depends on the maturation rates of individual Chinook stocks. Chinook spawn at three to six years of age, with some stocks returning primarily as three-year-old fish and other stocks as four- or five-year-old fish.

currently does, with two exceptions: (1) annual harvest could reach 500,000 metric tons; and (2) the potential for increased tribal participation the fishery, which would result in a larger proportion of whiting being caught in the northern part of the action area. Previous analyses (NMFS 2017d) indicated that stock composition and magnitude of Chinook bycatch was heavily influenced by the location of the whiting fleet (north or south) and magnitude of whiting harvest. So we evaluated four scenarios defined by the latitudinal distribution of the whiting fleet and the attainment of whiting catch. These are described in more detail in the following discussion.

For the non-whiting fishery, we assume that (1) the RCA will be opened as described in the Council's preliminary preferred alternative; (2) catch levels of groundfish stocks will be as described in Table 1.2.1; (3) the geographic distribution of the fleet is similar to the pattern that existed prior to trawl rationalization (see scenario 2B(1) in NMFS 2017d); (4) Chinook bycatch rates will be similar to those observed recently (see scenario 2B(1) in NMFS 2017d); (5) the midwater yellowtail/widow rockfish fishery is similar to the historical pattern when the fishery occurred previously (see scenario 2B(1) in NMFS 2017d)A.

Whiting -Chinook

Previous analyses indicated that stock composition and magnitude of Chinook bycatch is sensitive to the location of the whiting fleet (north or south) and magnitude of whiting harvest (NMFS 2017d). The analysis encompasses four scenarios of fleet distribution and whiting attainment that affect the level of Chinook bycatch and resulting impacts on listed Chinook and coho salmon ESUs. The whiting fleet historically fished two distinct patterns of distribution driven by the distribution of whiting and constraints on overfished rockfish species. A northern fleet distribution is defined by the years 2009-2010 and the southern pattern by more recent years (2012-2015)[22]. Either of these patterns is likely to occur in the future driven by the same factors (Figure 2-11). These two distributions of the whiting fleet were evaluated, defined by the latitudinal distribution of Chinook bycatch in the commercial at-sea sectors (via predominantly northern versus southern at-sea effort and corresponding bycatch patterns). Previous analysis indicated that latitude was an important factor in determining expected Chinook bycatch and associated stock composition (NMFS 2017d). The shorebased whiting sector however, has not shown a conspicuous pattern of distribution as is the case with the at-sea sector (NMFS 2017d) so we assumed the distribution of effort for the shorebased sector was the same under each of the scenarios. Similarly, the analysis also examines two scenarios for attainment of whiting (1) 100 percent attainment assuming a

[22] The fleet distribution in 2011 was intermediate between the more defined north and southern patterns.

TAC level of 500,000 mt consistent with the proposed action, and (2) an average attainment scenario based on recent years that may be more likely to occur. Attainment of the Total Allowable Catch has been much lower than the ceiling in recent years across all whiting sectors (**Table 2-47**) driven by marketing and other factors. These factors could affect attainment in future years as well, so it makes it prudent for us to include a scenario based on average annual attainment, as well as 100 percent attainment, to account for a major source of uncertainty that influences Chinook bycatch. Analyzing the higher level of attainment provides a conservative estimate for analytical purposes. We can test the sensitivity of impacts on listed Chinook salmon populations across the four scenarios.

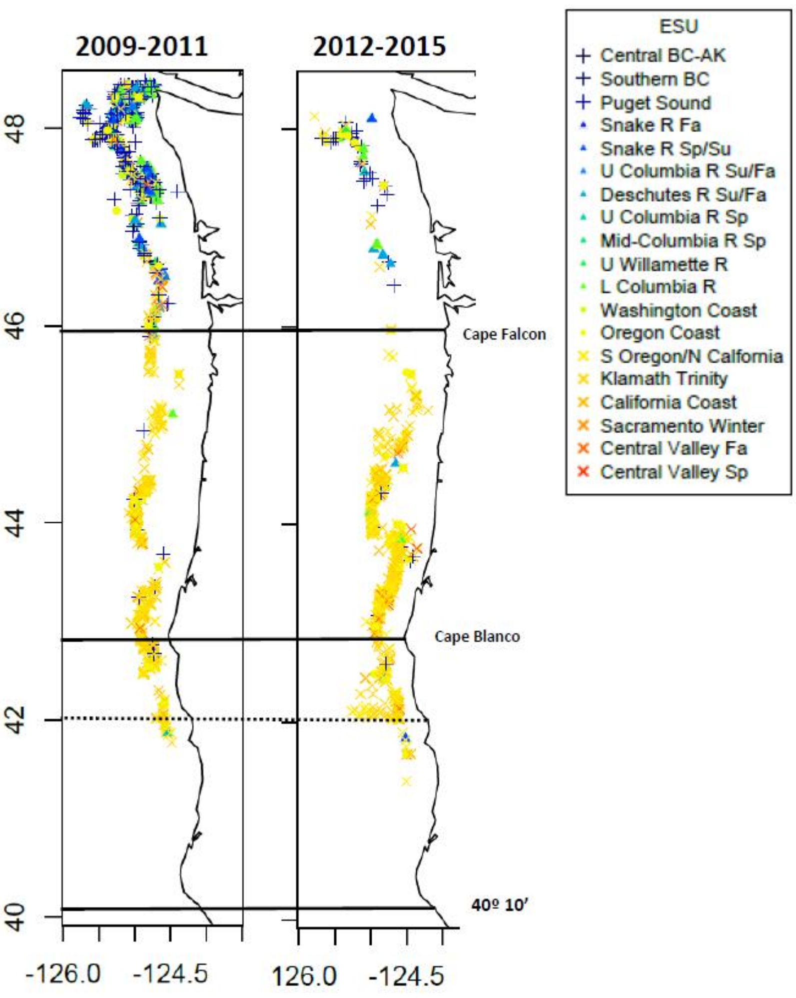

Figure 2-11. Distribution of the genetic samples from Chinook bycatch in the at-sea whiting fleet. The pattern reveals distinct northern and southern patterns of fishing and the resulting change in stock composition of the Chinook bycatch. Note that processing south of 42˚ N. Latitude has been prohibited during these time frames.

Table 2-48. Annual values for the U.S. portion of the Joint Canada/United States Whiting TAC, together with sector allocations and attainment values for those allocations, over the past eight years, from 2008 to 2016.

Year	Allocation attainment (%)			TAC	Allocation values (mt)			Attained harvest
	CP	MS	SS		CP	MS	SS	
2008	93%	99%	85%	267,545	115,789	58,087	58,669	232,545
2009	98%	100%	100%	135,939	35,376	24,034	40,738	100,148
2010	102%	95%	95%	193,935	53,379	37,679	65,938	156,996
2011	95%	94%	97%	290,903	75,138	53,039	92,818	220,995
2012	99%	98%	95%	186,037	55,584	39,235	68,662	163,481
2013	98%	93%	99%	269,745	79,573	56,170	98,297	234,040
2014	100%	85%	77%	316,206	103,203	73,049	127,835	304,087
2015	68%	39%	46%	325,072	100,873	71,204	124,604	296,681
2016	95%	81%	60%	367,553	114,149	80,575	141,007	335,731
Average	94%	87%	**79%**	261,437	81,452	54,786	90,952	227,189

The northern distribution of the at-sea whiting fleet and the 100 percent attainment of whiting scenarios would accommodate a more robust tribal fishery than currently occurs. The tribes are constrained to fishing within their U&A fishing areas, which are north of Cape Falcon for all coastal Washington treaty tribes. Distribution of whiting since 2012 has resulted in minimal tribal fisheries, in part, because whiting distribution and overfished rockfish constraints have shifted the whiting fleet further south, outside tribal U&As.

To date, only the Makah have fished for Pacific whiting. However, greater tribal participation in the whiting fishery may occur in the future if the Quileute and Quinault Tribes, who have expressed interest join the fishery. Both the Quileute and Quinault Tribes' U&A fishing areas are off the northern coast of Washington. Discussions with tribal representatives and staff indicate that the expected catch would be approximately 8,000 mt of whiting per year for each tribe, and that their strategy would resemble a mothership operation, but would likely be prosecuted with small vessels, indicating relatively shallow bottom depths. However, examination of the boundaries of the relevant U&A fishing areas (81 FR 36806, June 8, 2016) indicate the potential for access by both tribes to substantial area with deeper bottom depths (greater than 200fm). These conditions could enable more typical mothership operation of the fishery that characteristically tends to show lower bycatch rates than the shorebased fleet.

The Makah tribe implemented salmon bycatch reduction measures starting in 2008, which they expect to remain in place for the foreseeable future (R. Svec, pers. comm.). Chinook and coho bycatch greatly declined after these measures were put in place. The tribal fishery also shows a shift to deeper depths, beginning in 2008, which is typically associated with lower Chinook bycatch rates (NMFS 2017d). Should a more robust tribal fishery resume, the northern distribution scenario would be more reflective of a resumption of a robust tribal fishery, given the location of the tribes' U&A fishing areas.

The fact that unused tribal allocation may be reapportioned to the commercial non-tribal sectors is also important in NMFS' consideration of bycatch. Catch reapportioned to the at-sea, non-tribal fisheries generally results in bycatch occurring in deeper depths and further south than is typical for tribal fisheries. Any estimate of tribal Chinook bycatch alone is not additive with full fleet bycatch estimates, since additional commercial sector opportunity due to reapportionment cannot effectively be disentangled. Should the Quileute and Quinault tribes participate, we anticipate that any reapportionment at that time would reflect that broader tribal participation. Given that the scenarios assess bycatch associated with a much higher whiting TAC than recent attainment rates suggest is likely to be achieved and the confounding effect of reapportionment, the range of bycatch represented by the four scenarios should reflect a reasonable range and distribution of expected Chinook bycatch, including resumption of a robust tribal fishery. Should the tribal fishery remain limited, NMFS' analysis could overestimate the likely bycatch of Chinook salmon and impacts on listed ESUs. A more detailed discussion of this topic is provided in NMFS 2017d.

Table 56 shows projected distributions of Chinook bycatch for the four latitude and attainment scenarios described above. Histograms showing the corresponding distributions for Table 2-49 are shown in the following figures: Figure 2-12, Figure 2-13, Figure 2-14, and Figure 2-15. Table 2-50 includes the latitude of the boundaries of general groundfish management areas for comparison against the latitudinal distribution of Chinook bycatch illustrated in Figure 2-12, Figure 2-13, Figure 2-14, and Figure 2-15.

Table 2-49. Quantiles for predicted distributions of annual Chinook bycatch by targeted whiting sector for commercial sectors. Tables on the left assume 100 percent attainment of whiting allocation, and those on the right assume average annual attainment for the at-sea sector (catcher-processor and mothership) blocked by their prominent latitudinal distribution (northern versus southern). Shoreside predictions used all years analyzed (2011 to 2016). The 80th quantile highlights the upper end of the range of bycatch most likely to occur under the proposed action.

100% attainment

56a. Chinook, Northern scenario (2008-2010)

Quantiles	Shoreside	CP	MS	Sum
min	1,207	39	226	1,472
0.01	1,359	64	310	1,734
0.01	1,445	76	344	1,865
0.25	2,173	103	416	2,693
0.5	5,935	593	1,168	7,696
mean	5,692	469	952	7,114
0.75	7,018	684	1,272	8,974
0.8	7,352	703	1,293	9,348
0.85	10,474	724	1,315	12,514
0.95	12,125	808	1,388	14,321
0.99	13,088	942	1,474	15,505
max	14,942	1,272	1,695	17,909

56c. Chinook, Southern scenario (2012-2016)

Quantiles	Shoreside	CP	MS	Sum
min	1,207	2,042	414	3,663
0.01	1,359	2,427	480	4,267
0.01	1,445	2,707	528	4,681
0.25	2,173	3,190	827	6,191
0.5	5,935	3,620	3,699	13,254
mean	5,692	3,966	3,188	12,846
0.75	7,018	4,819	4,971	16,807
0.8	7,352	4,969	5,335	17,656
0.85	10,474	5,143	5,648	21,265
0.95	12,125	5,634	6,282	24,040
0.99	13,088	6,276	6,816	26,181
max	14,942	7,935	8,010	30,887

average attainment (2008-2016)

56b. Chinook, Northern scenario (2008-2010)

Quantiles	Shoreside	CP	MS	Sum
min	938	42	207	1,187
0.01	1,075	59	264	1,397
0.05	1,139	72	297	1,508
0.25	1,724	98	366	2,188
0.5	4,682	551	1,012	6,245
mean	4,506	440	831	5,777
0.75	5,523	642	1,108	7,273
0.8	5,837	660	1,127	7,623
0.85	8,174	682	1,151	10,006
0.95	9,623	767	1,216	11,606
0.99	10,594	891	1,292	12,777
max	11,961	1,117	1,449	14,528

56d. Chinook, Southern scenario (2012-2016)

Quantiles	Shoreside	CP	MS	Sum
min	938	1,763	347	3,048
0.01	1,075	2,234	415	3,724
0.05	1,139	2,520	457	4,116
0.25	1,724	3,001	695	5,420
0.5	4,682	3,206	3,206	11,094
mean	4,506	2,745	2,745	9,997
0.75	5,523	4,282	4,282	14,087
0.8	5,837	4,693	4,571	15,101
0.85	8,174	4,852	4,833	17,859
0.95	9,623	5,446	5,446	20,514
0.99	10,594	5,994	5,994	22,582
max	11,961	7,104	7,104	26,170

Table 2-50. Latitude of boundaries for groundfish management areas

Location	Latitude and Longitude
Cape Falcon	45.7676° N
Cape Blanco	42.8376° N
Cape Mendocino	40.4401° N

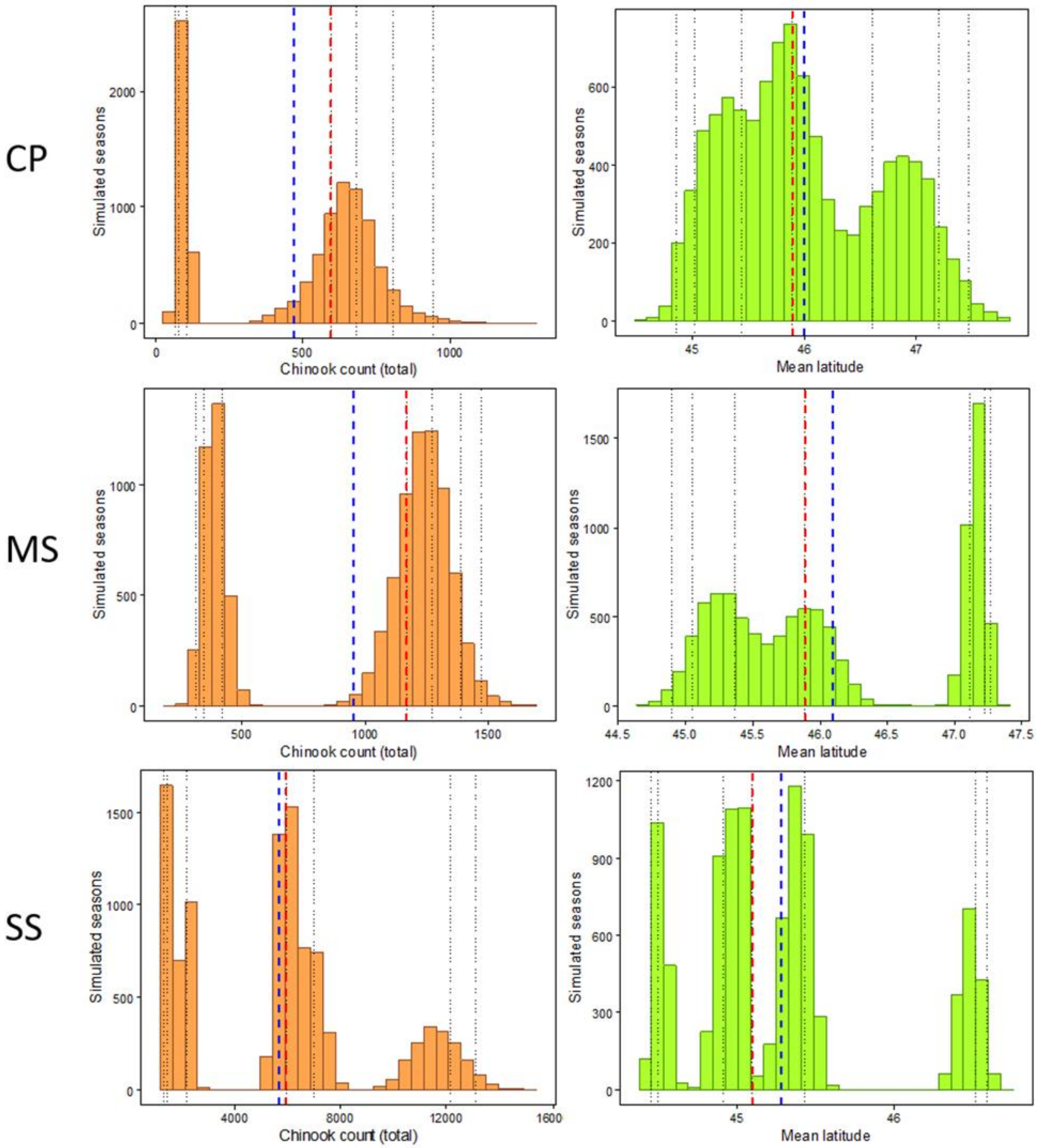

Figure 2-12. Projected distributions of Chinook bycatch assuming a Northern distribution (2008 to 2010 for at-sea), coastwide for shorebased, and 100 percent attainment for each sector, applied to a whiting TAC of 500,000 mt. Predicted distributions of Chinook bycatch (count), and mean latitude (degrees), under the conditions specified for the final projected action. Blue dashed line = mean, red dash = median, dotted lines = quantiles from Table 56a.

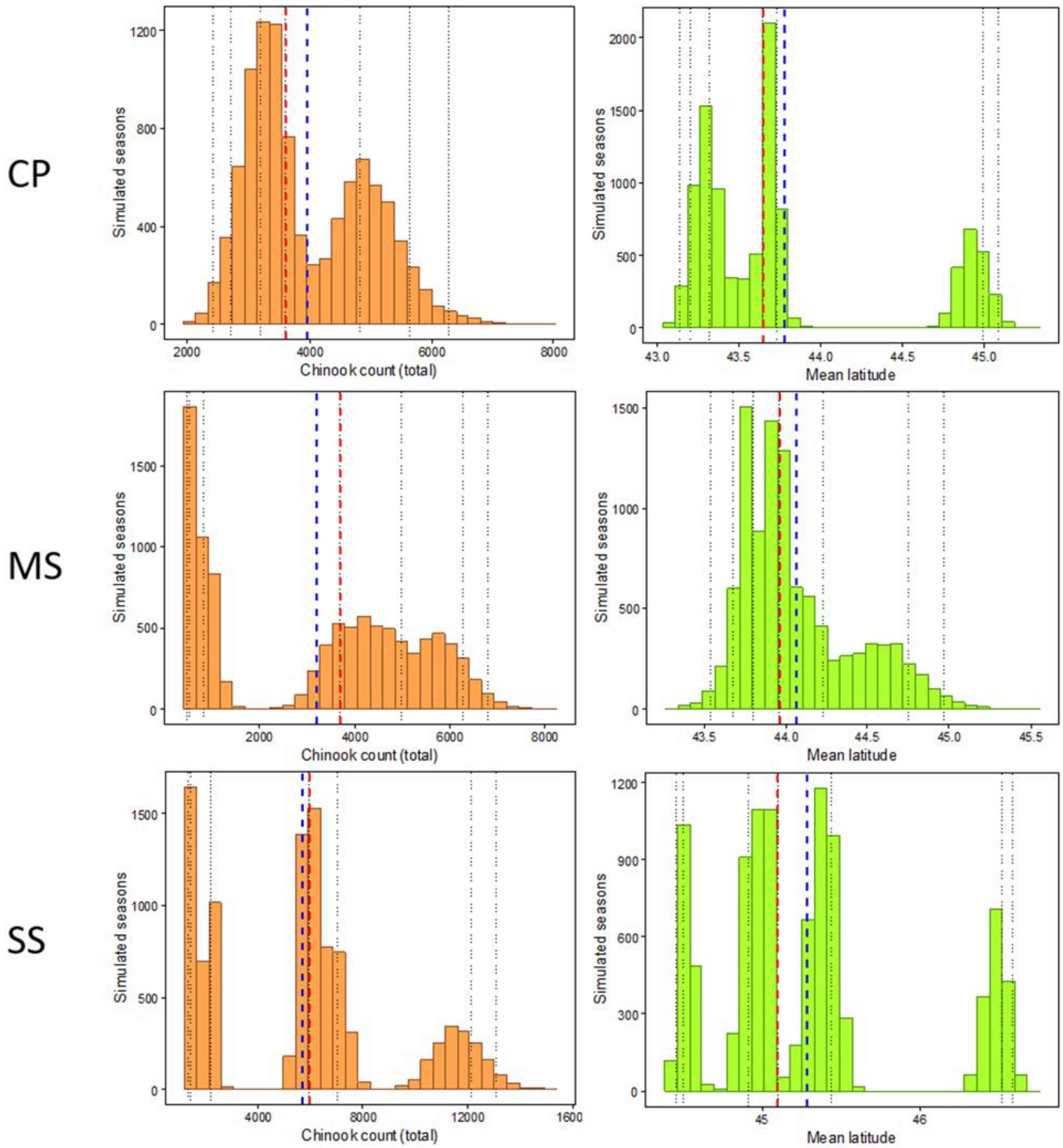

Figure 2-13. Projected distributions of Chinook bycatch assuming a Southern distribution (2012 to 2016 for at-sea), coastwide for shorebased, and 100 percent attainment for each sector, applied to a whiting TAC of 500,000 mt. Predicted distributions of Chinook bycatch (count), and mean latitude (degrees), under the conditions specified for the final projected action. Blue dashed line = mean, red dash = median, dotted lines = quantiles from Table 56c.

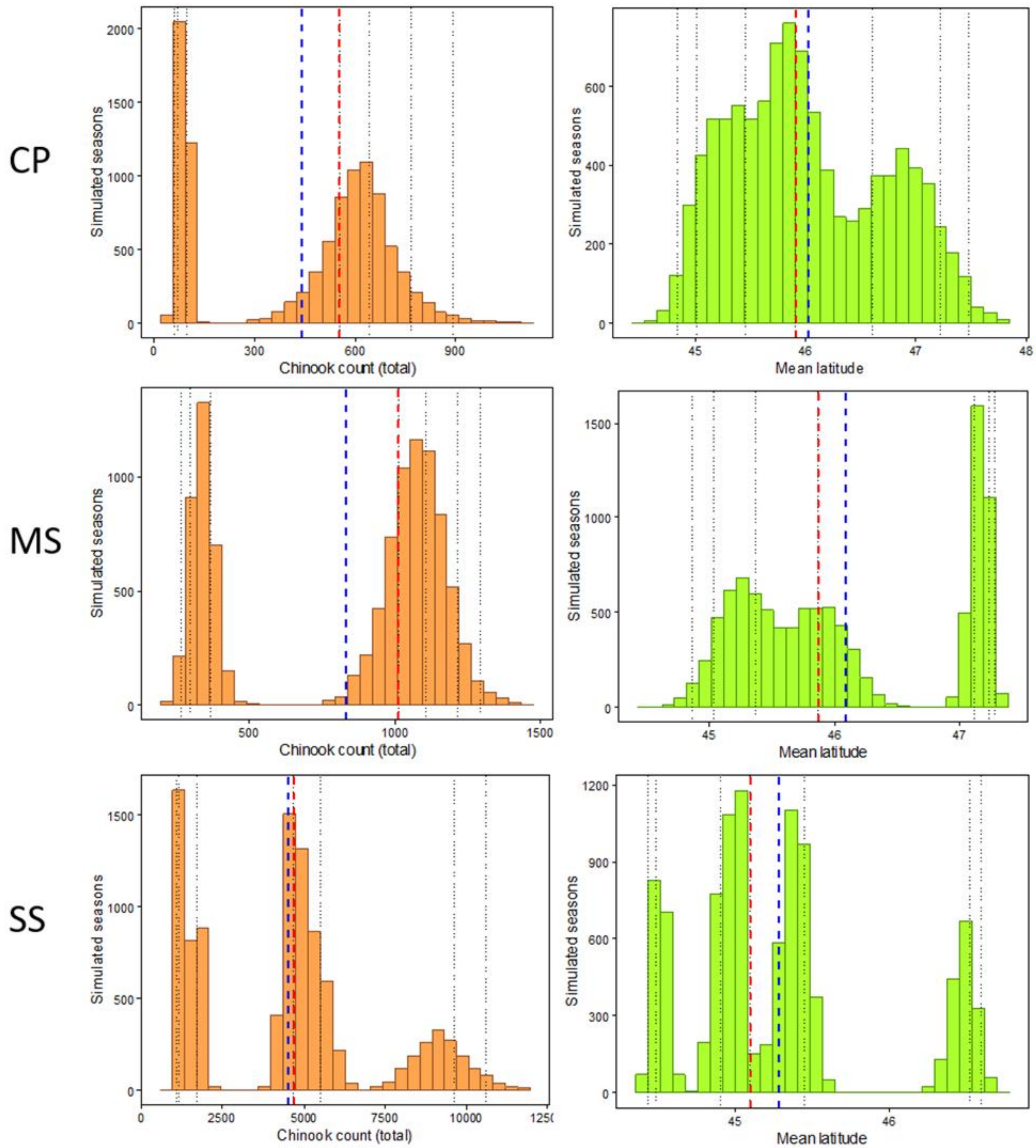

Figure 2-14. Projected distributions of Chinook bycatch assuming a Northern distribution (2008 to 2010 for at-sea), coastwide for shorebased, and average attainment for each sector, applied to a whiting TAC of 500,000 mt. Predicted distributions of Chinook bycatch (count), and mean latitude (degrees), under the conditions specified for the final projected action. Blue dashed line = mean, red dash = median, dotted lines = quantiles from Table 56b.

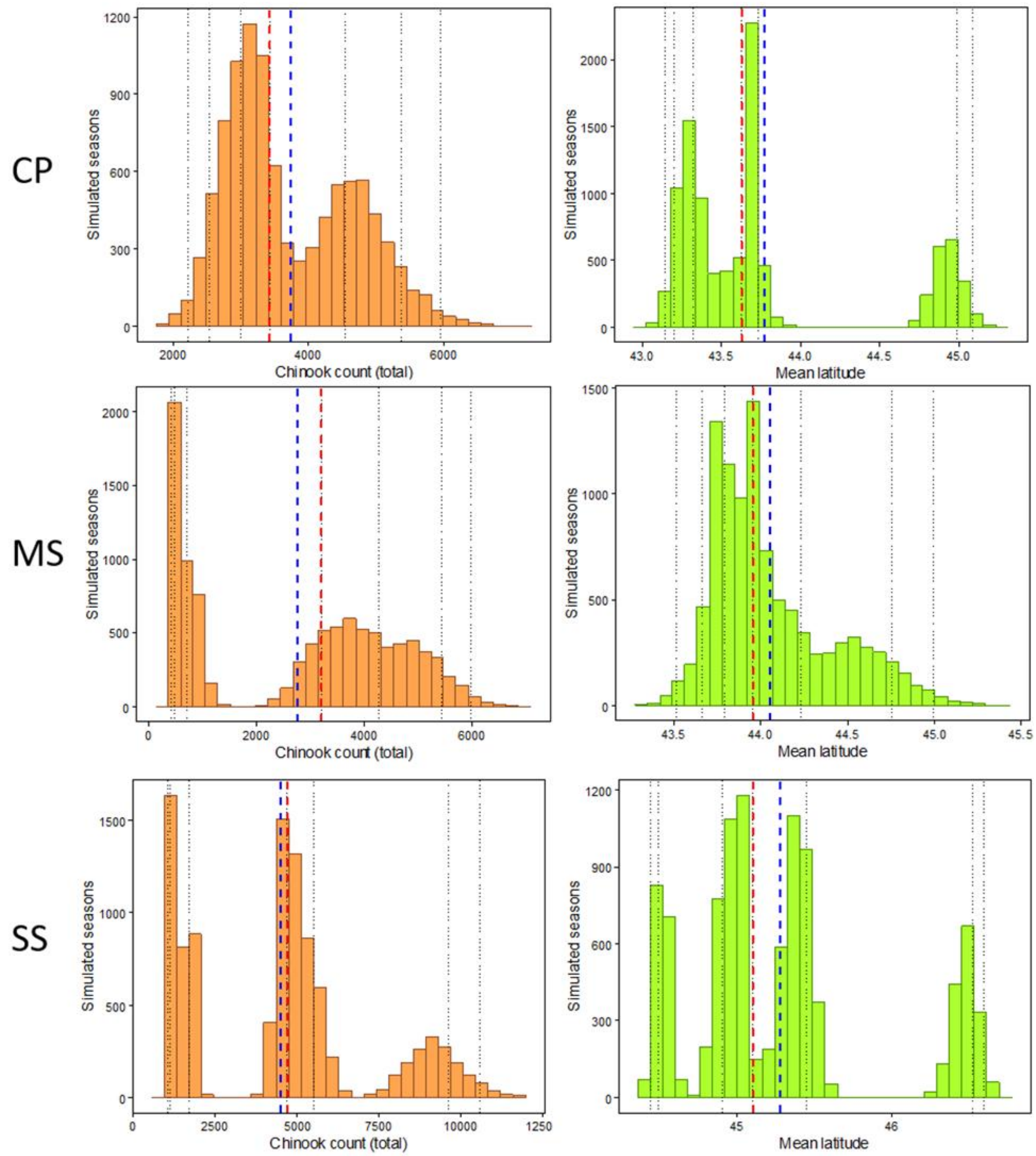

Figure 2-15. Projected distributions of Chinook bycatch assuming a Southern distribution (2012 to 2016 for at-sea), coastwide for shorebased, and average attainment for each sector, applied to a whiting TAC of 500,000 mt. Predicted distributions of Chinook bycatch (count), and mean latitude (degrees), under the conditions specified for the final projected action. Blue dashed line = mean, red dash = median, dotted lines = quantiles from Table 56d.

The two most notable aspects of the results are (1) the projected bycatch is substantially higher, especially at the higher quantiles, under assumptions of a Southern distribution than under a Northern Distribution, even more so under an assumption of 100 percent attainment; and (2) the distributions are multimodal. The latter reflects the large interannual variation in Chinook bycatch seen in previous analysis (NMFS 2017d), and suggests variable alternative outcomes in terms of both Chinook bycatch, and the location of that bycatch.

Bycatch estimates for the whiting sector are below the 11,000 guideline under the Northern distribution within the likely bycatch range (i.e., up to the 80th quantile), but they suggest the potential to exceed the guideline frequently under the Southern distribution for the at-sea fleet. The most likely range of bycatch is from 1,187 from 9,348 Chinook under the Northern distribution scenarios (Table 56a and Table 56b.). Most of the bycatch under this scenario would occur in the shoreside sector. Under the Southern distribution, bycatch could exceed the 11,000-bycatch guideline more than 50 percent of the time under either of the attainment levels, acknowledging the variation in location, depth, and other factors inherent in the data. Under this scenario, most of the bycatch would occur in the at-sea sector. Bycatch could be as high as 17,656 Chinook under the likely bycatch range for the Southern distribution, depending on the level of attainment. Magnitude of bycatch in the shoreside sector is influenced more by level of attainment than latitude, since the shoreside fleet stays closer to the ports of landing (NMFS 2017d). The analysis indicates that either sector could exceed the guideline on its own, should ECEs occur. This suggests a considerable likelihood of the whiting fishery crossing into or even exceeding the guideline plus the Reserve in some years when the fleet is distributed south. We discuss this further in the subsequent section on the Reserve.

Figure 2-13, Figure 2-14, Figure 2-15, and Figure 2-16 generally show a bimodal distribution of bycatch for the at-sea sectors and a trimodal distribution for the shorebased sector, although the modes differ among sectors and scenarios. The differences in bycatch among modes is substantial in most instances. Bycatch under an assumption of a Northern distribution shows modes of more than 200 and between 400 and 1,000 Chinook for catcher-processors and more than 600 and between 900 and 1,550 Chinook for motherships. Bycatch under an assumption of a Southern distribution shows modes between 2,000 and 4,000 Chinook and between 4,000 and 7,000 Chinook for catcher-processor and more than 1,500 and between approximately 2,000 and 7,000 Chinook for motherships. The shoreside sector shows modes below 2,000, between 5,000 and 8,000, and between 9,000 and 14,000 Chinook. Distributional patterns in bycatch are essentially the same in Figures 25 and 27, but the estimated bycatch values are lower, due to the average attainment assumption, rather than 100 percent attainment.

Distributional patterns in bycatch are essentially the same for similar distribution scenarios, but they vary greatly, depending on whether the at-sea fleet is north or south. If the fleet was distributed north, a range of mean seasonal latitude for bycatch of 45° to 47° N. latitude (i.e. primarily North of Cape Falcon) was the most frequent in the at-sea sectors. The catcher-processor sector shows a relatively uniform bycatch distribution, while the mothership sector shows a pronounced secondary high mode just north of 47° N. latitude. If the fleet was distributed south, the range of most frequent mean seasonal latitude for bycatch shifted to between 43.5° and just north of 44.5° N. latitude (between Cape Blanco and Cape Falcon). The multimodal distributions generally trailed raggedly northward for the mothership sector, while the catcher-processor sector showed a pronounced secondary high mode around 45° N. latitude. In the shoreside sector, three relatively equally spaced modes were seen centered at roughly 43°, 45° and 45.5° N. latitude (between Cape Blanco and Cape Falcon), with another somewhat lesser peak near 47° N. latitude (North of Cape Falcon).

Previous analyses indicated higher bycatch is more likely when fishing in the whiting sector occurs later in the year and when fishing is concentrated between Cape Falcon and Cape Blanco even under more typical whiting TACs and at depths out to 200 fm (NMFS 2017d). That analysis indicated bulk of the Chinook bycatch tends to occur in the area between Cape Falcon and Cape Blanco, in the 150 to 200 fm depth zone. However, the same analysis indicated a general trend of higher bycatch rates and larger variability in bycatch rate for shallower depths, where ECEs tend to occur.

Non-whiting - Chinook

The proposed action for non-whiting fisheries was based on Alternative 2B(1) in NMFS 2017d, with modifications. Scenario 2B(1) assumes recent fishing practices and bycatch rates, but with higher effort and attainment rates for groundfish. The geographic distribution of the fleet is similar to the most recent pre-RCA historical period. The scenario assumes the midwater rockfish component of the IFQ fishery expands to levels similar to those before the RCA and other restrictive groundfish management measures were implemented in the early 2000s, when canary rockfish had a much higher ACL and were not considered overfished, and widow and yellowtail rockfish were significant target species. Consistent with the proposed action, the effects analysis assumes increased groundfish attainment and removal of the trawl RCAs in waters off Oregon and California (Table 1-2). Groundfish catch assumptions included in the proposed action (Table 1-2) were used, together with their recommended distribution among the two non-whiting trawl gear types (bottom and midwater trawl). The results and expressed as landings (Table 57). As with whiting, the assumptions included in the proposed action regarding future attainment of groundfish harvest (Table 1-2 and Table 57) is optimistic compared with recent catches.

The bycatch estimates for the non-whiting sector include the midwater trawl, bottom trawl and fixed gear sectors of the fishery, as described in the proposed action. Two EFPs, occurring in 2017 and 2018, are analyzed as part of the bottom trawl and midwater trawl sectors.[23] The EFPs have their own sub-guidelines for Chinook bycatch, which we assume the EFPs will be managed to stay within. However, the bycatch in the EFPs would count against the overall bycatch guideline of 5,500 for the non-whiting fishery (i.e., would be part of that guideline, not an addition to it). The purpose of these EFPs is to allow vessels to target rockfish stocks more effectively as pilot projects, while also gathering data and information to help NMFS assess potential impacts of the Council's recommended changes to the current trawl gear restrictions.

The EFPs allow fishing in areas or times currently prohibited for the broader fleet, which could affect stock composition of the Chinook bycatch. Under the proposed 2018 EFP, non-whiting midwater trawl effort within the trawl RCA would likely occur south of 42° N. latitude prior to May 15th (it is already permitted after May 15th) and south of 40°10' N. latitude before and after May 15th (within the current boundaries of the trawl RCA), but the proportion of effort relative to northern midwater trawling effort would likely be lower than historically observed. Those differences are accounted for in the analysis to the extent possible. The following discussion summarizes and incorporates by reference the extensive analysis regarding the non-whiting fishery in Matson and Erickson 2017.

The proposed action contemplates that fishing in the RCA off Oregon and California will be allowed. However, data regarding salmon bycatch from fishing in the RCA is very limited, because the observer program, which is the source of much recent data, began only a year before the RCA was implemented. Given the lack of recent data from fishing in the RCA, two historical datasets were analyzed from the 1980s (Pikitch et al. 1988)[24] and 1990s (Sampson 2002) from studies that included bottom trawl catches within the area of the current RCA to explore the uncertainty of around salmon bycatch levels that may occur if the RCA is open to fishing. Although the historical datasets provide some direct observations of Chinook salmon bycatch within the portion of the current RCA to be opened, there is substantial

[23] Because of data limitations associated with evaluating aspects of the EFPs, e.g., stock composition south of 40°10' N. latitude, the results of the analysis should be extrapolated to the larger fleet. Data are being collected from the EFPs that can be used to inform a larger fishery if the Council considers that action in the future.

[24] Erickson and Pikitch (1994) provided caution against using their results to project salmon bycatch for years beyond 1990.

uncertainty in the bycatch projections using data from 1980s and 1990s (or early 2000s), due to the substantial changes that have occurred within the fishery since that period. As such, analyses using historical data were undertaken only to explore uncertainty and interannual variation (Appendix A of Matson and Erickson 2017).

In estimating the effects of the proposed action, NMFS concluded that the current IFQ management system, management tools, bycatch avoidance incentives, and near-real time catch data would likely result in larger groundfish catches, but lower salmon bycatch rates, than occurred historically. Under this assumption, bycatch rates are expected to remain similar to those recently estimated by WCGOP regardless of whether the RCA off Oregon and California would stay in place or be removed. There are several reasons that support this assumption. Incentives and improved efficiencies associated with the catch shares program, along with real time, 100 percent monitoring and near-real time data reporting, mean that IFQ fishermen can selectively choose where, when, and how to fish to increase catch of target species, while minimizing bycatch. These tools were not available to managers or fishermen in the 1980s and 1990s. Also, the catch share program and the vessel buyback program have resulted in significant fleet consolidation. These programs, combined with improved efficiencies, have resulted in increased catch per unit of effort of groundfish species with fewer trips and tows that may encounter salmon.

The trawl industry has the additional incentive of reducing bycatch of all species to remain certified by the Marine Stewardship Council (NMFS and PFMC 2017). The Marine Stewardship Council certified the West Coast LE groundfish trawl fishery as sustainable in 2014 (MSC.org). It is unlikely that fishing strategies will change dramatically throughout the EEZ, due to reasons described above, and any changes in distribution of effort and gear type could be strategic (i.e., to improve efficiency and maintain or reduce bycatch; NMFS and PFMC 2017; Agenda Item G.8 Attachment, March 2016; Matson and Erickson 2017).

Aside from the change in fleet dynamics and development of incentives to avoid bycatch, the Council could institute block closures in specific areas to reduce impacts on salmon if bycatch rates become noticeably high, consistent with the provisions of the Council's preliminary preferred alternative for the RCA changes. The EFH/RCA action alternative, described in the Agenda Item F.4.a, Project Team Report, identifies block closures as an accountability measure to limit the impacts on prohibited and protected species, which include salmon. NMFS has access to real-time (updated daily) observer and electronic monitoring data with Chinook salmon counts available by IFQ sector. Further, if those data revealed a guideline exceedance, more granular data detailing Chinook salmon bycatch by area and depth would be available via WCGOP, which would support quick inseason decision making for implementing specific block area closures. The availability of these measures and the increased incentives to avoid bycatch combined with advancements in management, monitoring, and technology, would result in Chinook salmon bycatch rates more similar to recent years consistent with Scenario 2B(1) in the proposed action, rather than those reflected in the historic data sets.For these reasons the assumption of more recent Chinook salmon bycatch rates would better reflect the operation of the fishery going forward.

Projected salmon bycatch by non-trawl groundfish fisheries is based on estimates from three sources: (1) WCGOP bycatch tables for commercial fisheries (NWFSC 2017), (2) Washington, Oregon, and California state agency queries for recreational groundfish trips, and (3) a draft EA that provided estimates of potential bycatch from a long-leader "midwater" recreational groundfish fishery that may occur off Oregon beginning 2018 (NMFS 2016c). Because salmon bycatch is sporadic, and sampling coverage is low for fixed gear fisheries (Matson and Erickson 2017; Somers et al. 2016), non-retention mortality is difficult to estimate. A buffer was added to the final estimate of maximum salmon mortality projections for the non-trawl groundfish fisheries to account for this uncertainty.

Data from WCGOP were analyzed, including both total Chinook salmon counts and total combined retained groundfish weights (round, mt), from 2012 to 2016 for the bottom and non-whiting midwater trawl fisheries. Data from 2015 and 2016 were combined from both observed and electronically monitored trips. These years provide a balanced picture of Chinook salmon bycatch across the range from high to low (Matson and Erickson 2017). Retained catch was used as a currency in the analysis because of its broad availability in historical data as landings on tickets, and in logbooks to help apportion effort between areas. It also enables direct comparisons with analytical assumptions from the Alternatives Document (NMFS 2017d) and the bycatch reports (e.g., NMFS 2016b) that were provided at the March 2017 Council meeting. The bootstrap method was used to project Chinook salmon bycatch as described previously in Section 2.5.1 (Assessment Approach).

As discussed previously, we did not initially impose bounds on the amount of Chinook salmon bycatch itself in our projections in order to evaluate the importance of active management to stay within the guidelines and Reserve. The species- and gear-specific assumptions described in the proposed action (Appendix 1) were used to calculate projected catch levels for groundfish species, including IFQ and non-IFQ species (Table 2-51) and to assess associated Chinook bycatch. Those assumptions were applied to

2018 IFQ sector allocations.[25] This approach allowed us to project bycatch counts of Chinook salmon and their latitudinal distributions, coincident with simulated seasons with defined amounts of groundfish retained catch, and assess those projections against the proposed guidelines,. In aggregate, the proposed assumptions about future attainment of groundfish catch (Table 1-3) were very similar to the model-based projections for Pacific Coast IFQ species categories in the 2017-to-2018 groundfish harvest specifications (aggregate amounts within less than one percent) (PFMC 2016b). Thus, we did not present additional scenarios to bracket uncertainty for groundfish catch, given the agreement between the two sources. Expectations for groundfish harvest in the near future are optimistic compared with recent catches, and this could lead to overestimating Chinook bycatch. Such optimistic projections could lead to overestimating Chinook salmon bycatch if future groundfish catches are, in fact, lower.

Projections of Chinook salmon bycatch (Table 2-52) were made using the conditions and assumptions in the proposed action, including assuming the current EFH area closures, and other inherent characteristics of the IFQ fishery catch data between 2014 and 2016 as defined in the proposed action. The results indicate that, under the proposed action, projected Chinook salmon bycatch would fall below the guideline of 5,500 Chinook salmon for the non-whiting fleet within the range of bycatch most likely to occur; the

0.80 quantile demonstrates that Chinook salmon bycatch would be lower than or equal to 4,580 fish (Table 2-52). Considering the non-trawl Chinook bycatch (404), the number is still likely to remain below the 5,500 Chinook bycatch guideline (i.e., 4,984 at the 80th quantile). Based on the results, the non-whiting fishery is unlikely to require access to the Reserve except in the case of ECEs. Previous analyses (NMFS 2017d) indicated high variability and high bycatch rates during winter for the bottom trawl component.

[25] Although the original motion described nearly identical assumptions to be applied both to 2017 and 2018 allocations, we limited our analysis to using 2018 allocations, because this ESA salmon consultation will be completed near the end of 2017.

Table 2-51. Groundfish catch used in the model (retained mt) by species, IFQ gear type, and target. Projected landings and relevant assumptions are shown.

IFQ species category	Area[1/]	2018 Shorebased trawl allocation[2/]	Assumption[3/]	Avg. 2014-16 IFQ attain	Council assumed 2018 catch[4/]	Avg. 2014-16 ret. Rate	Council assumed 2018 ret.[5/]	2016 p(IFQ trawl)		Projected landings	
								Bottom trawl p(landed) [6/]	Midwater NW p(landed) [7/]	Bottom trawl	Midwater NW
Arrowtooth flounder	Coastwide	10,992.6	Avg. 2014-16 attain.	0.497	5464.2	0.757	4,136.4	0.989	0.000	4,092.40	0.17
Bocaccio rockfish	South of 40°10' N. lat.	283.3	100% attainment	0.365	283.3	0.986	279.4	1.000	0.000	279.44	0.00
Canary rockfish	Coastwide	1,014.1	100% attainment	0.592	1014.1	0.996	1,009.8	0.383	0.289	386.48	292.03
Chilipepper	South of 40°10' N. lat.	1,845.8	100% attainment	0.171	1845.8	0.929	1,714.7	1.000	0.000	1,714.75	0.00
Cowcod	South of 40°10' N. lat.	1.4	100% attainment	0.222	1.4	0.995	1.4	1.000	0.000	1.39	0.00
Darkblotched rockfish	Coastwide	518.4	100% attainment	0.400	518.4	0.949	491.9	0.869	0.000	427.12	0.01
Dover sole	Coastwide	45,981.0	Avg. 2014-16 attain.	0.195	8955.4	0.990	8,863.0	1.000	0.000	8,862.30	0.00
English sole	Coastwide	6,953.0	Avg. 2014-16 attain.	0.046	319.8	0.772	246.9	1.000	0.000	246.88	0.02
Lingcod	North of 40°10' N. lat.	1,259.3	100% attainment	0.204	1259.3	0.924	1,163.4	0.967	0.002	1,067.61	2.13
Lingcod	South of 40°10' N. lat.	510.8	100% attainment	0.056	510.8	0.762	389.1	1.000	0.000	388.99	0.00
Longspine thornyhead	North of 34°27' N. lat.	2,560.2	Avg. 2014-16 attain.	0.330	844.7	0.968	817.9	1.000	0.000	817.84	0.00
Minor Shelf	North of 40°10'	1,146.8	Avg. 2014-16	0.043	49.3	0.675	33.3	0.715	0.050	23.80	1.67

								2016 p(IFQ trawl)		Projected landings	
IFQ species category	Area[1/]	2018 Shorebased trawl allocation[2/]	Assumption[3/]	Avg. 2014-16 IFQ attain	Council assumed 2018 catch[4/]	Avg. 2014-16 ret. Rate	Council assumed 2018 ret.[5/]	Bottom trawl p(landed) [6/]	Midwater NW p(landed) [7/]	Bottom trawl	Midwater NW
Rockfish	N. lat.		attain.								
Minor Shelf Rockfish	South of 40°10' N. lat.	192.4	Avg. 2014-16 attain.	0.063	12.1	0.218	2.7	1.000	0.000	2.65	0.00
Minor Slope Rockfish	North of 40°10' N. lat.	1,268.0	Avg. 2014-16 attain.	0.184	232.7	0.896	208.5	0.675	0.000	139.90	0.00
Minor Slope Rockfish	South of 40°10' N. lat.	433.9	Avg. 2014-16 attain.	0.181	78.5	0.968	76.0	1.000	0.000	74.71	0.00
Other Flatfish	Coastwide	6,349.3	Avg. 2014-16 attain.	0.148	941.5	0.781	735.4	0.992	0.000	729.44	0.02
Pacific cod	Coastwide	1,031.4	Avg. 2014-16 attain.	0.295	304.7	0.998	304.2	1.000	0.000	304.10	0.01
Pacific ocean perch	North of 40°10' N. lat.	198.3	100% attainment	0.407	198.3	0.982	194.6	0.486	0.000	94.56	0.01
Pacific whiting	Coastwide	NA	Avg. 2014-16 landed	NA	NA	0.992	NA	0.000	0.001	44.75	50.51
Petrale sole	Coastwide	2,628.5	100% attainment	0.969	2628.5	0.992	2,608.2	1.000	0.000	2,608.09	0.01
Sablefish	North of 36° N;. lat.	2,521.9	100% attainment	0.968	2521.9	0.983	2,479.8	0.996	0.000	1,799.43	0.07
Sablefish	South of 36° N. lat.	814.4	Avg. 2014-16 attain.	0.270	219.8	0.968	212.8	1.000	0.000	17.29	0.00
Shortspine thornyhead	North of 34°27' N. lat.	1,537.0	100% attainment	0.477	1537.0	0.987	1,517.8	0.984	0.000	1,492.18	0.00
Shortspine thornyhead	South of 34°27' N. lat	50.0	100% attainment	0.037	50.0	0.896	44.8	0.000	0.000	0.00	0.00

IFQ species category	Area[1/]	2018 Shorebased trawl allocation[2/]	Assumption[3/]	Avg. 2014-16 IFQ attain	Council assumed 2018 catch[4/]	Avg. 2014-16 ret. Rate	Council assumed 2018 ret.[5/]	2016 p(IFQ trawl)		Projected landings	
								Bottom trawl p(landed) [6/]	Midwater NW p(landed) [7/]	Bottom trawl	Midwater NW
Splitnose rockfish	South of 40°10' N. lat.	1,662.8	Avg. 2014-16 attain.	0.023	37.6	0.204	7.7	1.000	0.000	7.66	0.00
Starry flounder	Coastwide	630.9	Avg. 2014-16 attain.	0.015	9.4	0.921	8.7	1.000	0.000	8.65	0.00
Widow rockfish	Coastwide	10,661.5	100% attainment	0.607	10661.5	0.994	10,601.8	0.008	0.707	80.57	7,493.02
Yelloweye rockfish	Coastwide	1.1	Avg. 2014-16 attain.	0.046	0.1	0.987	0.0	1.000	0.000	0.04	0.00
Yellowtail rockfish	North of 40°10' N. lat.	4,075.4	100% attainment	0.324	4075.4	0.999	4,072.7	0.095	0.478	386.03	1,945.33
Non-IFQ groundfish	NA	NA	Avg. 2014-16 landed	NA	NA	NA	NA	NA	NA	786.76	19.12
Sum IFQ species	NA	NA	NA	NA	NA	NA	NA	NA	NA	26,099.07	9,785.02
Sum all groundfish	NA	NA	NA	NA	NA	NA	NA	NA	NA	**26,885.83**	**9,804.14**

[1/] IFQ area as defined in regulation, according to management line.

[2/] Indicates which assumption regarding catch was used consistent with the Council motion; 100% of the sector allocation attained, or average attainment over the period from 2014 to 2016.

[3/]Resultant projections for 2018 catch after applying the detailed assumption of the Council motion.

[4/] Resultant projected retained catch after applying the detailed assumption of the Council motion and average retention rates during 2014 to 2016.

[5/] Proportion of landed IFQ catch per IFQ subsector, based on average proportion of non-whiting trawl catch from 2014 to 2016 from WCGOP data.

[6/] Proportion of landed IFQ catch per IFQ subsector, based on average proportion of non-whiting trawl catch from 2014 to 2016 from WCGOP data.

Table 2-52. Quantiles for predicted distributions of annual Chinook salmon bycatch (number) by commercial non-whiting trawl gear types (bottom and midwater). Mean values were provided for comparison. Bycatch projections were rounded. Note that 404 Chinook salmon were also projected for non-trawl groundfish fisheries (commercial and recreational; see Section). Source: West Coast Groundfish Observer Program data.

Chinook, non-whiting sector by gear type			
Quantiles	**Bottom trawl**	**Midwater trawl**	**Sum**
min	73	289	362
0.01	165	331	496
0.05	307	355	662
0.25	483	1,155	1,638
0.5	638	1,722	2,360
mean	960	2,898	3,858
0.75	1,555	2,684	4,239
0.8	1,642	2,938	4,580
0.85	1,726	8,149	9,875
0.95	1,971	9,085	11,056
0.99	2,339	8,111	10,450
max	3,290	11,184	14,474

Coho and Chinook salmon bycatch numbers associated with the non-trawl fisheries are shown in Table 52 and Table 59. Chinook salmon bycatch by these fisheries ranged from 0 to 124 fish per year.[26] All Chinook salmon bycatch in the federally managed commercial fixed gear fisheries were taken by the commercial nearshore fishery north of 40°10' N. latitude (Somers et al. 2014; NWFSC 2017). The maximum annual estimated mortality for Chinook and coho salmon is shown in Table 59. Observer coverage is low on commercial non-trawl groundfish trips, especially nearshore groundfish trips where most salmon are caught (Somers et al. 2016). A buffer of 250 Chinook salmon and 250 coho salmon mortality is also included in Table 59 to account for this uncertainty (as well as uncertainty in mortality estimates provided for recreational groundfish fisheries; see below).

[26]Note that this maximum value was corrected since salmon bycatch was reported to the Council in March, 2017 (see above, NMFS 2016b)

Table 2-53. Chinook and coho salmon mortality in ocean recreational groundfish fisheries and commercial groundfish non-trawl fisheries.

	Species	
Non-trawl groundfish fishery	**Chinook salmon (number)**	**Coho salmon (number)**
Commercial non-trawl[a/]	124	106
OR long-leader recreational[b/]	12	130
CA recreational skiff fishery[c/]	18	8
WA ocean bottomfish fishery[d/]	NA	NA
OR ocean bottomfish fishery[d/]	NA	NA
CA ocean bottomfish fishery[d/]	NA	NA
Buffer[e/]	250	250
Total	404	494

a/Maxiumum catch from 2002-2015; 100% discard mortality assumed; Table 5.
b/Bycatch rates were calculated from 2009-2011 long-leader EFPs
c/Ocean recreational groundfish fisheries outside of salmon season; 2012-2016. Chinook salmon mortality ranged from 0 to 17.78 per year; Coho 0 to 5.7 per year
d/Salmon catch by WA, OR, and CA ocean recreational groundfish fisheries is already accounted for in salmon pre-season modeling. Not reported here.
e/Buffer to account for OR and WA ocean recreational fisheries outside of the salmon season and uncertainty associated with commercial non-trawl estimates.

Based on results of the simulation analysis, it is possible (but unlikely) that the non-whiting trawl fishery may periodically have to use the Reserve in the case of ECEs, or if the bycatch rates are higher than anticipated. Non-whiting midwater bycatch rates tend to be higher and more variable than results shown for bottom trawl, and that is reflected in these predictions (Table 58; Figure 28). This is shown by the uncertainty generated by the model. Although the data show strong year effects in Chinook salmon bycatch for both gear types, non-whiting midwater trawl shows the most disparate distribution of predicted bycatch for the same quantiles and the highest bycatch rates of the two gear types. The underlying distributions for the two non-whiting gear types are both multimodal (Figure 28), due to strong year effects and explicit accommodation for this feature in the model (Matson and Erickson 2017). Bottom trawl projections show modes at approximately 500 Chinook salmon and 1,500 Chinook salmon (Figure 2-16), at approximately the 0.25 and 0.75 quantiles. This suggests that, under proposed action, Chinook salmon bycatch is expected to fall within the 500-fish to 1,500-fish bounds approximately 50 percent of the time. Projections for non-whiting midwater trawl show modes at approximately 300, 1,300, and 8,500 fish, illustrating a somewhat more chaotic picture (Figure 2-16). The middle 50 percent of the midwater distribution is captured between 1,155 and 2,684 fish. Bottom trawl projections showed a unimodal latitudinal distribution of predicted bycatch, while the midwater fishery showed a multimodal distribution (Figure 2-16). Distributional patterns differ between the bottom trawl and midwater trawl gears. Chinook bycatch in the bottom trawl fleet occurs north of 42° N. latitude, primarily between Cape Blanco and Cape Falcon (Figure 2-16). The bottom trawl gear sector shows a unimodal bycatch peak between 42 and 43 N. latitude that trails raggedly northward. Chinook bycatch in the non-whiting midwater trawl shows three relatively equally spaced modes north of 46° N. latitude in waters north of Cape Falcon. The distribution for the midwater gear sector largely reflects recent years for which reliable data are available. Under the proposed action, this could change if chilipepper rockfish were to become targeted using midwater gear off California, or if the midwater fleet were to target widow or yellowtail rockfish futher south. However, limited data from the 1990s when relatively full access was available suggests that bycatch in the midwater trawl gear sector still occurred primarily North of Cape Falcon (NMFS 2017d) although centered closer to the Columbia River area.

We acknowledge there are few data that directly reflect the proposed action (e.g., open RCA). Historical information from the 1980s (Pikitch et al., 1988)[27] and 1990s (Sampson 2002) from studies that included bottom-trawl catches within the area of the current RCA indicate significant interannual variability and the potential for bycatch several magnitudes higher than that of Table 58 (Matson and Erickson 2017), because of higher bycatch rates within the RCA. We also note that Chinook bycatch in the bottom trawl component in 2002 and 2003, just as the RCA was implemented, was just over 14,900 and 16,400, respectively. Because of the reasons stated at the beginning of this section, this outcome would be unlikely, but higher bycatch in some years would not be out of the realm of possibility.

[27] Erickson and Pikitch (1994) provided caution against using their results to project salmon bycatch for years beyond 1990.

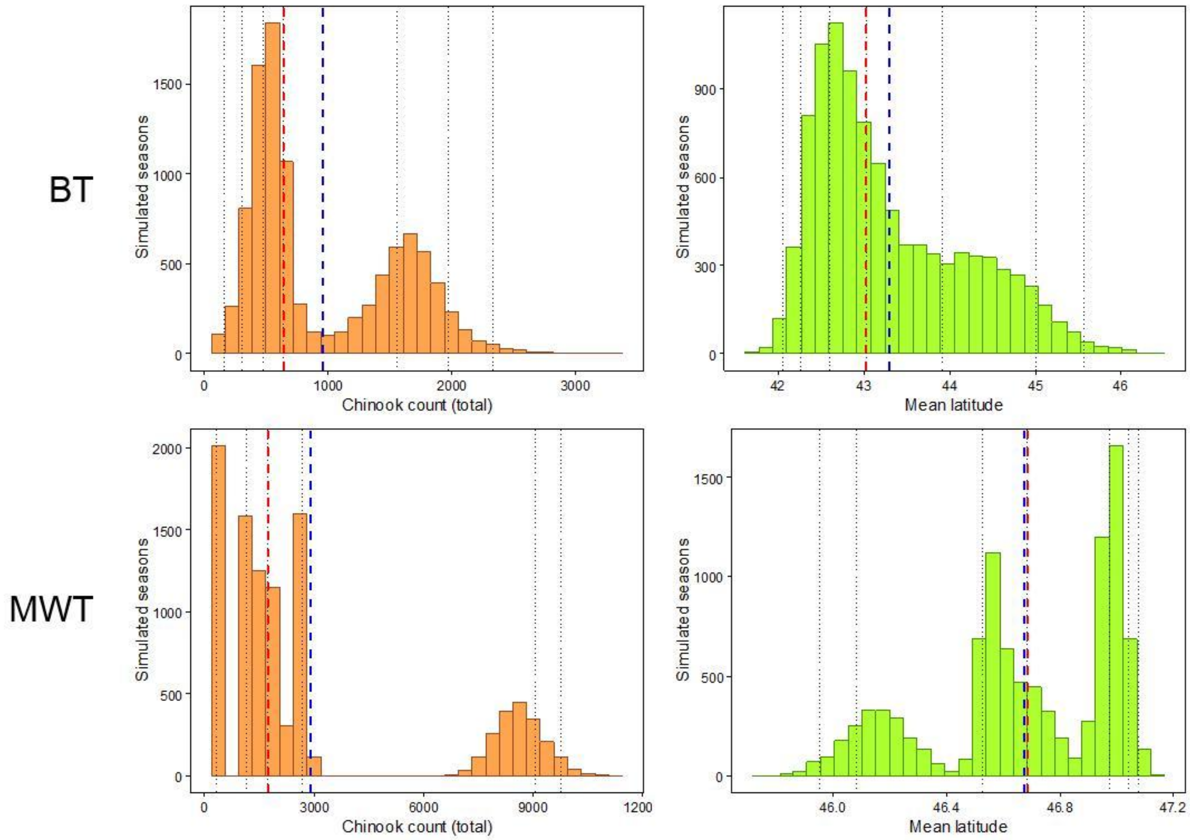

Figure 2-16. Projected distributions of Chinook salmon bycatch (count) and mean latitude (degrees), assuming groundfish catch guidelines and fishery conditions under the proposed action, for bottom trawl and non-whiting midwater trawl. Blue dashed line = mean, red dash = median, dotted lines = quantiles. Source: West Coast Observer Program data (2012 to 2016).

Reserve - Chinook

Our effects analysis assumes, consistent with the stated intent of the proposed action, that the fisheries will be managed to keep Chinook bycatch within the Chinook bycatch thresholds described in the proposed action. The proposed action also includes the concept of a Reserve. The Reserve has not yet been developed for full implementation so details about how it might be used are unavailable. However, the proposed action anticipates that the Reserve is a specific amount of Chinook salmon bycatch that could be added to the whiting or non-whiting bycatch guideline in cases where the guideline has been exceeded. The previous analysis indicates that either sector could exceed its guideline without additional management measures to limit bycatch and thus supports the need for a Reserve. The proposed action includes a total bycatch Reserve of 3,500 Chinook (i.e., a total of 3,500 Chinook salmon may be available to one or both fleets combined during a single year, not 3,500 Chinook salmon to each fleet during the same year). Access to the Reserve may be available to any sector that exceeds its recommended guideline, so there is no guarantee that a specific sector would be granted access to any or all of the Reserve during a given year (e.g., the Reserve could be taken by a different sector). As described in the proposed action and elsewhere in this document, we assume that the fisheries would be managed to stay within the bycatch guidelines, and thus the Reserve would be accessed only as a safety net to minimize disruption to the fishery where actions that were already actively being taken to reduce bycatch were insufficient (i.e., "the Reserve would not be an entitlement or a de facto increase in the guidelines…").

While detail is lacking as to how a Reserve would be implemented, we analyze the effect of allocating the Reserve to the whiting fishery versus the non-whiting fishery, and its potential allocation to specific whiting sectors, because its use could change the effects of the groundfish fishery on individual listed ESUs. We also examined the potential that multiple sectors would need to access to the Reserve within the same year to better evaluate its likely access between sectors and the likelihood of exceeding the Reserve. However, several technical issues made this approach infeasible (Matson and Erickson 2017). Therefore, the likelihood of both whiting and non-whiting sectors reaching their Chinook bycatch guidelines and seeking access to the Reserve in the same year was qualitatively evaluated using correlations of annual salmon bycatch between pairs of sectors.

There were no apparent or significant relationships in annual bycatch of Chinook salmon between whiting and non-whiting sectors using data from 2002 to 2016. Significant correlations were observed within sectors that share the same bycatch guidelines but not between sectors with different guidelines (Matson and Erickson 2017). That is, a significant increase in Chinook bycatch in one sector would not mean that the Chinook bycatch in the other sector is also likely to occur. The fact that there appears to be correlation between sectors that share the same bycatch guidelines is not informative as to how the Reserve would actually be implemented. However, the lack of correlation between bycatch levels in the whiting and non-whiting sectors suggest a low likelihood of both whiting and non-whiting sectors exceeding their respective guidelines and needing access to the Reserve within the same year.

The potential for accessing the Reserve was assessed from the patterns in projected bycatch previously discussed for the whiting and non-whiting sectors. As such, this assessment should be considered a simple and blunt characterization of potential outcomes. We examined the potential for each sector to exceed the sum of its guideline plus the Reserve (e.g., 5,500 guideline plus the 3,500 Reserve = 9,000 Chinook salmon for the non-whiting sector). The second step was to examine impacts under the assumption that the entire Reserve is taken by a single sector (i.e., whiting or non-whiting) or a single gear type within a sector (i.e., non-whiting midwater trawl or bottom trawl; Table 60a, Table 60b, Table 60c, and Table

60d). See Matson and Erickson 2017 for approach to distributing projected catches.

The potential need to access the non-whiting trawl Reserve is indicated by the quantile associated with the Chinook salmon guideline (i.e., 5,500 fish). Table 58 indicates that the approximate probability of exceeding both the 5,500 Chinook salmon guideline and 9,000 Chinook salmon (guideline plus Reserve) in any one year by the bottom trawl and non-whiting midwater trawl together lies between the 0.80 and 0.81 quantiles. This is due to the steep rise at the high end of the predicted bycatch distribution for the midwater trawl gear (and disparate bimodal distribution; Figure 28), as evidenced by the same quantiles given for each individual gear type (1,642 and 1,658 for bottom trawl, versus 2,938 and 7,525 for midwater trawl; Figure 28). The steep rise is the result of high variance from strong year effects in the data for midwater trawl (Matson and Erickson 2017). The uncertainty in the available data discussed earlier could also result in higher bycatch. Therefore, although Chinook salmon bycatch in the non-whiting trawl fishery is expected to be below the 5,500 guideline in most years, bycatch could increase quickly, requiring access to the Reserve and potential additional action such that bycatch would not exceed the combined guideline and Reserve.

Based on the simulations (see Figure 28), projected Chinook salmon catch by bottom trawl would likely never reach 6,062 fish, even though we forced bottom trawl to achieve that amount (Table 60 and Table 61), as proscribed in the proposed action, for the Reserve analysis. The maximum catch by bottom trawl at the maximum quantile would be 3,290 Chinook salmon (Table 58).[28] However, the analysis also indicates significant correlations within sectors. In other words, if Chinook salmon catch by bottom trawl reached the maximum level shown in Table 58, then catch by non-whiting midwater trawl would likely be higher than shown at the 0.80 quantile (i.e., greater than 2,938) in Table 60 and Table 61. The degree to which these two situations, the likelihood that the bottom trawl Chinook bycatch is lower than simulated and the non-whiting midwater trawl bycatch higher than simulated, counter each other is uncertain.

Projected bycatch of Chinook salmon by the whiting sector depends on the assumptions discussed previously, i.e., the distribution of the sector and the level of attainment of the whiting TAC. For the northern distribution of the at-sea whiting fleet, the whiting sector would most likely remain lower than their proposed guideline of 11,000 Chinook salmon regardless of the assumed whiting attainment level (Table 60a and Table 60b). Furthermore, these analyses show a 95 percent to 96 percent probability that the whiting sector would remain below its Chinook salmon guideline plus Reserve, equaling a total of

[28] Hence, for cases where we assumed bottom trawl would need the Reserve in Table 60 and Table 61, the associated quantile was reported as NA.

14,500 fish (Table 60b) under the northern distribution scenario. Combining whiting and non-whiting sector information under the assumption that the at-sea whiting fleet fished the northern areas, if one sector catches their entire Chinook salmon guideline plus Reserve under the proposed action, then there is at least an 80 percent probability that the other sector would remain at or below their guideline, regardless of the assumption of whiting attainment (Table 60a and Table 60b).

Results are much different for the whiting sector when the at-sea fleet shows a southern distribution of fishing effort (Table 60a, Table 60b, Table 60c, and Table 61). In both scenarios of attainment, the whiting sector is expected to exceed its threshold plus the Reserve frequently. Thus the Reserve would not be available to the non-whiting sector (Table 60c). The probability that the whiting sector would remain at or below its guideline or guideline plus Reserve is less than 80 percent for all cases (Table 61). In the worst-case scenario, the probability that the whiting sector would remain below its guideline of 11,000 Chinook, assuming 100 percent attainment of the whiting TAC, is 25 percent to 50 percent and below its guideline plus Reserve of 14,500 Chinook would be 60 percent to 61 percent (Table 61b). In these cases, additional management actions could be required to limit bycatch in the whiting fishery to ensure the fishery stays within its guideline or guideline plus Reserve. Combining whiting and non-whiting sector information under the assumptions that the at-sea whiting fleet fished a southern distribution, there is a significant probability that all or at least part of the Reserve would not be available to either the whiting or non-whiting sector. Under the Southern scenario of distribution, the combined bycatch could exceed 22,000 Chinook salmon (i.e., Reserve plus guideline) without additional and proactive management actions to reduce bycatch (Table 60c).

Table 2-54. Chinook counts and quantiles assuming one sector (e.g., whiting or non-whiting) or one gear type within the non-whiting sector (i.e., midwater trawl or bottom trawl) receives and catches the entire Reserve (= shaded cells). Quantiles were set at a minimum of 0.80 for this analysis; projected Chinook salmon bycatch associated with that quantile was reported, based on simulation analyses. If salmon bycatch rates were high, and the guideline plus Reserve would be exceeded at 0.80 quantile, then projected bycatch at 0.80 quantile was reported (even if it exceeded the guideline plus Reserve). If Chinook bycatch rates were low, and bycatch would be less than the guideline plus Reserve at 0.80 quantile, then projected bycatches were increased until the guideline plus Reserve was met; the associated quantile was then reported. Sum of bottom trawl and non-trawl groundfish (commercial and recreational) projections of Chinook salmon bycatch is shown as a footnote (a total of 404 Chinook salmon was assumed maximum bycatch for commercial fixed gear and recreational groundfish fisheries, Table 59). **NA = exceeds the maximum possible quantile (Max = 3,290 Chinook salmon) shown in Table 58.** MDT = midwater trawl.

60a. Scenario that includes **Northern** distribution of at-sea whiting and **average** whiting attainment

	Sector and gear type receiving the reserve shown by shaded cells					
Sector/Gear type	Chinook count	Quantile	Chinook count	Quantile	Chinook count	Quantile
Bottom trawl[1/]	1,642	0.80	6,062	NA	1,642	0.80
non-whiting MDT	7,358	0.80-0.81	2,938	0.80	2,938	0.80
Total (non-whting sector)	9,000	0.80-0.81	9,000	0.80-0.81	4,580	0.80
Catcher/Processor (CP)	660	0.80	660	0.80	1,115	
Mothership (MS)	1,127	0.80	1,127	0.80	1,446	0.99-1.0
Shoreside whiting (SS)	5,837	0.80	5,837	0.80	11,939	
Total (whiting sector)	7,624		7,624		14,500	
1/ BT + Fixed Gear	**2,046**		**6,466**		**2,046**	

60b. Scenario that includes **Northern** distribution of at-sea whiting and **100%** whiting attainment

	Sector and gear type receiving the reserve shown by shaded cells					
Sector/Gear type	Chinook count	Quantile	Chinook count	Quantile	Chinook count	Quantile
Bottom trawl[1/]	1,642	0.80	6,062	NA	1,642	0.80
non-whiting MDT	7,358	0.80-0.81	2,938	0.80	2,938	0.80
Total (non-whting sector)	9,000	0.80-0.81	9,000	0.80-0.81	4,580	0.80
Catcher/Processor (CP)	703	0.80	703	0.80	824	
Mothership (MS)	1,293	0.80	1,293	0.80	1,398	0.95-0.96
Shoreside whiting (SS)	7,352	0.80	7,352	0.80	12,278	
Total (whiting sector)	9,348		9,348		14,500	
1/ BT + Fixed Gear	**2,046**		**6,466**		**2,046**	

60c. **Southern** distribution of at-sea whiting by attainment percentage

	average whiting attainment		**100%** whiting attainment	
Sector/Gear type	Chinook count	Quantile	Chinook count	Quantile
Bottom trawl[1/]	1,642	0.80	1,642	0.80
non-whiting MDT	2,938	0.80	2,938	0.80
Total (non-whting sector)	4,580	0.80	4,580	0.80
Catcher/Processor (CP)	4,693	0.80	4,969	0.80
Mothership (MS)	4,571	0.80	5,335	0.80
Shoreside whiting (SS)	5,837	0.80	7,352	0.80
Total (whiting sector)	15,101		17,656	
1/ BT + Fixed Gear	**2,046**		**2,046**	

Table 2-55. Chinook salmon counts and quantiles assuming one sector (e.g., whiting or non-whiting) or one gear type within the non-whiting sector (i.e., midwater trawl or bottom trawl) receives the entire Reserve (= shaded cells). Only southern distribution of the commercial (non-tribal) at-sea whiting fleet is shown (years 2012-2016) for both average attainment and 100 percent attainment (see Matson, unpublished). Total projected catch is capped at the guideline or guideline plus Reserve; quantiles associated with the projected catch is shown. Sum of bottom trawl and non-trawl groundfish (commercial and recreational) projections of Chinook salmon bycatch is shown as a footnote (a total of 404 Chinook was assumed maximum bycatch for commercial fixed gear and recreational groundfish fisheries). **NA = exceeds the maximum quantile (Max = 3,290 Chinook salmon) shown in Table 58.** MDT = midwater trawl.

61a. Scenario that includes **Southern** distribution of at-sea whiting and **average** whiting attainment
Also assumes measures are taken to limit whiting bycatch to either 11,000 guideline or 14,500 Reserve

Sector/Gear type	Sector and gear type receiving the reserve shown by shaded cells					
	Chinook count	Quantile	Chinook count	Quantile	Chinook count	Quantile
Bottom trawl[1/]	1,642	0.80	6,062	NA	1,642	0.80
non-whiting MDT	7,358	0.80-0.81	2,938	0.80	2,938	0.80
Total (non-whting sector)	9,000	0.80-0.81	9,000	0.80-0.81	4,580	0.80
Catcher/Processor (CP)	3,325	0.40-0.50	660	0.40-0.50	1,115	0.76-0.77
Mothership (MS)	3,119	0.40-0.50	1,127	0.40-0.50	1,446	0.76-0.77
Shoreside whiting (SS)	4,556	0.40-0.50	5,837	0.40-0.50	11,939	0.76-0.77
Total (whiting sector)	11,000	0.40-0.50	7,624	0.40-0.50	14,500	0.76-0.77
1/ BT + Fixed Gear	**2,046**		**6,466**		**2,046**	

61b. Scenario that includes **Northern** distribution of at-sea whiting and **100%** whiting attainment

Sector/Gear type	Sector and gear type receiving the reserve shown by shaded cells					
	Chinook count	Quantile	Chinook count	Quantile	Chinook count	Quantile
Bottom trawl[1/]	1,642	0.80	6,062	NA	1,642	0.80
non-whiting MDT	7,358	0.80-0.81	2,938	0.80	2,938	0.80
Total (non-whting sector)	9,000	0.80-0.81	9,000	0.80-0.81	4,580	0.80
Catcher/Processor (CP)	3,004	0.25-0.50	3,004	0.25-0.50	4,098	0.60-0.61
Mothership (MS)	3,070	0.25-0.50	3,070	0.25-0.50	4,197	0.60-0.61
Shoreside whiting (SS)	4,926	0.25-0.50	4,926	0.25-0.50	6,206	0.60-0.61
Total (whiting sector)	11,000	0.25-0.50	11,000	0.25-0.50	14,501	0.60-0.61
1/ BT + Fixed Gear	**2,046**		**6,466**		**2,046**	

Coho – Whiting and non-whiting

As described in the Environmental Baseline, coho bycatch in the groundfish fisheries is highly variable. Bycatch averaged 163 (range = 13 to 430) and 60 (range = 8 to 105) coho in the whiting and non-whiting sectors, respectively, from 2002 to 2015 (Table 52). Coincident with actions taken to reduce bycatch, bycatch in the tribal whiting fishery decreased substantially after 2007. Coho salmon bycatch in the federally managed commercial fixed gear fisheries during 2002-2015 occurred only north of 40°10' N. latitude (Somers et al. 2014; NWFSC 2017). The proposed action includes a long-leader recreational fishery off the Oregon coast and coho encountered in recreational groundfish fisheries. Observer coverage is low on commercial non-trawl groundfish trips, especially nearshore groundfish trips where most salmon are caught (Somers et al. 2016), and sampling in many recreational fisheries outside the salmon season can be challenging. A mortality buffer of 250 coho salmon was included in Table 59 to account for this uncertainty (as well as uncertainty in mortality estimates provided for recreational groundfish fisheries). The maximum annual estimated mortality of coho salmon by sector analyzed in this opinion is shown in Table 2-56. These include the estimates described in Table 2-53.

Table 2-56. Maximum coho bycatch estimated by sector. The non-trawl sector includes bycatch in commercial fixed gear and recreational fisheries plus an additional mortality buffer.

Sector	Gear type	Coho mortality
Whiting	At-Sea Non-Tribal	226
	Shoreside Non-Tribal	141
	Tribal Mothership And Shoreside	107
Non-Whiting	Bottom And Midwater Trawl	66
	Non-Trawl	494

2.5.2.1 Stock composition

Whiting and non-whiting without Reserve -Chinook

Table 63 summarizes the estimated annual bycatch by sector and scenario for the individual listed Chinook ESUs affected by the proposed action at the 80th quantile (see bycatch estimates in Table 56 and Table 58). The estimates include impacts from the fixed gear and EFP proposed for south of 40° 10’ N. latitude. Because stock composition information is not available for the fixed gear sector, the bottom trawl fishery was used to represent stock composition for the fixed gear sector since the bottom trawl fishery has a more coastwide distribution than the non-whiting midwater trawl sector and is similar to the broader distribution of the fixed gear sector (NMFS 2017d). The stock composition estimates for the non-whiting midwater trawl gear type also includes bycatch from the proposed EFP fishing in 2018 south of 40° 10’ N. latitude.

The estimates provided here of ESU-specific impacts are likely higher than will actually occur for several reasons: 1) the estimates are based on the highest level of bycatch reasonably expected to occur (80th quantile) with implementation of the proposed action, although higher impacts are possible occasionally given the uncertainty in the data; 2) the estimates will include some small level of unlisted hatchery fish that share a similar genetic heritage; and, 3) the groundfish fishery catches two and three-year old fish; not all of which will return to spawn because of natural mortality. Chinook typically spawn at three or four years of age and coho at three years of age. Therefore, these estimates represent the maximum level of annual estimated impact to the listed Chinook ESUs affected by the proposed action.

The primary contributors to Chinook bycatch in both the whiting and non-whiting sectors are the Puget Sound, LCR, Snake River and CC Chinook salmon ESUs. Bycatch of the three remaining Chinook ESUs would be rare; contributing only a few tens of Chinook apiece. These three ESUs share a spring type life history and are typically encountered in ocean fisheries during the late-winter to early-spring period as described earlier. An element of the proposed action is a midwater yellowtail/widow rockfish fishery conducted in a manner similar to historical patterns when such a fishery took place. As described previously, the 2018 EFP allows fishing during January to May which has been closed to fishing since the early 2000s. If fishing resumes during the January-to-May period in the future for the non-whiting midwater trawl fleet which could increase impacts on these ESUs above what the simulations indicate. So it will be important to monitor impacts on these ESUs if that occurs. However, even if impacts were to double (i.e., historic CWT information indicated 30 percent of recoveries prior to May 1), they would remain low.

Impacts on individual ESUs vary according to fishery sector and are primarily influenced by the latitudinal distribution of the at-sea whiting fleet. For the whiting sector, the level of impact in terms of absolute numbers of Chinook varies primarily according to fleet distribution rather than level of attainment. Impacts under the northern distribution of the at-sea sector range from approximately 200 to 450 Chinook per ESU across attainment scenarios depending on the ESU. When the whiting fleet fishes south, impacts on the LCR ESU decline by about half and impacts on the CC Chinook ESU triple. Impacts on the Puget Sound and Snake River Chinook ESUs remain about the same because, although their stock contribution decreases, that lower stock composition is applied to a much higher level of bycatch expected to occur under a southern distribution. Impacts on the four primary contributing Chinook salmon ESUs in the non-whiting sector are estimated to range from approximately 200 to 400 Chinook per ESU per year depending on the ESU. To put the impacts in the context of the abundance of the population, the impacts were calculated as a proportion of the estimated average ocean abundance of the ESU (2008 to 2016) (Table 2-57). ERs are less than one percent for all the Chinook ESUs except for the CC Chinook ESU. ERs for the CC Chinook salmon ESU range from one percent to two percent depending on the distribution of the at-sea whiting fleet (Table 2-57).[29] As

[29] The ESA consultation standard for CCChinook in salmon fisheries is an age-four ocean HR of no greater than 16 percent on Klamath River fall Chinook salmon. This ER is calculated based on an ocean abundance of three and four-year-old Chinook salmon.

discussed in the Status of the Species and Environmental Baseline sections, data on the abundance, productivity and ocean distribution of CC Chinook is extremely limited so the Klamath River fall Chinook salmon stock is used as a proxy for ocean distribution and impact rates. The impact on the Klamath River fall Chinook stock in the Chinook bycatch from the groundfish fishery was also used in this opinion to estimate the ER on CC Chinook in the groundfish fishery so there is greater uncertainty about what the impacts to CC Chinook salmon are in the groundfish fishery. For comparison, the impacts of the ocean salmon fisheries on California Coastal Chinook are limited to an age-4 ocean HR of no greater than 16 percent on Klamath River fall Chinook salmon. This ER is calculated based on an ocean abundance of age-4 year old Chinook, and is therefore not directly comparable to the impact rate in the groundfish fishery because Chinook bycatch in the groundfish fishery comprises younger fish, i.e., primarily age-2 and age 3 year old Chinook salmon.

Estimates of impacts on the various ESUs depend largely on the fishing latitude and subsequent coastal distribution of bycatch for the sectors and gear types. Applicability of the bycatch and stock composition results into the future assume the distribution of the fleets will reflect the general patterns in Figures 2-13 through 2-17.

Table 2-57. Chinook bycatch by listed ESU by sector, gear type and scenario. The mean latitude from the haul level data was used in the coerced linear regression model to estimate stock composition. MDT = midwater trawl.

Table 63a. **Northern** distribution of at-sea whiting, **100%** whiting TAC attainment

Sector/Geartype	Mean Latitude	Chinook count	California Coast*	L Columbia R*	U Willamette R*	U Columbia R Sp*	Snake R Sp/Su*	Snake R Fa*	Puget Sound*
Bottom trawl[1]	43.30071	2,046	117	0	0	0	0	10	0
Non-whiting MDT	46.67375	2,938	74	290	11	7	14	72	391
Total (non-whiting sector)		4,984	191	290	11	8	14	82	391
Catcher/Processor (CP)	46.00519	703	22	51	2	1	3	14	75
Mothership (MS)	46.09677	1,293	38	99	4	3	5	27	142
Shoreside whiting (SS)	45.27982	7,352	185	298	0	0	0	113	78
Total (whiting sector)		9,348	245	449	6	4	7	155	295

1/Including Fixed Gear 2/includes impacts from proposed EFP south of 40.10 N latitude

Table 63b. **Southern** distribution of at-sea whiting, **100%** whiting TAC attainment

Sector/Geartype	Mean Latitude	Chinook count	California Coast	L Columbia R	U Willamette R	U Columbia R Sp*	Snake R Sp/Su	Snake R Fa	Puget Sound
Bottom trawl[1]	43.30071	2,046	117	0	0	0	0	10	0
Non-whiting MDT	46.67375	2,938	74	290	11	7	14	72	391
Total (non-whiting sector)		4,984	191	290	11	8	14	82	391
Catcher/Processor (CP)	43.77493	4,969	271	0	0	3	0	38	85
Mothership (MS)	44.06135	5,335	278	0	0	4	3	50	153
Shoreside whiting (SS)	45.27982	7,352	185	298	0	0	0	113	78
Total (whiting sector)		17,656	734	298	0	6	3	202	316

1/Including Fixed Gear 2/includes impacts from proposed EFP south of 40.10 N latitude

Table 63c. **Northern** distribution of at-sea whiting, **average** whiting TAC attainment

Sector/Geartype	Mean Latitude	Chinook count	California Coast	L Columbia R	U Willamette R	U Columbia R Sp*	Snake R Sp/Su	Snake R Fa	Puget Sound
Bottom trawl[1]	43.30071	2,046	117	0	0	0	0	10	0
Non-whiting MDT	46.67375	2,938	74	290	11	7	14	72	391
Total (non-whiting sector)		4,984	191	290	11	8	14	82	391
Catcher/Processor (CP)	46.00519	660	20	48	2	1	2	14	70
Mothership (MS)	46.09677	1,127	33	86	3	2	4	24	124
Shoreside whiting (SS)	45.27982	5,837	147	237	0	0	0	90	62
Total (whiting sector)		7,623	200	371	5	4	7	127	256

1/Including Fixed Gear 2/includes impacts from proposed EFP south of 40.10 N latitude

Table 63d. **Southern** distribution of at-sea whiting, **average** whiting TAC attainment

Sector/Geartype	Mean Latitude	Chinook count	California Coast	L Columbia R	U Willamette R	U Columbia R Sp*	Snake R Sp/Su	Snake R Fa	Puget Sound
Bottom trawl[1]	43.30071	2,046	117	0	0	0	0	10	0
Non-whiting MDT	46.67375	2,938	74	290	11	7	14	72	391
Total (non-whiting sector)		4,984	191	290	11	8	14	82	391
Catcher/Processor (CP)	43.77493	4,693	256	0	0	2	0	36	80
Mothership (MS)	44.06135	4,571	238	0	0	3	2	43	131
Shoreside whiting (SS)	45.27982	5,837	147	237	0	0	0	90	62
Total (whiting sector)		15,101	641	237	0	6	3	169	273

1/Including Fixed Gear 2/includes impacts from proposed EFP south of 40.10 N latitude

Table 2-58.. Estimated ERs by listed Chinook ESU for each sector and scenario of at-sea fleet distribution and attainment for bycatch at the 80th quantile (based on bycatch estimates by listed Chinook ESU in Table 2-57).

Scenario	Sector	Puget Sound	L. Columbia River	U. Willamette	U. Columbia River sp	Snake River sp/su	Snake River fall	California Coastal
Northern at-sea scenario/ 100% attainment	Non-whiting	<1%	<1%	<1%	<1%	<1%	<1%	<1%
	Whiting	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Southern at-sea scenario/ 100% attainment	Non-whiting	<1%	<1%	<1%	<1%	<1%	<1%	<1%
	Whiting	<1%	<1%	<1%	<1%	<1%	<1%	<2%
Northern at-sea scenario/ average attainment	Non-whiting	<1%	<1%	<1%	<1%	<1%	<1%	<1%
	Whiting	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Southern at-sea scenario/ average attainment	Non-whiting	<1%	<1%	<1%	<1%	<1%	<1%	<1%
	Whiting	<1%	<1%	<1%	<1%	<1%	<1%	<2%

Reserve - Chinook

Table 65a, Table 65b, Table 65c, and Table 65d summarize the estimated annual bycatch by sector and Reserve scenario for the individual listed Chinook ESUs affected by the proposed action (see bycatch estimates in Table 60a-b and Table 61a-b). The results presented in these tables assume inseason management actions would be taken in the whiting sector to keep bycatch within the guideline or Reserve, depending on the scenario presented, and some portion of the Reserve would be available to the either fleet in all scenarios. Under the Southern distribution scenarios, without actions taken to reduce bycatch to stay within its 11,000 Chinook bycatch guideline, the Reserve would already have been taken defacto by the whiting sector and would be unavailable to the non-whiting sector as illustrated in Table 60c. Those results were presented in Table 63b and Table 63d. As discussed previously, based on the simulations (see Figure 28), projected Chinook salmon catch by bottom trawl would likely never reach 6,062 fish, even though for the Reserves analysis, we forced bottom trawl to achieve that amount (Table 60 and Table 61). The maximum bottom trawl catch at the maximum quantile would be 3,290 Chinook salmon (Table 58).[30] However, the analysis also indicates significant correlations within sectors. In other words, if Chinook salmon catch by bottom trawl reached the maximum level shown in Table 58, then catch by non-whiting midwater trawl would likely be higher than shown at the 0.80 quantile (i.e., greater

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[30] Hence, for cases where we assumed bottom trawl would need the Reserve in Table 60 and Table 61, the associated quantile was reported as NA.

than 2,938) in Table 60 and Table 61. The degree to which these two situations counter each other is uncertain.

The primary contributors to Chinook bycatch are the Puget Sound, Snake River fall, LCR, and CC Chinook salmon ESUs, regardless of sector or scenario, although there are differences in contribution of the four ESUs among the different sectors and gear types. The Upper Willamette, Upper Columbia spring and Snake River spring/summer Chinook ESUs contribute very little to the bycatch in the groundfish fishery; at most a few tens of fish for any one of the ESUs, regardless of scenario or which sector takes the Reserve. Impacts on the four primary contributing ESUs range from about 75 Chinook to just over 900 Chinook, depending on the scenario and which sector/gear type takes the Reserve (Table 64a, Table 64b, Table 64c, and Table 64d). In the non-whiting sector, the bottom trawl bycatch is almost exclusively from the CC Chinook ESU, ranging from just over 100 to about 350 CC Chinook, depending on whether it takes the Reserve.

All four ESUs contribute to the bycatch in the non-whiting midwater trawl fishery due to a mean latitude for the fleet that is farther north than that of the bottom trawl fleet. The Puget Sound and Lower Columbia Chinook ESUs show the greatest contribution to bycatch for the midwater fleet, which varies from about 300 to 400 Chinook when the bottom trawl or whiting fleet takes the Reserve to about 700 to just over 900 Chinook when the midwater fleet takes the Reserve. The Snake River fall and CC Chinook salmon ESUs contribute about 75 Chinook salmon when the bottom trawl or whiting fleets take the Reserve to about 175 Chinook when the bottom trawl fleet takes the Reserve. For the whiting sector, the shoreside fleet accounts for the majority of the impacts on listed Chinook ESUs, followed by the mothership and then the catcher-processor fleets, because of the higher associated bycatch for the shoreside fleet. The range of impacts on the four ESUs varies with distribution of the at-sea fleet.

Under the northern distribution, impacts are distributed among the four ESUs with relatively low impacts from the mothership and catcher-processor fleets (a few tens to about 160 Chinook at the most when the whiting fleet takes the Reserve)(Table 65a and Table 65b). Under the southern distribution, bycatch is more evenly distributed among the three whiting gear types. Impacts on Puget Sound and Columbia River ESUs in the whiting sector decrease substantially (Table 65a and Table 65b). Impacts on CC Chinook increase substantially for all three whiting gear types, and it becomes the primary ESU contributing to bycatch (Table 2-59 and Table 2-60).

Table 2-59. Chinook bycatch by listed ESU by sector, gear type assuming Northern distribution, average whiting attainment. The mean latitude from the haul level data was used in the coerced linear regression model to estimate stock composition. MDT = midwater trawl.

Counts where Non-whiting MWT takes reserve

Sector/Geartype	Chinook count	California Coast*	L Columbia R*	U Willamette R*	U Columbia R Sp*	Snake R Sp/Su*	Snake R Fa*	Puget Sound*
Bottom trawl[1]	2,046	117	0	0	0	0	10	0
Non-whiting MDT[2]	6,954	168	687	26	17	33	170	925
Total (non-whiting sector	9,000	284	687	26	18	33	180	925
Catcher/Processor (CP)	660	20	48	2	1	2	14	70
Mothership (MS)	1,127	33	86	3	2	4	24	124
Shoreside whiting (SS)	5,837	147	237	0	0	0	90	62
Total (whiting sector)	7,624	200	371	5	4	7	127	256

1/Including Fixed Gear 2/includes impacts from proposed EFP south of 40.10 N latitude

Counts where Bottom trawl takes reserve

Sector/Geartype	Chinook count	California Coast*	L Columbia R*	U Willamette R*	U Columbia R Sp*	Snake R Sp/Su*	Snake R Fa*	Puget Sound*
Bottom trawl[1]	6,062	346	0	0	1	0	29	0
Non-whiting MDT[2]	2,938	74	290	11	7	14	72	391
Total (non-whiting sector	9,000	421	290	11	8	14	101	391
Catcher/Processor (CP)	660	20	48	2	1	2	14	70
Mothership (MS)	1,127	33	86	3	2	4	24	124
Shoreside whiting (SS)	5,837	147	237	0	0	0	90	62
Total (whiting sector)	7,623	200	371	5	4	7	127	256

1/Including Fixed Gear 2/includes impacts from proposed EFP south of 40.10 N latitude

Counts where Whiting sector takes reserve

Sector/Geartype	Chinook count	California Coast*	L Columbia R*	U Willamette R*	U Columbia R Sp*	Snake R Sp/Su*	Snake R Fa*	Puget Sound*
Bottom trawl[1]	2,046	117	0	0	0	0	10	0
Non-whiting MDT[2]	2,938	74	290	11	7	14	72	391
Total (non-whiting sector	4,984	191	290	11	8	14	82	391
Catcher/Processor (CP)	1,115	34	81	3	2	4	23	119
Mothership (MS)	1,446	43	111	4	3	5	31	159
Shoreside whiting (SS)	11,939	300	485	0	0	0	184	126
Total (whiting sector)	14,500	377	677	7	5	9	237	404

1/Including Fixed Gear 2/includes impacts from proposed EFP south of 40.10 N latitude

Table 2-60. Chinook bycatch by listed ESU by sector, gear type assuming **Northern distribution, 100 percent whiting attainment**. The mean latitude from the haul level data was used in the coerced linear regression model to estimate stock composition. MDT = midwater trawl.

Counts where Non-whiting MWT takes reserve

Sector/Geartype	Chinook count	California Coast*	L Columbia R*	U Willamette R*	U Columbia R Sp*	Snake R Sp/Su*	Snake R Fa*	Puget Sound*
Bottom trawl1	2,046	117	0	0	0	0	10	0
Non-whiting MDT[2]	6,954	168	687	26	17	33	170	925
Total (non-whiting sector	9,000	284	687	26	18	33	180	925
Catcher/Processor (CP)	703	22	51	2	1	3	14	75
Mothership (MS)	1,293	38	99	4	3	5	27	142
Shoreside whiting (SS)	7,352	185	298	0	0	0	113	78
Total (whiting sector)	9,348	245	449	6	4	7	155	295

1/Including Fixed Gear   2/includes impacts from proposed EFP south of 40.10 N latitude

Counts where Bottom trawl takes reserve

Sector/Geartype	Chinook count	California Coast*	L Columbia R*	U Willamette R*	U Columbia R Sp*	Snake R Sp/Su*	Snake R Fa*	Puget Sound*
Bottom trawl1	6,062	346	0	0	1	0	29	0
Non-whiting MDT[2]	2,938	74	290	11	7	14	72	391
Total (non-whiting sector	9,000	421	290	11	8	14	101	391
Catcher/Processor (CP)	703	22	51	2	1	3	14	75
Mothership (MS)	1,293	38	99	4	3	5	27	142
Shoreside whiting (SS)	7,352	185	298	0	0	0	113	78
Total (whiting sector)	9,348	245	449	6	4	7	155	295

1/Including Fixed Gear   2/includes impacts from proposed EFP south of 40.10 N latitude

Counts where Whiting sector takes reserve

Sector/Geartype	Chinook count	California Coast*	L Columbia R*	U Willamette R*	U Columbia R Sp*	Snake R Sp/Su*	Snake R Fa*	Puget Sound*
Bottom trawl1	2,046	117	0	0	0	0	10	0
Non-whiting MDT[2]	2,938	74	290	11	7	14	72	391
Total (non-whiting sector	4,984	191	290	11	8	14	82	391
Catcher/Processor (CP)	824	25	60	2	2	3	17	88
Mothership (MS)	1,398	41	107	4	3	5	30	154
Shoreside whiting (SS)	12,278	309	498	0	0	0	189	130
Total (whiting sector)	14,500	376	666	6	5	8	236	371

1/Including Fixed Gear   2/includes impacts from proposed EFP south of 40.10 N latitude

Table 2-61. Chinook bycatch by listed ESU by sector, gear type assuming Southern distribution, average whiting attainment. The mean latitude from the haul level data was used in the coerced linear regression model to estimate stock composition. MDT = midwater trawl.

Counts where Non-whiting MWT takes reserve

Sector/Geartype	Chinook count	California Coast*	L Columbia R*	U Willamette R*	U Columbia R Sp*	Snake R Sp/Su*	Snake R Fa*	Puget Sound*
Bottom trawl[1]	2,046	117	0	0	0	0	10	0
Non-whiting MDT[2]	6,954	168	687	26	17	33	170	925
Total (non-whiting sector	9,000	284	687	26	18	33	180	925
Catcher/Processor (CP)	3,325	181	0	0	2	0	26	57
Mothership (MS)	3,119	162	0	0	2	2	29	90
Shoreside whiting (SS)	4,556	115	185	0	0	0	70	48
Total (whiting sector)	11,000	458	185	0	4	2	125	195

1/ Including Fixed Gear 2/ includes impacts from proposed EFP south of 40.10 N latitude

Counts where Bottom trawl takes reserve

Sector/Geartype	Chinook count	California Coast*	L Columbia R*	U Willamette R*	U Columbia R Sp*	Snake R Sp/Su*	Snake R Fa*	Puget Sound*
Bottom trawl[1]	6,062	346	0	0	1	0	29	0
Non-whiting MDT[2]	2,938	74	290	11	7	14	72	391
Total (non-whiting sector	9,000	421	290	11	8	14	101	391
Catcher/Processor (CP)	3,325	181	0	0	2	0	26	57
Mothership (MS)	3,119	162	0	0	2	2	29	90
Shoreside whiting (SS)	4,556	115	185	0	0	0	70	48
Total (whiting sector)	11,000	458	185	0	4	2	125	195

1/ Including Fixed Gear 2/ includes impacts from proposed EFP south of 40.10 N latitude

Counts where Whiting sector takes reserve

Sector/Geartype	Chinook count	California Coast*	L Columbia R*	U Willamette R*	U Columbia R Sp*	Snake R Sp/Su*	Snake R Fa*	Puget Sound*
Bottom trawl[1]	2,046	117	0	0	0	0	10	0
Non-whiting MDT[2]	2,938	74	290	11	7	14	72	391
Total (non-whiting sector	4,984	191	290	11	8	14	82	391
Catcher/Processor (CP)	4,571	249	0	0	2	0	35	78
Mothership (MS)	4,345	226	0	0	3	2	41	125
Shoreside whiting (SS)	5,585	141	227	0	0	0	86	59
Total (whiting sector)	14,500	616	227	0	6	3	162	262

1/ Including Fixed Gear 2/ includes impacts from proposed EFP south of 40.10 N latitude

Table 2-62. Chinook bycatch by listed ESU by sector, gear type assuming Southern distribution, 100 percent whiting attainment. The mean latitude from the haul level data was used in the coerced linear regression model to estimate stock composition. MDT = midwater trawl.

Counts where Non-whiting MWT takes reserve

Sector/Geartype	Chinook count	California Coast*	L Columbia R*	U Willamette R*	U Columbia R Sp*	Snake R Sp/Su*	Snake R Fa*	Puget Sound*
Bottom trawl[1]	2,046	117	0	0	0	0	10	0
Non-whiting MDT[2]	6,954	168	687	26	17	33	170	925
Total (non-whiting sector	9,000	284	687	26	18	33	180	925
Catcher/Processor (CP)	3,004	164	0	0	2	0	23	51
Mothership (MS)	3,070	160	0	0	2	2	29	88
Shoreside whiting (SS)	4,926	124	200	0	0	0	76	52
Total (whiting sector)	11,000	448	200	0	4	2	128	192

1/Including Fixed Gear 2/includes impacts from proposed EFP south of 40.10 N latitude

Counts where Bottom trawl takes reserve

Sector/Geartype	Chinook count	California Coast*	L Columbia R*	U Willamette R*	U Columbia R Sp*	Snake R Sp/Su*	Snake R Fa*	Puget Sound*
Bottom trawl[1]	6,062	346	0	0	1	0	29	0
Non-whiting MDT[2]	2,938	74	290	11	7	14	72	391
Total (non-whiting sector	9,000	421	290	11	8	14	101	391
Catcher/Processor (CP)	3,004	164	0	0	2	0	23	51
Mothership (MS)	3,070	160	0	0	2	2	29	88
Shoreside whiting (SS)	4,926	124	200	0	0	0	76	52
Total (whiting sector)	11,000	448	200	0	4	2	128	192

1/Including Fixed Gear 2/includes impacts from proposed EFP south of 40.10 N latitude

Counts where Whiting sector takes reserve

Sector/Geartype	Chinook count	California Coast*	L Columbia R*	U Willamette R*	U Columbia R Sp*	Snake R Sp/Su*	Snake R Fa*	Puget Sound*
Bottom trawl[1]	2,046	117	0	0	0	0	10	0
Non-whiting MDT[2]	2,938	74	290	11	7	14	72	391
Total (non-whiting sector	4,984	191	290	11	8	14	82	391
Catcher/Processor (CP)	4,098	224	0	0	2	0	32	70
Mothership (MS)	4,197	218	0	0	3	2	40	120
Shoreside whiting (SS)	6,206	156	252	0	0	0	96	66
Total (whiting sector)	14,500	598	252	0	5	3	167	256

1/Including Fixed Gear 2/includes impacts from proposed EFP south of 40.10 N latitude

ERs are less than one percent for all ESUs except CC Chinook across all scenarios, regardless of which sector has access to the Reserve (Table 2-63). ERs on CC Chinook range from 3 to 7 percent for the non-whiting sector, depending on whether either of the non-whiting sectors access the Reserve. Rates are highest when the bottom trawl fishery accesses the full Reserve. ERs in the whiting fleet range from 3 percent to 10 percent. Rates are highest when the whiting fleet fishes under a southern distribution and accesses the full Reserve.

Table 2-63. Estimated ERs by listed Chinook ESU for each sector and scenario of at-sea fleet distribution and attainment (based on bycatch estimates by listed Chinook ESU in Table 2-59, Table 2-60, Table 2-61, and Table 2-62).

Non-whiting midwater trawl takes reserve

Scenario	Sector	Puget Sound	L. Columbia River	U. Willamette	U. Columbia River sp	Snake River sp/su	Snake River fall	California Coastal
Northern at-sea scenario/	Non-whiting	<1%	<1%	<1%	<1%	<1%	<1%	<1%
100% attainment	Whiting	<1%	<1%	<1%	<1%	<1%	<1%	1%
Southern at-sea scenario/	Non-whiting	<1%	<1%	<1%	<1%	<1%	<1%	<1%
100% attainment	Whiting	<1%	<1%	<1%	<1%	<1%	<1%	1%
Northern at-sea scenario/	Non-whiting	<1%	<1%	<1%	<1%	<1%	<1%	<1%
average attainment	Whiting	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Southern at-sea scenario/	Non-whiting	<1%	<1%	<1%	<1%	<1%	<1%	<1%
average attainment	Whiting	<1%	<1%	<1%	<1%	<1%	<1%	1%

Bottom trawl takes reserve

Scenario	Sector	Puget Sound	L. Columbia River	U. Willamette	U. Columbia River sp	Snake River sp/su	Snake River fall	California Coastal
Northern at-sea scenario/	Non-whiting	<1%	<1%	<1%	<1%	<1%	<1%	1%
100% attainment	Whiting	<1%	<1%	<1%	<1%	<1%	<1%	1%
Southern at-sea scenario/	Non-whiting	<1%	<1%	<1%	<1%	<1%	<1%	1%
100% attainment	Whiting	<1%	<1%	<1%	<1%	<1%	<1%	1%
Northern at-sea scenario/	Non-whiting	<1%	<1%	<1%	<1%	<1%	<1%	1%
average attainment	Whiting	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Southern at-sea scenario/	Non-whiting	<1%	<1%	<1%	<1%	<1%	<1%	1%
average attainment	Whiting	<1%	<1%	<1%	<1%	<1%	<1%	1%

Whiting takes reserve

Scenario	Sector	Puget Sound	L. Columbia River	U. Willamette	U. Columbia River sp	Snake River sp/su	Snake River fall	California Coastal
Northern at-sea scenario/	Non-whiting	<1%	<1%	<1%	<1%	<1%	<1%	<1%
100% attainment	Whiting	<1%	<1%	<1%	<1%	<1%	<1%	1%
Southern at-sea scenario/	Non-whiting	<1%	<1%	<1%	<1%	<1%	<1%	<1%
100% attainment	Whiting	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Northern at-sea scenario/	Non-whiting	<1%	<1%	<1%	<1%	<1%	<1%	<1%
average attainment	Whiting	<1%	<1%	<1%	<1%	<1%	<1%	1%
Southern at-sea scenario/	Non-whiting	<1%	<1%	<1%	<1%	<1%	<1%	<1%
average attainment	Whiting	<1%	<1%	<1%	<1%	<1%	<1%	1%

Summary –

Chinook

The likelihood that a sector would exceed its guideline or access the Reserve depends primarily on the distribution of the whiting fleet and the uncertainty in the bycatch estimates for the non-whiting sector. Under the scenario that the at-sea whiting fleet fishes mostly in the northern areas, it is unlikely that either the whiting sector or the non-whiting sector would exceed its Chinook salmon guideline at the 80th percentile. In other words, for the northern distribution of the at-sea whiting fleet, if one sector had to use the Reserve, the other sector would most likely not be affected. However, if the at-sea whiting sector shifted its distribution to more southern areas, where Chinook salmon bycatch is highest, the analysis suggests the whiting sector could surpass both its guideline and the Reserve without active management actions to reduce Chinook bycatch. In the scenarios where the at-sea whiting fleet fished solely in the southern area, the whiting and non-whiting sectors combined could exceed the combined Chinook salmon guidelines for each sector plus the Reserve for the trawl fishery as a whole. This could occur even though the non-whiting trawl sector would likely remain within its 5,500 Chinook guideline. Although both whiting and non-whiting sectors show the potential for periodic high bycatch years, they have shown a pattern of doing so in either the whiting sector or the non-whiting sector, but not both sectors in the same year, over the relatively long period from 2002 to 2016. Continuation of this historical pattern would make management of Chinook salmon bycatch more likely to remain within the guidelines plus Reserve capacity.

Although the analysis suggests the non-whiting sector is likely to stay within its guideline, there is uncertainty because of the very limited data available to analyze the proposed action. The proposed action describes a fishery that has not occurred in at least 15 years. The historical information available at the time a fishery like that occurred indicates much higher bycatch rates and associated bycatch; particularly within the portions of the RCA that would be open under the proposed action, or during winter months. Fishery operation and fleet behavior have become more sophisticated at avoiding bycatch since then. The IFQ management framework itself incentivizes bycatch reduction as described previously. For these reasons, we concluded that the high bycatch suggested by the historical information is unlikely to occur. However, if bycatch rates were to substantially increase as reflected by the historical data or, more likely, ECEs were to happen, the non-whiting fishery could need access to the Reserve. The analysis suggests this is most likely to happen for the midwater trawl fishery gear type of the non-whiting sector.

Impacts on individual ESUs vary according to fishery sector and are primarily influenced by by the latitudinal distribution of the at-sea whiting fleet. The stock composition is heavily dependent on the assumed distribution of fleets within both the whiting and non-whiting sectors. The stock composition analysis indicates impacts to all listed Chinook ESUs are negligible to low and differ among sectors and gear types. ERs range from substantially less than one percent to less than two percent per ESU depending on the ESU and the scenario. Bycatch of ESUs with spring/summer life histories (UWR, UCR spring, SR spring/summer) is expected to be negligible although data used in the analysis were extremely limited for the winter time period in which these ESUs are most likely to be caught. Based on the available information, impacts are higher on the Puget Sound and Columbia River Chinook salmon ESUs when the whiting fleet has a northern distribution. Impacts are higher on the CC Chinook Salmon ESU when the whiting fleet has a southern distribution. For the whiting sector, the shoreside fleet accounts for the majority of impacts, followed by the mothership and then catcher/process fleets because of the higher associated bycatch for the shoreside fleet. Impacts are distributed across the four listed fall Chinook salmon ESUs. In the non-whiting sector, the bottom trawl bycatch is almost exclusively from the CC Chinook Salmon ESU and bycatch in the non-whiting midwater fishery includes contribution from all the listed ESUs detected in the Chinook bycatch.

As with the Chinook bycatch estimates, the amount of uncertainty in the stock composition of the non-whiting sector warrants cautious use of the data. Bycatch has been very low and the fishery has not occurred in many of the places and times where it could occur under the proposed action so direct estimates of stock composition for any component of the non-whiting sector are not available. Instead the analysis relied on extrapolation of data from the whiting sector and latitudinal modelling to assess stock composition of the Chinook bycatch in the non-whiting sector. Because of the strong demonstrated effect of location on stock composition (Appendix 2) reflective of salmon migration patterns, this approach is reasonable and should be generally representative of stock composition. However, distinctions in fishing patterns, gear and a variety of other factors between the whiting and non-whiting could result in important differences in stock composition, particularly where data are most lacking (i.e., areas south of 42°N latitude, the RCA and winter). The proposed action includes some measures like the EFPs that are designed to collect data to address these data limitations and inform management as the fisheries evolve.

Coho – whiting and non-whiting

Table 2-64 summarizes the estimated stock composition by sector for the individual listed coho ESUs affected by the proposed action and the estimated ER associated with those impacts. Bycatch in the non-whiting sector was available by general management area. Bycatch in the whiting fishery was not available by management area due to confidentiality; however, we can make some inferences about distribution. Bycatch in the tribal fisheries would only occur north of Cape Falcon, within the tribal U&As. For bycatch in the shoreside and non-tribal at-sea sectors, we used the coastwide latitude of the

Chinook bycatch to assign coho bycatch to the various management areas for the whiting sector. Estimated stock composition from the FRAM was then applied to the bycatch estimates for each management area. Because we are extrapolating the information, the magnitude of impacts is more relevant than the absolute numbers. Bycatch is low, ranging from a few tens to over 100 coho for the Oregon Coast Natural Coho Salmon ESU. To put this in the context of the abundance of the population, the impacts were calculated as a proportion of the estimated average ocean abundance of the ESU (2008 to 2016). Because of the significant uncertainty regarding escapement of the CCC Coho Salmon ESU, impacts from the SONC Coho Salmon ESU is used as a surrogate for the CCC Coho Salmon ESU (Spence et al. 2016). ERs are less than 1 percent for all the coho salmon ESUs.

Table 2-64. Estimated coho bycatch by listed coho salmon ESU and sector. The non-trawl sector includes bycatch in commercial fixed gear and recreational fisheries plus an additional mortality buffer.

Sector	Coho Salmon ESU	Estimated impacts	Estimated Exploitation Ratea/
Whiting	LCR	26	<1%
	Oregon Coast Natural	103	<1%
	Southern Oregon, Northern California	21	<1%
	Central California Coast	14	<1%
Non-whiting	LCR	22	<1%
	Oregon Coast Natural	146	<1%
	Southern Oregon, Northern California	27	<1%
	Central California Coast	34	<1%

[a/] Ocean abundance was provided from the following data sources: Spence 2016, PFMC 2017d, CTC unpubl., Puget Sound Abundance and Productivity tables (2017), Oregon Production Technical Team unpublished, TAC 2017.

2.6 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). Future Federal actions that are unrelated to the proposed actions are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline vs. cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 2.4).

Some types of human activities that contribute to cumulative effects are expected to have adverse impacts on listed populations many of which are activities that have occurred in the recent past and have had an effect on the environmental baseline (Section 2.4). These can be considered reasonably certain to occur in the future, because they occurred frequently in the recent past, especially if authorizations or permits have not yet expired. Activities in the action area are primarily those conducted under state, tribal, or Federal government management. Future tribal, state, and local government actions will likely be in the form of legislation, administrative rules, or ocean policy initiatives; shoreline growth management and development; designation of marine protected areas; and resource permitting, including fishing. Private activities include continued resource extraction, vessel traffic, development, and other activities that contribute to non-point source pollution. Any of these actions could impact listed species. Government actions are subject to political, legislative, legal and fiscal uncertainties. These realities, added to the geographic scope of the action area, which encompasses several government entities exercising various authorities, as well as changing economies of the region, make any analysis of cumulative effects difficult and speculative. Although state, tribal, and local governments have developed plans and initiatives to benefit listed fish, they must be applied and sustained in a comprehensive way before NMFS can consider them "reasonably foreseeable" in its analysis of cumulative effects.

2.7 Integration and Synthesis

The Integration and Synthesis Section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed actions. In this section, we add the effects of the action on species (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the rangewide status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed actions is likely to (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat for the conservation of the species.

As demonstrated in Section 2.5 (Effects of the Action on Species), in all but one case, mortality to listed Chinook and coho ESUs anticipated under the proposed action represents a small fraction of the various species' abundances. The actual mortalities could be much smaller than the estimates described for several reasons. First, the analysis was conducted on the upper limit of the range of bycatch reasonably expected to occur. Although higher bycatch than analyzed is possible due to ECEs, modelling indicates that bycatch would be lower than the level analyzed 79 percent of the time. Second, the scenarios for the non-whiting bottom trawl and midwater trawl fisheries were forced to take the full amount of the Reserve, even when the modeling indicated that bycatch was likely to be lower. A buffer was added to the non-trawl sector for both Chinook and coho to account for lower sampling rates for the fishery. Third, the calculation of ERs treated every mortality as if it were a potential spawner. ERs would be lower if data were available to adjust them to account for the higher natural mortality of younger age fish that make up the majority of bycatch in the groundfish fishery. Nonetheless, the significant limitations of the available data described previously for key components of the analysis, combined with the uncertainty in where and how the fleets will fish as the fisheries continue to evolve, support a conservative approach to the analysis.

2.7.1 Puget Sound Chinook

As described above in Section 2.2, Rangewide Status of the Species, all 22 populations in the Puget Sound Chinook salmon ESU are currently at high risk (NMFS 2006a). Three of the five regions (Strait of Juan de Fuca, Georgia Basin, and Hood Canal) contain only two populations, both of which must be recovered to viability to recover the ESU (NMFS 2006a). In general, the Strait of Juan de Fuca, Georgia Basin, and Hood Canal regions are at greater risk than the other regions. In addition spatial structure, or geographic distribution, of the White, Skagit, Elwha[31], and Skokomish populations has been substantially reduced or impeded by the loss of access to the upper portions of those tributary basins because of flood control activities and hydropower development. It is likely that genetic diversity has also been reduced by this habitat loss. Most Puget Sound Chinook populations are well below escapement levels identified as required for recovery to low extinction risk. All populations are consistently below productivity goals identified in the recovery plan. Although trends vary for individual populations across the ESU, most populations exhibit a stable or increasing trend in natural escapement. While the 2011 status review concluded there was no obvious trend for the total ESU, addition of the data to 2014 now does show

[31] Removal of both dams on the Elwha River was completed in 2015.

widespread negative trends in natural-origin Chinook salmon spawner population abundances (NWFSC 2015).

At this time, we do not have any data that indicates the proposed action is likely to differentially affect Chinook spawning populations within the listed ESU. The anticipated impact is very low and would be spread across the populations. Therefore, we do not expect it to have a measureable effect on the species' structure or diversity, and our analysis of effects focuses primarily on abundance. Productivity may also be affected by the proposed action, but those effects would be the result of effects on abundance. As the effects section describes, the level of impacts varies by sector/gear type and depends on the distribution of the at-sea whiting fleet. The midwater trawl gear in the non-whiting fishery and all gear types within the whiting sector affect this ESU. The bottom trawl gear type has negligible impact on this ESU based on the available information. The ER is anticipated to be much less than one percent for each of the whiting and non-whiting sectors, and less than one percent overall. Therefore, the effects of the proposed action would result in a small increase in the mortality imposed on the ESU. The mortality of listed Puget Sound Chinook as a result of the proposed action is even lower than estimated here because the estimates of impacts include hatchery fish with clipped adipose fins for which take is not prohibited. The level of take expected for the proposed action is therefore so small that we do not anticipate it would have any notably deleterious effect on any of the 22 Puget Sound Chinook populations, nor would it add materially to the ongoing effects already occurring in the action area as described in the Environmental Baseline section. Therefore, the lack of substantial impacts on the Puget Sound Chinook ESU, based on the low expected impacts of the fishery, supports the conclusion that the proposed fishing will not appreciably reduce the likelihood of survival and recovery of the species.

2.7.2 Lower Columbia River Chinook

As described above in Section 2.2, Rangewide Status of the Species and Critical Habitat, the LCR Chinook ESU is composed of 32 historical populations: 9 spring-run, 21 fall-run, and 2 late-fall run, organized in 6 MPGs. The populations are distributed through three Major Population Groups. Relative to baseline viability levels there has been an overall improvement in the status of a number of fall-run populations, although most are still far from the recovery plan goals. However, the majority of the populations in this ESU remain at high risk, with low natural-origin abundance levels, especially the spring-run Chinook population in this ESU (NWFSC 2015). Spatial structure has been substantially reduced in several populations. Low abundance, legacy hatchery effects, and ongoing hatchery straying may have reduced genetic diversity within and among LCR Chinook salmon populations. Hatchery-origin fish spawning naturally may also have reduced population productivity (NMFS 2016c). Abundance and productivity are currently low to very low for most populations, except for spring Chinook salmon in the Sandy River (moderate) and late-fall Chinook salmon in North Fork Lewis River and Sandy Rivers (very high for both). Because spring-run Chinook salmon populations have generally low abundance levels from hydroelectric dams cutting off access to essential spawning habitat, it is unlikely that there will be significant improvements in the status of the ESU until efforts to improve juvenile passage systems are in place and proven successful (NWFSC 2015).

At this time, we do not have any data that indicates the proposed action is likely to differentially affect Chinook spawning populations within the listed ESU. The anticipated impact is very low and would be spread across the populations. Therefore, we do not expect it to have a measureable effect on the species' structure or diversity, and our analysis of effects focuses primarily on abundance. Productivity may also be affected by the proposed action, but those effects would be the result of effects on abundance. As the effects section describes, the level of impacts depends on the sector/gear type and distribution of the at-sea whiting fleet. The midwater gear in the non-whiting fishery and shoreside gear type within the whiting sector impact this ESU, particularly when the at-sea fleet fishes with a northern distribution. The bottom trawl gear type has negligible impact on this ESU based on the available information. The ER is anticipated to be much less than one percent for each of the whiting and non-whiting sectors, and less than one percent overall. The mortality of listed LCR Chinook as a result of the proposed action for which take has been prohibited is even lower because the estimates of impacts include hatchery fish with clipped adipose fins for which take is not prohibited. The level of take expected for the proposed action is therefore so small that we do not anticipate it would have any notably deleterious effect on any of the 32 LCR Chinook populations, nor would it add materially to the ongoing effects already occurring in the action area as described in the Environmental Baseline section. Therefore, the lack of substantial impacts on the LCR Chinook ESU, based on the low expected impacts of the fishery, supports the conclusion that the proposed fishing will not appreciably reduce the likelihood of survival and recovery of the species.

2.7.3 Upper Willamette Spring Chinook

As described above in Section 2.2, Rangewide Status of the Species and Critical Habitat, the seven populations in the Upper Willamette spring Chinook salmon ESU are at moderate to high risk. Abundance levels for five of the seven natural populations in this ESU remain well below their recovery goals and trends are mixed. Two of the populations are either functionally extinct or critically low. Abundance for three other populations have improved but remain in the high hundreds and abundance has declined for the remaining two stronghold populations. The primary limiting factor for Upper Willamette River Chinook continues to be their restricted access to historical spawning and rearing areas due to large dams in the four historically most productive tributaries for UWR spring-run Chinook salmon (North Santiam, South Santiam, Middle Fork Willamette, and McKenzie rivers. In the absence of effective passage programs, access will continue to be confined to more lowland reaches where land development, water temperatures, and water quality may be limiting. Given current climatic conditions and the prospect of long-term climatic change, the inability of many populations to access historical headwater spawning and rearing areas may put this ESU at greater risk in the near future.

At this time, we do not have any data that indicates the proposed action is likely to differentially affect Chinook spawning populations within the listed Upper Willamette spring Chinook salmon ESU. The anticipated impact is extremely low and would be spread across the populations. Therefore, we do not expect it to have a measureable effect on the species' structure or diversity, and our analysis of effects focuses primarily on abundance. Productivity may also be affected by the proposed action, but those effects would be the result of effects on abundance. As the effects section describes, the ER is anticipated as a fraction of one percent for each of the non-whiting and whiting sectors. Therefore, the effects of the proposed action would result in an extremely small increase in the mortality imposed on the ESU. The mortality of listed Upper Willamette River spring Chinook as a result of the proposed action for which take has been prohibited is even lower because the estimates of impacts include hatchery fish with clipped adipose fins for which take is not prohibited. The level of take expected for the proposed action is therefore so small that we do not anticipate it would have any notably deleterious effect on any of the seven Upper Willamette River spring Chinook populations, nor would it add materially to the ongoing effects already occurring in the action area as described in the Environmental Baseline section. Therefore, the lack of substantial impacts on the Upper Willamette River spring Chinook ESU, based on the low expected impacts of the proposed action, supports the conclusion that the proposed fishing will not appreciably reduce the likelihood of survival and recovery of the species.

As mentioned in the effects analysis, the proposed action is expected to expand into times and areas (e.g., January through May) for which current data are unavailable. In particular, expanding fishing earlier in the calendar year could result in higher impacts on spring run fish, which are more likely to be present in the action area at that time. Historical data collected under a very different management framework and for different purposes indicates that if this were to occur, impacts could be higher than the bycatch estimated for this ESU in this opinion. The proposed action includes monitoring and data collection that will allow managers to update the stock composition information and track impacts to this ESU as the fishery evolves.

2.7.4 Upper Columbia River Spring Chinook

As described above in Section 2.2, Rangewide Status of the Species and Critical Habitat, the UCR spring-run Chinook Salmon ESU is at high risk. Spatial structure and diversity have been severely constricted in the ESU. Eight natural populations within three Major Population Groups historically comprised the Upper Columbia spring-run Chinook Salmon ESU, but the ESU is currently limited to one Major Population Group and three extant populations. Approximately half of the area that originally produced spring Chinook salmon in this ESU is now blocked by dams. Chronically high proportions of hatchery-origin spawners in natural spawning areas and a lack of genetic diversity among the natural-origin spawners has adversely affected diversity. Over the last 10 years, abundance of adult natural-origin spawners has increased for each population relative to the levels reported in the 2011 status review, but natural origin escapements remain below the viability goals.

At this time, we do not have any data that indicates the proposed action is likely to differentially affect Chinook spawning populations within the listed ESU. The anticipated impact is extremely low and would be spread across the populations. Therefore, we do not expect it to have a measureable effect on the species' structure or diversity, and our analysis of effects focuses primarily on abundance. Productivity may also be affected by the proposed action, but those effects would be the result of effects on abundance. As the effects section describes, the ER is anticipated as a fraction of one percent for each of the non-whiting and whiting sectors. Therefore, the effects of the proposed action would result in an extremely small increase in the mortality imposed on the ESU. The mortality of listed UCR spring Chinook as a result of the proposed action for which take has been prohibited is even lower because the estimates of impacts include hatchery fish with clipped adipose fins for which take is not prohibited. The level of take expected for the proposed action is therefore so small that we do not anticipate it would have any notably deleterious effect on any of the three Upper Columbia spring Chinook populations, nor would it add materially to the ongoing effects already occurring in the action area as described in the Environmental Baseline section. Therefore, the lack of substantial impacts on the Upper Columbia spring Chinook ESU, based on the low expected impacts of the proposed action, supports the conclusion that the proposed fishing will not appreciably reduce the likelihood of survival and recovery of the species.

As mentioned in the effects analysis, the proposed action is expected to expand into times and areas (e.g., January through May) for which current data are unavailable. In particular, expanding fishing earlier in the calendar year could result in higher impacts on spring run fish, which are more likely to be present in the action area at that time. Historical data collected under a very different management framework and for different purposes indicates that if this were to occur, impacts could be higher than the bycatch estimated for this ESU in this opinion. The proposed action includes monitoring and data collection that will allow managers to update the stock composition information and track impacts to this ESU as the fishery evolves.

2.7.5 Snake River Spring/summer Chinook

As described above in Section 2.2, Rangewide Status of the Species and Critical Habitat, the 28 populations in the Snake River spring/summer Chinook salmon ESU are at high risk, with the exception of the Chamberlain Creek population, which has improved. Abundance has increased for most populations since the 2011 status review, likely due to relatively high ocean survivals in recent years. Trends in productivity among the populations are mixed. Spatial structure and diversity for the populations is at low or moderate risk due to loss of spawning and rearing habitat and adverse effects of hatchery fish spawning naturally with natural-origin fish.

At this time, we do not have any data that indicates the proposed action is likely to differentially affect Chinook spawning populations within the listed ESU. The anticipated impact is extremely low and would be spread across the populations. Therefore, we do not expect it to have a measureable effect on the species' structure or diversity, and our analysis of effects focuses primarily on abundance. Productivity may also be affected by the proposed action, but those effects would be the result of effects on abundance. As the effects section describes, the ER is anticipated as a fraction of one percent for each of the non-whiting and whiting sectors. Therefore, the effects of the proposed action would result in an extremely small increase in the mortality imposed on the ESU. The mortality of listed Snake River spring/summer Chinook as a result of the proposed action for which take has been prohibited is even lower because the estimates of impacts include hatchery fish with clipped adipose fins for which take is not prohibited. The level of take expected for the proposed action is therefore so small that we do not anticipate it would have any notably deleterious effect on any of the three Snake River spring/summer Chinook populations, nor would it add materially to the ongoing effects already occurring in the action area as described in the Environmental Baseline section. Therefore, the lack of substantial impacts on the Snake River spring/summer Chinook ESU, based on the low expected impacts of the proposed action, supports the conclusion that the proposed fishing will not appreciably reduce the likelihood of survival and recovery of the species.

As mentioned in the effects analysis, the proposed action is expected to expand into times and areas (e.g., January through May) for which current data are unavailable. In particular, expanding fishing earlier in the calendar year could result in higher impacts on spring run fish, which are more likely to be present in the action area at that time. Historical data collected under a very different management framework and for different purposes indicates that if this were to occur, impacts could be higher than the bycatch estimated for this ESU in this opinion. The proposed action includes monitoring and data collection that will allow managers to update the stock composition information and track impacts to this ESU as the fishery evolves.

2.7.6 Snake River Fall Chinook

As described above in Section 2.2, Rangewide Status of the Species and Critical Habitat, the Snake River fall Chinook ESU has one population that included five major spawning aggregates. Historically, natural production from this ESU was mainly from spawning in the mainstem of the Snake River upstream of the Hells Canyon Dam complex. The decline of this ESU was due to heavy fishing pressure beginning in the 1890s and loss of habitat with the construction of Swan Falls Dam in 1901 and the Hells Canyon Complex from 1958 to 1967, which extirpated one of the historical populations. Hatcheries mitigating for losses caused by the dams have played a major role in the production of Snake River fall-run Chinook salmon since the 1980s. The accessible spawning and rearing habitat represents approximately 20 percent of the total historical habitat available to the ESU. Overall, the status of Snake River fall Chinook salmon has clearly improved compared to the time of listing and compared to prior status reviews. The overall abundance of Snake River Fall Chinook has increased substantially in recent years, but the proportion of natural-origin fish in the escapement has also decreased steadily overtime. The hatchery supplementation program has clearly contributed to the increase in abundance and the decrease in the relative abundance of natural-origin fish. The single extant population in the ESU is currently meeting the criteria for a rating of “viable” developed by the Interior Columbia Technical Review Team, but the ESU as a whole is not meeting the recovery goals described in the recovery plan for the species, which require the single population to be “highly viable with high certainty” and/or will require reintroduction of a viable population above the Hells Canyon Dam complex.

At this time, we do not have any data that indicates the proposed action is likely to differentially affect Chinook spawning populations within the listed ESU. The anticipated impact is very low and would be spread across the populations. Therefore, we do not expect it to have a measureable effect on the species’ structure or diversity, and our analysis of effects focuses primarily on abundance. Productivity may also be affected by the proposed action, but those effects would be the result of effects on abundance. As the effects section describes, the level of impacts depends on the sector/gear type and distribution of the at-sea whiting fleet. The midwater gear in the non-whiting fishery and shoreside gear type within the whiting sector impact this ESU, particularly when the at-sea fleet fishes with a northern distribution. The ER is anticipated to be less than one percent for each of the non-whiting and whiting sectors; overall less than one percent. Therefore, the effects of the proposed action would result in an extremely small increase in the mortality imposed on the ESU. The mortality of listed Snake River fall Chinook as a result of the proposed action for which take has been prohibited is even lower because the estimates of impacts include hatchery fish with clipped adipose fins for which take is not prohibited. The level of take expected for the proposed action is therefore so small that we do not anticipate it would have any notably deleterious effect on the extant Snake River fall Chinook population, nor would it add materially to the ongoing effects already occurring in the action area as described in the Environmental Baseline section. Therefore, the lack of substantial impacts on the Snake River fall Chinook ESU, based on the low expected impacts of the fishery, supports the conclusion that the proposed fishing will not appreciably reduce the likelihood of survival and recovery of the species.

2.7.7 California Coastal Chinook

As described above in Section 2.2, Rangewide Status of the Species, all populations in the California Coastal Chinook salmon ESU are currently at high risk. The spatial structure and diversity of the ESU has been severely compromised with the loss of the spring life history and extirpation of populations in significant portions of some regional strata. The significant gap in distribution diminishes connectivity among strata across the ESU. Coastal California streams support small, sporadically monitored populations of Chinook salmon; no estimates of absolute population abundance are available for most populations which makes it difficult to assess trends. Of the information available, most populations had stable or declining trends. Artificial production efforts in combination with the fragmentation of populations have likely adversely affected genetic diversity despite the relatively wide distribution of populations within the ESU. Actions affecting water quantity and quality, instream flows, and fish passage, such as agriculture, continue to impede California Coastal Chinook salmon recovery. It is important to note that information to assess status and trends of the ESU is extremely limited. Since the 2011 status review, new information has become available as a result of implementation of the Coastal Monitoring Program in some portions of the ESU. Because some of these survey efforts have targeted coho salmon, they have not necessarily covered the full spatial and temporal extent of Chinook salmon spawning. Nevertheless, these efforts have significantly improved our understanding of the viability of Chinook salmon in this ESU.

At this time, we do not have any data that indicates the proposed action is likely to differentially affect Chinook spawning populations within the listed ESU. The anticipated impact is low and would be spread across the populations. Therefore, we do not expect it to have a measureable effect on the species' structure or diversity, and our analysis of effects focuses primarily on abundance. Productivity may also be affected by the proposed action, but those effects would be the result of effects on abundance. As the effects section describes, the ER is anticipated to be less than one percent for the non-whiting sector and less than two percent for the whiting sector; overall two percent or less. Estimated ERs from other fishery activities in the action area is 11 percent. Since California Coastal Chinook are not coded-wire tagged, the nearby Klamath Chinook is used as a surrogate ESA consultation standard for the ocean salmon fishery, i.e., an ocean ER no greater than 16 percent on age-4 Klamath fall Chinook. The estimated impacts from the proposed action represent a small increase in the estimated ER in the action area from what would occur without the proposed action.

The relatively low ER and the likelihood that impacts will be much lower in most years, support the conclusion that the proposed fishing will not appreciably reduce the likelihood of survival and recovery of the species. However, as discussed in the effects analysis, there is significant uncertainty in abundance estimates for this ESU, its status is critical status and populations within the ESU are continuing to decline. Monitoring of the bycatch in the fishery that is included in the proposed action and expected improvements in assessing abundance of the ESU described in the Status of the Species should reduce this uncertainty going forward. NMFS will continue to work with the Council in using this improved information to adaptively manage the salmon bycatch in the groundfish fishery.

2.7.8 Lower Columbia River Coho

As described above in Section 2.2, Rangewide Status of the Species, twenty-one of the 24 populations in the ESU are at a very high risk of extinction. The strongest remaining populations occur in Oregon and include the Clackamas River and Scappoose Creek (both at moderate risk of extinction). Recovery plans rate spatial structure as moderate to very high viability in nearly all populations of LCR coho. The populations that rate lowest have fish passage barriers, but management actions are underway to improve the situation. Diversity is considered to be low to very low in most of the coho populations. Pervasive hatchery effects and small population bottlenecks have greatly reduced the diversity of coho salmon populations. Wild coho in the Columbia basin have been in decline for the last 50 years. Of the 24 historical populations that comprised the LCR coho ESU, only in the case of the Clackamas and Sandy is there direct evidence of persistence during the adverse conditions of the 1990s. Since 2000, the numbers of wild coho have increased in both the Clackamas and Sandy basins. During this same period, naturally reproducing coho populations have become re-established in the Scappoose and Clatskanie basins. Habitat for LCR coho has been adversely affected by changes in access, stream flow, water quality, sedimentation, habitat diversity, channel stability, riparian conditions, channel alternations, and floodplain interactions and blocked passage to migration.

At this time, we do not have any data that indicates the proposed action is likely to differentially affect coho spawning populations within the listed ESU. The anticipated impact is very low and would be spread across the populations. Therefore, we do not expect it to have a measureable effect on the species' structure or diversity, and our analysis of effects focuses primarily on abundance. Productivity may also be affected by the proposed action, but those effects would be the result of effects on abundance. As the effects section describes, the ER is anticipated to be less than one percent for each of the non-whiting and whiting sectors; less than one percent overall. Therefore, the effects of the proposed action would result in a small increase in the mortality imposed on the ESU. The mortality of listed LCR coho as a result of the proposed action for which take has been prohibited is even lower because the estimates of impacts include hatchery fish with clipped adipose fins for which take is not prohibited. The ESA consultation standard for LCR coho in ocean salmon fisheries ranges from 10 to 30 percent depending on survival and abundance of the parent brood. Recent total ERs have averaged 15 percent consistent with higher abundance. The level of take expected for the proposed action is so small that we do not anticipate it would have any notably deleterious effect on any of the 24 LCR coho populations, nor would it add materially to the ongoing effects already occurring in the action area as described in the Environmental Baseline section. Therefore, the lack of substantial impacts on the LCR coho ESU, based on the low expected impacts of the fishery, supports the conclusion that the proposed fishing will not appreciably reduce the likelihood of survival and recovery of the species.

2.7.9 Oregon Coast Coho

As described above in Section 2.2, Rangewide Status of the Species, all 56 populations in the Oregon Coast coho salmon ESU are currently at risk. Low escapement for populations in some regions of the ESU and high contributions of naturally spawning hatchery fish have raised concerns about loss of spatial structure and diversity. Oregon Coast coho salmon populations are highly variable from year to year. For the ESU as a whole, spawners and recruits have declined at a 5 percent rate over the past 33 years. Over the past ten years abundance has been cyclical and the trend nearly flat. Some threats, in particular hatchery production and harvest, have been greatly reduced over the last decade and appear to have been largely eliminated as significant sources of risk. Other factors, such as habitat degradation and water quality, are considered to be ongoing threats that appear to have changed little over the last decade (NMFS 2011a). Changes to freshwater and marine habitat due to global climate change are also considered to be threats likely to become manifest in the future.

At this time, we do not have any data that indicates the proposed action is likely to differentially affect coho spawning populations within the listed ESU. The anticipated impact is very low and would be spread across the populations. Therefore, we do not expect it to have a measureable effect on the species' structure or diversity, and our analysis of effects focuses primarily on abundance. Productivity may also be affected by the proposed action, but those effects would be the result of effects on abundance. As the effects section describes, the ER is anticipated to be less than one percent in each of the whiting and non-whiting sectors. Ocean impacts from other fishing activities described in the action area average just over 11 percent. Therefore, the effects of the proposed action would result in a small increase in the mortality imposed on the ESU. The mortality of listed Oregon Coast coho as a result of the proposed action for which take has been prohibited is even lower because the estimates of impacts include hatchery fish with clipped adipose fins for which take is not prohibited. The level of take expected for the proposed action is therefore so small that we do not anticipate it would have any notably deleterious effect on any of the 56 Oregon Coast coho populations, nor would it add materially to the ongoing effects already occurring in the action area as described in the Environmental Baseline section. Therefore, the lack of substantial impacts on the Oregon Coast coho ESU, based on the low expected impacts of the fishery, supports the conclusion that the proposed fishing will not appreciably reduce the likelihood of survival and recovery of the species.

2.7.10 Southern Oregon/Northern California Coho

The Southern Oregon/Northern California coho salmon ESU is divided into Coastal and Inland strata with 20 populations; six are identified as functionally independent and another four as potentially independent from one another. The remaining populations are considered dependent or ephemeral. Although long-term data on coho abundance in the SONCC Coho Salmon ESU are scarce, available data indicate that the abundance and productivity of the ESU has declined substantially since the early 2000's. Recent returns to several major populations in the ESU have been highly variable, although data are lacking for abundance and productivity for many of the other populations in the ESU. The spatial structure of the ESU has become constricted as populations are extirpated or at risk of becoming extirpated. Pervasive hatchery effects and small population bottlenecks have greatly reduced the diversity of coho salmon populations. Given the recent trends in abundance across the ESU, the genetic and life history diversity of populations is likely very low.

At this time, we do not have any data that indicates the proposed action is likely to differentially affect coho spawning populations within the listed ESU. The anticipated impact is very low and would be spread across the populations. Therefore, we do not expect it to have a measureable effect on the species' structure or diversity, and our analysis of effects focuses primarily on abundance. Productivity may also be affected by the proposed action, but those effects would be the result of effects on abundance. As the effects section describes, the ER is anticipated to be a fraction of one percent in each of the whiting and non-whiting sectors, and less than one percent overall. Therefore, the effects of the proposed action would result in a small increase in the mortality imposed on the ESU. The mortality of listed Southern Oregon/Northern California coho as a result of the proposed action for which take has been prohibited is even lower because the estimates of impacts include hatchery fish with clipped adipose fins for which take is not prohibited. The level of take expected for the proposed action is therefore so small that we do not anticipate it would have any notably deleterious effect on any of the populations, nor would it add materially to the ongoing effects already occurring in the action area as described in the Environmental Baseline section. The ESA consultation standard for the ocean salmon fisheries is no more than a 13 percent ocean ER, and the impacts of the proposed action are magnitudes smaller. Therefore, the lack of substantial impacts on the Southern Oregon/Northern California ESU, based on the low expected impacts of the fishery, supports the conclusion that the proposed fishing will not appreciably reduce the likelihood of survival and recovery of the species.

2.7.11 Central California Coast Coho

The CCC coho salmon ESU is listed as endangered. CCC coho salmon abundance is approximately one percent of its historic abundance and the population is likely continuing to decline in number. Many independent populations that supported the species overall numbers and geographic distributions have been extirpated. The spatial structure and diversity of the population has been significantly constricted and fragmented compared with historic patterns of distribution and life history. The near-term (10 - 20 years) viability of many of the extant independent CCC coho salmon populations is of serious concern. Long term data series to assess status and trends is extremely limited for this ESU. Implementation of the Coastal Monitoring Program has improved data collection and assessment of viability compared with previous reviews. We expect the information collected through the program will increase greatly in value as these time series become longer

At this time, we do not have any data that indicates the proposed action is likely to differentially affect coho spawning populations within the listed ESU. The anticipated impact would be spread across the remaining populations. Therefore, we do not expect it to have a measureable effect on the species' structure or diversity, and our analysis of effects focuses primarily on abundance. Productivity may also be affected by the proposed action, but those effects would be the result of effects on abundance. As the effects section describes, the ER is anticipated to be less than one percent for each of the whiting and the non-whiting fishery. Estimated ERs from other fishery activities in the action area is less than six percent, primarily resulting from non-retention mortality in salmon fisheries. Therefore, the effects of the proposed action based on the best available information would result in a small increase in the level of mortality imposed on the ESU from what would occur without the action.

The relatively low ER in combination with measures the PFMC will develop to reduce bycatch, and the likelihood that impacts will be much lower in most years, supports the conclusion that the proposed fishing will not appreciably reduce the likelihood of survival and recovery of the species. However, given the significant uncertainty in abundance, the endangered status of the ESU, and continuing decline of the populations in the ESU, all mortality is a concern. Monitoring of the bycatch in the fishery that is included in the proposed action and expected improvements in assessing abundance of the ESU described in the Status of the Species should reduce the uncertainty regarding the status of this species and the effects of this action going forward. NMFS will continue to work with the Council in using this improved information to adaptively manage the salmon bycatch in the groundfish fishery.

2.8 Conclusion

2.8.1 Puget Sound Chinook

After reviewing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed actions, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed actions are not likely to jeopardize the continued existence of listed Puget Sound Chinook salmon.

2.8.2 Lower Columbia River Chinook

After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed actions, any effects of interrelated and interdependent actions, and cumulative effects, it is NMFS' biological opinion that the proposed actions are not likely to jeopardize the continued existence of listed LCR Chinook salmon.

2.8.3 Upper Willamette River Chinook

After reviewing the current status of the listed species, the environmental baseline for the action area, the effects of the proposed actions, and the cumulative effects, NMFS concludes that the proposed actions not likely to jeopardize the continued existence of listed UWR Chinook salmon.

2.8.4 Upper Columbia River Spring Chinook

After reviewing the current status of the listed species the environmental baseline for the action area, the effects of the proposed actions, and the cumulative effects, NMFS concludes that the proposed actions not likely to jeopardize the continued existence of UCR Spring salmon.

2.8.5 Snake River Spring/summer Chinook

After reviewing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed actions, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed actions are not likely to jeopardize the continued existence of listed Snake River spring/summer Chinook salmon.

2.8.6 Snake River Fall Chinook

After reviewing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed actions, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed actions are not likely to jeopardize the continued existence of listed Snake River fall Chinook salmon.

2.8.7 California Coastal Chinook

After reviewing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed actions, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed actions are not likely to jeopardize the continued existence of listed CC Chinook salmon.

2.8.8 Lower Columbia River Coho

After reviewing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed actions, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed actions are not likely to jeopardize the continued existence of listed LCR coho salmon.

2.8.9 Oregon Coast Coho

After reviewing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed actions, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed actions are not likely to jeopardize the continued existence of listed Oregon Coast coho salmon.

2.8.10 Southern Oregon/Northern California Coho

After reviewing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed actions, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed actions are not likely to jeopardize the continued existence of listed Southern Oregon/Northern California salmon.

2.8.11 Central California Coast Coho

After reviewing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed actions are not likely to jeopardize the continued existence of listed CCC coho salmon.

2.9 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

This incidental take statement specifies the impact of any incidental taking of endangered or threatened species. It also provides reasonable and prudent measures that are necessary or appropriate to minimize impacts and sets forth terms and conditions in order to implement the reasonable and prudent measures.

2.9.1 Amount or Extent of Take

In the biological opinion, NMFS determined that incidental take is reasonably certain to occur for the reasons outlined in the sections below. The number of estimated salmon taken as bycatch through the proposed action, both listed and non-listed, is used to define the extent of take rather than the number of listed fish from individual ESUs for several reasons: (1) it is a key parameter used to analyze the effects of the proposed action; (2) while information is available inseason to assess the overall take of salmon by species and inform management actions; information is not available inseason to assess impacts on specific salmon ESUs; (3) salmon bycatch can be monitored and assessed; (4) it is directly related to the take of listed species and, (5) the associated take of listed species associated with the bycatch is low. The stock composition of Chinook bycatch and the magnitude of impacts on individual ESUs are influenced primarily by location (latitude and depth), distribution of groundfish catch and the bycatch rate between the different sectors. Therefore, bycatch is defined by sector because of the substantial differences in the timing, location, and capacity of the fleets.

Whiting Fishery

Estimates of the bycatch of listed coho and Chinook salmon in the whiting sector are based on the distribution of the fishery, recent bycatch patterns in the case of coho, and the guidelines provided in the proposed action. The estimated bycatch of listed salmon in the whiting sector in the future assumes the following

- That the distribution of bycatch will not change substantially from that described in Section 2.5.2,
- That the sector will take actions to reduce bycatch to remain within the guideline of 11,000 Chinook per year,
- That bycatch will not exceed 14,500 Chinook per year including a Reserve of 3,500 Chinook per year in the event that bycatch increases unexpectedly,
- That coho bycatch will not exceed 474 coho salmon per year.

Bycatch resulting from EFPs in 2018 and beyond will be included within these bycatch limits. Consultation shall be reinitiated if any of the following events occur: (1) the total bycatch in the sector exceeds 14,500 Chinook salmon or 474 coho in a calendar year, (2) any of the Reserve is used in three out of any consecutive five years, (3) the distribution of the whiting fleet changes substantially from that described in Figures 24 and 26 under the Northern distribution or Figures 25 and 27 under the Southern distribution. In particular, bycatch and bycatch rates are anticipated to be higher and more variable when the whiting fleet fishes under a Southern distribution; the fleet therefore has a substantial risk of exceeding the allowable take limits without effective management measures. The limit of 474 coho salmon is the highest annual bycatch of coho salmon observed since 2002.

Non-whiting Fishery (Bottom trawl, midwater non-whiting trawl, LE and OA fixed gear, and recreational fisheries combined)

Estimates of the bycatch of listed salmon in the non-whiting sector are based on the distribution of the fishery and the guidelines provided in the proposed action. The estimated bycatch of listed salmon in the non-whiting sector in the future assumes the following:

- That the distribution of bycatch will not change substantially from that described in Section 2.5.2,

- That the sector will take actions to reduce bycatch to remain within the guideline of 5,500 Chinook salmon per year,
- That the sector will not exceed 9,000 Chinook salmon per year, including a Reserve of 3,500 Chinook salmon per year in the event that bycatch increases unexpectedly,
- That coho bycatch will not exceed 560 coho per year.

Bycatch resulting from EFPs in 2018 and beyond will be included within these bycatch limits. Consultation shall be reinitiated if any of the following occurs: (1) the total bycatch of Chinook in the sector exceeds 9,000 Chinook salmon per year, (2) any of the Reserve is used in three out of any consecutive five years, (3) the distribution of the fleets changes substantially from that described in Figure 28. In particular, the RPMs include a precautionary measure to ensure that management proceeds cautiously if fishing effort increases in nearshore areas, during the winter months, or in the Eureka or Monterey areas where current information on bycatch, bycatch rates, and associated stock composition is extremely limited, to ensure that impacts do not exceed those analyzed in the opinion. Reinitiation will be triggered if more than 560 coho salmon are taken as bycatch in any year. This is the highest annual bycatch of coho salmon observed in the non-whiting commercial trawl and non-trawl fisheries since 2002 combined with a buffer for uncertainty in the commercial non-trawl and recreational sectors.

Reserve

Consistent with the take amounts described above, one or both of the whiting or non-whiting sectors may access some or all of the Reserve in any year. Access of the whiting and non-whiting sectors to the Reserve in any year shall not exceed 3,500 Chinook salmon.

2.9.2 Effect of the Take

In the biological opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed actions, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.9.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02). Measures for this action are listed below.

1. NMFS, in consultation with the Council, will review existing mechanisms for monitoring salmon

bycatch in the groundfish fishery, and will develop mechanisms (if they do not already exist) that a) provide timely inseason data regarding the amount and location of salmon bycatch by sector, and; b) provide timely inseason data regarding the geographic distribution of the at-sea whiting fleet.

2. The Council and NMFS will review existing regulatory mechanisms for reducing salmon bycatch, and will revise these mechanisms or develop and implement new mechanisms to ensure that, should inseason data show the annual coastwide bycatch will exceed 11,000 Chinook or 474 coho for the whiting sector or 5,500 Chinook or 560 coho for the non-whiting sector, NMFS and the PFMC will take timely and effective inseason action to avoid an exceedance of these bycatch thresholds.
3. The Council and NMFS will develop and implement regulations regarding the Reserve and its use, ensuring that the Reserve will be available only to address unexpected high bycatch levels, and it will not be available as a matter of course to allow the sectors to exceed their bycatch guidelines.
4. NMFS and the Council shall take steps to eliminate data gaps and implement adaptive management to minimize and avoid take of coho and Chinook salmon prior to allowing fishing at times and in areas where it has not been allowed since the year 2001. The analysis indicates a potential for continued high variability in salmon bycatch and uncertainty surrounding distributional bycatch effects with changing ocean conditions and increased access to rebuilt rockfish species.
5. Given the uncertainties in the analysis, NMFS and the Council shall identify factors that contribute to greater bycatch of Chinook and coho salmon in order to improve our ability to predict when greater levels of bycatch may occur, and to address these factors in the future. The Council shall consider this information when developing bycatch reduction management measures.
6. NMFS, working with the Council, shall compile and provide a report on an annual basis summarizing the following: a) all observed, reported, and estimated take of salmon by fishery sector, species, gear type, and location of bycatch in the groundfish fishery; b) stock composition of the Chinook bycatch by fishery sector and gear type including analysis of genetic data and expanded CWTs recovered by fishery sector, species and gear type, and c) the use of bycatch reduction measures in that year and evaluation of their effectiveness.

2.9.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and NMFS or any applicant must comply with them in order to implement the RPMs (50 CFR 402.14) described above. NMFS or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, the protective coverage for the proposed actions would likely lapse.

MONITORING

1a. NMFS, in cooperation with the Council, shall monitor salmon bycatch and implementation of other management measures to address salmon bycatch at levels that are sufficient to ensure compliance with specified management limitations.

i. NMFS shall monitor inseason salmon bycatch by species, groundfish management area, and sector for the trawl fisheries on a weekly basis.

ii. NMFS shall work with WCGOP and the Council to ensure that information collected on the salmon bycatch, and implementation of other management measures designed to control salmon bycatch, associated with fisheries that are the subject of this opinion is of comparable or better quality to currently collected information. If the Council in the future considers different levels of monitoring coverage in the fisheries, the Council and NMFS would compare the quality of estimates produced by the new levels compared to the status quo.

iii. NMFS shall work with WCGOP and the Council to ensure that salmon bycatch in the fisheries that are the subject of this opinion are monitored and evaluated as follows to allow for a thorough post-season analysis of fishery impacts on listed Chinook and coho salmon ESUs species:

a. Monitoring of bycatch and implementation of bycatch control measures required in this opinion will be conducted using the best available methods.

b. The location at which salmon bycatch is taken in the fisheries shall be recorded and reported to NMFS.

c. Salmon taken in as bycatch in the fisheries shall be sampled for stock composition, CWTs, and other biological information including age, sex and size. For the whiting, bottom trawl and non-whiting midwater trawl fisheries, this includes taking genetic samples from the bycatch.

iv. NMFS shall work with WCGOP and other entities as appropriate to ensure that the distribution of fishing effort will be tracked and reported to NMFS.

1.b. NMFS shall evaluate changes in the geographic and temporal distribution of fishing effort by gear type, compare them to the distribution of effort assumed in the opinion, and develop a report to characterize changes on a biennial basis. For example, NMFS shall report any significant changes in the spatial and temporal characteristics of fisheries. If the information indicates that the geographic distribution of the fishery is substantially different than that underlying the analysis in this opinion, NMFS will evaluate whether the change has resulted in impacts on listed salmon ESUs outside the effects analysis in this opinion.

DEVELOPING MEASURES TO KEEP BYCATCH WITHIN GUIDELINES

2.a. As part of its process for developing the biennial specifications for the groundfish fishery for 2019 and 2020, the Council will review the existing mechanisms in the FMP and regulations for avoiding and reducing salmon bycatch, including but not limited to 50 CFR 660.60(d), to determine if these measures are adequate to allow for timely inseason management to keep the sectors from exceeding their bycatch guidelines. This review shall consider, at a minimum, (1) the effectiveness of the Ocean Salmon Conservation Zone and Bycatch Reduction Zones for addressing the potential for bycatch guideline exceedances inseason, and (2) the efficacy of using BRAs to reduce interactions between the whiting fisheries and salmon. The review shall include recommendations for increasing the effectiveness of these measures.

2.b. If the Council determines that additional management measures are needed to allow for timely inseason management to keep the sectors from exceeding their bycatch guidelines, the Council will develop such measures and recommend them to NMFS within three years of the issuance of this opinion. Such measures may include, but are not limited to: sector-specific catch limits, bycatch thresholds, harvest guidelines, time and area closures, and gear restrictions. They may be described as NMFS automatic actions or Council inseason actions.

2.c. No later than May 15th, 2019, NMFS will amend the provisions regarding reapportionment of the treaty tribes' whiting allocation to the non-treaty sectors (50 CFR 660.131) to require that NMFS consider the level of Chinook bycatch when determining whether to reapportion whiting.

2.d. The Council and NMFS shall retain the following restrictions to minimize Chinook bycatch for the duration of this opinion:

- The 10,000-lb trip limit restriction on targeted harvest of whiting inside of 100 fathoms in the Eureka area,
- The delay of the start of the primary Pacific whiting season until May 15th for all sectors, north of 40°30' N. latitude.

- The prohibition on at-sea processing south of 42°00' N. latitude,
- When shore-based fishing for whiting beginning April 15 south of 40°30' N. latitude is allowed, no more than 5 percent of the shore-based allocation may be taken prior to the opening of the main shore-based fishery on May 15.

2e. All whiting trawling within the nearshore Klamath and Columbia River Salmon Conservation Zones is prohibited. NMFS and the Council shall implement regulations within 2 years of issuance of this opinion to prohibit the following within the nearshore Klamath and Columbia River Salmon Conservation Zones:

1. Bottom trawling (except with a selective flatfish trawl gear), and
2. All non-whiting midwater trawling.

RESERVE

3.a. The Council and NMFS shall develop and implement initial regulations governing the Reserve of 3,500 Chinook as part of the 2019-2020 biennial specifications and management measures. These regulations will be designed to, among other things, allow for inseason action to prevent any exceedance of a sector guideline plus the full amount of the Reserve and minimize the chance that the Reserve is used in three out of any consecutive five years.

3.b. NMFS shall monitor the use of the Reserve in 2019 and will provide a report to the Council during the process of developing the biennial specifications for 2021-2022. The report will summarize the use of the Reserve and recommending, if needed, changes to the regulations governing the Reserve.

3.c. If, at any time during the fishery, it is anticipated that the coastwide bycatch will exceed the annual Chinook bycatch guideline of 11,000 for the whiting sector or 5,500 for the non-whiting sector, NMFS and the Council will take action to avoid an exceedance of either guideline. If either sector exceeds its guideline plus the Reserve, fisheries for that sector will close for the remainder of the year. If a sector exceeds its guideline plus the Reserve, but the other sector has not exceeded its guideline, only the sector that has exceeded its guideline plus the Reserve will be closed. If one sector has been closed for the remainder of the year under the above scenario, and the other sector reaches its guideline, all sectors would be closed for the remainder of the year. NMFS and the Council shall develop and implement regulations governing closure of the fishery sector(s) as described here as part of the biennial harvest specifications and management measures for 2019-2020.

NEW TIMES AND AREAS

4.a. Opening the trawl RCAs off Oregon and California according to the Council's PPA is part of the proposed action, however, as discussed in the effects analysis there is significant uncertainty regarding the effects of bycatch in the trawl RCA on individual listed ESUs. Therefore, NMFS and the Council should proceed cautiously and include measures to ensure the impacts are consistent with the analysis in this opinion. If salmon bycatch rates in the RCAs exceed the rates used in this analysis by more than 25 percent, the Council and NMFS will evaluate whether the change could subsequently result in salmon bycatch levels higher than the thresholds or impacts to listed salmon ESUs that would be outside the effects analysis in this opinion. If so, the Council and NMFS will develop and implement measures to reduce those rates to keep within the bycatch thresholds and ESU impacts of the opinion.

4b. As discussed in the effects analysis, there is significant uncertainty regarding the bycatch effects on individual listed ESUs in the non-whiting midwater fishery and bottom trawl fishery; particularly in areas south of 42° N. latitude. Data on the status of Chinook and coho ESUs from this area are very limited and what is available indicate they are in critical status. Prior to allowing additional non-whiting trawling south of 42° N. latitude, NMFS will implement one or more EFPs designed to collect information about Chinook and coho bycatch levels and stock composition from fishing in those areas or at those times for a minimum of three years.

4.c. A coastwide, year around non-whiting midwater trawl fishing is part of the proposed action, i.e., “midwater yellowtail/widow rockfish fishery is conducted in a manner similar to historical patterns when such a fishery took place”. However, as discussed in the effects analysis there is significant uncertainty regarding the effects of bycatch during January through mid-May on individual listed ESUs since a non-whiting midwater trawl fishery has not occurred in that time since routine data collection began. Chinook ESUs with spring-run type life histories are more prevalent during this time than at times later in the year. Therefore, NMFS and the Council should proceed cautiously and include measures to ensure the impacts are consistent with the analysis in this opinion. Prior to allowing additional open non-whiting trawling from January through mid-May, NMFS shall implement EFPs designed to collect information about Chinook and coho bycatch levels and stock composition from fishing during that time for a minimum of three years. In doing so, NMFS should take into account relevant information from existing EFPs. Information from the EFPs will be used to inform measures the Council may adopt to ensure the impacts are consistent with the analysis in this opinion.

4.d. The Council and NMFS will consider data collected as described in 4.a. and 4.b. in developing future management measures for the fishery.

IDENTIFYING AND ADDRESSING HIGH BYCATCH TIMES/AREAS/CONDITIONS

5.a. NMFS, working with the Council shall identify areas (‘hot spots’) and times of consistently high

Chinook and coho bycatch and shall incorporate that information as appropriate in developing mitigation measures to reduce bycatch.

5.b. Over the next two years then every five years thereafter, NMFS, working with the Council and its advisory bodies, will conduct analysis to identify the following:

i. Indicators that are most useful in indicating anomalous ocean conditions that are likely to result in high Chinook bycatch, and;

ii. The most important indicators or combinations of circumstances that are likely to result in extreme salmon bycatch events in the whiting and non-whiting trawl fisheries. Information suggests that the top 0.5 percent of hauls in a gear type (i.e., at-sea whiting, shoreside whiting, bottom trawl, non-whiting midwater trawl) can account for a disproportionate amount of Chinook bycatch (NMFS 2017d).

5.c. NMFS working with the Council shall produce a report(s) summarizing the findings of its analyses in T&C 5a and 5b and recommendations on how the information could be incorporated into management. The first report(s) is due within two years of issuance of this Opinion and every 5 years thereafter.

REPORTING & EVALUATION

6a. NMFS will produce an annual postseason report by November 1 the year following each season that includes the following:

- A summary of the observed salmon bycatch by season, fishing depth, bottom depth, and area for the previous fishing year.
- A summary of stock composition (genetic data and available estimated CWTs) and any other biological information regarding the salmon taken as bycatch during the season.
- A summary of the bycatch reduction measures used and an evaluation of their effectiveness.
- A comparison of the fishery's geographic distribution during the season against the assumptions made about that distribution in this opinion.

6b. NMFS, in consultation with the Council, and the states of Washington, Oregon and California, shall review existing monitoring and reporting systems used in the commercial fixed gear and recreational groundfish fisheries with respect to the timeliness of bycatch reporting and assessment of salmon bycatch. NMFS shall produce a report summarizing the findings of this review and recommendations to address deficiencies in existing systems within two years of issuance of this opinion. NMFS shall work with the Council and states to implement the recommendations within one year after issuance of its report.

2.10 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02). NMFS believes the following conservation recommendations are consistent with these obligations and, therefore, should be implemented by NMFS.

(1) NMFS in collaboration with the Council and groundfish industry should continue to evaluate improvement in gear technologies and fishing techniques to reduce impacts on listed Chinook and coho salmon.

(2) NMFS in collaboration with the Council, and with assistance from the GMT and STT, should develop methods that would assess impacts to listed salmon ESUsin the groundfish fishery in terms of exploitation rates that could be compared with those in salmon fisheries in order to provide more comprehensive accounting of impacts to the listed salmon ESUs and to improve management flexibility.

(3) NMFS in collaboration with the Council should continue to investigate the relationship between salmon bycatch in the groundfish fishery and salmon abundance, and consider harvest guidelines that vary annually in accordance to the projected abundance of salmon. This could be particularly important in years of low abundance of one or more Chinook stocks where a single bycatch guideline may be insensitive to the bycatch of a relatively substantial proportion of smaller Chinook populations. The Council could set harvest guidelines at amounts below the take limits for the individual sectors dependent upon the salmon forecast. If a harvest guideline was reached, it could trigger implementation of a mitigation measure (e.g. time or area closure) which could either be done automatically or through a Council recommendation to NMFS.

2.11 "Not Likely to Adversely Affect" Determinations

Sacramento winter-run and Central Valley spring-run Chinook salmon ESUs

The above ESA-listed salmon ESUs may occur in the action area and may be directly affected by interaction with gear under the proposed fishing. However, available data indicates Sacramento winter-run and Central Valley spring-run Chinook salmon are not present in the bycatch (Table 2-65). This is despite observed bycatch of other spring Chinook ESUs with similar migration timing through the action area and bycatch for which abundance is as low or lower. Returning adults from the Sacramento winter-run and Central Valley spring-run Chinook salmon ESUs enter their natal rivers beginning in December and March, respectively; exiting the ocean prior to the current start of some groundfish fisheries in the area and outside peak fishing for other groundfish sectors. Nonetheless, given the evolving nature of the fishery, we will continue monitoring stock composition in the groundfish fishery with observer programs, which will allow us to identify any take of these ESUs that would occur. Based on the low potential for exposure and the lack of observed bycatch, it is extremely unlikely that the proposed fishing effort will result in interactions with either of the above salmon ESUs and the potential effects are, therefore, discountable.

Table 2-65. Average 2008 to 2015 (range) contribution by Chinook ESU to the at-sea and shoreside whiting fisheries used to assess stock composition of Chinook bycatch in this opinion.

	% contribution to the catch	
Salmon ESU	**At-sea**	**Shorebased**
Puget Sound Chinook	7.0%	1.1%
Upper Columbia River spring Chinook	0.2%	0.0%
Upper Willamette River Chinook	0.2%	0.0%
Lower Columbia River Chinook	5.9%	4.1%
Snake River spring/summer Chinook	0.2%	0.0%
Snake River Fall Chinook	1.5%	1.5%
California Coastal Chinook	4.0%	2.5%
Sacramento Winter-run Chinook	0.0%	0.0%
Central Valley Spring-run Chinook	0.0%	0.0%

2.12 Reinitiation of Consultation

This concludes formal consultation for the impacts of programs administered by the Bureau of Indian Affairs that support Puget Sound tribal salmon fisheries, salmon fishing activities authorized by the USFWS, and fisheries authorized by the U.S. Fraser Panel in 2016.

As 50 CFR 402.16 states, reinitiation of formal consultation is required and shall be requested by the Federal agency or y the Service, where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and: (a) if the amount or extent of taking specified in the ITS is exceeded; (b) if new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (c) if the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion; or (4) if a new species is listed or critical habitat designated that may be affected by the identified action.

3 DATA QUALITY ACT DOCUMENTATION AND PREDISSEMINATION REVIEW

The DQA specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

3.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this consultation are the applicants, the Council and NMFS listed on the first page. Other interested users could include other federal agencies, state and tribal governments, applicants, and the American public. Individual copies of this opinion were provided to NMFS and the Council. This opinion will be posted on the Public Consultation Tracking System web site (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). The format and naming adhere to conventional standards for style.

3.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

3.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; they were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, and 50 CFR 402.01 et seq.

Best Available Information: This consultation and supporting documents use the best available information, as contained in the References section. The analyses in this opinion contain more background on information sources and quality.

Referencing: All supporting materials, information, data, and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA, and it was reviewed in accordance with WCR ESA quality control and assurance processes.

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Appendix 1

2.1 Appendix 1. Pacific Fisheries Management Council Proposed Action:

Provide Final Recommendations to NMFS on Chinook Bycatch Thresholds and Other Measures for the Endangered Species Act Section 7 Consultation

(Agenda Item F.3, April 2017)

Description of Fisheries

With regard to the scenario that best represents the future conditions in fisheries management under the Pacific Coast Groundfish Fishery Management Plan (FMP), use Scenario 1A for the whiting fishery, and the distribution and bycatch rate assuptions in Scenario 2B(1) for bottom trawl, LE and OA fixed gear, non-whiting midwater trawl, and recreational fisheries, as updated by the Groundfish Management Team (GMT) in F.3.a, Supplemental GMT Reports 1 and 2 and Agenda Item I.1.a., NMFS Report 1, March 2017.

Also, in recognition of the Council's ongoing process to consider revisions to groundfish EFH and rockfish conservation areas (RCAs), consider the preliminary preferred alternatives as the projected RCA configurations.

Estimated Harvest Levels

In determining the expected amounts of groundfish that would be harvested, include the following assumptions in the analysis:

1. The U.S. share of the Pacific whiting total allowable catch will be achieved and, for the purposes of the analysis, estimate that amount to be up to 500,000 mt in the future;
2. The at-sea trawl whiting groundfish allocations and set asides will be fully harvested by the at-sea sectors;
3. For the IFQ fishery (i.e., shoreside whiting, bottom trawl, and midwater non-whiting trawl), allocations for the following species will be fully harvested: sablefish, petrale sole, lingcod, shortspine and longspine thornyheads, and overfished rockfish species (i.e., bocaccio, cowcod, darkblotched, and yelloweye rockfish, and POP);
4. For the IFQ fishery, allocations for other groundifish stocks, for which it has harvested 75 percent

or more of its allocations in 2014 to 2016, will be achieved;

5. For the IFQ fishery, the harvest levels in 2014 to 2016 for canary, widow, yellowtail, and chilipepper rockfish will be taken in the shoreside whiting and bottom trawl fisheries, and the balance of the IFQ allocations will be harvested in the midwater non-whiting trawl fishery;

6. For all other groundfish stocks, harvest levels for 2014 to 2016 for trawl fisheries will likely continue; and

7. LE and OA fixed gear and recreational fishery allocations, harvest guidelines, and harvest levels will likely continue.

<u>Chinook Management Thresholds for Analysis</u>

For the Chinook management thresholds, assess the following:

Fishery	Chinook Bycatch Guideline
Whiting fishery	*11,000 Chinook guideline*
Bottom trawl, midwater non-whiting trawl, LE and OA fixed gear, and recreational fisheries combined	*5,500 Chinook guideline*
Bycatch Reserve:	*3,500 Chinook*

With regard to the Bycatch Reserve, this would not be an entitlement or *de facto* increase in the bycatch threshold, but rather a safety net to minimize disruption to the fishery where actions that were already actively being taken to reduce bycatch were insufficient.

In the analysis of the Reserve, analyze three scenarios such that the entire Reserve is taken in the following fisheries in their status quo times and areas: (1) whiting, (2) bottom trawl, and (3) midwater non-whiting trawl. For each scenario, if it is determined that accessing the full amount of the Reserve may result in jeopardy then identify appropriate sub-thresholds, as needed, for each of these sectors.

<u>Future Management Measures</u>

Taking the results of the Reserve analysis described above into consideration, through the Biennial Groundfish Harvest Specifications and Management Process, the Council could consider maintaining the concept of a Reserve and limiting portions of the Reserve to specific sectors, or eliminating the Reserve.

For 2017, it is our understanding that NMFS plans to:

- Retain the selective flatfish trawl gear requirement shoreward of the RCA;
- Provide a midwater non-whiting trawl fishery through an exempted fishing permit (EFP) that includes the following conditions:
    - Fishing to occur north of the California/Oregon border (42° N. latitude) only,
    - EFP Chinook bycatch cap of 3,500 Chinook (which is a subset of the 5,500 Chinook management threshold described above),
    - Upon projected attainment of the cap, NMFS would terminate the EFP (i.e., participating vessels would need to comply with the selective flatfish trawl gear requirement).

For 2018, the Council would recommend that NMFS consider the discussions, reports, and recommendations under this agenda item when considering issuance of a potential subsequent midwater non-whiting trawl EFP.

For 2019 and 2020, and beyond, through the Biennial Groundfish Harvest Specifications and Management Process, the Council intends to develop and consider a range of alternatives for management measures to address the bycatch of salmon in groundfish fisheries. Such measures may include: sector-specific catch limits, bycatch thresholds, harvest guidelines, time and area closures, and gear restrictions. These measures may be implemented preseason or inseason, and may be described as NMFS automatic actions or Council actions.

Appendix 2

2.2 Appendix 2. Analysis of Chinook bycatch stock composition using a coerced linear regression model based on the latitudinal distribution of bycatch

The following characterizes the relationship between genetic stock composition of Chinook salmon Evolutionarily Significant Units (ESUs) and latitudinal distribution of bycatch in the US West Coast, at-sea, Pacific whiting fishery. Predictive models were used to estimate the likely composition of Chinook salmon ESUs in bycatch. This method was used to estimate stock composition in the at-sea whiting sector and extrapolated to the non-whiting sectors for which stock composition data are not currently available. For the shoreside whiting sector, observed genetic stock composition from two years of available data (2013-2014) were used to estimate stock composition.

We used independent cross validation (to evaluate the predictive ability of three different regression methods: 1) Dirichlet regression, 2) multinomial logistic regression, and 3) simple linear regression adapted to this multinomial application by zero truncation and re-scaling to 1.0. We focused on the best performer. However, because of concerns raised by the SSC about our non-standard application of linear regression (zero-truncation and re-scaling-to-1), we also presented some results based on multinomial logistic regression, a more statistically defensible method and the runner up in terms of predictive accuracy. Dirichlet regression did not appear to be as accurate as the other methods and was not used to estimate ESU impacts.

All three statistical approaches are described below. Two different error metrics were used to evaluate predictive accuracy. Mean squared error (MSE) weights differences in large proportions, whereas mean average percentage error (MAPE) emphasizes errors in the estimation of small proportions. Although all three models performed similarly (Figure B1), the linear regression model predicted the most accurate stock proportions when compared to observed data that were independent of the model (i.e., MSE values were as follows: 0.0003, 0.0006, and 0.0007 for linear regression, Dirichlet regression and multinomial logistic regression, respectively. MAPE values: 378, 780, and 4683 for multinomial logistic regression, linear regression, and Dirichlet regression). We rely primarily on linear regression for most of our analyses with exceptions noted. Dirichlet regression seemed the least accurate of the three, especially by MAPE, and was therefore omitted from further consideration. In general, the multinomial logistic regression model predicted higher impacts on southern stocks and lower impacts on northern stocks relative to the linear regression method across the scenarios. The linear regression model was used to assess stock composition for the fishery scenarios described in the effects section (section 2.2.5), whereas the multinomial logistic regression model to assess stock composition for the Exempted Fishing Permit (EFP) proposed for south of 42° N latitude. The bycatch in the EFP would occur outside the range of observed data for annual mean bycatch from the whiting fleet, violating a central tenet of predictive modeling, i.e., predictions should be constrained to the range of observed data. Because multinomial logistic regression is based on individual fish rather that mean latitudes for annual samples, it was possible to safely make inferences about more southerly bycatch anticipated in the EFP.

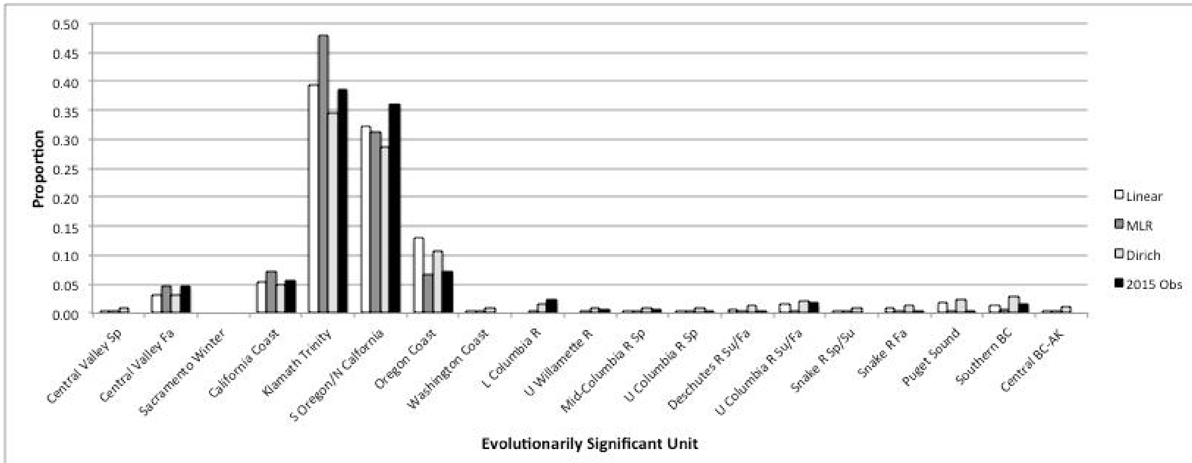

Figure B1. Comparison of predicted stock composition of at-sea whiting Chinook bycatch from three different regression methods with observed stock composition in 2015, an independent cross-validation sample.

Chinook bycatch samples and collection data were obtained by NOAA's At-Sea Hake Observer Program. Conditional maximum likelihood genetic mixture modeling was used based on the GAPS Microsatellite Baseline. Baseline reference populations were aggregated into reporting groups according to membership (genetic affinity) in ESUs (Table B2). Full description of sample collection, laboratory procedures, and data analysis are described in more detail in Moran and Tuttle (2011).

Linear Regression

Observation of genetic stock composition between 2008 and 2014 showed strong differences that could be attributed to the latitudinal distribution of bycatch, as expressed by mean latitude of all bycatch in a given year (Figure B2, a 2015 bycatch sample was held in reserve as a cross-validation sample). Linear regression was used to model the relationship between mean latitude (x) and proportional contribution of each ESU (y) for bycatch in a given year (Table B1). Those point estimates and regression lines are shown in Figure B3. Note that zero truncation and scaling of the proportional estimates to 1.0 effectively fits those linear relationships to a multinomial logistic model, similar to Dirichlet regression and multinomial logistic regression.

Cross validation from independent data were carried out on a newly available 2015 Chinook salmon bycatch sample, not included in the model (Figure B1). Those modeled and observed values were broadly concordant but with a few divergent estimates for individual ESUs. The most concerning of those was the substantial underestimate of the ESA-listed Lower Columbia River ESU. However, the proportion of that ESU was relatively low (0.024) at that latitude (43.5).

The mean latitude of bycatch in 2015 was identical to the value observed in 2013 (43.8˚ N. Latitude). That coincidence allowed an evaluation of inter-annual variation in stock composition (Figure B4). The difference observed between estimated and observed stock composition in 2015 (Figure B1) was essentially the same as the difference between years at the same latitude (Figure B4) (mean squared error 0.00031 versus 0.00025, respectively), indicating stability in stock composition for a given latitude among the years for which data are available.

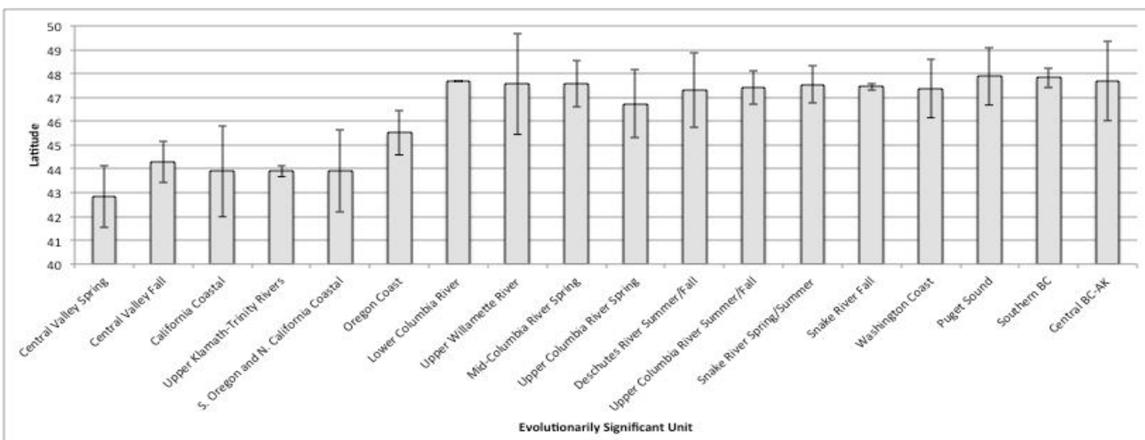

Figure B2. Mean latitude of encounter for each Chinook ESU (A-SHOP samples, all years)

Table B1. Linear regression models used to infer stock composition for various fisheries and scenarios. Resulting values were zero truncated and the entire set of proportions was scaled to 1.0.

ESU	Linear model	r^2 (adj)	*P* value
Central Valley Sp	$y = -7.114\text{e-}05x + 0.003$	-0.17	0.7374
Central Valley Fa	$y = -0.006x + 0.273$	0.20	0.1729
Sacramento Winter	NA		
California Coast	$y = -0.011x + 0.532$	0.52	0.0416
Klamath Trinity	$y = -0.093x + 4.448$	0.97	4.53E-05
S Oregon/N California	$y = -0.067x + 3.266$	0.98	1.66E-05
Oregon Coast	$y = -0.007x + 0.436$	0.08	0.2746
Washington Coast	$y = 0.0012x - 0.052$	0.53	0.0384
L Columbia R	$y = 0.038x + -1.676$	0.86	0.0016
U Willamette R	$y = 0.001x - 0.060$	0.86	0.0016
Mid-Columbia R Sp	$y = 0.0002x - 0.009$	-0.13	0.6008
U Columbia R Sp	$y = 0.0007x - 0.028$	0.68	0.0138
Deschutes R Su/Fa	$y = 0.002x - 0.082$	0.25	0.1429
U Columbia R Su/Fa	$y = 0.012x - 0.504$	0.73	0.0086
Snake R Sp/Su	$y = 0.0016x - 0.068$	0.96	0.0001
Snake R Fa	$y = 0.006x - 0.240$	0.62	0.0213
Puget Sound	$y = 0.039x - 1.702$	0.98	1.40E-05
Southern BC	$y = 0.076x - 3.327$	0.93	0.0003
Central BC-AK	$y = 0.005x - 0.220$	0.83	0.0027

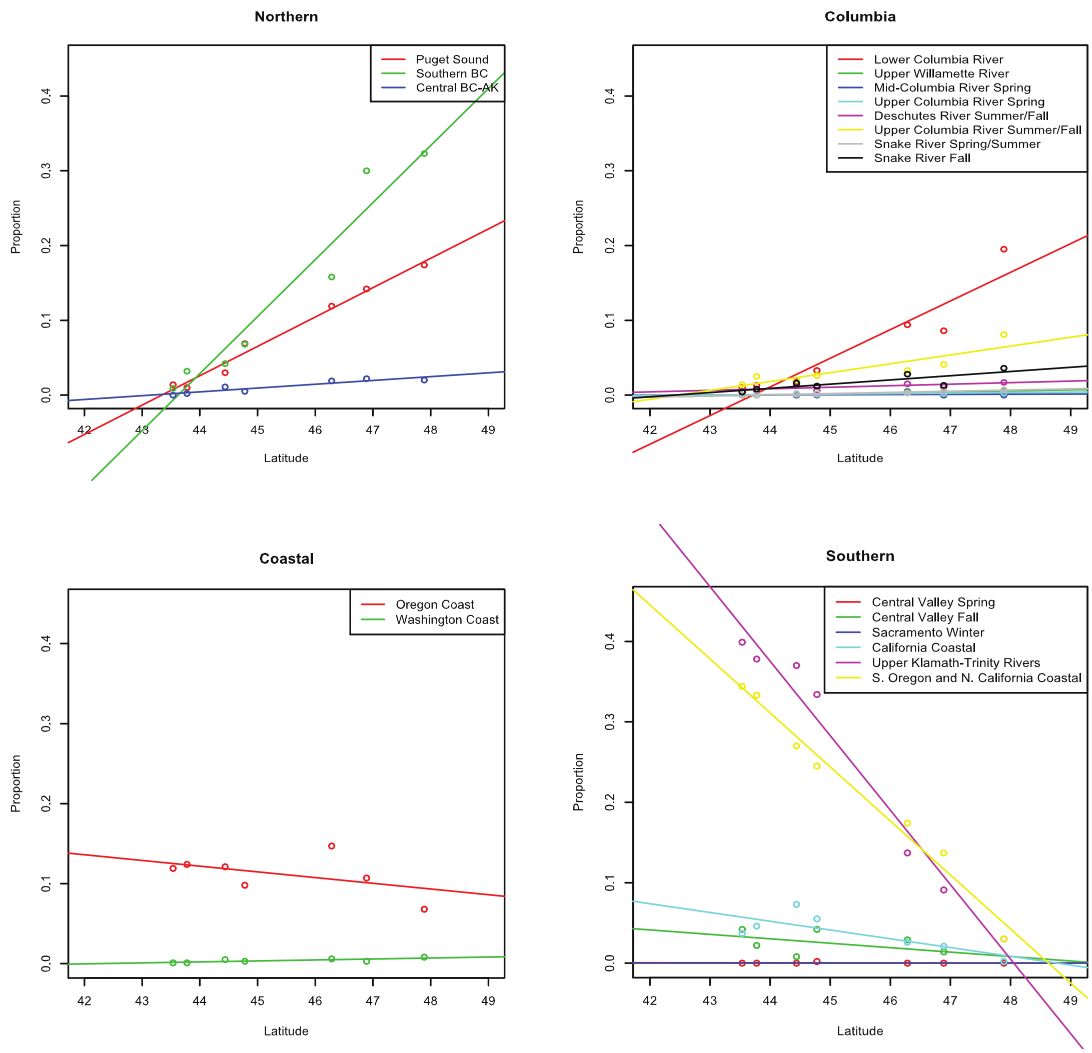

Figure B3. Chinook salmon ESU proportions are highly dependent on the mean latitude of annual bycatch in West Coast, At-Sea, whiting fisheries (2008 - 2014, N = 3964).

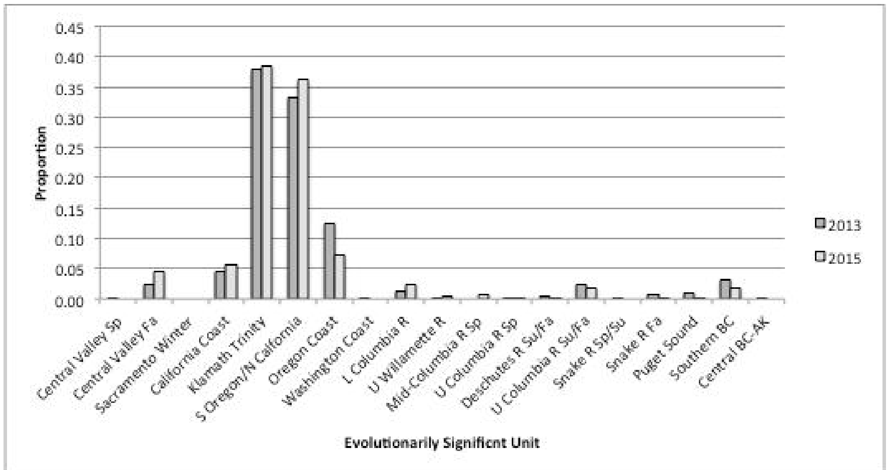

***Figure B4**. Comparison of annual bycatch replicate samples taken in 2013 and 2015, years that had identical mean latitude (43.8). Mean squared error was similar between the model cross validation (Figure B5) and comparison of empirical estimates in this plot (0.0003).*

Table B2. Reference populations and reporting group structure for genetic mixture analysis based on Evolutionarily Significant Units (pers. com. J. Myers, January 2016). Populations from Seeb et al. (2007). Status: E = Endangered, T = Threatened, C = Candidate, NW = Not Warranted.

Genetic baseline population	ESU reporting group	Status
Mill Cr sp	Central Valley Spring	T
Butte Cr Sp	Central Valley Spring	T
Deer Cr sp	Central Valley Spring	T
Feather H sp	Central Valley Spring	T
Stanislaus R	Central Valley Fall	C
Butte Cr f	Central Valley Fall	C
Feather H fa	Central Valley Fall	C
Battle Cr	Central Valley Fall	C
Sacramento H	Sacramento Winter	E
Russian R	California Coastal	T
Eel R	California Coastal	T
Trinity H f	Upper Klamath-Trinity Rivers	NW
TrinityH sp	Upper Klamath-Trinity Rivers	NW
Klamath R fa	Upper Klamath-Trinity Rivers	NW
Chetco R	S. Oregon and N. California Coastal	NW
Cole Rivers H	S. Oregon and N. California Coastal	NW
Applegate Cr	S. Oregon and N. California Coastal	NW
Siuslaw R	Oregon Coast	NW
Umpqua H	Oregon Coast	NW

Genetic baseline population	ESU reporting group	Status
Millicoma R	Oregon Coast	NW
Coos H	Oregon Coast	NW
SCoos H	Oregon Coast	NW
Elk H	Oregon Coast	NW
Sixes R	Oregon Coast	NW
S Umpqua H	Oregon Coast	NW
Coquille R	Oregon Coast	NW
Alsea R	Oregon Coast	NW
Nehalem R	Oregon Coast	NW
Siletz R	Oregon Coast	NW
Kilchis R	Oregon Coast	NW
Necanicum H	Oregon Coast	NW
Nestucca H	Oregon Coast	NW
Salmon R f	Oregon Coast	NW
Trask R	Oregon Coast	NW
Wilson R	Oregon Coast	NW
Yaquina R	Oregon Coast	NW
Cowlitz H sp	Lower Columbia River	T
Kalama H sp	Lower Columbia River	T
Lewis H sp	Lower Columbia River	T
Sandy R	Lower Columbia River	T

Genetic baseline population	ESU reporting group	Status
Cowlitz H fa	Lower Columbia River	T
Lewis R f	Lower Columbia River	T
McKenzie H	Upper Willamette River	T
NSantiam H	Upper Willamette River	T
Spring Cr H	Lower Columbia River	T
U Yakima H	Mid-Columbia River Spring	NW
Warm Springs H	Mid-Columbia River Spring	NW
Wenatchee R sp	Upper Columbia River Spring	E
Wenatchee H sp	Upper Columbia River Spring	E
Carson H	Upper Columbia River Spring	N/A
John Day R	Upper Columbia River Spring	E
U Deschutes R	Deschutes River Summer/Fall	NW
L Deschutes R	Deschutes River Summer/Fall	NW
Methow R	Upper Columbia River Summer/Fall	NW
Wells H	Upper Columbia River Summer/Fall	NW
Wenatchee R sf	Upper Columbia River Summer/Fall	NW
Hanford Reach	Upper Columbia River Summer/Fall	NW
Minam R	Snake River Spring/Summer	T
Rapid R H	Snake River Spring/Summer	T
Secesh R	Snake River Spring/Summer	T
Tucannon H	Snake River Spring/Summer	T

Genetic baseline population	ESU reporting group	Status
Tucannon R	Snake River Spring/Summer	T
Newsome Cr	Snake River Spring/Summer	T
WF Yankee Frk	Snake River Spring/Summer	T
EF Salmon R	Snake River Spring/Summer	T
Imnaha R	Snake River Spring/Summer	T
Lyons Ferry H	Snake River Fall	T
Queets R	Washington Coast	NW
Sol Duc H	Washington Coast	NW
Forks Cr H	Washington Coast	NW
Hoh R	Washington Coast	NW
Humptulips H	Washington Coast	NW
Makah H	Washington Coast	NW
George Adams H	Puget Sound	T
Hamma Hamma R	Puget Sound	T
Elwha H	Puget Sound	T
Elwha R	Puget Sound	T
Dungeness R	Puget Sound	T
Voights H	Puget Sound	T
Soos H	Puget Sound	T
White H	Puget Sound	T
Hupp Sp H	Puget Sound	T

Genetic baseline population	ESU reporting group	Status
Clear Cr H	Puget Sound	T
S Prairie Cr	Puget Sound	T
Skagit R	Puget Sound	T
U Skagit R	Puget Sound	T
U Sauk R	Puget Sound	T
L Sauk R	Puget Sound	T
Suiattle R	Puget Sound	T
Marblemount H sp	Puget Sound	T
Marblemount H su	Puget Sound	T
U Cascade R	Puget Sound	T
Samish H	Puget Sound	T
Snoqualmie R	Puget Sound	T
Wallace H	Puget Sound	T
Skykomish R	Puget Sound	T
NF Stillaguam H	Puget Sound	T
NF Nooksack H	Puget Sound	T
Birkenhead H	Southern BC	N/A
W Chilliwack H	Southern BC	N/A
Maria Slough	Southern BC	N/A
Nicola H	Southern BC	N/A
Spius H	Southern BC	N/A

Genetic baseline population	ESU reporting group	Status
M Shuswap H	Southern BC	N/A
L Adams H	Southern BC	N/A
L Thom R	Southern BC	N/A
Raft R	Southern BC	N/A
Deadman H	Southern BC	N/A
Clearwater R	Southern BC	N/A
Louis Cr	Southern BC	N/A
Nechako R	Southern BC	N/A
Quesnel R	Southern BC	N/A
Stuart R	Southern BC	N/A
U Chilcotin R	Southern BC	N/A
Chilko R	Southern BC	N/A
Morkill R	Southern BC	N/A
Salmon R sp	Southern BC	N/A
Swift R	Southern BC	N/A
Torpy R	Southern BC	N/A
Big Qualicum H	Southern BC	N/A
Quinsam H	Southern BC	N/A
Nanaimo H f	Southern BC	N/A
Puntledge H f	Southern BC	N/A
Cowichan H	Southern BC	N/A

Genetic baseline population	ESU reporting group	Status
Marble H	Southern BC	N/A
Nitinat H	Southern BC	N/A
Robertson H	Southern BC	N/A
Sarita H	Southern BC	N/A
Tahsis R	Southern BC	N/A
Tranquil R	Southern BC	N/A
Conuma H	Southern BC	N/A
Porteau Cove H	Southern BC	N/A
Klinaklini R	Southern BC	N/A
Wannock H	Central BC-AK	N/A
Atnarko H	Central BC-AK	N/A
Kitimat H	Central BC-AK	N/A
Ecstall R	Central BC-AK	N/A
L Kalum R	Central BC-AK	N/A
Bulkley R	Central BC-AK	N/A
Sustut R	Central BC-AK	N/A
Babine H	Central BC-AK	N/A
Owegee R	Central BC-AK	N/A
Damdochax R	Central BC-AK	N/A
Kincolith R	Central BC-AK	N/A
Kwinageese R	Central BC-AK	N/A

Genetic baseline population	ESU reporting group	Status
L Tahltan R	Central BC-AK	N/A
Nakina R	Central BC-AK	N/A
Tatsatua Cr	Central BC-AK	N/A
U Nahlin R	Central BC-AK	N/A
Kowatua Cr	Central BC-AK	N/A
Chickamin/White H	Central BC-AK	N/A
Chickamin R	Central BC-AK	N/A
Chickamin H	Central BC-AK	N/A
Clear Cr	Central BC-AK	N/A
Cripple Cr	Central BC-AK	N/A
Keta R	Central BC-AK	N/A
King Cr	Central BC-AK	N/A
Andrew Cr	Central BC-AK	N/A
Andrew/Mac H	Central BC-AK	N/A
Andrew/Med H	Central BC-AK	N/A
Andrew/Cry H	Central BC-AK	N/A
King Salmon R	Central BC-AK	N/A
Tahini R	Central BC-AK	N/A
Tahini/Mac H	Central BC-AK	N/A
Big Boulder Cr	Central BC-AK	N/A
Klukshu R	Central BC-AK	N/A

Genetic baseline population	ESU reporting group	Status
Situk R	Central BC-AK	N/A