Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response

Consultation on the Delegation of Management Authority for Specified Salmon Fisheries to the State of Alaska

NMFS Consultation Number: WCR-2018-10660

Action Agencies: The National Marine Fisheries Service (NMFS) of the National Oceanic and Atmospheric Administration (NOAA)

Affected Species and NMFS' Determinations:

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?**
Lower Columbia River Chinook Salmon (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	No	No
Snake River Fall-run Chinook Salmon (*O. tshawytscha*)	Threatened	Yes	No	No	No
Upper Willamette River Chinook Salmon (*O. tshawytscha*)	Threatened	Yes	No	No	No
Puget Sound Chinook Salmon (*O. tshawytscha*)	Threatened	Yes	No	Yes	No
Upper Columbia River spring-run Chinook Salmon (*O. tshawytscha*)	Endangered	No	No	No	No
Snake River spring/summer-run Chinook Salmon (*O. tshawytscha*)	Threatened	No	No	No	No
California Coastal Chinook Salmon (*O. tshawytscha*)	Threatened	No	No	No	No
Central Valley spring-run Chinook Salmon (*O. tshawytscha*)	Threatened	No	No	No	No

Sacramento River winter-run Chinook Salmon (*O. tshawytscha*)	Endangered	No	No	No	No
Central California Coast Coho Salmon (*Oncorhynchus kisutch*)	Endangered	No	No	No	No
Southern Oregon/Northern California Coast Coho Salmon (*O. kisutch*)	Threatened	No	No	No	No
Oregon Coast Coho Salmon (*O. kisutch*)	Threatened	No	No	No	No
Lower Columbia River Coho Salmon (*O. kisutch*)	Threatened	No	No	No	No
Columbia River Chum Salmon (*Oncorhynchus keta*)	Threatened	No	No	No	No
Hood Canal summer-run Chum salmon (*O. keta*)	Threatened	No	No	No	No
Snake River Sockeye Salmon (*Oncorhynchus nerka*)	Endangered	No	No	No	No
Lake Ozette Sockeye Salmon (*O. nerka*)	Threatened	No	No	No	No
Puget Sound steelhead (*Oncorhynchus mykiss*)	Threatened	No	No	No	No
Upper Columbia River steelhead (*O. mykiss*)	Threatened	No	No	No	No
Snake River Basin steelhead (*O. mykiss*)	Threatened	No	No	No	No
Middle Columbia River steelhead (*O. mykiss*)	Threatened	No	No	No	No
Upper Willamette River steelhead (*O. mykiss*)	Threatened	No	No	No	No
Lower Columbia River steelhead (*O. mykiss*)	Threatened	No	No	No	No
Northern California Coast steelhead (*O. mykiss*)	Threatened	No	No	No	No

California Central Valley steelhead (*O. mykiss*)	Threatened	No	No	No	No
Central California Coast steelhead (*O. mykiss*)	Threatened	No	No	No	No
South Central California Coast steelhead (*O. mykiss*)	Threatened	No	No	No	No
Southern California Coast steelhead (*O. mykiss*)	Endangered	No	No	No	No
Southern Resident killer whales (*Orcinus orca*)	Endangered	Yes	No	Yes	No
Humpback whale (*Megaptera novaeangliae*) Mexico DPS	Threatened	Yes	No	No	No
Western Steller Sea Lion (*Eumetopias jubatus*)	Endangered	Yes	No	No	No
Blue Whale (*Balaenoptera musculus*)	Endangered	No	No	No	No
Fin Whale (*B. physalus*)	Endangered	No	No	No	No
Sei Whale (*B. borealis*)	Endangered	No	No	No	No
North Pacific Right Whale (*Eubalaena japonica*)	Endangered	No	No	No	No
Sperm Whale (*Physeter microcephalus*)	Endangered	No	No	No	No
Western North Pacific Gray Whale (*Eschrichtius robustus*)	Endangered	No	No	No	No

*Please refer to section 2.11 for the analysis of species or critical habitat that are not likely to be adversely affected.

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Fishery Management Plan for the Salmon Fisheries in the EEZ Off Alaska	No	No
Fishery Management Plan for the	No	No

Scallop Fishery Off Alaska		
Pacific Coast Salmon	No	No
Fishery Management Plan for Groundfish of the Gulf of Alaska	No	No

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By: ______________________________
Ryan J. Wulff
Assistant Regional Administrator
for Sustainable Fisheries

Date: April 5, 2019

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LIST OF ACRONYMS

µPa	Micropascal
AABM	Aggregate Abundance-Based Management
Abs	Absolute
ACOE	Army Corps of Engineers
ADFG	Alaska Department of Fish and Game
AIs	Abundance Indices
AK	Alaska
AKR	Alaska Region
AMMOP	Alaska Marine Mammal Observer Program
A/P	Abundance and Productivity
BC	British Columbia
BIAs	Biologically Important Areas
BiOp	Biological Opinion
BRT	Biological Review Team
BSAI	Bering Sea/Aleutian Islands
CAN	Canada
CCSP	Climate Change Science Program
CET	Critical Escapement Thresholds
CI	Confidence Interval
CIF	Central Incubation Facility
CNP	Central North Pacific
CO2	Carbon Dioxide
CPFV	Commercial Passenger Fishing Vessel
CPUE	Catch per Unit Effort
CTC	Chinook Technical Committee
CTWSR	Confederated Tribes of the Warm Springs Reservation
CV	Coefficient of Variation
CWA	Clean Water Act
CWR	Center for Whale Research
CWT	Coded-wire Tag
CYER	Calendar Year Exploitation Rate
dB	Decibels
DDTs	Dichlorodiphenyltrichloroethane
DITs	Double Index Tags
DNA	Deoxyribonucleic Acid
DPERs	Daily Prey Energy Requirements
DPS	Distinct Population Segment
DQA	Data Quality Act
DTAGs	Digital Acoustic Recording Tags
ECHO	Enhancing Cetacean Habitat and Observation Program
EDPS	Eastern Distinct Population Segment
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EFP	Exempted Fishing Permit
EPA	Environmental Protection Agency
ER	Exploitation Rate
ESA	Endangered Species Act
ESCA	Endangered Species Conservation Act
ESU	Evolutionarily Significant Unit (a term used by NMFS)
FCRPS	Federal Columbia River Power System
FMEP	Fisheries Management and Evaluation Plans
FMP	Fishery Management Plan
FR	Federal Register
FRAM	Fishery Regulation Assessment Model
FY	Fiscal Year
GOA	Gulf of Alaska
GSI	Genetic Stock Identification
HGMP	Hatchery Genetic Management Plan
HPA	Hydraulic Project Approval
HR	High Risk
HRIs	Harvest Rate Indices
HV	Highly Viable
IC	Interior Columbia
ICTRT	Interior Columbia Technical Recovery Team
IHA	Incidental Harassment Authorization
IHNV	Infectious Hematopoietic Necrosis Virus
IPCC	Independent Panel on Climate Change
ISAB	Independent Scientific Advisory Board
ISBM	Independent Stock-Based Management
ISRP	Independent Scientific Review Panel

ITS	Incidental Take Statement
kcal	Kilocalories
kg	Kilogram
kHz	Kilohertz
km	Kilometer
LCFRB	Lower Columbia Fish Recovery Board
LCR	Lower Columbia River
LFH	Lyons Fish Hatchery
LOF	List of Fisheries
m	Meters
M/A/G	Mill/Abernathy/Germany
Mb	Body Mass (in kg)
MCR	Middle Columbia River
MEF	Mideye to fork of the tail length
MF	Middle Fork
MMAP	Marine Mammal Authorization Program
MMPA	Marine Mammal Protection Act
MPG	Major Population Group
MSA	Magnuson-Stevens Fishery Conservation and Management Act
M/SI	Mortality and Serious Injury
MSST	Minimum Stock Size Threshold
MSY	Maximum Sustainable Yield
MtDNA	Mitochondrial Deoxyribonucleic Acid
MU	Management Unit
NA	Not Available
NBC	Northern British Columbia
NCBC	North/Central British Columbia
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPFMC	North Pacific Fishery Management Council
NPS	National Park Service
NWFSC	Northwest Fisheries Science Center
ODFW	Oregon Department of Fish and Wildlife
OLE	Office of Law Enforcement
OR	Oregon
PAHs	Polycyclic Aromatic Hydrocarbons
PBFs	Physical or Biological Features
PBR	Potential Biological Removal
PBT	Parental Based Genetic Tagging
PC	Proportionality Constant
PCBs	Polychlorinated Biphenyls
PCE	Primary Constituent Element
PFMC	Pacific Fishery Management Council
pHOS	Proportion of hatchery-origin fish on the spawning grounds
PIT	Passive Integrated Transponder
PNI	Proportion Natural Influence
pNOB	Proportion Natural-Origin Fish in Broodstock
ppb	Parts per Billion
PRA	Population Recovery Approach
PSC/Commission	Pacific Salmon Commission
PSIT	Puget Sound Indian Tribes
PSO	Protected Species Observer
PST/Treaty	Pacific Salmon Treaty
PSTRT	Puget Sound Technical Recovery Team
PSTT	Puget Sound Treaty Tribes
QCI	Queen Charlotte Islands
R/S	Recruits per Spawner
Rel	Relative
RER	Rebuilding Exploitation Rate
RMP	Resource Management Plan
rms	Root Mean Square
ROD	Record of Decision
RPA	Reasonable and Prudent Alternative
RPMs	Reasonable and Prudent Measures
SARs	Stock Assessment Reports
SEAK	Southeast Alaska
SRFI	Snake River Fall-run Chinook Index
SRKW	Southern Resident Killer Whales
SRS	Sediment Retention Structure
SS/D	Spatial Structure/Diversity
SSPS	Shared Strategy for Puget Sound
SUS	Southern United States
SWFSC	Southwest Fisheries Science Center
TAC	Total Allowable Catch
TAMM	Terminal Area Management Module
TBD	To Be Determined
TBR	Transboundary River
TRT	Technical Recovery Team
TTS	Temporary Threshold Shifts
UET	Rebuilding/Upper Escapement

Thresholds
U.S. United States
USCG United States Coast Guard
USFWS U.S. Fish and Wildlife Service
USGCRP United States Global Change Research Program
UWR Upper Willamette River
VSP Viable Salmonid Populations
WA Washington
WCR West Coast Region
WCVI West Coast Vancouver Island
WDFW Washington Department of Fish and Wildlife
WDPS Western Distinct Population Segment
WLC Willamette Lower Columbia
WLC TRT Willamette Lower Columbia Technical Recovery Team
WNP Western North Pacific

1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 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 (16 USC 1531 et seq.), and implementing regulations at 50 CFR 402.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.

We 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 the NOAA Institutional Repository (https://repository.library.noaa.gov/), after approximately two weeks. A complete record of this consultation is on file at Lacey, Washington.

This opinion considers the effects of three proposed actions on four ESA-listed species of Chinook salmon shown in Table 1 and three marine mammals. A species of salmon designated for ESA listing is referred to as an Evolutionarily Significant Unit (ESU). Other ESA-listed species discussed in the Opinion are referred to as a Distinct Population Segment (DPS). In section 2.12 we also provide information supporting the determinations that the proposed actions are not likely to adversely affect other ESA-listed salmonids or marine mammals which are not present nor impacted in the action area (described in section 2.4).

Table 1. Federal Register (FR) notices for the final rules that list species, designate critical habitat, or apply protective regulations to a listed species considered in this consultation (Listing status: 'T' means listed as threatened under the ESA; 'E' means listed as endangered).

Species	Listing Status	Critical Habitat	Protective Regulations
Chinook salmon *(Oncorhynchus tshawytscha)*			
Puget Sound	T: 79 FR 20802, 4/14/14	70 FR 52685, 9/02/05	70 FR 37160, 6/28/05
Lower Columbia River	T: 79 FR 20802, 4/14/14	70 FR 52706, 9/02/05	70 FR 37160, 6/28/05
Upper Willamette River	T: 79 FR 20802, 4/14/14	70 FR 52720, 9/02/05	70 FR 37160, 6/28/05
Snake River fall-run	T: 79 FR 20802, 4/14/14	58 FR 68543, 12/28/93	70 FR 37160, 6/28/05

Species	Listing Status	Critical Habitat	Protective Regulations
Killer Whales (*Orcinus orca*)			
Southern Resident DPS	E: 70 FR 69903; 11/18/05	71 FR 69054; 11/29/06	Issued under ESA Section 9
Humpback Whales (*Megaptera novaeangliae*)			
Mexico DPS	T: 81 FR 62260; 8/8/16	n/a	81 FR 62021, 9/8/16
Sea Lions (*Eumetopias jubatus*)			
Western Steller	E: 62 FR 24345; 5/5/97	58 FR 45269	Issued under ESA Section 9

The second and third proposed actions, described below in section 1.3, are a direct result of implementation of the Pacific Salmon Treaty, and therefore it is necessary to review its construction and general components. The. The United States (U.S.) and Canada (collectively the Parties) ratified the Pacific Salmon Treaty (PST, or Treaty) in 1985 following many years of intermittent negotiations. The Treaty provides a framework for the management of salmon fisheries in those waters of the U.S. and Canada that fall within the Treaty's geographical scope. In addition to institutional and procedural provisions (e.g., establishment of the Pacific Salmon Commission (Commission, or PSC) and its panels; meeting schedules and protocols, etc.), the Treaty established fishing regimes that set upper limits on intercepting fisheries, defined as fisheries in one country that harvest salmon originating in another country, and sometimes include provisions that apply to the management of the Parties' non-intercepting fisheries as well. The Treaty also established procedural mechanisms for revising the regimes when necessary. The overall purpose of the regimes, which are found in Chapters 1-6 of Annex IV, is to accomplish the conservation, production, and harvest allocation objectives set forth in the Treaty. It is important to note that these fishing regimes are not self-executing; they must be implemented by the Parties with conforming regulations issued under the authority of their respective management agencies.

The fishing regimes contained in Annex IV of the Treaty are expected to be amended periodically upon recommendation of the Commission as new information becomes available to better accomplish the Treaty's conservation, production, and allocation objectives (Turner and Reid 2018). The original (1985) regimes varied in duration and some were modified and extended for several years, but by the end of 1992, all had expired. Despite several years of negotiations, both within the Commission and a variety of other processes and forums, the U.S. and Canada were unable to reach a comprehensive new agreement until 1999. During the interim period (1993 through 1998), fisheries subject to the Treaty generally were managed pursuant to short term (annual) agreements that governed only some of the fisheries. When even short term agreements were not reached, the fisheries were managed independently by the Parties' respective domestic management agencies, but generally in approximate conformity with the most recently applicable bilateral agreement.

The agreement finally reached in 1999 (the 1999 Agreement) came to fruition through a government-to-government process rather than within the normal PSC process established under the Treaty. The 1999 Agreement was comprehensive, and included amended versions of Chapters 1-6 of Annex IV, as well as a variety of other provisions designed to improve implementation of the Treaty and the operations of the Commission. The fishing regimes in Chapters 1-6 applied for ten years, expiring at the end of 2008, except for Chapter 4 (Fraser River Sockeye and Pink Salmon), which extended through 2010. The Parties engaged in a new round of negotiations as the term of the 1999 Agreement was coming to an end. The resulting 2009 Agreement revised key provisions of each Chapter and again set a ten year term for the Agreement. The 2009 Agreement is therefore due to expire at the end of 2018 except for Chapter 4 which extends for one additional year and expire at the end of 2019.

Anticipating the expiration of the fishing regimes established in the 2009 Agreement and the time required to negotiate new regimes, the Commission began negotiations for new regimes in January of 2017. After more than 18 months of negotiations, the Commission reached agreement in July of 2018 on amended versions of each of the five expiring Chapters of Annex IV. By letter dated August 23, 2018 the Commission transmitted the amended Chapters to the governments of Canada and the U.S. and recommended their approval (Turner and Reid 2018).

A major component of the 2019 Agreement, and the one that proved most difficult and time-consuming to negotiate, is the management regime set forth in Chapter 3 of Annex IV for Chinook salmon. The Chinook chapter carried forward the basic structure of the two prior agreements. The three major ocean Chinook salmon fisheries in southeast Alaska and Canada are managed using the aggregate abundance-based management (AABM) approach, coupled with an individual stock-based management (ISBM) approach for all other Treaty-area fisheries in Canada and the Pacific Northwest.

This opinion assumes that the State of Alaska manages its SEAK salmon fisheries consistent with provisions of the 2019 PST Agreement. Provisions of the Agreement establish an integrated management framework that also applies to fisheries in Canada and the southern U.S. Therefore, in order to provide a more comprehensive framework for analyzing the effects of the SEAK fishery on listed species, we look broadly at provisions of Chapter 3 of the 2019 Agreement and how it will be implemented coast-wide.

1.2 Consultation History

The first ESA listings of salmon species in the Pacific Northwest occurred in 1992. NMFS conducted its first ESA review of salmon fisheries in SEAK in 1993, and continued their consideration of the SEAK fisheries by means of annual consultations through 1998 (NMFS 1993; 1998). The Parties tentatively concluded the 1999 Agreement in June of 1999. Final approval of the 1999 Agreement by the U.S. also was subject to contingencies in the PST Act that related to ESA review, as well as to certain funding provisions. It was understood that the ESA review would take several months. The proposed agreement was concluded just a few days before the start of the summer fishery in SEAK. Nonetheless, Alaska modified its fishing plan to comply with the tentative agreement. There was little time between the announcement of the agreement and the pending start of the 1999 fishery in SEAK on July 1. This time constraint combined with NMFS' obligation to provide a more comprehensive review of the entire PST agreement prior to December 31, 1999, resulted in a biological opinion issued on June 30, 1999 (NMFS 1999b). In its 1999 opinion, NMFS considered the effects on listed species resulting from SEAK fisheries managed under the new regime for the 1999 summer and 1999/2000 winter seasons. NMFS subsequently completed consultation on the full scope of the 1999 Agreement on November 18, 1999 (NMFS 1999b). Once the ESA and funding contingencies were satisfied, the 1999 Agreement was finalized by the governments and provided the basis for managing the affected fisheries in the U.S. and Canada during the ten year term of the Agreement.

Section 7 consultations covering southern U.S. fisheries also began in 1992 as a consequence of the initial ESA listings. These consultations have focused, in particular, on fisheries off the coast of Washington, Oregon, and California managed by the Pacific Fishery Management Council, as well as fisheries in the Columbia River Basin and Puget Sound. During these consultations and those on the SEAK fishery prior to the 1999 Agreement, NMFS generally tried to anticipate the effect of Canadian fisheries on the species status. But absent an agreement with Canada that set forth specific fishing provisions, Canadian fisheries were not in the baseline or part of a proposed action. The consultation on the 1999 Agreement was therefore the first time that NMFS was able to consult directly on a proposed fishery management regime that involved specific harvest provisions for both U.S. and Canadian fisheries. The proposed actions considered in the 1999 opinion included a Federal action related to the implementation of the SEAK fishery (i.e., decision by NMFS to approve the North Pacific Fishery Management Council's (NPFMC) deferral to Alaska Department of Fish and Game (ADFG) management of the SEAK fisheries in the U.S. exclusive economic zone (EEZ) consistent with the PST) and approval by the U.S. Secretary of State, on behalf of the U.S., of the fishing regimes in the 1999 Agreement (NMFS 1999b).

The opinion on the 1999 Agreement focused primarily on the effects of fisheries in SEAK and Canada ("northern fisheries") on four Chinook salmon ESUs and Hood Canal summer-run chum that were subject to the highest levels of take. The four Chinook salmon ESUs included Snake River fall-run Chinook, Lower Columbia River (LCR) Chinook, Upper Willamette River (UWR) Chinook, and Puget Sound Chinook salmon. NMFS concluded in the 1999 opinion that the proposed actions were not likely to jeopardize the continued existence of any of these or other listed species and that the actions were not likely to destroy or adversely modify designated critical habitat for any of the listed species (NMFS 1999b).

NMFS again consulted on the proposed 2009 Agreement. We note that the scope of the consultation in this opinion differed somewhat from that of the opinion on the 1999 Agreement (NMFS 1999b). In the 1999 opinion the action area was limited to the SEAK and Canadian fisheries - the so called northern fisheries. However, the opinion on the 2009 Agreement included in its specified action area the northern fisheries, as well as all marine and freshwater areas in the southern U.S. subject to provisions of the PST. The opinion again focused in particular on the effects on the same four Chinook salmon ESUs and Hood Canal summer-run chum, and for the first time, Southern Resident Killer Whales (SRKW). The SRKW DPS was listed as endangered under the ESA in 2005 (70 FR 69903). Critical habitat was also designated in 2006 (71 FR 69054). NMFS concluded in the 2008 opinion on the proposed 2009 Agreement that the proposed actions were not likely to jeopardize the continued existence of any of the listed species and that the actions were not likely to destroy or adversely modify designated critical habitat for any of the listed species (NMFS 2008d).

In 2012, NMFS Alaska Region approved the NPFMC's recommendation to adopt Amendment 12 to the Fishery Management Plan for the Salmon Fisheries in the EEZ off Alaska. For the East Area (the area of the EEZ in the Gulf of Alaska east of the longitude of Cape Suckling), Amendment 12 reaffirmed the delegation of management of the East Area EEZ to the State of Alaska, continued the existing prohibition on net fishing in the East Area EEZ, and continued the authorization of troll fishing in the East Area EEZ, all of which had been in place since 1990. At that time, NMFS conducted ESA informal consultations on the effects to ESA-listed salmon and marine mammals. For ESA-listed salmon, NMFS West Coast Region concurred that Amendment 12 would have no direct or indirect effects on the marine environment, including ESA-listed salmon species, relative to the status quo (NMFS 2012f). For ESA-listed marine mammals, NMFS Alaska Region concurred that Amendment 12 and the salmon fisheries conducted in federal waters pursuant to Amendment 12 were not likely to adversely affect ESA-listed species or designated critical habitat (NMFS 2012e).

Since listing the SRKW DPS NMFS has conducted a series of consultations to evaluate effects of southern U.S. fisheries off the coast of Washington, Oregon, and California managed by the Pacific Fishery Management Council (2006-2007, 2007-2008 and the 2009 opinion that is still in place) and the U.S. Fraser Panel fisheries (2007 and 2008) on this species. NMFS also consulted on the effects of Columbia River fisheries on SRKW in conjunction with the conclusion of the 2018 *U.S. v. Oregon* Agreement (2018-2027). The effects of Puget Sound fisheries on SRKW during the 2018-2019 season were evaluated by NMFS during consultation on the proposed Puget Sound fisheries for the 2018 and 2019 fishing season (NMFS 2018a).

This consultation includes NMFS' reinitiation of consultation on delegation of management authority over salmon fisheries in the EEZ in SEAK to the State of Alaska on the basis of new information regarding the effects of the action and the condition of ESA-listed species. NMFS also consults on the effects of the following two proposed actions on ESA listed species: (1) Federal funding through grants to the State of Alaska for the State's management of commercial and sport salmon fisheries and transboundary river enhancement necessary to implement the 2019 Pacific Salmon Treaty Agreement, and (2) Federal funding of a conservation program for critical Puget Sound stocks and SRKW related to the 2019 Agreement. Federally funded fisheries in SEAK are likely to have direct and indirect effects on ESA listed salmon species considered in this opinion. These federally funded fisheries may have direct and indirect effects on non-listed salmon that are prey resources that would otherwise be available to SRKW. Federally funded fisheries that are part of the proposed action may directly or indirectly effect SRKW. Fishing gear interactions occur in the SEAK fisheries that may affect the Mexico DPS of humpback whales and the western DPS of Steller sea lions. Federal funding of a conservation program for critical Puget Sound stocks and SRKW are expected to have effects on listed salmon and SRKW.

1.3 Proposed Federal Action

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). For EFH consultations, "Federal action" means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910).

First, NMFS is reinitiating consultation on the delegation of management authority over salmon troll fishery and the sport salmon fishery (the only authorized fisheries currently occurring in the SEAK EEZ) in the SEAK EEZ to the State of Alaska. The Fishery Management Plan (FMP) for the Salmon Fisheries in the EEZ Off Alaska, as adopted by the NPFMC and approved by NMFS, delegates management authority over salmon troll fishery and the sport salmon fishery in the SEAK EEZ to the State of Alaska consistent with the FMP, the MSA, the PST, the ESA, and other applicable laws (NPFMC 2012). The FMP prohibits commercial fishing for salmon with nets in the EEZ.

The NPFMC and NMFS oversee state management of the salmon fisheries occurring in the EEZ to ensure consistency with the Salmon FMP and other applicable Federal law. Thus the State applies management regulations, limited entry licensing programs, reporting requirements, and other management-related actions, to salmon troll fishery and the sport salmon fishery in the EEZ unless NMFS determines that a State management measure is inconsistent with the FMP, the MSA, or other applicable law. In such a case, NMFS may specify management measures applicable to the EEZ that differ from those of the State if the State does not correct the identified inconsistencies.

Because State regulations governing salmon management of the troll and sport fisheries in SEAK do not differentiate between EEZ and state waters, the FMP's ongoing delegation means that the State of Alaska manages the southeast salmon troll fishery within State waters in a manner that is consistent with its management of salmon troll fishery in the EEZ. While the FMP delegates management of any sport fishing in the EEZ to the State, the FMP does not contain any measures specific to the sport salmon fishery.

In previous consultations, NMFS considered the effects of the delegation of management authority over salmon fisheries in the EEZ in SEAK to the State of Alaska, and on the 2009 PST Agreement. NMFS is reinitiating consultation to ensure that ongoing delegation of management authority over salmon troll and sport fisheries in the EEZ does not jeopardize the continued existence of species listed under the ESA. NMFS is also reinitiating consultation to consider new information regarding the effects of the action and the status of ESA-listed species of Chinook salmon, SRKW, western DPS of Steller sea lions, and humpback whales.

The second proposed action relates to Federal funding. NMFS may in its discretion disburse grants to the State of Alaska to monitor and manage salmon fisheries in State and Federal waters to meet the obligations of the PST through 2028. NMFS has already approved and disbursed funds to the State of Alaska under the 2009 PST through the State's current fiscal year. Following the 2019 PST effective date NMFS intends to review and, if appropriate, approve the next annual cycle of grants. NMFS expects that the proposed funding initiatives for the State to implement the 2019 PST Agreement over the next ten-year cycle will be similar to the funding initiatives that implemented the 2009 PST Agreement under the prior ten-year cycle. This includes the following, or similar, funding initiatives, which are explained next. In disbursing funds to implement the 2019 PST Agreement, NMFS will consider whether to approve grants to the State annually for the next ten years. Generally, NMFS approves the grants to the State each year, and the grants are awarded for one fiscal year (July to July each year), although one grant is approved for up to five years and is disbursed through annual awards. Consistent with Federal law and regulations, NMFS reviews actions taken by the State of Alaska consistent with the proposed grants. For this proposed action, the proposed funding initiative has three elements and follows the funding process utilized under the 2009 PST Agreement.

1) The PST Transboundary River (TBR) Enhancement initiative, is a five-year, multi-disciplinary initiative grant to the ADFG totaling $2.4 million, or $460K to $498K per year. Although this initiative was begun under the 2009 PST Agreement, it would continue under the new 2019 PST Agreement. This initiative is targeted at supplementing the number of sockeye available to fishermen by increasing fry production from several Transboundary Lakes through hatchery incubation in the U.S. The goal of the enhancement efforts has been to produce 100,000 additional sockeye, worth approximately $900,000, to each of the Taku and Stikine River drainages. The U.S. and Canada agreed to joint enhancement projects on the Stikine and Taku Rivers according to Understandings signed in 2009. At that time it was determined that Parties would share the cost of joint enhancement. The TBR Salmon Enhancement Program provides funding to cover the costs that will be incurred by the U.S. in the course of meeting obligations specified in the Understandings. These obligations include: 1) operation of the Port Snettisham Sockeye Central Incubation Facility (CIF) for the incubation and rearing of sockeye eggs received from Canadian Lakes on the Stikine and Taku River drainage; 2) pathology screening of eggs and fry and otolith marking of fry reared at the CIF; 3) transport of fry back to enhancement sites; and 4) sampling and analysis of returning enhanced adult fish taken by U.S. fisheries and in the Transboundary rivers.

   The sampling and analysis component entails the use of otolith mass marks to identify enhanced fish and the establishment of a monitoring program to recover marks in mixed stock fisheries targeting on the adults returning to the Transboundary Rivers. Information from the monitoring program is used in development of management models to ensure optimal harvest and adequate escapement during the season. The estimates of enhanced contribution provide the means for determining if U.S. and Canada meet their allocation goals as specified in the Pacific Salmon PST agreement and annexes.

2) The PST Sport Harvest Monitoring and Wild Chinook Stock Assessment is funded through individual one-year grants at approximately $600K per year, which will cover permanent staff responsible for analytical, supervisory and coordination duties associated with long-term wild Chinook salmon stock assessment and marine sport harvest monitoring projects in SEAK. Chinook salmon spawning abundance and age and length compositions will be estimated for nine indicator stocks in SEAK. Spawning abundance will be estimated using a combination of weirs, aerial and foot surveys, and mark-recapture experiments. For the Chilkat, Taku, Stikine and Unuk rivers wild stocks of Chinook salmon, juvenile coded wire tag (CWT) projects will allow smolt abundance, marine harvest, exploitation, and marine survival estimates. This project will also support key activities of the sport harvest monitoring program strategically focusing on Chinook salmon. This includes necessary coordination to estimate harvest of Chinook salmon by port in SEAK and to increase sampling rates for CWTs in marine sport

fisheries in SEAK to maintain or surpass an inspection rate of 20% of all Chinook salmon caught. The results will be used in support of multiple Pacific Salmon Commission Chinook Technical Committee Chinook salmon analyses and in abundance-based management of these stocks, as directed by the 2019 PST agreement. Goals and objectives for this element include:

a. Estimate the escapements of large (≥660 mm MEF(mideye to fork of tail length)) Chinook salmon in the Chilkat, Taku, King Salmon, Stikine, Unuk, Chickamin, Blossom and Keta rivers and Andrew Creek, such that estimates are within 25% of the true value 90% of the time (Coefficient of variation (CV) ≤ 15%).
b. Estimate the age and sex composition of large Chinook salmon spawning in the Chilkat, Taku, King Salmon, Stikine, Unuk, Chickamin, Blossom and Keta rivers and Andrew Creek, such that all estimated proportions are within 10% of the true values 90% of the time.
c. Estimate the marine harvest of wild Chinook salmon from the Chilkat, Taku, Stikine and Unuk rivers such that the estimate is within 35% of the true value 90% of the time, a target CV of 21%.
d. Estimate the number of wild Chinook salmon smolt emigrating from the Chilkat, Taku, Stikine, and Unuk rivers in spring such that the estimate is within 35% of the true value 90% of the time, a target CV of 21%.
e. Estimate the preliminary yearly values of the following characteristics of the Chinook salmon harvest such that the relative precision is within 20 percentage points of the true value 90% of the time for each port.
f. Estimate the early season (late April to mid-July) harvest of Chinook salmon in District 108 (Petersburg/-Wrangell) and District 111 (Juneau).
g. Maintain or increase CWT sampling rates of 20% or more for Chinook salmon caught in marine sport fisheries in SEAK.

Other tasks/objectives associated with the stock assessment component of this project include: 1) estimating mean length-at-age of Chinook salmon; 2) estimating the escapement and age-sex composition of small (<400 mm MEF) and medium (≥400 mm and <660 mm MEF) Chinook salmon with precision of estimates dependent on the number of small and medium fish sampled and present in the drainage; 3) sampling all Chinook salmon captured for adipose fin clips; 4) counting all large fish observed during age-sex-length sampling trips; and 5) estimation of the exploitation rate (expected CV = 20% or less), total adult production, and the marine survival rate (smolt to adult). Other tasks/objectives associated with the marine sport harvest monitoring component of this project include: 1) increase CWT recovery efficiency by using handheld tag detection wands by identification of "No Tags" (Chinook salmon with adipose fin clips but not having a CWT); 2) sub-sample adipose-intact Chinook salmon from the marine sport fisheries at a rate of 1 in 10 for double index tags (DITs); 3) collect matched scales and tissues; and 4) estimate the proportion of the catch of Chinook salmon (both <28 inches: small and ≥28 inches: large) that were released.

3) The PST Implementation Program Support is funded through individual one-year grants at approximately $3.4 million per year. The PST Implementation grant administered by ADF&G funds several programs including administrative, management, research,

information technology services, and enhancement required to implement the PST in Southeast Alaska according to PST terms agreed to by the United States and Canada. PST provisions are overseen and implemented by the implemented by the PSC. Numerous abundance-based PST agreements directly influence the harvest of salmon from Yakutat to Ketchikan in five gillnet, one purse seine, and three troll fisheries. These agreements indirectly influence salmon harvesting in many other fisheries. Compliance with PST requirements entails management and research programs which provide accurate and timely forecasting, catch, effort, escapement, stock identification, and run timing data. Because current harvest sharing agreements are based on annual abundance, total return (catch in all significant fisheries plus escapement) of treaty stocks must be reconstructed on an annual basis.

Programs that operate under this grant are organized under five Project Titles: 1) Program Support; 2) Regional Treaty Support, 3) Transboundary Annex; 4) Northern Boundary Annex; and 5) Chinook Annex. Program Support provides clerical and administrative support, travel, training, supplies and contractual items for administrative personnel and PST related projects operating out of the ADF&G PSC Regional Office in Douglas, Region I Headquarters in Juneau, and field offices in Ketchikan, Craig, Wrangell, Petersburg, Sitka, and Yakutat. Regional Treaty Support personnel involved in the design, development, maintenance, and analytical capabilities of the regional catch and effort database. Programs under the Transboundary Annex (Alsek, Taku, and Stikine Rivers) support PST-related: 1) management, research, sampling and stock identification of treaty stocks in directed Transboundary fisheries; 2) in-river stock assessment efforts and; 3) enhancement of shared Transboundary stocks. Adherence with abundance-based harvest sharing agreements for U.S. and Canadian fisheries requires inseason management and stock assessment efforts in Alaskan fisheries near the mouths of rivers to pass sufficient fish for Canadian in-river fisheries while also insuring adequate escapement to spawning grounds. Successful enhancement programs currently return large numbers of sockeye salmon to both the Taku and Stikine rivers. Inseason programs which identify the enhanced component of the run are needed to facilitate appropriate harvest levels on commingled enhanced and wild stocks. Programs grouped under Northern Boundary Area Annex will support the 2019 revision of the PST which places specific, abundance-based harvest constraints on Canadian-origin sockeye salmon in U.S. fisheries and on U.S.-origin pink salmon in Canadian fisheries in the Northern Boundary Area. These programs support basic stock assessment and management, sockeye salmon tissue sampling for genetic analysis, run forecasting, and inseason catch and effort monitoring programs needed to adhere to abundance-based PST agreements, reconstruct total returns, estimate escapements, and evaluate compliance with agreed harvest shares. Programs grouped under the Chinook Annex fund personnel, supplies, travel and contractual items used in Chinook management, stock assessment, run forecasting, and inseason catch and effort monitoring programs needed to adhere to abundance-based PST harvest sharing agreements.

The third proposed action relates to funding of a conservation program for critical Puget Sound stocks and SRKW. As discussed in Section 2.2, the status of Puget Sound Chinook salmon and SRKWs have declined in recent years. A key objective of the U.S. Section during the negotiating process for a new Agreement was therefore to achieve harvest reductions to help address ongoing conservation concerns for Puget Sound Chinook and coincidentally provide benefits for SRKWs. Because of the complicated relationship between fisheries in Alaska, Canada, and the southern U.S. that are subject to the Agreement and the need to find a balanced solution, it was necessary to see that all fisheries were reduced. Fisheries have been reduced substantially since the PST was first ratified in 1985. There were significant reductions associated with the 1999 Agreement and again in 2009. Further reductions are proposed in conjunction with the 2019 Agreement, but there was a practical limit to what could be achieved through the bilateral negotiation process. As a consequence, and in addition to the southeast Alaska, Canadian, and SUS fishery measures identified in the 2019 PST Agreement, the U.S. Section generally recognized that more would be required to mitigate the effects of harvest and other limiting factors that contributed to the reduced status of Puget Sound Chinook salmon and SRKWs that could be addressed through a targeted funding initiative. The funding initiative is relevant to NMFS' consideration of the SEAK fishery in this opinion, and will likewise be an essential element of the environmental baseline in upcoming opinions regarding Puget Sound and other southern U.S. fisheries. Funding for the program will be received by NMFS and administered through a grant program. Individual projects will be evaluated and reviewed as needed to insure they comply with ESA and other regulatory requirements.

The proposed funding initiative has three elements. For Puget Sound Chinook salmon the initiative is targeted at the weakest populations that are considered essential for recovery and those most affected by northern fisheries. These include the Nooksack, Dungeness, Stillaguamish, and Mid-Hood Canal populations. The funding is designed to support continuation of conservation hatchery programs that are already in place on the Nooksack, Dungeness, and Stillaguamish rivers and a new program for the Mid-Hood Canal population. These programs would operate each year for the duration of the Agreement at an annual cost of approximately $3.06 million per year (these and the following cost estimates are adjusted to account for administrative overhead charges of approximately 12 percent that have been applicable in the recent past). The funding was also designed to take immediate action to address limiting habitat conditions for these four populations, in particular, protect existing habitat against further degradation, and possibly others, to make progress toward recovery by improving Chinook salmon abundance and productivity more generally to increase prey availability for SRKWs. These habitat related recovery projects are one time capital projects that would cost approximately $31.2 million and be funded and completed during the first three years of the Agreement. The conservation hatchery and habitat programs would contribute to prey abundance for SRKWs over the intermediate and long term, but the third element of the funding initiative was specifically designed to increase the production of hatchery Chinook salmon to provide an immediate and meaningful increase in prey availability for SRKWs.

A preliminary design of the SRKW hatchery production program was developed, and is described below, in order to provide cost estimates and further definition for how the program should be designed and implemented to achieve the "meaningful increase" in prey availability that is intended. The preliminary design should be used as a benchmark for evaluating the program that will presumably be funded and implemented. However, there is flexibility to adjust the design to account for new information so long as the key objective of the program is met. By key objective we focus in particular on the intention to increase prey availability by 4-5 percent in areas that are most important to SRKWs as described below.

The new production should be distributed broadly to supplement prey abundance in Puget Sound in the summer and offshore areas in the winter, times and areas that have been identified as most limiting. The hatchery production program would operate each year at a cost of no less than $5.6 million per year including an adjustment for administrative overhead. The goal of the hatchery production initiative for supplementing prey abundance is to provide a "meaningful" increase in the abundance of age 3-5 Chinook salmon in the times and areas most important to SRKWs. It would be prioritized to increase abundance in inside areas (Puget Sound) in the summer and outside areas (coastal) during the winter where we believe prey abundance is most limiting (Dygert et al. 2018). For the estimated cost per year an additional 20 million Chinook salmon smolts could be expected. Five or six million smolts should come from facilities in Puget Sound with the remainder from the Washington coast and Columbia River. This disproportionate distribution results from the fact that the abundance of Chinook salmon in the ocean is about three times higher than it is in the Puget Sound. Increasing production by 20 million smolts with the above described distribution is expected to increase prey abundance by 4-5 percent in inside areas in the summer and coastal areas in the winter (Dygert et al. 2018).

For purposes of this consultation, we consider the third proposed action to be a framework programmatic action. See 50 CFR 402.02. The specific details of how the three activities for which funding would be used have not been developed at this point. For example, while a list of potential habitat restoration projects that could be funded to benefit the four Puget Sound Chinook salmon populations exists, it has not been decided which projects would be funded through this action. We expect, as discussed further below, that as the details regarding funded activities becomes available, we will assess these activities to determine if they are covered by existing programmatic biological opinions or require additional site-specific ESA consultation.

For purposes of this analysis, we assume that funding for the conservation program for Puget Sound Chinook salmon and SRKW will be forthcoming largely as described and the program will be implemented during the duration of the new Chinook salmon regime as proposed. The benefits from reduction in harvest in SEAK and other fisheries resulting from the new PST Agreement will be effective immediately. However it is important to note that the effects assumed in the analysis related to the funding initiative will not take place for at least four to five years into the future as funding is attained, fish from the conservation hatchery programs reach maturity in the oceans and productivity improvements are realized from the habitat mitigation. We recognize that there is a degree of uncertainty regarding whether Congress will provide the funding, in whole or in part, that was agreed to by the U.S. Section in a timely manner. In the event the required funding is not provided in time for actions to take effect during the agreement, or if the anticipated actions are not otherwise implemented through other means (e.g., non-fishing related restoration activities, other funding sources) this may constitute a modification to the proposed action that could result in effects on Puget Sound Chinook salmon and SRKW not considered in this opinion. If this was answered in the affirmative, reinitiation of consultation would therefore be required. See 50 CFR section 402.16(c). We expect this opinion and ITS to remain in place during the interim should reinitiation occur.

It is important to emphasize that, although the funding initiative is relevant to NMFS' consideration of the SEAK fishery in the opinion, it will likewise be an essential element of our review of future fisheries in Puget Sound and the southern U.S. For example, a new 10 year Puget Sound Chinook Harvest Resource Management Plan, currently under development, will be subject to ESA evaluation regarding the effects on salmon and SRKWs. Fundamentally, all U.S fisheries may be affected by decisions made in the event that funding is not provided.

Chinook Salmon Management Regime

Some background information related to the biology of Chinook salmon, how Chinook fisheries are managed under the PST, and a description of the proposed 2019-2028 Chinook salmon regime follows:

Chinook salmon have a complex life cycle that involves a freshwater rearing period followed by 2-4 years of ocean feeding prior to their spawning migration. Chinook salmon from individual brood years can return over a 2-6 year period, although most adult Chinook salmon return to spawn as 4 and 5 year old fish. As a result, a single year class can be vulnerable to conditions in the marine environment, including fisheries for several years. Chinook salmon migrate and feed over great distances during their marine life stage; some stocks range from the Columbia River and coastal Oregon rivers to as far north as the ocean waters off British Columbia (BC), specifically North/Central British Columbia. (NCBC) and SEAK. Other stocks migrate in a less distant but still significantly northerly direction, while still others remain in local waters or range to the south of their natal streams. While there is great diversity in the range and migratory habits among different stock groups of Chinook salmon, there also is a remarkable consistency in the migratory habits within stock groups, which greatly facilitates stock-specific fishery planning.

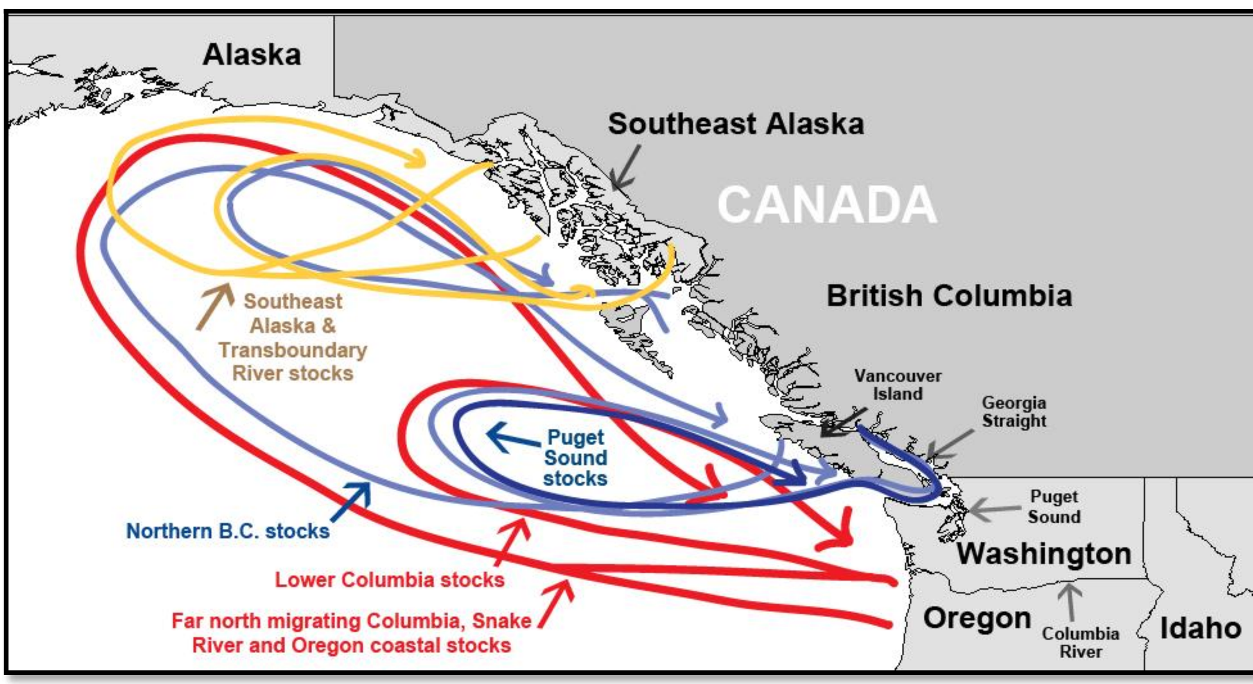

Figure 1. Migratory patterns of major Chinook salmon stock groups.

Their extended migrations, vulnerability to fisheries at multiple age classes, and the extreme mixed stock nature of many Chinook salmon fisheries greatly complicate the management of

Chinook salmon. U.S. stocks are caught in Canadian fisheries and Canadian stocks are caught in U.S. fisheries. The coast wide Chinook management regime evolved over time to address the need for a coordinated management framework and concerns for conservation and sharing of available harvest. In doing so, the Parties have agreed, among other things that:

> *fishery management measures implemented under the Treaty are intended to be appropriate for recovering, sustaining, and protecting salmon stocks in Canada and the United States and are responsive to changes in productivity of Chinook salmon stocks associated with environmental conditions (Paragraph 1.(b) of the 2019 Agreement).*

Under the Chinook regime, fisheries are classified into two categories – AABM and ISBM fisheries. AABM fisheries are managed using a graduated harvest rate approach based on a relationship between the aggregate abundance of all stocks available to the fishery and a harvest rate index (Table 2, referred to as Appendix C of the 2019 Agreement). Estimates of abundance are translated through the harvest rate index to an associated annual catch limit. Abundance levels are expressed as a proportion of the abundance observed during the 1979-1982 base period. An abundance of 1.0, for example, means that the available abundance is the same as the average observed during the base period. An abundance of 1.2 means that the abundance is 20 percent greater than the 1979-1982 base period. AABM fisheries are managed by setting limits on the landed catch, but the Agreement also limits incidental mortality so that the total mortality associated with each AABM fishery is constrained.

Table 2. Relationships between Abundance Indices (AIs), Catches and Harvest Rate Indices (HRIs) - (Referred to as Appendix C to Annex IV, Chapter 3 in the 2019 Agreement).

Southeast Alaska All Gear	North BC Troll & QCI Sport	WCVI Troll & Outside Sport
Proportionality Constant (PC) = 12.38 Harvest Rate Index (HRI) = EXP(LN(Troll Catch / AI) - PC) Troll Catch = (Total Catch - Net Catch) * 0.8 = EXP(PC + LN(HRI * AI)) Total Catch = Net Catch + Troll Catch / 0.8	Proportionality Constant (PC) = 11.83 Harvest Rate Index = EXP(LN(Troll Catch / AI) - PC) Troll Catch = Total Catch * 0.8 = EXP(PC + LN(HRI * AI)) Total Catch = Troll Catch / 0.8	Proportionality Constant (PC) = 13.10 Harvest Rate Index = EXP(LN(Troll Catch / AI) - PC) Troll Catch = Total Catch * 0.8 = EXP(PC + LN(HRI * AI)) Total Catch = Troll Catch / 0.80
<u>Reduction in Total Catch from 2009 Agreement:</u> AIs less than 1.805 - 7.5%, Net Catch = 15,725 AIs between 1.805 and 2.2 - 3.25%, Net Catch = 16,448 AIs greater than 2.2 - 1.5%, Net Catch = 16,745	<u>Reduction in Total Catch from 2009 Agreement:</u> 0%	<u>Reduction in Total Catch from 2009 Agreement:</u> AIs less than 0.93 - 12.5% AIs between 0.93 and 1.12 - 4.8% AIs greater than 1.12 - 2.4%
<u>For AIs less than 1.005</u> Total Catch = 15,725 + 102,213 * AI	<u>For AIs less than 1.205</u> Total Catch = 130,000 * AI	<u>For AIs less than 0.5</u> Total Catch = 112,304 * AI

Troll Catch = (102,213 * AI) * 0.8 HRI = 0.344 <u>For AIs between 1.005 and 1.2</u> Total Catch = -106,144 + 224,081 * AI Troll Catch = (-121,869 + 224,081 * AI) * 0.8 HRI increasing from 0.346 to 0.412 <u>For AIs between 1.205 and 1.5</u> Total Catch = 15,725 + 140,342 * AI Troll Catch = (140,342 * AI) * 0.8 HRI = 0.472 <u>For AIs between 1.505 and 1.8</u> Total Catch = 15,725 + 152,037 * AI Troll Catch = (152,037 * AI) * 0.8 HRI = 0.511 <u>For AIs between 1.805 and 2.2</u> Total Catch = 16,448 + 159,023 * AI Troll Catch = (159,023 * AI) * 0.8 HRI = 0.535 <u>For AIs greater than 2.2</u> Total Catch = 16,745 + 161,899 * AI Troll Catch = (161,899 * AI) * 0.8 HRI = 0.544	Troll Catch = (130,000 * AI) * 0.8 HRI = 0.757 <u>For AIs between 1.205 and 1.5</u> Total Catch = -20,000 + 146,667 * AI Troll Catch = (-20,000 + 146,667 * AI) * 0.8 HRI increasing from 0.757 to 0.777 <u>For AIs greater than 1.5</u> Total Catch = 145,892 * AI Troll Catch = (145,892 * AI) * 0.8 HRI = 0.85	Troll Catch = (112,304 * AI) * 0.8 HRI = 0.184 <u>For AIs between 0.5 and 0.925</u> Total Catch = 131,021 * AI Troll Catch = (131,021 * AI) * 0.8 HRI = 0.214 <u>For AIs between 0.93 and 1.0</u> Total Catch = 142,551 * AI Troll Catch = (142,551 * AI) * 0.8 HRI = 0.233 <u>For AIs between 1.005 and 1.12</u> Total Catch = 162,916 * AI Troll Catch = (162,916 * AI) * 0.8 HRI = 0.267 <u>For AIs greater than 1.12</u> Total Catch = 167,023 * AI Troll Catch = (167,023 * AI) * 0.8 HRI = 0.273

Three fishery complexes are designated for management as AABM fisheries: 1) the SEAK sport, net and troll fisheries; 2) the Northern British Columbia (NBC) troll (Canada's Pacific Fishery Management Areas 1-2, 101-105 and 142) and the Queen Charlotte Islands (QCI) sport (Canada's Pacific Fishery Management Areas 1-2, 101, 102 and 142) and 3) the West Coast Vancouver Island (WCVI) troll and outside sport (Canada's Pacific Fishery Management Areas 21, 23-27, 121, 123-127 but with additional time and area specifications which distinguish WCVI outside sport from inside sport). Abundance levels for the AABM fisheries are determined each year in one of two ways. Abundance indices for the NBC and WCVI are calculated by the PSC's Chinook Technical Committee (CTC) using the CTC's Chinook salmon model. Abundance levels for the SEAK fishery are established using measures of the catch per unit effort (CPUE) from the winter power troll fishery in District 113 during statistical weeks 41-48. The CPUE method for estimating abundance in the SEAK fishery is new. A comparison of the new CPUE method and existing method that relies on CTC model based estimates indicated that the methods were nearly identical in terms of their relative error and accuracy. Nonetheless, the Agreement includes specific provisions that will require close monitoring and review of the method during the term of the Agreement. Catch limits associated with the year specific estimates of abundance for the NBC and WCVI, and SEAK fisheries are shown in Table 3 and Table 4 (referred to as Tables 1 and 2 in the 2019 Agreement). Catch limits for the SEAK fisheries are determined using a tiered approach. There are seven tiers that are defined by a range of abundance index values. For example, tier 3 is associated with abundance indices from 1.005-1-2. A catch ceiling is associated with each tier (Table 4). The catch ceiling for the SEAK fishery for tier 3 is 140,323. Although the SEAK fishery uses this tiered approach, the abundance levels and associated catch ceilings are nonetheless tied directly to the values in Table 3.

Table 3. Catches specified for AABM fisheries at levels of the Chinook abundance index - (Referred to as Table 1 in the 2019 Agreement)[1].

Abundance Index	SEAK	NBC	WCVI
0.25	41,300	32,500	28,100
0.30	46,400	39,000	33,700
0.35	51,500	45,500	39,300
0.40	56,600	52,000	44,900
0.45	61,700	58,500	50,500
0.495	66,300	64,400	55,600
0.50	66,800	65,000	65,500
0.55	71,900	71,500	72,100
0.60	77,100	78,000	78,600
0.65	82,200	84,500	85,200
0.70	87,300	91,000	91,700
0.75	92,400	97,500	98,300
0.80	97,500	104,000	104,800
0.85	102,600	110,500	111,400
0.90	107,700	117,000	117,900
0.95	112,800	123,500	135,400
1.00	117,900	130,000	142,600
1.005	119,100	130,700	163,700
1.05	129,100	136,500	171,100
1.10	140,300	143,000	179,200
1.15	151,500	149,500	192,100
1.20	162,800	156,000	200,400
1.205	184,800	156,700	201,300
1.25	191,200	163,300	208,800
1.30	198,200	170,700	217,100
1.35	205,200	178,000	225,500
1.40	212,200	185,300	233,800
1.45	219,200	192,700	242,200
1.50	226,200	200,000	250,500
1.505	244,500	219,600	251,400
1.55	251,400	226,100	258,900
1.60	259,000	233,400	267,200
1.65	266,600	240,700	275,600
1.70	274,200	248,000	283,900
1.75	281,800	255,300	292,300
1.80	289,400	262,600	300,600
1.805	303,500	263,300	301,500
1.85	310,600	269,900	309,000
1.90	318,600	277,200	317,300
1.95	326,500	284,500	325,700
2.00	334,500	291,800	334,000
2.05	342,400	299,100	342,400
2.10	350,400	306,400	350,700
2.15	358,300	313,700	359,100
2.20	366,300	321,000	367,500
2.25	381,000	328,300	375,800

1. Values for catch at levels of abundance between those stated may be linearly interpolated between adjacent values.

Table 4. Catch limits for the SEAK AABM fishery and the CPUE-based tiers - (Referred to as Table 2 in the 2019 Agreement).

CPUE-based Tier	AI-based Tier	Catch Limit
Less than 2.0	Less than 0.875	Commission Determination
2.0 to less than 2.6	Between 0.875 and 1.0	111,833
2.6 to less than 3.8	Between 1.005 and 1.2	140,323
3.8 to less than 6.0	Between 1.205 and 1.5	205,165
6.0 to less than 8.7	Between 1.505 and 1.8	266,585
8.7 to less than 20.5	Between 1.805 and 2.2	334,465
20.5 and greater	Greater than 2.2	372,921

The Agreement allows for the use of alternative approaches for estimating the abundances including, for example, the use inseason data for the NBC or WCVI fisheries, or reliance on the CTC model for the SEAK fisheries.

Provisions of the 2019 Agreement result in reductions in catch in the SEAK and WCVI AABM fisheries relative to those allowed under the 2009 Agreement, but the magnitude of the reduction changes depending on the abundance. Generally, the required reductions are less in years of high abundance. In the SEAK fishery, in most cases, catch is reduced by 7.5 percent relative to what was allowed in the 2009 Agreement, but at higher abundance levels catch reductions are either 3.25 or 1.5 percent. In the WCVI fishery, in most cases, catch is reduced by 12.5 percent relative to what was allowed in the 2009 Agreement, but are either 4.8 or 2.4 percent during years of high abundance (see Table 2). The abundance break points were set with the expectation that the SEAK and WCVI reductions would be at 7.5 and 12.5 percent in three out of four years, and at 3.25 and 4.8 percent, respectively in most remaining years. The reductions would be 1.5 and 2.4 percent in the SEAK and WCVI fisheries only if abundance levels exceed those observed over the same time period. All Chinook salmon fisheries subject to the Treaty that are not AABM fisheries are classified as ISBM fisheries. ISBM fisheries include, but are not limited to: northern British Columbia marine net and coastal sport (excluding Haida Gwaii), and freshwater sport and net; central British Columbia marine net, sport and troll and freshwater sport and net; southern British Columbia marine net, troll and sport and freshwater sport and net; West Coast of Vancouver Island inside marine sport and net and freshwater sport and net; south Puget Sound marine net and sport and freshwater sport and net; north Puget Sound marine net and sport and freshwater sport and net; Juan de Fuca marine net, troll and sport and freshwater sport and net; Washington Coastal marine net, troll and sport and freshwater sport and net; Washington Ocean marine troll and sport; Columbia River net and sport; Oregon marine net, sport and troll, and freshwater sport; Idaho (Snake River Basin) freshwater sport and net.

ISBM fisheries are fundamentally different from AABM fisheries. In AABM fisheries, a limit on total catch is set based on measures of the aggregate abundance of all stocks available to the fishery. ISBM fisheries are managed to meet the management objectives for a set of individual stocks, and, if those objectives are not met, to limit the stock specific exploitation rate (ER) in the ISBM fisheries for each stock. The indicator stocks used to manage the ISBM fisheries and their associated management objectives are listed in Table 5 (referred to as Attachment I in the 2019 Agreement). There are twelve Canadian indicator stocks and nineteen indicator stocks from the southern U.S. The calendar year ER limit (CYER) for each stock is also listed in Table 5. The ER limits are expressed relative to the 2009-2015 average CYER. For some stocks 2009-

2015 average is the ER limit (e.g., 100 percent avg. 09-15); for other stocks the limit is expressed as a reduction from the 2009-2015 average (e.g., 85 percent avg. 09-15). If the management objectives for the indicator stocks is still "to be determined" (TBD), the CYER limit always applies. If the management is specified, the CYER limit only applies in years when the management objective will not be met.

Table 5. Indicator stocks, ISBM fishery limits, and management objectives applicable to obligations specified in paragraphs 1, 5, 6, and 7 (referred to as Appendix I in the 2019 Agreement). NA=Not Available, avg=Average, adj=indicates that CWT tag recoveries in the terminal area need to be adjusted for the differences in harvest rate between the tagged hatchery fish and the natural-origin stock that they represent.

Stock Region	Escapement Indicator Stock (CWT Indicator Stock[8])	Canadian ISBM CYER Limit	US ISBM CYER Limit	Management Objective
SEAK/ TBR	Situk[1] (TBD)	NA	NA	500-1,000
	Alsek[1,2] (TBD)	NA	NA	3,500-5,300
	Taku[1,2]	NA	NA	19,000-36,000
	Chilkat[1]	NA	NA	1,750-3,500
	Stikine[1,2]	NA	NA	14,000-28,000
	Unuk[1]	NA	NA	1,800-3,800
BC	Skeena	100% avg 09-15	NA[3]	TBD[6]
	Atnarko	100% avg 09-15	NA[3]	5,009[4,5]
	NWVI Natural Aggregate (Colonial-Cayeagle, Tashish, Artlish, Kaouk) (RBT adj)	95% avg 09-15	NA[3]	TBD[6]
	SWVI Natural Aggregate (Bedwell-Ursus, Megin, Moyeha) (RBT adj)	95% avg 09-15	NA[3]	TBD[6]
	East Vancouver Island North (TBD) (QUI adj)	95% avg 09-15	NA[3]	TBD[6]
	Phillips	100% avg 09-15	NA[3]	TBD[6]
	Cowichan	95% avg 09-15	95% avg 09-15	6,500
	Nicola	95% avg 09-15	95% avg 09-15	TBD[6]
	Chilcotin (in development)	95% avg 09-15	NA[3]	TBD[6]
	Chilko (in development)	95% avg 09-15	NA[3]	TBD[6]
	Lower Shuswap	100% avg 09-15	NA[3]	12,300[4]
	Harrison	95% avg 09-15	95% avg 09-15	75,100
	Canadian Okanagan (SUM adj)[9]	NA[3]	TBD	TBD[6]
WA/ OR/ID	Nooksack Spring	87.5% avg 09-15	100% avg 09-15	TBD[6]
	Skagit Spring	87.5% avg 09-15	95% avg 09-15	690[4]
	Skagit Summer/Fall	87.5% avg 09-15	95% avg 09-15	9,202[4]
	Stillaguamish	87.5% avg 09-15	100% avg 09-15	TBD[6]
	Snohomish	87.5% avg 09-15	100% avg 09-15	TBD[6]
	Hoko	NA[3]	10% CYER[7]	TBD[6]
	Grays Harbor Fall (QUE adj)	NA[3]	85% avg 09-15	13,326
	Queets Fall	NA[3]	85% avg 09-15	2,500

Stock Region	Escapement Indicator Stock (CWT Indicator Stock[8])	Canadian ISBM CYER Limit	US ISBM CYER Limit	Management Objective
	Quillayute Fall (QUE adj)	NA[3]	85% avg 09-15	3,000
	Hoh Fall (QUE adj)	NA[3]	85% avg 09-15	1,200
	Upriver Brights	NA[3]	85% avg 09-15	40,000
	Lewis	NA[3]	85% avg 09-15	5,700
	Coweeman	NA[3]	100% avg 09-15	TBD[6]
	Mid-Columbia Summers	NA[3]	85% avg 09-15	12,143
	Nehalem (SRH adj)	NA[3]	85% avg 09-15	6,989
	Siletz (SRH adj)	NA[3]	85% avg 09-15	2,944
	Siuslaw (SRH adj)	NA[3]	85% avg 09-15	12,925
	South Umpqua (ELK adj)	NA[3]	85% avg 09-15	TBD[6]
	Coquille (ELK adj)	NA[3]	85% avg 09-15	TBD[6]

[1]Identified for management of SEAK fisheries in paragraph 6(b)(iv).
[2]Stock specific harvest limits specified in Chapter 1.
[3]Not Applicable since less than 15% of the recent total mortality was in these fisheries.
[4]Agency escapement goal to have the same status as CTC agreed escapement goal for implementation of Chapter 3.
[5]Natural origin spawners.
[6]To Be Determined after CTC review specified in paragraph 2(b)(iv).
[7]ISBM limit set at 10% in recognition of closure of the Hoko River to Chinook salmon fishing in 2009-2015.
[8] CWT indicator stocks and fishery adjustments described in (PSC 2016).
[9]Pending the review specified in paragraph 5(b) and a subsequent Commission decision.

There are several points to be made that help clarify key features of the Agreement. As explained above, fisheries are classified into one of two categories – AABM or ISBM. The AABM fisheries include the three large mixed stock fisheries in SEAK and off of NBC and WCVI. The ISBM fisheries include the remaining near-shore and inland marine and freshwater fisheries that affect any of the designated stocks of interest. By definition, fisheries that are not AABM fisheries are ISBM fisheries. As a consequence, all fishery related mortality is accounted for across the entire suite of fisheries, whether they are the result of AABM fisheries or fisheries managed for specific stock limits (ISBM).

Second, the ISBM limits are expressed as a mortality rate (CYER limits) that is indexed to the 2009-2015 base period as opposed, for example, to expressing the limit as an absolute ER. Expressing the limits as a CYER index requires some translation to determine the total absolute ER on particular stocks, but facilitates the negotiation of limits within the PSC process and implementation, evaluation and monitoring of those limits during implementation of the Agreement. In the 2009 Agreement ISBM fisheries were also managed using an index of relative change. For example, U.S. ISBM fisheries were managed subject to a 60 percent reduction in total adult equivalent mortality relative to the 1979 to 1982 base period. The 2019 Agreement will use a different measure of mortality (CYER) and a different base period (2009 to 2015), but still uses an indexing approach to measure relative change in the ISBM fisheries.

Third, the limits for the ISBM fisheries are established and monitored relative to a specific list of natural stock or stock groups identified in Table 5. The stocks on this list are those that are significantly affected by the particular ISBM fisheries, are thought to be broadly representative of natural stocks of similar life histories from a particular region, and have a sufficiently long time series of data to facilitate management and the monitoring of compliance with the commitments in the Agreement. It is important to note that the purpose of the stock list and the criteria used to place a stock on the list may be different than what might be used, for example, by U.S. domestic managers for assessing the status of populations in a listed ESU.

Finally, it is important to note that a Party may choose voluntarily to apply more constraints to its fisheries than are specifically required by the Agreement. In fact, it was clearly understood throughout the negotiations that U.S. ISBM fisheries have been and would continue to be managed to meet the requirements of the ESA, and that the international obligations should not be more restrictive than domestic obligations. As explained previously, the PSC negotiations seek to assign conservation obligations and harvest sharing among AABM fisheries versus ISBM fisheries, Canadian fisheries versus U.S. fisheries, and Alaskan fisheries versus southern U.S. fisheries; the bilateral negotiations do not attempt to develop the stock and fishery-specific constraints that are required by the ESA. Just as it was expected that the United States would further constrain its ISBM fisheries to meet ESA requirements, it was understood that Canada might choose to further constrain its AABM or ISBM fisheries, for example, to meet Canadian domestic allocation and/or conservation objectives for Canadian stocks.

The proposed 2019 Agreement includes a number of changes relative to the regime it replaces. The most notable and immediate change is that it reduces the allowable annual catch in the SEAK and WCVI AABM fisheries by 7.5 and 12.5 percent (in most years), respectively, compared to the previous agreement. This comes on top of the reductions of 15 and 30 percent for those same fisheries that occurred as a result of the 2009 Agreement. ISBM fisheries are also subject to greater limits than those in the 2009 Agreement. CYERs obligations are set relative to the 2009-2015 average (Table 5). Managing to a recent year average means that future fisheries will be reduced. For example, if the ERs in the last five years were 5, 10, 15, 20 and 25 percent, the average is 15 percent. If future fisheries are now subject to a 15 percent ER limit, it is no longer possible to manage in any particular year for rates that are higher than 15 percent and the average from future fisheries will be less. Although provisions of the Agreement are complex, they were specifically designed to reduce fishery impacts in both the AABM and ISBM fisheries to respond to conservation concerns for a number of U.S. and Canadian stocks.

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, each Federal agency must ensure that its 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 agency's actions would affect listed species and their critical habitats. 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 (RPMs) and terms and conditions to minimize such impacts.

This opinion considers the effects of the proposed action on the ESUs and DPSs of ESA-listed species listed in Table 1.

NMFS determined the proposed action described in Section 1.3 are not likely to adversely affect ESA species shown in Table 6 or their critical habitat. The basis for these determinations is discussed in the "Not Likely to Adversely Affect" Determinations Section (2.12).

Table 6. Species not likely adversely affected by the proposed actions described in Section 1.3.

Species	Listing Status[1]	Critical Habitat	Protective Regulations
Chinook salmon *(O. tshawytscha)*			
Upper Columbia River spring-run	E: 70 FR 20816, 4/14/14	70 FR 52732, 9/02/05	Issued under ESA Section 9
Snake River spring/summer-run	T: 79 FR 20802, 4/14/14	64 FR 57399, 10/25/99	70 FR 37160, 6/28/05
California Coastal	T: 79 FR 20802, 4/14/14	70 FR 52488, 9/02/05	70 FR 37160, 6/28/05
Central Valley spring-run	T: 79 FR 20802, 4/14/14	70 FR 52488, 9/02/05	70 FR 37160, 6/28/05
Sacramento River winter-run	E: 59 FR 440, 01/04/94	58 FR 33212, 06/16/93	Issued under ESA Section 9
Coho salmon *(O. kisutch)*			
Lower Columbia River	T: 79 FR 20802, 4/14/14	81 FR 9252, 02/24/16	70 FR 37160, 6/28/05
Oregon Coast	T: 79 FR 20802, 4/14/14	73 FR 7816, 02/11/08	73 FR 7816, 02/11/08
Southern Oregon/Northern California Coast	T: 79 FR 20802, 4/14/14	64 FR 24049, 05/05/99	70 FR 37160, 6/28/05
Central California Coast	E: 79 FR 20802, 4/14/14	64 FR 24049, 5/05/99	Issued under ESA

Species	**Listing Status[1]**	**Critical Habitat**	**Protective Regulations**
			Section 9
Chum salmon *(O. keta)*			
Columbia River	T: 79 FR 20802, 4/14/14	70 FR 52746, 9/02/05	70 FR 37160, 6/28/05
Hood Canal summer-run	T: 79 FR 20802, 4/14/14	70 FR 52630, 9/02/05	70 FR 37160, 6/28/05
Sockeye salmon *(O. nerka)*			
Ozette Lake	T: 79 FR 20802, 4/14/14	70 FR 52756, 9/02/05	70 FR 37160, 6/28/05
Snake River	E: 79 FR 20802, 04/14/14	70 FR 52630, 9/02/05	Issued under ESA Section 9
Steelhead *(O. mykiss)*			
Puget Sound	T: 79 FR 20802, 4/14/14	81 FR 9252, 02/24/16	73 FR 55451, 9/25/08
Lower Columbia River	T: 79 FR 20802, 4/14/14	70 FR 52833, 9/02/05	70 FR 37160, 6/28/05
Upper Willamette River	T: 79 FR 20802, 4/14/14	70 FR 52848, 9/02/05	70 FR 37160, 6/28/05
Middle Columbia River	T: 79 FR 20802, 4/14/14	70 FR 52808, 9/02/05	70 FR 37160, 6/28/05
Upper Columbia River	T: 79 FR 20802, 4/14/14	70 FR 52630, 9/02/05	71 FR 5178, 2/01/06
Snake River Basin	T: 79 FR 20802, 4/14/14	70 FR 52769, 9/02/05	70 FR 37160, 6/28/05
Northern California	T: 71 FR 834, 1/05/06	70 FR 52769, 9/02/05	70 FR 37160, 6/28/05
California Central Valley	T: 79 FR 20802, 4/14/14	70 FR 52769, 9/02/05	70 FR 37160, 6/28/05
Central California Coast	T: 79 FR 20802, 4/14/14	70 FR 52769, 9/02/05	70 FR 37160, 6/28/05
South-Central California Coast	T: 79 FR 20802, 4/14/14	70 FR 52769, 9/02/05	70 FR 37160, 6/28/05
Southern California	E: 79 FR 20802, 4/14/14	70 FR 52769, 9/02/05	Issued under ESA Section 9
Marine Mammals			
Blue Whale *(Balaenoptera musculus)*	E: 35 FR 18319, 12/02/70	N/A	Issued under ESA Section 9
Fin Whale (*B. physalus*)	E: 35 FR 12222, 7/30/70	N/A	Issued under ESA

Species	Listing Status[1]	Critical Habitat	Protective Regulations
			Section 9
Sei Whale (*B. borealis*)	E: 35 FR 12222, 7/30/70	N/A	Issued under ESA Section 9
North Pacific Right Whale (*Eubalaena japonica*)	E: 73 FR 12024, 3/06/08	73 FR 19000, 4/08/08	81 FR 62021, 9/08/16
Sperm Whale (*Physeter microcephalus*)	E: 35 FR 18319, 12/02/70	N/A	Issued under ESA Section 9
Western North Pacific Gray Whale (*Eschrichtius robustus*)	E: 35 FR 18319, 12/02/70	N/A	Issued under ESA Section 9

1. Listing status of T = threatened; E = endangered.

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 rangewide status of the species and critical habitat expected 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). 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 rangewide status of listed species, we rely on viability assessments and criteria in technical recovery team documents and recovery plans, and other information where available, that describe how VSP criteria are applied to specific populations, major population groups, and species. We determine the rangewide status of critical habitat by examining the condition of its physical or biological features (also called "primary constituent elements" or PCEs in some designations) which were identified when the critical habitat was designated.

- *Describe the environmental baseline in the action area.* The environmental baseline (Section 2.4) includes the past and present impacts of Federal, state, or private actions and other human activities in the action area (Section 2.3). 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 2.5), 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 2.7).

- *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, suggest a RPA 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 and Critical Habitat

This opinion examines the status of each species that would be adversely 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, and listing decisions. 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. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential PBFs that help to form that conservation value.

This section consists of narratives for each of the endangered and threatened species that occur in the action area and that may be adversely affected by the proposed action. In each narrative, we present a summary of information on the population structure and distribution of each species to provide a foundation for the exposure analyses that appear later in this opinion. Then we summarize information on the threats to the species and the species' status given those threats to provide points of reference for the jeopardy determinations we make later in this opinion. That is, we rely on a species' status and trend to determine whether or not an action's direct or indirect effects are likely to increase the species' probability of becoming extinct.

2.2.1 Status of Listed Species

For Pacific salmon and steelhead, NMFS commonly uses four parameters to assess the viability of the populations that, together, constitute the species: abundance, productivity, spatial structure, and diversity (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 substantially influenced by habitat and other environmental conditions.

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

"Productivity," as applied to viability factors, refers to the entire life cycle; i.e., the number of naturally-spawning adults (i.e., progeny). 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.

"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 accessibility to the habitat, 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).

In describing the range-wide status of listed species, we rely on viability assessments, status reviews, and criteria in Technical Recovery Team (TRT) documents, recovery plans, and other available information when available, that describe VSP criteria at the population, major population group (MPG), and species scales (i.e., salmon ESUs and steelhead DPSs). For species with multiple populations, once the biological status of a species' populations and MPGs has been determined, NMFS assesses the status of the entire species. 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 meta-populations (McElhany et al. 2000).

In order to describe a species' status, it is first necessary to define what the term "species" means in this context. In addition to defining "species" as including an entire taxonomic species or subspecies of animals or plants, the ESA also recognizes listing units that are a subset of the species as a whole. As described above, the ESA allows a DPS (or in the case of salmon, an ESU) of a species to be listed as threatened or endangered. In terms of determining the status of a species, the Willamette Lower Columbia TRT (WLC TRT) developed a hierarchical approach for determining ESU-level viability criteria (Figure 2).

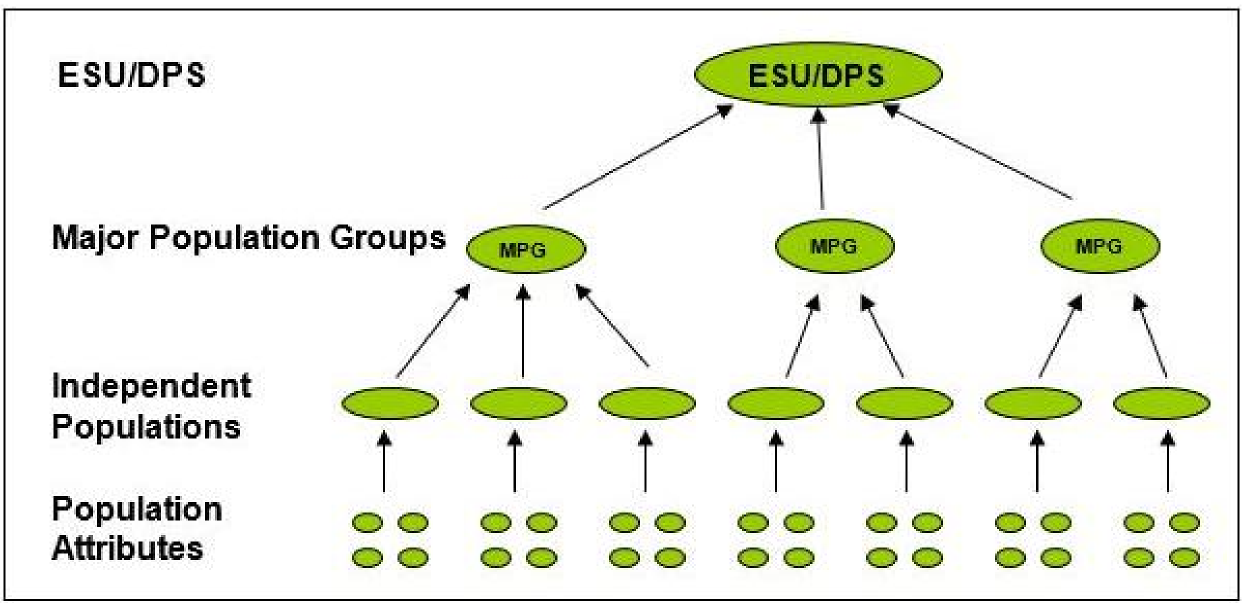

Figure 2. Hierarchical approach to ESU viability criteria.

Briefly, an ESU or DPS is divided into natural populations (McElhany et al. 2000). The risk of extinction of each population is evaluated, taking into account population-specific measures of abundance, productivity, spatial structure, and diversity. Natural populations are then grouped into ecologically and geographically similar *strata,* referred to as major population groups (MPG) which are evaluated on the basis of population status. In order to be considered viable, an MPG generally must have at least half of its historically present natural populations meeting their population-level viability criteria (McElhany et al. 2006). At the MPG-level each of the ESU's MPGs also must be viable. A viable salmonid ESU or DPS is naturally self-sustaining, with a high probability of persistence over a 100-year time period.

NMFS has taken a very similar approach for Puget Sound Chinook, but there are some differences in the details related to recovery criteria. The 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 (Puget Sound Salmon Recovery Plan (SSPS 2007) and Final Supplement to the Shared Strategy's Puget Sound Salmon Recovery Plan (NMFS 2006b). The recovery plan adopts ESU and population level viability criteria recommended by the Puget Sound Technical Recovery Team (PSTRT) (Ruckelshaus et al. 2002; Ruckelshaus et al. 2006). 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 long-term[2];
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;
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.

In assessing status, we start with the information used in its most recent ESA status review for the salmon and steelhead species considered in this opinion, and if applicable consider more recent data, that are relevant to the species' rangewide status. Many times, this information exists in ESA recovery plans or annual performance reports from existing ESA authorizations. Recent information from recovery plans, where they are developed for a species, is often relevant and is used to supplement the overall review of the species' status. This step of the analysis tells us how well the species is doing over its entire range in terms of trends in abundance and productivity, spatial distribution, and diversity. It also identifies the causes for the species' decline.

The status review starts with a description of the general life history characteristics and the population structure of the ESU or DPS including the MPGs where they occur. We review VSP information that is available including abundance, productivity and trends (information on trends supplements the assessment of abundance and productivity parameters), and spatial structure and diversity. We also summarize available estimates of extinction risk that are used to characterize the viability of each natural population leading-up to a risk assessment for the ESU or DPS, and the limiting factors and threats. This Section concludes by examining the status of critical habitat.

Recovery plans are an important source of information that describe, among other things, the status of the species and its component populations, limiting factors, recovery goals and actions that are recommended to address limiting factors. Recovery plans are not regulatory documents. Consistency of a proposed action with a recovery plan, therefore, does not by itself provide the basis for determining that an action does not jeopardize the species. However, recovery plans do provide a perspective encompassing all human impacts that is important when assessing the effects of an action. Information from existing recovery plans for each respective ESA-listed salmon and steelhead is discussed where it applies in various sections of this opinion.

Recovery domains are the geographically-based areas within which NMFS prepares recovery plans. The species analyzed in the consultation occur in three recovery domains (Table 7).

Table 7. Recovery planning domains identified by NMFS and their ESA-listed salmon and steelhead species.

Recovery Domain	Species
Willamette-Lower Columbia (WLC)	LCR Chinook salmon UWR Chinook salmon
Interior Columbia (IC)	SR fall-run Chinook salmon
Puget Sound	Puget Sound Chinook salmon

For each recovery domain, a TRT appointed by NMFS has developed, or is developing, criteria necessary to identify independent populations within each species, recommended viability criteria for those species, and descriptions of factors that limit species survival. Viability criteria are prescriptions of the biological conditions for populations, biogeographic strata, and evolutionarily significant units ESUs and distinct population segments DPSs that, if met, would indicate that an ESU or DPS will have a negligible risk of extinction over a 100-year time frame.[1]

Although the TRTs dealing with anadromous fish species operated from the common set of biological principals described in McElhany et al. (2000), they worked semi-independently from each other and developed criteria suitable to the species and conditions found in their specific recovery domains. All of the criteria have qualitative as well as quantitative aspects. The

[1] For Pacific salmon, NMFS uses its 1991 ESU policy, which states that a population or group of populations will be considered a Distinct Population Segment if it is an Evolutionarily Significant Unit. An ESU represents a distinct population segment of Pacific salmon under the Endangered Species Act that: (1) is substantially reproductively isolated from conspecific populations, and (2) represents an important component of the evolutionary legacy of the species. The species *O. mykiss* is under the joint jurisdiction of NMFS and the United States Fish and Wildlife Service (USFWS), so in making its January 2006 listing determinations NMFS elected to use the 1996 joint FWS-NMFS DPS policy for this species.

diversity of salmonid species and populations makes it impossible to set narrow quantitative guidelines that will fit all populations in all situations. For this and other reasons, viability criteria vary among species, mainly in the number and type of metrics and the scales at which the metrics apply (*i.e.*, population, MPG, or ESU/DPS) (Busch et al. 2008).

Most TRTs included in their viability criteria a combined risk rating for abundance and productivity (A/P), and an integrated spatial structure and diversity (SS/D) risk rating (*e.g.*, Interior Columbia TRT) or separate risk ratings for spatial structure and diversity (*e.g.,* WLC TRT).

The boundaries of each population were defined using a combination of genetic information, geography, life-history traits, morphological traits, and population dynamics that indicate the extent of reproductive isolation among spawning groups. The overall viability of a species is a function of the VSP attributes of its constituent populations. Until a viability analysis of a species is completed, the VSP guidelines recommend that all populations should be managed to retain the potential to achieve viable status to ensure a rapid start along the road to recovery, and that no significant parts of the species are lost before a full recovery plan is implemented (McElhany et al. 2000).

Viability status or probability or population persistence is described below for each of the populations considered in this opinion. The Sections that follow describe the status of the ESA-listed species, and their designated critical habitats, that occur within the geographic area of this proposed action and are considered in this opinion.

2.2.2 Status of the Chinook salmon ESUs

Chinook salmon have a wide variety of life-history patterns that include: 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). Ocean-type Chinook salmon reside in coastal ocean waters for three to four years before returning to freshwater and exhibit extensive offshore ocean migrations, compared to stream-type Chinook salmon that spend two to three years in coastal ocean waters. The ocean-type 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 typically reside in freshwater 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.

Chinook salmon species evaluated in this consultation include Puget Sound Chinook salmon, LCR Chinook salmon, UWR Chinook salmon, and Snake River Fall-Run Chinook Salmon. The TRTs identified 62 demographically independent populations of Pacific Chinook salmon (Table 8). These populations were further aggregated into strata or MPGs, groupings above the population level that are connected by some degree of migration, based on ecological subregions.

Table 8. Chinook ESA-listed salmon populations considered in this opinion.

Species	Populations
LCR Chinook salmon	32
UWR Chinook salmon	7
Snake River Fall-Run Chinook Salmon	1
Puget Sound Chinook salmon	22
Total	62

2.2.2.1 Lower Columbia River Chinook Salmon ESU

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 (79 FR 20802). Critical Habitat for LCR Chinook salmon was designated on September 2, 2005 (70 FR 52706).

Within the geographic range of this ESU, 27 hatchery Chinook salmon programs are currently operational. Fourteen of these hatchery programs are included in the ESU (Table 9), while the remaining 13 programs are excluded (Jones Jr. 2015). 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 and will be included in any listing of the ESU" (NMFS 2005d). For a detailed description of how NMFS evaluates and determines whether to include hatchery fish in an ESU or DPS, see NMFS (2005d).

Table 9. LCR Chinook Salmon ESU description and MPGs (NMFS 2013c; Jones Jr. 2015; NWFSC 2015; NMFS 2016c).

ESU Description[1]	
Threatened	Listed under ESA in 1999; updated in 2014.
6 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)
Artificial production	

ESU Description[1]	
Hatchery programs included in ESU (14)	Big Creek Tule Fall Chinook, Astoria High School (STEP), Tule Fall Chinook, Warrenton High School (STEP), 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, Little White Salmon NFH Spring Chinook

[1] The designations "(C)" and "(G)" identify Core and Genetic Legacy populations, respectively.[2]

Thirty-two historical populations, within six MPGs, comprise the LCR Chinook Salmon ESU. These are distributed through three ecological zones[3] (Figure 3). A combination of life-history types, based on run timing and ecological zones, result in six MPGs, some of which are considered extirpated or nearly extirpated (Table 10). The run timing distributions across the 32 historical populations are: nine spring populations, 21 early-fall populations, and two late-fall populations (Table 10).

[2] 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 may exhibit important life-history characteristics that are no longer found throughout the ESU (McElhany et al. 2003).

[3] There are a number of methods of classifying 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 10. Current status for LCR Chinook salmon populations and recommended status under the recovery scenario (NMFS 2013c).

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
Cascade Late Fall	North Fork Lewis (WA)	VH	Primary	VH	7,300
	Sandy (OR)	H	Primary	VH	3,561

[1] (LCFRB 2010) used the late 1990s as a baseline period for evaluating status; ODFW (2010a) assume average environmental conditions of the period 1974-2004. VL = very low, L = low, M = moderate, H = high, VH = very high. These are adopted in the recovery plan (NMFS 2013c).

[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 2013c).

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

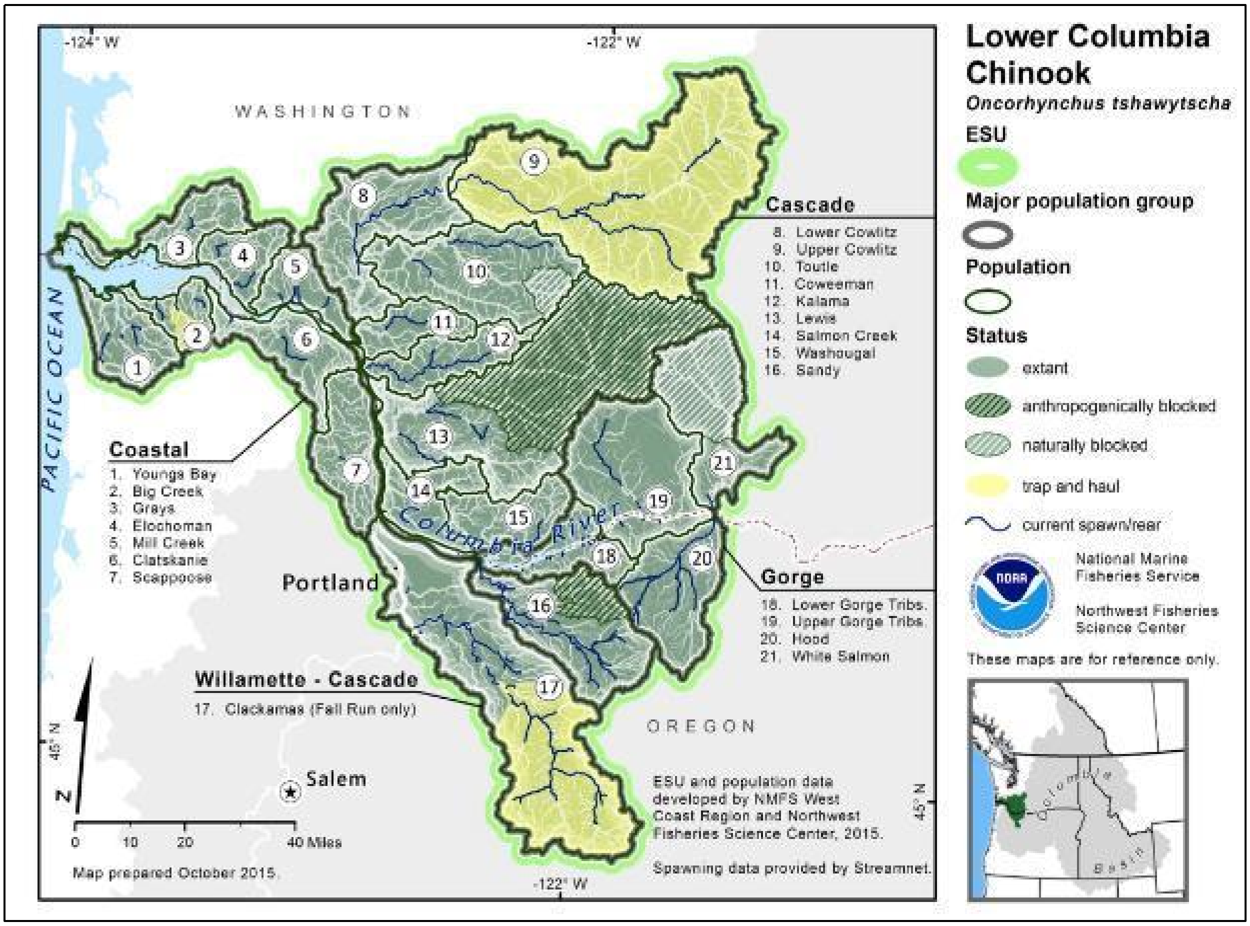

Figure 3. Map of the LCR Chinook Salmon ESU's spawning and rearing areas, illustrating populations and MPGs. Several watersheds contain or historically contained both fall and spring runs; only the fall-run populations are illustrated here (NWFSC 2015).

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 11). 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 and rivers as large as the mainstem Columbia (NMFS 2013c). Stream characteristics determine the distribution of run types among LCR streams. Depending on run type, Chinook salmon may rear anywhere from 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 can reach sizes of 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 2013c).

Table 11. Life-history and population characteristics of LCR Chinook salmon.

Characteristic	Life-History Features		
	Spring	**Early-fall (tule)**	**Late-fall (bright)**
Number of extant populations	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	mainstem large tributaries	mainstem 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 mainstem	mainstem, tributaries, sloughs, estuary	mainstem, 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 a 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 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) (NMFS 2013c). 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 have a more northern oceanic distribution. Currently, the abundance of all fall Chinook salmon greatly exceeds that of the spring component (NWFSC 2015; NMFS 2016c).

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 10. Additionally Table 10 provides the 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 < 40%) to very high (probability

>99%).

If the recovery scenario in Table 10 were achieved, it would exceed the WLC TRT's MPG-level viability criteria for the Coast and Cascade fall MPGs, the Cascade spring MPG, and the Cascade late-fall MPG. However, the recovery scenario for Gorge spring and Gorge fall Chinook salmon does not meet WLC TRT criteria as, within each MPG, the scenario targets only one population (the Hood) for high persistence probability. Exceeding the WLC TRT criteria, particularly in the Cascade fall and Cascade spring Chinook salmon MPG, was intentional on the part of local recovery planners to compensate for uncertainties about meeting the WLC TRT's criteria in the Gorge fall and spring MPGs. In addition, multiple spring Chinook salmon natural populations are prioritized for aggressive recovery efforts to balance risks associated with the uncertainty of success in reintroducing spring Chinook salmon populations above tributary dams in the Cowlitz and Lewis systems.

NMFS (2013c) 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, due to 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, as it will help 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.

In 2017 NMFS adopted a Record of Decision ("Mitchell Act ROD") for a policy direction that would be used to guide NMFS' decision on the distribution of funds for hatchery production under the Mitchell Act (16 US CFR 755 757), which NMFS administers. NMFS' continued funding of Mitchell Act hatchery programs, under the Mitchell Act ROD, was analyzed under the ESA and found not likely to jeopardize the continued existence of any species in the Columbia Basin (NMFS 2017e). The Mitchell Act ROD directs NMFS to apply stronger performance goals to all Mitchell Act-funded, Columbia River Basin, hatchery programs that affect ESA-listed primary and contributing salmon and steelhead populations. These stronger performance goals reduced the risks of hatchery programs to natural-origin salmon and steelhead populations, including the LCR Chinook Salmon ESU, and primarily to the tule Chinook salmon MPGs. It required integrated hatchery programs to be better integrated and isolated hatchery programs to be better isolated. The following information presented is a review of updated status information available. NMFS expects the prevalence of hatchery-origin tule Chinook salmon spawning contribution to decrease over the course of the 2019 Agreement, due to the ITS limits and terms and conditions required by the opinion (NMFS 2017e).

The information provided by the WLC TRT and the management unit recovery planners led NMFS to conclude in the recovery plan that the recovery scenario (Table 10) represents one of multiple possible scenarios that would meet biological criteria for delisting. The similarities between the Gorge and Cascade MPG, 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 9). 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 are provided in Table 12. The combined hatchery-origin and natural-origin LCR spring Chinook salmon run sizes for the Cowlitz, Kalama, and Sandy rivers populations have all numbered in the thousands in recent years (Table 12). 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 (NMFS 2013c). Cowlitz and Kalama river hatcheries' escapement objectives have been met in recent years with few exceptions (Table 12).

A reintroduction program is now being implemented on the Cowlitz River that 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. However, for the time being, the reintroduction program relies primarily on the use of surplus hatchery adults. (Information on the hatchery program and associated Settlement Agreement with Tacoma Power can be found at: 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, first priority is populations that are managed 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 the 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.

The Cowlitz and Kalama river systems have all met their hatchery's escapement objectives in recent years, with a few exceptions based on the goals established in their respective Hatchery Genetic and Management Plan (HGMP; Table 12). Escapement for the Lewis River hatchery has fallen short in recent years, but additional harvest management measures have been taken to help offset the projected shortfalls. This, 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 as habitat there was probably not as productive for spring Chinook salmon as other spring Chinook salmon populations in the ESU (NMFS 2013c). In the recovery scenario, the Kalama spring Chinook salmon population is designated as a contributing population targeted for a relatively lower persistence probability, as again habitat there was likely not as productive historically for spring Chinook salmon (Table 3 in NMFS 2013c).

Legacy effects of the 1980 Mount St. Helens eruption are still a fundamental limiting factor for the Toutle spring Chinook salmon natural population (NMFS 2013c). The North Fork Toutle 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 sediment 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 2013c), 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 population has been designated a contributing population targeted for medium persistence probability under the recovery scenario (Table 10).

Table 12. Total tributary returns for LCR spring Chinook along with hatchery escapement and natural spawning estimates (*U.S. v. Oregon* TAC 2017, Table 2.1.10)*.

Year	Cowlitz			Kalama			Lewis			Sandy		
	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	n/a	935
1998	1,055	812	262	407	408	42	1,611	1,148	211	3,577	n/a	700
1999	2,069	1,321	235	977	794	215	1,753	845	241	3,585	n/a	581
2000	2,199	1,408	264	1,418	1,256	33	2,515	776	473	3,641	n/a	564
2001	1,609	1,306	315	1,796	952	555	3,777	1,193	678	5,329	n/a	988
2002	5,152	2,713	781	2,912	1,374	886	3,514	1,865	493	5,905	n/a	1,445
2003	15,954	10,481	2,485	4,556	3,802	766	5,040	3,056	679	5,615	n/a	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	n/a	3,149	2,642	n/a	1,006	908	147	4,657	365	2,023
2016	22,478	n/a	n/a	3,980	n/a	n/a	473	n/a	n/a	4,151	123	3,590

* Hatchery and natural won't 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.

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 10), 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 5,600 since 2000 (Table 12). 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 targeted persistence probability level.

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 Oregon Department of Fish and Wildlife (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 (NMFS 2016c). Additionally, the White Salmon River population is considered extirpated (NMFS 2013c, Appendix C).

Most of the habitat that was historically available to spring Chinook salmon in the Hood River is still accessible. Due to 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 Middle Columbia River (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. These deficiencies are attributed to production practices (ISRP 2008; CTWSR 2009; NMFS 2013c). The delisting persistence probability target is listed as very high, but NMFS (2013c) believes that the prospects for meeting that target are uncertain. The estimates of spring Chinook salmon returning to the Hood River are in Table 13.

Table 13. Total, hatchery, and natural-origin spring Chinook returns to the Hood River *(U.S. v. Oregon* 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%

Year	Total Run Size [1]	Clipped Hatchery Run Size	Unclipped Presumed Natural-origin Run Size	Proportion Presumed Natural-origin
2009	1,314	1,248	66	5.0%
2010	635	507	128	20.2%
2011	1,377	1,377	n/a	n/a
2012	1,114	1,114	n/a	n/a
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 in 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; NMFS 2016c). 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, at this time, there is not enough data available 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 10).

Coast Fall MPG

There are seven natural populations in the Coast Fall Chinook salmon MPG. None are considered genetic legacy populations. 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 10). 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 is targeted for medium plus persistence probability. The Big Creek and Youngs Bay populations are targeted for low persistence probability (Table 10).

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 for the first time on the Grays River 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, and by 2010 the weir was functionally able to begin removing hatchery strays. It is worth noting that the escapement data, reported in Table 14, have been updated through 2015 relative to those reported in the 2010 status review (Ford et al. 2011a).

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 2013c). The last returns of these hatchery fish were likely 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 14) with most being of hatchery-origin (Beamesderfer et al. 2011). The M/A/G population does not have an in-basin hatchery program, but still has several hundred hatchery spawners each year. However, numbers have decreased slightly in the most recent years (Table 14).

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 2010a). 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 1997 to 2016 were based on expanded index counts, where 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 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 were seen in 2009 or 2010. All of the information above suggests that there are significant problems with the historical time series for the Clatskanie that have been 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 that data. The Clatskanie data was used in life-cycle modeling analysis done by the NWFSC (2010). The Clatskanie data was also used indirectly for the modeling analysis of the Scappoose natural population. As there were no direct estimates of abundance for the Scappoose, the data from the Clatskanie was 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. However, the recent data suggests that there are few hatchery strays and little or no natural production in the Clatskanie or Scappoose, and that the natural populations may be extirpated or nearly extirpated. Confirmation of these tentative conclusions will depend on more monitoring.

Table 14. 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 (pHOS1) on the spawning grounds for the Coast Fall MPG populations, 1997-2017 (from Washington Department of Fish and Wildlife (WDFW) SCoRE[2]).

Year	Clatskanie[3]	pHOS	Grays	pHOS	Elochoman[5]	pHOS	M/A/G[5]	pHOS	Youngs Bay[4]	pHOS
1997	7	n/a	2	88%	206	89%	139	77%	n/a	n/a
1998	9	n/a	23	76%	57	75%	221	40%	n/a	n/a
1999	10	n/a	133	32%	180	75%	397	31%	n/a	n/a
2000	26	90%	118	30%	122	38%	241	42%	n/a	n/a
2001	26	90%	112	57%	1,930	18%	1,569	61%	n/a	n/a
2002	39	90%	50	53%	0	100%	167	95%	n/a	n/a
2003	48	90%	155	61%	4,433	35%	2,134	44%	n/a	n/a
2004	11	90%	192	75%	48	99%	136	98%	n/a	n/a
2005	10	90%	60	59%	110	95%	271	87%	n/a	n/a
2006	4	90%	302	0%	317	0%	394	38%	n/a	n/a
2007	9	90%	63	0%	165	0%	161	52%	n/a	n/a
2008	9	90%	27	32%	84	90%	368	51%	n/a	n/a
2009	94	44%	134	57%	404	82%	562	7%	n/a	n/a
2010	12	88%	83	51%	137	89%	157	94%	1,152	0%
2011	12	100%	62	85%	63	94%	94	92%	1,584	61%
2012	6	92%	35	78%	62	70%	21	86%	170	97%
2013	3	92%	90	95%	80	82%	127	81%	409	95%
2014	7	91%	185	81%	150	78%	34	94%	119	95%
2015	4	91%	220	71%	234	76%	80	92%	382	81%
2016	2	98%	80	77%	92	75%	87	78%		
2017	n/a	n/a	295	48%	0	89%	17	83%		

[1] Proportion of hatchery-origin spawners (pHOS): hatchery fish escaping to the spawning grounds. For example, Clatskanie in 2007 had 9 natural-origin spawners and 90% 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/species/chinook.jsp?species=Chinook Date Accessed: October 4, 2017

[3] Clatskanie estimates are from: http://odfwrecoverytracker.org/explorer/species/Chinook/run/fall/esu/241/244/ Date Accessed: October 4, 2017

[4] Youngs Bay estimate is from: http://odfw.forestry.oregonstate.edu/spawn/pdf%20files/reports/2012-13LCTuleSummary%20.pdf Date accessed: May 19, 2016

[5] Elochoman and Germany/Abernathy/Mill estimates from 1997-2009 are considered a proportion on the WDFW SCoRE website. Elochoman estimates include the Skamokawa Creek Fall Chinook Spawners (proportion).

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 are 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 10). 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. The 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 2013c) (Table 10).

Escapements (natural-origin) to the Coweeman and Lewis have averaged 806 and 1,284, respectively, since 1997 (Table 15). The recovery abundance target for the Coweeman is 900 natural-origin fish, and 1,500 natural-origin fish for the East Fork Lewis (Table 10). 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). We have less information on returns to the Clackamas and Sandy Rivers, but ODFW indicated for that 90 percent of their spawners are likely hatchery strays from as many as three adjacent hatchery programs (NMFS 2013c, Appendix A).

The Coweeman and Lewis populations do not have in-basin hatchery programs and 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 broodstock 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 are described in more detail in Frazier (2011) and Stahl (2011).

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 of these populations is very low (Table 10). 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. However, as discussed earlier in this subsection, it is unlikely that the high viability objective can be met (Table 10). 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 2013c). 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 2013c, Appendix C). The number of fall Chinook salmon spawners in the White Salmon averaged 583 from 2005 to 2017 (Table 16). 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[4]. 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 broodstock, 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.

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 16). 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 2013c, 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 16). 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 16). As a consequence, hatchery-origin fish contribution to spawning levels varies in all of the Gorge area tributaries, but actual estimates are unknown for areas like Eagle Creek, Tanner Creek and Herman Creek.

[4] These fish are not part of the LCR Chinook Salmon ESU.

Table 15. LCR tule Chinook salmon total natural spawner escapement (natural-origin) and the proportion of hatchery-origin fish (pHOS[1]) on the spawning grounds for Cascade Fall MPG populations, 1997-2017 (from WDFW SCoRE[2])*.

Year	Coweeman	pHOS	Washougal	pHOS	Kalama	pHOS	Lewis	pHOS	Upper Cowlitz[3]	pHOS	Lower Cowlitz	pHOS	Toutle[4]	pHOS
1997	689	0%	560	88%	1,416	60%	305	0%	27	n/a	1,445	28%	n/a	n/a
1998	491	0%	713	76%	2,963	31%	127	0%	257	n/a	616	63%	1,353	n/a
1999	299	0%	2,128	32%	77	97%	331	0%	1	n/a	155	84%	720	n/a
2000	290	0%	1,509	30%	270	79%	515	0%	1	n/a	217	90%	879	n/a
2001	585	27%	1,677	57%	640	82%	525	30%	3,646	n/a	1,605	56%	4,971	n/a
2002	851	3%	2,844	53%	186	99%	795	23%	6,113	n/a	7,350	24%	7,896	n/a
2003	984	11%	1,343	61%	0	100%	723	2%	4,165	n/a	6,161	12%	13,943	n/a
2004	1,368	9%	2,649	75%	708	89%	403	71%	2,145	n/a	3,235	30%	4,711	n/a
2005	512	40%	1,098	59%	272	97%	607	0%	2,901	n/a	505	83%	3,303	n/a
2006	561	0%	271	86%	104	99%	1,066	18%	1,782	n/a	964	53%	5,752	n/a
2007	234	0%	1,329	13%	198	94%	359	27%	1,325	n/a	743	47%	1,149	n/a
2008	210	48%	2,317	7%	149	96%	493	13%	1,845	n/a	1,133	10%	1,725	n/a
2009	491	37%	822	70%	755	90%	299	0%	7,491	n/a	1,171	55%	539	n/a
2010	413	29%	592	89%	595	89%	1,534	37%	3,144	69%	2,550	32%	228	88%
2011	623	12%	471	85%	425	94%	1,651	29%	4,255	70%	2,745	26%	198	87%
2012	464	12%	253	74%	292	96%	1,259	33%	1,966	68%	1,553	43%	235	74%
2013	1,567	33%	1,196	67%	815	90%	6,171	25%	3,315	55%	3,478	20%	914	48%
2014	794	4%	998	35%	766	92%	3,427	46%	90	60%	2,921	33%	402	49%
2015	1,359	2%	1,334	54%	2,897	55%	6,079	45%	n/a	n/a	4,187	30%	378	37%
2016	411	6%	879	60%	2,544	40%	3,189	46%	n/a	n/a	2,879	26%	370	54%
2017	721	14%	658	41%	1,733	43%	2,412	38%	n/a	n/a	2,926	19%	314	47%

[1] proportion of hatchery-origin spawners (pHOS): hatchery fish escaping to the spawning grounds. For example, Coweeman in 2013 had 1,398 natural-origin spawners and 31% 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/species/chinook.jsp?species=Chinook
* Date Accessed: October 4, 2017
[3] Upper Cowlitz includes the Cispus portions of the Cowlitz River. Only natural spawner abundance estimates are shown. No data exists 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.

Table 16. LCR tule Chinook salmon total natural-origin spawner abundance estimates in Gorge Fall Strata populations, 2005-2017. Upper Gorge represents Washington (WA) estimates only.

Year	Upper Gorge (WA estimates only)[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	n/a	1,448	n/a	42	14%
2006	235	n/a	755	n/a	49	11%
2007	263	n/a	898	n/a	45	0%
2008	181	n/a	770	n/a	21	22%
2009	343	n/a	964	n/a	57	12%
2010	21	75%	313	10%	n/a	n/a
2011	210	82%	371	41%	n/a	n/a
2012	66	84%	220	57%	n/a	n/a
2013	559	73%	256	71%	n/a	n/a
2014	333	80%	447	54%	n/a	n/a
2015	1,594	66%	238	72%	n/a	n/a
2016	21	75%	313	10%	n/a	n/a
2017	n/a	n/a	n/a	n/a	n/a	n/a

[1] Online at: https://fortress.wa.gov/dfw/score/score/species/chinook.jsp?species=Chinook
Date Accessed: October 4, 2017

[2] For example, Hood River in 2005 had 42 natural-origin spawners and 14 % hatchery spawners. To calculate hatchery-origin numbers multiply (42/ (1-.14))-42 = ~7 hatchery-origin spawners. Online at: http://www.odfwrecoverytracker.org/explorer/species/Chinook/run/fall/esu/241/243/

[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 9). The baseline persistence probabilities of the Lewis and Sandy populations are very high and high, respectively; both populations are targeted for very high persistence probability under the recovery scenario (Table 10).

The *U.S. v. Oregon* Technical Advisory Committee designated for the 2019 Agreement provided estimates of the escapement of bright Chinook salmon to the Sandy River (Table 17). These estimates of spawning escapement are estimated using peak redd counts obtained from direct surveys in a 16 kilometer (km) index area that are expanded to estimates of spawning escapement by multiplying by a factor of 2.5 (*U.S. v. Oregon* TAC 2017). The recovery plan includes an appendix that describes how index counts are expanded to estimates of total abundance (ODFW 2010a, Appendix C). There are some minor differences between the values reported in ODFW (2010a, Appendix C) and those shown in Table 17 that reflect updates or revisions in prior index area estimates. The abundance target for delisting is 3,747 natural-origin fish (Table 10), and escapements have averaged about 728 natural-origin fish since 1995 (Table 17).

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 maximum sustained yield (MSY), is 5,700. The escapement has averaged 9,000 over the last ten years and has generally exceeded the goal by a wide margin since at least 1980. Escapement was below the goal from 2006 through 2008 (Table 17). 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 the goal since (Table 17). NMFS (2013c) identifies an abundance target under the recovery scenario of 7,300 natural-origin fish (Table 10), which is 1,600 more fish than the currently managed for 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, therefore exceeding the abundance objective (Table 17). Escapement of bright Chinook salmon to the Lewis River is expected to vary from year to year as it has in the past, but generally remain high relative to the population's escapement objectives, which suggests that the population is near capacity (NWFSC 2015; NMFS 2016c).

Table 17. Annual escapement of natural-origin LCR bright Chinook salmon from 1995-2016.*

Year	Lewis River[1, 2]	Sandy River
1995	9,715	1,036
1996	13,077	505
1997	8,168	2,001
1998	5,173	773
1999	2,417	447
2000	8,741	84
2001	11,274	824
2002	13,293	1,275
2003	12,912	619
2004	12,928	601
2005	9,775	770
2006	5,066	1,130
2007	3,708	171
2008	5,485	602
2009	6,283	318
2010	9,294	373
2011	8,205	1,019
2012	8,143	62
2013	15,197	1,253
2014	20,809	436
2015	23,614	1,274
2016	8,957	451

[1] Online at: https://fortress.wa.gov/dfw/score/score/species/chinook.jsp?species=Chinook. These have been updated and adjusted with the BA (*U.S. v. Oregon* TAC 2017).
[2] Data are total spawner estimates of wild late fall (bright) Chinook salmon.
* Date Accessed: October 4, 2017

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 2013c). The 2015 VSP status for LCR Chinook salmon populations indicate that a total of 2 of 32 populations are at their recovery viability goals (Table 18), although under the recovery plan scenario only one of these populations are at a moderate level of viability (NWFSC 2015; NMFS 2016c). The remaining populations generally require a higher level of viability, and most require substantial improvements to reach their viability goals (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 18 provides recently updated information about the abundance and productivity (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 (LCFRB 2010; ODFW 2010a).

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 2016j). Five of the six strata fall significantly short of the WLC-TRT criteria for viability; one stratum, Cascade late-fall, meets the WLC TRT criteria (NMFS 2013c; 2016j).

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 Rivers (very high for both) (Table 18) (NMFS 2013c). 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 due to inadequate spawning surveys and the presence of unmarked hatchery-origin spawners (NWFSC 2015; NMFS 2016c).

Table 18. 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 (NWFSC 2015; NMFS 2016c).[1] (WA=Washington, OR=Oregon)

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

MPG		Spawning Population (Watershed)	A/P	Spatial Structure	Diversity	Overall Persistence Probability
Ecological Subregion	**Run Timing**					
		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
		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	Youngs 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) (NWFSC 2015).

Figure 4 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 et al. 2011a). 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 abundance and productivity 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 4). Relative to baseline VSP levels identified in the recovery plan (NMFS 2013c), 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; NMFS 2016c).

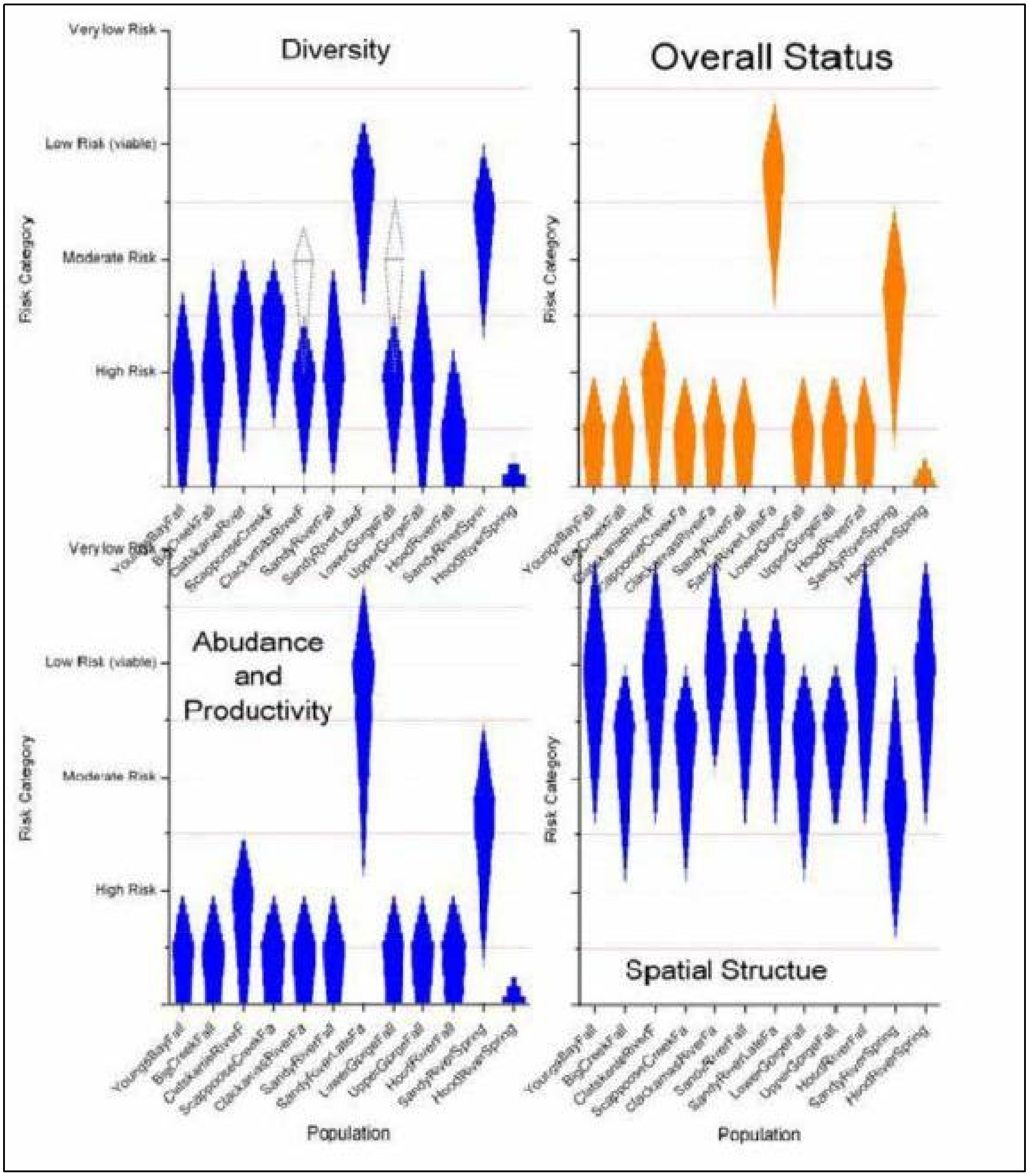

Figure 4. Extinction risk ratings for LCR Chinook salmon natural populations in Oregon for the assessment attributes abundance/productivity, diversity, and spatial structure, as well as overall ratings for populations that combine the three attributes (Ford et al. 2011a).

The recent status review (NMFS 2016c) concluded that there has been little change since the last status review (Ford et al. 2011a) 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, the majority of the populations in this ESU remain at high risk, with low natural-origin abundance levels, especially the spring-run Chinook salmon population in this ESU (NWFSC 2015; NMFS 2016c). 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 fish returning to the ESU, even though hatchery production has been reduced (NWFSC 2015; NMFS 2016c). 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; NMFS 2016c).

Limiting Factors

There are many factors that 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 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, including predation and environmental variability. The recovery plan consolidates available information regarding limiting factors and threats for the LCR Chinook Salmon ESU (NMFS 2013c).

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 2013c) describes limiting factors on a regional scale, and 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 2013c) includes details on large scale issues including:

- Ecological interactions,
- Climate change, and
- 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. The discussion of limiting factors in Chapter 7 (NMFS 2013c) is organized to address:

- Tributary habitat,
- Estuary habitat,
- Hydropower,
- Hatcheries,

- Harvest, and
- Predation.

Rather than repeating the extensive discussion from the recovery plan, it is incorporated here by reference.

As mentioned above, the continuing high proportions of hatchery-origin fish in spawning populations has been purposeful in some areas, e.g. for reintroduction purposes in the Hood, Cowlitz, and Lewis subbasins. However, the recent opinion on the majority of hatchery production affecting this ESU (NMFS 2017e) expects Federal funding guidelines to require reductions in limiting factors relative to hatchery effects over the course of the next decade.

The effects of harvest as a limiting factor began to decline even before the LCR Chinook salmon were listed in 1999. Estimates available from the 2008 biological opinion on the 2009 PST Agreement summarize the long term trends in ER through 2006 (NMFS 2008d). The ER for LCR spring Chinook salmon averaged 51 percent from 1980 to 1991 and 31 percent thereafter (Figure 5). Reductions occurred in both ocean and inriver fisheries. ERs on LCR tule Chinook salmon declined from 1983 to 1993, but still averaged 69 percent during that time frame. From 1994 to 2006 the ER averaged 41 percent (Figure 5). Harvest has been reduced even further in recent years by managers in both the ocean and river. In 2001, fisheries were subject to a total ER limit of 65 percent. From 2002 to 2006 fisheries were managed subject to a limit of 49 percent. The limit was reduced further to 42 percent in 2007, 41 percent in 2008, 38 percent in 2010, and since 2012 LCR tule Chinook salmon have been managed to an ER limit that varies from 30 to 41 percent depending on abundance (NMFS 2012b). The harvest of LCR bright Chinook salmon also declined gradually through the early 1990's and more substantively thereafter. From 1979 to 1992, the total ER in ocean and inriver fisheries averaged 54 percent (Figure 5). From 1993 to 2006, the total ER for all fisheries averaged 34 percent (NMFS 2008d).

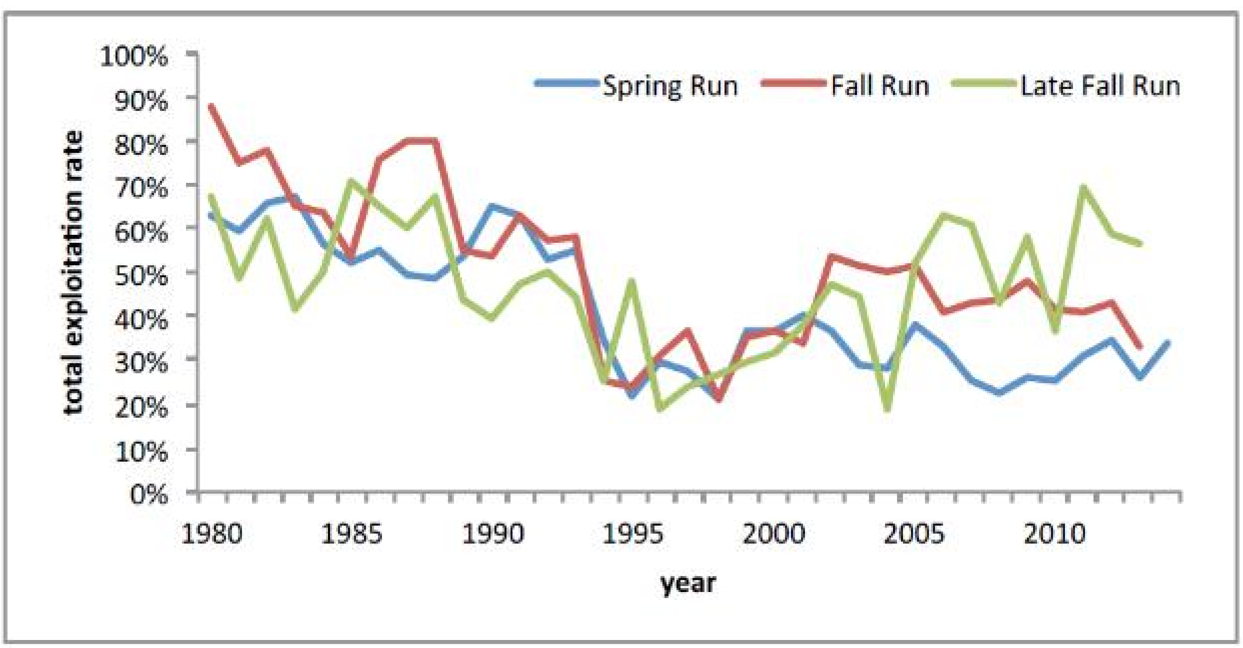

Figure 5. Total exploitation rates on the three components of the LCR Chinook Salmon ESU

(figure 56 in NWFSC 2015).

2.2.2.2 Upper Willamette River Chinook Salmon ESU

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, the Willamette River and its tributaries, as well as several artificial propagation programs, above Willamette Falls, Oregon (Figure 6). Genetic resources can be housed in a hatchery program, but for a detailed description of how NMFS evaluates and determines whether to include hatchery fish in an ESU or DPS, see NMFS (2005d). The ESU contains seven historical populations, within a single MPG (western Cascade Range, Table 19).

Table 19. UWR Chinook Salmon ESU description and MPG (Jones Jr. 2015; NWFSC 2015; NMFS 2016f).

ESU Description	
Threatened	Listed under ESA in 1999; updated in 2014.
1 major population group	7 historical populations
Major Population Group	***Populations***
Western Cascade Range	Clackamas River, Molalla River, North Santiam River, South Santiam River, Calapooia River, McKenzie River, MF Willamette River
Artificial production	
Hatchery programs included in ESU (6)	McKenzie River spring, North Santiam spring, Molalla spring, South Santiam spring, MF 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 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 a zoogeographic isolating mechanism for a considerable period of time Waples et al. (2004). This isolation 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 (NMFS and ODFW 2011).

The generalized life history traits of UWR Chinook salmon are summarized in Table 20. Today adult UWR Chinook salmon begin appearing in the lower Willamette River in January, with fish entering the Clackamas River as early as March. The majority of the run ascends Willamette Falls from late April through May, with the run extending into mid-August (Myers et al. 2006).

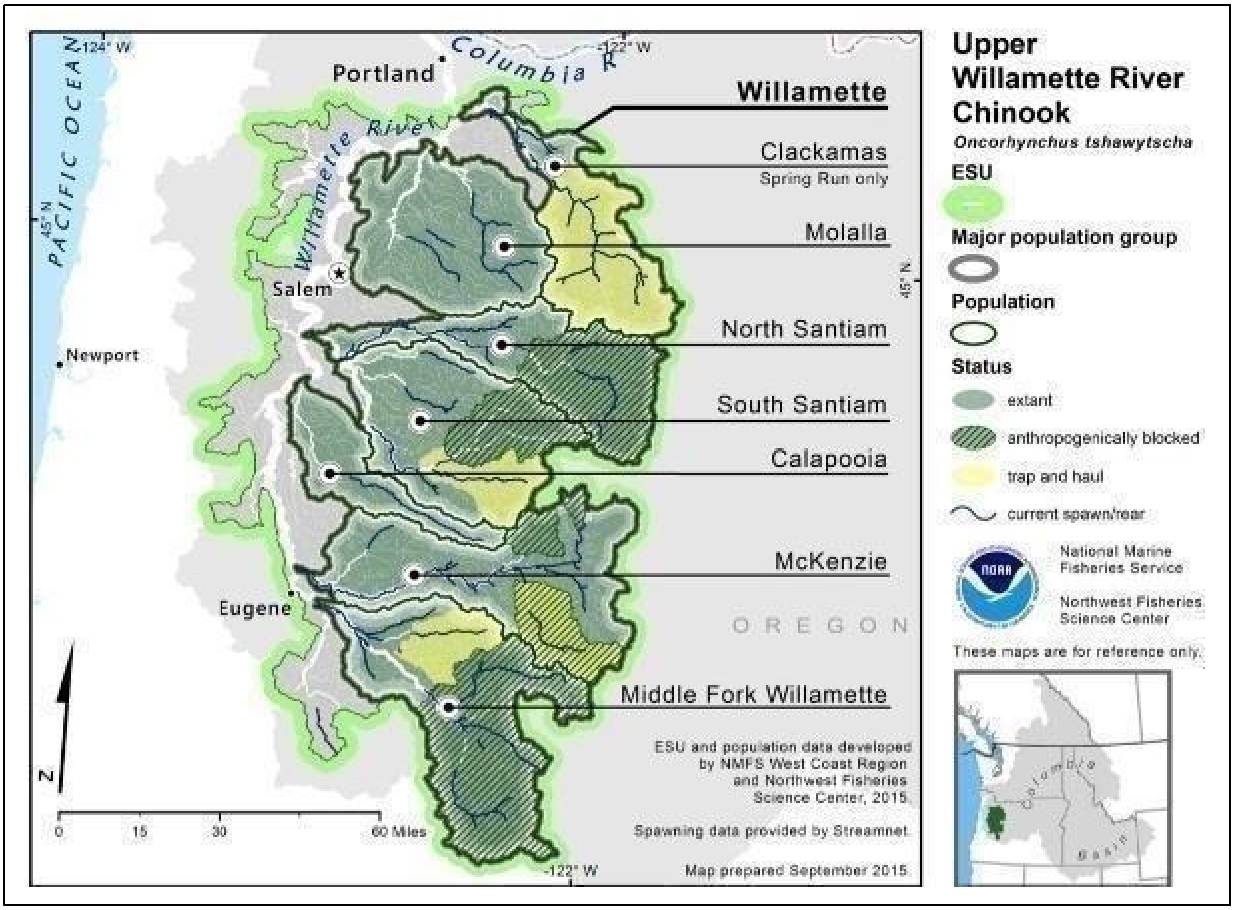

Figure 6. Map of the UWR Chinook Salmon ESU's spawning and rearing areas, illustrating populations and MPGs (NWFSC 2015).

Chinook salmon 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, meaning only larger fish would have been able to ascend. Mattson (1963) discusses a late spring Chinook salmon 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 heavily influence the water quality at the time. Chinook salmon now ascend the falls via a fish ladder at Willamette Falls.

Table 20. 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

Life-History Trait	Characteristic
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	Predominantly north, as far as southeast Alaska
Age at return	3-6 years, primarily 4-5 years

[1] Data are from numerous sources (NMFS and ODFW 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 (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, but it is not clear what role they may have played in reducing localized adaptations in UWR fish populations. Little information exists on the life-history characteristics of the historical UWR Chinook salmon 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 collection 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 (NMFS and ODFW 2011).

According to the most recent status review (NMFS 2016f), 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). Abundances, in terms of adult returns, in the North and South Santiam Rivers have risen since the last review (Ford et al. 2011a), but still range only in the high hundreds of fish. Improvements in the status of the MF 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 (MF) Willamette River individual population. The status review incorporates valuable information from the Fall Creek program, 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[5] (NWFSC 2015; NMFS 2016f).

All seven historical natural populations of UWR Chinook salmon identified by the WLC-TRT occur within the action area and are contained within a single ecological subregion, the Western Cascade Range. Within the range and ESU the Clackamas and McKenzie River populations had the best overall extinction risk, A/P, spatial structure, and diversity ratings, as of 2016 (Table 21).

Table 21. Scores for the key elements (A/P, diversity, and spatial structure) used to determine current overall viability risk for UWR Chinook salmon (NMFS and ODFW 2011; NWFSC 2015; NMFS 2016f)[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 (NWFSC 2015).

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 (NMFS and ODFW 2011). Recovery plans target key limiting factors for future actions. However, there have been no significant actions taken since the 2011 status review to restore access to historical habitat above dams, or to remove hatchery fish from the spawning grounds (NWFSC 2015; NMFS 2016f). Furthermore, limited data are available for natural-origin spawner abundance for UWR Chinook salmon populations.

Table 22 includes the most up-to-date available data for natural-origin 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 22. Estimated number of natural-origin spring Chinook salmon spawners in surveyed subbasins of the UWR from 2005 through 2015 (ODFW 2015)[1].

[5] 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 of hatchery-origin. While there is some spawning below the Dam, it is not clear whether any progeny from the downstream redds contribute to escapement.

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
Recent 5 year average	461	689	1,617	129

[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 abundance and productivity criteria), spatial structure, diversity, and also 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 23) (NWFSC 2015; NMFS 2016f).

Table 23. Summary of VSP scores and recovery goals for UWR Chinook salmon populations (NWFSC 2015; NMFS 2016f).

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	MF Willamette River	0	3

Limiting Factors

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.

There are many factors that affect the abundance, productivity, spatial structure, and diversity of the UWR Chinook Salmon ESU. Factors that affect the ESU and its populations 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 (NWFSC 2015; NMFS 2016f).

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

Additionally, NWFSC (2015) and NMFS (2016f) outlines additional limiting factors for the UWR Chinook Salmon ESU which include:

- 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, and

UWR Chinook salmon are harvested in ocean fisheries (primarily in Canada and Alaska), in lower mainstem Columbia River fisheries, in fisheries in the mainstem Willamette River, and tributary terminal areas (Figure 7 and Figure 8). ERs from commercial and recreational fisheries on UWR spring Chinook have been substantially reduced in response to extremely low returns in the mid-1990s and subsequent ESA listing in 1999. Freshwater fishery impacts have been reduced by approximately 75 percent from 2001 to present compared to the 1980s by implementing selective harvest of hatchery-origin fish in commercial and recreational fisheries, with all unmarked, wild spring Chinook salmon being released.

The effects of harvest as a limiting factor declined even before UWR Chinook salmon were listed in 1999. Estimates available from the 2008 biological opinion on the 2009 PST Agreement summarize the long term trends in ER through 2006 (NMFS 2008d). Harvest was reduced initially because of conservation concerns for Canadian stocks and the newly listed spring/summer and fall Chinook salmon species from the Snake River. From 1980 to 1995 the total ER in ocean and inriver fisheries averaged 51 percent (Figure 7). From 1996 to 2006 the total ER for all fisheries averaged 21 percent (NMFS 2008d).

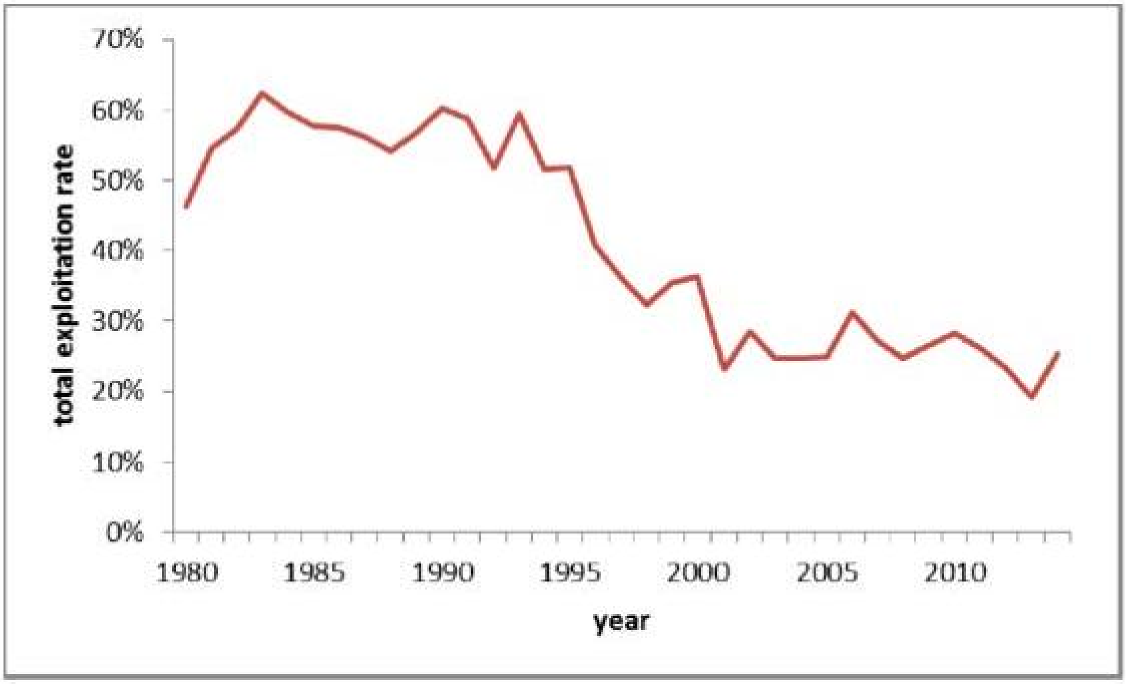

Figure 7. Total ERs for UWR Chinook salmon (figure 86 in NWFSC 2015).

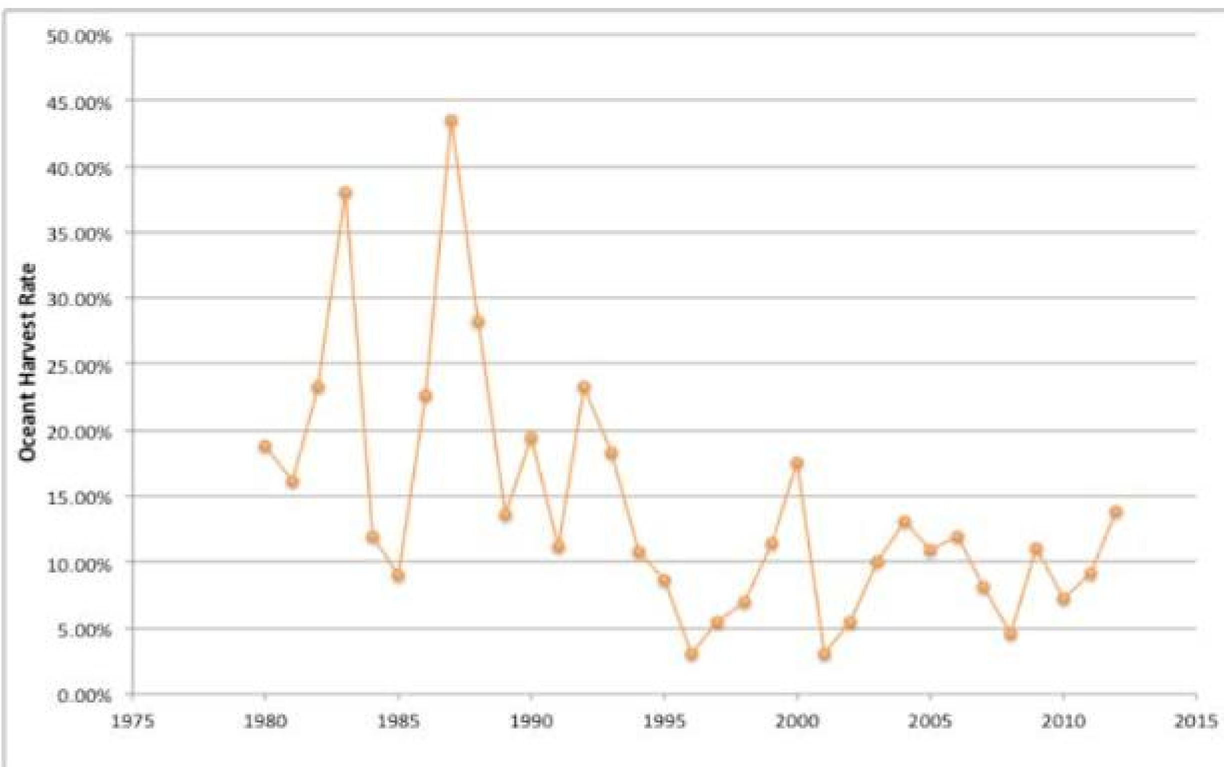

Figure 8. Marine Area harvest rates for UWR Chinook salmon (figure 87 in NWFSC 2015).

In the Willamette River in 2001 NMFS evaluated a Fishery Management Evaluation Plan (FMEP) for UWR spring-run Chinook salmon (NMFS 2001a) submitted under Limit 4 of the final 4(d) rule. After evaluation with respect to the criteria specified for Limit 4, NMFS determined that the plan adequately addressed all of the criteria. In the FMEP ODFW proposed to implement selective fisheries for hatchery-origin spring-run Chinook salmon in all freshwater fishing areas, meaning that all hatchery-origin spring-run Chinook salmon would be ad clipped and that only fish that are ad clipped would be retained in freshwater fisheries beginning in 2002 and thereafter. The FMEP proposed to limit the harvest rate to no more than 15 percent. All unmarked, natural-origin fish were to be released unharmed. The monitoring and evaluation measures identified in the FMEP assessed the encounter rate of natural-origin fish in the fisheries, fishery mortality, the abundance of hatchery-origin and natural-origin fish throughout the entire UWR Basin, and angler compliance. This information is used annually to assess whether impacts on ESA-listed fish are as expected. ODFW also conducts a comprehensive review of the FMEP at five year intervals to evaluate whether the objectives of the FMEP are being accomplished. Since implementation of the FMEP the annual harvest rate on natural-origin UWR spring-run Chinook salmon in freshwater fisheries has averaged 10.1 percent (ODFW 2017) which is below the levels proposed in the FMEP.

Excessive fishery harvest was cited as a listing factor for the UWR Chinook ESU in 1999 when fishery ERs were greater than 50 percent in ocean and freshwater fisheries (NMFS 2008d). However, in light of the significant reforms in harvest management implemented since the time of listing under the Pacific Salmon Treaty for ocean fisheries (NMFS 2008d) and ODFW's FMEP for freshwater fisheries (ODFW 2001; 2010b), the plan did not identify fishery harvest as a primary or secondary limiting factors and explained that other primary and secondary limiting factors are the key bottlenecks currently impeding the recovery of these spring Chinook salmon populations (NMFS and ODFW 2011).

2.2.2.3 Snake River Fall-Run Chinook Salmon ESU

On June 3, 1992, NMFS listed the Snake River fall-run Chinook Salmon ESU as a threatened species (57 FR 23458). 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 4 artificial propagation programs (Jones Jr. 2015; NWFSC 2015; NMFS 2016e). None of the hatchery programs are excluded from the ESU. As NMFS (2005d) explains, genetic resources can be housed in a hatchery program. For a detailed description of how NMFS evaluates and determines whether to include hatchery fish in an ESU or DPS, see NMFS (2005d). Table 24 lists the natural and hatchery populations included in the ESU.

Table 24. Snake River Fall-Run Chinook Salmon ESU description and MPGs (Jones Jr. 2015; NWFSC 2015; NMFS 2016e).

ESU Description	
Threatened	Listed under ESA in 1992; updated in 2014

ESU Description	
1 major population groups	2 historical populations (1 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 (1 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 9 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. Additionally construction of the Hells Canyon Complex from 1958 to 1967 led to the extirpation of 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 2012c). Since the species were originally listed in 1992, fishery impacts have been reduced in both ocean and river fisheries. Total ER has been relatively stable in the range of 40% to 50% since the mid-1990s (NWFSC 2015; NMFS 2016e).

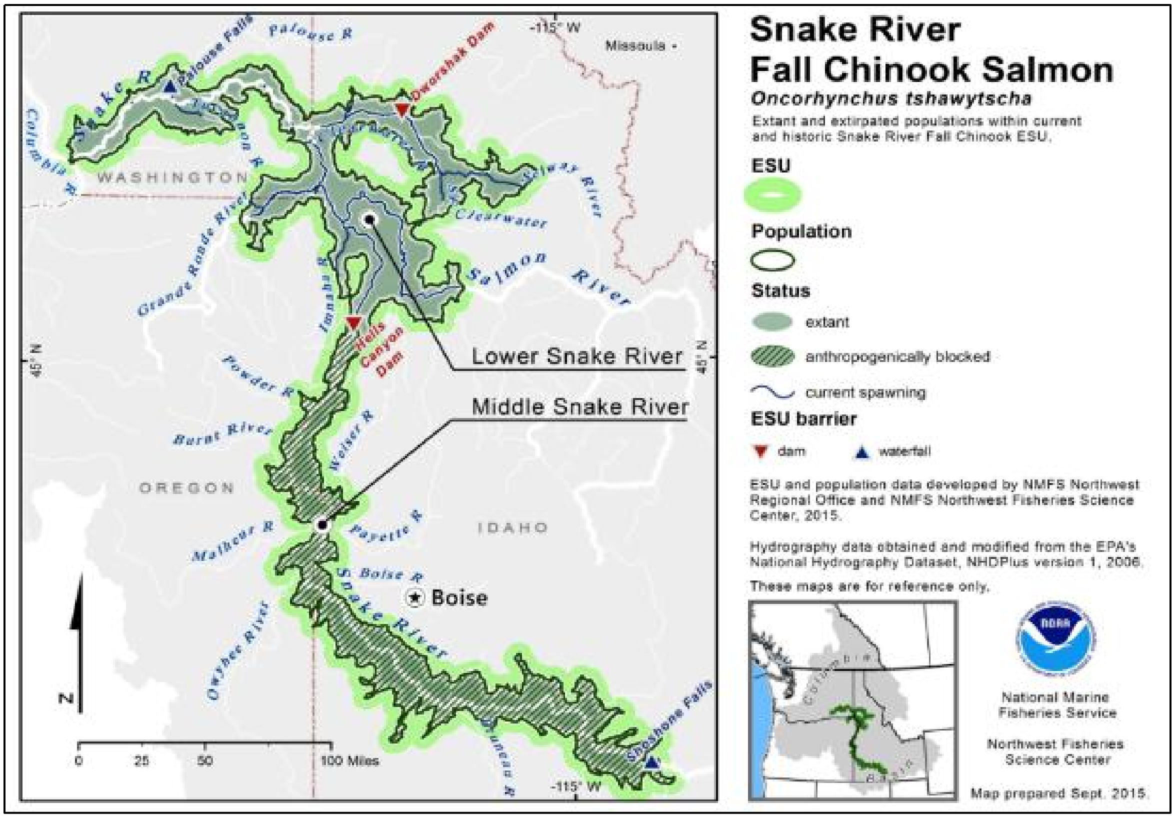

Figure 9. Map of the Snake River Fall-Run Chinook Salmon ESU's spawning and rearing areas, illustrating populations and MPGs (NWFSC 2015).

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% of ESU's spawning and rearing habitat. Swan Falls Dam was the first barrier to upstream migration in the Snake River, followed by the Hells Canyon Complex, composed of Brownlee Dam (completed in 1958), Oxbow Dam (completed in 1961), and Hells Canyon Dam (completed in 1967). Natural spawning is currently limited to the Snake River from the upper end of 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 dam (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 may spawn elsewhere as well. The vast majority of spawning today occurs upstream of LGR, with the largest concentration of spawning sites in the mainstem Snake River (about 60%) and in the Clearwater River, downstream from Lolo Creek (about 30%) (NMFS 2012c).

As a consequence of losing access to historic spawning and rearing sites (heavily influenced by the influx of ground water in the Upper Snake River), as well as the effects of the dams on downstream water temperatures, Snake River fall-run Chinook salmon now reside in waters that may have thermal regimes which differ from historical regimes. 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 of these 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 to the ocean.

Snake River fall-run Chinook salmon also spawned historically in the lower mainstem 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 of these areas, although returns to the Tucannon River are predominantly releases and strays from the Lyons Ferry Hatchery (LFH) program (NMFS 2012c).

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, (Snake River fall-run Chinook Salmon ESU) remains at threatened status, based on a low risk rating for abundance/productivity, and a moderate risk rating for spatial structure/diversity (NWFSC 2015; NMFS 2016e).

Separate estimates of the numbers of adult (age 4 and older) and jack (age 3) fall-run Chinook salmon passing over Lower Granite Dam are derived using ladder counts, in addition to 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 CWT recovery results, passive integrated transponder (PIT) 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; NMFS 2016e).

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)[6] 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; NMFS 2016e).

[6] PBT is 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.

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 25). In recent years, naturally spawning fall-run Chinook salmon in the lower Snake River have included returns both originating from naturally spawning parents, and from returning hatchery releases (NWFSC 2015; NMFS 2016e). Hatchery-origin fall-run Chinook salmon escaping upstream of Lower Granite Dam and spawning naturally are predominantly returns from hatchery supplementation programs (i.e. juvenile releases in reaches above Lower Granite Dam, and releases at LFH that have dispersed upstream).

Table 25. Escapement data for Snake River fall-run Chinook natural-origin salmon returning to Lower Granite River, from 2000-2016 (*U.S. v. Oregon* 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 TRT (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 assure that all sources of mortality are accounted for, 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 productivity 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 NMFS Snake River fall-run Chinook Recovery Plan (NMFS 2017f) proposes 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 a single population viability scenario could be possible if major spawning areas, supporting the bulk of natural returns, are operating consistently with long-term diversity objectives in the proposed plan. Under this single population scenario, the requirements for a sufficient combination of natural abundance and productivity 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 26), there is no indication of a strong differential distribution of hatchery returns among major spawning areas due to the widespread distribution of hatchery releases and the lack of direct sampling of reach-specific spawner compositions.

Table 26. Fall-run Chinook redd counts in the Snake River Basin, from 2000-2016 *(U.S. v. Oregon* 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; NMFS 2016e), resulting in an overall spatial structure and diversity rating of moderate risk (Table 27). 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-run Chinook salmon population is viable, as indicated by the bold outlined cell in Table 2-51. The “viable” rating for risk is an improvement over the “moderate” rating provided as a result of the prior status review (Ford et al. 2011a) and is based primarily on an increase in measures of abundance and productivity. However, the single population delisting options provided in the Snake River Fall Chinook Salmon Recovery Plan would require the population to meet or exceed minimum requirements for a risk rating of Highly Viable 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 A/P, 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 (R/S) method to estimate the current productivity for this population (1990-2009 brood years) and determined it was 1.5. Given remaining uncertainty and the current level of variability, the point estimate of current productivity would need 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; NMFS 2016e).

Table 27. Matrix used to assess natural population viability risk rating across VSP parameters for the Lower Mainstem Snake River fall-run Chinook Salmon ESU (NWFSC 2015).[1]

		Spatial Structure/Diversity Risk			
		Very Low	Low	Moderate	High
Abundance/ Productivity Risk[2]	Very Low (<1%)	HV	HV	V	M
	Low (1-5%)	V	V	V Lower Mainstem Snake River	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. The darkest cells indicate combinations of A/P and SS/D at greatest risk (NWFSC 2015).
[2] Percentage represents the probability of extinction in a 100-year time period.

For spatial structure/diversity, 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; NMFS 2016e).

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 (NWFSC 2015; NMFS 2016e).

Limiting Factors

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 the year 2000 (NMFS 2017f).

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 et al. 2011a). 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 2017f).

The recovery plan (NMFS 2017f) provides a detailed discussion of limiting factors and threats and describes strategies for addressing each of them. Section 3.3 of the plan provides criteria for addressing the underlying causes of decline. Furthermore, Section 4.1.2 B.4. of the plan (NMFS 2017f) describes the changes in current impacts on Snake River fall-run Chinook salmon. These changes include:

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

Rather than repeating the extensive discussion from the recovery plan, it is incorporated here by reference.

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. However, 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 (NWFSC 2015; NMFS 2016e).

The effects of harvest to Snake River fall-run Chinook salmon as a limiting factor declined significantly since they were first listed under the ESA in 1992. Estimates available from the 2008 biological opinion on the 2009 PST Agreement summarize the long term trends in ER through 2006 (NMFS 2008d). From 1986 to 1991 the total exploitation averaged 75 percent (Figure 10). From 1992 to 2006 the ER averaged 48 percent. Snake River fall-run Chinook salmon are managed using separate limits for ocean and inriver fisheries. Ocean fisheries have been managed subject to a 30 percent reduction in the age-3 and age-4 adult equivalent total ER relative to the 1988 to 1993 base period (NMFS 1999b). Inriver fisheries are currently managed subject to an abundance based harvest rate limit that ranges between 30 and 45 percent (NMFS 2018a). Harvest mortality has been reduced in both the ocean and inriver fisheries since listing (Figure 10).

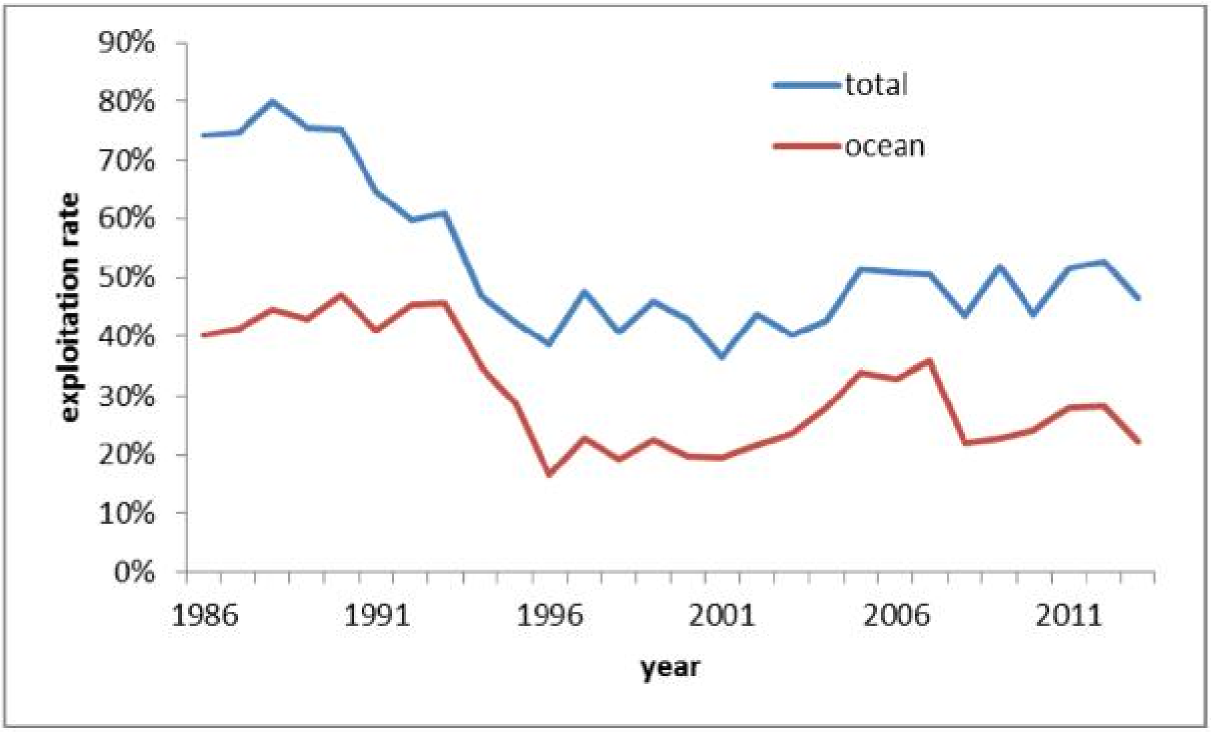

Figure 10. Total exploitation rate for Snake River fall-run Chinook salmon (figure 31 in NWFSC 2015).

2.2.2.4 Puget Sound Chinook ESU

This ESU was listed as a threatened species in 1999; its threatened status was reaffirmed June 28, 2005 (70 FR 37160), and again on April 14, 2014 (79 FR 20802). As part of the review, NOAA's Northwest Fisheries Science Center evaluated the viability of the listed species undergoing 5-year reviews and issued a status review update providing updated information and analysis of the biological status of the listed species (NWFSC 2015). In addition the most recent status review incorporated the findings of the Science Center's report, summarized new information concerning the delineation of the ESU and inclusion of closely related salmonid hatchery programs, and included an evaluation of the listing factors (NMFS 2016d). Where possible, particularly as new material becomes available, the status review information is supplemented with more recent information and other population specific data that may not have been considered during the status review so that NMFS is assured of using the best available information.

The 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 (Puget Sound Salmon Recovery Plan (SSPS 2005b)) and Final Supplement to the Shared Strategy's Puget Sound Salmon Recovery Plan (NMFS 2006b). The recovery plan adopts ESU and population level viability criteria recommended by the Puget Sound Technical Recovery Team (PSTRT) (Ruckelshaus et al. 2002; Ruckelshaus et al. 2006). 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 long-term[7];

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;

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.

Spatial Structure and Diversity

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 28). 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 extinct[8] (Ruckelshaus 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. Also included in the ESU are 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; Voight's 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

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[7] The number of populations required depends on the number of diversity groups in the region. For example, three of the regions only have 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.

[8] It was not possible in most cases to determine whether these Chinook salmon spawning groups historically represented independent populations or were distinct spawning aggregations within larger populations.

Hatchery Program; Elwha Channel Hatchery Program; and the Skookum Creek Hatchery Spring-run Program (79 FR 20802).

Table 28. Extant PS 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 need to be viable for recovery of the ESU. The PSTRT noted that the Nisqually watershed is in comparatively good condition, and 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 2006b).

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 2006b). Under the 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 2006b).

The TRT did not define the relative roles of the remaining populations in the Whidbey and Central/South Sound Basins to ESU viability. Therefore, NMFS developed additional guidance which 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 Salmon ESU. In doing so it is important to take into account whether the genetic legacy of the population is intact or if it is no longer distinct. Populations are defined by their relative isolation from each other, and by the unique genetic characteristics that evolve as a result 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 insure 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. However, if the genetic legacy is gone, 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 (NMFS 2010b) (Figure 11). 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 (Ruckelshaus et al. 2002; NMFS 2006b). The assigned tier indicates the relative role of each of the 22 populations comprising the ESU to 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 to Tier 1 populations would be more likely to affect the viability of the ESU as a whole than similar impacts to 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 2005b; 2005c; 2008e; 2008d; 2010a; 2011b; 2013c; 2014b; 2015b; 2016h; 2017b).

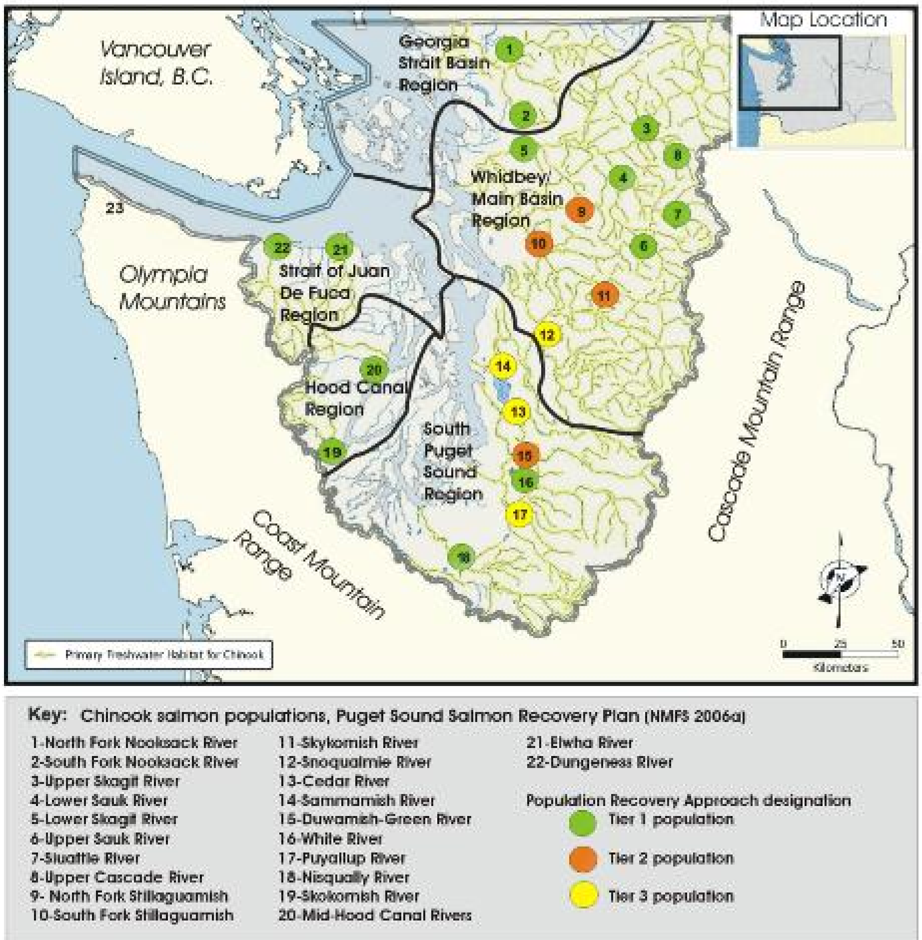

Figure 11. Puget Sound Chinook populations.

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 six of the 10 populations within the Region. All other regions have moderate to high proportions of hatchery-origin spawners (Table 29).

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; SSPS 2005b; NMFS 2008b; 2008c; 2008a). It is likely that genetic and life history diversity has been significantly adversely affected by this habitat loss.

Abundance and Productivity

Most Puget Sound Chinook salmon populations are well below escapement levels identified as required for recovery to low extinction risk (Table 29). All populations are consistently below productivity goals identified in the recovery plan (Table 29). Although trends vary for individual populations across the ESU, currently 19 populations exhibit a stable or increasing trend in natural escapement (Table 30). Fourteen of 22 populations show a growth rate in the 17-year geometric mean natural-origin spawner abundances that is greater or equal to 1.00. Both the previous status review in 2015 (NWFSC 2015), current status review (NMFS 2016d), and the 2016 Pacific Salmon Commission Chinook Technical Committee's Evaluation Report had concluded there was a widespread negative trend for the total ESU. Both reports were based on data through 2013 or 2014 when available, and was the best available information at the time of the completion of previous opinions (NMFS 2016h; 2017b; CTC 2018). The most recent opinion on Puget Sound fisheries (NMFS 2018a) incorporated an updated long term data series, and three additional years of escapement data (2015-2017). Incorporation of this information indicates a more positive picture of trends in natural-origin Chinook salmon spawner population across the ESU (Table 30).[9] For populations which did experience increased escapements, when the average natural-origin escapements for 2010-2014 are compared to the average natural-origin escapements reported in 2015-2017, these recent average escapements represent an 8-53 percent increase in natural-origin escapement (for the Lower and Upper Sauk, Upper Skagit, North Fork and South Fork Stillaguamish, Skykomish, Snoqualmie, Cedar, Green, Puyallup, Nisqually and Dungeness populations). Additionally, for some populations the updated long-term data series reflects the use of newer technologies or methodologies. For example in the Stillaguamish River escapement estimates are now generated using genetic mark-recapture estimation methods. Information on abundance and productivity continues to be updated as new data become available, but Table 29 and Table 30 represent the best available information at this time regarding the general status and trends of Puget Sound Chinook populations.

Natural-origin escapements for eight populations are at or below their critical thresholds[10]. Both populations in three of the five biogeographical regions that have only two populations are below or near their critical threshold: Georgia Strait, Hood Canal and Strait of Juan de Fuca (Table 29). When hatchery spawners are included, aggregate average escapement is over 1,000 for one of the two populations in each of these three regions; reducing the demographic risk to the populations in these regions. Nine populations are above their rebuilding thresholds[11]; eight of them in the Whidbey/Main Basin Region. This appears to reflect modest improvements in population status since previous opinions evaluating the effects of fisheries in Puget Sound and freshwater rivers emptying into it (NMFS 2016h; 2017b) were completed. However, in 2017 NMFS updated the rebuilding thresholds which are the Maximum Sustained Yield estimate of spawners based on

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[9] This is a synopsis of information provided in the recent five-year status review and supplemental data and complementary analysis from other sources, including the Northwest Fisheries Science Center (NWFSC) Abundance and Productivity Tables. Differences in results reported in Tables 3 and 4 from those in the status review are related to the data source, method, and time period analyzed (e.g., 15 vs 25 years).

[10] After taking into account 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 2000).

[11] The rebuilding threshold is defined as the escapement that will achieve MSY under current environmental and habitat conditions (NMFS 2000), and is based on an updated spawner-recruit assessment in the Puget Sound Chinook Harvest Management Plan, December 1, 2018. Thresholds were based on population-specific data, where available.

available habitat. The new spawner-recruit analyses for several populations indicated a significant reduction in the number of spawners that can be supported by the available habitat when compared to analyses conducted 10-15 years ago. This may be due to further habitat degradation or improved productivity assessment or, more likely, a combination of the two. For example, the updated rebuilding escapement threshold for the Green River is 2,200 spawners compared to the previous rebuilding escapement threshold of 5,523 spawners. So although several populations are above the updated rebuilding thresholds, indicating that escapement is sufficient for the available habitat in many cases, the overall abundance has declined.

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 30). Currently, 14 populations show productivity that is at or above replacement for natural-origin escapement including populations in all regions. Eight populations in four of the five regions demonstrate positive growth rates in natural-origin recruitment (Table 30).

Life history traits such as size at age can affect growth rate of recruitment. Studies examining those variables responsible for influencing the fecundity of female salmonids indicate that as the average body size at maturation is reduced, the productivity of the population also exhibits a reduction. This reduction is related to the production of fewer and smaller eggs, and the reduced ability to dig redds deep enough to withstand scouring (Healey and Heard 1984; Healey 1991; Hixon et al. 2014). Because Puget Sound Chinook salmon populations are not exhibiting a reduction in body size at age of maturation (Ohlberger et al. 2018), the productivity estimates reported (Table 30) for many of the populations continue to demonstrate stable levels of recruitment.

Table 29. Estimates of escapement and productivity (recruits/spawner) for Puget Sound Chinook populations. Natural origin escapement information is provided where available. Populations at or below their critical escapement threshold are bolded. For several populations, hatchery contribution to natural spawning data are limited or unavailable. MU=Management Unit.

Region	Population	1999 to 2017 Geometric mean Escapement (Spawners)		NMFS Escapement Thresholds		Recovery Planning Abundance Target in Spawners (productivity)[2]	Average % hatchery fish in escapement 1999-2017 (min-max)[5]
		Natural [1]	Natural-Origin (Productivity[2])	Critical[3]	Rebuilding[4]		
Georgia Basin	*Nooksack MU*	2,233	262	400	500		
	NF Nooksack	1,537	**203**[9] (0.3)	*200*[6]	-	3,800 (3.4)	85 (63-94)
	SF Nooksack	43	**24**[9] (1.0)	*200*[6]	-	2,000 (3.6)	85 (62-96)
Whidbey/Main Basin	*Skagit Summer/Fall MU*						
	Upper Skagit River	9,390	8,188[9] (1.7)	738	5,836	5,380 (3.8)	3 (1-8)
	Lower Sauk River	572	504[9] (1.5)	*200*[6]	371	1,400 (3.0)	1 (0-10)
	Lower Skagit River	2,098	1,800[9] (1.6)	281	2,475	3,900 (3.0)	4 (2-8)
	Skagit Spring MU						
	Upper Sauk River	603	530[9] (2.4)	170	484	750 (3.0)	2 (0-5)
	Suiattle River	368	332[9] (2.1)	170	250	160 (2.8)	2 (0-7)
	Upper Cascade River	301	266[9] (1.5)	130	196	290 (3.0)	9 (0-50)
	Stillaguamish MU						
	NF Stillaguamish R.	1,147	565 (0.8)	300	550	4,000 (3.4)	48 (28-71)
	SF Stillaguamish R.	111	**98** (1.1)	*200*[6]	300	3,600 (3.3)	10 (0-49)
	Snohomish MU						
	Skykomish River	3,409	2,040[9] (1.3)	400	1,500	8,700 (3.4)	34 (17-62)
	Snoqualmie River	1,526	1,110[9] (1.1)	400	900	5,500 (3.6)	19 (8-35)
Central/South Sound	Cedar River	931	837[9] (1.8)	*200*[6]	*200-500*[7]	2,000 (3.1)	25 (10-46)
	Sammamish River	1,164	**183**[9] (0.6)	*200*[6]	*1,250*[6]	1,000 (3.0)	84 (66-95)
	Duwamish-Green R.	3,964	1,175[9] (1.2)	400	2,200	-	64 (36-79)
	White River[10]	1,778	720[9] (0.7)	*200*[6]	380[7]	-	53 (27-87)
	Puyallup River[11]	1,655	695[9] (1.1)	*200*[6]	797[7]	5,300 (2.3)	48 (18-76)
	Nisqually River	1,658	533[9] (1.3)	*200*[6]	1,200[8]	3,400 (3.0)	67 (43-87)
Hood Canal	Skokomish River	1,357	**312** (0.9)	452	1,160	-	68 (7-95)
	Mid-Hood	**179**		*200*[6]	*1,250*[6]	1,300 (3.0)	53 (5-90)

	Canal Rivers[12]						
Strait of Juan de Fuca	Dungeness River	356	**99**[9] (0.6)	*200*[6]	925[8]	1,200 (3.0)	71 (39-96)
	Elwha River[13]	1,388	**101**[9]	*200*[6]	*1,250*[6]	6,900 (4.6)	92 (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. Sammamish productivity estimate has not been revised to include Issaquah Creek. Source for Recovery Planning productivity target is the final supplement to the Puget Sound Salmon Recovery Plan (NMFS 2008a); measured as recruits/spawner associated with the number of spawners at Maximum Sustained Yield under recovered conditions.
[3] Critical natural-origin escapement thresholds under current habitat and environmental conditions (McElhany et al. 2000; NMFS 2000).
[4] Rebuilding natural-origin escapement thresholds under current habitat and environmental conditions (McElhany et al. 2000; NMFS 2000).
[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 (WDFW and PSTIT 2005; 2006; 2007; 2008; 2009; 2010; 2011; 2012; PSIT and WDFW 2013; WDFW and PSTIT 2013; 2014; 2015; 2016), James and Dufault (2018) (preliminary data), 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 2000).
[7]Based on spawner-recruit assessment (Puget Sound Chinook Harvest Management Plan, December 1, 2018).
[8] Based on alternative habitat assessment.
[9] Estimates of natural-origin escapement for Nooksack available only for 1999-2015; Skagit springs, Skagit falls available only for 1999-2015; Snohomish for 1999-2001 and 2005-2017; Both Lake Washington populations (Cedar & Sammamish) for 2003-2016; White River 2005-2017; Puyallup for 2002-2017; Nisqually for 2005-2017; Dungeness for 2001-2017; Elwha for 2010-2017.
[10] 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- and early run hatchery programs in the White and Puyallup River basins.
[11] 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 for which spawners or redds can be consistently counted (PSIT and WDFW 2010).
[12] 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 is very limited; primarily based on returns to the Hamma Hamma River.
[13] 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 30. Long-term trends in abundance and productivity 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] (1990-2017)**		**Natural Origin Growth Rate[2] (1990-2015)**	
		NMFS		**Recruitment (Recruits)**	**Escapement (Spawners)**
Georgia Basin	NF Nooksack (early)	1.12	increasing	1.04	1.02
	SF Nooksack (early)	0.99	stable	1.00	0.98
Whidbey/Main Basin	Upper Skagit River (moderately early)	1.02	stable	1.00	1.02
	Lower Sauk River (moderately early)	1.00	stable	0.96	0.99
	Lower Skagit River (late)	1.02	stable	0.98	1.01
	Upper Sauk River (early)	1.05	increasing	1.00	1.03
	Suiattle River (very early)	1.01	stable	0.99	1.01
	Upper Cascade River (moderately early)	1.02	stable	0.99	1.02
	NF Stillaguamish R. (early)	0.99	stable	0.97	1.00
	SF Stillaguamish R[3] (moderately early)	0.96	**declining**	0.94	0.97
	Skykomish River (late)	1.00	stable	0.99	1.00
	Snoqualmie River (late)	1.01	stable	0.97	0.98
Central/South Sound	Cedar River (late)	1.05	increasing	1.01	1.04
	Sammamish River[4] (late)	1.01	stable	1.02	1.04
	Duwamish-Green R. (late)	0.97	**declining**	0.92	0.95
	White River[5] (early)	1.10	increasing	1.02	1.05
	Puyallup River (late)	0.98	**declining**	0.92	0.94
	Nisqually River (late)	1.05	increasing	0.93	1.00
Hood Canal	Skokomish River (late)	1.02	stable	0.90	0.99
	Mid-Hood Canal Rivers[3] (late)	1.04	stable	0.97	1.04
Strait of Juan de Fuca	Dungeness River (early)	1.05	increasing	1.03	1.06
	Elwha River[3] (late)	1.04	increasing	0.91	0.93

[1] 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 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 has not been revised to include escapement in Issaquah Creek.

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

Limiting Factors

Limiting factors described in SSPS (2005b) and reiterated in NMFS (2017a) include:

- 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; NMFS 2016d). Improvements in hatchery operations associated with on-going ESA review and determination processes are expected to further reduce hatchery-related risks.

The effects of harvest as a limiting factor began to decline even before Puget Sound Chinook salmon were listed in 1999. Long term trends in ER for Puget Sound stocks are available for 1992 through 2016 from recently completed postseason FRAM model runs (Oct 2018) (pers. comm. J. Carey, NMFS West Coast Region (WCR)). That information is incorporated in to the region-specific discussions that follow.

ERs on Strait of Juan de Fuca and Mid-Hood Canal Chinook salmon populations have declined since the early 1990s. Total ERs for Strait of Juan de Fuca populations, which averaged 25 percent from 1992 to 1994, have since decreased to an average of 14 percent between 2009 and 2016 (Figure 12). Total ERs for the Mid-Hood Canal population averaged 41 percent between 1992 and 1994 but have since decreased to an average of 23 percent between 2009 and 2016 (Figure 12). Total ERs for the Skokomish population averaged 58 percent between 1992 and 1994. After a period of decline through 2000 where the ER averaged 31 percent, the ER on the Skokomish population increased and has since been similar to the levels observed in the early 1990s (Figure 12).

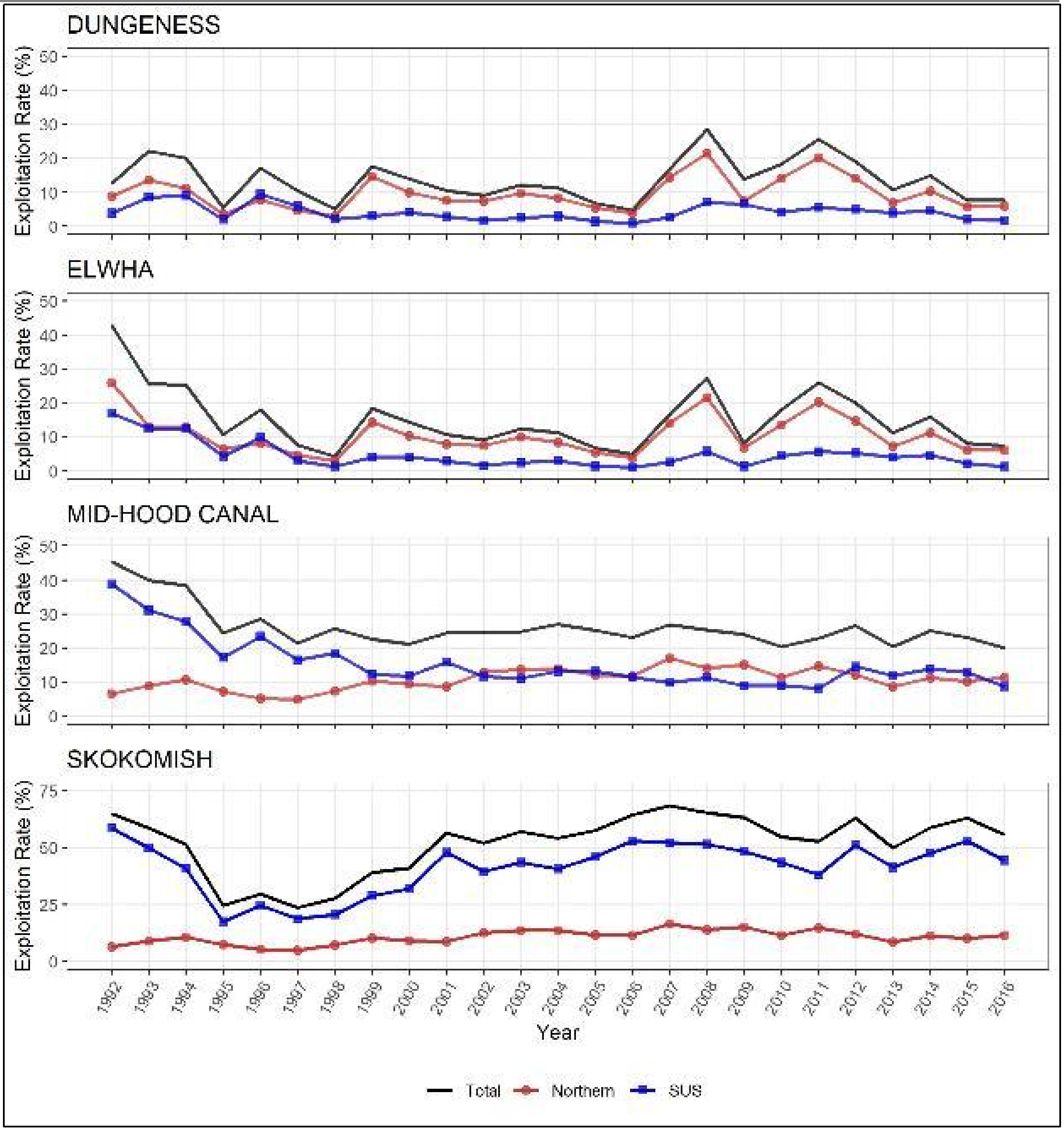

Figure 12. Total harvest exploitation of Hood Canal and Strait of Juan de Fuca Puget Sound Chinook salmon populations from (pers. comm. J. Carey, NMFS WCR). SUS=Southern United States.

ERs on populations in northern Puget Sound have steadily declined since the mid-1980s (Figure 13). From 1992 to 1994 the total ER on Nooksack River spring Chinook salmon averaged 59 percent (Figure 13). Between 2009 and 2016 the total ER for all fisheries declined to an average of 30 percent (Figure 13). From 1992 to 1994, average total ERs were 44 percent for Stillaguamish River Chinook salmon and 55 percent for Skagit River summer/fall stocks (Figure

13). Between 2009 and 2016, total ERs declined to averages of 23 percent for Stillaguamish River Chinook salmon and 45 percent for Skagit River summer/fall stocks (Figure 13). Under current fishery regimes, fifty percent or more of all harvest on these populations occurs in Alaskan and Canadian (northern) fisheries, primarily in the WCVI sport and troll and Juan de Fuca/Georgia Strait sport fisheries (NMFS 2008d).

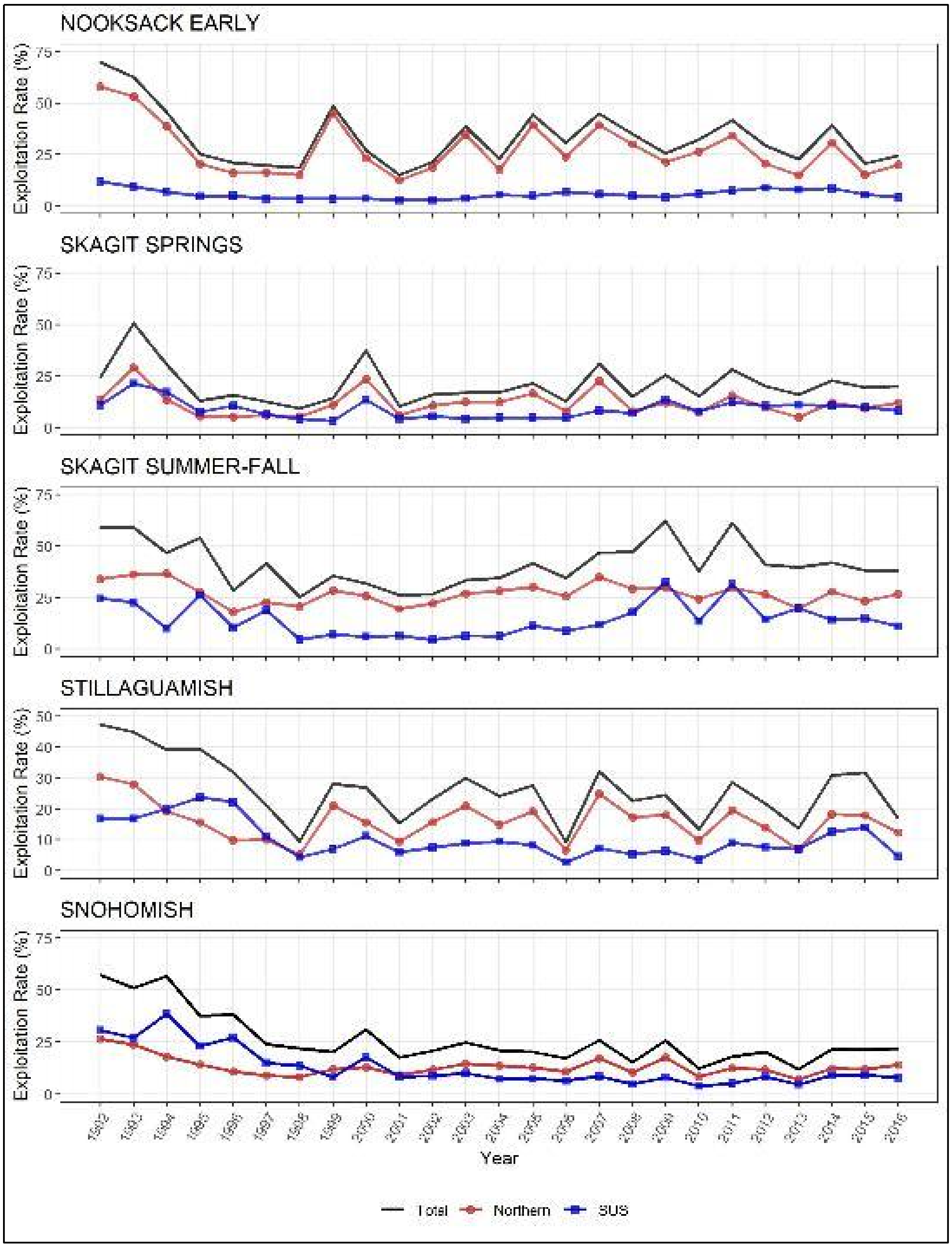

Figure 13. Total harvest exploitation of northern Puget Sound Chinook salmon populations from

(pers. comm. J. Carey, NMFS WCR).

ERs on the Puget Sound Chinook salmon populations in Lake Washington and the Duwamish/Green and White rivers have also declined since the early 1990s (Figure 14). Unlike populations in the Strait of Georgia and Whidbey/Main Basin regions, most of the harvest of the Central/South Sound populations occurs in southern U.S. fisheries (NMFS 2008d). Figure 14 depicts the changes in ER over time for the populations in these regions. From 1992 to 1994, average total ERs ranged from 37 percent to 76 percent. Between 2009 and 2016, total ERs averaged 22 percent to 52 percent representing a decrease of 28 to 55 percent in ERs (Figure 14).

While harvest management as a limiting factor and total fishery ERs have declined since the 1980s, weak natural-origin Chinook salmon populations in Puget Sound still require additional protective measures to reduce the overall risk to survival and recovery.

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; NMFS 2016d). Concerns regarding existing regulatory mechanisms, including: 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, 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, and thus certain permitting actions allow direct and indirect species take and/or adverse habitat effects.

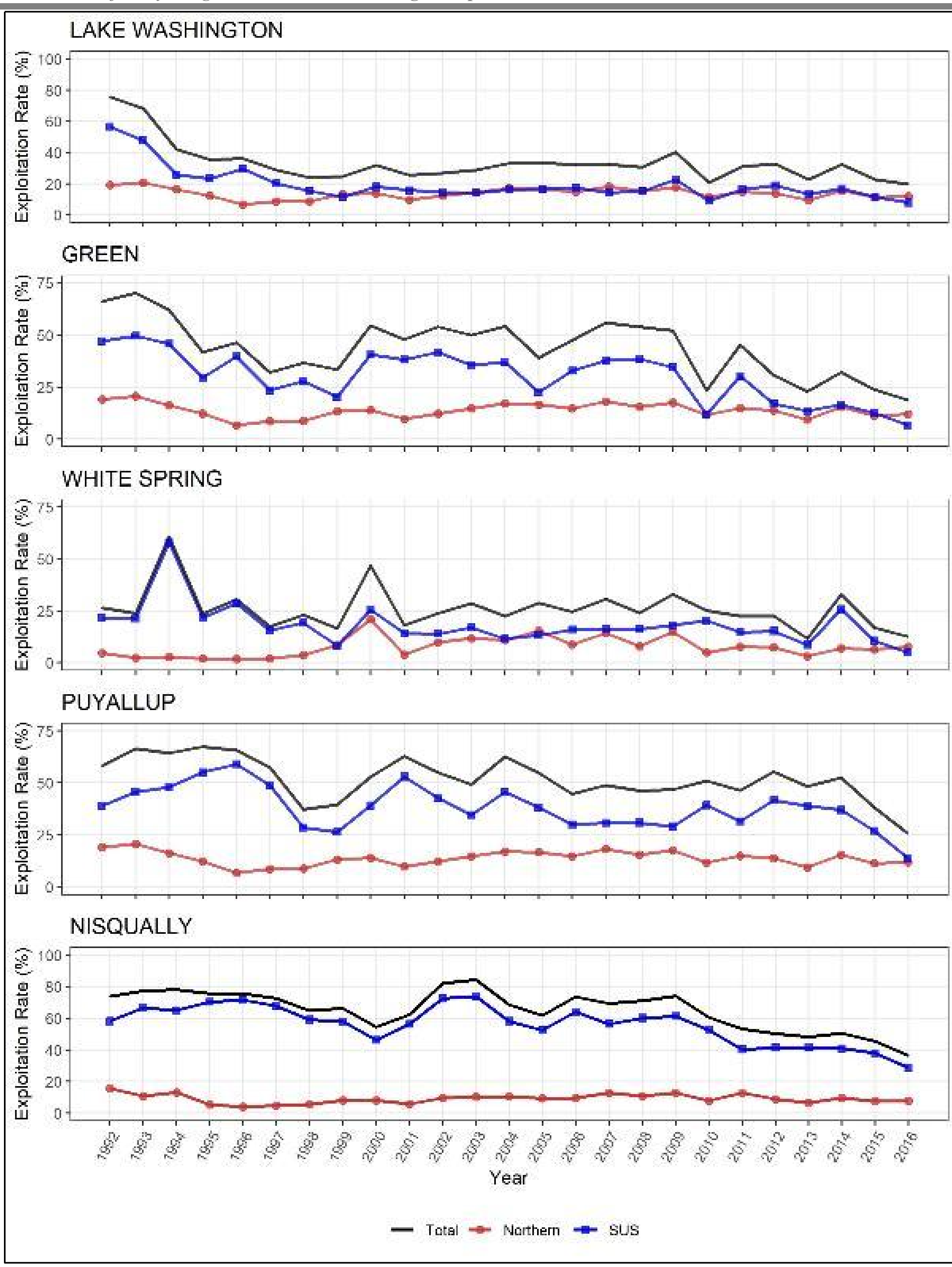

Figure 14. Total harvest exploitation of mid- and south-Puget Sound Chinook salmon populations from (pers. comm. J. Carey, NMFS WCR).

2.2.3 Status of the marine mammal DPSs

2.2.3.1 Status of the Southern Resident Killer Whale DPS

The SRKW DPS, composed of J, K and L pods, was listed as endangered under the ESA on November 18, 2005 (70 FR 69903). A 5-year review under the ESA completed in 2016 concluded that Southern Residents should remain listed as endangered and includes recent information on the population, threats, and new research results and publications (NMFS 2016n).

The limiting factors described in the final recovery plan included reduced prey availability and quality, high levels of contaminants from pollution, and disturbances from vessels and sound (NMFS 2008g). This section summarizes the status of SRKW throughout their range. This section summarizes information taken largely from the recovery plan (NMFS 2008g), recent 5-year review (NMFS 2016n), as well as new data that became available more recently.

Abundance, Productivity, and Trends

SRKW are a long-lived species, with late onset of sexual maturity (review in NMFS (2008g)). Females produce a low number of surviving calves over the course of their reproductive life span (Bain 1990; Olesiuk et al. 1990). Compared to Northern Resident killer whales (a resident killer whale population with a sympatric geographic distribution ranging from coastal waters of Washington State and British Columbia north to Southeast Alaska) Southern Resident females appear to have reduced fecundity (Ward et al. 2013; Velez-Espino et al. 2014); the average inter-birth interval for reproductive Southern Resident females is 6.1 years, which is longer than the 4.88 years estimated for Northern Resident killer whales (Olesiuk et al. 2005). Recent evidence has indicated pregnancy hormones (progesterone and testosterone) can be detected in SRKW feces and have indicated several miscarriages, particularly in late pregnancy (Wasser et al. 2017). The authors suggest this reduced fecundity is largely due to nutritional limitation. Mothers and offspring maintain highly stable social bonds throughout their lives, which is the basis for the matrilineal social structure in the Southern Resident population (Bigg et al. 1990; Baird 2000; Ford et al. 2000). Groups of related matrilines form pods. Three pods – J, K, and L – make up the Southern Resident community. Clans are composed of pods with similar vocal dialects and all three pods of the Southern Residents are part of J clan.

At present, the Southern Resident population has declined to historically low levels (Figure 15). Since censuses began in 1974, J and K pods have steadily increased their sizes. However, the population suffered an almost 20 percent decline from 1996-2001 (from 97 whales in 1996 to 81 whales in 2001), largely driven by lower survival rates in L pod. The overall population had increased slightly from 2002 to 2010 (from 83 whales to 86 whales). During the international science panel review of the effects of salmon fisheries (Hilborn et al. 2012), the Panel stated that during 1974 to 2011, the population experienced a realized growth rate of 0.71 percent, from 67 individuals to 87 individuals. In 2014 and 2015, there was a “baby boom” in the SRKW population that was the result of multiple successful pregnancies that occurred in 2013 and 2014. However, as of December 2018, the population has decreased to only 74 whales, a historical low in the last 30 years with a current realized growth rate (from 1974 to 2017) at half of the previous estimate described in the Panel report, 0.29 percent.

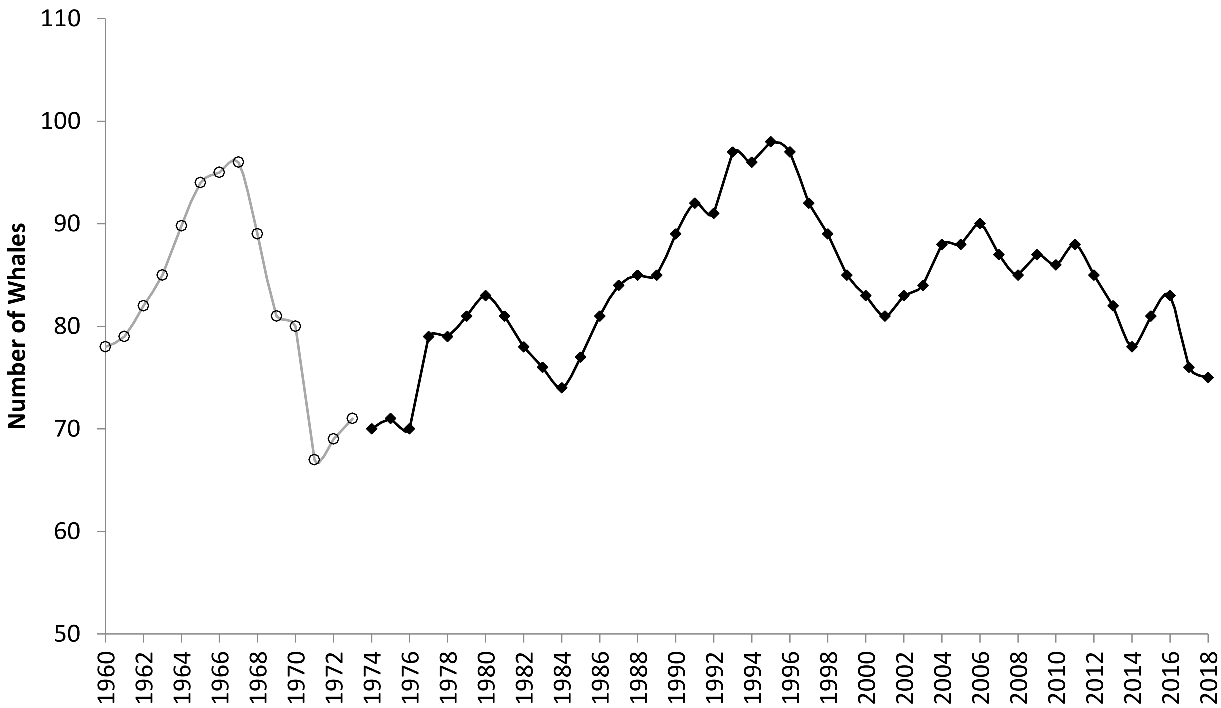

Figure 15. Population size and trend of SRKW, 1960-2017. Data from 1960-1973 (open circles, gray line) are number projections from the matrix model of Olesiuk et al. (1990). Data from 1974-2018 (diamonds, black line) were obtained through photo-identification surveys of the three pods (J, K, and L) in this community and were provided by the Center for Whale Research (CWR unpubl. data) and NMFS (2008g).

There is representation in all three pods, with 22 whales in J pod, 18 whales in K pod and 34 whales in L pod. Although the age and sex distribution is generally similar to that of Northern Residents that are a stable and increasing population (Olesiuk et al. 2005), there are several demographic factors of the Southern Resident population that are cause for concern, namely reduced fecundity, sub-adult survivorship in L pod, and the total number of individuals in the population (review in NMFS 2008g)). Based on an updated pedigree from new genetic data, most of the offspring in recent years were sired by two fathers, meaning that less than 30 individuals make up the effective reproducing portion of the population. Because a small number of males were identified as the fathers of many offspring, a smaller number may be sufficient to support population growth than was previously thought (Ford et al. 2011b, NWFSC unpublished data). Some offspring were the result of matings within the same pod raising questions and concerns about inbreeding effects. Research into the relationship between genetic diversity, effective breeding population size, and health is currently underway to determine how this metric can inform us about extinction risk and inform recovery (NWFSC unpublished data).

The historical abundance of SRKW is estimated from 140 to an unknown upper bound. The minimum estimate (~140) is the number of whales killed or removed for public display in the 1960s and 1970s added to the remaining population at the time the captures ended. Several lines of evidence (i.e., known kills and removals (Olesiuk et al. 1990), salmon declines (Krahn et al. 2002) and genetics (Krahn et al. 2002; Ford et al. 2011b)) all indicate that the population used to be larger than it is now and likely experienced a recent reduction in size, but there is currently no reliable estimate of the upper bound of the historical population size.

Seasonal mortality rates among Southern and Northern Resident whales may be highest during the winter and early spring, based on the numbers of animals missing from pods returning to inland waters each spring. Olesiuk et al. (2005) identified high neonate mortality that occurred outside of the summer season. At least 12 newborn calves (9 in the southern community and 3 in the northern community) were seen outside the summer field season and disappeared by the next field season. Additionally, stranding rates are higher in winter and spring for all killer whale forms in Washington and Oregon (Norman et al. 2004). Data collected from three SRKW strandings in the last five years have contributed to our knowledge of the health of the population and the impact of the threats to which they are exposed. Transboundary partnerships have supported thorough necropsies of L112 in 2012, J32 in 2014, and L95 in 2016, which included testing for contaminant load, disease and pathogens, organ condition, and diet composition12. A final necropsy report for J34, who was found dead near Sechelt, British Columbia on December 20, 2016 is still pending[13].

The NWFSC continues to evaluate changes in fecundity and mortality rates, and has updated the work on population viability analyses conducted for the 2004 Status Review for SRKW and the science panel review of the effects of salmon fisheries (Krahn et al. 2004a; Hilborn et al. 2012; Ward et al. 2013). Following from that work, the data now suggests a downward trend in population growth projected over the next 50 years. As the model projects out over a longer time frame (50 years) there is increased uncertainty around the estimates, however, if all of the parameters in the model remain the same the overall trend shows a decline in later years. This downward trend is in part due to the changing age and sex structure of the population, but also related to the relatively low fecundity rate observed over the period from 2011 to 2016 (Figure 16,NMFS (2016n)). To explore potential demographic projections, Lacy et al. (2017) constructed a population viability assessment that considered sublethal effects and the cumulative impacts of threats (contaminants, acoustic disturbance, and prey abundance). They found that over the range of scenarios tested, the effects of prey abundance on fecundity and survival had the largest impact on the population growth rate. Furthermore, they suggested in order for the population to reach the recovery target of 2.3 percent growth rate, the acoustic disturbance would need to be reduced in half and the Chinook abundance would need to be increased by 15 percent (Lacy et al. 2017).

[12] Reports for those necropsies are available at: http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/killer_whal e/rpi_strandings.html
[13] The initial findings can be found at: http://www.pac.dfo-mpo.gc.ca/fm-gp/species-especes/mammalsmammiferes/srkw-eprs-j34-eng.html

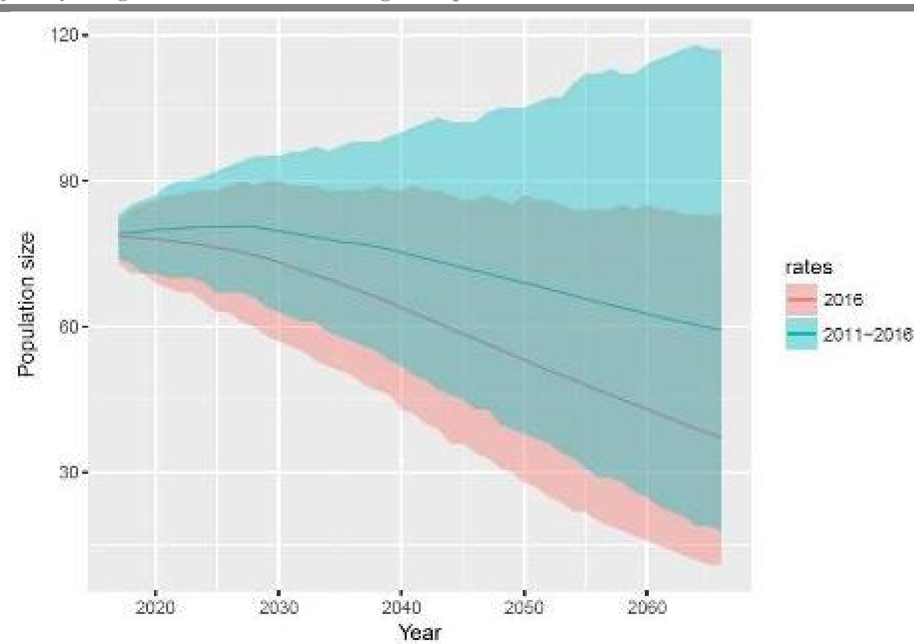

Figure 16. SRKW population size projections from 2016 to 2066 using 2 scenarios: (1) projections using demographic rates held at 2016 levels, and (2) projections using demographic rates from 2011 to 2016. The pink line represents the projection assuming future rates are similar to those in 2016, whereas the blue represents the scenario with future rates being similar to 2011 to 2016 (NMFS 2016n).

Because of this population's small abundance, it is also susceptible to demographic stochasticity – randomness in the pattern of births and deaths among individuals in a population. Several other sources of stochasticity can affect small populations and contribute to variance in a population's growth and extinction risk. Other sources include environmental stochasticity, or fluctuations in the environment that drive fluctuations in birth and death rates, and demographic heterogeneity, or variation in birth or death rates of individuals because of differences in their individual fitness (including sexual determinations). In combination, these and other sources of random variation combine to amplify the probability of extinction, known as the extinction vortex (Gilpin and Michael 1986; Fagan and Holmes 2006; Melbourne and Hastings 2008). The larger the population size, the greater the buffer against stochastic events and genetic risks. A delisting criterion for the SRKW DPS is an average growth rate of 2.3 percent for 28 years (NMFS 2008g). In light of the current average growth rate of 0.29 percent (from 1974 to present), this recovery criterion reinforces the need to allow the population to grow quickly.

Population growth is also important because of the influence of demographic and individual heterogeneity on a population's long-term viability. Population-wide distribution of lifetime reproductive success can be highly variable, such that some individuals produce more offspring than others to subsequent generations, and male variance in reproductive success can be greater than that of females (i.e., Clutton-Brock 1988; Hochachka 2006). For long-lived vertebrates such as killer whales, some females in the population might contribute less than the number of offspring required to maintain a constant population size (n = 2), while others might produce more offspring. The smaller the population, the more weight an individual's reproductive success has on the population’s growth or decline (i.e., Coulson et al. 2006). For example, although there are currently 27 reproductive aged females (ages 10-42) in the SRKW population, only 14 have successfully reproduced in the last 10 years (CWR unpubl. data). This further illustrates the risk of demographic stochasticity for a small population like SRKW – the smaller a population, the greater the chance that random variation will result in too few successful individuals to maintain the population.

Geographic Range and Distribution

Southern Residents occur throughout the coastal waters off Washington, Oregon, and Vancouver Island and are known to travel as far south as central California and as far north as Southeast Alaska (NMFS 2008g; Hanson et al. 2013; Carretta et al. 2017b) (Figure 17). Southern Residents are highly mobile and can travel up to 86 miles (160 km) in a single day (Erickson 1978; Baird 2000), with seasonal movements likely tied to the migration of their primary prey, salmon. During the spring, summer, and fall months, the whales spend a substantial amount of time in the inland waterways of the Strait of Georgia, Strait of Juan de Fuca, and Puget Sound (Bigg 1982; Ford et al. 2000; Krahn et al. 2002; Hauser et al. 2007). In general, the three pods are increasingly more present in May and June and spend a considerable amount of time in inland waters through September. Late summer and early fall movements of Southern Residents in the Georgia Basin are consistent, with strong site fidelity shown to the region as a whole and high occurrence in the San Juan Island area (Hauser et al. 2007; Hanson and Emmons 2010). All three pods generally remain in the Georgia Basin through October and make frequent trips to the outer coasts of Washington and southern Vancouver Island and are occasionally sighted as far west as Tofino and Barkley Sound (Ford et al. 2000; Hanson and Emmons 2010; Whale Museum unpublished data). Sightings in late fall decline as the whales shift to the outer coasts of Vancouver Island and Washington.

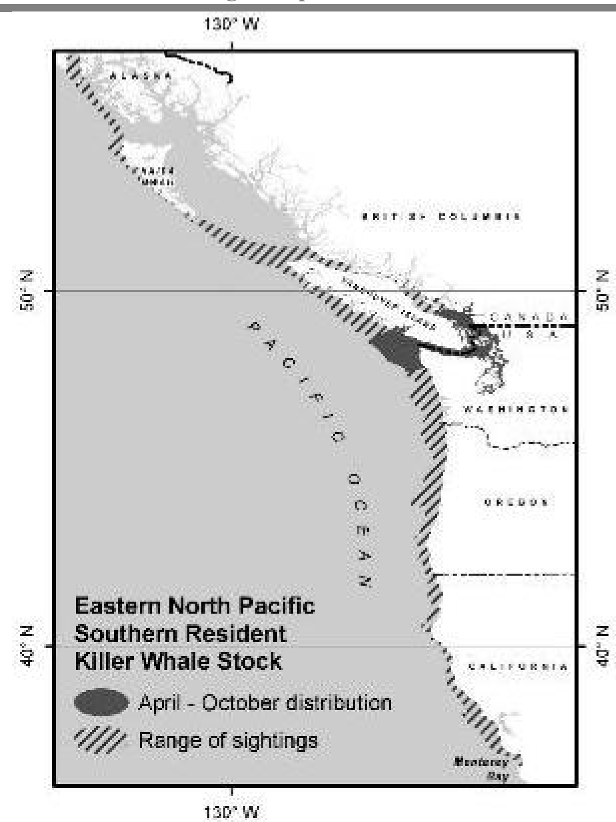

Figure 17. Geographic range of SRKW (reprinted from Carretta et al. (2017a)).

Although seasonal movements are generally predictable, there can be large inter-annual variability in arrival time and days present in inland waters from spring through fall, with late arrivals and fewer days present in recent years (Hanson and Emmons 2010; Whale Museum unpublished data). For example, K pod has had variable occurrence in June ranging from 0 days of occurrence in inland waters to over 25 days (Figure 18). Fewer observed days in inland waters likely indicates changes in their prey availability (i.e., abundance, distribution and accessibility). During fall and early winter, Southern Resident pods, and J pod in particular, expand their routine movements into Puget Sound, likely to take advantage of chum and Chinook salmon runs (Osborne 1999; Hanson et al. 2010).

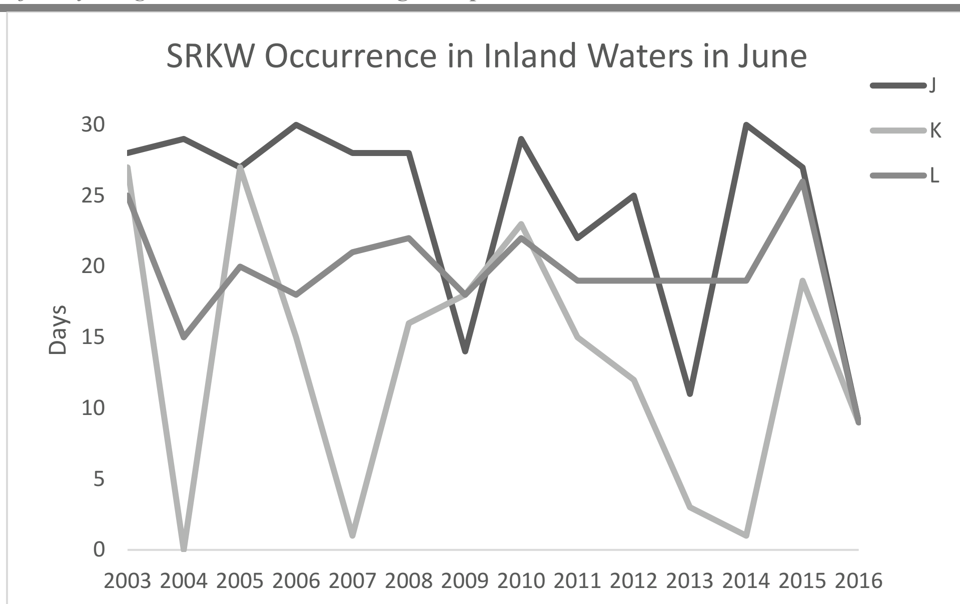

Figure 18. Number of days of SRKW occurrence in inland waters in June for each year from 2003 to 2016 (data from The Whale Museum).

In recent years, several sightings and acoustic detections of Southern Residents have been obtained off the Washington and Oregon coasts in the winter and spring (Hanson et al. 2010; Hanson et al. 2013; NWFSC unpublished data). Satellite-linked tag deployments have also provided more data on the SRKW movements in the winter indicating that K and L pods use the coastal waters along Washington, Oregon, and California during non-summer months. Detection rates of K and L pods on the passive acoustic recorders indicate Southern Residents occur with greater frequency off the Columbia River and Westport and are most common in March (Hanson et al. 2013). J pod has also only been detected on one of seven passive acoustic recorders positioned along the outer coast (Hanson et al. 2013). The limited range of the sightings/ acoustic detections of J pod in coastal waters, the lack of coincident occurrence during the K and L pod sightings, and the results from satellite tagging in 2012–2016 (NWFSC unpubl. data) indicate J pod's limited occurrence along the outer coast and extensive occurrence in inland waters, particularly in the northern Georgia Strait.

Limiting Factors and Threats

Several factors identified in the final recovery plan for Southern Residents may be limiting recovery. These are quantity and quality of prey, toxic chemicals that accumulate in top predators, and disturbance from sound and vessels. Oil spills are also a risk factor. It is likely that multiple threats are acting together to impact the whales. Modeling exercises have attempted to identify which threats are most significant to survival and recovery (Lacy et al. 2017) and available data suggests that all of the threats are potential limiting factors (NMFS 2008g).

Quantity and Quality of Prey

SRKW consume a variety of fish species (22 species) and one species of squid (Ford et al. 1998;

Ford et al. 2000; Ford and Ellis 2006; Hanson et al. 2010; Ford et al. 2016a), but salmon are identified as their primary prey. Southern Residents are the subject of ongoing research, including direct observation, scale and tissue sampling of prey remains, and fecal sampling. The diet data indicate that the whales are consuming mostly larger (i.e., older) Chinook salmon. Chinook salmon is their primary prey despite the much lower abundance in some areas and during certain time periods in comparison to other salmonids, for mechanisms that remain unknown but factors of potential importance include the species' large size, high fat and energy content, and year-round occurrence in the whales' geographic range. Chinook salmon have the highest value of total energy content compared to other salmonids because of their larger body size and higher energy density (kilocalories/kilogram(kcal/kg)) (O'Neill et al. 2014). For example, in order for a killer whale to obtain the total energy value of one Chinook salmon, they would need to consume approximately 2.7 coho, 3.1 chum, 3.1 sockeye, or 6.4 pink salmon (O'Neill et al. 2014). Caloric content and size at maturity are likely similar in wild and hatchery fish, however size at return is dependent on age class and differences in wild and hatchery age classes are known to occur. Recent research suggests that killer whales are capable of detecting, localizing and recognizing Chinook salmon through their ability to distinguish Chinook echo structure as different from other salmon (Au et al. 2010).

Scale and tissue sampling from May to September in inland waters of WA and BC indicate that their diet consists of a high percentage of Chinook salmon (monthly proportions as high as >90 percent) (Hanson et al. 2010; Ford et al. 2016a). Genetic analysis of the Hanson et al. (2010) samples indicate that when Southern Residents are in inland waters from May to September, they consume Chinook stocks that originate from regions including the Fraser River (including Upper Fraser, Mid Fraser, Lower Fraser, North Thompson, South Thompson and Lower Thompson), Puget Sound (North and South Puget Sound), the Central British Columbia Coast and West and East Vancouver Island.

DNA (deoxyribonucleic acid) quantification methods are used to estimate the proportion of different prey species in the diet from fecal samples (Deagle et al. 2005). Recently, Ford et al. (2016a) confirmed the importance of Chinook salmon to the Southern Residents in the summer months using DNA sequencing from whale feces. Salmon and steelhead made up to 98 percent of the inferred diet, of which almost 80 percent were Chinook salmon. Coho salmon and steelhead are also found in the diet in spring and fall months when Chinook salmon are less abundant. Specifically, coho salmon contribute to over 40 percent of the diet in late summer, which is evidence of prey shifting at the end of summer towards coho salmon (Ford et al. 1998; Ford and Ellis 2006; Hanson et al. 2010; Ford et al. 2016a). Less than 3 percent each of chum salmon, sockeye salmon, and steelhead were observed in fecal DNA samples collected in the summer months (May through September). Prey remains and fecal samples collected in inland waters during October through December indicate Chinook and chum salmon are primary contributors of the whale's diet (NWFSC unpubl. data).

Observations of whales overlapping with salmon runs (Wiles 2004; Zamon et al. 2007; Krahn et al. 2009) and collection of prey and fecal samples have also occurred in coastal waters in the winter months. Preliminary analysis of prey remains and fecal samples sampled during the winter and spring in coastal waters indicated the majority of prey samples were Chinook salmon, with a smaller number of steelhead, chum salmon, and halibut (NWFSC unpubl. data). The occurrence of K and L pods off the Columbia River in March suggests the importance of Columbia River spring runs of Chinook salmon in their diet (Hanson et al. 2013). Chinook genetic stock identification from samples collected in winter and spring in coastal waters included 12 U.S. west coast stocks, and over half the Chinook salmon consumed originated in the Columbia River (NWFSC unpubl. data). Columbia River, Central Valley, Puget Sound, and Fraser River Chinook salmon comprise over 90% of the whales' coastal Chinook salmon diet (NWFSC unpubl. data).

In general, over the past decade, some Chinook salmon stocks within the range of the whales have had relatively high abundance (e.g. WA/OR coastal stocks, some Columbia River stocks) compared to the previous decade, whereas other stocks originating in the more northern and southern ends of the whales' range (e.g. most Fraser stocks, Northern and Central B.C. stocks, Georgia Strait, Puget Sound, and Central Valley) have declined. Changing ocean conditions driven by climate change may influence ocean survival of Chinook and other Pacific salmon, further affecting the prey available to Southern Residents.

In an effort to identify Chinook salmon stocks that are important to SRKW and prioritize recovery efforts to increase the whales' prey base, NMFS and WDFW released a priority stock report identifying the Chinook salmon stocks of most importance to the health of the Southern Resident populations along the West Coast (NOAA and WDFW 2018) [14]. The priority stock report was created by analyzing scat and prey scale/tissue samples to identify Chinook salmon stocks in the whales' diet, observing the killer whale body condition through aerial photographs, and estimating the spatial and temporal overlap with Chinook salmon stocks ranging from SEAK to California. Extra weight was given to the salmon runs that support the Southern Residents during times of the year when the whales' body condition is more likely reduced and when Chinook salmon may be less available, such as in winter months. Table 31 is a summary of those stock descriptions.

[14] https://www.westcoast.fisheries.noaa.gov/publications/protected_species/marine_mammals/killer_whales/recovery/srkw_priority_chinook_stocks_conceptual_model_report___list_22june2018.pdf

Table 31. Summary of the priority Chinook salmon stocks (adapted from NOAA and WDFW (2018))

Priority	ESU/Stock Group	Run Type	Rivers or Stocks in Group
1	North Puget Sound South Puget Sound	Fall	Nooksack, Elwha, Dungeness, Skagit, Stillaguamish, Snohomish, Nisqually, Puyallup, Green, Duwamish, Deschutes, Hood Canal Systems
2	Lower Columbia Strait of Georgia	Fall	Fall Tules and Fall Brights (Cowlitz, Kalama, Clackamas, Lewis, others), Lower Strait (Cowichan, Nanaimo), Upper Strait (Klinaklini, Wakeman, others), Fraser (Harrison)
3	Upper Columbia & Snake	Fall	Upriver Brights, Spring 1.3 (Upper Pitt, Birkenhead; Mid & Upper Fraser; North and South Thompson) and Spring 1.2 (Thompson, Louis Creek, Bessette Creak); Lewis, Cowlitz, Kalama, Big White Salmon
	Fraser	Spring	
	Lower Columbia	Spring	
4	Middle Columbia	Fall	Fall Brights
5	Snake River	Spring/summer	Snake, Salmon, Clearwater, Nooksack, Elwha, Dungeness, Skagit (Stillaguamish, Snohomish)
	Northern Puget Sound	Spring	
6	Washington Coast	Spring and Fall	Hoh, Queets, Quillayute, Grays Harbor
7	Central Valley	Spring	Sacramento and tributaries
8	Middle/Upper Columbia	Spring/Summer	Columbia, Yakima, Wenatchee, Methow, Okanagan
9	Fraser	Summer	Summer 0.3 (South Thompson, Lower Fraser, Shuswap, Adams, Little River, Maria Slough) and Summer 1.3 (Nechako, Chilko, Quesnel, Clearwater River)
10	Central Valley	Fall and late Fall	Sacramento, San Joaquin, Upper Klamath, and Trinity
	Klamath River	Fall and Spring	
11	Upper Willamette	Spring	Willamette
12	South Puget Sound	Spring	Nisqually, Puyallup, Green, Duwamish, Deschutes, Hood Canal systems
13	Central Valley	Winter	Sacramento and tributaries
14	North/Central Oregon Coast	Fall	Northern (Siuslaw, Nehalem, Siletz) and Central (Coos, Elk, Coquille, Umpqua)
15	West Vancouver Island	Fall	Robertson Creek, WCVI Wild
16	Southern OR & Northern CA Coastal	Fall and Spring	Rogue, Chetco, Smith, Lower Klamath, Mad, Eel, Russian
	California Coastal	Fall and Spring	

There are many factors that affect the abundance, productivity, spatial structure, and diversity, of Chinook salmon (as described above) and thus affect prey availability for the whales. For example, LCR Chinook salmon populations began to decline by the early 1900s because of habitat alterations and harvest rates that were unsustainable, particularly given these changing habitat conditions. Human impacts and limiting factors come from multiple sources, including hydropower development, habitat degradation, hatchery effects, fishery management and harvest decisions, and ecological factors, including predation and environmental variability.

The effects of fisheries on prey availability has been described in multiple biological opinions (e.g. NMFS 2008d; 2011a; 2018b). Following issuance of the 2011 biological opinion on the management plan for Puget Sound fisheries (NMFS 2011a), NMFS implemented conservation measures that included convening an independent science panel to critically evaluate the effects of salmon fisheries on the abundance of Chinook salmon available to Southern Residents. Overall, the panel concluded that at a broad scale, salmon abundance will likely influence the recovery of the whales, but the impact of reduced Chinook salmon harvest on future availability of Chinook salmon to Southern Residents is not clear, and cautioned against overreliance on correlative studies or implicating any particular fishery (Hilborn et al. 2012). Following the independent science panel approach on the effects of salmon fisheries on SRKW (Hilborn et al. 2012), NMFS and partners have actively engaged in research and analyses to fill gaps and reduce uncertainties raised by the panel in their report.

Currently, hatchery production is a significant component of the salmon prey base returning to watersheds within the range of SRKW (Barnett-Johnson et al. 2007; NMFS 2008g). Although hatchery production has contributed some offset of the historical declines in the abundance of natural-origin salmon within the range of the whales, hatcheries also pose risks to natural-origin salmon populations (Nickelson et al. 1986; Ford 2002; Levin and Williams 2002; Naish et al. 2007). Healthy natural-origin salmon populations are important to the long-term maintenance of prey populations available to Southern Residents because it is uncertain whether a hatchery dominated mix of stocks is sustainable indefinitely and because hatchery fish can differ, relative to natural-origin Chinook salmon, for example, in size and hence caloric value and in availability/migration location and timing. However, the release of hatchery fish has not been identified as a threat to the survival or persistence of Southern Residents. It is possible that hatchery produced fish may benefit this endangered population of whales by enhancing prey availability as scarcity of prey is a primary threat to SRKW survival and hatchery fish often contribute to the salmon stocks consumed (Hanson et al. 2010).

Nutritional Limitation and Body Condition

When prey is scarce, Southern Residents likely spend more time foraging than when prey is plentiful. Increased energy expenditure and prey limitation can cause poor body condition and nutritional stress. Nutritional stress is the condition of being unable to acquire adequate energy and nutrients from prey resources and as a chronic condition, can lead to reduced body size of individuals and to lower reproductive and survival rates of a population (Trites and Donnelly 2003). During periods of nutritional stress and poor body condition, cetaceans lose adipose tissue behind the cranium, displaying a condition known as “peanut-head” in extreme cases (Pettis et al. 2004; Bradford et al. 2012; Joblon et al. 2014). Between 1994 and 2008, 13 SRKW were observed from boats to have a pronounced “peanut-head”; and all but two subsequently died (Durban et al. 2009; Center for Whale Research unpublished data). None of the whales that died were subsequently recovered, and therefore definitive cause of death could not be identified. Both females and males across a range of ages were found in poor body condition.

Since 2008, NMFS’s Southwest Fisheries Science Center (SWFSC) has used aerial photogrammetry to assess the body condition and health of SRKW, initially in collaboration with the CWR and, more recently, with the Vancouver Aquarium and SR^3. Aerial photogrammetry studies have provided finer resolution for detecting poor condition, even before it manifests in “peanut heads” that are observable from boats. Annual aerial surveys of the population from 2013-2017 (with exception of 2014) have detected declines in condition before the death of seven Southern Residents (L52 and J8 as reported in Fearnbach et al. (2018); J14, J2, J28, J54, and J52 as reported in Durban et al. (2017)), including five of the six most recent mortalities (Trites and Rosen 2018). These data have provided evidence of a general decline in SRKW body condition since 2008, and documented members of J pod being in poorer body condition in May compared to September (at least in 2016 and 2017) (Trites and Rosen 2018).

Although body condition in whales can be influenced by a number of factors, including prey availability, disease, physiological or life history status, and may vary by season and across years, prey limitation is the most likely cause of observed changes in body condition in wild mammalian populations (Matkin et al. 2017). It is possible that poor nutrition could contribute to mortality through a variety of mechanisms. To demonstrate how this is possible, we reference studies that have demonstrated the effects of energetic stress (caused by incremental increases in energy expenditures or incremental reductions in available energy) on adult females and juveniles, which have been studied extensively (e.g., adult females: Gamel et al. (2005), Schaefer (1996), Daan et al. (1996), juveniles: Noren et al. (2009), Trites and Donnelly (2003)). Small, incremental increases in energy demands should have the same effect on an animal’s energy budget as small, incremental reductions in available energy, such as one would expect from reductions in prey. Ford and Ellis (2006) report that resident killer whales engage in prey sharing about 76 percent of the time. Prey sharing presumably would distribute more evenly the effects of prey limitation across individuals of the population than would otherwise be the case (i.e., if the most successful foragers did not share with other individuals). Therefore, although cause of death for most individuals that disappear from the population is unknown, poor nutrition could contribute to additional mortality in this population.

Toxic Chemicals

Various adverse health effects in humans, laboratory animals, and wildlife have been associated with exposures to persistent pollutants. These pollutants have the ability to cause endocrine disruption, reproductive disruption or failure, immunotoxicity, neurotoxicity, neurobehavioral disruption, and cancer (Reijnders 1986; Subramanian et al. 1987; de Swart et al. 1996; Bonefeld-Jørgensen et al. 2001; Reddy et al. 2001; Schwacke et al. 2002; Darnerud 2003; Legler and Brouwer 2003; Viberg et al. 2003; Ylitalo et al. 2005; Fonnum et al. 2006; Viberg et al. 2006; Darnerud 2008; Legler 2008). Southern Residents are exposed to a mixture of pollutants, some of which may interact synergistically and enhance toxicity, influencing their health. High levels of these pollutants have been measured in blubber biopsy samples from Southern Residents

(Ross et al. 2000; Krahn et al. 2007; Krahn et al. 2009), and more recently, these pollutants were measured in fecal samples collected from Southern Residents providing another potential opportunity to evaluate exposure to these pollutants (Lundin et al. 2016a; Lundin et al. 2016b).

Killer whales are exposed to persistent pollutants primarily through their diet. For example, Chinook salmon contain higher levels of some persistent pollutants than other salmon species, but only limited information is available for pollutant levels in Chinook salmon (Krahn et al. 2007; O'Neill and West 2009; Veldhoen et al. 2010; Mongillo et al. 2016). These harmful pollutants, through consumption of prey species that contain these pollutants, are stored in the killer whale's blubber and can later be released; when the pollutants are released, they are redistributed to other tissues when the whales metabolize the blubber in response to food shortages or reduced acquisition of food energy that could occur for a variety of other reasons. The release of pollutants can also occur during gestation or lactation. Once the pollutants mobilize in to circulation, they have the potential to cause a toxic response. Therefore, nutritional stress from reduced Chinook salmon populations may act synergistically with high pollutant levels in Southern Residents and result in adverse health effects.

In April 2015, NMFS hosted a 2-day SRKW health workshop to assess the causes of decreased survival and reproduction in the killer whales. Following the workshop, a list of potential action items to better understand what is causing decreased reproduction and increased mortality in this population was generated and then reviewed and prioritized to produce the Priorities Report (NMFS 2015d). The report also provides prioritized opportunities to establish important baseline information on Southern Resident and reference populations to better assess negative impacts of future health risks, as well as positive impacts of mitigation strategies on SRKW health.

Disturbance from Vessels and Sound

Vessels have the potential to affect killer whales through the physical presence and activity of the vessel, increased underwater sound levels generated by boat engines, or a combination of these factors. Vessel strikes are rare, but do occur and can result in injury or mortality (Gaydos and Raverty 2007). In addition to vessels, underwater sound can be generated by a variety of other human activities, such as dredging, drilling, construction, seismic testing, and sonar (Richardson et al. 1995a; Gordon and Moscrop. 1996; National Research Council 2003). Impacts from these sources can range from serious injury and mortality to changes in behavior. In other cetaceans, hormonal changes indicative of stress have been recorded in response to intense sound exposure (Romano et al. 2003). Chronic stress is known to induce harmful physiological conditions including lowered immune function, in terrestrial mammals and likely does so in cetaceans (Gordon and Moscrop. 1996).

Killer whales rely on their highly developed acoustic sensory system for navigating, locating prey, and communicating with other individuals. While in inland waters of Washington and British Columbia, SRKW are the principal target species for the commercial whale watch industry (Hoyt 2001; O'Connor et al. 2009) and encounter a variety of other vessels in their urban environment (e.g., recreational, fishing, ferries, military, shipping). Several main threats from vessels include direct vessel strikes, the masking of echolocation and communication signals by anthropogenic sound, and behavioral changes (NMFS 2008g). There is a growing body of evidence documenting effects from vessels on small cetaceans and other marine mammals (NMFS 2010c; 2016n; 2018h). Research has shown that the whales spend more time traveling and performing surface active behaviors and less time foraging in the presence of all vessel types, including kayaks, and that noise from motoring vessels up to 400 meters away has the potential to affect the echolocation abilities of foraging whales (Holt 2008; Lusseau et al. 2009; Noren et al. 2009; Williams et al. 2010). Individual energy balance may be impacted when vessels are present because of the combined increase in energetic costs resulting from changes in whale activity with the decrease in prey consumption resulting from reduced foraging opportunities (Williams et al. 2006; Lusseau et al. 2009; Noren et al. 2009; Noren et al. 2012).

At the time of the whales' listing under the ESA, NMFS reviewed existing protections for the whales and developed recovery actions, including vessel regulations, to address the threat of vessels to killer whales. NMFS concluded it was necessary and advisable to adopt regulations to protect killer whales from disturbance and sound associated with vessels, to support recovery of SRKW. Federal vessel regulations were established in 2011 to prohibit vessels from approaching killer whales within 200 yards (182.9 meters (m)) and from parking in the path of the whales within 400 yards (365.8 m). These regulations apply to all vessels in inland waters of Washington State with exemptions to maintain safe navigation and for government vessels in the course of official duties, ships in the shipping lanes, research vessels under permit, and vessels lawfully engaged in commercial or treaty Indian fishing that are actively setting, retrieving, or closely tending fishing gear (76 FR 20870, April, 14, 2011).

In the final rule, NMFS committed to reviewing the vessel regulations to evaluate effectiveness, and also to study the impact of the regulations on the viability of the local whale watch industry. In March 2013, NMFS held a killer whale protection workshop[15] to review the current vessel regulations, guidelines, and associated analyses; review monitoring, boater education, and enforcement efforts; review available industry and economic information and identify data gaps; and provide a forum for stakeholder input to explore next steps for addressing vessel effects on killer whales.

In December 2017, NMFS completed a technical memorandum evaluating the effectiveness of regulations adopted in 2011 to help protect endangered SRKW from the impacts of vessel traffic and noise (Ferrara et al. 2017). In the assessment, Ferrara et al. (2017) used five measures: education and outreach efforts, enforcement, vessel compliance, biological effectiveness, and economic impacts. For each measure, the trends and observations in the 5 years leading up to the regulations (2006-2010) were compared to the trends and observations in the 5 years following the regulations (2011-2015). The memo finds that the regulations have benefited the whales by reducing impacts without causing economic harm to the commercial whale-watching industry or local communities. The authors also find room for improvement in terms of increasing awareness and enforcement of the regulations, which would help improve compliance and further reduce biological impacts to the whales.

Oil Spills

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[15] The presentations and supporting documents (including workshop notes) can be found at http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/killer_whale/vessel_regulations.html.

In the Northwest, SRKW are the most vulnerable marine mammal population to the risks imposed by an oil spill due to their small population size, strong site fidelity to areas with high oil spill risk, large group size, late reproductive maturity, low reproductive rate, and specialized diet, among other attributes (Jarvela Rosenberger et al. 2017). Oil spills have occurred in the range of Southern Residents in the past, and there is potential for spills in the future. Oil can be discharged into the marine environment in any number of ways, including shipping accidents, refineries and associated production facilities, and pipelines. Despite many improvements in spill prevention since the late 1980s, much of the region inhabited by Southern Residents remains at risk from serious spills because of the heavy volume of shipping traffic and proximity to petroleum refining centers in inland waters. Numerous oil tankers transit through the inland waters range of Southern Residents throughout the year. The magnitude of risk posed by oil discharges in the action area is difficult to precisely quantify. The total volume of oil spills declined from 2007 to 2013, but then increased from 2013 to 2017 (WDOE 2017). The percent of potential high-risk vessels that were boarded and inspected between 2009 to 2017 declined (from 26 percent inspected in 2009 to 12.2 percent by 2017) (WDOE 2017).

Repeated ingestion of petroleum hydrocarbons by killer whales likely causes adverse effects; however, long-term consequences are poorly understood. In marine mammals, acute exposure to petroleum products can cause changes in behavior and reduced activity, inflammation of the mucous membranes, lung congestion and disease, pneumonia, liver disorders, neurological damage, adrenal toxicity, reduced reproductive rates, and changes in immune function (Geraci and Aubin 1990; Schwacke et al. 2013; Venn-Watson et al. 2015; de Guise et al. 2017; Kellar et al. 2017), potentially death and long-term effects on population viability (Matkin et al. 2008; Ziccardi et al. 2015). For example, 122 cetaceans stranded or were reported dead within 5 months following the Deepwater Horizon spill in the Gulf of Mexico (Ziccardi et al. 2015). An additional 785 cetaceans were found stranded from November 2010 to June 2013, which was declared an Unusual Mortality Event (Ziccardi et al. 2015). In addition, oil spills have the potential to adversely impact habitat and prey populations, and, therefore, may adversely affect Southern Residents by reducing food availability.

2.2.3.2 Status of the Mexico DPS Humpback Whale

Humpback whales are large baleen whales that are primarily dark grey in appearance, with variable areas of white on their fins, bellies, and flukes. The coloration of flukes is unique to individual whales. The lifespan of humpback whales is estimated to be 80 to 100 years. Sexual maturity is reached at five to 11 years of age. The gestation period of humpback whales is 11 months, and calves are nursed for 12 months. The average calving interval is two to three years. Birthing occurs in low latitudes during winter months.

Humpback whale feeding occurs in high latitudes during summer months. They exhibit a wide range of foraging behaviors and feed on a range of prey types, such as small schooling fishes, krill, and other large zooplankton.

Humpback whales produce a variety of vocalizations ranging from 20 Hz to 10 kHz (Winn et al. 1970; Tyack and Whitehead 1983; Payne and Payne 1985; Silber 1986; Thompson et al. 1986; Richardson et al. 1995b; Au 2000; Frazer and Mercado III 2000; Erbe 2002; Au et al. 2006; Vu et al. 2012). NMFS categorizes humpback whales in the low-frequency cetacean (i.e., baleen whale) functional hearing group. As a group, it is estimated that baleen whales applied frequency range is between 7 Hz and 35 kHz (NMFS 2018f).

Additional information on humpback whales can be found at:
http://www.nmfs.noaa.gov/pr/species/mammals/whales/humpback-whale.html

We used information available in the status review (Bettridge et al. 2015), most recent stock assessments (Muto et al. 2017; Muto et al. 2018a; Muto et al. 2018b), NMFS species information (see website above), report on estimated abundance and migratory destinations for North Pacific humpback whales (Wade et al. 2016), and recent biological opinions to summarize the status of the species, as follows.

Abundance, Productivity and Trends

The humpback whale was listed as endangered under the Endangered Species Conservation Act (ESCA) on December 2, 1970 (35 FR 18319). Congress replaced the ESCA with the ESA in 1973, and humpback whales continued to be listed as endangered. NMFS recently conducted a global status review and changed the status of humpback whales under the ESA (81 FR 62260; September 8, 2016). Under the final rule, 14 DPSs of humpback whales are recognized worldwide:

- North Atlantic
  - West Indies
  - Cape Verde Islands/Northwest Africa
- North Pacific
  - Western North Pacific (WNP)
  - Hawaii
  - Mexico
  - Central America
- Northern Indian Ocean
  - Arabian Sea
- Southern Hemisphere
  - Brazil
  - Gabon/Southwest Africa
  - Southeast Africa/Madagascar
  - West Australia
  - East Australia
  - Oceania
  - Southeastern Pacific

Humpback whales in the entire action area may belong to the WNP, Hawaii, Mexico, or Central America DPSs (81 FR 62260) (Table 32). However, we do not anticipate any effects of the proposed actions described in Section 1.3 on WNP and Central America DPS of humpback whales because the probability of encountering these DPSs in SEAK waters, where the effects of the proposed actions would occur, is 0% (Table 32). Therefore, we do not discuss these two humpback DPSs further in this Opinion.

Table 32. Probability of encountering humpback whales from each DPS in the North Pacific Ocean (columns) in various feeding areas (on left). Adapted from Wade et al. (2016).

Summer Feeding Areas	North Pacific Distinct Population Segments			
	Western North Pacific DPS (endangered)[1]	Hawaii DPS (not listed)	Mexico DPS (threatened)	Central America DPS (endangered)[1]
Kamchatka	100%	0%	0%	0%
Aleutian I/Bering/Chukchi	4.4%	86.5%	11.3%	0%
Gulf of Alaska	0.5%	89%	10.5%	0%
Southeast Alaska / Northern BC	0%	93.9%	6.1%	0%
Southern BC / WA	0%	52.9%	41.9%	14.7%
OR/CA	0%	0%	89.6%	19.7%

[1]For the endangered DPSs, these percentages reflect the 95% confidence interval of the probability of occurrence in order to give the benefit of the doubt to the species and to reduce the chance of underestimating potential takes.

Humpback whales in the SEAK portion of the action area may belong to the Mexico or Hawaii DPSs. The Mexico DPS (which includes a small proportion of humpback whales found in the Southeast Alaska portions of the action area) is listed as threatened, and the Hawaii DPS (which includes most humpback whales found in Southeast Alaska) is not listed. The most current stock assessment report (SAR) for humpback whales on the west coast of the United States (Carretta et al. 2018) has not modified the Marine Mammal Protection Act (MMPA) definition of humpback whale stocks in response to the new ESA listings; thus we use the existing SARs and sometimes refer to the Mexico DPS in the entire action area as a part of the Central North Pacific and WA/OR/CA stocks. These MMPA stocks include whales from multiple DPSs. The CA/OR/WA stock spends the winter primarily in coastal waters of Mexico and Central America, and the summer along the West Coast from California to British Columbia. The Central North Pacific stock primarily spends winters in Hawaii and summers in Alaska, and its distribution may partially overlap with that of the CA/OR/WA stock off the coast of Washington and British Columbia (Clapham 2009). There is some mixing between these populations, though they are still considered distinct stocks.

Wade et al. (2016) estimated the abundance of the Mexico DPS to be 3,264 based on revised analysis of the available data. Relatively high densities of humpback whales occur throughout much of Southeast Alaska and northern British Columbia, particularly during the summer months. The abundance estimate for humpback whales in the Southeast Alaska is estimated to be 6,137 (CV= 0.07) animals which includes whales from the Hawaii DPS (94%) and Mexico DPS (6%) (Wade et al. 2016). Although no specific estimate of the current growth rate of this DPS is available, it is likely that the positive growth rates of humpback whales along the U.S. west coast and in the North Pacific at large that have been documented are at least somewhat reflecting positive growth of this DPS, given its relative population size. The potential biological removal (PBR), which is defined by the MMPA as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population, allocation for U.S. waters is 83 whales per year for the Central North Pacific (CNP) stock and 16.7 for the CA/OR/WA stock (Carretta et al. 2018; Muto et al. 2018b). There is no PBR for Mexico DPS humpback whales.

Geographic Range and Distribution

Humpback whales are widely distributed in the Atlantic, Indian, Pacific, and Southern Oceans. Individuals generally migrate seasonally between warmer, tropical and sub-tropical waters in winter months (where they reproduce and give birth to calves) and cooler, temperate and sub-Arctic waters in summer months (where they feed). In their summer foraging areas and winter calving areas, they tend to occupy shallower, coastal waters; though during seasonal migrations they disperse widely in deep, pelagic waters and tend to avoid shallower coastal waters (Winn and Reichley 1985) .

Humpback whales are present in Southeast Alaska in all months of the year and occurrence in the action area year round is considered likely. Most Southeast Alaska humpback whales winter in low latitudes, but some individuals have been documented over-wintering near Sitka and Juneau (National Park Service (NPS) Fact Sheet available at http://www.nps.gov/glba). Humpback whales are the most commonly observed baleen whale in Sitka Sound and generally throughout Southeast Alaska (ECO49 2017). Late fall and winter whale habitat in Southeast Alaska appears to correlate with areas that have over-wintering herring such as lower Lynn Canal, Tenakee Inlet, Whale Bay, Ketchikan, and Sitka Sound area (Baker 1985; Straley 1990a). Ferguson et al. (2015) identified four Biologically Important Areas (BIAs) for humpback whale feeding in the Gulf of Alaska based on feeding aggregations that have persisted through time. These feeding BIAs in Southeast Alaska occurring the spring (March-May), summer (June-August) and fall (September-November) (Figure 19).

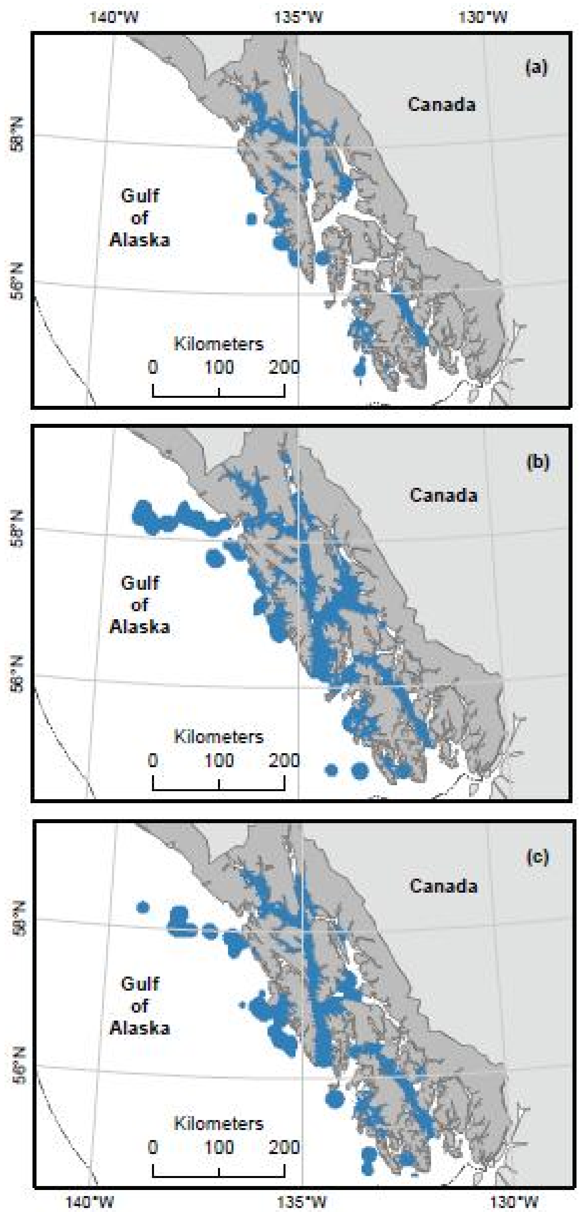

Figure 19. Seasonal humpback whale feeding BIAs in Southeast Alaska for (a) spring; (b) summer; and (c) fall (Ferguson et al. 2015).

Although migration timing varies among individuals, most whales from the Hawaii and Mexico DPSs depart for Hawaii or Mexico in fall or winter and begin returning to Southeast Alaska in spring, with continued returns through the summer and a peak occurrence in Southeast Alaska during late summer to early fall. However, there are significant overlaps in departures and returns (Baker et al. 1985; Straley 1990b). Whales from these two DPSs overlap on feeding grounds off Alaska, and are not easily distinguishable. Given their widespread range and their opportunistic foraging strategies, Mexico DPS humpback whales may be in the vicinity and overlap with the SEAK fisheries.

Limiting Factors and Threats

- The humpback whale species was originally listed as endangered because of past commercial whaling. Additional threats to the species include ship strikes, fisheries interactions (including entanglement) and noise. Brief descriptions of threats to humpback whales follow. More detailed information can be found in:
- The Humpback Whale Recovery Plan (NMFS 1991) (available at: http://www.nmfs.noaa.gov/pr/pdfs/recovery/whale_humpback.pdf);
- Alaska Marine Mammal Stock Assessments, 2017 (available at: http://www.nmfs.noaa.gov/pr/sars/species.htm);
- Global Status Review (Fleming and Jackson 2011)(available at: http://www.car-spaw-rac.org/IMG/pdf/Global_review_of_humpback_whales_Megaptera_novaeangliae_.pdf); and
- Status Review of Humpback Whale (*Megaptera novaeangliae*) (Bettridge et al. 2015) (available at http://www.nmfs.noaa.gov/pr/species/Status%20Reviews/humpback_whale_sr_2015.pdf).

Natural Threats

The most common predator of humpback whales is the killer whale (*Orcinus orca*, Jefferson et al. (1991)), although predation by large sharks may also be significant (attacks are mostly undocumented). Predation by killer whales on humpback calves has been inferred by the presence of distinctive parallel 'rake' marks from killer whale teeth across the flukes (Shevchenko 1975). While killer whale attacks of humpback whales are rarely observed in the field (Ford and Reeves 2008), the proportion of photo-identified whales bearing rake scars is between zero and 40 percent, with the greater proportion of whales showing mild scarring (1-3 rake marks) (Mehta et al. 2007; Steiger et al. 2008). This suggests that attacks by killer whales on humpback whales vary in frequency across regions. It also suggests either that most killer whale attacks result in mild scarring, or that those resulting in severe scarring (4 or more rakes, parts of fluke missing) are more often fatal. Most observations of humpback whales under attack from killer whales reported vigorous defensive behavior and tight grouping where more than one humpback whale was present (Ford and Reeves 2008).

Photo-identification data indicate that rake marks are often acquired very early in life, though attacks on adults also occur (Mehta et al. 2007; Steiger et al. 2008). Killer whale predation may be a factor influencing survival during the first year of life (Mehta et al. 2007). There has been some debate as to whether killer whale predation (especially on calves) is a motivating factor for the migratory behavior of humpback whales (Corkeron and Connor 1999; Clapham 2001), however, this remains unsubstantiated.

There is also evidence of shark predation on calves and entangled whales (Mazzuca et al. 1998). Shark bite marks on stranded whales may often represent post-mortem feeding rather than predation, i.e., scavenging on carcasses (Long and Jones 1996).

Other natural threats include exposure and effects from toxins and parasites. For example, domoic acid was detected in all 13 species examined in Alaska and had 38 percent prevalence in humpback whales. Saxitoxin was detected in 10 of the 13 species, with the highest prevalence in humpback whales (50%) (Lefebvre et al. 2016). Humpback whales can also carry the giant nematode *Crassicauda boopis* (Baylis 1920), which appears to increase the potential for kidney failure in humpback whales and may be preventing some populations from recovering (Lambertsen 1992). No information specific to the various DPS's is available.

Anthropogenic Threats

Fleming and Jackson (2011), Bettridge et al. (2015), and the 1991 Humpback Whale Recovery Plan (NMFS 1991) list the following range-wide anthropogenic threats for the species: vessel strikes, fishery interactions including entanglement in fishing gear, subsistence harvest, illegal whaling or resumed legal whaling, pollution, and acoustic disturbance. Vessel strikes (Fleming and Jackson 2011), and fishing gear entanglement (Fleming and Jackson 2011; Bettridge et al. 2015) are listed as the main threats and sources of anthropogenic impacts to humpback whale DPSs in Alaska.

Fishery Interactions including Entanglements

Entanglement in fishing gear is a documented source of injury and mortality to cetaceans. Entanglement may result in only minor injury or may potentially significantly affect individual health, reproduction, or survival (Fleming and Jackson 2011). Bettridge et al. (2015) report that fishing gear entanglements may moderately reduce the population size or the growth rate of the Mexico DPS.

Interactions resulting in entanglements, mortality, or serious injury of CNP humpback whales occurred in several known fisheries between 2010-2015 including: Bering Sea Aleutian Islands (BSAI) commercial pot gear, BSAI pollock trawl, SEAK salmon drift gillnet, SEAK commercial salmon purse seine gear, Kodiak Island commercial salmon purse seine gear, Kodiak commercial salmon set gillnet, Prince William Sound commercial pot gear, Prince William Sound commercial salmon drift gillnet, and Hawaii deep-set longline (Muto et al. 2018a). Within SEAK, information on interactions between CNP humpback whales that may belong to the Mexico DPS and fixed gear fisheries are detailed at length in Section 2.5.5 Effects Analysis of Humpback Whales and Steller Sea Lions. Pot and trap gear are the most commonly documented source of mortality and serious injury to humpback whales off the U.S. West Coast outside of Alaska (Carretta et al. 2017a). A photographic study of humpback whales in southeastern Alaska in 2003 and 2004 found at least 53% of individuals showed some kind of scarring from entanglement (Neilson et al. 2005).

Based on events that have not been attributed to a specific fishery listed on the MMPA List of Fisheries (82 FR 3655; January 12, 2017), the minimum mean annual mortality and serious injury rate from gear entanglements in unknown fisheries is 8.8 humpback whales in 2011-2015 (Muto et al. 2018a). Some small portion of this is Mexico DPS.

Subsistence, Illegal Whaling, or Resumed Legal Whaling

There are no reported takes of humpback whales by subsistence hunters in Alaska or Russia for the 2011-2015 period (Muto et al. 2018a).

Vessel Strikes and Disturbance

Vessel strikes often result in life-threatening trauma or death for cetaceans. Impact is often initiated by forceful contact with the bow or propeller of the vessel. Ship strikes on humpback whales are typically identified by evidence of massive blunt trauma (fractures of heavy bones and/or hemorrhaging) in stranded whales, propeller wounds (deep slashes or cuts into the blubber), and fluke/fin amputations on stranded or live whales (Fleming and Jackson 2011).

Pollution

Humpback whales can accumulate lipophilic compounds (e.g., halogenated hydrocarbons) and pesticides (e.g. Dichlorodiphenyltrichloroethane (DDT)) in their blubber, as a result either of feeding on contaminated prey (bioaccumulation) or inhalation in areas of high contaminant concentrations (e.g. regions of atmospheric deposition) (Barrie et al. 1992; Wania and Mackay 1993). The health effects of different doses of contaminants are currently unknown for humpback whales (Krahn et al. 2004b).

Acoustic Disturbance

Anthropogenic sound has increased in all oceans over the last 50 years and is thought to have doubled each decade in some areas of the ocean over the last 30 or so years (Croll et al. 2001; Weilgart 2007). Low-frequency sound comprises a significant portion of this and stems from a variety of sources including shipping, research, naval activities, and oil and gas exploration. Understanding the specific impacts of these sounds on mysticetes, and humpback whales specifically, is difficult. However, it is clear that the geographic scope of potential impacts is vast, as low-frequency sounds can travel great distances under water.

It does not appear that humpback whales are often involved in strandings related to noise events. There is one record of two humpback whales found dead with extensive damage to the temporal bones near the site of a 5,000-kg explosion, which likely produced shock waves that were responsible for the injuries (Weilgart 2007). Other detrimental effects of anthropogenic noise include masking and temporary threshold shifts (TTS). These processes are described in greater detail later in this document.

2.2.3.3 Status of the Western DPS Steller Sea Lion

Steller sea lions are the largest of the eared seals (Otariidae), though there is significant difference in size between males and females: males reach lengths of 3.3 m (10.8 ft.) and can weigh up to 1,120 kg (2,469 lb.) and females reach lengths of 2.9 m (9.5 ft.) and can weigh up to 350 kg (772 lb.). Their fur is light buff to reddish brown and slightly darker on the chest and abdomen; their skin is black. Sexual maturity is reached and fist breeding occurs between 3 and 8 years of age. Pupping occurs on rookeries between May and June and females breed 11 days after giving birth. Implantation of the fertilized egg is delayed for about 3.5 months, and gestation occurs until the following May or June.

Most adult Steller sea lions occupy rookeries during pupping and breeding season (late May-early July). During the breeding season, most juvenile and non-breeding adults are at haulouts, though some occur at or near rookeries. Adult females and pups continue to stay on rookeries through August beginning a regular routine of alternating foraging trips at sea with nursing their pups on land. During the non-breeding season many Steller sea lions disperse from rookeries and increase their use of haulouts. Steller sea lions do not migrate, but they often disperse widely outside of the breeding season (Loughlin 1997). At sea, Steller sea lions commonly occur near the 200 m (656 ft.) depth contour, but have been seen from near shore to well beyond the continental shelf (Kajimura and Loughlin 1988).

The ability to detect sound and communicate underwater and in-air is important for a variety of Steller sea lion life functions, including reproduction and predator avoidance. NMFS categorizes Steller sea lions in the otariid pinniped functional hearing group with an applied frequency range between 60 and 39 kilohertz (kHz) in water (NMFS 2018f). An underwater audiogram shows the typical mammalian U-shape. Higher hearing thresholds, indicating poorer sensitivity, were observed for signals below 16 kHz and above 25 kHz (Kastelein et al. 2005).

Additional information on Steller sea lions can be found at: https://alaskafisheries.noaa.gov/pr/steller-sea-lions.

We used information available in the recent stock assessment reports (Muto et al. 2018a; Muto et al. 2018b), recovery plan (NMFS 2008i), the status review (NMFS 1995), listing document (62 FR 24345), NMFS species information, and recent biological opinions to summarize the status of the species, as follows.

Abundance, Productivity and Trends

The Steller sea lion was listed as a threatened species under the ESA on November 26, 1990 (55 FR 49204). In 1997, NMFS reclassified Steller sea lions as two DPSs based on genetic studies and other information (62 FR 24345); at that time the eastern DPS was listed as threatened and the western DPS was listed as endangered. On November 4, 2013, the eastern DPS was removed from the endangered species list (78 FR 66139).

The western DPS population declined approximately 75 percent from 1976 to 1990 (the year of ESA-listing). Since 2000, the abundance of the western DPS has increased, but there has been considerable regional variation in trend (Muto et al. 2018a). The minimum population estimate of western DPS Steller sea lions in Alaska is 54,267 individuals (Muto et al. 2018b). The PBR allocation for U.S. waters is 326 Western DPS Steller sea lions and the minimum mean annual U.S. commercial fishery-related mortality and serious injury of 40 sea lions is more than 10% of the PBR, and, therefore, cannot be considered insignificant and approaching a zero mortality and injury rate (Muto et al. 2018b). Based on the available data, the total estimated annual level of human-caused mortality and serious injury (252 sea lions) is below the PBR level for this stock. Using data collected through 2017, there is strong evidence that non-pup and pup counts of western DPS Steller sea lions in Alaska were at their lowest levels in 2002 and 2003 and increased at ~2% per year between 2002 and 2017 (Muto et al. 2018b; Muto et al. 2018a), although we recognize that recent counts in some areas have declined over the last few years (Sweeney et al. 2017). Populations in the eastern Gulf of Alaska are increasing at an average rate of 5.36% for non-pups and 4.61% for pups annually (Muto et al. 2018a).

Geographic Range and Distribution

Steller sea lions are distributed throughout the northern Pacific Ocean, including coastal and inland waters in Russia (Kuril Islands and the Sea of Okhotsk), east to Alaska, and south to central California (Año Nuevo Island) (Figure 20). Animals from the eastern DPS occur primarily east of Cape Suckling, Alaska (144° W) and animals from the endangered western DPS occur primarily west of Cape Suckling. The western DPS includes Steller sea lions that reside primarily in the central and western Gulf of Alaska, Aleutian Islands, and those that inhabit and breed in the coastal waters of Asia (e.g., Japan and Russia). The eastern DPS includes sea lions living primarily in southeast Alaska, British Columbia, California, and Oregon.

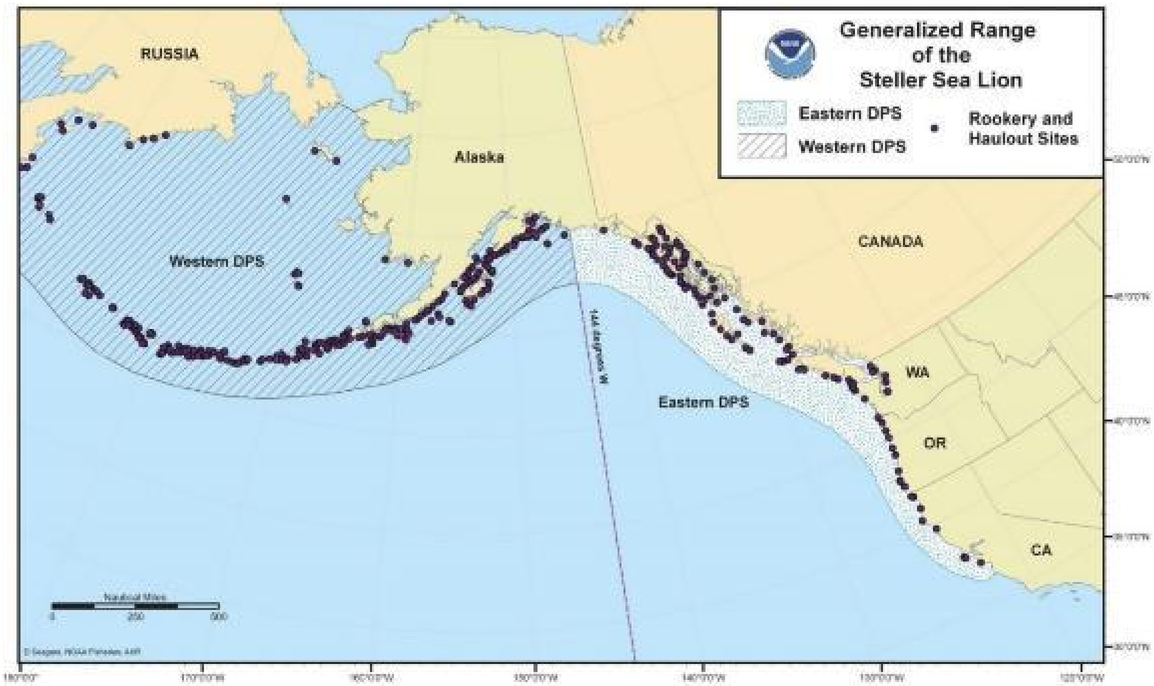

Figure 20. Generalized range of Steller sea lion, including rookery and haulout locations.

Within the action area, Steller sea lions are anticipated to be predominantly from the eastern DPS, with a minimum population estimate of 41,638 and PBR of 2,498 (Muto et al. 2018a). However, studies have confirmed movement of animals across the 144° W longitude boundary (Raum-Suryan et al. 2002; Pitcher et al. 2007; Fritz et al. 2013; Jemison et al. 2013b). Jemison et al. (2013b) found regularly occurring temporary movements of western DPS Steller sea lions across the 144° W longitude boundary, and some western DPS females have likely emigrated permanently and given birth at White Sisters and Graves rookeries. Fritz et al. (2013) estimated an average annual breeding season movement of western DPS Steller sea lions to southeast Alaska of 917 animals. Based on Jemison et al. (2013a) and Fritz et al. (2013), NMFS concludes that western DPS Steller sea lions are common north of Sumner Strait (see http://alaskafisheries.noaa.gov/protectedresources/stellers/esa/wdps_sect7guidance1213%20final.pdf).

In 1998 a single Steller sea lion pup was observed on Graves Rock just north of Cross Sound in Southeast Alaska, and within 15 years (2013) pup counts had increased to 551 (DeMaster 2014). Mitochondrial and microsatellite analysis of pup tissue samples collected in 2002 revealed that approximately 70 percent of the pups had mitochondrial DNA (mtDNA) haplotypes that were consistent with those found in the western stock (Gelatt et al. 2007). Similarly, a rookery to the south on the White Sisters Islands, where pups were first noted in 1990, was also sampled in 2002 and approximately 45 percent of those pups had western stock haplotypes. Collectively, this information demonstrates that these two most recently established rookeries in northern Southeast Alaska have been partially to predominately established by western stock females.

Steller sea lions occur in coastal and nearshore habitats throughout Southeast Alaska. Steller sea lions are opportunistic predators, feeding primarily on a wide variety of fishes and cephalopods including Atka mackerel (*Pleurogrammus monopterygius*), Pacific herring (*Clupea pallasi*), walleye pollock (*Gadus chalcogramma*), capelin (*Mallotus villosus*), Pacific sand lance (*Ammodytes hexapterus*), Pacific cod (*Gadus macrocephalus*), salmon (*Oncorhynchus* spp.), and squid (*Teuthida* spp.) (Jefferson et al. 2008; Wynne et al. 2011). Figure 21 depicts a likely seasonal foraging strategy for Steller sea lions in Southeast Alaska. These results suggest that seasonally aggregated high-energy prey species, such as eulachon and herring in late spring and salmon in summer and fall, influence the seasonal distribution of Steller sea lions in some areas of Southeast Alaska (Womble et al. 2009).

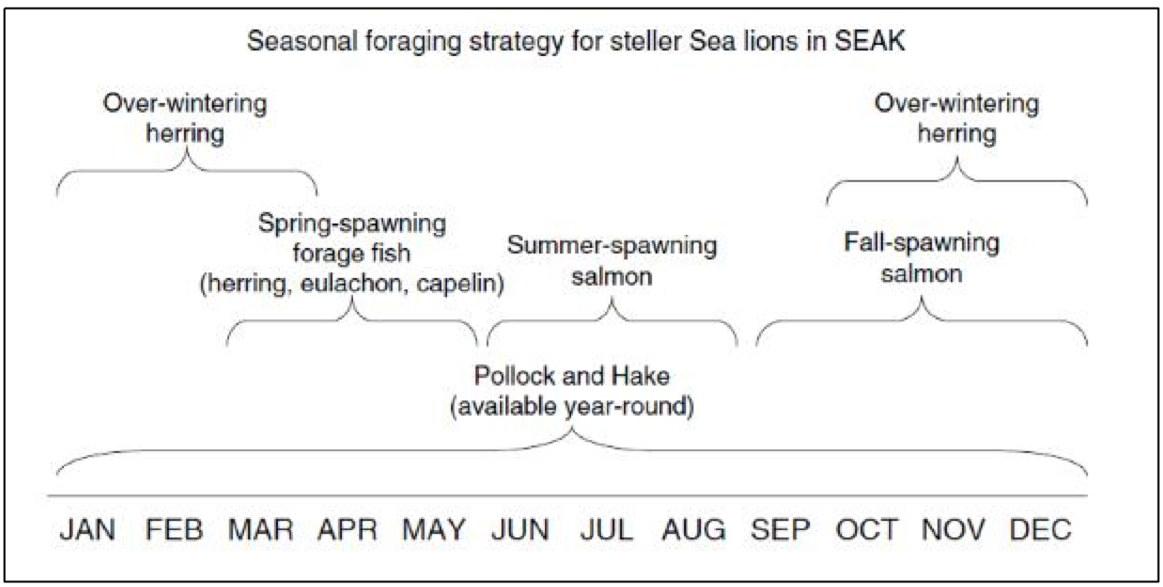

Figure 21. Seasonal foraging ecology of Steller sea lions in Southeast Alaska (Womble et al. 2009).

Limiting Factors and Threats

Factors affecting the continued existence of the western DPS at the time of its listing included changes in the availability or quality of prey as a result of environmental changes or human activities and removals of Steller sea lions from the wild. Concern about possible adverse effects of contaminants was also noted. Additional threats to the species include environmental variability, competition with fisheries, predation by killer whales, toxic substances, incidental take due to interactions with active fishing gear, illegal shooting, entanglement in marine debris, disease and parasites, and disturbance from vessel traffic, tourism, and research activities.

Brief descriptions of threats to Steller sea lions follow. More detailed information can be found in the Steller sea lion Recovery Plan (available at: http://alaskafisheries.noaa.gov/protectedresources/stellers/recovery/sslrpfinalrev030408.pdf), the Stock Assessment Reports (available at: http://www.nmfs.noaa.gov/pr/sars/species.htm), and the Alaska Groundfish Biological Opinion (NMFS 2014d).

Natural Threats

The Steller Sea Lion Recovery Plan (NMFS 2008i) ranked predation by killer whales as a potentially high threat to the recovery of the Western DPS (WDPS). Steller sea lions in both the eastern and western stocks are eaten by killer whales (Maniscalco et al. 2007; Dahlheim and White 2010; Horning and Mellish 2012).

Relative to other WDPS sub-regions, transient killer whale abundance and predation on Steller sea lions has been well studied in the Prince William Sound and Kenai Fjords portion of the eastern Gulf of Alaska (GOA). Steller sea lions represented 33 percent (Heise 2003) and 5 percent (NMFS 2014e) of the remains found in deceased killer whale stomachs in the GOA, depending on the specific study results. Matkin (2012) estimated the abundance of transient killer whales in the eastern GOA to be 18. Maniscalco et al. (2007) identified 19 transient killer whales in Kenai Fjords from 2000 through 2005 and observed killer whale predation on six pup and three juvenile Steller sea lions. Maniscalco et al. (2007) estimated that 11 percent of the Steller sea lion pups born at the Chiswell Island rookery (in the Kenai Fjords area) were preyed upon by killer whales from 2000 through 2005 and concluded that GOA transient killer whales were having a minor impact on the recovery of the sea lions in the area (Maniscalco et al. 2007). Maniscalco et al. (2008) further studied Steller sea lion pup mortality using remote video at Chiswell Island. Pup mortality up to 2.5 months postpartum averaged 15.4 percent, with causes varying greatly across years (2001–2007). They noted that high surf conditions and killer whale predation accounted for over half the mortalities. Even at this level of pup mortality, the Chiswell Island Steller sea lion population has increased.

Other studies in the Kenai Fjords/Prince William Sound region have also found evidence for high levels of juvenile Steller sea lion mortality, presumably from killer whales. Based on data collected post-mortem from juvenile Steller sea lions implanted with life history tags, 12 of 36 juvenile Steller sea lions were confirmed dead, at least 11 of which were killed by predators (Horning and Mellish 2012). Horning and Mellish (2012) estimated that over half of juvenile Steller sea lions in this region are consumed by predators before age 4 yr. They suggested that low juvenile survival due to predation, rather than low natality, may be the primary impediment to recovery of the WDPS of Steller sea lions in the Kenai Fjords/Prince William Sound region.

Steller sea lions may also be attacked by sharks, though little evidence exists to indicate that sharks prey on Steller sea lions. The Steller Sea Lion Recovery Plan did not rank shark predation as a threat to the recovery of the WDPS (NMFS 2008h). Sleeper shark and sea lion home ranges overlap (Hulbert et al. 2006) and one study suggested that predation on Steller sea lions by sleeper sharks may be occurring (Horning and Mellish 2012). A significant increase in the relative abundance of sleeper sharks occurred during 1989–2000 in the central GOA; however, samples of 198 sleeper shark stomachs found no evidence of Steller sea lion predation (Sigler et al. 2006). Sigler et al. (2006) sampled sleeper shark stomachs collected in the GOA near sea lion rookeries when pups may be most vulnerable to predation (i.e., first water entrance and weaning) and found that fish and cephalopods were the dominant prey. Tissues of marine mammals were found in 15 percent of the shark stomachs, but no Steller sea lion tissues were detected. Overall, Steller sea lions are unlikely prey for sleeper sharks (Sigler et al. 2006).

The Steller Sea Lion Recovery Plan (NMFS 2008i) ranked diseases and parasites as a low threat to the recovery of the WPDS.

The Steller Sea Lion Recovery Plan ranks environmental variability as a potentially high threat to recovery of the WDPS (NMFS 2008i). The Bering Sea and Gulf of Alaska are subjected to large-scale forcing mechanisms that can lead to basin-wide shifts in the marine ecosystem resulting in significant changes to physical and biological characteristics, including sea surface temperature, salinity, and sea ice extent and amount. Physical forcing affects food availability and can change the structure of trophic relationships by impacting climate conditions that influence reproduction, survival, distribution, and predator-prey relationships at all trophic levels (Wiese et al. 2012). Populations of Steller sea lions in the GOA and Bering Sea have experienced large fluctuations due to environmental and anthropogenic forcing (Mueter et al. 2009). As we work to understand how these mechanisms affect various trophic levels in the marine ecosystem, we must consider the additional effects of global warming, which are expected to be most significant at northern latitudes (Mueter et al. 2009; IPCC 2013).

Anthropogenic Threats

Fishing Gear and Marine Debris Entanglement

Although Steller Sea Lion Recovery Plan (NMFS 2008i) ranked interactions with fishing gear and marine debris as a low threat to the recovery of the WDPS, it is likely that many entangled sea lions may be unable to swim to shore once entangled, may die at sea, and may not be available to count (Loughlin 1986; Raum-Suryan et al. 2009). Based on data collected by Alaska Department of Fish and Game and NMFS, Helker et al. (2016) reported Steller sea lions to be the most common species of human-caused mortality and serious injury between 2011 and 2015. In SEAK, there were 468 cases of serious injuries to Eastern DPS (EDPS) Steller sea lions from interactions with fishing gear and marine debris. While these cases are attributed to the eastern stock because they occurred east of 144° W, eastern and western DPS animals overlap in Southeast Alaska, and these takes may have occurred to western DPS animals.

Competition between Commercial Fishing and Steller Sea Lions for Prey Species

The Steller Sea Lion Recovery Plan (NMFS 2008i) ranked competition with fisheries for prey as a potentially high threat to the recovery of the WDPS. Substantial scientific debate surrounds the question about the impact of potential competition between fisheries and Steller sea lions. It is generally well accepted that commercial fisheries target several important Steller sea lion prey species (NRC 2003) including salmon species, Pacific cod, Atka mackerel, pollock, and others. These fisheries could be reducing sea lion prey biomass and quality at regional and/or local spatial and temporal scales such that sea lion survival and reproduction are reduced. (NMFS 2014d) analyzes this threat in detail.

Subsistence Hunting and Illegal Shooting

Steller sea lions are hunted for subsistence purposes. As of 2009, data on community subsistence harvest are no longer being consistently collected; therefore, the most recent estimate of annual statewide (excluding St. Paul Island) harvest is 172.3 individuals from the 5-year period from 2004 to 2008. More recent data from St. Paul and St. George are available; the annual harvest is 30 and 2.4 sea lions respectively from the 5-year period from 2011 to 2015. This results in a total take of 204 individuals (Muto et al. 2018a). In addition, data were collected on Alaska Native harvest of Steller sea lions for 7 communities on Kodiak Island for 2011 and 15 communities in Southcentral Alaska in 2014; the Alaska Native Harbor Seal Commission and ADFG estimated a total of 20 adult sea lions were harvested on Kodiak Island in 2011, and 7.9 sea lions (CI = 6-15.3) were harvested in Southcentral Alaska in 2014, with adults comprising 84% of the harvest (Muto et al. 2018a).

The Steller Sea Lion Recovery Plan (NMFS 2008i) ranked illegal shooting as a low threat to the recovery of the WDPS. Illegal shooting of sea lions was thought to be a potentially significant source of mortality prior to the listing of sea lions as threatened under the ESA in 1990.

On June 1, 2015, the NMFS Alaska Region (AKR) Stranding Response Program received reports of at least five dead Steller sea lions on the Copper River Delta. Two NMFS biologists recorded at least 18 pinniped carcasses, most of which were Steller sea lions, on June 2, 2015. A majority of the carcasses had evidence that they had been intentionally killed by humans. Subsequent surveys resulted in locating two additional Steller sea lions, some showing evidence suggestive that they had been intentionally killed. This incident was investigated and referred to the U.S. Attorney's Office for criminal prosecution. Two individuals (the vessel captain and a crewmember) were charged and pled guilty to violations of the Marine Mammal Protection Act.

NMFS Alaska Region designed a 2016 survey plan for the Copper River Delta focused on the time period of greatest overlap between the salmon driftnet fishery and marine mammals. The purpose of the surveys was to determine if the intentional killing observed in 2015 continued, and to collect cause of death evidence and samples for health assessments. Intentional killing by humans appears to be continuing and was the leading cause of death of the pinnipeds NMFS assessed on the Copper River Delta from May 10 to August 9, 2016. Without continuous monitoring in past years it is impossible to know if the lack of reported carcasses in the decade prior to 2015 accurately reflects past intentional killings by humans. Numbers of marine mammals found dead with evidence of human interaction dropped considerably between 2015 and 2017, and may be a result of increased Office of Law Enforcement (OLE), NMFS Alaska Region, and United States Coast Guard (USCG) presence and activity in the Delta (Wright 2018).

2.2.4 Status of Critical Habitat

This Section of the opinion examines the range-wide status of designated critical habitat for the affected species. NMFS has reviewed the status of critical habitat affected by the proposed action. Within the action area (defined in Section 2.3, Action Area), critical habitat is designated for those species affected by the proposed actions listed in in Section 1.3. Critical habitat for these species includes the stream channels within designated stream reaches and a lateral extent, as defined by the ordinary high-water line (33 CFR 319.11).

2.2.4.1 Chinook Salmon Critical Habitat

Lower Columbia, Upper Willamette, and Snake River Chinook Salmon

Critical habitat for the LCR Chinook and UWR Chinook salmon ESUs were designated on September 2, 2005 (70 FR 52706). Designated critical habitat for LCR Chinook salmon includes all Columbia River estuarine areas and river reaches proceeding upstream to the confluence with the Hood River as well as specific stream reaches in the following subbasins: Middle Columbia/Hood, Lower Columbia/Sandy, Lewis, Lower Columbia/Clatskanie, Upper Cowlitz, Cowlitz, Lower Columbia, Grays/Elochoman, Clackamas, and Lower Willamette (70 FR 52706).

Designated critical habitat for UWR Chinook salmon includes all Columbia River estuarine areas and river reaches proceeding upstream to the confluence with the Willamette River as well as specific stream reaches in the following subbasins: Middle Fork Willamette, Coast Fork Willamette, Upper Willamette, McKenzie, North Santiam, South Santiam, Middle Willamette, Molalla/Pudding, Clackamas, and Lower Willamette (70 FR 52720)..

Critical habitat for Snake River fall-run Chinook salmon was designated on December 28, 1993 (58 FR 68543). Designated critical habitat for Snake River fall-run Chinook salmon includes all Columbia River estuarine areas and river reaches proceeding upstream to the confluence of the Columbia and Snake rivers; all Snake River reaches from the confluence of the Columbia River upstream to Hells Canyon Dam; the Palouse River from its confluence with the Snake River upstream to Palouse Falls; the Clearwater River from its confluence with the Snake River upstream to its confluence with Lolo Creek; and the North Fork Clearwater River from its confluence with the Clearwater River upstream to Dworshak Dam. Critical habitat also includes river reaches presently or historically accessible (except those above impassable natural falls and Dworshak and Hells Canyon dams) in the following subbasins: Clearwater, Hells Canyon, Imnaha, Lower Grande Ronde, Lower North Fork Clearwater, Lower Salmon, Lower Snake, Lower Snake-Asotin, Lower Snake-Tucannon, and Palouse. Designated areas consist of the water, waterway bottom, and the adjacent riparian zone (defined as an area 300 feet from the normal high water line on each side of the river channel) (58 FR 68543).

The designated critical habitat for each of these ESUs are outside the limits of where effects occur as a result of the proposed actions described in Section 1.3 and are therefore not discussed further in this opinion.

Puget Sound

Critical habitat for the Puget Sound Chinook salmon ESU was designated on September 2, 2005 (70 FR 52685). It includes estuarine areas and specific river reaches associated with the following subbasins: Strait of Georgia, Nooksack, Upper Skagit, Sauk, Lower Skagit, Stillaguamish, Skykomish, Snoqualmie, Snohomish, Lake Washington, Duwamish, Puyallup, Nisqually, Deschutes, Skokomish, Hood Canal, Kitsap, and Dungeness/Elwha (70 FR 52685). The designation also includes some nearshore areas extending from extreme high water out to a depth of 30 meters and adjacent to watersheds occupied by the 22 populations because of their importance to rearing and migration for Chinook salmon and their prey, but does not otherwise include offshore marine areas. There are 61 watersheds within the range of this ESU. Twelve watersheds received a low rating, nine received a medium rating, and 40 received a high rating of conservation value to the ESU (70 FR 52685). Nineteen nearshore marine areas also received a rating of high conservation value. Of the 4,597 miles of stream and nearshore habitat eligible for designation, 3,852 miles are designated critical habitat while the remaining 745 miles were excluded because they are lands controlled by the military, overlap with Indian lands, or the benefits of exclusion outweighed the benefits of designation (70 FR 52685). It does not include marine or open ocean waters.

PBFs involve those sites and habitat components that support one or more life stages, including general categories of: (1) water quantity, quality, and forage to support spawning, rearing, individual growth, and maturation; (2) areas free of obstruction and excessive predation; and (3) the type and amount of structure and rugosity that supports juvenile growth and mobility. Major management activities affecting PBFs are forestry, grazing, agriculture, channel/bank modifications, road building/maintenance, urbanization, sand and gravel mining, dams, irrigation impoundments and withdrawals, river, estuary and ocean traffic, wetland loss, and forage fish/species harvest.

2.2.4.2 Southern Resident Killer Whale Critical Habitat

Critical habitat for the SRKW DPS was designated on November 29, 2006 (71 FR 69054). Critical habitat includes approximately 2,560 square miles of inland waters of Washington in three specific areas: 1) the Summer Core Area in Haro Strait and waters around the San Juan Islands; 2) Puget Sound; and 3) the Strait of Juan de Fuca. On January 21, 2014, NMFS received a petition requesting that we revise critical habitat citing recent information on the whales' habitat use along the West Coast of the United States. Center for Biological Diversity proposes that the critical habitat designation be revised and expanded to include areas of the Pacific Ocean between Cape Flattery, WA, and Point Reyes, CA, extending approximately 47 miles (76 km) offshore. NMFS published a 90 day finding on April 25, 2014 (79 FR 22933) that the petition contained substantial information to support the proposed measure and that NMFS would further consider the action. We also solicited information from the public. Based upon our review of public comments and the available information, NMFS issued a 12 month finding on February 24, 2015 (80 FR 9682) describing how we intended to proceed with the requested revision, which is currently in development.

Water Quality

Water quality in Puget Sound, in general, is degraded as described in the Puget Sound Partnership 2016 Action Agenda and Comprehensive Plan (Partnership 2016). For example, toxicants in Puget Sound persist and build up in marine organisms including Southern Residents and their prey resources, despite bans in the 1970s of some harmful substances and cleanup efforts. The primary concern for direct effects on whales from water quality is oil spills, although oil spills can also have long-lasting impacts on other habitat features. The Environmental Protection Agency and U.S. Coast Guard oversee the Oil Pollution Prevention regulations promulgated under the authority of the Federal Water Pollution Control Act. There is a Northwest Area Contingency Plan, developed by the Northwest Area Committee, which serves as the primary guidance document for oil spill response in Washington and Oregon. In 2017, the

Washington State Department of Ecology published a new Spill Prevention, Preparedness, and Response Program Annual Report describing the Spills Program as well as the performance measures from 2007 – 2017 (WDOE 2017).

Prey Quantity, Quality, and Availability
As discussed above under Limiting Factors and Threats, most wild salmon stocks throughout the Northwest are at fractions of their historic levels. Beginning in the early 1990s, 28 ESUs and DPSs of salmon and steelhead in Washington, Oregon, Idaho, and California were listed as threatened or endangered under the ESA. Historically, overfishing, habitat losses, and hatchery practices were major causes of decline. Poor ocean conditions over the past two decades have reduced populations already weakened by the degradation and loss of freshwater and estuary habitat, fishing, hydropower system management, and hatchery practices. While wild salmon stocks have declined in many areas, hatchery production has been generally strong.

Contaminants and pollution also affect the quality of SRKW prey in Puget Sound. Contaminants enter marine waters and sediment from numerous sources, but are typically concentrated near areas of high human population and industrialization. Once in the environment these substances proceed up the food chain, accumulating in long-lived top predators like SRKW. Chemical contamination of prey is a potential threat to SRKW critical habitat, despite the enactment of modern pollution controls in recent decades, which were successful in reducing, but not eliminating, the presence of many contaminants in the environment. The size of Chinook salmon is also an important aspect of prey quality (i.e., Southern Residents primarily consume large Chinook, as discussed above), and any reduction in Chinook salmon size is therefore a threat to their critical habitat. In addition, vessels and sound may reduce the effective zone of echolocation and reduce availability of fish for the whales in their critical habitat (Holt 2008).

Passage
Southern Residents are highly mobile and use a variety of areas for foraging and other activities, as well as for traveling between these areas. Human activities can interfere with movements of the whales and impact their passage. In particular, vessels may present obstacles to whale passage, causing the whales to swim further and change direction more often, which can increase energy expenditure for whales and impacts foraging behavior (review in NMFS (2010c), Ferrara et al. (2017)).

2.2.4.1 Humpback Whale DPS Critical Habitat

Critical Habitat
There is no critical habitat designated for the any of the listed humpback whale DPSs.

2.2.4.1 Western DPS Steller Sea Lion Critical Habitat

On August 27, 1993, NMFS designated critical habitat for Steller sea lions based on the location of terrestrial rookery and haulout sites, spatial extent of foraging trips, and availability of prey items (58 FR 45269). Designated critical habitat is listed in 50 CFR § 226.202, and includes 1) a terrestrial zone that extends 3,000 ft. (0.9 km) landward from the baseline or base point of each major rookery and major haulout; 2) an air zone that extends 3,000 ft. (0.9 km) above the terrestrial zone of each major rookery and major haulout, measured vertically from sea level; 3) an aquatic zone that extends 3,000 ft. (0.9 km) seaward in state and federally managed waters from the baseline or basepoint of each major rookery and major haulout in Alaska that is east of 144° W longitude; 4) an aquatic zone that extends 20 nm (37 km) seaward in state and federally managed waters from the baseline or basepoint of each major rookery and major haulout in Alaska that is west of 144° W longitude; and 5) three special aquatic foraging areas in Alaska: the Shelikof Strait area, the Bogoslof area, and the Seguam Pass area.

Critical habitat in Southeast Alaska (east of 144° W. longitude) includes a terrestrial zone, an aquatic zone, and an air zone that extend 3,000 feet landward, seaward, and above, respectively, at each major rookery and haulout (Figure 22) (50 CFR 226.202(a)). Designated Steller sea lion critical habitat is discussed further in Section 2.12

Figure 22. Designated Steller sea lion critical habitat in Southeast Alaska.

2.2.5 Climate Change

One factor affecting the rangewide status of species, and aquatic habitat at large is climate change. The U.S. Global Change Research Program (USGCRP)[16], mandated by Congress in the Global Change Research Act of 1990, reports average warming of about 1.3ºF from 1895 to 2011 and projects an increase in average annual temperature of 3.3ºF to 9.7ºF by 2070 to 2099 (CCSP 2014). Climate change has negative implications for designated critical habitats in the Pacific Northwest (Climate Impacts Group 2004; Scheuerell and Williams 2005; Zabel et al. 2006; ISAB 2007). According to the Independent Scientific Advisory Board (ISAB)[17], these effects pose the following impacts into the future:

- Warmer air temperatures will result in diminished snowpack 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 Northwest. 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. Overall, climate change effects are likely to occur to some degree over the next ten years expected at a similar rate as the last ten years, and effects outside this timeframe are too speculative for NMFS to describe.

Climate change is predicted to cause a variety of impacts to Pacific salmon and their ecosystems (Mote et al. 2003; Crozier et al. 2008a; Martins et al. 2012; Wainwright and Weitkamp 2013). The complex life cycles of anadromous fishes including salmon rely on productive freshwater, estuarine, and marine habitats for growth and survival, making them particularly vulnerable to environmental variation (Morrison et al. 2016). Ultimately, the effect of climate change on salmon and steelhead across the Pacific Northwest will be determined by the specific nature, level, and rate of change and the synergy between interconnected terrestrial/freshwater, estuarine, nearshore and ocean environments.

The primary effects of climate change on Pacific Northwest salmon and steelhead are:

- direct effects of increased water temperatures of fish physiology
- temperature-induced changes to stream flow patterns
- alterations to freshwater, estuarine, and marine food webs
- changes in estuarine and ocean productivity

[16] http://www.globalchange.gov
[17] The Independent Scientific Advisory Board (ISAB) serves the National Marine Fisheries Service (NOAA Fisheries), Columbia River Indian Tribes, and Northwest Power and Conservation Council by providing independent scientific advice and recommendations regarding scientific issues that relate to the respective agencies' fish and wildlife programs. https://www.nwcouncil.org/fw/isab/

While all habitats used by Pacific salmon will be affected, the impacts and certainty of the change vary by habitat type. Some effects (e.g., increasing temperature) affect salmon at all life stages in all habitats, while others are habitat specific, such as stream flow variation in freshwater, sea level rise in estuaries, and upwelling in the ocean. How climate change will affect each stock or population of salmon also varies widely depending on the level or extent of change and the rate of change and the unique life history characteristics of different natural populations (Crozier et al. 2008b). For example, a few weeks difference in migration timing can have large differences in the thermal regime experienced by migrating fish (Martins et al. 2011). This occurred in 2015 on Upriver Sockeye in the Columbia River when over 475,000 sockeye entered the River but only 2 percent of sockeye counted at Bonneville Dam survived to their spawning grounds. Most died in the Columbia River beginning in June when the water warmed to above 68 degrees, the temperature at which salmon begin to die. It got up to 73 degrees in July due to elevated temperatures associated with lower snow pack from the previous winter and drought conditions exacerbate due to increased occurrences of warm weather patterns.

Temperature Effects

Like most fishes, salmon are poikilotherms (cold-blooded animals), therefore increasing temperatures in all habitats can have pronounced effects on their physiology, growth, and development rates (see review by Whitney et al. (2016). Increases in water temperatures beyond their thermal optima will likely be detrimental through a variety of processes including: increased metabolic rates (and therefore food demand), decreased disease resistance, increased physiological stress, and reduced reproductive success. All of these processes are likely to reduce survival (Beechie et al. 2013; Wainwright and Weitkamp 2013; Whitney et al. 2016). As examples of this, high mortality rates for adult sockeye salmon in the Columbia River have recently been attributed to higher water temperatures and likewise in the Fraser River, as increasing temperatures during adult upstream migration are expected to result in increased mortality of sockeye salmon adults by 9 to 16% by century's end (Martins et al. 2011). Juvenile parr-to-smolt survival of Snake River Chinook salmon are predicted to decrease by 31 to 47% due to increased summer temperatures (Crozier et al. 2008b).

By contrast, increased temperatures at ranges well below thermal optima (i.e., when the water is cold) can increase growth and development rates. Examples of this include accelerated emergence timing during egg incubation stages, or increased growth rates during fry stages (Crozier et al. 2008a; Martins et al. 2011). Temperature is also an important behavioral cue for migration (Sykes et al. 2009), and elevated temperatures may result in earlier-than-normal migration timing. While there are situations or stocks where this acceleration in processes or behaviors is beneficial, there are also others where it is detrimental (Martins et al. 2012; Whitney et al. 2016).

Freshwater Effects

As described previously, climate change is predicted to increase the intensity of storms, reduce winter snow pack at low and middle elevations, and increase snowpack at high elevations in northern areas. Middle and lower elevation streams will have larger fall/winter flood events and lower late summer flows, while higher elevations may have higher minimum flows. How these changes will affect freshwater ecosystems largely depends on their specific characteristics and location, which vary at fine spatial scales (Crozier et al. 2008b; Martins et al. 2012). For example, within a relatively small geographic area (Salmon River Basin, Idaho), survival of some Chinook salmon populations was shown to be determined largely by temperature, while others were determined by flow (Crozier and Zabel 2006). Certain salmon populations inhabiting regions that are already near or exceeding thermal maxima will be most affected by further increases in temperature and perhaps the rate of the increases while the effects of altered flow are less clear and likely to be basin-specific (Crozier et al. 2008b; Beechie et al. 2013). However, river flow is already becoming more variable in many rivers, and is believed to negatively affect anadromous fish survival more than other environmental parameters (Ward et al. 2015). It is likely this increasingly variable flow is detrimental to multiple salmon and steelhead populations, and likely multiple other freshwater fish species in the Columbia River Basin as well.

Stream ecosystems will likely change in response to climate change in ways that are difficult to predict (Lynch et al. 2016). Changes in stream temperature and flow regimes will likely lead to shifts in the distributions of native species and provide “invasion opportunities” for exotic species. This will result in novel species interactions including predator-prey dynamics, where juvenile native species may be either predators or prey (Lynch et al. 2016; Rehage and Blanchard 2016). How juvenile native species will fare as part of “hybrid food webs,” which are constructed from natives, native invaders, and exotic species, is difficult to predict (Naiman et al. 2012).

Estuarine Effects

In estuarine environments, the two big concerns associated with climate change are rates of sea level rise and temperature warming (Wainwright and Weitkamp 2013; Limburg et al. 2016). Estuaries will be affected directly by sea-level rise: as sea level rises, terrestrial habitats will be flooded and tidal wetlands will be submerged (Kirwan et al. 2010; Wainwright and Weitkamp 2013; Limburg et al. 2016). The net effect on wetland habitats depends on whether rates of sea-level rise are sufficiently slow that the rates of marsh plant growth and sedimentation can compensate (Kirwan et al. 2010).

Due to subsidence, sea level rise will affect some areas more than others, with the largest effects expected for the lowlands, like southern Vancouver Island and central Washington coastal areas (Verdonck 2006; Lemmen et al. 2016). The widespread presence of dikes in Pacific Northwest estuaries will restrict upward estuary expansion as sea levels rise, likely resulting in a near-term loss of wetland habitats for salmon (Wainwright and Weitkamp 2013). Sea level rise will also result in greater intrusion of marine water into estuaries, resulting in an overall increase in salinity, which will also contribute to changes in estuarine floral and faunal communities (Kennedy 1990). While not all anadromous fish species are generally highly reliant on estuaries for rearing, extended estuarine use may be important in some populations (Jones et al. 2014), especially if stream habitats are degraded and become less productive.

Marine Impacts

In marine waters, increasing temperatures are associated with observed and predicted poleward range expansions of fish and invertebrates in both the Atlantic and Pacific oceans (Lucey and Nye 2010; Asch 2015; Cheung et al. 2015). Rapid poleward species shifts in distribution in response to anomalously warm ocean temperatures have been well documented in recent years, confirming this expectation at short time scales. Range extensions were documented in many species from southern California to Alaska during unusually warm water associated with "The Blob" in 2014 and 2015 (Bond et al. 2015; Di Lorenzo and Mantua 2016), and past strong El Niño events (Pearcy 2002; Fisher et al. 2015).

Exotic species benefit from these extreme conditions to increase their distributions. Green crab (*Carcinus maenas*) recruitment increased in Washington and Oregon waters during winters with warm surface waters, including 2014 (Yamada et al. 2015). Similarly, Humboldt squid (*Dosidicus gigas*) dramatically expanded their range during warm years of 2004-2009 (Litz et al. 2011). The frequency of extreme conditions, such as those associated with El Niño events or "blobs" are predicted to increase in the future (Di Lorenzo and Mantua 2016). This is likely to occur to some degree over the next ten years, but at a similar rate as the last ten years.

As with changes to stream ecosystems, expected changes to marine ecosystems due to increased temperature, altered productivity, or acidification, will have large ecological implications through mismatches of co-evolved species and unpredictable trophic effects (Cheung et al. 2015; Rehage and Blanchard 2016). These effects will certainly occur, but predicting the composition or outcomes of future trophic interactions is not possible with the tools available at this time.

Pacific Northwest anadromous fish inhabit as many as three marine ecosystems during their ocean residence period: the Salish Sea, the California Current, and the Gulf of Alaska (Brodeur et al. 1992; Weitkamp and Neely 2002; Morris et al. 2007). The response of these ecosystems to climate change is expected to differ, although there is considerable uncertainty in all predictions. It is also unclear whether overall marine survival of anadromous fish in a given year depends on conditions experienced in one versus multiple marine ecosystems. Several are important to Columbia River Basin and Puget Sound species, including the California Current and Gulf of Alaska.

Wind-driven upwelling is responsible for the extremely high productivity in the California Current ecosystem (Bograd et al. 2009; Peterson et al. 2014). Minor changes to the timing, intensity, or duration of upwelling, or the depth of water column stratification, can have dramatic effects on the productivity of the ecosystem (Black et al. 2014; Peterson et al. 2014). Current projections for changes to upwelling are mixed: some climate models show upwelling unchanged, but others predict that upwelling will be delayed in spring, and more intense during summer (Rykaczewski et al. 2015). Should the timing and intensity of upwelling change in the future, it may result in a mismatch between the onset of spring ecosystem productivity and the timing of salmon entering the ocean, and a shift towards food webs with a strong sub-tropical component (Bakun et al. 2015).

Columbia River and Puget Sound anadromous fish also use coastal areas of British Columbia and Alaska, and mid-ocean marine habitats in the Gulf of Alaska, although their fine-scale distribution and marine ecology during this period are poorly understood (Morris et al. 2007; Pearcy and McKinnell 2007). Increases in temperature in Alaskan marine waters have generally been associated with increases in productivity and salmon survival (Mantua et al. 1997; Martins et al. 2012), thought to result from temperatures that have been below thermal optima (Gargett 1997). Warm ocean temperatures in the Gulf of Alaska are also associated with intensified down welling and increased coastal stratification, which may result in increased food availability to juvenile salmon along the coast (Hollowed et al. 2009; Martins et al. 2012). Predicted increases in freshwater discharge in British Columbia and Alaska may influence coastal current patterns (Foreman et al. 2014), but the effects on coastal ecosystems are poorly understood.

In addition to becoming warmer, the world's oceans are becoming more acidic as increased atmospheric Carbon Dioxide (CO2) is absorbed by water. The North Pacific is already acidic compared to other oceans, making it particularly susceptible to further increases in acidification (Lemmen et al. 2016). Laboratory and field studies of ocean acidification show it has the greatest effects on invertebrates with calcium-carbonate shells and relatively little direct influence on finfish (see reviews by Haigh et al. (2015) and Mathis et al. (2015). Consequently, the largest impact of ocean acidification on salmon will likely be its influence on marine food webs, especially its effects on lower trophic levels, which are largely composed of invertebrates (Haigh et al. 2015; Mathis et al. 2015).

Uncertainty in Climate Predictions
There is considerable uncertainty in the predicted effects of climate change on the globe as a whole, and on Pacific Northwest in particular and there is also the question of indirect effects of climate change and whether human "climate refugees" will move into the range of salmon and steelhead, increasing stresses on their respective habitats (Dalton et al. 2013; Poesch et al. 2016).

Many of the effects of climate change (e.g., increased temperature, altered flow, coastal productivity, etc.) will have direct impacts on the food webs that species examined in this analysis rely on in freshwater, estuarine, and marine habitats to grow and survive. Such ecological effects are extremely difficult to predict even in fairly simple systems, and minor differences in life history characteristics among stocks of salmon may lead to large differences in their response (e.g., Crozier et al. (2008b); Martins et al. (2011); Martins et al. (2012). This means it is likely that there will be "winners and losers" meaning some salmon populations may enjoy different degrees or levels of benefit from climate change while others will suffer varying levels of harm.

Pacific anadromous fish are adapted to natural cycles of variation in freshwater and marine environments, and their resilience to future environmental conditions depends both on characteristics of each individual population and on the level and rate of change. They should be able to adapt to some changes, but others are beyond their adaptive capacity (Crozier et al. 2008a; Waples et al. 2009). With their complex life cycles, it is also unclear how conditions experienced in one life stage are carried over to subsequent life stages, including changes to the timing of migration between habitats. Systems already stressed due to human disturbance are less resilient to predicted changes than those that are less stressed, leading to additional uncertainty in predictions (Bottom et al. 2011; Naiman et al. 2012; Whitney et al. 2016).

Climate change is expected to impact anadromous fish, (e.g., salmon, steelhead, and green sturgeon), during all stages of their complex life cycle. In addition to the direct effects of rising temperatures, indirect effects include alterations in stream flow patterns in freshwater and changes to food webs in freshwater, estuarine and marine habitats. There is high certainty that predicted physical and chemical changes will occur; however, the ability to predict bioecological changes to fish or food webs in response to these physical/chemical changes is extremely limited, leading to considerable uncertainty.

Climate Change effects related to Marine Mammals

Overwhelming data indicate the planet is warming (IPCC 2014), which poses a threat to most Arctic and Subarctic marine mammals. Climate change has the potential to impact species abundance, geographic distribution, migration patterns, timing of seasonal activities (IPCC 2014), and species viability into the future. Climate change is also expected to result in the expansion of low oxygen zones in the marine environment (Gilly et al. 2013). Though predicting the precise consequences of climate change on highly mobile marine species, such as many of those considered in this opinion, is difficult (Simmonds and Isaac 2007), recent research has indicated a range of consequences already occurring. MacLeod (2009) estimated, based upon expected shifts in water temperature, 88 percent of cetaceans would be affected by climate change, with 47 percent likely to be negatively affected.

The indirect effects of climate change would result from changes in the distribution of temperatures suitable for the distribution and abundance of prey and the distribution and abundance of competitors or predators. For example, variations in the localized recruitment of herring in or near the action area caused by climate change could change the distribution and localized abundance of humpback whales. However, we have no information to indicate that this has happened to date. Warmer waters could favor productivity of some species of forage fish, but the impact on recruitment of important prey fish of Steller sea lions is unpredictable. Recruitment of large year-classes of gadids (e.g., pollock) and herring has occurred more often in warm than cool years, but the distribution and recruitment of other fish (e.g., osmerids) could be negatively affected (NMFS 2008i).

For ESA-listed species that undergo long migrations, if either prey availability or habitat suitability is disrupted by changing ocean temperature regimes, the timing of migration can change or negatively impact population sustainability (Simmonds and Eliott. 2009). Low reproductive success and body condition in humpback whales may have resulted from the 1997/1998 El Niño (Cerchio et al. 2005).

The effects of these changes to the marine ecosystems of the Bering Sea, Aleutian Islands, and the Gulf of Alaska, and how they may affect Steller sea lions are uncertain. Warmer waters could favor productivity of some species of forage fish, but the impact on recruitment of important prey fish of Steller sea lions is unpredictable. Recruitment of large year-classes of gadids (e.g., pollock) and herring has occurred more often in warm than cool years, but the distribution and recruitment of other fish (e.g., osmerids) could be negatively affected (NMFS 2008i).

As temperatures in the Arctic and subarctic waters are warming and sea ice is diminishing, there is an increased potential for harmful algal blooms that produce toxins to affect marine life (Figure 23). Biotoxins like domoic acid and saxitoxin may pose a risk to marine mammals in Alaska. In addition, increased temperatures can increase Brucella infections in marine mammals from 13 species were sampled including; humpback whales, bowhead whales, beluga whales, harbor porpoises, northern fur seals, Steller sea lions, harbor seals, ringed seals, bearded seals, spotted seals, ribbon seals, Pacific walruses, and northern sea otters (Lefebvre et al. 2016).

Domoic acid was detected in all 13 species examined and had 38% prevalence in humpback whales, and 27% in Steller sea lions. Additionally, fetuses from a beluga whale, a harbor porpoise and a Steller sea lion contained detectable concentrations of domoic acid documenting maternal toxin transfer in these species. Saxitoxin was detected in 10 of the 13 species, with the highest prevalence in humpback whales (50%) and 10% prevalence in Steller sea lions (Lefebvre et al. 2016).

Figure 23. Algal toxins detected in 13 species of marine mammals from southeast Alaska to the Arctic from 2004 to 2013 (Lefebvre et al. 2016).

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). The extent of the action area for this consultation is defined largely in terms of the effects of the proposed actions on endangered SRKW. SRKW range from the Queen Charlotte Islands in the north to central California.

The first and second parts of the proposed action relate to management of the salmon fisheries in SEAK – the first part (delegation) specifically to management in the EEZ and the second part (funding) to management of salmon fisheries throughout SEAK. SEAK includes all marine and freshwater fishing areas, including waters of the EEZ, between the longitude of Cape Suckling (143 53' 36'' West.) to the north and the international Boundary in Dixon Entrance to the south. The SEAK fisheries take listed Chinook salmon and have the potential to affect listed humpbacks and Steller sea lions where they occur, thus the area where the fisheries occur is included in the action area. In addition, the SEAK fishery catches Chinook salmon from areas to the south that would otherwise be available to the SRKW as they forage throughout their range. Chinooks stocks caught in the SEAK fishery include those from Canada, Puget Sound, and the Columbia River, and the Washington and Oregon coast. The action area therefore includes the overlap in the range of SRKW and the marine distribution of Chinook salmon stocks caught in the SEAK fishery, which extends from the Queen Charlotte Islands to the Oregon/California border (see Figure 24 for reference).

The third action relates to the proposed funding initiative to support listed Puget Sound Chinook and SRKW through actions in the Puget Sound and Columbia River basins, and the Washington Coast. As described in Section 1.3, the funding initiative has three elements including support for four specific conservation hatchery programs in Puget Sound, habitat work to address limiting factors for these same Puget Sound populations in particular and possibly others, and a program designed to increase the production of hatchery Chinook salmon with the specific purpose of increasing prey availability for SRKWs. Elements of the conservation hatchery program are reasonably well defined in terms of location and intent. As a consequence, we expand the action area to include the Nooksack, Stillaguamish, Dungeness, and Mid-Hood Canal watersheds, tributaries, and nearshore marine waters where salmon are proposed to be collected as broodstock, spawned, incubated, acclimated and released. The second element of the conservation program is designed to address limiting habitat conditions for these same four populations in particular; such work would likely be conducted in the areas described above relevant to the four populations.

The hatchery production initiative for SRKWs is less well defined and does not lend itself to further specification of the action area or analysis.

The initiative has specific goals described in Section 1.3. In particular, the objective is to increase prey availability by 4-5 percent in areas that are most important to SRKWs. We expect that the production increases will occur primarily in Puget Sound, the Columbia River and on the Washington coast. However, exactly where the new production will go is not known and cannot be analyzed further at this time. Projects related to the hatchery production initiative will likely be subject to additional review once they are fully described.

The action area for this opinion is a result of the combined areas for the three actions and therefore includes fishing areas in SEAK, the marine areas from the Queen Charlotte Islands to the Oregon/California, and the watersheds, tributaries, and nearshore marine waters for the four specified Puget Sound populations.

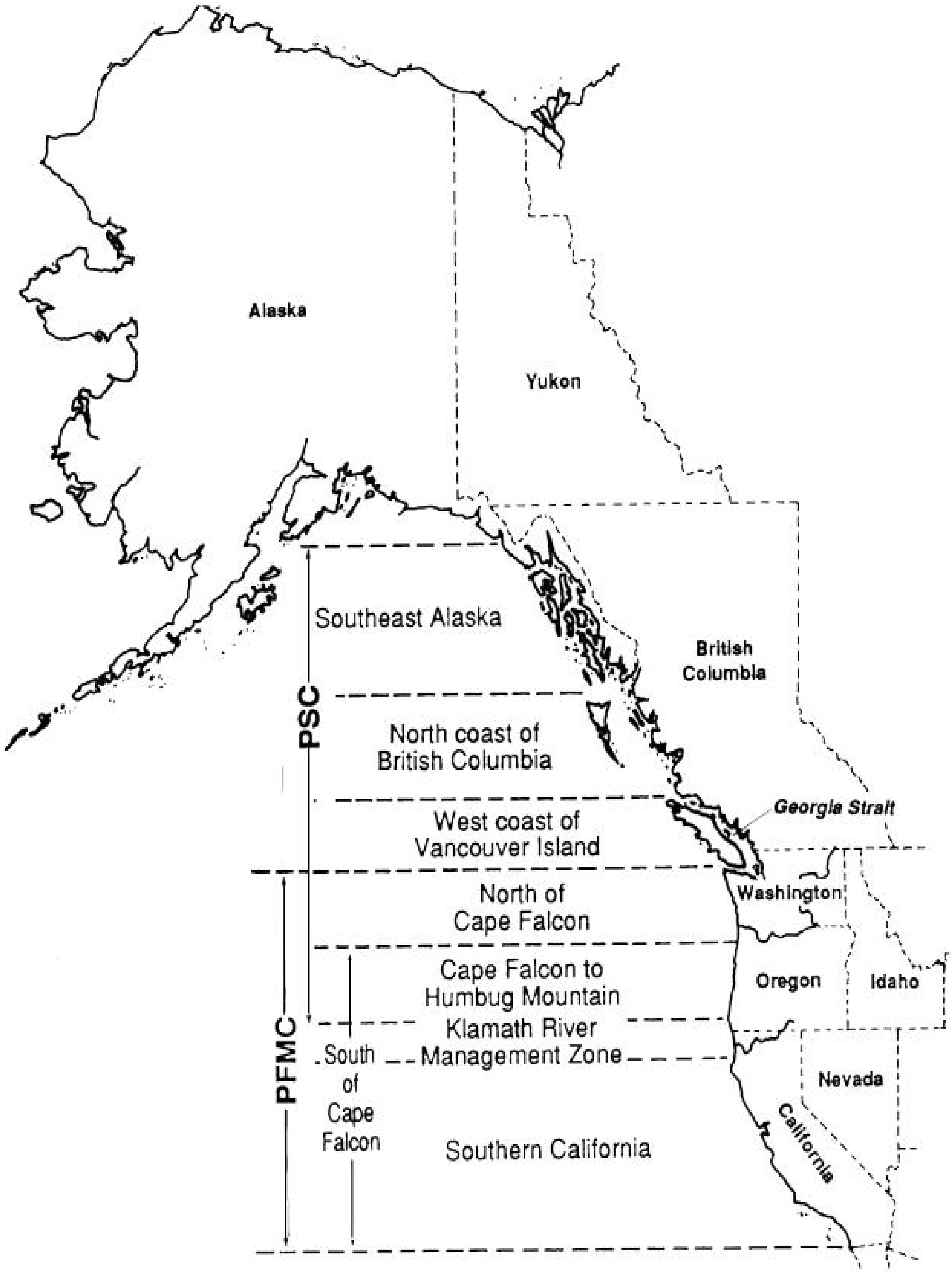

Figure 24. Areas managed subject to the jurisdiction of the PSC and the Pacific Fishery Management Council (PFMC) and various geographic subdivisions of each that are referenced throughout this opinion.

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).

Focusing on the impacts of activities specifically within the action area allows us to assess the prior experience and condition of the animals that will be exposed to effects from the actions under consultation. This focus is important because individuals of ESA-listed species may commonly exhibit, or be more susceptible to, adverse responses to stressors in some life history states, stages, or areas within their distributions than in others. These localized stress responses or baseline stress conditions may increase the severity of the adverse effects expected from proposed actions.

The environmental baseline for the species affected by the proposed actions includes the effects of many activities that occur across the action area considered in this opinion. In Section 2.2.5, we describe the on-going and anticipated temperature, freshwater, and marine effects of climate change. Because the impacts of climate change are ongoing, the effects are reflected in the most recent status of the species, which NMFS recently re-evaluated in 2015 (NWFSC 2015) and summarized in Section 2.2.5, Climate Change of this opinion. The status of the species described in Section 2.2 of this opinion is a consequence of those effects. In the following discussion of the environmental baseline we provide an overview of relevant federal actions in the action area that have undergone consultation and are therefore part of the baseline. In status Section 2.2 we summarize the limiting factors for each of the Chinook ESUs. Because the action area is largely comprised of marine waters, the discussion here first focuses in particular on harvest activities which are the primary activities affecting Chinook salmon in marine waters that occur in the action area.

The following section is organized to discuss the baseline for the Chinook species in marine portions of the action area first, followed by the freshwater areas in the action area, and then to discuss the baseline for the affected marine mammal species. In the status section we provided an overview of the long term trends in the harvest of Chinook salmon and efforts made to address harvest as a limiting for each of the Chinook ESUs. In this section, we provide more detail about the magnitude and distribution of harvest in recent years. In particular, we detail the total adult equivalent calendar year ERs that occurred between 1999 and 2014 and how that harvest was distributed across marine area fisheries in the action area. The estimates of ERs are derived from post season runs using the Fishery Regulation Assessment Model (FRAM), which was recently re-calibrated to a base period dataset that uses CWT recoveries from brood years 2005 through 2008. We describe the environmental baseline using FRAM-based ERs so that the information provided below is directly comparable to modeling results presented in the effects section, where FRAM was also used to simulate a variety of fishing scenarios related to the proposed action.

2.4.1 Southeast Alaska (SEAK)

2.4.1.1 Salmon Fisheries

In its 1999 opinion, NMFS considered the effects on listed species resulting from SEAK fisheries managed under the new regime for the 1999 summer and 1999/2000 winter seasons. NMFS subsequently completed consultation on the full scope of the 1999 Agreement on November 18, 1999 (NMFS 1999b). Once the ESA and funding contingencies were satisfied, the 1999 Agreement was finalized by the governments and provided the basis for managing the affected fisheries in the U.S. and Canada during the ten year term of the 1999 Agreement. Subsequently, in 2008 NMFS considered effects on listed species resulting from SEAK fisheries managed based on a newly negotiated regime described in the 2009 Agreement (NMFS 2008d).

Section 7 consultations covering southern U.S. fisheries also began to be conducted in 1992 as a consequence of the initial ESA listings of salmonids. These consultations have focused, in particular, on fisheries off the coast of Washington, Oregon, and California managed by the Pacific Fishery Management Council, as well as fisheries in the Columbia River Basin and Puget Sound. During these consultations and those on the SEAK fishery prior to the 1999 Agreement, NMFS generally tried to anticipate the effect of Canadian fisheries on the species status. Per past Agreement performance NMFS has been able to rely on those to project Canadian fishing levels in its biological opinions.

During the past two Agreements an all-gear total allowable treaty catch for SEAK AABM fishery has been determined in time for the opening of the SEAK early winter troll fishery. This total allowable treaty catch is allocated among troll, net, and sport fisheries through regulations established by the Alaska Board of Fisheries. Funding for management of the SEAK fisheries has generally accompanied past agreements, in varying amounts, enabling management plans to operate in state waters to set aside fish for set gillnet fisheries, purse seine and drift gillnet fisheries, respectively. After net catches are removed from the total allowable treaty catch, the remaining allowable catch is allocated to troll fisheries and the remaining is allocated to sport fisheries. Certain fisheries and fish have been excluded from the treaty catch. Three terminal area fisheries are excluded from the treaty catch; in the Situk, Taku, and Stikine Rivers. All fisheries have been sampled for coded-wire tags, which are processed and used to determine the proportion of catch comprised of Alaska hatchery fish and in this section we will review past results of fishery performance.

Annual accounting of catch in troll fisheries occurs on a cycle that begins October 1 and ends September 30 each year. The troll fishery consists of three periods: (1) a winter fishery that occurs from October through April, (2) a spring fishery that occurs in May and June, and (3) a summer fishery that occurs from July through September. The winter troll fishery is managed to a guideline harvest level of 45,000 Chinook salmon (excluding Alaska hatchery add-on). The catches in spring troll fisheries are typically lower than winter or summer troll catches, as these fisheries generally target Alaskan hatchery produced Chinook salmon. Chinook salmon retention periods during summer troll fisheries are managed to target remaining allowable season-total troll catch after the winter and spring fisheries have occurred, although other factors may be taken into consideration, including status of local wild stocks. Regulations for net fisheries vary by year but they typically occur from mid to late June through early fall. With the exception of directed gillnet harvest for Chinook salmon in some terminal areas as described in the Transboundary Rivers chapter of the 2009 PST agreement, all other net harvest of Chinook salmon is incidental to the harvest of other species. Sport fisheries generally occur throughout the year, however, bag limits may vary annually depending on the level of allowable catch.

The SEAK salmon fisheries catch a mix of Alaska origin, Canadian origin, and Washington/Oregon origin Chinook salmon. This includes fish from four Washington and Oregon ESA listed ESUs, as described in detail below.

LCR Chinook Salmon ESU

The LCR Chinook Salmon ESU has three components including spring stocks, tule stocks, and far-north migrating bright stocks. These components have different distributions and are subject to different rates of harvest. LCR spring Chinook salmon are not subject to specific harvest impact limits for marine area fisheries. NMFS has concluded that management constraints for other stocks provide adequate protections (NMFS 2012b). ERs in marine area fisheries generally ranged between 10 and 20 percent from 1999 to 2014, but were notably higher in 2008 and 2011 with the increases occurring mostly in the southern U.S. and Canadian (CAN) fisheries (Figure 25). Between 1999 and 2014 the ER on LCR spring Chinook salmon in the action area (marine area fisheries) averaged 18.7 percent (Table 33). The ER in the SEAK fishery was 1.8 percent (Table 33) which accounted for an average of 9.7 percent of the overall marine area harvest (Figure 26).

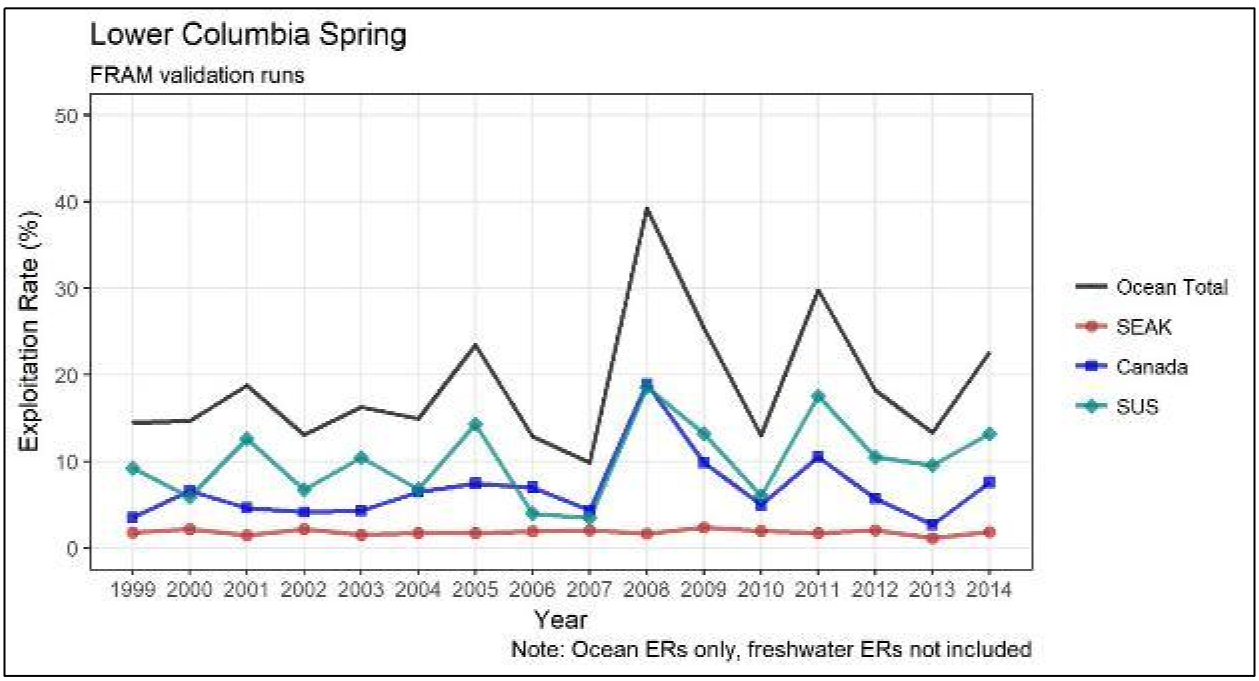

Figure 25. LCR spring Chinook salmon exploitation between 1999 and 2014 from FRAM model runs using actual post-season fishery catches and best available estimates of annual stock abundances.

Table 33. LCR Chinook Salmon ESU exploitation in marine area fisheries between 1999 and

2014.

LCR Chinook Salmon components	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	WA Coast Bays	Marine Area Exploitation
	Average 1999 – 2014					
Spring	1.8%	6.8%	10.0%	0.2%	0.0%	18.7%
Tule fall	2.4%	16.9%	13.4%	0.2%	0.1%	33.1%[1]
Bright (late-fall)	10.5%	22.9%	17.3%	0.0%	0.0%	50.7%

1. Adding in freshwater Columbia River terminal fisheries results in an average total ER of 42.0 percent over the same time period.

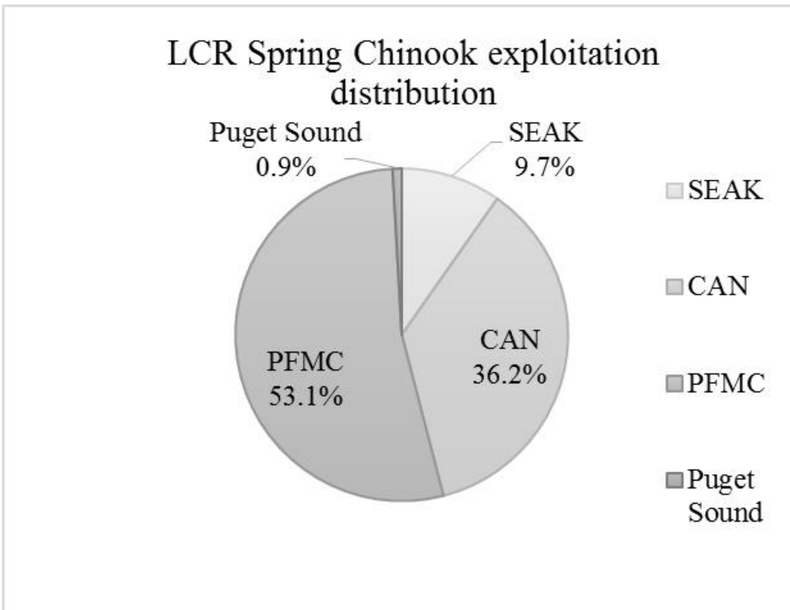

Figure 26. LCR spring Chinook salmon average exploitation distribution in marine area fisheries between 1999 and 2014.

The tule component of the LCR Chinook Salmon ESU in SUS fisheries has been managed in recent years subject to a total ER, that applies to all marine and mainstem Columbia River freshwater fisheries below Bonneville Dam. The ER limit applied by fishery managers for tule Chinook salmon has declined over the years as reflected in a series of consultations on SUS fisheries from 65 percent in 2001 to the current abundance based management framework that allows the ER to vary from 30 to 41 percent depending on abundance (see Section 2.2.2.1 for a more detailed review). LCR tule Chinook salmon are not a far north migrating stock and, as a consequence, impacts in SEAK fisheries are relatively low (Table 33). LCR tule Chinook salmon are caught primarily in Canadian and southern U.S. fisheries Figure 27. Nonetheless, current management framework for the PFMC fisheries requires that all fisheries including the PST, PFMC, and Columbia River fisheries, be managed subject to a total ER limit (NMFS 2012b). ERs in marine area fisheries have declined in since 2005 (Figure 27). Between 1999 and 2014 the ER on LCR tule populations in marine area fisheries averaged 33.1 percent (Table 33). The

ER in the SEAK fishery averaged 2.4 percent and accounted for 7.1 percent of the overall marine area harvest of LCR tule Chinook salmon (Figure 28).

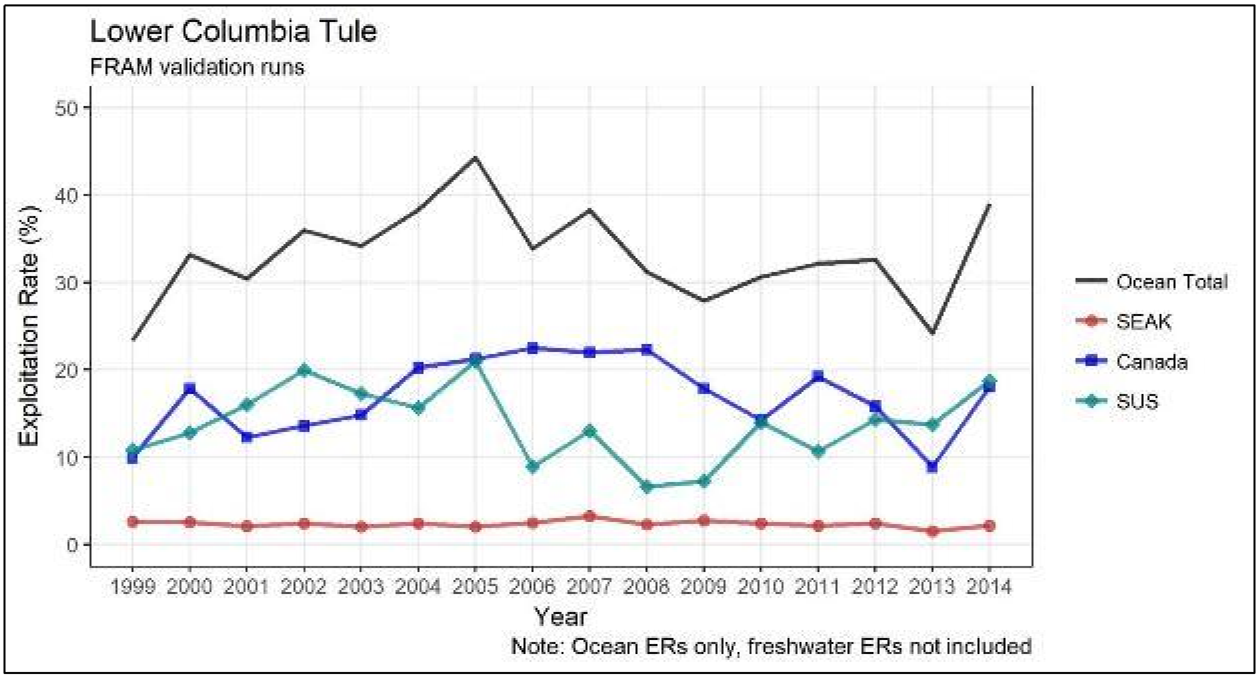

Figure 27. LCR tule Chinook salmon exploitation between 1999 and 2014 from FRAM model runs using actual post-season fishery catches and best available estimates of annual stock abundances.

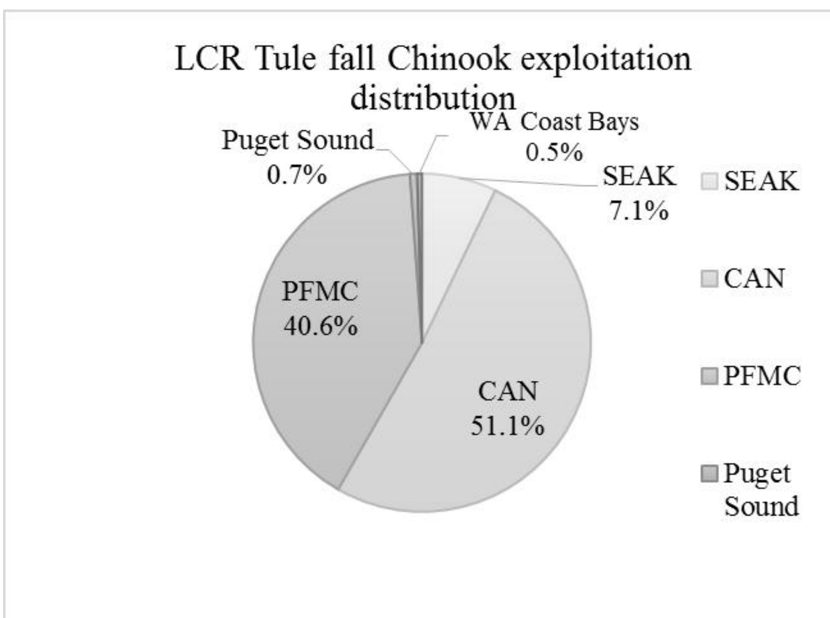

Figure 28. LCR tule fall Chinook salmon average exploitation distribution in marine area fisheries between 1999 and 2014.

North Fork Lewis River fall Chinook salmon are the primary representative of the bright component of the LCR Chinook Salmon ESU, commonly referred to as the Lower Columbia Wild stock. As noted in the Status Section 2.2.2.1 this is one of the few healthy wild stocks in the LCR. As with the spring Chinook salmon component of the ESU, fishery managers do not apply a specific impact limit to the bright component because NMFS has deemed the impact limit framework for LCR tule Chinook to be sufficient to protect the ESU as a whole. This is a far-north migrating stock so the marine area harvest occurs primarily in northern fisheries in Alaska and Canada. ERs in marine area fisheries have been relatively stable since 1999 with modest reductions in Canadian and SEAK fisheries in recent years (Figure 29). The ER on LCR bright populations averaged 50.7 percent in marine area fisheries and 10.5 percent in SEAK the fishery between 1999 and 2014 (Table 33). The SEAK fishery accounted for 20.7 percent of the overall marine area harvest (Figure 30).

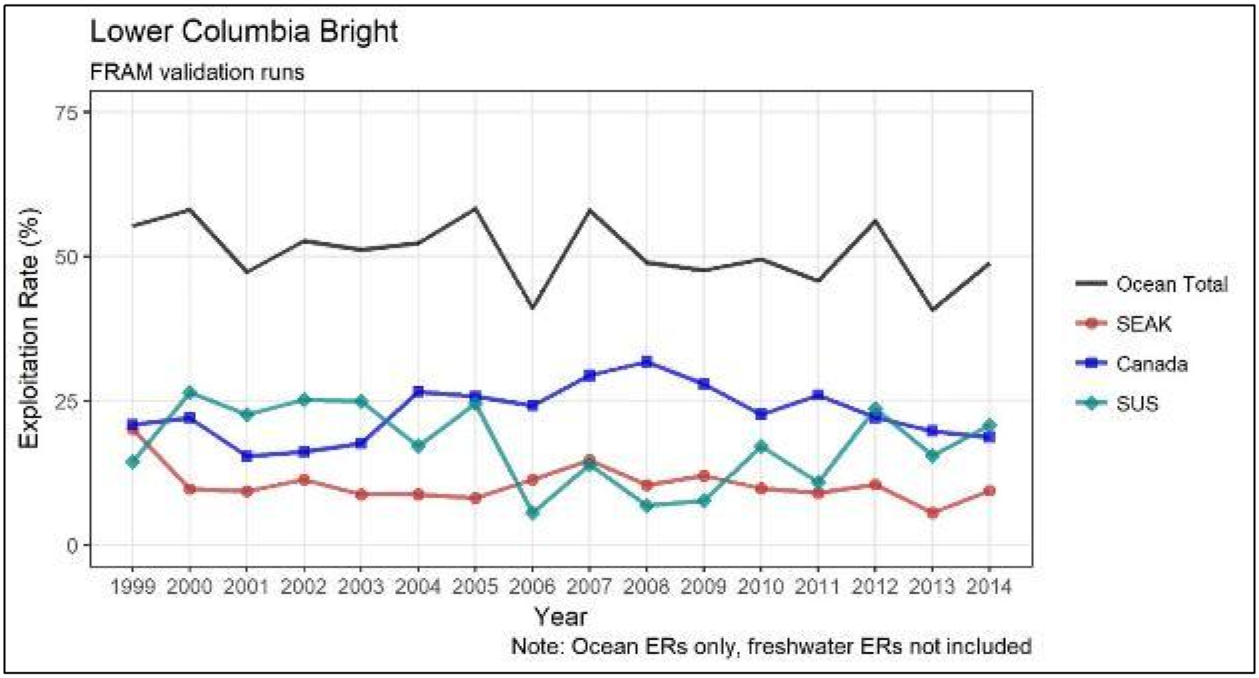

Figure 29. LCR bright Chinook salmon exploitation between 1999 and 2014 from FRAM model runs using actual post-season fishery catches and best available estimates of annual stock abundances.

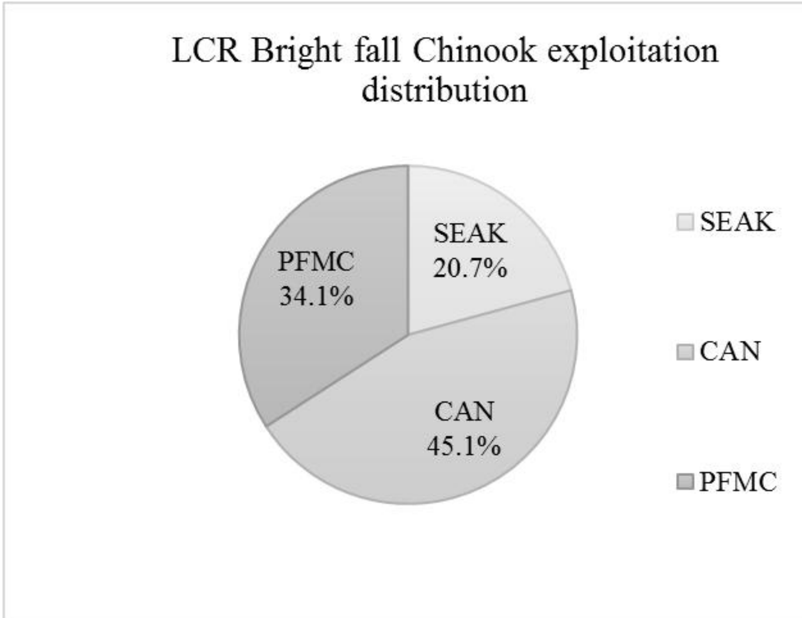

Figure 30. LCR bright fall Chinook salmon average exploitation distribution in marine area fisheries between 1999 and 2014.

Upper Willamette Spring Chinook Salmon ESU

UWR Chinook salmon are also a far-north migrating stock. The ER on UWR Chinook in marine area fisheries is generally low averaging 10.2 between 1999 and 2014 (Table 34). As discussed in the Status section 2.2.2.2, most of the harvest related conservation constraints for UWR Chinook occur in freshwater fisheries, which is outside the action area. Marine fishery managers do not apply a specific impact limit for UWR Chinook salmon. Because of their northerly distribution and early return timing, the ER of UWR Chinook salmon in SEAK fisheries is greater than in other areas. Maturing UWR Chinook salmon exit the marine area between February and April, before the start of most marine area fisheries in the south. ER estimates in marine area fisheries have been relatively stable since 1999 (Figure 31). ERs on UWR Chinook salmon from 1999 to 2014 have averaged 10.2 percent in the action area (marine area fisheries) and 4.3 percent in SEAK (Table 34). SEAK fisheries accounted for 42.7 percent of the marine area exploitation of UWR Chinook salmon between 1999 and 2014 (Figure 32).

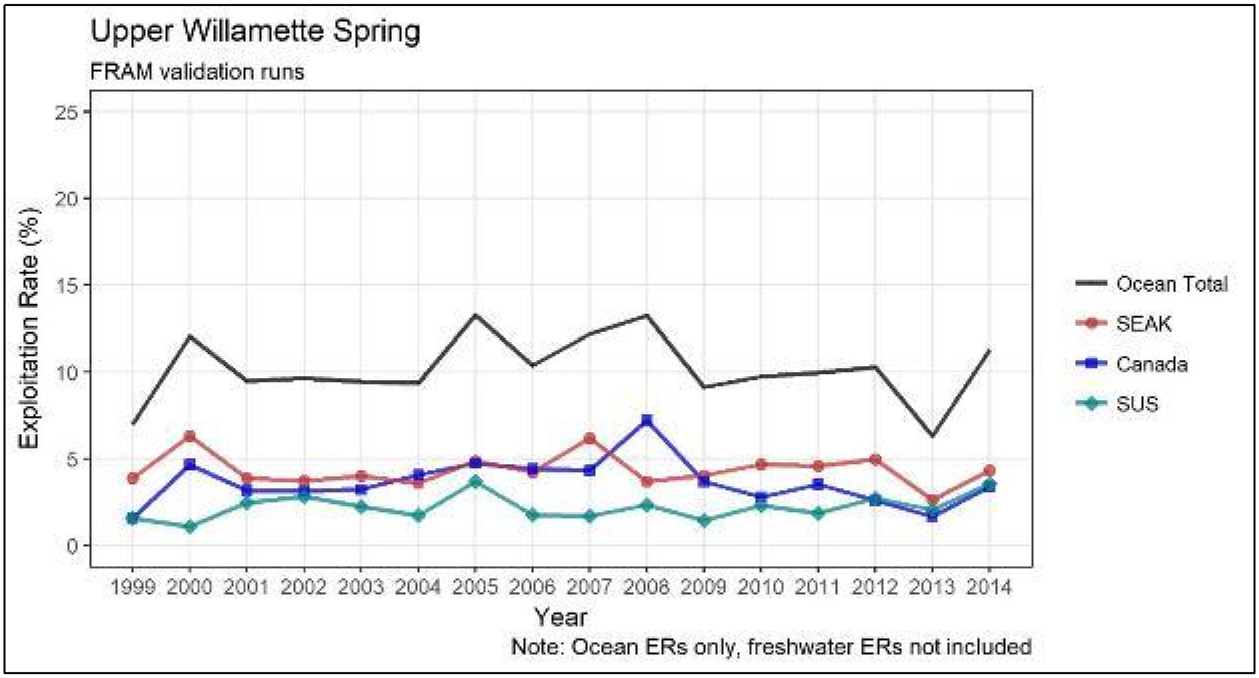

Figure 31. UWR Chinook Salmon exploitation between 1999 and 2014 from FRAM model runs using actual post-season fishery catches and best available estimates of annual stock abundances.

Table 34. UWR Chinook Salmon ESU exploitation in marine area fisheries between 1999 and 2014.

ESU	**SEAK Exploitation**	**Canadian Exploitation**	**PFMC Exploitation**	**Puget Sound Exploitation**	**Marine Area Exploitation**
	Average 1999 – 2014				
UWR Chinook Salmon	4.3%	3.6%	2.1%	0.1%	10.2%

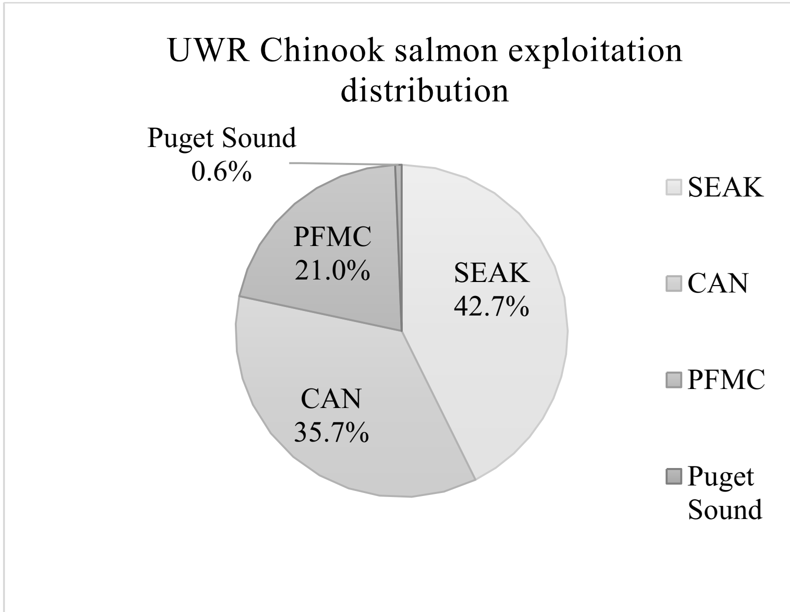

Figure 32. UWR Chinook Salmon ESU average exploitation distribution in marine area fisheries between 1999 and 2014.

Snake River Fall-run Chinook Salmon ESU

Snake River fall-run Chinook salmon have a broad marine area distribution that ranges from Oregon to SEAK. NMFS concluded in the 2008 biological opinion on the Pacific Salmon Treaty that a marine area standard requiring that the SEAK, Canadian, and PFMC marine area fisheries combined achieve a 30 percent reduction in the age-3 and age-4 adult equivalent total ER relative to the 1988 to 1993 base period is not likely to jeopardize this ESU. As discussed in the status section 2.2.2.3, there is a separate standard used for managing freshwater fisheries. The 30 percent reduction standard is generally reported as a proportion (referred to as the Snake River fall-run Chinook index (SRFI)). A 30 percent reduction in the average base period ER equates to an index value of 0.70. A value less than 0.70 therefore represents a reduction that exceeds the 30 percent standard. An index of 0.60 equates to a 40 percent reduction in ER relative to the base period average. This standard has been in use since the mid-1990's and is described in more detail in the biological opinion on the 1999 PST Agreement (NMFS 1999b). Although the index is evaluated each year during the PFMC preseason planning process, it has not constrained fisheries in recent years.

Post season estimates of the SRFI index are shown in Figure 33 and compared to the 0.70 index that represents a 30 percent reduction in base period exploitation rate. Although the post season estimates indicate that the SRFI limit of 0.70 was exceeded in three of the last 21 years, the index has averaged 0.51 since 1994 meaning that the marine area exploitation rate has been reduced by nearly 50 percent.

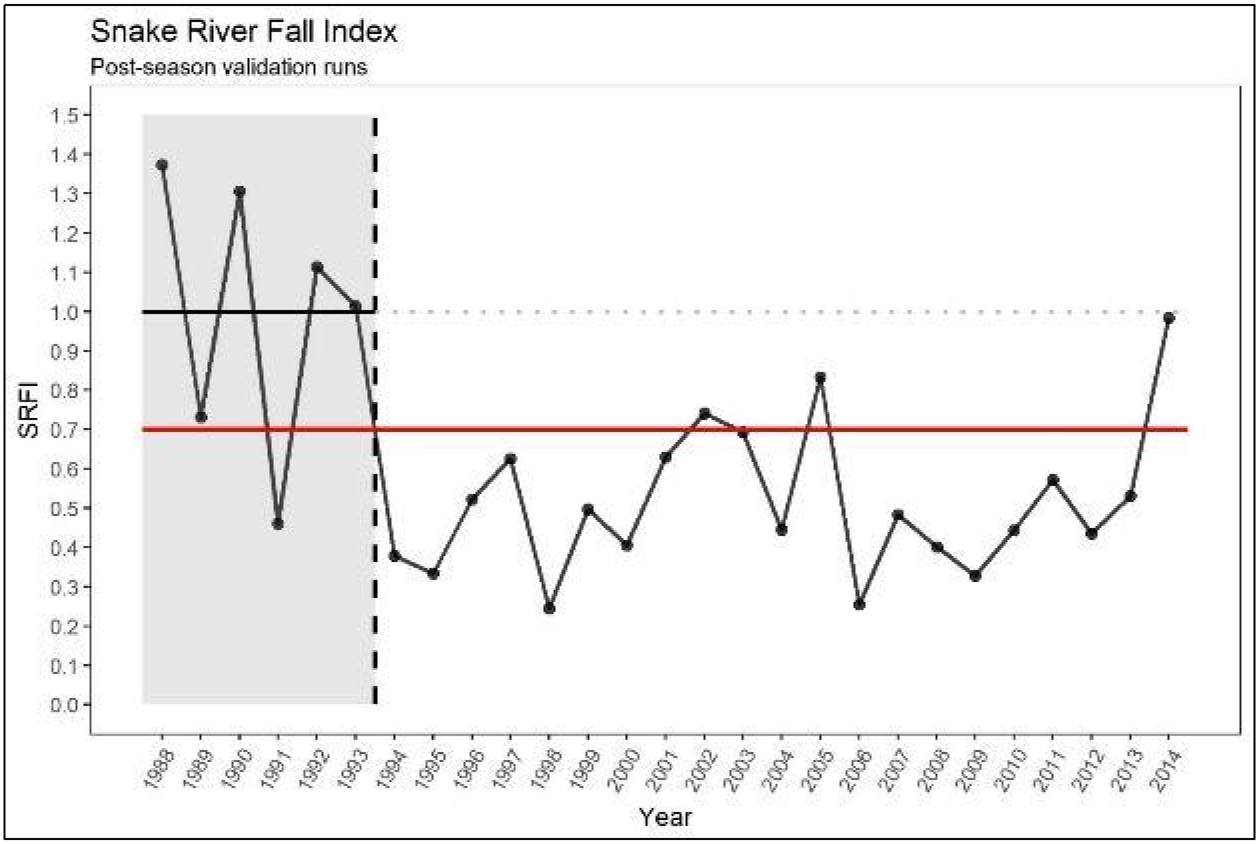

Figure 33. The Snake River fall Chinook Index (SRFI). The horizontal lines shows the 1988 to 1993 average (1.0) and a value of 0.70 which represents the 30 percent reduction in the base period average.

The SRFI index approach was developed shortly after the SRFC were listed and at a time when data related to harvest of SRFC was quite limited. At the time, this relative index method was considered the best way to measure harvest impacts. The data improved over time, particularly as we added years of CWT recoveries that allow us to estimated exploitation rates more directly. The FRAM model is used here to report ERs in marine area fisheries; these have varied between roughly 30 and 50 percent since 1999 with the greatest variability occurring in the southern U.S. fisheries. ERs on Snake River fall-run Chinook salmon have averaged 38.9 percent in marine area fisheries (Figure 34). The Snake River fall-run Chinook salmon ER in SEAK fisheries averaged 2.0 percent between 1999 and 2014 (Table 35) and accounted for 5.1 percent of marine area harvest (Figure 35).

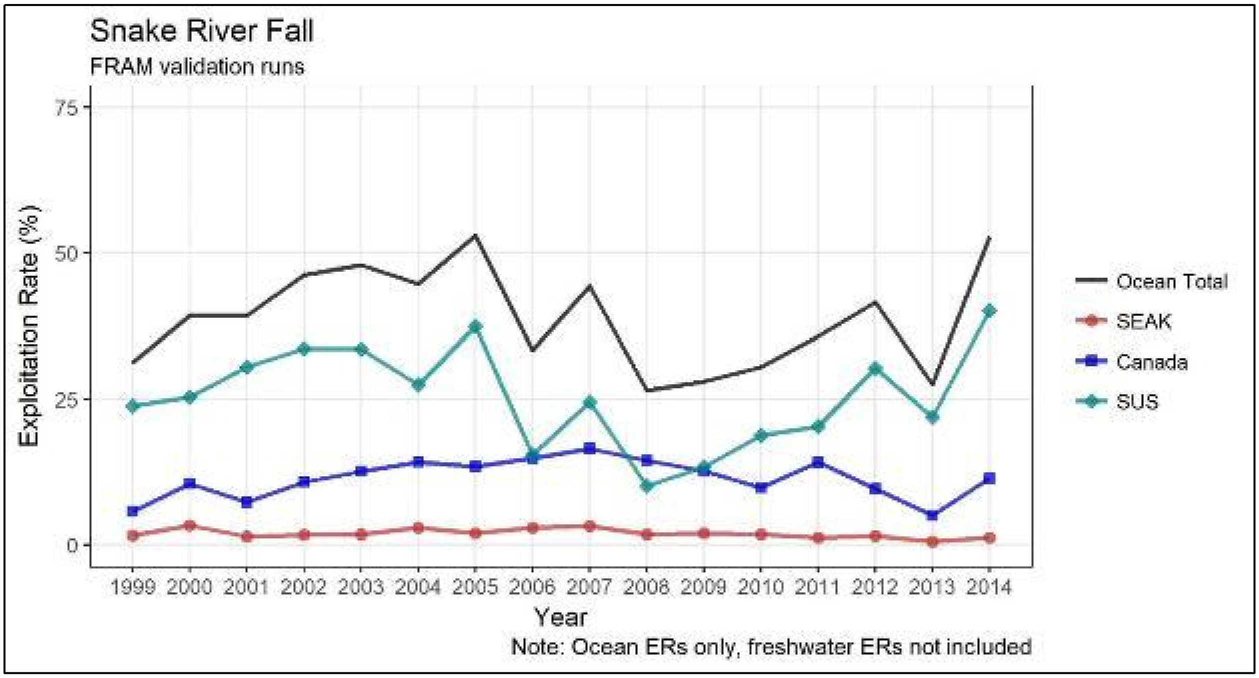

Figure 34. Snake River fall-run Chinook salmon exploitation between 1999 and 2014 from FRAM model runs using actual post-season fishery catches and best available estimates of annual stock abundances.

Table 35. Snake River fall-run Chinook Salmon ESU exploitation in marine area fisheries between 1999 and 2014.

ESU	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
	Average 2005 – 2014				
Snake River fall-run Chinook	2.0%	11.5%	25.1%	0.3%	38.9%

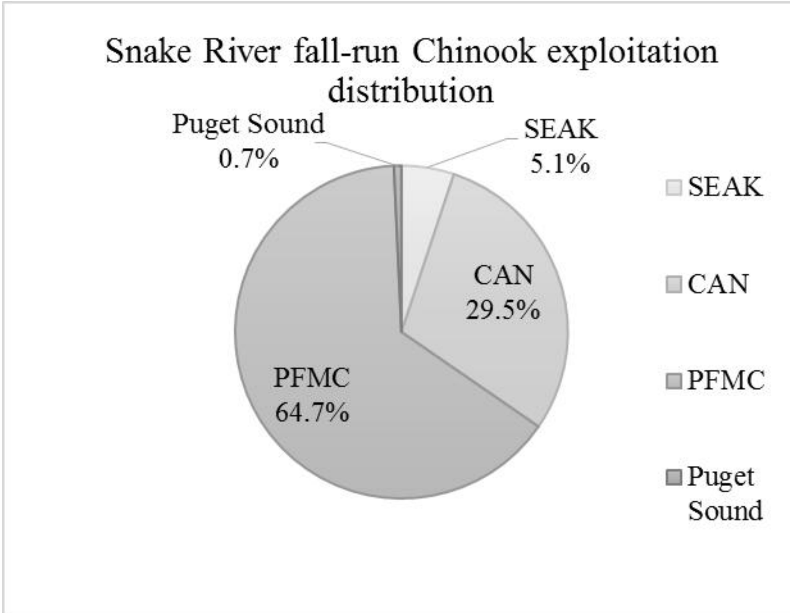

Figure 35. Snake River fall-run Chinook Salmon ESU average exploitation distribution in marine area fisheries between 1999 and 2014.

Puget Sound Chinook Salmon ESU

As discussed in Section 2.2.2.1 there are 22 Puget Sound Chinook salmon populations that are aggregated for management purposes into 14 management units. The populations have distinct migration patterns that affect where harvest impacts occur and the relative magnitude of harvest impacts. However, none of the populations are far north migrating so impacts in SEAK fisheries are generally low. Population-specific impact limits are applied to Puget Sound fisheries. Since the expiration of the 2010 management plan developed by the Puget Sound treaty tribes and State of Washington (co-managers) in 2014 and approved by NMFS under the ESA 4(d) rule for salmon and steelhead, population-specific impact limits have been developed on an annual basis. These limits are specific to each management unit and vary considerably depending on the status of each unit. They are generally expressed as total ER or southern U.S. ER limits. The management objectives used in Table 36 have generally been used in recent years and are described in the biological opinion on the proposed Puget Sound fisheries for the 2018 and pre-May 2019 fishing season (NMFS 2018b). The Puget Sound co-managers are currently working on a new long-term RMP that will have new conservation objectives with the expectation that it can be completed and reviewed in time for implementation during the 2020/21 season.

Table 36. Example Puget Sound Chinook salmon conservation objectives for the 2018 fishing year (from NMFS (2018e)).

Management Unit/Population	Normal Abundance: Exploitation Rate Ceiling: Total	Normal Abundance: Exploitation Rate Ceiling: Southern US (PT=Preterminal)	Minimum Fishing Regime: Low Abundance Threshold	Minimum Fishing Regime: Critical Exploitation Rate: So. US	Minimum Fishing Regime: Critical Exploitation Rate: Preterminal So. US
Nooksack spring NF Nooksack SF Nooksack	Minimum Fishing Regime applies		1,000[2] 1,000[2]	7.0%/9.0%[1]	

Skagit Summer/Fall Upper Skagit Lower Skagit Lower Sauk	50.0%			4,800 2,200 900 400	15.0%	
Skagit Spring Suiattle Upper Sauk Cascade	38.0%			576 170 130 170	18.0%	
Stillaguamish NF Stillaguamish SF Stillaguamish	25.0%			700[2] 500[2] 200[2]	15.0%	
Snohomish Skykomish Snoqualmie	21.0%			2,800[2] 1,745[2] 521[2]	15.0%	
Lake Washington Cedar River		*20.0%*		*200*		*10.0%*
Green River	*Pre-terminal fisheries will operate under the minimum fishing regime; Terminal fisheries will not target Chinook and other species fisheries in the terminal area will be shaped*			*1,800*		*12%*
White River	20.0%			200	15.0%	
Puyallup	50.0%			500		12.0%[3]
Nisqually	50.0%			700	50% reduction of SUS ER[4]	
Skokomish	50.0%			800 natural[5] 500 hatchery[5]		12.0%
Mid-Hood Canal		15.0% PT		400		12.0%
Dungeness		10.0%		500	6.0%	
Elwha		10.0%		1,000	6.0%	

[1] Expected Southern US rate will not exceed 7.0% in 4 out of 5 years and 9.0% in 1 out of 5 years.
[2] Threshold expressed as natural-origin spawners.
[3] The total southern U.S. exploitation rate for the Puyallup is expected to fall within the range of 23% to 27%.
[4] Southern U.S. ER ceiling will be one-half (50%) of the difference between 50% exploitation rate objective and the expected ER associated with fisheries in Alaska and British Columbia.
[5] Anticipated hatchery or natural escapements below these spawner abundances trigger specific additional management actions

The trends in total ER for the Puget Sound populations vary considerably. Most are relatively stable, but some show increasing trends over time (e.g., Skagit River summer/fall, Skokomish) while others show decreasing trends (e.g., Nooksack, Nisqually, and Green) (Figure 36 through Figure 40). Total ERs for Puget Sound Chinook salmon populations also vary considerably. The Nooksack populations are particularly vulnerable to harvest in Canada and have an ER that averages 42.9 percent (Table 37). The ER on Strait of Juan de Fuca populations (Elwha and Dungeness) is relatively low averaging 14.1 percent. ERs on South Puget Sound populations range from 25.6 percent to 64.6 percent. For mid-Puget Sound populations, rates range from 19.8 percent to 56.0 percent. With the exception of Skagit River summer/fall and Nooksack spring Chinook salmon populations, ERs in SEAK fisheries are less than 2 percent (Table 37). The proportion of the total harvest that occurs in the SEAK fishery also varies by management unit, but ranges from 0.1 percent to 20.3 percent (Table 38).

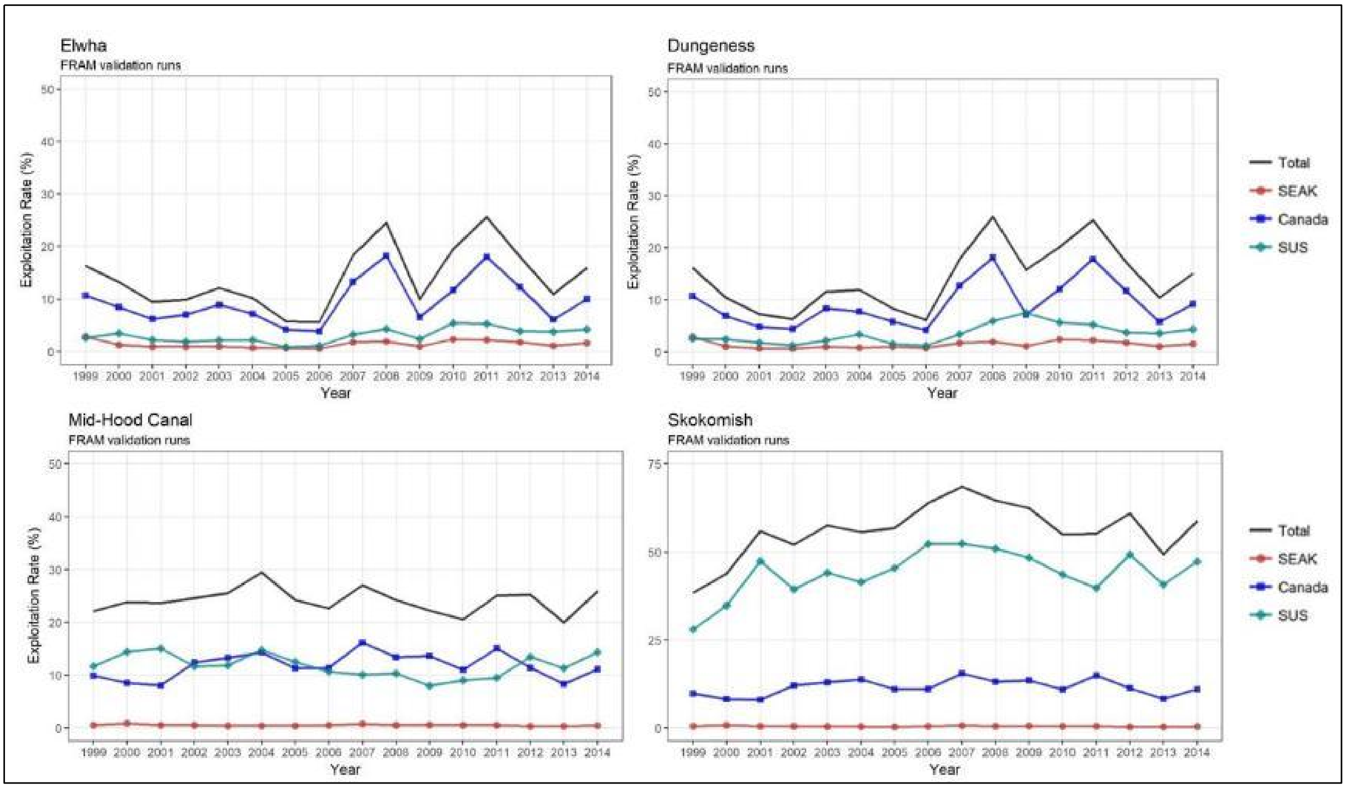

Figure 36. ERs on Strait of Juan de Fuca and Hood Canal Puget Sound Chinook salmon populations between 1999 and 2014 from FRAM model runs using actual post-season fishery catches and best available estimates of annual stock abundances.

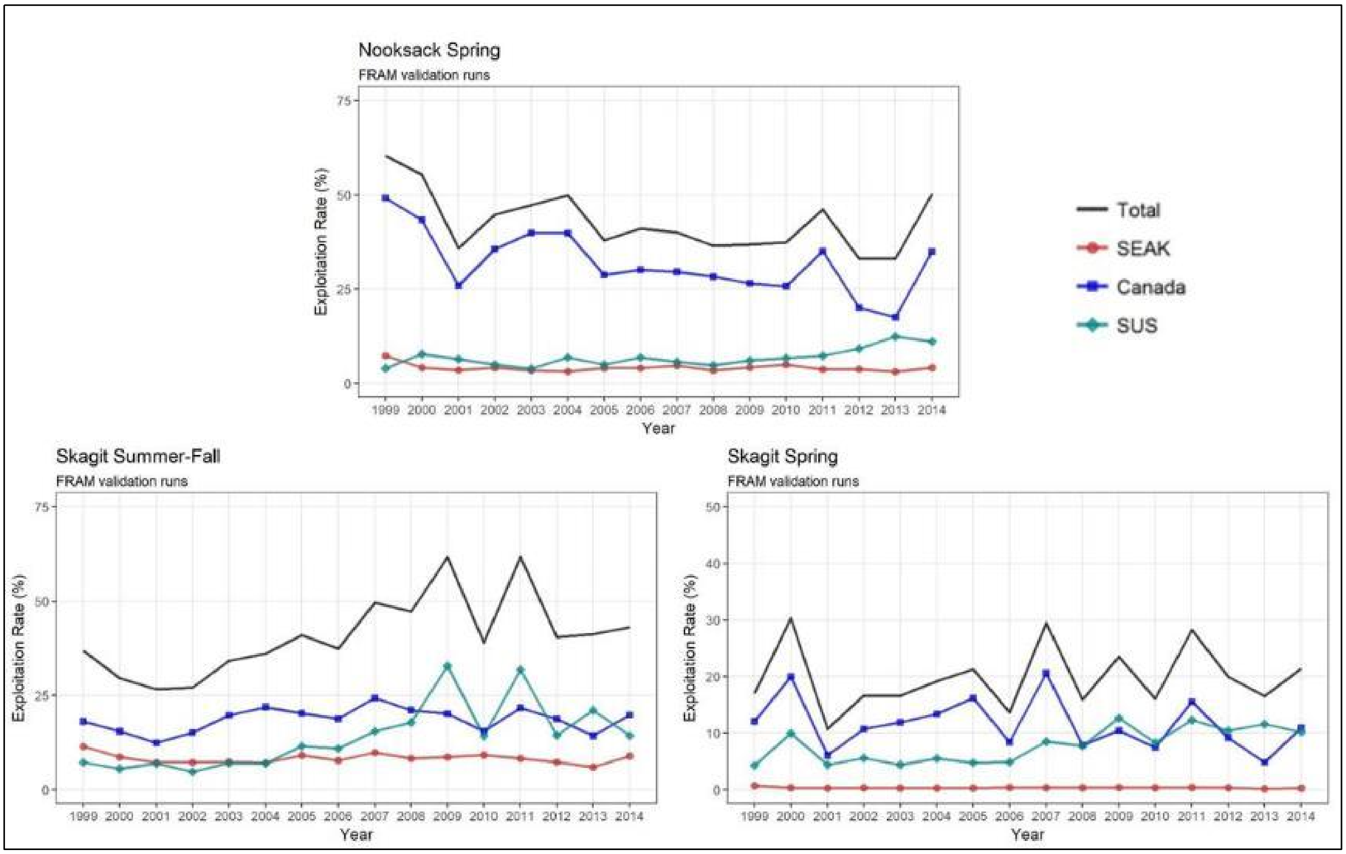

Figure 37. ERs on northern Puget Sound Chinook salmon populations between 1999 and 2014 from FRAM model runs using actual post-season fishery catches and best available estimates of annual stock abundances.

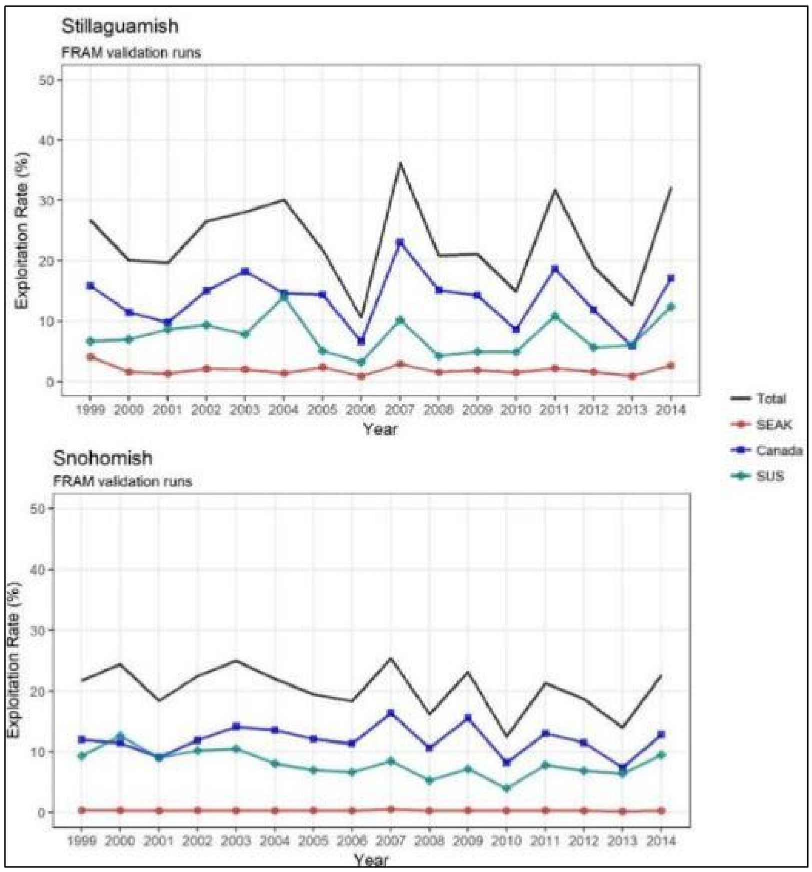

Figure 38. ERs on central Puget Sound Chinook salmon populations between 1999 and 2014 from FRAM model runs using actual post-season fishery catches and best available estimates of annual stock abundances.

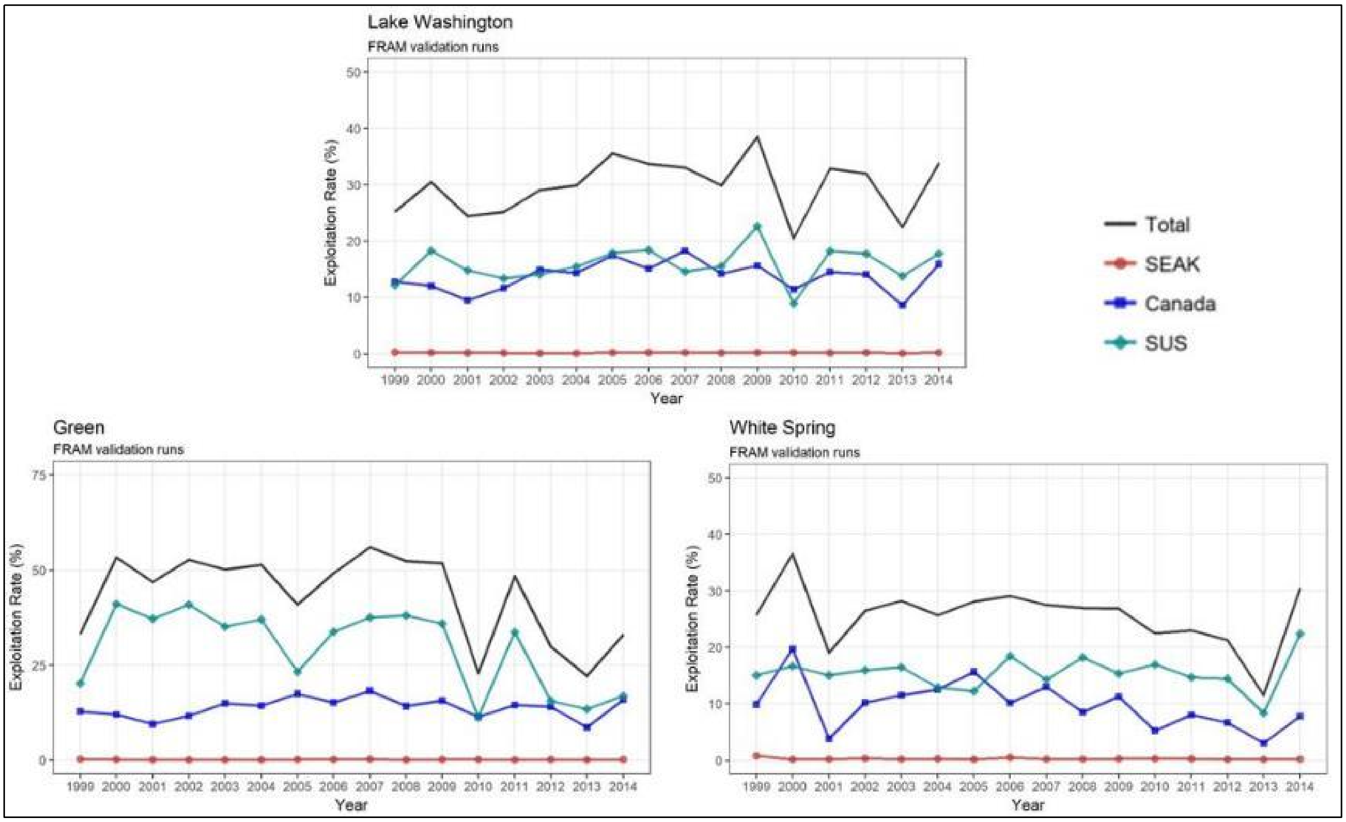

Figure 39. ERs on Lake Washington, Green River, and White River Puget Sound Chinook salmon populations between 1999 and 2014 from FRAM model runs using actual post-season fishery catches and best available estimates of annual stock abundances.

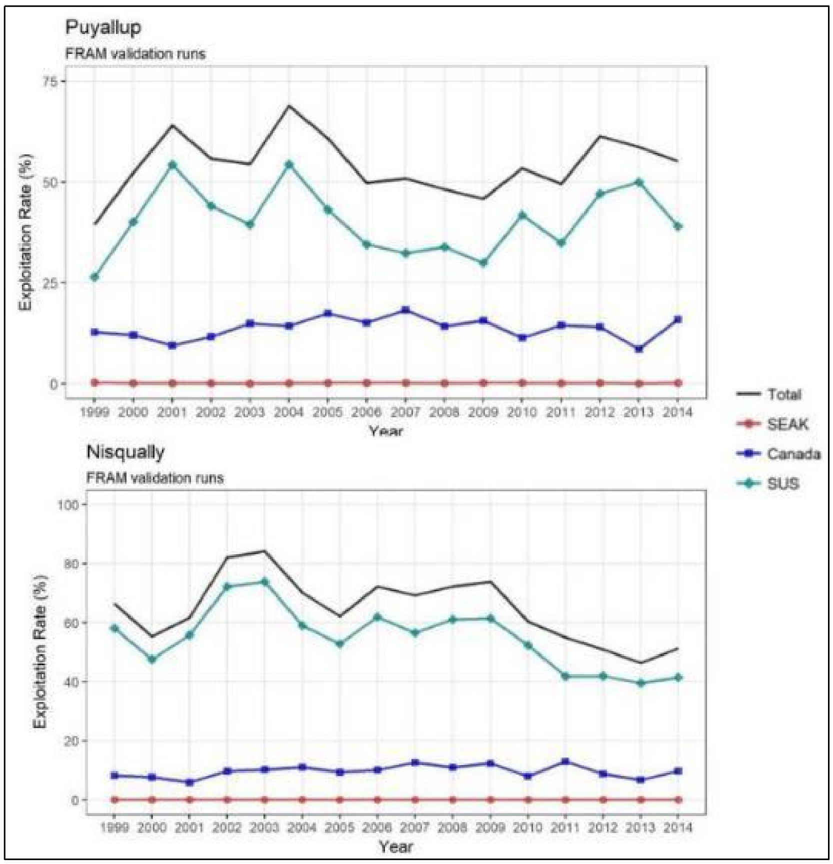

Figure 40. ERs on Puyallup River and Nisqually River Puget Sound Chinook salmon populations between 1999 and 2014 from FRAM model runs using actual post-season fishery catches and best available estimates of annual stock abundances.

Table 37. Puget Sound Chinook salmon ERs in marine area fisheries between 1999 and 2014.

Stock	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Total Exploitation
	Average 1999 – 2014				
Nooksack River (early)	4.1%	31.9%	2.5%	4.3%	42.9%
Skagit River (early)	0.3%	11.6%	0.8%	7.0%	19.8%
Skagit River (summer/fall)	8.3%	18.6%	1.1%	12.8%	40.8%
Stillaguamish River	1.9%	13.8%	1.9%	5.6%	23.3%
Snohomish River	0.3%	11.9%	1.7%	6.4%	20.3%
Lake Washington	0.2%	13.8%	4.6%	11.3%	29.8%
Duwamish-Green River	0.2%	13.8%	4.6%	24.8%	43.4%
Puyallup River	0.2%	13.8%	4.6%	35.7%	54.3%
Nisqually River	0.1%	9.7%	6.3%	48.6%	64.6%
White River (early)	0.3%	9.8%	1.6%	13.8%	25.6%
Skokomish River	0.5%	11.6%	5.8%	38.2%	56.2%
Mid-Hood Canal Rivers	0.5%	11.8%	5.9%	5.8%	24.2%
Dungeness River (early)	1.4%	9.2%	1.0%	2.5%	14.1%
Elwha River	1.4%	9.6%	0.9%	2.2%	14.1%

Table 38. The proportional distribution of harvest impacts of Puget Sound Chinook salmon distribution in marine areas and Puget Sound fisheries between 1999 and 2014.

Stock	SEAK % of Exploitation	Canadian % of Exploitation	PFMC % of Exploitation	Puget Sound % of Exploitation
	Average 1999 – 2014			
Nooksack River (early)	9.7%	74.4%	5.9%	10.0%
Skagit River (early)	1.7%	58.6%	4.2%	35.5%
Skagit River (summer/fall)	20.3%	45.6%	2.8%	31.4%
Stillaguamish River	8.3%	59.3%	8.3%	24.2%
Snohomish River	1.6%	58.7%	8.2%	31.4%
Lake Washington	0.6%	46.2%	15.4%	37.8%
Duwamish-Green River	0.4%	31.8%	10.6%	57.3%

Stock	SEAK % of Exploitation	Canadian % of Exploitation	PFMC % of Exploitation	Puget Sound % of Exploitation
	Average 1999 – 2014			
Puyallup River	0.3%	25.4%	8.4%	65.9%
Nisqually River	0.1%	15.0%	9.7%	75.2%
White River (early)	1.1%	38.4%	6.4%	54.1%
Skokomish River	0.9%	20.6%	10.4%	68.1%
Mid-Hood Canal Rivers	2.2%	49.0%	24.6%	24.1%
Dungeness River (early)	10.0%	65.4%	6.8%	17.9%
Elwha River	10.2%	67.8%	6.6%	15.3%

2.4.1.2 Gulf of Alaska Groundfish Fisheries

Chinook salmon are caught incidentally in the BSAI and GOA groundfish fisheries. The BSAI fisheries occur outside the action area considered in this biological opinion and are therefore not discussed further.

Groundfish fishing areas in the GOA managed under the NPFMC's GOA Groundfish FMP and salmon fishing areas in SEAK overlap, although most of the groundfish fishing occurs to the west of the salmon fishing areas. The incidental bycatch of salmonids in the GOA groundfish fishery is limited primarily to Chinook and chum salmon. Previous opinions (NMFS 1999c; 2007; 2012d) NMFS considered the NPFMC's proposed annual bycatch limit of 40,000 Chinook salmon for the GOA fishery and other related management actions and concluded that the proposed action would not jeopardize any of the affected Chinook salmon species. From 2003 to 2017 the bycatch of Chinook salmon has averaged 23,194 and ranged from 8,475 to 54,682 (NMFS 2018c).

NMFS last reviewed the effects of the GOA groundfish fishery on ESA listed salmon species through section 7 consultation in 2012 (NMFS 2012d). Estimates of the take of ESA listed Chinook come from a review of code-wire tags that have been recovered in the fishery over the last 20 years. Based on that review, NMFS estimated that the take UWR Chinook and LCR Chinook averaged 5 and 12 fish per year, respectively out of a total bycatch that averaged 21,986 from 1991 to 2010.

2.4.2 Canadian Salmon fisheries

In order to describe fishery performance under past agreements and account for changing ocean conditions, we are using the 1999 to 2014 time frame to characterize past and present harvest related impacts that are part of the environmental baseline. As described in section 1, Canadian fisheries were managed subject to provisions of the 1999 PST Agreement from 1999 to 2008 and subject to the 2009 Agreement from 2009 to 2018. Management provisions that applied to Canadian fisheries under those agreements are described in the respective biological opinions (NMFS 1999b; 2008d).

LCR Chinook Salmon ESU
ERs on LCR tule populations averaged 16.9 percent in Canadian fisheries between 1999 and 2014 (Table 33) and accounted for 51.1 percent of the ER of all marine area fisheries (Figure 28). The ER on LCR spring Chinook salmon populations averaged 6.8 percent over the same time period (Table 33), but accounted for an average of 36.2 of the marine area exploitation (Figure 26). For LCR bright populations, the 1999-2014 Canadian fisheries had ERs averaged 22.9 (Table 33) and accounted for 45.1 percent of the marine area exploitation (Figure 30).

Upper Willamette Spring Chinook Salmon ESU
Because of their northerly distribution and early return timing the marine area fishery impacts to UWR Chinook salmon are relatively low. The ER of UWR Chinook salmon in Canadian fisheries averaged 3.6 percent (Table 34) from 1999 to 2014, this comprised 35.7 percent of the marine area exploitation of UWR Chinook salmon over this time frame (Figure 32).

Snake River Fall-run Chinook Salmon ESU
The ER on Snake River fall-run Chinook salmon in Canadian fisheries averaged 11.5 percent between 1999 and 2014 (Table 35) comprising an average 29.5 percent of the marine area exploitation of Snake River fall-run Chinook salmon over this time period (Figure 32).

Puget Sound Chinook Salmon ESU
The ER on Puget Sound Chinook salmon in Canadian fisheries from 1999 to 2014 varied by stock ranging from 9.2 percent to 31.9 percent (Table 37). However, Canadian fisheries generally account for a larger proportion of the overall harvest than SEAK fisheries ranging from 15.0 percent to 46.2 percent for south Puget Sound stocks, 20.6 percent to 67.8 percent for Hood Canal and Strait of Juan de Fuca stocks, and 45.6 percent to 74.4 percent for north Puget Sound stocks (Table 38).

2.4.3 Southern U.S. Fisheries

2.4.3.1 PFMC Salmon Fisheries

NMFS promulgates regulations for fisheries in the EEZ off the Pacific Coast of Washington, Oregon, and California pursuant to the MSA through the PFMC. The PFMC develops annual regulations implementing the Pacific Coast Salmon FMP through a public process that leads to recommendations to NMFS. The Pacific Coast Salmon FMP provides a framework for setting annual regulations that define catch levels and allocations based on year specific circumstances (PFMC 2016). The current FMP requires that the PFMC manage fisheries consistent with NMFS' ESA-related consultation standards or recovery plans to meet the immediate needs for conservation and long-term recovery for all ESA listed species (PFMC 2016). These standards are either reasonable and prudent alternatives described in jeopardy biological opinions on the fishery, or are management standards or frameworks developed by the Council and approved by NMFS having been determined through an ESA section 7 consultation to be not likely to jeopardize the listed species in question. Annually at the beginning of the pre-season planning process, NMFS provides guidance on how to apply the various standards given abundance projections for the coming season. The 2018 guidance letter provides a recent example (NMFS 2018g). The PFMC then uses this guidance, and other conservation and allocation objectives for planning fisheries that are then recommended to NMFS for approval. While the PST Agreements have served as ceilings for management of Chinook salmon fisheries in the EEZ off the West Coast, in practical terms these fisheries are structured to avoid exceeding limits based on domestic law, particularly the ESA, as numerous ESA-listed Chinook salmon are impacted by the fisheries. This management has resulted in fisheries with lower impacts to Chinook salmon than would otherwise be allowed under the PST Agreements.

NMFS has previously considered the effects of PFMC salmon fisheries on ESA-listed species under its jurisdiction for ESA compliance through completion of biological opinions (NMFS 1996; 2001b; 2004; 2012b). These opinions are still in effect and address harvest effects to species that are affected by the proposed action considered in this opinion (see Table 1 for the species list). As a result of these previous consultations, the effects of PFMC fisheries for all of the currently ESA-listed salmon and steelhead species are covered by long term biological opinions. A more complete description of the consultation history for PFMC fisheries and the status of the currently applicable biological opinions can be found in the recent opinion that considered the effects of fishing to LCR coho salmon (NMFS 2015a).

Current opinions for some of the listed salmon species describe the extent of take resulting from implementation of harvest limits that are inclusive and overlap management jurisdictions. For the purposes of this consultation on SEAK fisheries, PFMC salmon fisheries are considered part of the baseline. We review the baseline effects of these fisheries by affected Chinook Salmon ESUs.

LCR Chinook Salmon ESU
As discussed in section 2.4.1.1, the LCR Chinook ESU has three components including spring, tule, and far-north migrating bright stocks. These stocks have different distributions and are subject to different harvest impacts. As discussed above, relative to the LCR Chinook ESU, PFMC salmon fisheries have been managed since 2012 using an abundance based management plan framework on the tule component. The plan specifies a total ER that may vary from year-to-year between 30 and 41 percent depending on a particular run size indicator. PFMC fisheries are managed such that all marine area salmon fisheries and inriver fisheries below Bonneville Dam stay within this total ER. NMFS reviewed the proposed management framework in 2012 and concluded that it would not jeopardize LCR Chinook salmon (NMFS 2012b).

Once catch limits for the northern fisheries are set as described in section 1.3, southern U.S. fisheries in the PFMC areas and Columbia River are adjusted so as not to exceed the year specific total ER limit. The necessary coordination occurs through the PFMC preseason process. In 2018, for example, the total ER limit for LCR tule Chinook salmon was 38 percent. At the end of the planning process, the projected total ER from all salmon fisheries on LCR tules was 37.7 percent (PFMC 2018a).

The ER on LCR spring Chinook salmon populations in PFMC fisheries averaged 10.0 percent exploitation from 1999 to 2014 (Table 33), accounting for 53.1 percent of the marine area exploitation (Figure 26).

The ER on LCR tule populations in PFMC fisheries has averaged 13.4 percent (Table 33) and accounted for 40.6 percent of the total exploitation on LCR tule Chinook salmon (Figure 28).

The ER on LCR bright populations averaged 17.3 percent in PFMC fisheries between 2005 and 2014 (Table 33) and accounted for 34.1 percent of the marine area exploitation (Figure 30).

Upper Willamette Spring Chinook Salmon ESU
UWR Chinook salmon are a far-north migrating stock. The marine area harvest occurs primarily in the Alaskan and northern Canadian fisheries, as reviewed above. Because of their northerly distribution and earlier return timing, the ER on UWR chinook in PFMC fisheries is low, averaging 2.1 percent between 1999 and 2014 (Table 34) and accounting for 21.0 percent of the marine area exploitation (Figure 32).

Snake River Fall-run Chinook Salmon ESU
As discussed in section 2.4.1.1, Snake River fall-run Chinook salmon are managed subject to an ER limit that applies to all marine area fisheries to a 30 percent reduction standard relative to the 1988 to 1993 base period. Because of their distribution and timing more of the marine area impacts to Snake River fall chinook occur in PFMC fisheries. From 1999 to 2014 ERs on Snake River fall-run Chinook salmon in PFMC fisheries averaged 25.1 percent (Table 35) and accounted for 64.7 percent of the overall marine area harvest (Figure 35).

Puget Sound Chinook Salmon ESU
The framework for managing fisheries affecting Puget Sound Chinook salmon is described in section 2.4.1.1. As discussed in Section 2.2.2.1 there are 22 Puget Sound Chinook salmon populations that are aggregated for management purposes into 14 management units. The populations have distinct migration patterns that affect where harvest impacts occur and the relative magnitude of harvest impacts. PFMC fisheries are managed for harvest limits specific to each management unit, and these vary considerably depending on the status of each unit. They are generally expressed as total ERs or southern U.S. ER limits. Since the expiration of the 2010 management plan developed by the Puget Sound treaty tribes and State of Washington (co-managers) in 2014 and approved by NMFS under the ESA 4(d) rule for salmon and steelhead, population-specific impact limits have been developed on an annual basis. The management objectives used in recent years are described in the biological opinion on the proposed Puget Sound fisheries for the 2018 and pre-May 2019 fishing season (NMFS 2018b). The Puget Sound co-managers are currently working on a new long-term RMP that will have new conservation objectives with the expectation that it can be completed and reviewed in time for implementation during the 2020/21 season.

The magnitude and distribution of harvest impacts to Puget Sound Chinook salmon varies by stock. Between 1999 and 2014 ERs on Puget Sound populations in PFMC fisheries ranged from 0.8 percent to 6.3 percent and, except for Mid-Hood Canal River populations, accounted for between 2.8 and 15.4 percent of each stock's total ER (Table 38).

2.4.3.2 PFMC Groundfish Fisheries

PFMC groundfish fisheries historically catch Chinook salmon as bycatch while conducting fisheries pursuant to the Pacific Coast Groundfish FMP. Chinook salmon bycatch in the groundfish fishery ranged from 3,068 to 15,319 from 2008 to 2015 and averaged 6,806 (NMFS

2017g). Bycatch consists of primarily subadult Chinook salmon taken annually in the groundfish fisheries.

NMFS concluded in previous opinions on PFMC groundfish fishery implementation that the effects on ESA-listed Chinook salmon ESUs most likely to be subject to measurable impacts (Snake River fall-run Chinook, LCR Chinook, and UWR Chinook salmon) were very low (NMFS 2017g).

However, limited monitoring and low Chinook salmon 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% per year" to "less than 1% per year," depending on the ESU or populations being considered (NMFS 1999a; 2006a). The most recent opinion issued in 2017 considers more information regarding the stock composition of the Chinook salmon bycatch, which was determined using samples taken from 2009 to 2014 from the at-sea and shore side sectors of the whiting fishery (NMFS 2017g). Bycatch in other sectors has been very low, with insufficient samples for either genetic or CWT-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 sector were from unlisted ESUs. They contributed, on average, Klamath/Trinity Chinook (28%) followed by south Oregon/north California (25%), Oregon Coast (10%), and northern British Columbia (11%) Chinook salmon (NMFS 2017g). Samples from Chinook salmon bycatch in the shore side whiting sector showed a contribution from Central Valley Chinook (13%), similar to the Oregon Coast and very low contribution from British Columbia Chinook salmon (NMFS 2017g). The remainder of stocks which included contributions from listed ESUs contributed 5% or less of the Chinook salmon bycatch in either fleet on average. In general, the shore side fishery is focused closer to shore. It does not extend as far south as the at- sea fishery (NMFS 2017g).

The results demonstrate a strong regional pattern in contribution of Chinook salmon ESUs, with a greater proportion of southern Chinook salmon ESUs as bycatch when the fleets move south along the coast and similar patterns in the distribution of those salmon between the at-sea and shore side fleets. Samples from years when fisheries had more southerly distribution include more southern ESUs and vice versa. Moreover, some ESUs 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). Catches further north included Columbia River and increasing percentages of Puget Sound and Fraser River Chinook salmon.

These low contribution rates to bycatch from the listed Chinook salmon ESUs (i.e., 5% or less) are consistent with the previous qualitative characterizations of likely bycatch levels described by NMFS in its most recent opinion on PFMC's groundfish fisheries (NMFS 2017g). 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 2017g).

Table 39. Bycatch of Chinook salmon in the Pacific Coast Groundfish Fisheries, 2008 to 2015

(NMFS 2017g).

Fishery	Species	2008	2009	2010	2011	2012	2013	2014	2015
At-Sea whiting	Chinook	718	318	714	3,989	4,209	3,739	6,695	1,806
Shorebased whiting	Chinook	1,962	279	2,997	3,722	2,359	1,263	6,898	2,002
Tribal-whiting[18]	Chinook	696	2,145	678	828	17	1,014	45	3
Bottom trawl	Chinook	449	304	282	175	304	323	984	996
Midwater non-whiting	Chinook	n/a	n/a	n/a	n/a	12	71	661	482
Non-trawl gear[19]	Chinook	0	22	16	8	63	124	36	40
Total	**Chinook**	**3,825**	**3,068**	**4,687**	**8,722**	**6,964**	**6,534**	**15,319**	**5,329**

2.4.3.3 Puget Sound Salmon Fisheries

LCR Chinook, UWR Chinook, and Snake River fall-run Chinook salmon are caught in Puget Sound fisheries on occasion, but the ERs in these fisheries on these ESUs are just fractions of 1 percent (Table 33, Table 34, and Table 35).

The effects of Puget Sound fisheries on Puget Sound stocks are of course higher. In 2004 the state and Tribal fishery co-managers began managing Chinook mortality in Puget Sound salmon and Tribal steelhead net fisheries to meet the conservation and allocation objectives described in the jointly-developed 2004-2009 Puget Sound Chinook Harvest Resource Management Plan (RMP), which expired April 30, 2010 (PSTT and WDFW 2004). NMFS evaluated the 2004-2009 Puget Sound Chinook Harvest RMP and found that it met the requirements of Limit 6 of the ESA 4(d) Rule and that fisheries managed consistent with the terms of the RMP would not jeopardize the survival and recovery of the ESU (NMFS 2005b).Since 2010, the state and Tribal fishery co-managers managed Chinook salmon mortality in Puget Sound salmon and Tribal steelhead fisheries to meet the conservation and allocation objectives described in the jointly-developed 2010-2014 Puget Sound Chinook Harvest RMP (PSIT and WDFW 2010; NMFS 2011a), and as amended in 2014 (Grayum and Anderson 2014; Redhorse 2014), 2015 and 2016 (Grayum and Unsworth 2015; Shaw 2015; 2016)}. The 2010-2014 Puget Sound Chinook Harvest RMP was adopted as the harvest component of the Puget Sound Salmon Recovery Plan which includes the Puget Sound Chinook ESU (NMFS 2011a). Provisions of the RMP used for the 2018/19 season are described in section 2.4.1.1. A new long-term RMP is under development and will be subject to ESA review once it is complete.

[18] Includes only the Pacific whiting fishery. Tribal non-whiting fishery values were not available.
[19] Includes bycatch by vessels fishing under Exempted Fishing Permits (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.

Recent year ERs in Puget Sound fisheries ranged from 2.2 percent to 48.6 percent since 1999 depending on stock (Table 35). Not surprisingly, a higher proportion of the overall harvest impact occurs in Puget Sound fisheries than in SEAK fisheries for stocks from the south and mid-Sound areas (Table 37).

2.4.3.4 Other Puget Sound Fisheries

Halibut Fisheries

Commercial and recreational halibut fisheries occur in the Strait of Juan de Fuca and San Juan Island areas of Puget Sound. 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 2018d). The total estimated non-retention mortality of Chinook salmon in Puget Sound recreational halibut fisheries is extremely low, averaging just under two Chinook salmon per year. Of these, the estimated catch of listed fish (hatchery and wild) is between one and two Puget Sound Chinook per year. Given the very low level of impacts and the fact that the fishery occurs in mixed stock areas, different populations within the ESUs are likely affected each year.

Puget Sound bottomfish and shrimp trawl fisheries

Recreational fishers targeting bottom fish and the shrimp trawl fishery in Puget Sound can incidentally catch listed Puget Sound Chinook. In 2012 NMFS issued an incidental take permit to the WDFW for listed species caught in these two fisheries, including Puget Sound Chinook salmon (NMFS 2012a). The permit was in effect for 5 years and authorized the total incidental take of up to 92 Puget Sound Chinook salmon annually. Some of these fish would be released. Some released fish were expected to survive; thus, of the total takes, we authorized a subset of lethal take of up to 50 Chinook salmon annually. As of 2018 this permit has not been renewed. WDFW has applied for a permit allowing incidental take of 137 Chinook salmon annually in the coming years.

2.4.4 Puget Sound freshwater areas

Components of the third proposed action, federally funded hatchery production and habitat restoration aimed at improving the status of four Puget Sound Chinook salmon populations, would occur in freshwater areas where the conservation hatchery and habitat restoration activities are proposed, specifically in the four watersheds occupied by these populations. NMFS has convened recovery planning efforts across Pacific Northwest to identify what actions are needed to recover listed salmon. A recovery plan for the Puget Sound Chinook ESU was completed in 2007. This plan is made up of two documents: a locally developed recovery plan and a NMFS-developed supplement (Puget Sound Salmon Recovery Plan (SSPS 2005b) and Final Supplement to the Shared Strategy's Puget Sound Salmon Recovery Plan (NMFS 2006b)). Use of the funds for conservation of the four Chinook populations is intended to be consistent with the recovery plan for Puget Sound Chinook salmon.

Hatcheries

Hatchery supplementation programs implemented as conservation measures to recover returning Chinook salmon currently operate in the Dungeness (NMFS 2016i), North and South Fork Nooksack rivers, and the North and South Fork Stillaguamish Rivers (NMFS 2018b). A Chinook salmon supplementation program in the Hamma Hamma River operated for 20 years but ceased in 2015. Table 40 lists the programs considered in the baseline.

Table 40. Conservation Chinook salmon programs funded through prior mitigation initiatives of the PST.

Species	Program	Operational Dates	Location	Release Number/Life Stage*
Chinook Salmon	Hamma Hamma Supplementation	1995-2015	Hamma Hamma River	110,000 fall sub-yrs
	Dungeness Spring Chinook	current	Dungeness River	150,000 sub-yrs 50,000 yrs
	Nooksack Native Chinook Restoration Program	current	North Fork and South Fork Nooksack	750,000 sub-yrs
	Stillaguamish Chinook	current	Stillaguamish River	220,000 summer sub-yrs 200,000 fall sub-yrs

* sub-yrs = subyearlings, and yrs = yearlings

Hatcheries can provide benefits 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 the Northwest tribes. 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 and steelhead. These factors are:

(1) the hatchery program 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 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 juvenile rearing areas,
(4) hatchery fish and the progeny of naturally spawning hatchery fish in the 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, and
(7) fisheries that exist because of the hatchery program, including terminal fisheries intended to reduce the escapement of hatchery-origin fish to spawning grounds.

Beginning in the 1990s, state and tribal co-managers took steps to reduce risks identified for Puget Sound hatchery programs as better information became available (PSTT and WDFW 2004), in response to reviews of hatchery programs (e.g., Currens and Busack 1995; HSRG 2002), and as part of the region-wide Puget Sound salmon recovery planning effort (SSPS 2005b). 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 maintain natural populations. Hatchery programs in the Pacific Northwest 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 with changes proposed to ensure that existing natural salmonid populations are preserved, and that hatchery-induced genetic and ecological effects on natural populations are minimized.

The hatchery programs in the baseline associated with the funding initiative incorporate natural-origin Chinook salmon as broodstock for supportive breeding (conservation) 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 is intended to reduce genetic diversity reduction risks by producing fish that are no more than moderately diverged from the associated, donor natural population. To allow monitoring and evaluation of the performance and effects of programs incorporating natural-origin fish as broodstock, all juvenile fish are marked prior to release with CWTs or with a clipped adipose fin so that they can be differentiated and accounted for separately from juvenile and returning adult natural-origin fish.

Habitat

Human activities have degraded extensive areas of salmon spawning and rearing habitat in Puget Sound. Most devastating to the long term viability of salmon has been the modification of the fundamental natural processes which allowed habitat to form and recover from disturbances such as floods, landslides, and droughts. Among the physical and chemical processes basic to habitat formation and salmon persistence are floods and droughts, sediment transport, heat and light, nutrient cycling, water chemistry, woody debris recruitment and floodplain structure (SSPS 2005b).

Development activities have limited access to historical spawning grounds and altered downstream flow and thermal conditions. Watershed development and associated urbanization throughout the Puget Sound, Hood Canal, and Strait of Juan de Fuca regions have resulted in direct loss of riparian vegetation and soils, significantly altered hydrologic and erosion rates and processes by creating impermeable surfaces (roads, buildings, parking lots, sidewalks etc.), and polluting waterways, raised water temperatures, decreased large woody debris recruitment, decreased gravel recruitment, reduced river pools and spawning areas, and dredged and filled estuarine rearing areas (Bishop and Morgan 1996). Hardening of nearshore bank areas with riprap or other material has altered marine shorelines; changing sediment transport patterns and reducing important juvenile habitat (SSPS 2005b). The development of land for agricultural purposes has resulted in reductions in river braiding, sinuosity, and side channels through the construction of dikes, hardening of banks with riprap, and channelization of the river main stems (SSPS 2005a; 2005b). Poor forest practices in upper watersheds have resulted in bank destabilization, excessive sedimentation and removal of riparian and other shade vegetation important for water quality, temperature regulation and other aspects of salmon rearing and spawning habitat (SSPS 2005b). While regulatory requirements and other initiatives are reducing the impacts to salmon habitat of many of these activities, population growth and continued development have continued to have negative effects on salmon habitat.

<u>Scientific Research</u>
Puget Sound salmon are also the subject of scientific research and monitoring activities. Biological opinions issued by NMFS 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 is currently provided coverage under Section 7 of the ESA or the 4(d) research Limit 7 (NMFS 2018b). For the year 2012 and beyond, NMFS has issued several section 10(a)(1)(A) scientific research permits allowing lethal and non-lethal take of listed species. In a separate process, NMFS also has completed the review of the state and tribal scientific salmon and research programs under ESA section 4(d) Limit 7 (NMFS 2018b).

2.4.5 Southern Resident Killer Whales (SRKW)

All of the categories of human activities have contributed to the current status of SRKW within the action area. The following discussion summarizes the principal human and natural factors within the action area (other than the proposed action) that are known to affect the likelihood that SRKW will survive and recover in the wild, and the likelihood that their critical habitat will function to support their recovery.

Mortality

Seasonal mortality rates of SRKW are believed to be highest during the winter and early spring, based on the numbers of animals missing from pods returning to inland waters each spring. Additionally, Olesiuk et al. (2005) identified high neonate mortality that occurred outside of the summer field research seasons, and multiple new calves have been documented in winter months that have not survived to the following summer season (CWR unpublished data).

Stranding rates are higher in winter and spring for all killer whale forms in Washington and Oregon (Norman et al. 2004). Southern Resident strandings in coastal waters offshore include five separate events (1995 and 1996 off of Northern Vancouver Island and the Queen Charlotte Islands, 2002 and 2012 offshore of Long Beach, WA, and 2016 on the west side of Vancouver Island). The causes of death are unknown for three of these events, while the fourth and fifth were determined to be blunt force trauma and infection, respectively (NMFS 2008g; 2016n). Sighting reports indicate anecdotal evidence of thin killer whales returning to inland waters in the spring, possibly due to greater nutritional demands in winter when prey is more widely dispersed (Wasser et al. 2017). For example, J pod was determined to be in worse condition in May compared to September, in both 2016 and 2017 (Trites and Rosen 2018).

Aerial photogrammetry was used to assess changes in 44 individual SRKW body conditions in 2008 and 2013. Eleven of these individuals were found to have significant declines in body condition, while five showed significant increases. Two of the whales with significant declines died prior to the next summer census, and one died shortly after being photographed (Fearnbach et al. 2018).

The official 2018 census for SRKW was 75 whales (annually conducted and reported by The Center for Whale Research, down from 77 whales in 2017). However, the death of J50 in September 2018 brings the current population down to 74 whales. Between July 1, 2016 and July

1, 2017, six SRKWs died and none were born alive (CWR Census 2017). Of these six, five were from J pod and one was from K pod. Four were females and two were males, including one calf.

Two of these six mortalities were from an age classes that usually have low mortality rates. Death of calves is not unusual and in recent years, reproductive rates of Southern Residents have been found to be significantly lower than those of Northern Residents or Alaska Residents (Ward et al. 2013). However, the death of calf J54 (at an age of 10 months) was most likely due to the death of his mother, J28, as he was still nursing at the time of her death (CWR website). Three of the mortalities in 2016/2017 were old females (J2, J14, and K13; 105, 42, and 45 years old, respectively), and one was a sub-adult male (J34, 18 years old). Mortality in post-reproductive females is not surprising. However, mortality is less common amongst reproductive females such as J28 and sub-adult males. Among resident killer whales, Olesiuk et al. (2005) found an estimated mortality rate of between 0.34 to 0.37% for females 20-40 years old, and 1.1% for males 15.5-19.5 years old.

Human Related Activities

Prey Availability

Chinook salmon are the primary prey of SRKW throughout their geographic range, which includes the action area (see further discussion in Section 2.2.3.1, Status of the Species). The availability of Chinook salmon to Southern Residents is affected by a number of natural and human actions. The most notable human activities that cause adverse effects include land use activities that result in habitat loss and degradation, hatchery practices, harvest and hydropower systems. Details regarding baseline conditions of Chinook salmon in inland and coastal waters that are listed under the Endangered Species Act are described above in Sections 2.4.1.- 2.4.4.

The baseline also includes Chinook salmon that are not ESA-listed. In addition, climate effects from Pacific decadal oscillation and the El Nino/Southern oscillation conditions and events cause changes in ocean productivity which can affect natural mortality of salmon. Predation in the ocean also contributes to natural mortality of salmon. Salmonids are prey for pelagic fishes, birds, and marine mammals (including SRKW).

Here we provide a review of SRKW determinations in previous ESA Section 7(a)(2) consultations where effects occurred in the action area, and where effects resulted in a significant reduction in available prey (i.e., where prey reduction was likely to adversely affect or jeopardize the continued existence of the whales). We also consider activities that have impacts in the action area, and are out of our jurisdiction for Section 7(a)(2) consultation, but nonetheless significantly reduce available prey. We then assess the remaining prey available to SRKW in light of this environmental baseline.

Habitat-altering activities such as agriculture, forestry, marine construction, levy maintenance, shoreline armoring, dredging, hydropower operations and new development can reduce prey available to Southern Residents. Many of these activities have a federal nexus and have undergone section 7 consultation. Those actions have all met the standard of not jeopardizing the continued existence of the listed salmonids or adversely modifying their critical habitat, or if they did not meet that standard, NMFS identified reasonable and prudent alternatives. In addition, the environmental baseline is influenced by many actions that pre-date the salmonid listings and that have substantially degraded salmon habitat and lowered natural production of ESA-listed Chinook salmon. In fact, Chinook salmon currently available to the whales are still below their pre-ESA listing levels, largely due to these past activities that pre-date the salmon listings. Since the Southern Residents were listed, federal agencies have also consulted on impacts to the whales, including impacts to available prey. In 2014, NMFS finalized its biological opinion on the operation and maintenance of the Mud Mountain Dam project (NMFS 2014c). These opinions concluded that the proposed actions would jeopardize the continued existence of Puget Sound Chinook salmon, Puget Sound steelhead, and SRKW and would adversely modify or destroy their designated critical habitats. We have also previously consulted on the effects of flood insurance on Southern Residents. NMFS' biological opinion on the National Flood Insurance Program in Washington State-Puget Sound region concluded that the action was likely to jeopardize the continued existence of the Puget Sound Chinook salmon ESU, and that the potential extinction of this ESU in the long-term jeopardized the continued existence of Southern Residents (NMFS 2008g). For these consultations, RPAs were identified in order to avoid jeopardy and not adversely modify or destroy designated critical habitat (NMFS 2008g; 2014c).

In 2017, NMFS' continued funding of Mitchell Act hatchery programs was analyzed under the ESA and was found to not likely to jeopardize the continued existence of any species in the Columbia Basin or SRKW (NMFS 2017e). The Mitchell Act Record of Decision directs NMFS to apply stronger performance goals to all Mitchell Act-funded, Columbia River Basin hatchery programs that affect ESA-listed primary and contributing salmon and steelhead populations. Funding of Mitchell Act hatchery programs will continue to benefit Southern Residents by producing a priority prey (the Tule fall Chinook are currently considered a priority prey stock for the whales; (NOAA and WDFW 2018). However, the proposed action included reductions in total hatchery releases, which will adversely affect SRKW in the short term. NMFS anticipates that in the long term, the action will be beneficial as its purpose is to improve the status of listed Chinook (NMFS 2017e).

In past harvest consultations including Puget Sound salmon fisheries (NMFS 2011a; 2014b; 2015b; 2016h; 2017b; 2018b), Pacific Coast Salmon Plan fisheries (NMFS 2008a), the *U.S. v. Oregon* Management Agreements (NMFS 2008e; 2018a), and the Pacific Salmon Treaty 2009 Agreement (NMFS 2008d), we characterized the short-term and long-term effects on Southern Residents from prey reduction caused by harvest. We considered the short-term direct effects to whales resulting from reductions in Chinook salmon abundance that occur during a specified year, and the long-term indirect effects to whales that could result if harvest affected viability of the salmon stock over time by decreasing the number of fish that escape to spawn. These past analyses suggested that in the short term, prey reductions were small relative to remaining prey available to the whales. In the long term, harvest actions have met the conservation objectives of harvested stocks, were not likely to appreciably reduce the survival or recovery of listed Chinook salmon, and were therefore not likely to jeopardize the continued existence of listed Chinook salmon. The harvest biological opinions referenced above concluded that the harvest actions cause prey reductions in a given year, and were likely to adversely affect but were not likely to jeopardize the continued existence of ESA-listed Chinook salmon. With the exception of *U.S. v.*

Oregon, the harvest biological opinions referenced above also conclude that the harvest actions were likely to adversely affect but were not likely to jeopardize the continued existence of SRKW. *U.S. v. Oregon* action was not likely to adversely affect Southern Residents because hatchery production offset the in-river harvest reductions, Columbia River salmon stocks are currently managed in line with recovery planning, the status of several stocks and ESUs have improved under the fishing regime, and hatchery programs are managed in ways to minimize effects to listed species. Similarly, the FCRPS action was not likely to adversely affect Southern Residents because part of the action included a significant production of hatchery Chinook salmon that more than offset Chinook salmon mortality (NMFS 2008f).

Assessing Baseline Prey Availability

We assessed Chinook availability in the action area by using a similar retrospective FRAM based analysis to that used in previous fisheries consultations listed above. Similar to the 2018 Puget Sound Chinook fisheries consultation (NMFS 2018b), we incorporated new FRAM base data along with new information available on the diet of SRKW (see Status of the Species section) and updated bioenergetics needs (based on updates to the population size and age- and sex-structure). The Chinook salmon abundances and kcal values estimated using the new FRAM base period (2007-2013) yielded different estimates than for the earlier fisheries consultations (prior to 2018) and thus cannot be directly compared. These differences are primarily due to updates to growth functions and maturation rates that occurred as part of the FRAM base period update. Here, we briefly describe the method developed to estimate the food energy of Chinook available, and provide recent updates to this methodology. For a more detailed description of the FRAM based analysis, refer to (NMFS 2011b).

FRAM provides year-specific ocean abundance estimates for most Chinook salmon stocks from the Sacramento River to central British Columbia including stocks from the Lower Columbia River, Upper Willamette River, Snake River, and Puget Sound ESUs. Chinook fisheries covered in FRAM extend from central California to Southeast Alaska (including inland waters of Washington and British Columbia). All Chinook stocks in FRAM travel through the range of SRKW. FRAM includes nearly all listed (with the exception of Sacramento winter Chinook and California coastal Chinook salmon) and non-listed Chinook stocks within the whales' range (with the exception of Klamath, Rogue and other central-southern Oregon Coastal Chinook and Grays Harbor Chinook salmon).

FRAM is a single-pool model and does not have spatial distribution of the stocks represented in it. However, the stock-specific catch by area during a period of less restricted open seasons, combined with escapement, can be used to estimate the distribution of each stock and allocate abundances into three regions: (1) waters of northern British Columbia and SEAK that are outside the range of Southern Residents, (2) coastal waters within their range from central British Columbia southward, and (3) inland waters including the Strait of Juan de Fuca, Puget Sound, Johnstone Strait and Georgia Strait (see detailed description in NMFS (2011b). For each stock, we calculate a set of three parameters: the proportion of abundance that occurs outside the range of Southern Residents, the proportion that occurs in coastal waters, and the proportion that occurs in inland waters. To generate these parameters, we use the distribution of fishery catch and escapement for each stock. We multiply the total age 3+ abundance (cohort size) of each stock by its respective inland or coastal distribution parameter, then sum up all stocks to estimate total prey availability for inland and coastal regions. The abundance estimates are specific to time periods in FRAM for an annual cycle: October to April, May to June, and July to September. For each FRAM time period, the model produces three sets of stock and age specific cohort abundances: one initial cohort prior to any mortality, one after natural mortality that occurs within the time period, and one after both natural and fishery mortality that occur within the time period. For this analysis we create an alternative cohort to be used, one where fishery mortality is removed but natural mortality remains included in the abundance. These stock specific abundances are apportioned into coastal and inland waters using the distributions identified above, then summed over all stocks for fish that are age three or older to give total prey availability estimates in coastal and inland waters. Additional updates to methods for estimating FRAM based abundance of Chinook salmon prey and energy (compared to those in NMFS (2011b)) include removing the size selectivity function, assigning equal probability to all 3 – 5 year old Chinook salmon as available prey, and varying the kilocalories based on the lipid content of specific stocks by size and age (data from O'Neill et al. (2014)). We incorporated the best available science to characterize the bioenergetics needs of the whales and their diet.

Using the updated FRAM and whale information we conducted a retrospective analysis to evaluate how fisheries have affected the prey available to the whales. This analysis involved comparing a series of "no fishing" scenarios to the FRAM validation runs, described below as Scenario 1 in Section 2.5.1. This provides baseline information on what prey was available in past years and how fisheries reduced prey in different seasons and different locations (i.e. coastal and inland waters; Table 41). It is important to note when interpreting percent reductions that, based on the way scenarios were modeled, the reductions are cumulative across time periods, meaning that a percent reduction reported for the May-June time period includes fishery reductions that occurred in both the October-April and May-June time periods. Based on this FRAM retrospective analysis, Canadian fisheries reduced the prey availability in coastal waters by up to 14.6%. In inland waters, Canadian fisheries reduced prey availability by up to 13.5%. U.S. fisheries, reduced prey available in coastal waters by up to 26.2% and up to 13.1% in inland waters. SEAK fisheries reduced prey by up to 15.1% (between July – September) in coastal waters and up to 2.9% in inland waters.

Table 41. Range in percent reductions that occurred from Canadian and U.S. fisheries in coastal and inland waters from 1999-2014. Note: the range for SEAK, PFMC and Puget Sound do not add up to equal the U.S. range because the highest and lowest values do not occur in the same years.

Fisheries	Region	October-April	May-June	July-September
Canadian	Coastal	0.0%-1.7%	1.0%-5.0%	3.7%-14.6%
	Inland	0.1%-3.0%	1.8%-6.2%	7.5%-13.5%
U.S.	Coastal	0.6%-2.8%	3.0%-10.1%	8.6%-26.2%
	Inland	0.7%-1.8%	2.5%-4.7%	7.8%-13.1%
SEAK	Coastal	0.2%-1.2%	0.8%-3.9%	2.7%-15.1%
	Inland	0.2%-0.7%	0.5%-1.5%	1.2%-2.9%
PFMC	Coastal	0.0%-2.2%	0.7%-9.0%	1.7%-21.7%
	Inland	0.0%-0.1%	0.8%-2.3%	1.3%-4.4%

Fisheries	Region	October-April	May-June	July-September
Puget Sound	Coastal	0.0%-0.2%	0.1%-0.3%	0.3%-1.1%
	Inland	0.4%-1.3%	0.5%-1.7%	4.1%-9.3%

In general, the largest reductions in prey availability from the Canadian and U.S. fisheries occurred in coastal and inland waters from May through September; reductions were relatively smaller in October through April (Table 41). The largest impacts on prey availability from the SEAK fisheries occurred in coastal waters from May to September and to a lesser degree in inland waters throughout the year. Similarly the PFMC fisheries had the largest impacts on prey availability in coastal waters in the spring and summer compared to in inland waters. The largest impacts on prey availability from the Puget Sound fisheries occurred in inland waters in July through September.

We also compared the "Likely" scenario described below as Scenario 2 in Section 2.5.1 with a version of the "Likely" scenario without the SEAK fisheries to evaluate how baseline fisheries (i.e. Canadian and U.S. fisheries except the SEAK fisheries) affect prey available to the whales moving forward under the 2019 Agreement levels. We name this new scenario without the SEAK fisheries as the "No SEAK fisheries" scenario. In general, the Likely scenario represents what we can reasonably expect to occur under both the 2019 Agreement and other likely domestic constraints but without the proposed action of delegation and funding for the SEAK fisheries. Based on the FRAM retrospective analysis for 1999-2014, Canadian fisheries would reduce the prey availability in coastal waters less than under the 2009 Agreement ranging from 0.1% - 1.3% during October – April, 1.3% - 4.2% during May – June, and 3.4% - 13.2% during July – September (Table 42). The PFMC fisheries would reduce prey available to the whales substantially in coastal waters during July - September (4.8% - 14.8%) and minimally in October - April (less than 1%; Table 42). In May - June, the PFMC fisheries would have the greatest impact on prey availability in coastal waters compared to impacts from the Canadian fisheries and Puget Sound fisheries. Puget Sound fisheries would reduce prey in coastal waters by less than 1% in all FRAM time steps.

In inland waters, Canadian fisheries would reduce prey availability substantially in July – September (6.8% - 12.9%, whereas in October - April they would reduce prey availability by less than 2% (Table 42). In May - June, Canadian fisheries would have a greater impact on prey reductions in inland waters than the Puget Sound fisheries or PFMC fisheries do. PFMC fisheries did not reduce the prey availability in inland waters in October – April, but reduced prey available by 1.4% - 1.7% in May – June, and 2.3% - 3.0% in July – September. Puget Sound fisheries would have the greatest impact to prey availability in inland waters during July - September when the whales most often occur (reducing prey by up to 8.1%).

Table 42. Range in percent reductions from baseline fisheries in coastal and inland waters (i.e. does not include the proposed SEAK fisheries) expected under the 2019 Agreement and other likely domestic constraints.

Fisheries	Region	October-April	May-June	July-September
Canadian	Coastal	0.1%-1.3%	1.3%-4.2%	3.4%-13.2%
	Inland	0.2%-1.7%	2.3%-5.4%	6.8%-12.9%

Fisheries	Region	October-April	May-June	July-September
PFMC	Coastal	0.2%-0.5%	1.9%-4.9%	4.8%-14.8%
	Inland	0.0%-0.0%	1.4%-1.7%	2.3%-3.0%
Puget Sound	Coastal	0.0%-0.1%	0.0%-0.2%	0.2%-0.7%
	Inland	0.4%-0.6%	0.1%-0.8%	3.9%-8.1%

The NWFSC has continued to collect prey samples from Southern Residents while they are in inland waters of Washington and British Columbia (Hanson et al. 2010; Ford et al. 2016a). Based on the new data, we have updated our estimates of the average proportion of Chinook salmon in the whales' inland diet for each FRAM season: (1) 55 percent from October to April, (2) 97 percent from May to June, and (3) 71 percent from July to September. Because the whales' diet is not exclusively Chinook salmon and varies by season, we incorporate these proportions in our prey energy requirements for inland and coastal waters (described further below).

Metabolic Needs. Noren (2011) developed estimates of the potential range of daily energy expenditure and prey energy requirements for SRKW for all ages and both sexes. The range in the daily prey energy requirements (DPERs) for Southern Residents took digestive efficiency into account, and was calculated from body mass according to these equations:

$$\text{Lower Bound DPER} = 413.2M_b^{0.75}$$
$$\text{Higher Bound DPER} = 495.9M_b^{0.75}$$

where DPER is in kcal per day and M_b is body mass in kg.

Using these equations with body mass estimates, the maximum prey energy requirements for female killer whales range between 49,657 (age 1) and 217,775 (ages 20+) kcal per day. For male killer whales, the maximum prey energy requirements range between 49,657 (age 1) and 269,458 (ages 20+) kcal per day. The prey energy requirements for the increased cost of body growth in juvenile whales and the increased cost of lactation in females who are nursing are currently unknown. Until these increases in prey energy requirements can be quantified, Noren (2011) recommends using the maximum DPER estimates. Similar to the previous analyses described in our 2018 Puget Sound chinook harvest biological opinion (NMFS 2018b), we combined the sex and age specific maximum daily prey energy requirement information with the population census data to estimate daily energetic requirements for all members of the Southern Resident population, based on the population size in July 2018 (75 whales).

Because we are able to estimate the prey energy requirements for all members of the population each day, we can estimate the prey energy requirements for the entire year, for specific seasons, and/or for geographic areas (inland waters and coastal waters). To estimate prey requirements when the whales are in inland waters, we averaged the number of SRKW sightings by number of days per pod per month and incorporated this seasonal occurrence into the prey energy requirements for inland waters. We used the SRKW sightings data specific to each pod from January 2003 to December 2017. Lastly, we multiplied the daily energy requirements of each pod by the average number of days that the pod was in inland waters for each FRAM time period (Oct-April; May-June; July-Sept). This provided monthly estimates of the energy required by pod and averaged estimates of energy required by FRAM time periods (Table 43). Similar methods were used to estimate the prey energy requirements for Southern Residents in coastal waters. For purposes of this analysis, we assumed that Southern Residents occurred west of the Strait of Juan de Fuca (in coastal waters) on days they were not sighted in inland waters, primarily because the population is highly visible in inland waters (Table 43). However, there have been sightings of SRKW in Canadian inland waters, such as the Strait of Georgia, so the inland estimates may overestimate inland prey needs. The same is true for coastal sightings and needs.

Table 43. Maximum DPERs in kcals for the SRKW population of 75 individuals using the average number of days in inland and coastal waters for the three FRAM time periods.

Time Period	Average Inland Max DPER	Average Coastal Max DPER
Oct-April	660,674,216	2,478,144,033
May-June	408,831,076	494,319,458
July-Sept	985,638,061	376,490,613

We summed the energy requirements across pods by time periods (shown in Table 43 above) and multiplied by the percent of Chinook in the inland diet for each time period (55% for October – April; 97% for May – June; 71% for July to September) and for coastal diet (an average of 77% for all time periods). With this approach, we are assuming that the whales' diet and needs in the past are representative of what they need in the future (i.e., does not account for potential differences in population abundance and sex / age structure over time, potential differences in time spent in inland vs. coastal waters, changes in diet composition, etc.). The DPER values by time period and coastal/inland waters were used as inputs into the FRAM modelling to assess the energy needs of Southern Residents compared with available Chinook prey.

Ratio of Prey Available to the Whales' Needs (Forage Ratio).

We compared the food energy of prey available to the whales to the estimated metabolic needs of the whales. To be conservative, we relied on the estimated maximum energy needs (based on the high-end of a typical range in daily needs, (Noren 2011)). Forage ratios indicate prey available is greater than the whales' needs by the magnitude of the value. For example, a ratio of 5.0 indicates that prey availability is 5 times the energy needs of the whales. Because there is no available information on the whales' foraging efficiency, it is difficult to evaluate the impact of prey reductions on the ratios. Although we have low confidence in the ratios, we consider them as an indicator to help focus our analysis on the time and location where prey availability may be lowest and where the action may have the most significant effect on the whales. Hilborn et al. (2012) cautioned that forage ratios provide limited insight into prey limitations without knowing the whale fitness/vital rates as a function of the supply and demand, however, they suggested ratios may be informative in an ecosystem context (by species or region). In response to the latter point, Chasco et al. (2017) compared forage ratios across regions, from California to Southeast Alaska. They found that the forage ratios (Chinook salmon available compared to the diet needs of killer whales) were useful to estimate declines in prey over the last four decades and to compare forage ratios across geographic areas. They found forage ratios were consistently higher in coastal waters of British Columbia and southeast Alaska than estimated ratios in Washington waters.

Table 44 summarizes the baseline food energy from Chinook available to Southern Residents compared to the whales' energy needs without implementation of the proposed action in inland and coastal waters during the three FRAM time steps (this includes Canadian and southern U.S. fishing). The forage ratios are prey available after fisheries have occurred but before natural mortality, thus they do not account for reductions in prey from competition with other predators, disease and other routes of natural mortality.

Table 44. Baseline Chinook salmon food energy available in inland and coastal waters without implementation of the proposed action (before natural mortality).

Year	Region	Oct - April	May - June	July - Sept
1999	Inland	24.0	23.6	12.7
	Coastal	11.7	57.6	69.0
2000	Inland	19.1	17.8	9.3
	Coastal	11.7	56.3	67.3
2001	Inland	26.2	25.0	13.2
	Coastal	17.3	85.3	105.1
2002	Inland	29.7	27.3	14.5
	Coastal	23.7	114.7	141.3
2003	Inland	32.8	30.0	15.90
	Coastal	24.7	117.8	143.8
2004	Inland	28.8	27.0	14.5
	Coastal	22.5	108.6	133.0
2005	Inland	24.3	22.8	12.1
	Coastal	18.0	87.0	104.8
2006	Inland	27.7	26.0	13.7
	Coastal	14.0	67.9	81.9
2007	Inland	21.8	20.3	10.7
	Coastal	8.3	39.1	46.1
2008	Inland	22.6	21.9	11.8
	Coastal	7.8	40.1	50.8
2009	Inland	19.2	17.8	9.4
	Coastal	7.9	39.3	49.4
2010	Inland	32.5	31.5	17.4
	Coastal	12.6	62.7	80.6
2011	Inland	27.1	24.8	13.1
	Coastal	12.9	62.8	78.6

2012	Inland	17.8	17.0	8.9
	Coastal	13.2	64.9	79.3
2013	Inland	26.7	25.6	14.0
	Coastal	20.7	106.8	137.5
2014	Inland	23.7	22.3	11.9
	Coastal	18.0	89.3	110.4

In inland waters, the ratios are lowest during the July through September time period ranging from 8.9 and 17.4. October through April and May through June ratios were similar in inland waters and ranged from 17.0 and 32.8. In coastal waters, the ratios are lowest during October through April regardless of the year. The ratios during this time are similar to the lowest in inland waters (ranging from 7.8 through 24.7). The highest ratios in coastal waters occurred during the July through September time period and ranged from 46.1 and 143.8.

The current estimated baseline ratios are not directly comparable with ratios described in previous harvest consultations with the exception of NMFS (2018b), limiting our interpretation and the weight of confidence in the ratios, because of the updates to FRAM. For example, in NMFS (2011a), the FRAM model produced stock and age specific cohort abundance for several stages: initial, after natural mortality, after fishing in mixed stock marine areas (pre-terminal), and mature run. For this analysis, the cohort abundance is estimated before natural mortality.

Entrapment and Entanglement in Fishing Gear

Drowning from accidental entanglements in nets and longlines is a minor source of fishing-related mortality in killer whales. In Washington, (Scheffer and Slipp 1948) documented several deaths of animals caught in nets between 1929 and 1943. More recently, one killer whale was reported interacting with a salmon gillnet in British Columbia in 1994, but did not get entangled (Guenther et al. 1995). Along the U.S. West Coast, two killer whales have been recorded entangled in Dungeness crab commercial trap fishery gear (one in 2015 and one in 2016) (NMFS 2016n). In 2013, a northern resident killer whale stranded in British Columbia and a fish hook was observed in its colon, but had no evidence of perforation or mucosal ulceration (NMFS strandings data, unpubl.). Typically, killer whales are able to avoid nets by swimming around or underneath them (Jacobsen 1986; Matkin 1994), and not all entanglements automatically result in death. For example, J39, a young male killer whale in J pod, was observed with a salmon flasher hooked in his mouth during the summer of 2015 around the San Juan Islands.

Entanglements of marine mammals in fishing gear must be reported in accordance with the MMPA. MMPA Section 118 established the Marine Mammal Authorization Program (MMAP) in 1994. Under MMAP all fishers are required to report any incidental taking (injuries or mortalities) of marine mammals during fishing operations. Any animal that ingests fishing gear or is released with fishing gear entangled, trailing, or perforating any part of the body is considered injured, must be reported[20]. No entanglements, injuries or mortalities have been reported in recent years.

[20] Review of reporting requirements and procedures, 50 CFR 229.6 and https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-authorization-program.

Prey Quality

Contaminants enter marine waters and sediments from numerous sources, but are typically concentrated near populated areas of high human activity and industrialization. Freshwater contamination is also a concern because it may contaminate salmon that are later consumed by the whales in marine habitats. Chinook salmon contain higher levels of some contaminants than other salmon species, however levels can vary considerably among salmon populations. Mongillo et al. (2016) reported data for salmon populations along the west coast of North America, from Alaska to California, and found salmon marine distribution was a large factor affecting persistent pollutant accumulation. Higher concentrations of persistent pollutants were in Chinook salmon populations that feed in close proximity to land-based sources of contaminants. Some of the highest levels of certain pollutants were observed in Chinook salmon from Puget Sound and the Harrison River, a subset of the Fraser River populations (Mongillo et al. 2016). These populations are primarily distributed within the urbanized waters of the Salish Sea and along the west coast of Vancouver Island (DFO 1999; Weitkamp 2010). However, populations of Chinook salmon that originated from the developed Fraser River that had a more northern distribution in the coastal waters of British Columbia and Alaska (DFO 1999) had much lower concentrations of certain contaminants (Mongillo et al. 2016). Additionally, (O'Neill and West 2009) discovered elevated concentrations of polychlorinated biphenyls (PCBs) in Puget Sound Chinook salmon compared to those outside Puget Sound. Similarly, J pod--the Southern Resident pod most frequently seen in Puget Sound--has also been found to have higher levels of PCBs, consistent with these higher PCB concentrations in Puget Sound Chinook salmon (O’Neill et al. 2006; Krahn et al. 2007). Intermediate levels of PCBs were measured in California and Oregon populations, but Chinook originating from California have been measured to have higher concentrations of DDTs (O’Neill et al. 2006; Mongillo et al. 2016).

Since the late 1970s, size and age structure in Chinook salmon has substantially changed across the Northeast Pacific Ocean (Ohlberger et al. 2018). Adult Chinook salmon (ocean ages 4 and 5) along most of the eastern North Pacific Ocean are becoming smaller, whereas the size of age 2 fish are generally increasing (Ohlberger et al. 2018). Additionally, most of the Chinook salmon populations from Oregon to Alaska have experienced lower proportions of age 4 and 5 year olds and an increase in the proportion of 2 year olds; the mean age of Chinook salmon in the majority of the populations has declined over time. Populations along the coast from western Alaska to northern Oregon had strong declining size trends of ocean-4 fish, including wild and hatchery fish. For Puget Sound Chinook salmon (primarily hatchery origin), there were little or weak trends in size-at-age of 4 year olds and the declining trend in the proportion of older ages in Washington stocks was also observed but slightly weaker than that in Alaska populations (Ohlberger et al. 2018).

Vessel Activities and Sound

Commercial shipping and military, recreational and fishing vessels occur in the coastal range of Southern Residents and additional whale watching, ferry operations, recreational and fishing vessel traffic in their inland range. The density of traffic is lower in coastal waters compared to inland waters of Washington State and British Columbia. Several studies in inland waters of

Washington State and British Columbia have linked interactions of vessels and Northern and SRKW with short-term behavioral changes (see review in Ferrara et al. (2017)). These vessel activities may affect foraging efficiency, communication, and/or energy expenditure through the physical presence of the vessels, underwater sound created by the vessels, or both. Collisions of killer whales with vessels may be an additional source of mortality, although the true effect of vessel collisions on mortality is unknown. Very few deceased killer whales are found and necropsied, and cause of death cannot always be determined.[21]

Vessel sounds in coastal waters are most likely from large ships, tankers and tugs, whereas vessel sounds in inland waters also come from whale watch platforms, ferry operations and smaller recreational vessels. Commercial sonar systems designed for fish finding, depth sounding, and sub-bottom profiling are widely used on recreational and commercial vessels and are often characterized by high operating frequencies, low power, narrow beam patterns, and short pulse length (National Research Council 2003). Frequencies fall between 1 and 500 kHz, which is within the hearing range of some marine mammals including killer whales and may have masking effects (i.e., sound that precludes the ability to detect and transmit biological signals used for communication and foraging).

Recently, there have been several studies that have characterized sound from ships and vessels as well as ambient noise levels in the inland waters (Bassett et al. 2012; McKenna et al. 2013; Houghton et al. 2015; Veirs et al. 2016). Bassett et al. (2012) assessed ambient noise levels in northern Admiralty Inlet (a waterway dominated by larger vessels). They found that vessel activity contributed most to the variability measured in the ambient noise and cargo ships contributed to the majority of the vessel noise budget. Veirs et al. (2016) estimated sound pressure levels for larger ships that transited through the Haro Strait, and found that the received levels were above background levels, and that underwater noise from ships extends up to high frequencies similar to noise from smaller boats. Commercial shipping was also identified as a significant source of low frequency ambient noise in the ocean, which has long-range propagation and therefore can be heard over long distances. Additionally, the contribution of shipping to ambient noise has increased by as much as 12dB over the past few decades (Hildebrand 2009). Ship noise was identified as a concern because of its potential to interfere with SRKW communication, foraging, and navigation (Veirs et al. 2016). Although there are several vessel characteristics that influence noise levels, vessel speed appears to be the most important predictor in source levels (McKenna et al. 2013; Houghton et al. 2015; Veirs et al. 2016; Holt et al. 2017), and reducing vessel speed would likely reduce acoustic exposure to Southern Residents.

Behavioral responses of killer whales to received levels from ships was estimated using a dose-response function (Williams et al. 2014). The authors found that the whales would have a 50% chance of responding behaviorally to ship noise when received noise levels were approximately 130 decibels (dB) root mean square (rms). Following this study, Holt et al. (2017) utilized digital acoustic recording tags (DTAGs) to measure received noise levels by the whales (in dB re 1micropascal (μPa)). The received noise levels (in the 1 to 40 kHz band) measured were between 96 and 127 dB re 1μPa, with an average of 108 dB ± 5.5. It is currently unclear if Southern

[21] https://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/killer_whale/rpi_strandings.html

Residents experience noise loud enough to have more than a short-term behavioral response; however, new research from the NWFSC is investigating fine scale details of subsurface acoustic and movement behavior under different scenarios, especially those predictive of foraging, to then determine potential effects of vessels and noise on SRKW behaviors.

Recent evidence indicates there is a higher energetic cost of surface active behaviors and vocal effort resulting from vessel disturbance (Williams et al. 2006; Noren et al. 2012; Noren et al. 2013; Holt et al. 2015). However, this increased energy expenditure may be less important than the reduced time spent feeding and the resulting potential reduction in prey consumption (Ferrara et al. 2017). Although the impacts of short-term behavioral changes on population dynamics is unknown, it is likely that because Southern Residents are exposed to vessels the majority of daylight hours they are in inland waters, there may be biologically relevant effects at the population-level (Ferrara et al. 2017).

The Be Whale Wise viewing guidelines and the 2011 federal vessel regulations (www.bewhalewise.org) were designed to reduce behavioral impacts, acoustic masking, and risk of vessel strike to Southern Residents in inland waters of Washington State. Since the regulations were codified, there is some evidence that the average distance between vessels and the whales has increased (Houghton 2014; Ferrara et al. 2017). The majority of vessels in close proximity to the whales are commercial and recreational whale watching vessels and the average number of boats accompanying whales can be high during the summer months (i.e., from 2006 to 2015 an average of 11 to 18 boats)(Seely 2016). A number of recommendations to improve compliance with guidelines and regulations are being implemented by a variety of partners to further reduce vessel disturbance (Ferrara et al. 2017).

Anthropogenic (human-generated) sound in inland and coastal waters is generated by other sources beside vessels, including construction activities, and military operations. Natural sounds in the marine environment include wind, waves, surf noise, precipitation, thunder, and biological noise from other marine species. The intensity and persistence of certain sounds (both natural and anthropogenic) in the vicinity of marine mammals vary by time and location and have the potential to interfere with important biological functions (e.g., hearing, echolocation, communication).

In-water construction activities are permitted by the Army Corps of Engineers (ACOE) under section 404 of the Clean Water Act and section 10 of the Rivers and Harbors Act of 1899 and by the State of Washington under its Hydraulic Project Approval (HPA) program. NMFS conducts consultations on these permits and helps project applicants incorporate conservation measures to minimize or eliminate potential effects of in-water activities, such as pile driving, to marine mammals. Sound, such as sonar generated by military vessels also has the potential to disturb killer whales and mitigation including shut down procedures are used to reduce impacts.

Oil Spills

As described in the Status of the Species section, Southern Residents are vulnerable to the risks imposed by an oil spill. The risk from serious spills is because of the heavy volume of shipping traffic and proximity to petroleum refining centers. The total volume of oil spills in inland waters of Washington has increased since 2013 and inspections of high-risk vessels have declined since 2009 (WDOE 2017). In 2014, NOAA responded to 16 actual and potential oil spills in Washington and Oregon[22]. In 2017, over 46,000 gallons of non-crude oil was spilled into marine waters from Hawaii to Alaska (Stephens 2018). Polycyclic aromatic hydrocarbons (PAHs), a component of oil (crude and refined) and motor exhaust, are a group of compounds known to be carcinogenic and mutagenic (Pashin and Bakhitova 1979). Exposure can occur through five known pathways: contact, adhesion, inhalation, dermal contact, direct ingestion, and ingestion through contaminated prey (Jarvela-Rosenberger et al. 2017).

Following the *Deepwater Horizon* oil spill, substantial research effort has occurred to document adverse health effects and mortality in cetaceans in the Gulf of Mexico. Common dolphins (*Tursiops truncates*) in Barataria Bay, an area that had prolonged and severe contamination from the Deepwater Horizon oil spill, were found to have health effects consistent with adrenal toxicity and increased lung disease (Schwacke et al. 2013; Venn-Watson et al. 2015), low reproductive success rates (Kellar et al. 2017), and changes in immune function (de Guise et al. 2017). Previous PAH exposure estimates suggested Southern Residents can be occasionally exposed to concerning levels (Lachmuth et al. 2011). More recently, Lundin et al. (2018) measured PAHs in whale fecal samples collected in inland waters of Washington between 2010 and 2013 and found low concentrations of the measured PAHs (<10 parts per billion (ppb), wet weight). However, PAHs were as high as 104 ppb in the first year of their study (2010) compared to the subsequent years. Although it is unclear the cause of this trend, higher levels were observed prior to the 2011 vessel regulations that increased the distance vessels could approach the whales.

Scientific Research

Most of the scientific research conducted on SRKW occurs in inland waters of Washington State and British Columbia. In general, the primary objective of this research is population monitoring or data gathering for behavioral and ecological studies. Research activities are typically conducted between May and October in inland waters and can include aerial surveys, vessel surveys, close approaches, and documentation, and biological sampling. Most of the authorized takes would occur in inland waters, with a small portion in the coastal range of Southern Residents. In light of the number of permits, associated takes, and research vessels and personnel present in the environment, repeated disturbance of individual killer whales is likely to occur in some instances. In recognition of the potential for disturbance and takes, NMFS took steps to limit repeated harassment and avoid unnecessary duplication of effort through conditions included in the permits requiring coordination among permit holders[23].

2.4.6 Mexico DPS Humpback Whale

A number of human activities have contributed to the current status of populations of the Mexico DPS in the action area. The factors that have likely had the greatest impact are discussed in the sections below. For more information on all factors affecting Mexico humpback whales

[22] Reference website
[23] Refer to NOAA Fisheries Authorizations and Permits for Protected Species (APPS) website https://apps.nmfs.noaa.gov/ for current authorizations.

considered in depth in this opinion, please refer to the following documents:

- "Alaska Marine Mammal Stock Assessments, 2017" (Muto et al. 2018a).
  - Available online at https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region

- "Status Review of the Humpback Whale (*Megaptera novaeangliae*)" (Bettridge et al. 2015)
  - Available online at: http://www.nmfs.noaa.gov/pr/species/Status%20Reviews/humpback_whale_sr_2015.pdf

Fisheries
Worldwide, fisheries interactions have an impact on many marine mammal species. More than 97 percent of whale entanglement is caused by derelict fishing gear (Baulch and Perry 2014). There is also concern that mortality from entanglement may be underreported, as many marine mammals that die from entanglement tend to sink rather than strand ashore. Entanglement may also make marine mammals more vulnerable to additional dangers, such as predation and ship strikes, by restricting agility and swimming speed.

Commercial fisheries may indirectly affect humpback whales by reducing the amount of available prey or affecting prey species composition. In Alaska, commercial fisheries target known prey species such as pollock and cod.

Harvest
Commercial whaling in the 19th and 20th centuries removed tens of thousands of whales from the North Pacific Ocean. As discussed in Section 2.2.3.2 of this opinion, commercial harvest was the primary factor for ESA-listing of humpback whales. This historical exploitation has impacted populations and distributions of humpback whales in the action area, and it is likely these impacts will continue to persist into the future.

Subsistence hunters in Alaska have reported one subsistence take of a humpback whale in South Norton Sound in 2006. There had not been any additional reported takes of humpback whales by subsistence hunters in Alaska until 2016 when hunters illegally harvested one near Toksook Bay, AK in May (DeMarban and Demer 2016).

Natural and Anthropogenic Noise
Humpback whales in the action area are exposed to several sources of natural and anthropogenic noise. Natural sources of underwater noise include sea ice, wind, waves, precipitation, and biological noise from marine mammals, fishes, and crustaceans. Anthropogenic sources of noise in the action area include: vessels (e.g. shipping, transportation, research); Construction activities (e.g. drilling, dredging, pile-driving); sonars; and aircraft. The combination of anthropogenic and natural noises contributes to the total noise at any one place and time.

Because responses to anthropogenic noise vary among species and individuals within species, it is difficult to determine long-term effects. Habitat abandonment due to anthropogenic noise exposure has been found in terrestrial species (Francis and Barber 2013). Clark et al. (2009) identified increasing levels of anthropogenic noise as a habitat concern for whales because of its potential effect on their ability to communicate (i.e. masking). Some research (Parks 2003; McDonald et al. 2006; Parks 2009) suggests marine mammals compensate for masking by changing the frequency, source level, redundancy, and timing of their calls. However, the long-term implications of these adjustments, if any, are currently unknown.

Noise Related to Construction Activities

NMFS has conducted numerous ESA section 7 consultations related to construction activities in Southeast Alaskan waters. Many of the consultations have authorized the take (by harassment) of humpback whales from sounds produced during pile driving, drilling, and vessel operations.

In 2017, NMFS conducted three consultations on the issuance of Incidental Harassment Authorizations (IHAs) to take marine mammals incidental to dock and ferry terminal construction in Southeast Alaska (Sawmill Cove Dock, Gustavus Ferry Terminal, and Haines Ferry Terminal). The incidental take statements in the three biological opinions estimated 45 Mexico DPS humpback whales, total, would be taken (by Level B harassment) as a result of exposure to continuous sounds at received levels at or above 120 dB re 1 μPa rms and impulsive sounds at received levels at or above 160 dB re 1 μPa rms. Only one Level A harassment of a Mexico DPS humpback whale was authorized.

Anticipated impacts by harassment from noise associated with construction activities generally include changes in behavioral state from low energy states (i.e., foraging, resting, and milling) to high energy states (i.e., traveling and avoidance).

Pollutants and Discharges

Previous development and discharges in portions of the action area are the source of multiple pollutants that may be bioavailable (i.e., may be taken up and absorbed by animals) to ESA-listed species or their prey items (NMFS 2013a).

The CWA of 1972 has several sections or programs applicable to activities in offshore waters. Section 402 of the CWA authorizes the U.S. Environmental Protection Agency (EPA) to administer the National Pollutant Discharge Elimination System (NPDES) permit program to regulate point source discharges into waters of the United States. Section 403 of the CWA requires that EPA conduct an ocean discharge criteria evaluation for discharges to the territorial seas, contiguous zones, and the oceans. The Ocean Discharge Criteria (40 CFR Part 125, Subpart M) sets forth specific determinations of unreasonable degradation that must be made before permits may be issued.

The EPA issued a NPDES vessel general permit that authorizes several types of discharges incidental to the normal operation of vessels, such as grey water, black water, coolant, bilge water, ballast, and deck wash (EPA 2013). The permit is effective from December 19, 2013 to December 19, 2017, and applies to owners and operators of non-recreational vessels that are at least 24 m (79 ft.) in length, as well as to owners and operators of commercial vessels less than 24 m that discharge ballast water.

The US Coast Guard has regulations related to pollution prevention and discharges for vessels carrying oil, noxious liquid substances, garbage, municipal or commercial waste, and ballast water (33 CFR Part 151). The State of Alaska regulates water quality standards within three miles of the shore.

Vessel Interactions

Ship strikes and other interactions with vessels unrelated to fisheries occur frequently with humpback whales. Neilson et al. (2012) summarized 108 large whale ship-strike events in Alaska from 1978 to 2011, 25 of which are known to have resulted in the whale's death. Eighty-six percent of these reports involved humpback whales. Neilson et al. (2012) also reported most vessels that strike whales in Southeast Alaska are less than 49 ft. long, occur at speeds over 13 knots, and occur between May and September. Calves and juveniles appear to be at higher risk of collisions than adult whales. Ship strikes and other interactions with vessels unrelated to fisheries resulted in a minimum mean annual mortality and serious injury rate from 2011-2015 of 4.4 humpback whales from the Central North Pacific stock, based on reports to the NMFS Alaska Region stranding network (Helker et al. 2017).

Most of the vessel collisions were reported in Southeast Alaska, but it is unknown whether the difference in ship strike rates between Southeast Alaska and other areas is due to differences in reporting, amount of vessel traffic, densities of whales, or other factors (Muto et al. 2018a).

NMFS implemented regulations to minimize harmful interactions between ships and humpback whales in Alaska (see 50 CFR §§ 216.18, 223.214, and 224.103(b)). These regulations require that all vessels:

e. Not approach within 100 yards of a humpback whale, or cause a vessel or other object to approach within 100 yards of a humpback whale,

f. Not place vessel in the path of oncoming humpback whales causing them to surface within 100 yards of vessel,

g. Not disrupt the normal behavior or prior activity of a whale, and

h. Operate vessel at a slow, safe speed when near a humpback whale. Safe speed is defined in regulation (see 33 CFR § 83.06).

In addition to the voluntary marine mammal viewing guidelines discussed previously, many of the marine mammal viewing tour boats voluntarily subscribe to even stricter approach guidelines by participating in the Whale Sense program. NMFS implemented Whale Sense Alaska in 2015, which is a voluntary program developed in collaboration with the whale-watching industry that recognizes companies who commit to responsible practices. More information is available at https://whalesense.org/.

Since 2011, cruise lines, pilots, NMFS, and the NPS biologists have worked together to produce weekly whale sightings maps to improve situational awareness for cruise ships and state ferries in Southeast Alaska. In 2016, NMFS and NPS launched Whale Alert, another voluntary program that receives and shares real-time whale sightings with controlled access to reduce the risk of ship strike and contribute to whale avoidance.

Scientific Research
NMFS issues scientific research permits that are valid for five years for ESA-listed species. When permits expire, researchers often apply for a new permit to continue their research. Additionally, applications for new permits are issued on an on-going basis; therefore, the number of active research permits is subject to change in the period during which this opinion is valid.

Species considered in this opinion also occur in Canadian waters. Although we do not have specific information about any permitted research activities in Canadian waters, we assume they will be similar to those described below.

Humpback whales are exposed to research activities documenting their distribution and movements throughout their ranges. There are 16 active research permits authorizing takes of humpback whales in Alaskan waters (NMFS 2016k). Additional research permits are authorized in the lower action area (off the southern U.S. waters); however, because the adverse effects from the proposed funding action for management of SEAK salmon fisheries will occur in SEAK waters, we describe the research activities there. Activities associated with these permits could occur in the action area, possibly at the same time as the proposed project activities. Currently permitted research activities include:

- Counting/surveying
- Opportunistic collection of sloughed skin and remains
- Behavioral and monitoring observations
- Various types of photography and videography
- Skin and blubber biopsy sampling
- Fecal sampling
- Suction-cup, dart/barb, satellite, and dorsal fin/ridge tagging

These research activities require close vessel approach. The permits also include incidental harassment takes to cover such activities as tagging, where the research vessel may come within 91 m (300 ft.) of other whales while in pursuit of a target whale. These activities may cause stress to individual whales and cause behavioral responses, but harassment is not expected to rise to the level where injury or mortality is expected to occur.

2.4.7 Western DPS Steller Sea Lion

A number of human activities have contributed to the current status of populations of Western DPS Steller Sea Lion in the action area. The factors that have likely had the greatest impact are discussed in the sections below. For more information on all factors affecting the ESA-listed species considered in depth in this opinion, please refer to the following documents:

- "Alaska Marine Mammal Stock Assessments, 2017" (Muto et al. 2018a).
  - Available online at https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region

- "Recovery Plan for the Steller Sea Lion, Eastern and Western Distinct Population Segments (*Eumetopias jubatus*)" (NMFS 2008i)
  - Available online at

https://alaskafisheries.noaa.gov/sites/default/files/sslrpfinalrev030408.pdf

Fisheries
Worldwide, fisheries interactions have an impact on many marine mammal species. There is also concern that mortality from entanglement may be underreported, as many marine mammals that die from entanglement tend to sink rather than strand ashore. Entanglement may also make marine mammals more vulnerable to additional dangers, such as predation and ship strikes, by restricting agility and swimming speed.

Commercial fisheries may indirectly affect Steller sea lions by reducing the amount of available prey or affecting prey species composition. In Alaska, commercial fisheries target known prey species such as pollock and cod.

As described in the Status Section above (2.2.4.1), there were multiple cases of serious injuries in SEAK to Eastern DPS Steller sea lions from interactions with fishing gear from and marine debris. Because eastern and western DPS animals overlap in Southeast Alaska, some of these takes may have occurred to western DPS animals. The available information on these interactions in recent years is described in detail in Section 2.5.5 Effects Analysis of Humpback Whales and Steller Sea Lions. Raum-Suryan et al. (2009) observed a minimum of 386 animals either entangled in marine debris or having ingested fishing gear over the period 2000-2007 in Southeast Alaska and northern British Columbia. Over the same period, there were 241 cases of mortality and serious injury reported for the WDPS: 31 in U.S. commercial fisheries, 1.4 in unknown fisheries (commercial, recreational, or subsistence), 2 in marine debris, 2.6 due to other causes (arrow strike, entangled in hatchery net, illegal shooting, research), and 204 in subsistence harvest. These animals mostly interacted with observed trawl (13) longline (2.8) troll (1), and gillnet (15) fisheries, typically resulting in death (Muto et al. 2018a).

The minimum estimated mortality rate of western Steller sea lions incidental to all U.S. commercial fisheries is 32 sea lions per year, based on Protected Species Observer (PSO) data (31) and stranding data (1.4) where PSO data were not available. Several fisheries that are known to interact with the WDPS have not been observed reaching the minimum estimated mortality rate (Muto et al. 2018a).

Harvest
As described in the Status Section (2.2.4.1), Steller sea lions are hunted for subsistence purposes. From the 5-year period from 2004 to 2008, the annual statewide (excluding St. Paul Island) harvest is 172.3 individuals. More recent data (from 2011 to 2015) from St. Paul and St. George indicate the annual harvest was 30 and 2.4 sea lions, respectively. This results in a total take of 204 individuals (Muto et al. 2018a). In addition, the Alaska Native Harbor Seal Commission and ADFG estimated a total of 20 adult sea lions were harvested on Kodiak Island in 2011, and 7.9 sea lions (confidence interval (CI) = 6-15.3) were harvested in Southcentral Alaska in 2014, with adults comprising 84% of the harvest (Muto et al. 2018a).

The NMFS Alaska Stranding Program documents 60 Steller sea lions with suspected or confirmed firearm injuries from 2000 – 2016 in Southeast Alaska. Recently, two cases of illegal shooting have been successfully prosecuted.

Natural and Anthropogenic Noise

Steller sea lions in the action area are exposed to several sources of natural and anthropogenic noise. Natural sources of underwater noise include sea ice, wind, waves, precipitation, and biological noise from marine mammals, fishes, and crustaceans. Anthropogenic sources of noise in the action area include: vessels (e.g. shipping, transportation, research); Construction activities (e.g. drilling, dredging, pile-driving); sonars; and aircraft. The combination of anthropogenic and natural noises contributes to the total noise at any one place and time.

Because responses to anthropogenic noise vary among species and individuals within species, it is difficult to determine long-term effects. Habitat abandonment due to anthropogenic noise exposure has been found in terrestrial species (Francis and Barber 2013).

Noise Related to Construction Activities

NMFS has conducted numerous ESA section 7 consultations related to construction activities in Southeast Alaskan waters. Many of the consultations have authorized the take (by harassment) of Steller sea lions from sounds produced during pile driving, drilling, and vessel operations.

In 2017, NMFS conducted three consultations on the issuance of IHAs to take marine mammals incidental to dock and ferry terminal construction in Southeast Alaska (Sawmill Cove Dock, Gustavus Ferry Terminal, and Haines Ferry Terminal). The incidental take statements in the three biological opinions estimated 797 western DPS Steller sea lions, total, would be taken (by Level B harassment) as a result of exposure to continuous sounds at received levels at or above 120 dB re 1 μPa rms and impulsive sounds at received levels at or above 160 dB re 1 μPa rms.

Anticipated impacts by harassment from noise associated with construction activities generally include changes in behavioral state from low energy states (i.e., foraging, resting, and milling) to high energy states (i.e., traveling and avoidance).

Pollutants and Discharges

Previous development and discharges in portions of the action area are the source of multiple pollutants that may be bioavailable (i.e., may be taken up and absorbed by animals) to ESA-listed species or their prey items (NMFS 2013a).

The CWA has several sections or programs applicable to activities in offshore waters. Section 402 of the CWA authorizes the U.S. EPA to administer the NPDES permit program to regulate point source discharges into waters of the United States. Section 403 of the CWA requires that EPA conduct an ocean discharge criteria evaluation for discharges to the territorial seas, contiguous zones, and the oceans. The Ocean Discharge Criteria (40 CFR Part 125, Subpart M) sets forth specific determinations of unreasonable degradation that must be made before permits may be issued.

The EPA issued a NPDES vessel general permit that authorizes several types of discharges incidental to the normal operation of vessels, such as grey water, black water, coolant, bilge water, ballast, and deck wash (EPA 2013). The permit is effective from December 19, 2013 to December 19, 2017, and applies to owners and operators of non-recreational vessels that are at least 24 m (79 ft.) in length, as well as to owners and operators of commercial vessels less than 24 m that discharge ballast water.

The USCG has regulations related to pollution prevention and discharges for vessels carrying oil, noxious liquid substances, garbage, municipal or commercial waste, and ballast water (33 CFR Part 151). The State of Alaska regulates water quality standards within three miles of the shore.

Vessel Interactions

There are three documented occurrences of Steller sea lions being struck by vessels in Southeast Alaska; all were near Sitka. Although risk of ship strike has not been identified as a significant concern for Steller sea lions (Loughlin and York 2000), the recovery plan for this species states that Steller sea lions may be more susceptible to ship strike mortality or injury in harbors or in areas where animals are concentrated (e.g., near rookeries or haulouts) (NMFS 2008i).

NMFS's guidelines for approaching marine mammals discourage vessels approaching within 100 yards of haulout and rookery locations.

Scientific Research

NMFS issues scientific research permits that are valid for five years for ESA-listed species. When permits expire, researchers often apply for a new permit to continue their research. Additionally, applications for new permits are issued on an on-going basis; therefore, the number of active research permits is subject to change in the period during which this opinion is valid.

Steller sea lions are exposed to research activities documenting their distribution and movements throughout their ranges. Activities associated with scientific research may cause stress to individual Steller sea lions, but, in most cases, harassment is not expected to rise to the level where injury or mortality is expected to occur.

2.5 Effects of the Actions

2.5.1 Delegation and Funding for SEAK Fisheries

We first describe the effects on listed salmonids of the first two parts of the proposed action – the reinitiation of consultation on the delegation of authority to manage salmon troll and sport fisheries in the EEZ to the State of Alaska, and funding to the State of Alaska for the implementation of the 2019 Agreement in SEAK. To analyze the effects of the SEAK fisheries under the 2019 Agreement on listed Chinook, we have developed the Retrospective Analysis that follows, considering different scenarios which allow us to isolate the likely effects of the SEAK fisheries under the new agreement from the other fisheries managed under the new agreement. Note that while technically the effects of these other fisheries are not part of the effects of the action – the future effects of the fisheries off the U.S. West Coast are covered by other consultations and thus are part of the environmental baseline, and the effects of the future fisheries off Canada are technically cumulative effects – we have considered those effects in the Retrospective Analysis for the sake of efficiency and to provide a comprehensive picture of the effects of fisheries under the new agreement. As discussed above, the fisheries off the U.S. West Coast and inland waters are managed to meet more restrictive domestic objectives for ESA listed salmon, and thus will not likely change as a result of the 2019 Agreement.

2.5.1.1 Retrospective Analysis

The effect of the 2019 Agreement on ERs and natural escapement for ESA-listed Chinook salmon was considered using a retrospective analysis. The analysis was conducted using the FRAM. The FRAM is the tool used primarily for assessing Chinook salmon fisheries by the PFMC off the west coast and in Puget Sound and is described in more detail below.

The retrospective analysis used for analyzing the effects of the proposed action relies on a review of past circumstances to develop an understanding of the likely influence of the 2019 Agreement on the fisheries, and the resulting effects on ERs and escapements of ESA-listed species and other stocks of concern. Actual outcomes over the next ten years will depend on year-specific circumstances related to individual stock abundance, the combined abundances of stocks in particular fisheries, and how fisheries actually are managed in response to these circumstances.

The retrospective analysis uses years from the recent past (1999 through 2014) because they provide a known set of prior circumstances regarding stock abundance and actual fishery affects. The retrospective analysis considers how outcomes would have changed under alternative management scenarios. The scenarios are explained in more detail below, but generally represent 1) what actually occurred based on post season estimates of stock abundance and fishery catches; 2) what we can reasonably expect to occur under the 2019 Agreement given an informed assessment of how fisheries are likely to be managed in the future, i.e., with domestic constraints in addition to those prescribed in the 2019 Agreement ; 3) the previous scenario but with SEAK fisheries set to levels of the 2009 agreement, to isolate the effects of the proposed action; and 4) how the fishery provisions in the 2019 Agreement would perform if there was an unexpected and broad scale decline of 40 percent in the abundance of Chinook salmon. The 40 percent abundance decline scenario is unlikely to occur during the term of the 2019 Agreement but is included to cover the situation of a prolonged and broad scale down turn in productivity and abundance that could occur as a consequence of long term cycles in ocean conditions or global climate change.

Before describing the scenarios used in the retrospective analysis in more detail, it is important to highlight one point. Although the bilateral Agreement sets limits on the fisheries, domestic conservation considerations often result in fisheries that are reduced further than require by the Agreement. The 2019 Agreement sets limits on harvest in both AABM and ISBM fisheries, but it is important to understand the context within which the limits were established. The fishery limits in the 2019 Agreement are the result of a complex bilateral negotiation wherein the Parties sought to find an acceptable and effective distribution of harvest opportunities and fishery constraints that, when combined with domestic fishery management constraints, would be consistent with the fundamental conservation and sharing objectives of the Treaty. The fisheries subject to the Agreement are governed by these constraints. The bilateral fishing regimes are reflective of many considerations, including the historical relationship among fisheries, the variable and evolving nature of the resource base in both countries, and a balancing among fisheries to allocate fishing opportunities and fishery constraints between and among mixed stock and more-terminal fisheries in the two countries. The fishery and stock-specific annual limits in the agreed regimes were negotiated with the clear understanding that, as previously described above, more restrictive fishery and stock-specific measures often would be required and applied in each country as necessary to meet domestic objectives, such as those required to meet ESA obligations for listed Chinook salmon species. This understanding is specifically acknowledged in paragraph 5(c) of the Chinook chapter of the 2019 Agreement which says:

> *either or both parties may implement domestic policies that constrain their respective fishery impacts on depressed Chinook stocks to a greater extent than is required by this Paragraph;*

Past experience has borne out this relationship between the international limits established in the PST agreements and domestic constraints: fisheries in Canada and the southern U.S. in particular often have been more constrained by ESA and/or other Canadian or U.S. domestic management considerations than was necessary to comply with the applicable bilateral Agreement. As an example, from 1999 to 2002 Canadian AABM fisheries were reduced greatly relative to what was allowed under the 1999 Agreement because of domestic concerns particularly for their WCVI Chinook stock. More recently, Canada has managed the NCBC AABM fishery at levels well below that required by the 2009 Agreement. Southern U.S. fisheries in Puget Sound and along the coast were also often constrained beyond the applicable ISBM requirements because of ESA and other management considerations and conservation constraints. Generally fisheries in SEAK have been managed to stay within PST catch limits. However, in 2018 SEAK fisheries were voluntarily and deliberately managed to a harvest limit that was 10 percent below the allowable harvest limit that was determined by the 2018 SEAK preseason AI from the PSC Chinook Model in order address concerns for Chinook salmon stocks in SEAK, Northern BC and the Transboundary Rivers. This difference between what was required in past bilateral agreements and the tighter constraints that have been applied for domestic reasons is used to inform the modeling in some of the scenarios described below and analyzed herein in the retrospective analysis.

For this analysis, the following four scenarios were run in FRAM using a retrospective analysis of the 1999-2014 fishing years:

Scenario 1: FRAM Validation

- *FRAM runs using actual post-season fishery catches and best available estimates of annual stock abundances.*

The FRAM Validation scenario approximates what actually occurred from 1999 to 2014 based on post season information. These runs are also used in other forums to evaluate the model and the management system and their relative success in meeting fishery and stock specific management objectives. These were described in Section 2.4, Environmental Baseline, as the exploitation between 1999 and 2014 and from this point forward are referred to as Scenario 1. See for example Figure 25 and Table 33.

Scenario 2: 2019 Likely

- *FRAM runs representing what we can reasonably expect to occur under both the 2019 Agreement and other likely domestic constraints.*

These runs were built off of the FRAM validation runs from Scenario 1 in a two-step process. First, fishery inputs were updated to best reflect what would have occurred had fisheries been managed under the 2019 Agreement. Next, each run was assessed independently to ensure that it also complied with likely domestic management objectives for ESA-listed Puget Sound Chinook salmon. For the other Chinook salmon ESUs fisheries in more terminal areas are outside the action area and so this step was not included.

Updates were made to both AABM and ISBM fisheries relative to the likely implementation of the 2019 Agreement. AABM fishery quotas were developed by first converting the historical pre-season AIs into a Total Allowable Catch (TAC) specific to each region using Table 2 for SEAK and Appendix C for NBC and WCVI in Annex IV Chapter 3 of the 2019 Agreement (Turner and Reid 2018). Next, in order to account for management error, an adjustment factor was applied to these TACs that was based on the mean and standard deviation of management error specific to each region (defined as observed catch / pre-season TAC for SEAK, Canada, and SUS areas). For example, if a fishery on average caught only 80 percent of its available TAC, the new TACs modeled in this scenario would be adjusted similarly. The resulting region-specific TACs for each scenario are provided in Appendix A. These TACs were then allocated to gear and time step specific quotas using the observed proportions from the FRAM validation runs.

ISBM fisheries in the 2019 Agreement are evaluated relative to 2009-2015 CYER averages, with reductions to that average varying by stock and whether identified management objectives are met (see Attachment I in Annex IV Chapter 3 of the 2019 Agreement for details). To best reflect this in the modeling scenario, we modeled the ISBM fisheries using 2009-2014 average rates (fishery scalars) from the FRAM validation runs in Scenario 1, as these rates should represent the average fishing scenario that produced the CYER obligation for each stock. (Note that the fishery scalar averages include 2009-2014 only, as a FRAM validation run containing 2015 abundances and catches did not exist at the time of this analysis.) For many stocks, either the Agreement requires no reduction from the 2009-2015 CYER average, or there are management objectives that are likely to be met. For other stocks, however, reductions to the 2009-2015 CYER average will need to occur. To address these reductions that vary by stock, small adjustments were made to some of the average fishing rates for fisheries that impact the stocks of interest. To address these obligations that vary by stock, the following assumptions were made:

- U.S. stocks from outside of Puget Sound will either meet their management objectives (if they exist) or southern fishery managers will modify terminal fisheries to meet U.S. ISBM obligations.
- Reductions to Canadian fisheries to meet Canadian ISBM obligations will also occur in terminal areas.
- To meet U.S. ISBM obligations on Canadian stocks (95 percent of 2009-2015 CYER average when management objectives are not met for Cowichan, Nicola, and Harrison), a 5 percent reduction was applied to the fishing rates for tribal and non-tribal troll fisheries

north of the Queets River and tribal and non-tribal net fisheries in commercial management areas 7 and 7A.
- To meet Canadian ISBM obligations on U.S. stocks (87.5 percent of 2009-2015 CYER average), a 12.5 percent reduction was applied to the fishing rates for Canadian sport fisheries that occur in the Strait of Juan de Fuca and north and south Georgia Strait.

Once the AABM and ISBM fisheries were updated to reflect the provisions of the 2019 Agreement, additional fishery modifications were often necessary to meet anticipated management objectives on Puget Sound stocks, but recall that other terminal areas for other Chinook salmon ESUs did not require this for the reason explained above. These modifications were made on a case-by-case basis depending on whether stock specific ERs in each year specific run with the above fishery inputs exceeded their limits. The general approach was to: (1) as necessary, reduce Puget Sound pre-terminal fisheries to achieve management criteria for stocks with minimal/no terminal harvest (i.e., Dungeness, Stillaguamish, Snohomish, Mid-Hood Canal), then (2) as necessary, reduce terminal fisheries to achieve management criteria for stocks with directed terminal harvest. Where possible, terminal fishery inputs from FRAM validation runs were converted from catch quotas to harvest rates, as the catches in these fisheries would be expected to change in response to differing terminal run sizes.

Scenario 3: 2019 Likely (SEAK 2009)

- *Identical to Scenario 2 (2019 Likely) except the SEAK fisheries are modeled at the levels of the 2009 Agreement.*

This scenario is intended to isolate the effects of the proposed action when compared the 2019 Likely scenario. The runs were built off of the 2019 Likely runs and the only changes made were to the SEAK fishery quotas. The SEAK catch inputs were still derived using historical pre-season AIs, however, they were converted into TACs using Appendix B of the 2009 Agreement. The same adjustments for management error were applied in this scenario as they were in the 2019 Likely scenario.

Scenario 4: 40 percent Abundance Decline

- *Similar to Scenario 2 (2019 Likely) except all stock abundances and pertinent fishery inputs were reduced to simulate an unexpected and broad scale reduction of 40 percent in the abundance of Chinook salmon.*

In this model scenario the starting cohort sizes for all stocks and ages were reduced by 40 percent. The AABM fishery inputs were derived using the same process as in the 2019 Likely scenario, except the pre-season AIs were reduced by 40 percent prior to determining the TAC. It should be noted that for SEAK the reduced AIs were often below 0.875, which according to Table 2 would set the catch limit at a level to be determined by the Commission. In these situations, the TAC was determined using the provisions for SEAK in Appendix C to Annex IV. The ISBM fishery inputs remained unchanged, as they were modeled as fishing effort rates and, thus, are responsive to changes in abundance. Lastly, for some fisheries and time periods there are Chinook non-retention inputs that include a significant number of encounters. Under the assumption that encounter rates would be a function of changes in abundance, all non-retention inputs from the 2019 Likely scenario were reduced by 40 percent prior to running this model scenario.

The 40 percent abundance decline scenario is best compared to the 2019 Likely scenario to provide a perspective on how the fishery provisions in the proposed agreement will respond to reduced abundance in terms of effect on ERs and resulting escapements. Because the ISBM fisheries were modeled as rates, the differences in this scenarios relative to the 2019 Likely scenario are generally due to the tiered reduction in harvest rates that occurs in AABM fisheries based on the provisions of the 2019 Agreement. If the abundance of Chinook salmon did in fact decline by 40 percent, catches in ISBM fisheries would likely be reduced further, beyond the rates used in these model runs to address stock specific conservation concerns.

Modeling Outcomes

For each of the ESA-listed natural Chinook salmon stocks, ERs were graphed for the four scenarios covering the 1999-2014 fishing years. Separate ERs were graphed for all fisheries (Total ER or Marine Area ER), fisheries in Alaska only, fisheries in Canada only, and U.S. fisheries south of Canada (southern fisheries). The total ER graphs show Rebuilding Exploitation Rates (RER) for those stocks that have NMFS derived RERs. Estimates of escapement are also shown for most stocks, particularly for those with escapement goals or other escapement related metrics. For example, Rebuilding/Upper Escapement Thresholds (UET) and Critical Escapement Thresholds (CET) are shown where available. Projected escapements are not shown for Snake River fall Chinook, Upper Willamette River Chinook, or the Lower Columbia River Chinook populations for a variety of reasons related to the specifics for those populations. Generally, the FRAM is not designed and has not been used to predict escapements for these populations. A detailed set of tables containing stock specific ERs and escapement predictions for each model scenario is provided in Appendix A.

Results from the retrospective analysis for Snake River fall Chinook are expressed in terms of the ERs rather than as SRFIs or escapements. As explained in more detail below and in the Environmental Baseline, marine area fisheries have been managed subject to standard limit referred to as the SRFI since 1996.

The FRAM

The FRAM is a single-pool deterministic fishery simulation model that is based on stock-specific escapement and catch data from analysis of CWTs recovered in fisheries and escapement areas (PFMC 2007). The model is essentially an accounting tool that links year-specific stock abundances with catches by fishery and time period according to a base period of historic catch distribution data from CWTs. The Chinook salmon FRAM base period data set has recently been updated and currently includes CWT recoveries from fishing years 2007 through 2013 which were released from brood years 2005 through 2008. In each year specific model run, the base period data set is scaled to reflect the abundance of each Chinook salmon stock and the total catch in each fishery for the given year. There are 39 Chinook salmon stocks and their marked and unmarked subcomponents in FRAM, representing production from southern British Columbia to California. FRAM contains 73 preterminal and terminal fisheries from southeast Alaska, Canada, Puget Sound, and off the coasts of Washington, Oregon and California. The model is equipped to with the ability to process all fisheries as either non-selective, mark-selective, or both. Preterminal fisheries are marine area fisheries, and terminal fisheries are estuary, bay, and freshwater area fisheries. Each run of FRAM incorporates the stock abundances and catches covering one management year that runs from May through the following April.

The Chinook salmon FRAM model has four time steps: October through April, May through June, July through September, and October through April of the next year. The initial age-specific cohort size for each stock is set at the beginning of the first time period (October through April) based on the year specific estimates of abundance from post-season run reconstruction. At the start of each time period 'prefishing' abundances are first reduced by applying an age specific natural mortality rate, then reduced again by impacts in preterminal fisheries derived from the FRAM data set of stock, age, and fishery specific ERs. After preterminal fishery impacts are subtracted, an age and stock specific maturation rate is applied to the remainder to produce a mature cohort (3 to 5 year old cohort) representing the portion of the run that is returning to spawn in that time period and subject to fisheries in the terminal areas. The non-mature (< 3 year old) remainder becomes the initial starting cohort in the next time step and the same stepwise accounting continues in the next time period. Most stocks only mature during the July to September time period; hence, the mature cohort is zero in October through June. Columbia River spring-run Chinook salmon mature in October through April. This general stepwise accounting system in FRAM produces stock, age, and time specific estimates of cohort abundances and fishing impacts for each model run year. Each year this is evaluated independently; there is no direct connection between adjacent years.

There are a variety of models used by management entities coast wide to assess Chinook salmon fisheries. The PSC CTC conducts an annual ER analysis using CWT recoveries in each year to assess impacts on tag groups representing individual stocks or stock aggregates. While this analysis forms the basis of the 2009-2015 CYER base period for ISBM fisheries in the 2019 Agreement, the data are often limited by inadequate escapement sampling or discontinuous or abbreviated time series that limit their utility in assessing harvest trends over time. Additionally, the CTC ER analysis from CWT recoveries is not easily adapted to scenario comparisons. The CTC also employs the PSC Chinook Model, with the primary purpose of establishing annual AIs. While this model is considerably different than FRAM, the two are similar in that they both rely on a base period of historic catch distribution data from CWTs, however, in the case of the PSC Chinook Model the base period is for catch years 1979-1982. The current version of the PSC Chinook model contains 30 stocks and 25 fisheries, although efforts are currently underway to update the stock and fishery stratification to a total of 40 stocks and 48 fisheries. Currently neither the CWT-base ER analysis or the PSC Chinook model are equipped to account for the differential effects of mark-selective fisheries, which have been employed for recreational Chinook fisheries in Puget Sound since 2003.

For this analysis, we chose to evaluate effects using the FRAM for a number of reasons. First, and most importantly, compared to other available models the stock stratification in the FRAM is best structured for evaluating impacts to specific Chinook salmon stocks within the Puget Sound Chinook ESU. It contains 19 separate Puget Sound stocks that are each separated into marked (adipose clipped) and unmarked (adipose intact) components. Through integration with the Terminal Area Management Module (TAMM), we are able to estimate ERs specific to each of the 14 management units within the Puget Sound Chinook ESU. In contrast, the Puget Sound stock structure is slightly more aggregated in the CTC's ER analysis and the PSC Chinook model, which contain 14 and 8 Puget Sound stocks, respectively, and cannot provide ER estimates for all 14 management units. Puget Sound Chinook salmon are also exposed to a substantial level of mark-selective fishing pressure which the CWT-based ER analysis and PSC Chinook Model are not currently equipped to properly account for. The FRAM base period has recently been updated to a contemporary dataset (catch years 2007-2013), which is closely aligned with the 2009-2015 CYER base period for ISBM fisheries identified in the 2019 Agreement. Finally, FRAM is structured in a manner that allows for straightforward systematic manipulation of inputs to reflect the specifics of the four model scenarios outlined above. It is important to note, however, that estimates of ER for a given stock derived from the various models may differ, sometimes significantly. Where differences exist it is necessary to look at the source data for the stock and consider why the difference may occur.

The variety of models and assessment techniques used to analyze various populations or ESUs under the various harvest scenarios can be confusing. This diversity of information becomes apparent particularly in a complex consultation like this one that considers such a broad range of species from several geographic domains. Unfortunately, it is simply a fact that methods have evolved over the last 16 years since the original ESA listings of salmon in 1992 based on circumstance at the time and the available information. We have made progress in bringing consistency to the ESA Section 7 review process as described in section 2.1 Analytical Approach. The VSP paper, for example, also provides a consistent context for assessing the status of populations (McElhany et al. 2000). But even now there is no single best method for assessing the effects of harvest or other types of actions. NMFS relies on the best information available at the time of any particular consultation, and will continue to do so despite its apparent complexity.

2.5.2 Chinook Salmon

2.5.2.1 Lower Columbia River Chinook

To assess the effects of the proposed actions using the retrospective analysis we first compare the observed ERs from the FRAM Validation runs (scenario 1) with the 2019 Likely scenario 2 for each component of the ESU (Figure 41, Figure 42, and Figure 43). For LCR spring Chinook salmon the absolute change in the average ER is -1.0 percent in marine area fisheries and -0.2 percent in the SEAK fishery, but these represent relative changes of -5.5 percent and -12.2 percent, respectively (Table 45). For LCR tule Chinook salmon the absolute change in the average ER is -3.8 percent in marine area fisheries and -0.3 percent in the SEAK fishery, and these represent relative changes of -11.4 percent and -10.6 percent, respectively (Table 45). And for LCR bright Chinook salmon the absolute change in the average ER is -5.0 percent in marine area fisheries and -0.7 percent in the SEAK fishery, and these represent relative changes of -9.9 percent and -6.4 percent, respectively (Table 45).

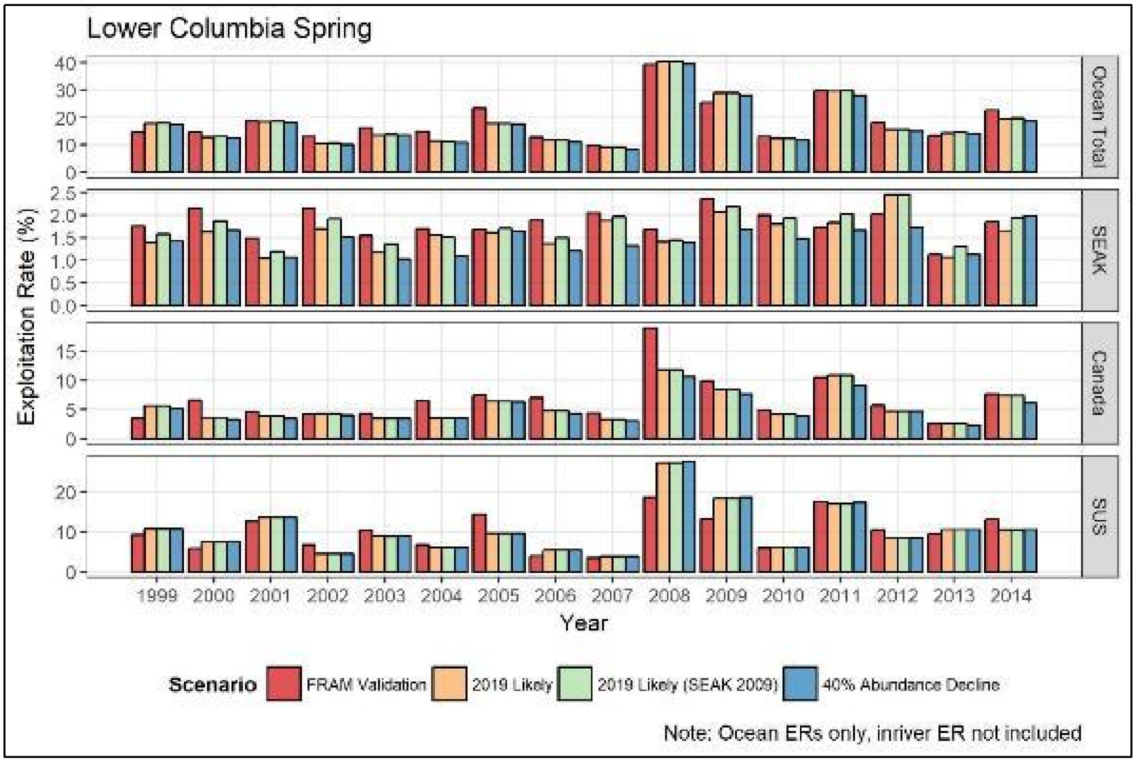

Figure 41. Comparison of ERs on LCR Spring Chinook salmon between scenarios 1 through 4 in the retrospective analysis.

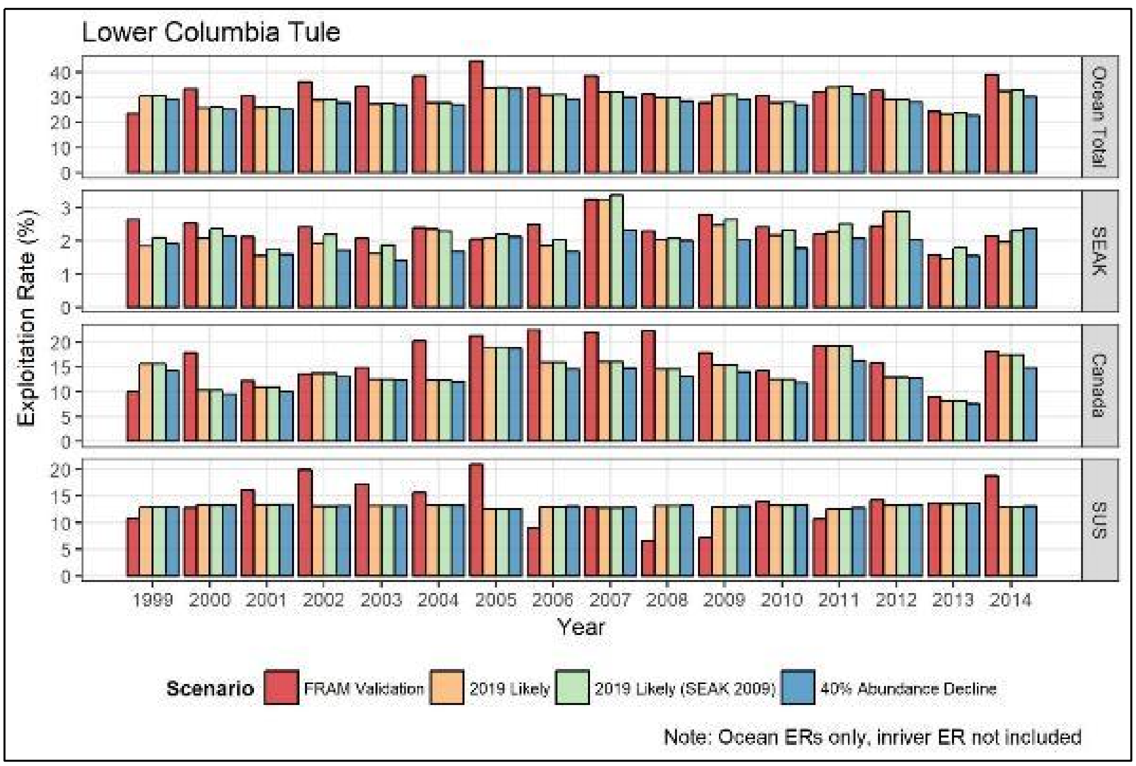

Figure 42. Comparison of ERs on LCR tule Chinook salmon between scenarios 1 through 4 in the retrospective analysis.

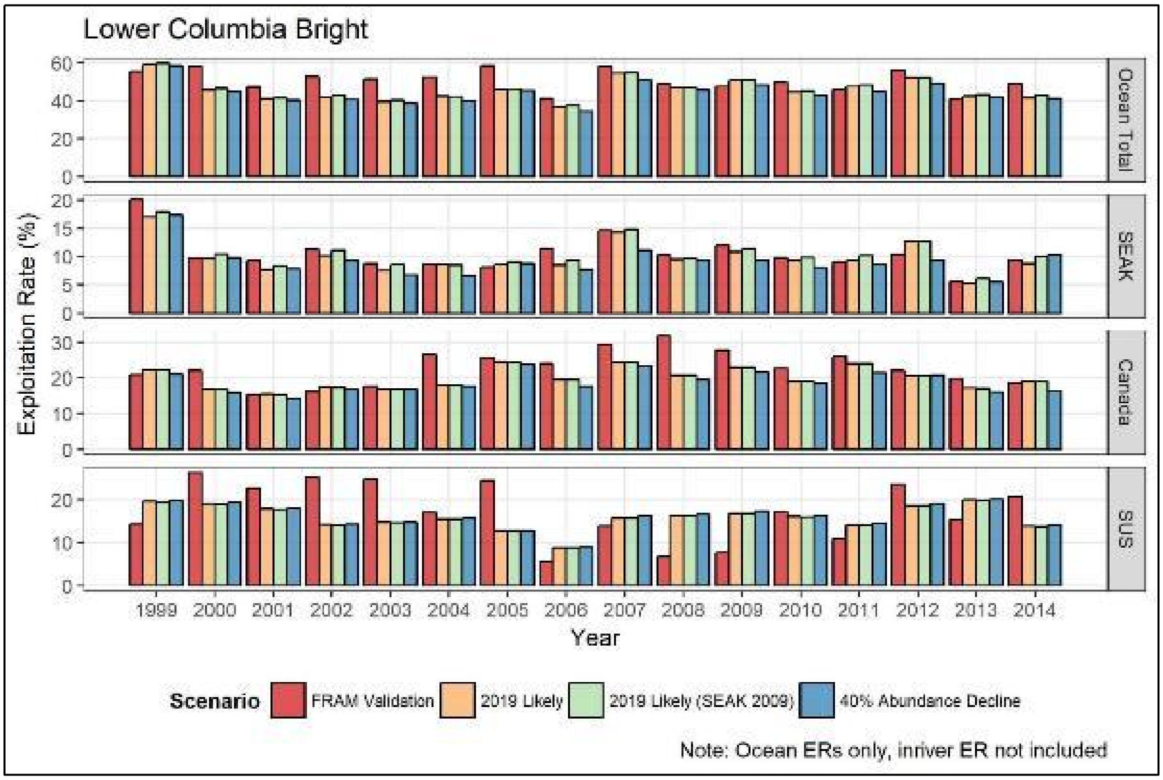

Figure 43. Comparison of ERs on LCR bright Chinook salmon between scenarios 1 through 4 in the retrospective analysis.

Table 45. ER changes between scenario 1 and scenario 2 in the retrospective analysis on LCR Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
LCR Chinook – Spring component	Scenario 1	1.8%	6.8%	10.0%	0.2%	18.7%
	Scenario 2	1.6%	5.6%	10.4%	0.1%	17.7%
	Abs ER Change	-0.2%	-1.2%	0.5%	0.0%	-1.0%
	Rel ER Change	-12.2%	-18.1%	4.5%	-12.1%	-5.5%
LCR Chinook – Tule component	Scenario 1	2.4%	16.9%	13.4%	0.2%	33.1%
	Scenario 2	2.1%	14.1%	12.7%	0.2%	29.3%
	Abs ER Change	-0.3%	-2.8%	-0.8%	0.0%	-3.8%
	Rel ER Change	-10.6%	-16.4%	-5.6%	-12.4%	-11.4%
LCR Chinook – Bright component	Scenario 1	10.5%	22.9%	17.3%	0.0%	50.7%
	Scenario 2	9.9%	20.0%	15.9%	0.0%	45.7%
	Abs ER Change	-0.7%	-2.9%	-1.4%	0.0%	-5.0%
	Rel ER Change	-6.4%	-12.8%	-8.1%	NA	-9.9%

Scenarios 2 and 3 provide a more direct comparison of how ER is expect to change as a result of the proposed reduction in the SEAK fishery from the 2009 Agreement (scenario 3) to the 2019 Agreement (scenario 2). Under the 2019 Agreement recall that in most years the SEAK fishery will be reduced by 7.5 percent relative to the 2009 Agreement. (See section 1.3 Proposed Action for more detail.) The proposed change will result in an absolute reduction in the average ER in the SEAK fishery of -0.1 percent on LCR spring Chinook salmon, -0.2 percent on LCR tule Chinook salmon, and -0.7 percent on LCR bright Chinook salmon. The proposed change will result in the average ER relative change in the SEAK fishery of -8.1 percent, -8.0 percent, and -6.2 percent, respectively (Table 46).

Table 46. ER changes between scenario 3 and scenario 2 in the retrospective analysis on LCR Chinook salmon. Abs=Absolute, Rel=Relative.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
LCR Chinook – Spring component	Scenario 3	1.7%	5.6%	10.4%	0.1%	17.8%
	Scenario 2	1.6%	5.6%	10.4%	0.1%	17.7%
	Abs ER Change	-0.1%	0.0%	0.0%	0.0%	-0.1%
	Rel ER Change	-8.1%	0.0%	0.1%	0.1%	-0.7%
LCR Chinook – Tule component	Scenario 3	2.3%	14.2%	12.7%	0.2%	29.5%
	Scenario 2	2.1%	14.1%	12.7%	0.2%	29.3%
	Abs ER Change	-0.2%	0.0%	0.0%	0.0%	-0.2%
	Rel ER Change	-8.0%	-0.1%	0.1%	0.0%	-0.6%
LCR Chinook – Bright component	Scenario 3	10.5%	19.9%	15.8%	0.0%	46.3%
	Scenario 2	9.9%	20.0%	15.9%	0.0%	45.7%
	Abs ER Change	-0.7%	0.0%	0.1%	0.0%	-0.5%
	Rel ER Change	-6.2%	0.2%	0.4%	NA	-1.2%

A comparison of scenarios 2 and 4 examine how the fisheries will respond to a 40 percent reduction in coast wide abundance (scenario 4). The proposed change will result in an absolute reduction in the average ER in the SEAK fishery of -0.2 percent on LCR spring Chinook salmon, -0.2 percent on LCR tule Chinook salmon, and -0.8 percent on LCR bright Chinook salmon. The proposed change will result in the average ER relative change in the SEAK fishery of -10.1 percent, -10.0 percent, and -7.7 percent, respectively (Table 47).

Table 47. ER changes between scenario 2 and scenario 4 in the retrospective analysis on LCR Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
LCR	Scenario 2	1.6%	5.6%	10.4%	0.1%	17.7%

Chinook – Spring component	Scenario 4	1.4%	5.1%	10.5%	0.1%	17.1%
	Abs ER Change	-0.2%	-0.5%	0.1%	0.0%	-0.6%
	Rel ER Change	-10.1%	-9.1%	0.9%	0.7%	-3.2%
LCR Chinook – Tule component	Scenario 2	2.1%	14.1%	12.7%	0.2%	29.3%
	Scenario 4	1.9%	13.1%	12.7%	0.2%	28.1%
	Abs ER Change	-0.2%	-1.1%	0.1%	0.0%	-1.2%
	Rel ER Change	-10.0%	-7.5%	0.6%	0.3%	-4.0%
LCR Chinook – Bright component	Scenario 2	9.9%	20.0%	15.9%	0.0%	45.7%
	Scenario 4	9.1%	18.9%	16.2%	0.0%	44.1%
	Abs ER Change	-0.8%	-1.1%	0.2%	0.0%	-1.6%
	Rel ER Change	-7.7%	-5.5%	1.5%	NA	-3.5%

2.5.2.2 Upper Willamette Chinook

The retrospective analysis is used to compare the observed ERs from the FRAM Validation runs (scenario 1) and the 2019 Likely scenario 2 for UWR Chinook salmon (Figure 44). The absolute change in the average ER is -1.2 percent in ocean fisheries and -0.5 percent in the SEAK fishery, but these represent relative changes of -11.3 percent and -11.7 percent, respectively (Table 48).

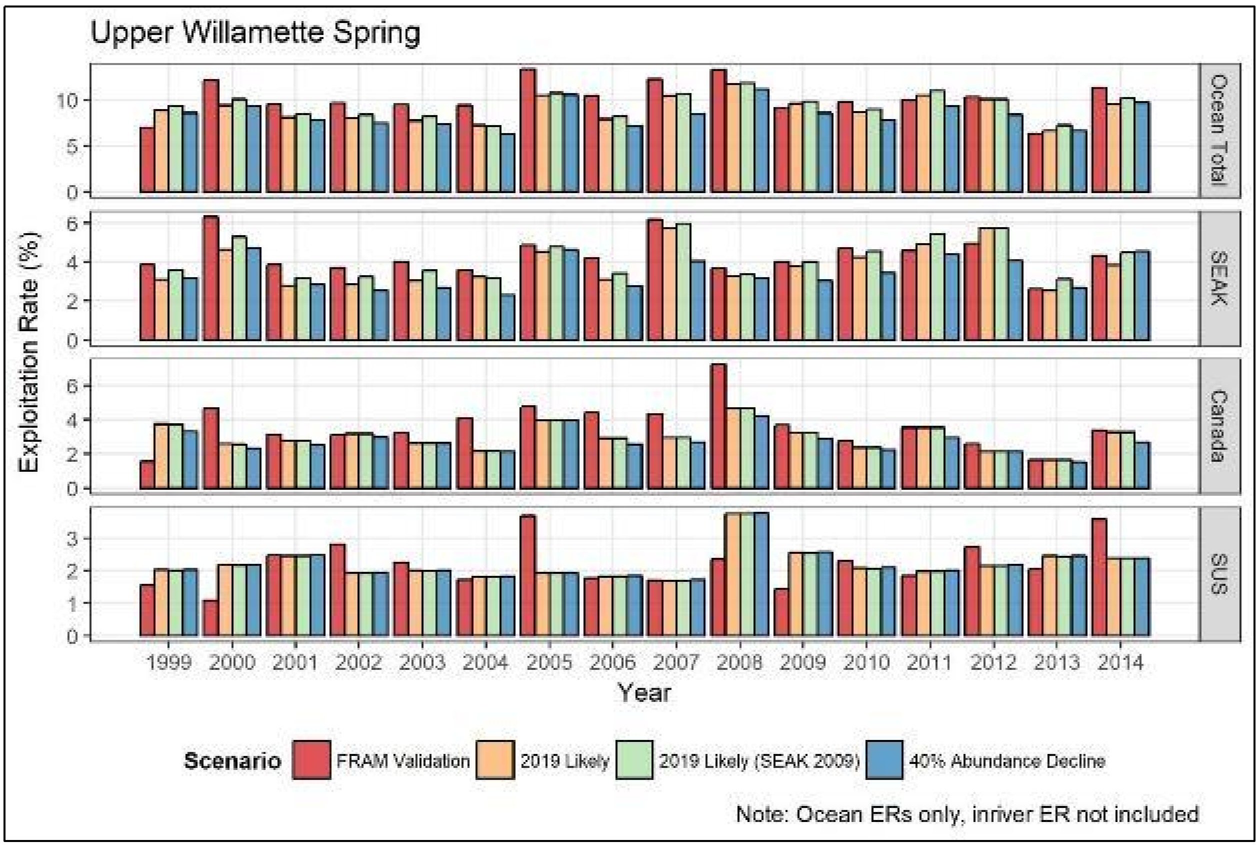

Figure 44. Comparison of ERs on UWR Spring Chinook salmon between Scenarios 1 through 4

in the retrospective analysis.

Table 48. ER changes between scenario 1 and scenario 2 in the retrospective analysis on UWR Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
UWR Chinook Salmon	Scenario 1	4.3%	3.6%	2.1%	0.1%	10.2%
	Scenario 2	3.8%	3.0%	2.1%	0.1%	9.0%
	Abs ER Change	-0.5%	-0.6%	0.0%	0.0%	-1.2%
	Rel ER Change	-11.7%	-17.6%	0.3%	-21.5%	-11.3%

Scenarios 2 and 3 provide a more direct comparison of how ER is expect to change as a result of the proposed reduction in the SEAK fishery from the 2009 Agreement (scenario 3) to the 2019 Agreement (scenario 2). (See section 1.3 Proposed Action for details related to the proposed change.) The proposed change will result in an absolute reduction in the average ER in the SEAK fishery of -0.3 percent and a relative change of -8.3 percent (Table 49).

Table 49. ER changes between scenario 3 and scenario 2 in the retrospective analysis on UWR Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
UWR Chinook Salmon	Scenario 3	4.2%	3.0%	2.1%	0.1%	9.4%
	Scenario 2	3.8%	3.0%	2.1%	0.1%	9.0%
	Abs ER Change	-0.3%	0.0%	0.0%	0.0%	-0.3%
	Rel ER Change	-8.3%	0.2%	0.3%	0.2%	-3.6%

A comparison of scenarios 2 and 4 examine how the fisheries will respond to a 40 percent reduction in coast wide abundance (scenario 4). The absolute change in the average ER is -0.6 percent in ocean fisheries and -0.4 percent in the SEAK fishery, but these represent relative changes of -7.1 percent and -10.4 percent, respectively (Table 50).

Table 50. ER changes between scenario 2 and scenario 4 in the retrospective analysis on UWR Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
UWR Chinook Salmon	Scenario 2	3.8%	3.0%	2.1%	0.1%	9.0%
	Scenario 4	3.4%	2.7%	2.2%	0.1%	8.4%
	Abs ER Change	-0.4%	-0.3%	0.0%	0.0%	-0.6%
	Rel ER Change	-10.4%	-8.6%	0.6%	0.4%	-7.1%

2.5.2.3 Snake River Fall-Run Chinook

The retrospective analysis is used to compare the observed ERs from the FRAM Validation runs (scenario 1) and the Likely scenario 2 for Snake River fall-run Chinook salmon (Figure 45). The absolute change in the average ER is -4.4 percent in ocean fisheries and -0.2 percent in the SEAK fishery, but these represent relative changes of -11.4 percent and-12.0 percent, respectively (Table 51).

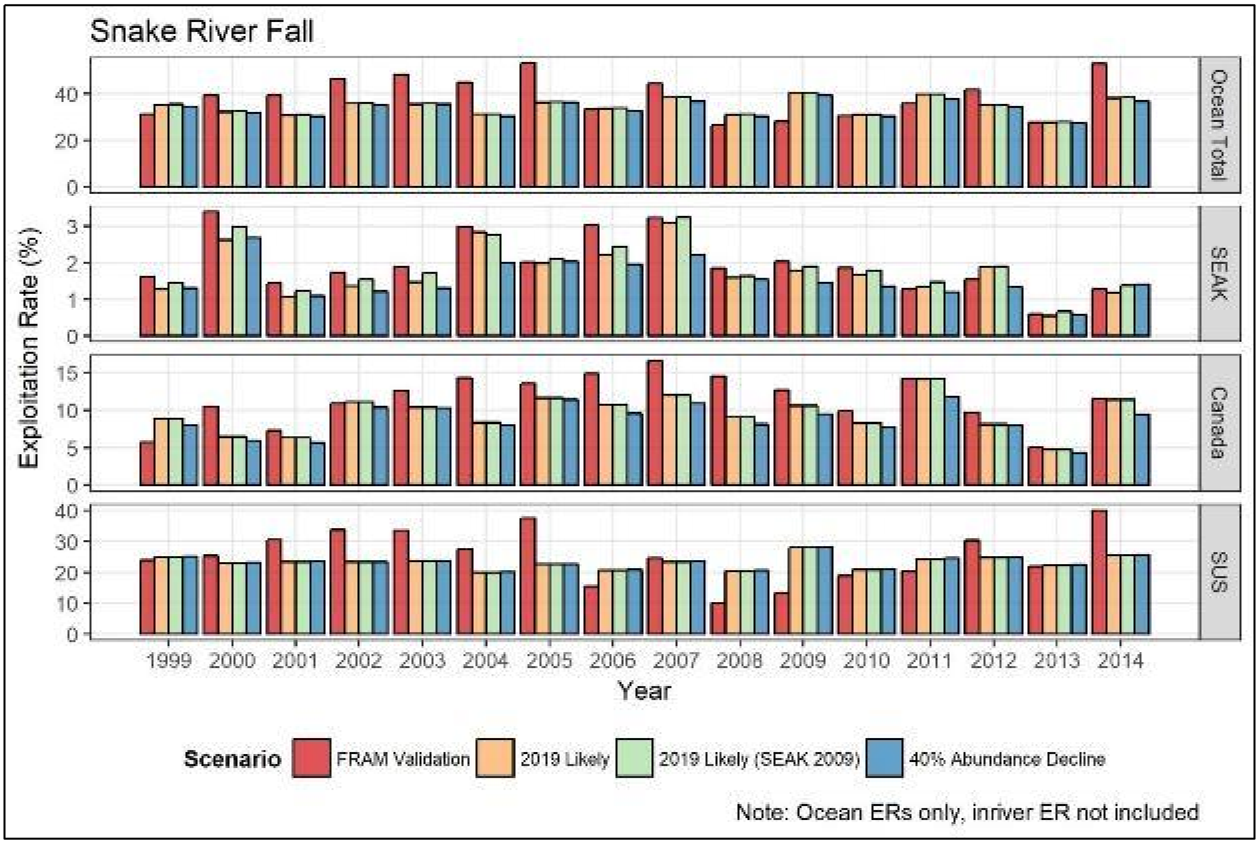

Figure 45. Comparison of ERs on Snake River fall-run Chinook salmon between scenarios 1 through 4 in the retrospective analysis.

Table 51. ER changes between scenario 1 and scenario 2 in the retrospective analysis on Snake River fall-run Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Snake River fall-run Chinook salmon	Scenario 1	2.0%	11.5%	25.1%	0.3%	38.9%
	Scenario 2	1.7%	9.5%	23.0%	0.2%	34.4%
	Abs ER Change	-0.2%	-2.0%	-2.2%	0.0%	-4.4%
	Rel ER Change	-12.0%	-17.3%	-8.6%	-16.8%	-11.4%

Scenarios 2 and 3 provide a more direct comparison of how ER is expect to change as a result of the proposed reduction in the SEAK fishery from the 2009 Agreement (scenario 3) to the 2019 Agreement (scenario 2). The proposed change will result in an absolute reduction in the average ER in the SEAK fishery of -0.1 percent and a relative change of -7.5 percent (Table 52).

Table 52. ER changes between scenario 3 and scenario 2 in the retrospective analysis on Snake River fall-run Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Snake River fall-run Chinook salmon	Scenario 3	1.9%	9.5%	23.0%	0.2%	34.6%
	Scenario 2	1.7%	9.5%	23.0%	0.2%	34.4%
	Abs ER Change	-0.1%	0.0%	0.0%	0.0%	-0.1%
	Rel ER Change	-7.5%	-0.1%	0.0%	0.0%	-0.4%

A comparison of scenarios 2 and 4 examine how the fisheries will respond to a 40 percent reduction in coast wide abundance (scenario 4). The absolute change in the average ER is -0.9 percent in ocean fisheries and -0.2 percent in the SEAK fishery, but these represent relative changes of -2.5 percent and -11.7 percent, respectively (Table 53).

Table 53. ER changes between scenario 2 and scenario 4 in the retrospective analysis on Snake River fall-run Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Snake River fall-run Chinook salmon	Scenario 2	1.7%	9.5%	23.0%	0.2%	34.4%
	Scenario 4	1.5%	8.7%	23.1%	0.2%	33.6%
	Abs ER Change	-0.2%	-0.8%	0.1%	0.0%	-0.9%
	Rel ER Change	-11.7%	-8.5%	0.6%	0.4%	-2.5%

2.5.2.4 Puget Sound Chinook

Effects of the proposed action on the various Puget Sound Chinook salmon populations as shown by the retrospective analysis vary considerably.

Strait of Juan de Fuca

Comparing the observed ERs from the FRAM Validation runs (scenario 1) with the 2019 Likely scenario 2 are captured in Figure 46 for Elwha River Chinook salmon. The absolute change in the average ER is -2.7 percent in ocean fisheries and -0.1 percent in the SEAK fishery, but these represent relative changes of -18.9 percent and -10.3 percent, respectively (Table 54).

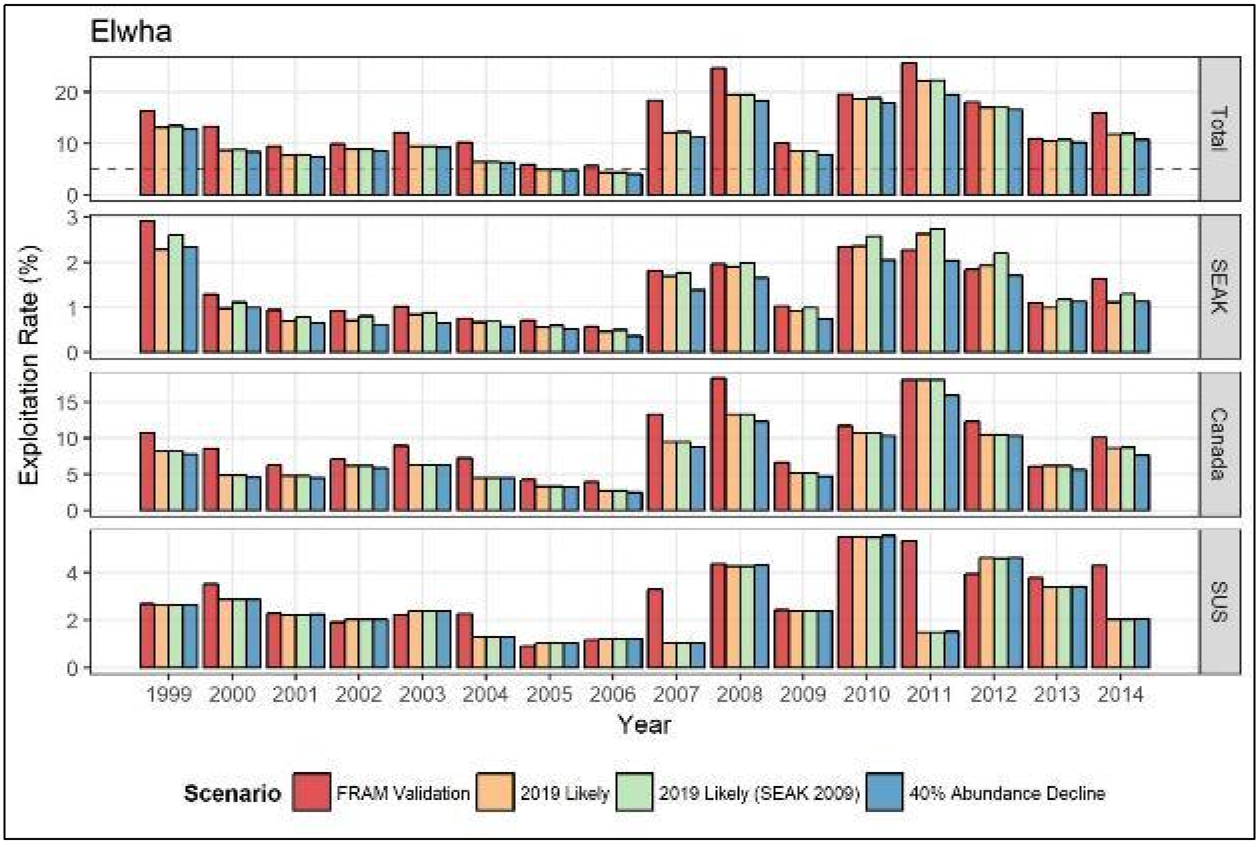

Figure 46. Comparison of ERs on Elwha River Chinook salmon between scenarios 1 through 4 in the retrospective analysis. (Dashed line on total ER plot represents RER)

Table 54. ER changes between scenario 1 and scenario 2 in the retrospective analysis on Elwha River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Elwha R	Scenario 1	1.4%	9.6%	0.9%	2.2%	14.1%
	Scenario 2	1.3%	7.6%	0.9%	1.6%	11.4%
	Abs ER Change	-0.1%	-1.9%	0.0%	-0.6%	-2.7%
	Rel ER Change	-10.3%	-20.2%	-2.6%	-26.3%	-18.9%

Scenarios 2 and 3 provide a more direct comparison of how ER is expect to change as a result of the proposed reduction in the SEAK fishery from the 2009 Agreement (scenario 3) to the 2019 Agreement (scenario 2). The proposed change will result in an absolute reduction in the average ER in the SEAK fishery of -0.1 percent and a relative change of -8.7 percent (Table 55).

Table 55. ER changes between scenario 3 and scenario 2 in the retrospective analysis on Elwha River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Elwha R	Scenario 3	1.4%	7.6%	0.9%	1.6%	11.6%
	Scenario 2	1.3%	7.6%	0.9%	1.6%	11.4%
	Abs ER Change	-0.1%	0.0%	0.0%	0.0%	-0.1%
	Rel ER Change	-8.7%	-0.1%	0.1%	0.1%	-1.1%

A comparison of scenarios 2 and 4 examine how the fisheries will respond to a 40 percent reduction in coast wide abundance (scenario 4). The absolute change in the average ER is -0.6 percent in ocean fisheries and -0.1 percent in the SEAK fishery, but these represent relative changes of -5.4 percent and -10.5 percent, respectively (Table 56).

Table 56. ER changes between scenario 2 and scenario 4 in the retrospective analysis on Elwha River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Elwha R	Scenario 2	1.3%	7.6%	0.9%	1.6%	11.4%
	Scenario 4	1.2%	7.1%	0.9%	1.6%	10.8%
	Abs ER Change	-0.1%	-0.5%	0.0%	0.0%	-0.6%
	Rel ER Change	-10.5%	-6.5%	0.6%	0.5%	-5.4%

Results of the FRAM Validation analysis for the Dungeness population are quite similar to those of the Elwha and are shown in Figure 47 and Table 57 through Table 59.

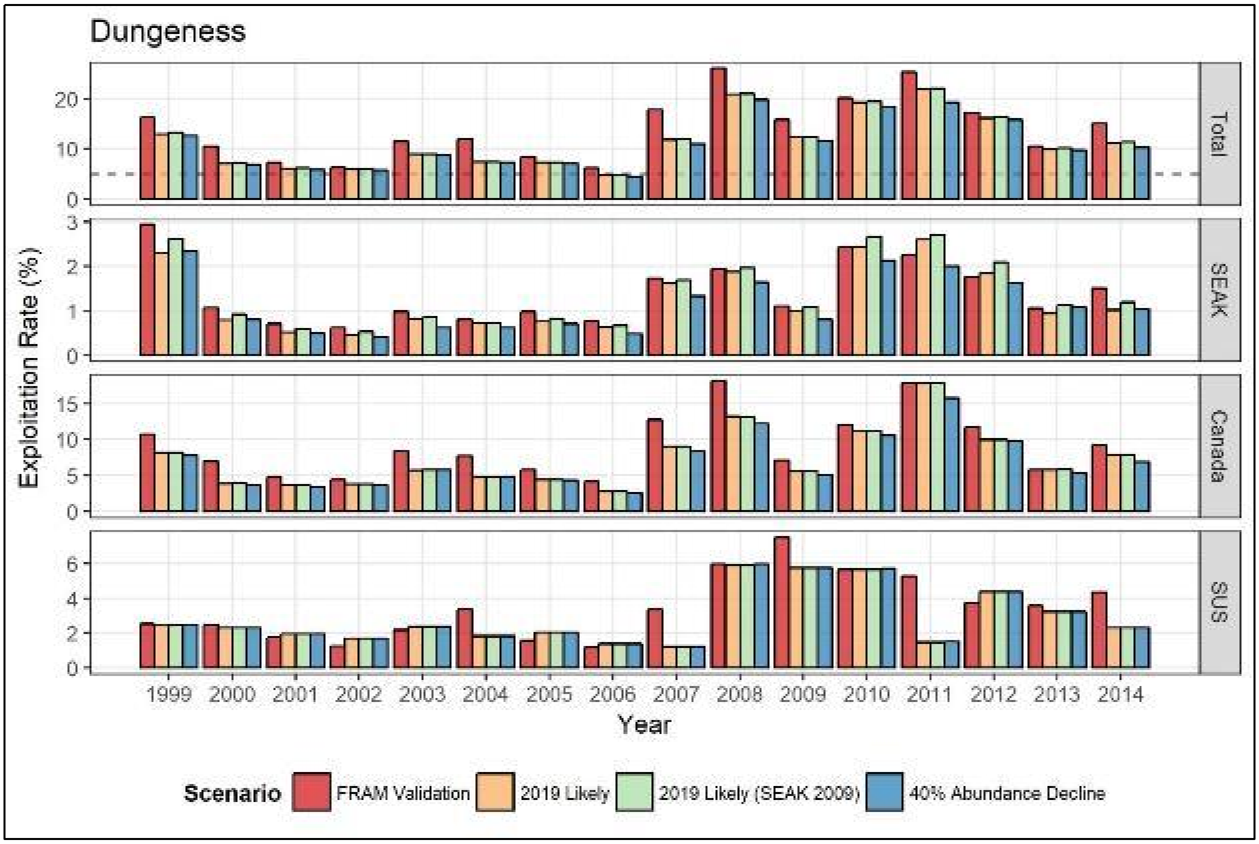

Figure 47. Comparison of ERs on Dungeness River Chinook salmon between scenarios 1 through 4 in the retrospective analysis. (Dashed line on total ER plot represents RER)

Table 57. ER changes between scenario 1 and scenario 2 in the retrospective analysis on Dungeness River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Dungeness R	Scenario 1	1.4%	9.2%	1.0%	2.5%	14.1%
	Scenario 2	1.3%	7.4%	0.9%	2.0%	11.5%
	Abs ER Change	-0.1%	-1.9%	-0.1%	-0.5%	-2.6%
	Rel ER Change	-10.1%	-20.3%	-8.4%	-21.1%	-18.6%

Scenarios 2 and 3 provide a more direct comparison of how ER is expect to change as a result of the proposed reduction in the SEAK fishery from the 2009 Agreement (scenario 3) to the 2019 Agreement (scenario 2). The proposed change will result in an absolute reduction in the average ER in the SEAK fishery of -0.1 percent and a relative change of -8.5 percent (Table 58).

Table 58. ER changes between scenario 3 and scenario 2 in the retrospective analysis on Dungeness River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Dungeness R	Scenario 3	1.4%	7.4%	0.9%	2.0%	11.6%
	Scenario 2	1.3%	7.4%	0.9%	2.0%	11.5%
	Abs ER Change	-0.1%	0.0%	0.0%	0.0%	-0.1%
	Rel ER Change	-8.5%	-0.1%	0.1%	0.1%	-1.0%

A comparison of scenarios 2 and 4 examine how the fisheries will respond to a 40 percent reduction in coast wide abundance (scenario 4). The absolute change in the average ER is -0.6 percent in ocean fisheries and -0.1 percent in the SEAK fishery, but these represent relative changes of -5.2 percent and -10.9 percent, respectively (Table 59).

Table 59. ER changes between scenario 2 and scenario 4 in the retrospective analysis on Dungeness River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Dungeness R	Scenario 2	1.3%	7.4%	0.9%	2.0%	11.5%
	Scenario 4	1.1%	6.9%	0.9%	2.0%	10.9%
	Abs ER Change	-0.1%	-0.5%	0.0%	0.0%	-0.6%
	Rel ER Change	-10.9%	-6.5%	0.6%	0.5%	-5.2%

Figure 48 captures the changes in expected escapements for the Strait of Juan de Fuca populations across each scenario. The Elwha population in general remains above its UET in all scenarios, except for scenario 4 where it falls below the UET in seven of the 16 years, but still remains above the CET. The Dungeness population only exceeds the UET in three years, and generally ends up with escapement between the UET and CET levels. There are six years where it falls below the CET level, generally under scenario 4.

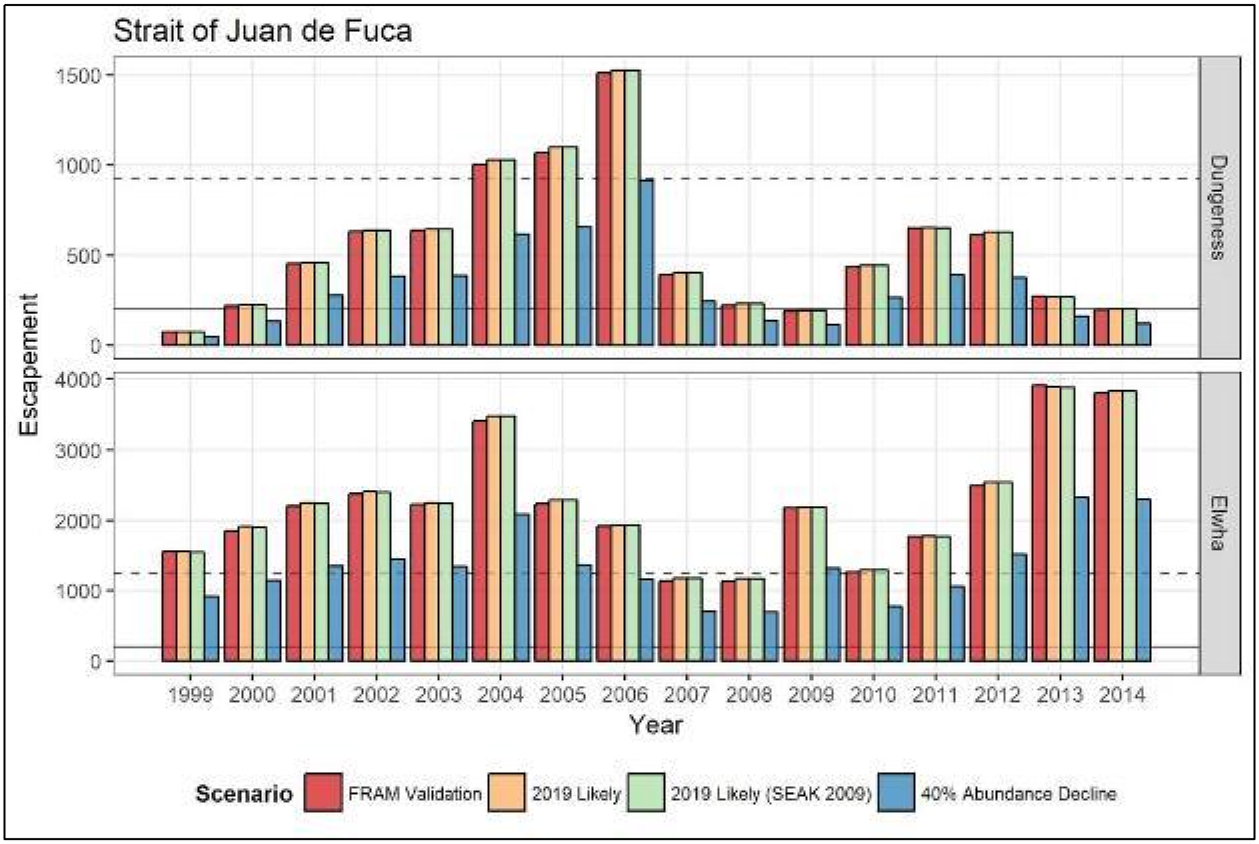

Figure 48. Escapement of Strait of Juan de Fuca populations based on retrospective analysis scenarios. (Dashed line represents UET, solid line represents CET, see Table 29 for population specific values).

Hood Canal

Comparing the observed ERs from the FRAM Validation runs (scenario 1) with the Likely scenario 2 are captured in Figure 49 for Mid-Hood Canal Chinook salmon. The absolute change in the average ER is -3.5 percent in ocean fisheries and -0.1 percent in the SEAK fishery, but these represent relative changes of -14.3 percent and -17.1 percent, respectively (Table 60).

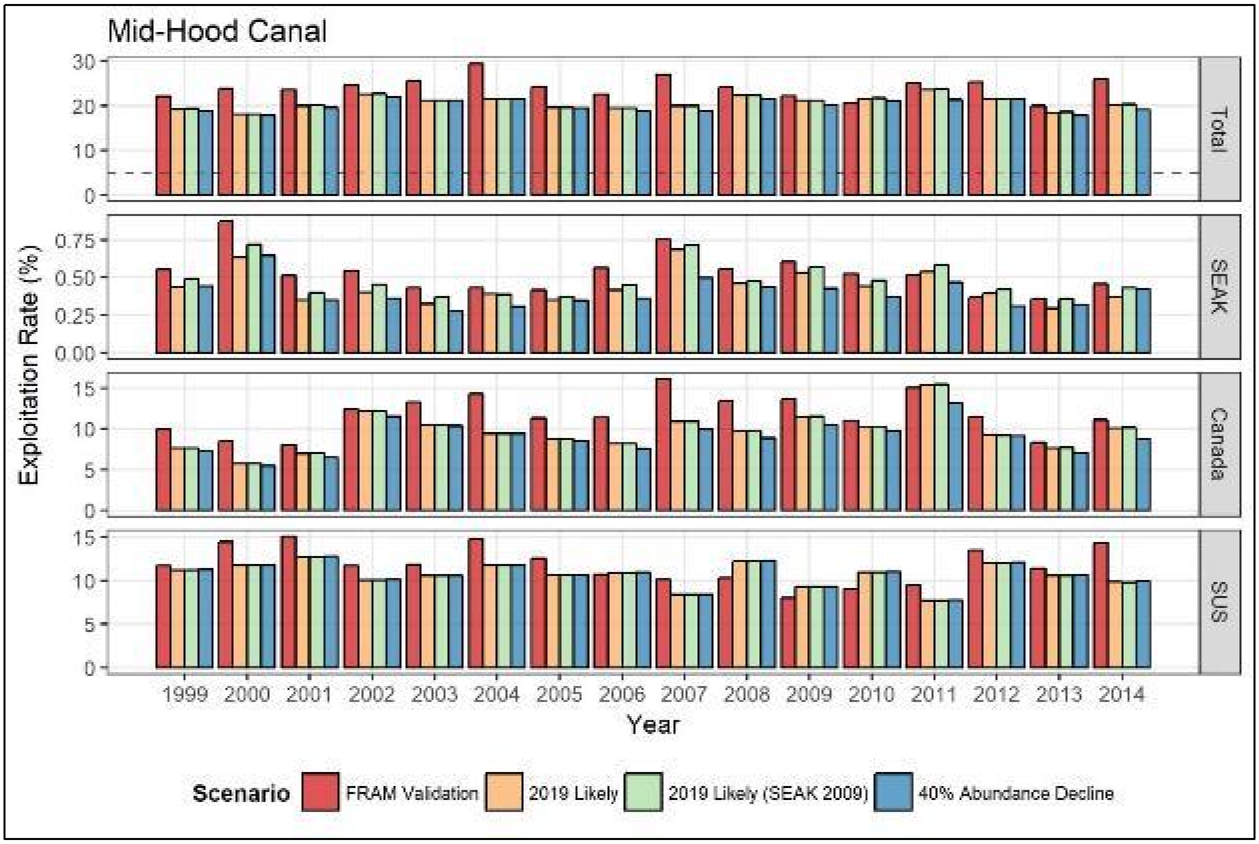

Figure 49. Comparison of ERs on Mid-Hood Canal Chinook salmon between scenarios 1 through 4 in the retrospective analysis. (Dashed line on total ER plot represents RER)

Table 60. ER changes between scenario 1 and scenario 2 in the retrospective analysis on Mid-Hood Canal Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Mid-Hood Canal	Scenario 1	0.5%	11.8%	5.9%	5.8%	24.2%
	Scenario 2	0.4%	9.6%	6.2%	4.5%	20.7%
	Abs ER Change	-0.1%	-2.2%	0.2%	-1.4%	-3.5%
	Rel ER Change	-17.1%	-18.7%	3.5%	-23.5%	-14.3%

Scenarios 2 and 3 provide a more direct comparison of how ER is expect to change as a result of the proposed reduction in the SEAK fishery from the 2009 Agreement (scenario 3) to the 2019 Agreement (scenario 2). The proposed change will result in an absolute reduction in the average ER of -0.04 percent and a relative change in the SEAK fishery of -8.5 percent (Table 61).

Table 61. ER changes between scenario 3 and scenario 2 in the retrospective analysis on Mid-Hood Canal Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Mid-Hood Canal	Scenario 3	0.5%	9.6%	6.2%	4.5%	20.7%
	Scenario 2	0.4%	9.6%	6.2%	4.5%	20.7%
	Abs ER Change	-0.04%	0.0%	0.0%	0.0%	-0.05%
	Rel ER Change	-8.5%	-0.1%	0.0%	0.0%	-0.2%

A comparison of scenarios 2 and 4 examine how the fisheries will respond to a 40 percent reduction in coast wide abundance (scenario 4). The absolute change in the average ER is -0.7 percent in ocean fisheries and -0.04 percent in the SEAK fishery, but these represent relative changes of -3.2 percent and -9.6 percent, respectively (Table 62).

Table 62. ER changes between scenario 2 and scenario 4 in the retrospective analysis on Mid-Hood Canal Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Mid-Hood Canal	Scenario 2	0.4%	9.6%	6.2%	4.5%	20.7%
	Scenario 4	0.4%	9.0%	6.2%	4.5%	20.0%
	Abs ER Change	-0.04%	-0.6%	0.0%	0.0%	-0.7%
	Rel ER Change	-9.6%	-6.8%	0.3%	0.4%	-3.2%

Comparing the observed ERs from the FRAM Validation runs (scenario 1) with the Likely scenario 2 are captured in Figure 50 for Skokomish River Chinook salmon. The absolute change in the average ER is -8.5 percent in ocean fisheries and -0.1 percent in the SEAK fishery, but these represent relative changes of -15.2 percent and -16.0 percent, respectively (Table 63).

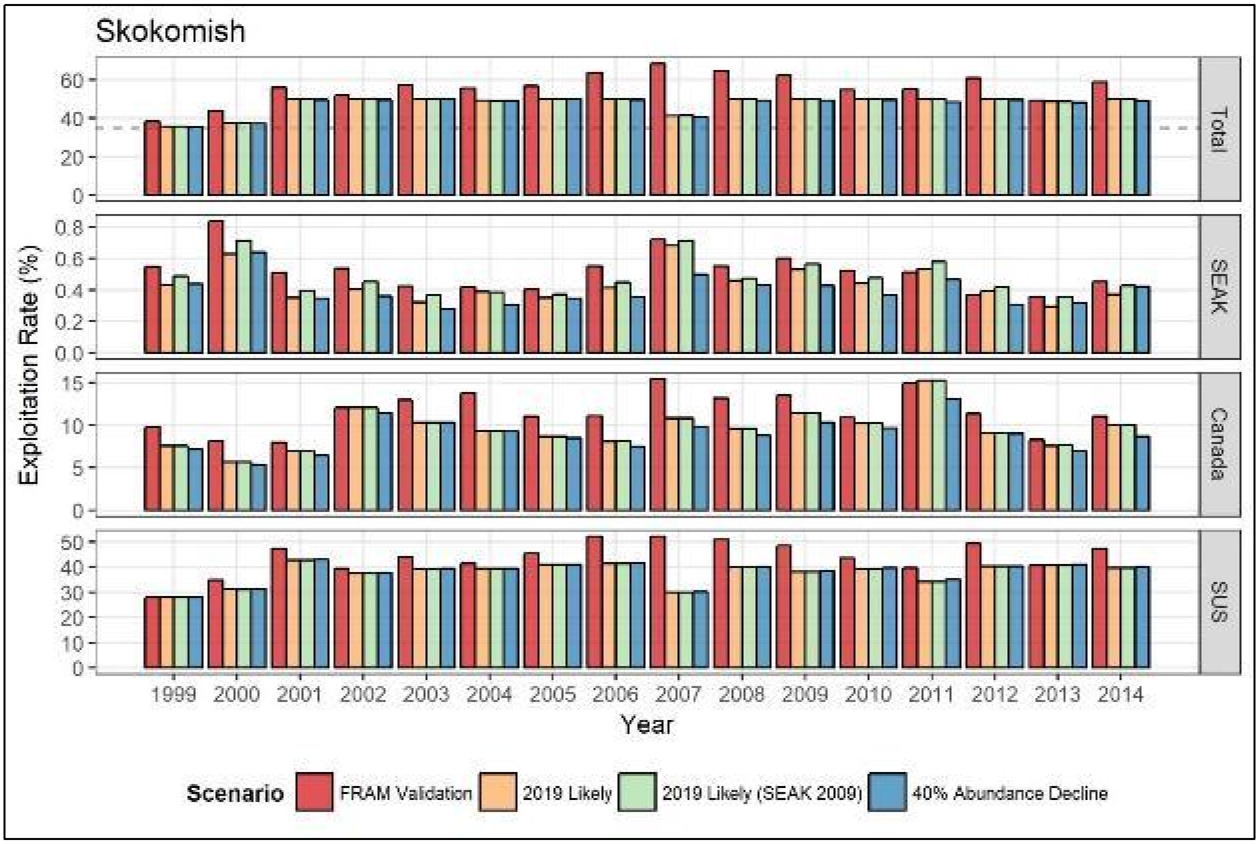

Figure 50. Comparison of ERs on Skokomish River Chinook salmon between scenarios 1 through 4 in the retrospective analysis (dashed line on total ER plot represents RER).

Table 63. ER changes between scenario 1 and scenario 2 in the retrospective analysis on Skokomish River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Skokomish R	Scenario 1	0.5%	11.6%	5.8%	38.2%	56.2%
	Scenario 2	0.4%	9.5%	6.1%	31.5%	47.6%
	Abs ER Change	-0.1%	-2.1%	0.3%	-6.7%	-8.5%
	Rel ER Change	-16.0%	-17.7%	4.7%	-17.5%	-15.2%

Scenarios 2 and 3 provide a more direct comparison of how ER is expect to change as a result of the proposed reduction in the SEAK fishery from the 2009 Agreement (scenario 3) to the 2019 Agreement (scenario 2). The proposed change will result in an absolute reduction in the average ER of -0.04 percent and a relative change in the SEAK fishery of -8.5 percent (Table 64).

Table 64. ER changes between scenario 3 and scenario 2 in the retrospective analysis on Skokomish River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Skokomish R	Scenario 3	0.5%	9.6%	6.1%	31.5%	47.7%
	Scenario 2	0.4%	9.5%	6.1%	31.5%	47.6%
	Abs ER Change	-0.04%	0.0%	0.0%	0.0%	-0.04%
	Rel ER Change	-8.5%	-0.1%	0.0%	0.0%	-0.1%

A comparison of scenarios 2 and 4 examine how the fisheries will respond to a 40 percent reduction in coast wide abundance (scenario 4). The absolute change in the average ER is -0.4 percent in ocean fisheries and -0.04 percent in the SEAK fishery, but these represent relative changes of -0.9 percent and -9.6 percent, respectively (Table 65).

Table 65. ER changes between scenario 2 and scenario 4 in the retrospective analysis on Skokomish River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Skokomish R	Scenario 2	0.4%	9.5%	6.1%	31.5%	47.6%
	Scenario 4	0.4%	8.9%	6.1%	31.8%	47.2%
	Abs ER Change	-0.04%	-0.6%	0.0%	0.2%	-0.4%
	Rel ER Change	-9.6%	-6.8%	0.3%	0.7%	-0.9%

Figure 51 captures the changes in expected escapements for the Hood Canal populations across each scenario. Both the Mid-Hood Canal and Skokomish natural-origin populations fail to exceed the UET in all scenarios. The Skokomish population also does not exceed the CET, but the Mid-Hood Canal population does in seven years for all scenarios.

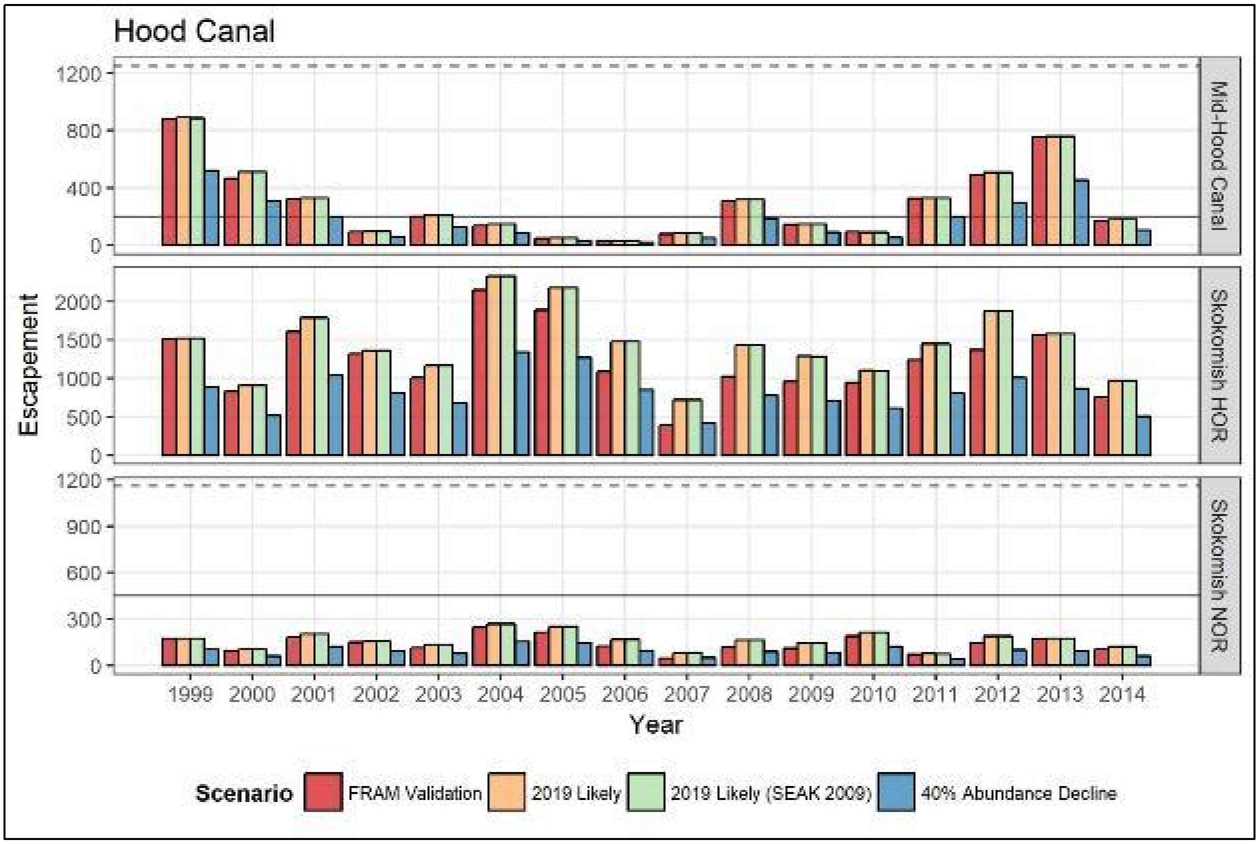

Figure 51. Escapement of Hood Canal populations based on retrospective analysis scenarios. (Dashed line represents UET, solid line represents CET, see Table 29 for population specific values).

Strait of Georgia

Comparing the observed ERs from the FRAM Validation runs (scenario 1) with the Likely scenario 2 are captured in Figure 52 for Nooksack River Chinook salmon. The absolute change in the average ER is -5.7 percent in ocean fisheries and -0.4 percent in the SEAK fishery, but these represent relative changes of -13.2 percent and -9.1 percent, respectively (Table 66).

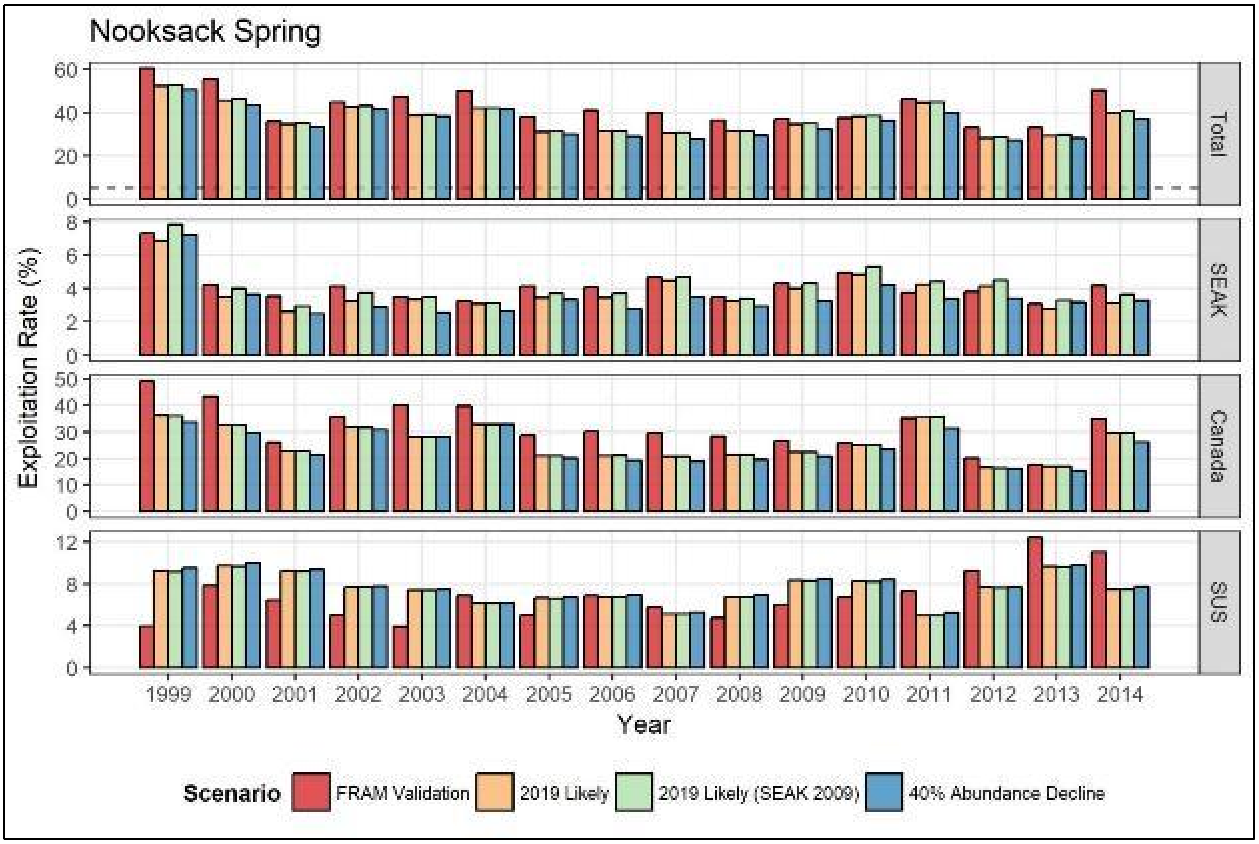

Figure 52. Comparison of ERs on Nooksack River Chinook salmon between scenarios 1 through 4 in the retrospective analysis (dashed line on total ER plot represents RER).

Table 66. ER changes between scenario 1 and scenario 2 in the retrospective analysis on Nooksack River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Nooksack R	Scenario 1	4.1%	31.9%	2.5%	4.3%	42.9%
	Scenario 2	3.8%	25.9%	2.9%	4.7%	37.2%
	Abs ER Change	-0.4%	-6.0%	0.3%	0.4%	-5.7%
	Rel ER Change	-9.1%	-18.9%	12.5%	10.2%	-13.2%

Scenarios 2 and 3 provide a more direct comparison of how ER is expect to change as a result of the proposed reduction in the SEAK fishery from the 2009 Agreement (scenario 3) to the 2019 Agreement (scenario 2). The proposed change will result in an absolute reduction in the average ER of -0.4 percent and a relative change in the SEAK fishery of -8.7 percent (Table 67).

Table 67. ER changes between scenario 3 and scenario 2 in the retrospective analysis on Nooksack River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Nooksack R	Scenario 3	4.1%	25.8%	2.8%	4.7%	37.5%
	Scenario 2	3.8%	25.9%	2.9%	4.7%	37.2%
	Abs ER Change	-0.4%	0.0%	0.0%	0.0%	-0.3%
	Rel ER Change	-8.7%	0.1%	0.3%	0.3%	-0.8%

A comparison of scenarios 2 and 4 examine how the fisheries will respond to a 40 percent reduction in coast wide abundance (scenario 4). The absolute change in the average ER is -1.9 percent in ocean fisheries and -0.4 percent in the SEAK fishery, but these represent relative changes of -5.0 percent and -9.3 percent, respectively (Table 68).

Table 68. ER changes between scenario 2 and scenario 4 in the retrospective analysis on Nooksack River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Nooksack R	Scenario 2	3.8%	25.9%	2.9%	4.7%	37.2%
	Scenario 4	3.4%	24.2%	2.9%	4.8%	35.3%
	Abs ER Change	-0.4%	-1.7%	0.0%	0.1%	-1.9%
	Rel ER Change	-9.3%	-6.4%	1.7%	2.0%	-5.0%

Figure 53 captures the changes in expected escapements for the Strait of Georgia populations across each scenario. Collectively, the Nooksack River populations exceed the UET in three years, under scenario 2 and scenario 3, but are generally between the UET and CET levels. The North Fork Nooksack River population exceed the CET in the majority of the years, but the South Fork Nooksack River population is generally below its CET for all scenarios.

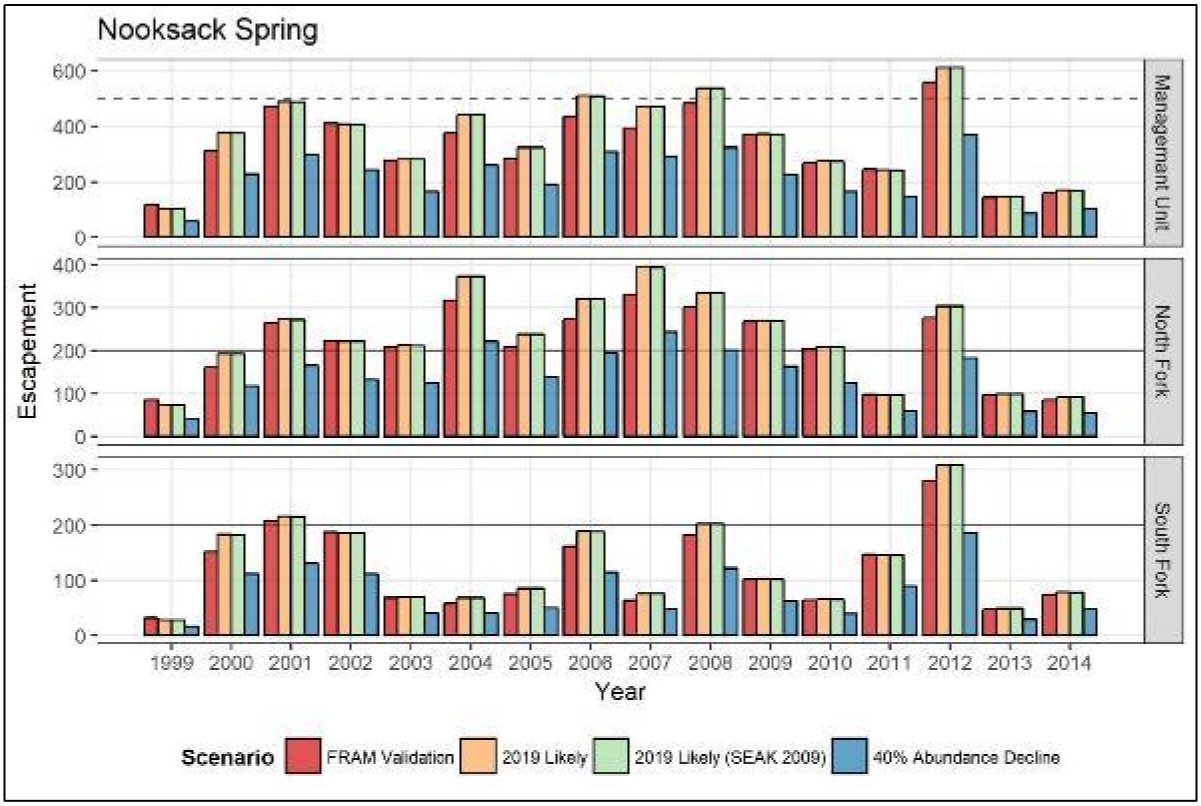

Figure 53. Escapement of Strait of Georgia populations based on retrospective analysis scenarios (dashed line represents UET, solid line represents CET, see Table 29 for population specific values).

Whidbey Basin

Comparing the observed ERs from the FRAM Validation runs (scenario 1) with the Likely scenario 2 are captured in Figure 54 for Skagit River spring Chinook salmon. The absolute change in the average ER is +1.4 percent in ocean fisheries but -0.03 percent in the SEAK fishery, and these represent relative changes of +7.1 percent and -8.9 percent, respectively (Table 69).

The higher Puget Sound ERs in scenario 2 compared to scenario 1 are a result of the new agreement and how the Likely scenario was modeled. In these runs, ISBM fisheries were modeled using the average rates that occurred over the 2009-2014 time period. In the Skagit River a freshwater net fishery targeting spring Chinook salmon was implemented beginning in 2008, resulting in a noticeable increase to ERs in freshwater fisheries. Thus, when the 2009-2014 average harvest rate in freshwater net fisheries was used in all years for the Likely scenario, it resulted ERs than were much higher than those in scenario 1 (what actually occurred) for the years 1999-2007.

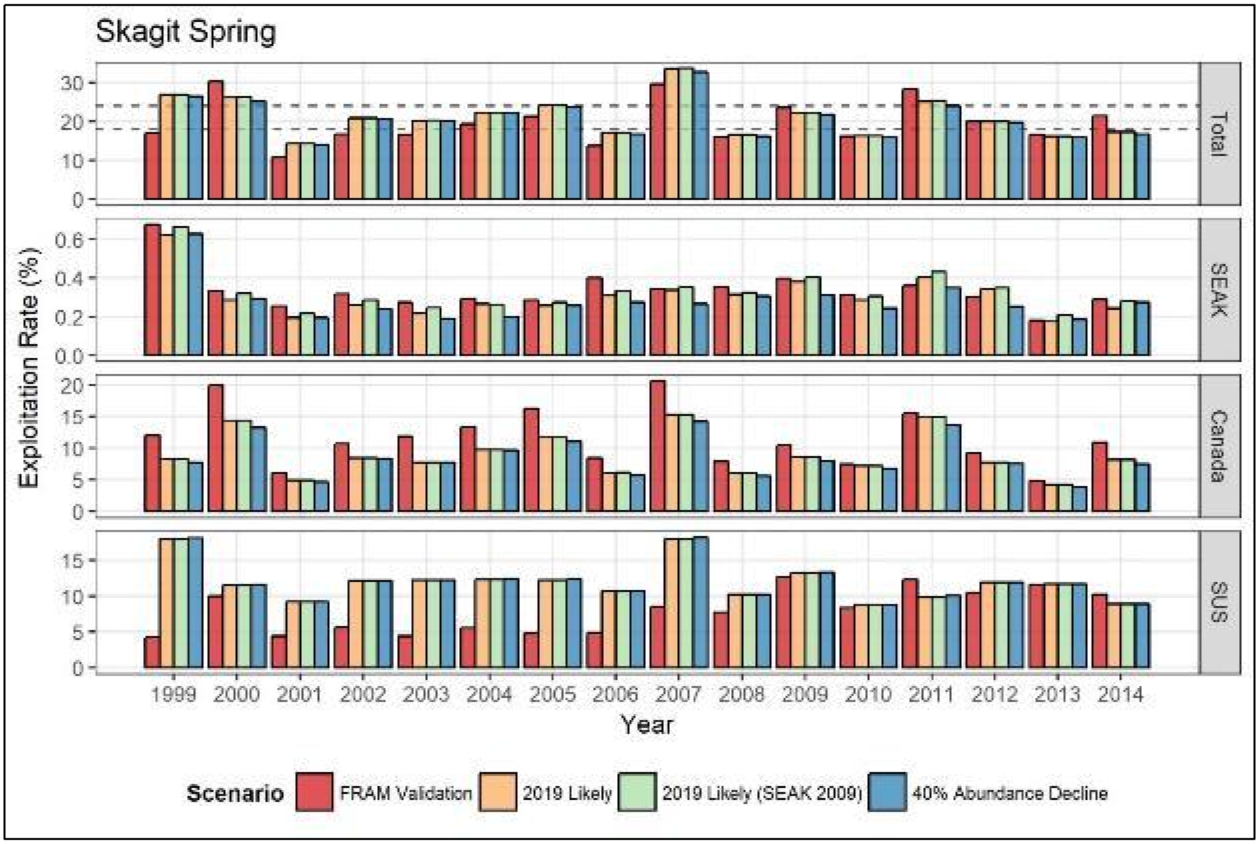

Figure 54. Comparison of ERs on Skagit River spring Chinook salmon between scenarios 1 through 4 in the retrospective analysis (dashed line on total ER plot represents RER range).

Table 69. ER changes between scenario 1 and scenario 2 in the retrospective analysis on Skagit River spring Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Skagit R spring	Scenario 1	0.3%	11.6%	0.8%	7.0%	19.8%
	Scenario 2	0.3%	9.0%	0.8%	11.1%	21.2%
	Abs ER Change	-0.03%	-2.6%	0.0%	4.1%	1.4%
	Rel ER Change	-8.9%	-22.7%	-1.0%	57.9%	7.1%

Scenarios 2 and 3 provide a more direct comparison of how ER is expect to change as a result of the proposed reduction in the SEAK fishery from the 2009 Agreement (scenario 3) to the 2019 Agreement (scenario 2). The proposed change will result in an absolute reduction in the average ER of -0.02 percent and a relative change in the SEAK fishery of -7.0 percent (Table 70).

Table 70. ER changes between scenario 3 and scenario 2 in the retrospective analysis on Skagit River spring Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Skagit R spring	Scenario 3	0.3%	9.0%	0.8%	11.1%	21.2%
	Scenario 2	0.3%	9.0%	0.8%	11.1%	21.2%
	Abs ER Change	-0.02%	0.0%	0.0%	0.0%	-0.03%
	Rel ER Change	-7.0%	-0.2%	0.0%	0.0%	-0.2%

A comparison of scenarios 2 and 4 examine how the fisheries will respond to a 40 percent reduction in coast wide abundance (scenario 4). The absolute change in the average ER is -1.9 percent in ocean fisheries and -0.4 percent in the SEAK fishery, but these represent relative changes of -5.0 percent and -9.3 percent, respectively (Table 71).

Table 71. ER changes between scenario 2 and scenario 4 in the retrospective analysis on Skagit River spring Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Skagit R spring	Scenario 2	3.8%	25.9%	2.9%	4.7%	37.2%
	Scenario 4	3.4%	24.2%	2.9%	4.8%	35.3%
	Abs ER Change	-0.4%	-1.7%	0.0%	0.1%	-1.9%
	Rel ER Change	-9.3%	-6.4%	1.7%	2.0%	-5.0%

Figure 55 captures the changes in expected escapements for the Skagit River spring Chinook salmon populations across each scenario. Both the Suiattle and Upper Cascade populations exceed the UET in the majority of scenarios, except scenario 4. The Upper Sauk population exceeds the UET in eight years, but generally falls between the UET and CET. The Upper Cascade population is the only Skagit River spring Chinook salmon population with one year failing to exceed the CET, while the other two populations have several occurrences.

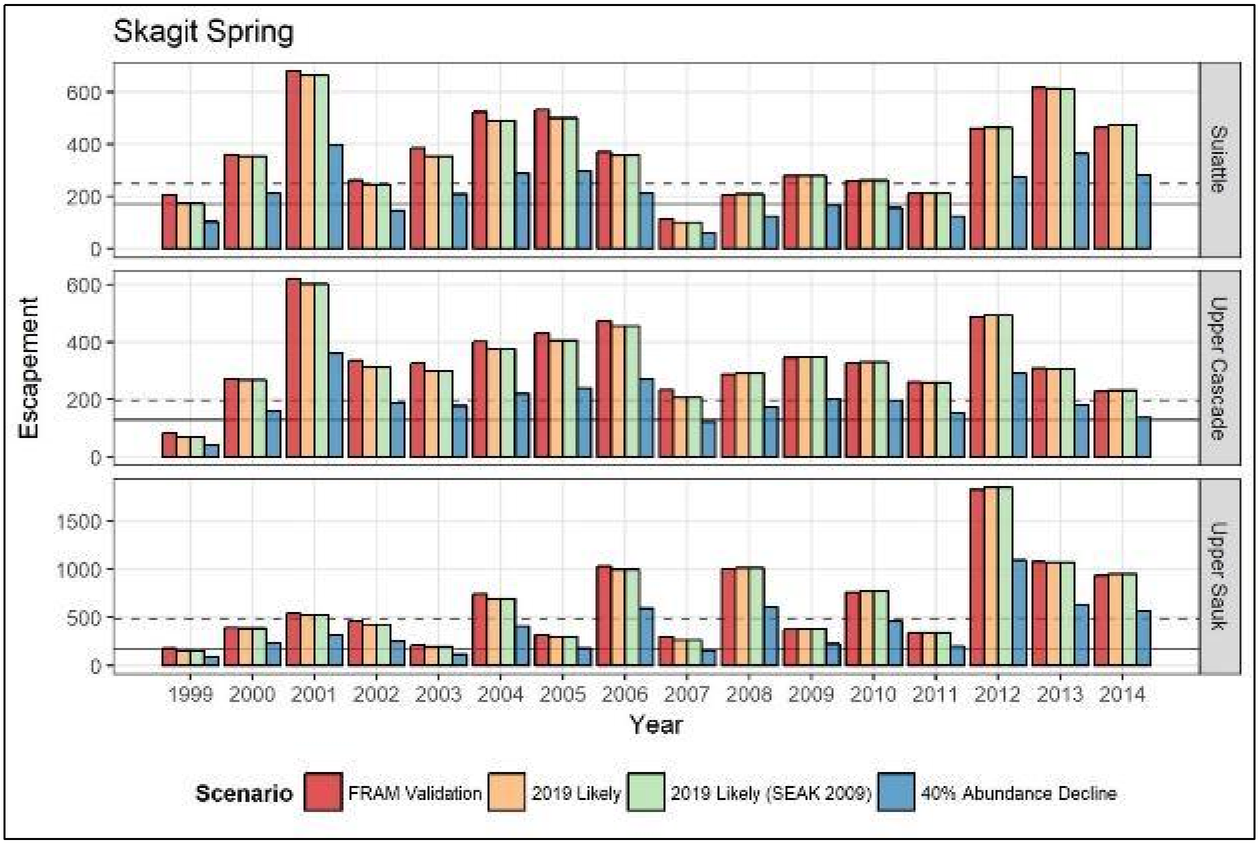

Figure 55. Escapement of Skagit River spring Chinook salmon populations based on retrospective analysis scenarios (dashed line represents UET, solid line represents CET, see Table 29 for population specific values).

Comparing the observed ERs from the FRAM Validation runs (scenario 1) with the Likely scenario 2 are captured in Figure 56 for Skagit River summer/fall Chinook salmon. The absolute change in the average ER is +1.9 percent in ocean fisheries and -1.1 percent in the SEAK fishery, but these represent relative changes of +4.6 percent and -13.5 percent, respectively (Table 72).

The higher Puget Sound ERs in scenario 2 compared to scenario 1 are a result of the new agreement and how the Likely scenario was modeled. In these runs, ISBM fisheries were modeled using the average rates that occurred over the 2009-2014 time period. In the Skagit River, the ER on summer/fall Chinook salmon in freshwater net fisheries increased noticeably beginning in 2005. Thus, when the 2009-2014 average harvest rate in freshwater net fisheries was used in all years for the Likely scenario, it resulted ERs than were much higher than those in scenario 1 (what actually occurred) for the years 1999-2004.

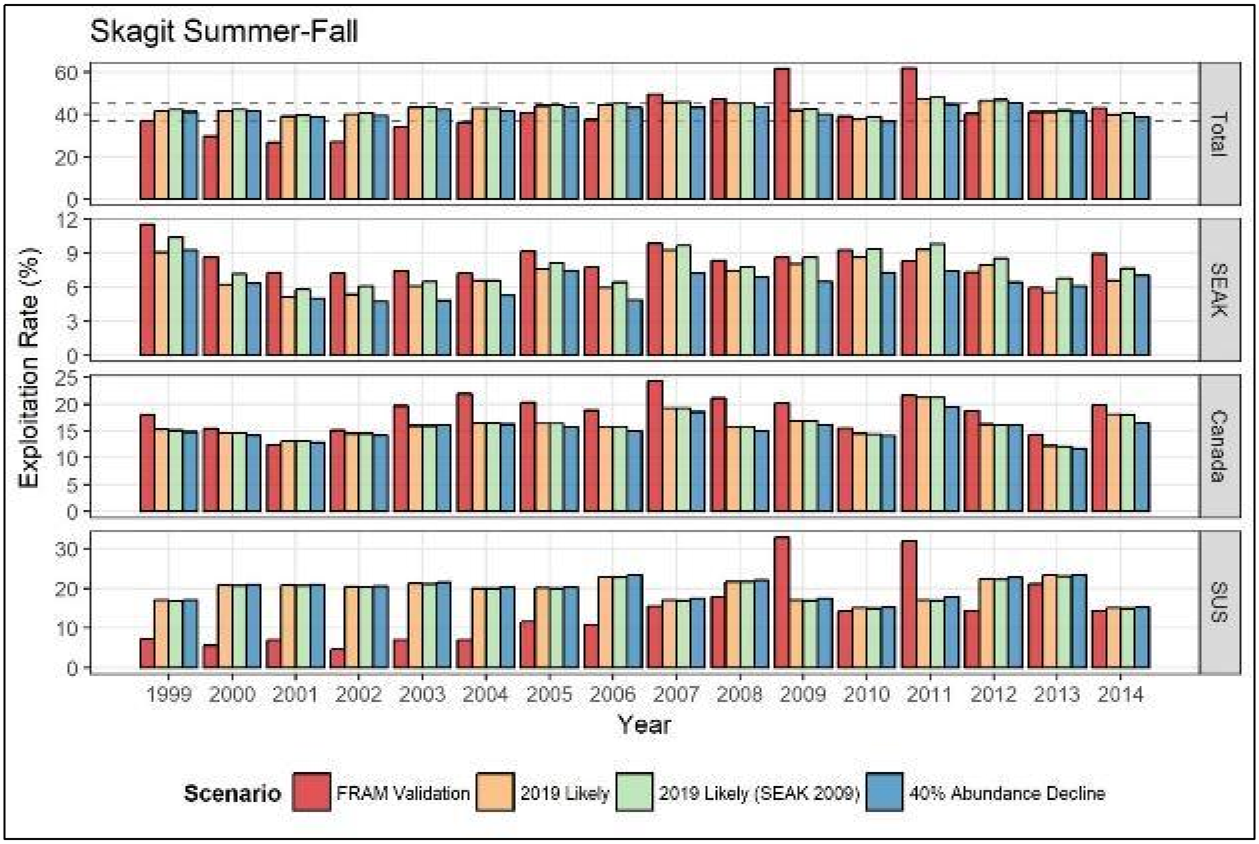

Figure 56. Comparison of ERs on Skagit River summer/fall Chinook salmon between scenarios 1 through 4 in the retrospective analysis (dashed line on total ER plot represents RER range).

Table 72. ER changes between scenario 1 and scenario 2 in the retrospective analysis on Skagit River summer/fall Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Skagit R summ/fall	Scenario 1	8.3%	18.6%	1.1%	12.8%	40.8%
	Scenario 2	7.2%	16.0%	1.2%	18.3%	42.6%
	Abs ER Change	-1.1%	-2.6%	0.0%	5.5%	1.9%
	Rel ER Change	-13.5%	-13.7%	2.7%	43.0%	4.6%

Scenarios 2 and 3 provide a more direct comparison of how ER is expect to change as a result of the proposed reduction in the SEAK fishery from the 2009 Agreement (scenario 3) to the 2019 Agreement (scenario 2). The proposed change will result in an absolute reduction in the average ER of -0.7 percent and a relative change in the SEAK fishery of -8.4 percent (Table 73).

Table 73. ER changes between scenario 3 and scenario 2 in the retrospective analysis on Skagit River summer/fall Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Skagit R summ/fall	Scenario 3	7.8%	16.0%	1.2%	18.2%	43.1%
	Scenario 2	7.2%	16.0%	1.2%	18.3%	42.6%
	Abs ER Change	-0.7%	0.1%	0.0%	0.1%	-0.5%
	Rel ER Change	-8.4%	0.3%	0.4%	0.7%	-1.1%

A comparison of scenarios 2 and 4 examine how the fisheries will respond to a 40 percent reduction in coast wide abundance (scenario 4). The absolute change in the average ER is -1.1 percent in ocean fisheries and -0.8 percent in the SEAK fishery, but these represent relative changes of -2.6 percent and -10.7 percent, respectively (Table 74).

Table 74. ER changes between scenario 2 and scenario 4 in the retrospective analysis on Skagit River summer/fall Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Skagit R summ/fall	Scenario 2	7.2%	16.0%	1.2%	18.3%	42.6%
	Scenario 4	6.4%	15.4%	1.2%	18.6%	41.5%
	Abs ER Change	-0.8%	-0.6%	0.0%	0.3%	-1.1%
	Rel ER Change	-10.7%	-3.9%	0.9%	1.5%	-2.6%

Figure 57 captures the changes in expected escapements for the Skagit River sum/fall Chinook salmon populations across each scenario. Both the Sauk and Upper Skagit populations exceed the UET in the majority of scenarios, except scenario 4. The Lower Skagit population exceeds the UET in six years for scenarios 1, 2 and 3, but generally falls between the UET and CET. The Sauk population is the only Skagit River summer/fall Chinook salmon population which fails to exceed the CET under any scenario, but generally exhibits the same pattern as the other populations, exceeding the CET across all years and scenarios (Figure 57).

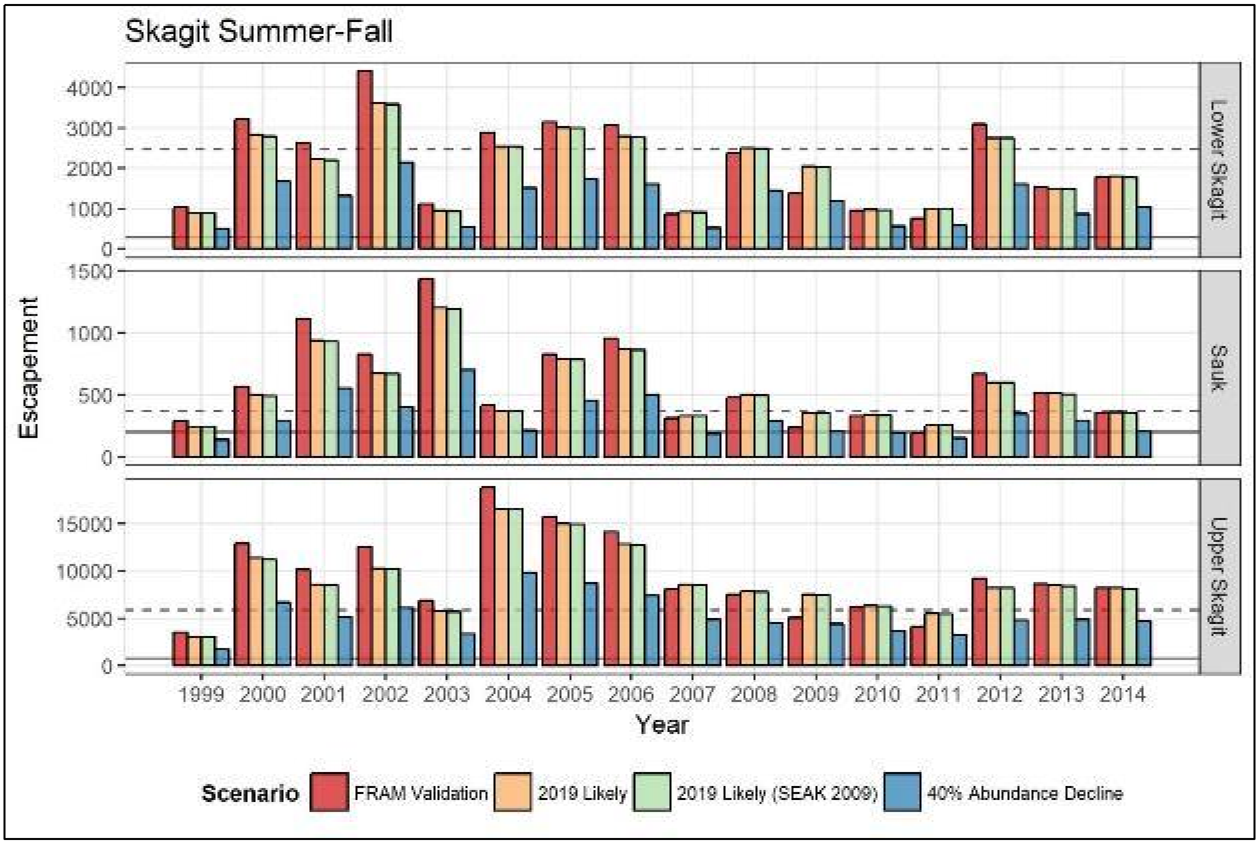

Figure 57. Escapement of Skagit River summer/fall Chinook salmon populations based on retrospective analysis scenarios (dashed line represents UET, solid line represents CET, see Table 29 for population specific values).

Comparing the observed ERs from the FRAM Validation runs (scenario 1) with the Likely scenario 2 are captured in Figure 58 for Stillaguamish River Chinook salmon. The absolute change in the average ER is -4.7 percent in ocean fisheries and -0.2 percent in the SEAK fishery, but these represent relative changes of -20.2 percent and -11.4 percent, respectively (Table 75).

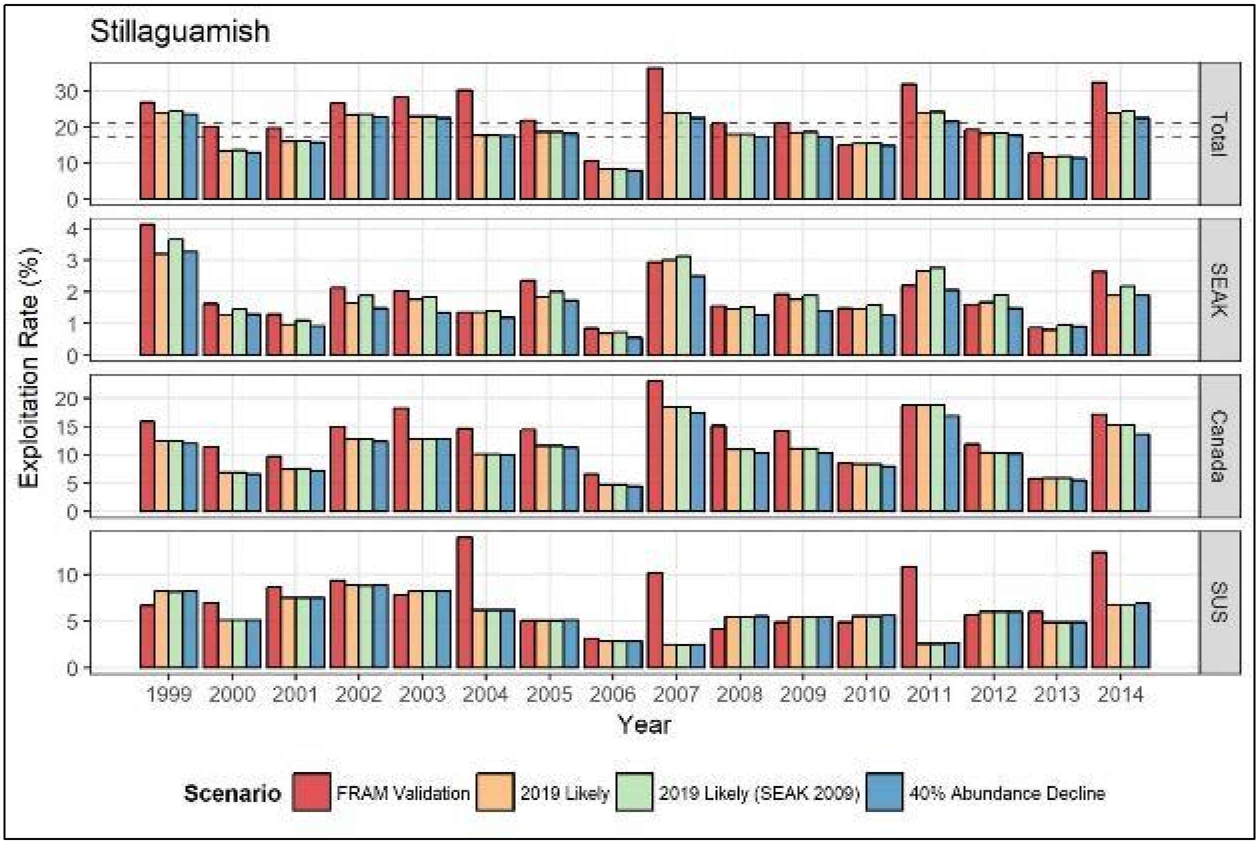

Figure 58. Comparison of ERs on Stillaguamish River Chinook salmon between scenarios 1 through 4 in the retrospective analysis (dashed lines on total ER plot represents RER range).

Table 75. ER changes between scenario 1 and scenario 2 in the retrospective analysis on Stillaguamish River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Stillaguamish R	Scenario 1	1.9%	13.8%	1.9%	5.6%	23.3%
	Scenario 2	1.7%	11.1%	1.6%	4.1%	18.6%
	Abs ER Change	-0.2%	-2.7%	-0.4%	-1.5%	-4.7%
	Rel ER Change	-11.4%	-19.3%	-18.3%	-26.3%	-20.2%

Scenarios 2 and 3 provide a more direct comparison of how ER is expect to change as a result of the proposed reduction in the SEAK fishery from the 2009 Agreement (scenario 3) to the 2019 Agreement (scenario 2). The proposed change will result in an absolute reduction in the average ER of -0.2 percent and a relative change in the SEAK fishery of -8.4 percent (Table 76).

Table 76. ER changes between scenario 3 and scenario 2 in the retrospective analysis on Stillaguamish River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Stillaguamish R	Scenario 3	1.9%	11.1%	1.6%	4.1%	18.7%
	Scenario 2	1.7%	11.1%	1.6%	4.1%	18.6%
	Abs ER Change	-0.2%	0.0%	0.0%	0.0%	-0.2%
	Rel ER Change	-8.4%	0.0%	0.1%	0.1%	-0.8%

A comparison of scenarios 2 and 4 examine how the fisheries will respond to a 40 percent reduction in coast wide abundance (scenario 4). The absolute change in the average ER is -0.7 percent in ocean fisheries and -0.2 percent in the SEAK fishery, but these represent relative changes of -4.0 percent and -10.7 percent, respectively (Table 77).

Table 77. ER changes between scenario 2 and scenario 4 in the retrospective analysis on Stillaguamish River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Stillaguamish R	Scenario 2	1.7%	11.1%	1.6%	4.1%	18.6%
	Scenario 4	1.5%	10.6%	1.6%	4.2%	17.8%
	Abs ER Change	-0.2%	-0.6%	0.0%	0.0%	-0.7%
	Rel ER Change	-10.7%	-5.2%	0.6%	0.3%	-4.0%

Figure 59 captures the changes in expected escapements for the Stillaguamish River Chinook salmon populations across each scenario. The North Fork population exceed the UET in eight years for each scenario except scenario 4. The South Fork fails to exceed the CET under all scenarios each year, while the North Fork populations fails to exceed the CET most commonly in scenario 4.

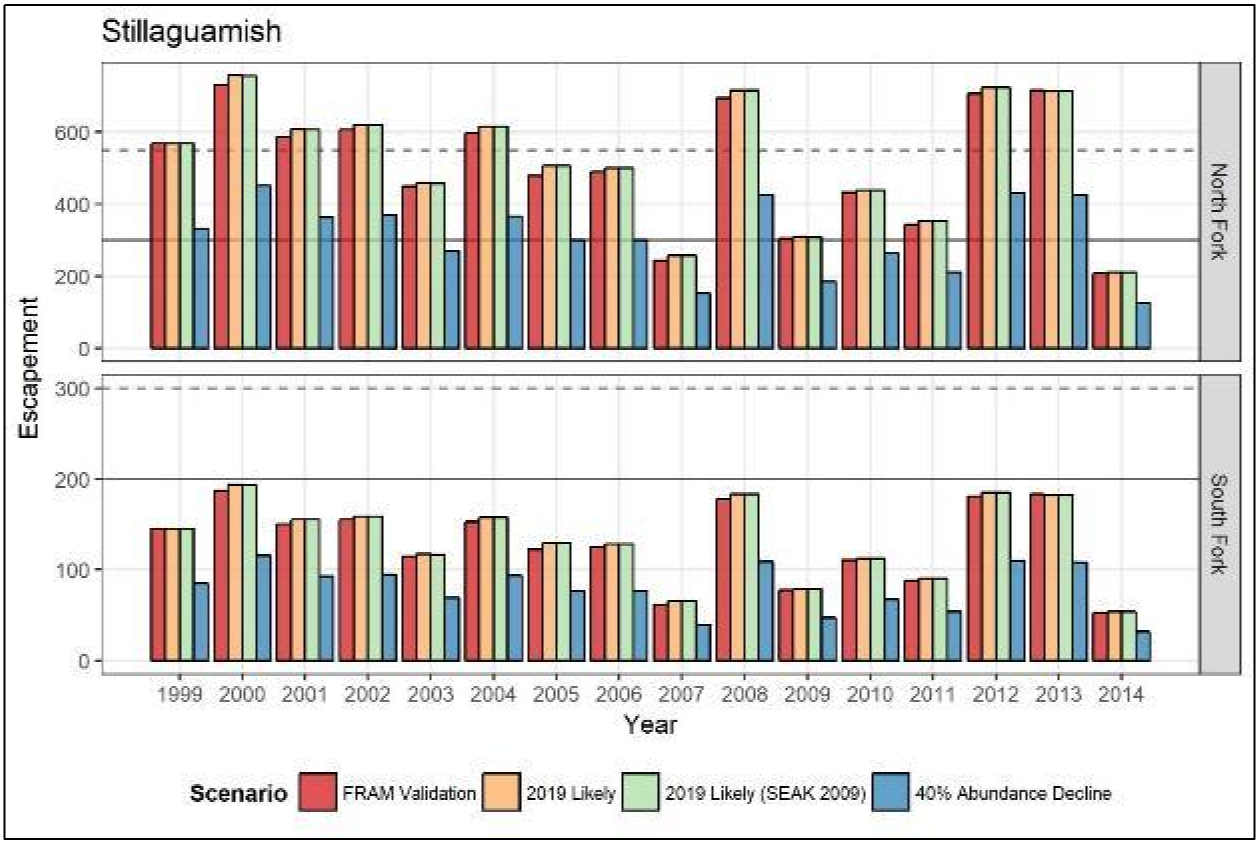

Figure 59. Escapement of Stillaguamish River Chinook salmon populations based on retrospective analysis scenarios (dashed line represents UET, solid line represents CET, see Table 29 for population specific values).

Comparing the observed ERs from the FRAM Validation runs (scenario 1) with the Likely scenario 2 are captured in Figure 60 for Snohomish River Chinook salmon. The absolute change in the average ER is -3.7 percent in marine area fisheries and -0.04 percent in the SEAK fishery, but these represent relative changes of -18.4 percent and -11.0 percent, respectively (Table 78).

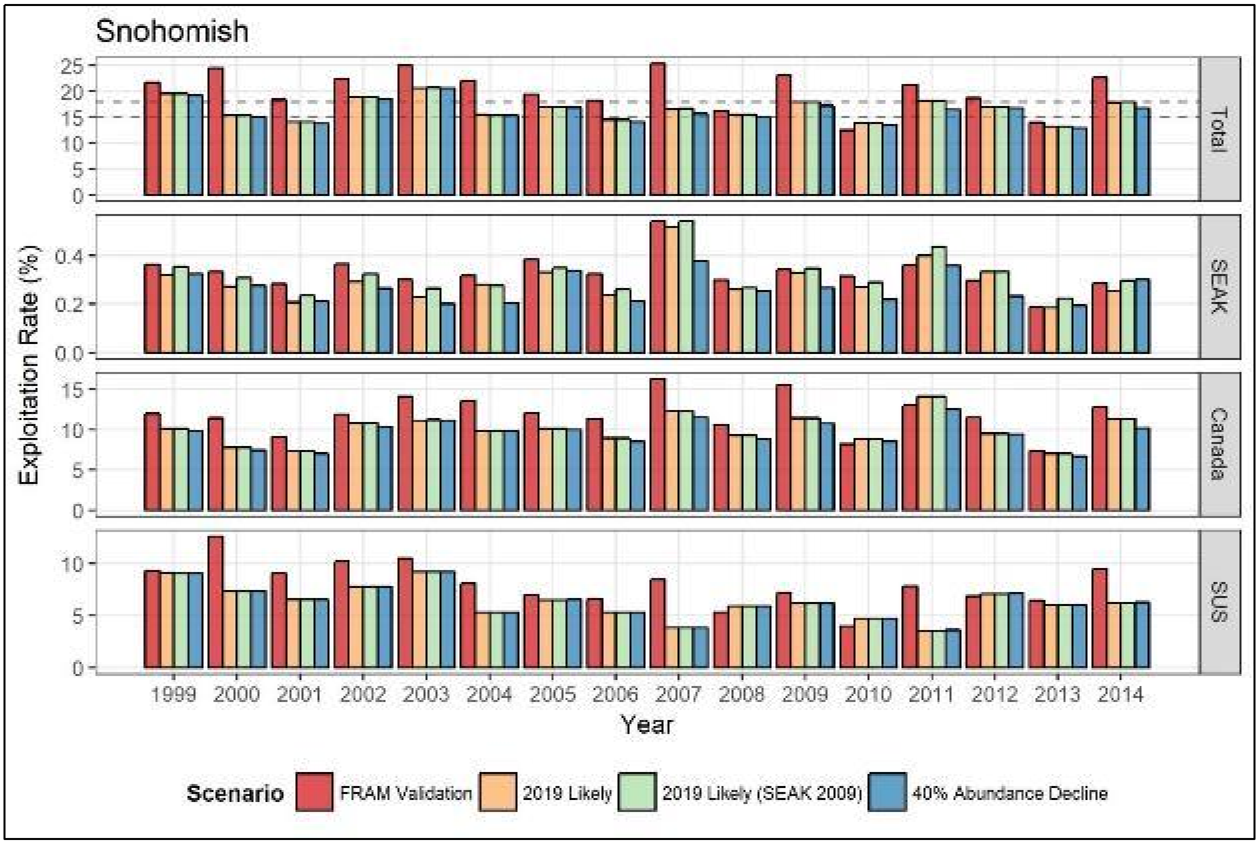

Figure 60. Comparison of ERs on Snohomish River Chinook salmon between scenarios 1 through 4 in the retrospective analysis (dashed lines on total ER plot represents RER range).

Table 78. ER changes between scenario 1 and scenario 2 in the retrospective analysis on Snohomish River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Snohomish R	Scenario 1	0.3%	11.9%	1.7%	6.4%	20.3%
	Scenario 2	0.3%	10.0%	1.7%	4.6%	16.6%
	Abs ER Change	-0.04%	-1.9%	0.1%	-1.8%	-3.7%
	Rel ER Change	-11.0%	-16.2%	4.0%	-28.7%	-18.4%

Scenarios 2 and 3 provide a more direct comparison of how ER is expect to change as a result of the proposed reduction in the SEAK fishery from the 2009 Agreement (scenario 3) to the 2019 Agreement (scenario 2). The proposed change will result in an absolute reduction in the average ER of -0.02 percent and a relative change of -7.6 percent (Table 79).

Table 79. ER changes between scenario 3 and scenario 2 in the retrospective analysis on Snohomish River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Snohomish R	Scenario 3	0.3%	10.0%	1.7%	4.6%	16.6%
	Scenario 2	0.3%	10.0%	1.7%	4.6%	16.6%
	Abs ER Change	-0.02%	0.0%	0.0%	0.0%	-0.03%
	Rel ER Change	-7.6%	-0.1%	0.0%	0.0%	-0.2%

A comparison of scenarios 2 and 4 examine how the fisheries will respond to a 40 percent reduction in coast wide abundance (scenario 4). The absolute change in the average ER is -0.5 percent in ocean fisheries and -0.03 percent in the SEAK fishery, but these represent relative changes of -2.9 percent and -10.3 percent, respectively (Table 80).

Table 80. ER changes between scenario 2 and scenario 4 in the retrospective analysis on Snohomish River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Snohomish R	Scenario 2	0.3%	10.0%	1.7%	4.6%	16.6%
	Scenario 4	0.3%	9.5%	1.7%	4.6%	16.1%
	Abs ER Change	-0.03%	-0.5%	0.0%	0.0%	-0.5%
	Rel ER Change	-10.3%	-4.6%	0.2%	0.1%	-2.9%

Figure 61 captures the changes in expected escapements for the Snohomish River Chinook salmon populations across each scenario. Both the Skykomish and Snoqualmie populations exceed the UET for each scenario the majority of the years. While each population does have occurrences falling below the UET, neither population fails to exceed the CET under any scenario.

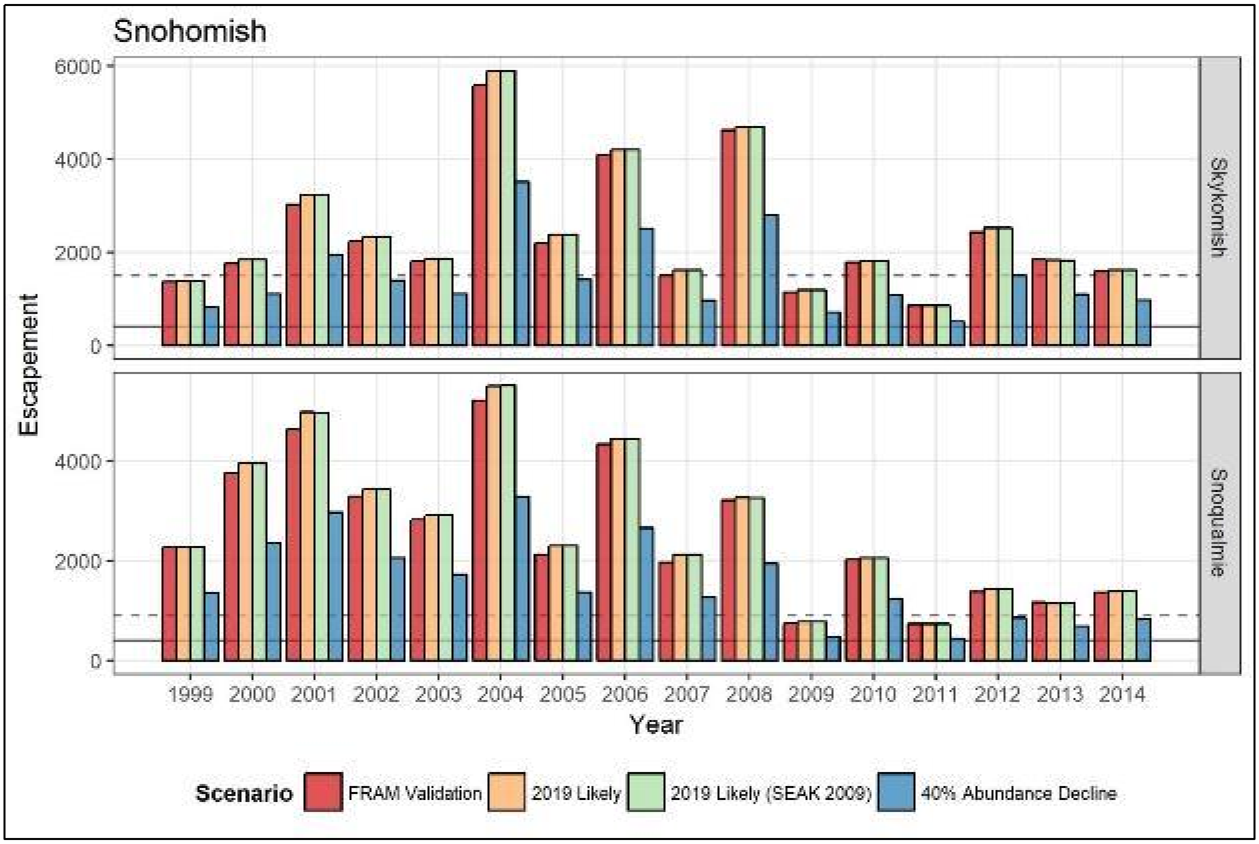

Figure 61. Escapement of Snohomish River Chinook salmon populations based on retrospective analysis scenarios (dashed line represents UET, solid line represents CET, see Table 29 for population specific values).

Central/South Puget Sound

Comparing the observed ERs from the FRAM Validation runs (scenario 1) with the Likely scenario 2 are captured in Figure 62 for Lake Washington Chinook salmon. The absolute change in the average ER is -4.2 percent in ocean fisheries and -0.02 percent in the SEAK fishery, and these represent relative changes of -14.1 percent and -14.2 percent, respectively (Table 81).

Figure 62. Comparison of ERs on Lake Washington Chinook salmon between scenarios 1 through 4 in the retrospective analysis (dashed lines on total ER plot represents RER range).

Table 81. ER changes between scenario 1 and scenario 2 in the retrospective analysis on Lake Washington Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Lake Washington	Scenario 1	0.2%	13.8%	4.6%	11.3%	29.8%
	Scenario 2	0.1%	11.2%	4.9%	9.4%	25.6%
	Abs ER Change	-0.02%	-2.6%	0.3%	-1.9%	-4.2%
	Rel ER Change	-14.2%	-18.6%	6.4%	-16.8%	-14.1%

Scenarios 2 and 3 provide a more direct comparison of how ER is expect to change as a result of the proposed reduction in the SEAK fishery from the 2009 Agreement (scenario 3) to the 2019 Agreement (scenario 2). The proposed change will result in an absolute reduction in the average ER of -0.01 percent and a relative change in the SEAK fishery of -9.2 percent (Table 82).

Table 82. ER changes between scenario 3 and scenario 2 in the retrospective analysis on Lake Washington Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Lake Washington	Scenario 3	0.2%	11.2%	4.9%	9.4%	25.6%
	Scenario 2	0.1%	11.2%	4.9%	9.4%	25.6%
	Abs ER Change	-0.01%	0.0%	0.0%	0.0%	-0.02%
	Rel ER Change	-9.2%	-0.1%	0.0%	0.0%	-0.1%

A comparison of scenarios 2 and 4 examine how the fisheries will respond to a 40 percent reduction in coast wide abundance (scenario 4). The absolute change in the average ER is -0.6 percent in ocean fisheries and -0.02 percent in the SEAK fishery, but these represent relative changes of -2.4 percent and -10.4 percent, respectively (Table 83).

Table 83. ER changes between scenario 2 and scenario 4 in the retrospective analysis on Lake Washington spring Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Lake Washington	Scenario 2	0.1%	11.2%	4.9%	9.4%	25.6%
	Scenario 4	0.1%	10.5%	4.9%	9.4%	25.0%
	Abs ER Change	-0.02%	-0.7%	0.0%	0.1%	-0.6%
	Rel ER Change	-10.4%	-6.1%	0.4%	0.7%	-2.4%

Figure 63 captures the changes in expected escapements for the Lake Washington Chinook salmon populations across each scenario. The Cedar River natural-origin population exceeds the UET for each scenario the majority of years. The Sammamish River natural-origin population exceeds the UET in only four years, failing for each scenario the majority of years. The Cedar River natural-origin population only falls below the UET one year for all scenarios, but the Sammamish River natural-origin population fails to exceed the CET under any scenario in four years.

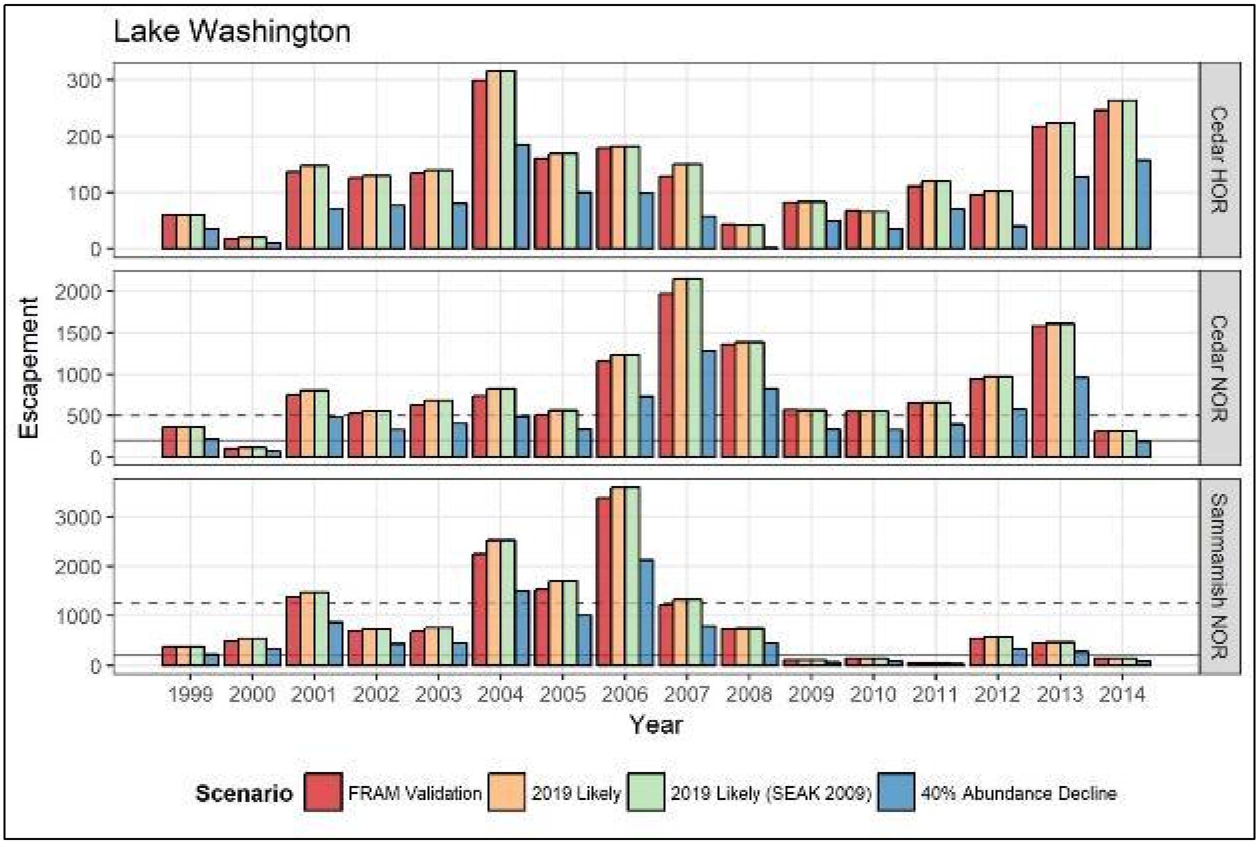

Figure 63. Escapement of Lake Washington Chinook salmon populations based on retrospective analysis scenarios (dashed line represents UET, solid line represents CET, see Table 29 for population specific values).

Comparing the observed ERs from the FRAM Validation runs (scenario 1) with the Likely scenario 2 are captured in Figure 64 for Green River Chinook salmon. The absolute change in the average ER is +0.2 percent in ocean fisheries and -0.02 percent in the SEAK fishery, but these represent relative changes of +0.4 percent and -14.2 percent, respectively (Table 84).

The higher Puget Sound ERs in scenario 2 compared to scenario 1 are a result of how the Likely scenario was modeled. In these runs, ISBM fisheries were initially modeled using the average rates that occurred over the 2009-2014 time period. However, this time frame represents a period of low returns of Green River Chinook salmon, and as a result terminal fisheries were generally limited to incidental harvest only. Since Green River Chinook salmon are not an indicator stock included in Attachment I of the 2019 agreement, it seemed unnecessary to apply the low 2009-2014 average terminal harvest rates across the entire 1999-2014 time period. Thus, in years prior to 2009, when returns exceeded escapement thresholds and domestic management objectives would have allowed for directed Chinook salmon fisheries, terminal harvest rates were increased to account for this, resulting in ERs in some years that were greater than those in scenario 1.

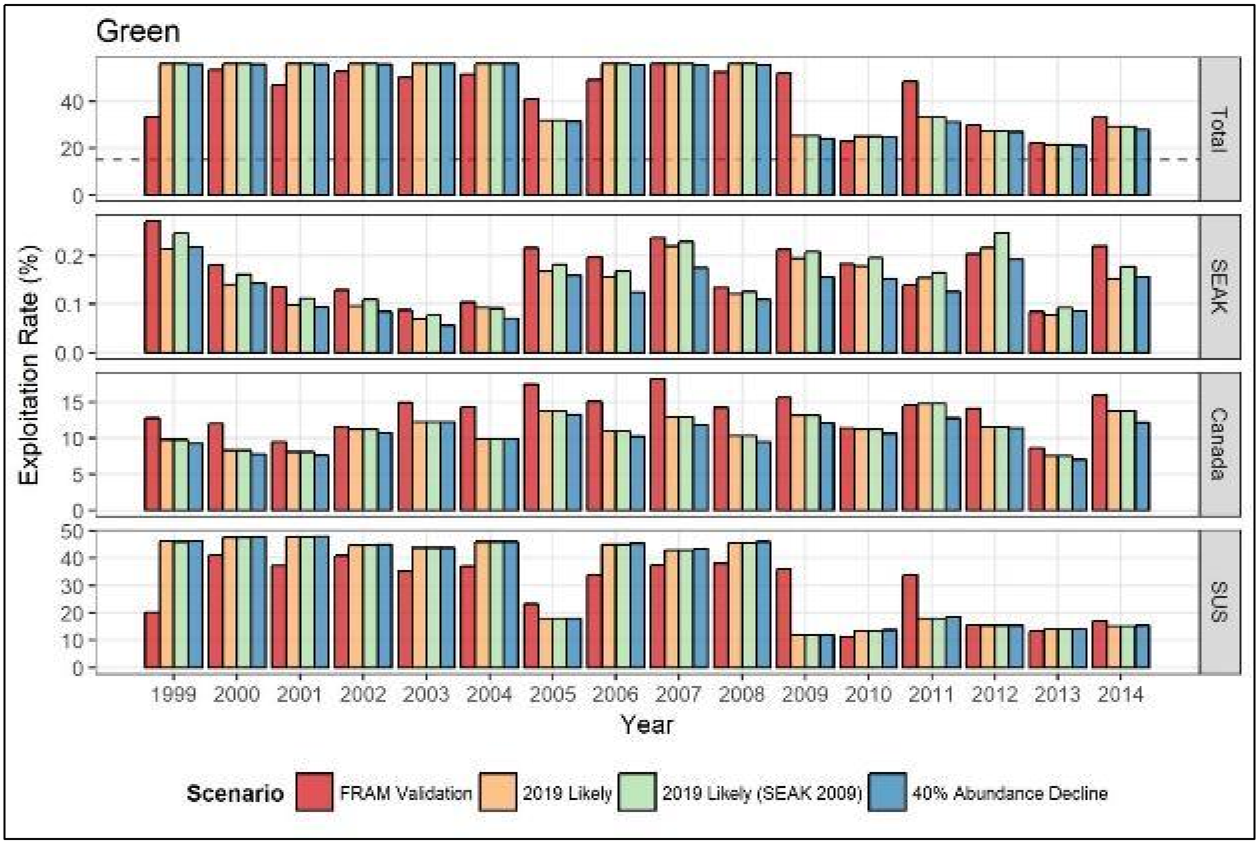

Figure 64. Comparison of ERs on Green River Chinook salmon between scenarios 1 through 4 in the retrospective analysis (dashed line on total ER plot represents RER).

Table 84. ER changes between scenario 1 and scenario 2 in the retrospective analysis on Green River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Green R	Scenario 1	0.2%	13.8%	4.6%	24.8%	43.4%
	Scenario 2	0.1%	11.2%	4.9%	27.3%	43.5%
	Abs ER Change	-0.02%	-2.6%	0.3%	2.5%	0.2%
	Rel ER Change	-14.2%	-18.6%	6.4%	9.9%	0.4%

Scenarios 2 and 3 provide a more direct comparison of how ER is expect to change as a result of the proposed reduction in the SEAK fishery from the 2009 Agreement (scenario 3) to the 2019 Agreement (scenario 2). The proposed change will result in an absolute reduction in the average ER of -0.01 percent and a relative change of -9.2 percent (Table 85).

Table 85. ER changes between scenario 3 and scenario 2 in the retrospective analysis on Green River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Green R	Scenario 3	0.2%	11.2%	4.9%	27.3%	43.6%
	Scenario 2	0.1%	11.2%	4.9%	27.3%	43.5%
	Abs ER Change	-0.01%	0.0%	0.0%	0.0%	-0.02%
	Rel ER Change	-9.2%	-0.1%	0.0%	0.0%	-0.04%

A comparison of scenarios 2 and 4 examine how the fisheries will respond to a 40 percent reduction in coast wide abundance (scenario 4). The absolute change in the average ER is -0.5 percent in ocean fisheries and -0.02 percent in the SEAK fishery, but these represent relative changes of -1.2 percent and -10.4 percent, respectively (Table 86).

Table 86. ER changes between scenario 2 and scenario 4 in the retrospective analysis on Green River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Green R	Scenario 2	0.1%	11.2%	4.9%	27.3%	43.5%
	Scenario 4	0.1%	10.5%	4.9%	27.5%	43.0%
	Abs ER Change	-0.02%	-0.7%	0.0%	0.2%	-0.5%
	Rel ER Change	-10.4%	-6.1%	0.4%	0.6%	-1.2%

Figure 65 captures the changes in expected escapements for the Lake Washington Chinook salmon populations across each scenario. Since 2009 the natural-origin population failed to exceed the UET in each scenario, but exceeded the CET in all scenarios but for two years.

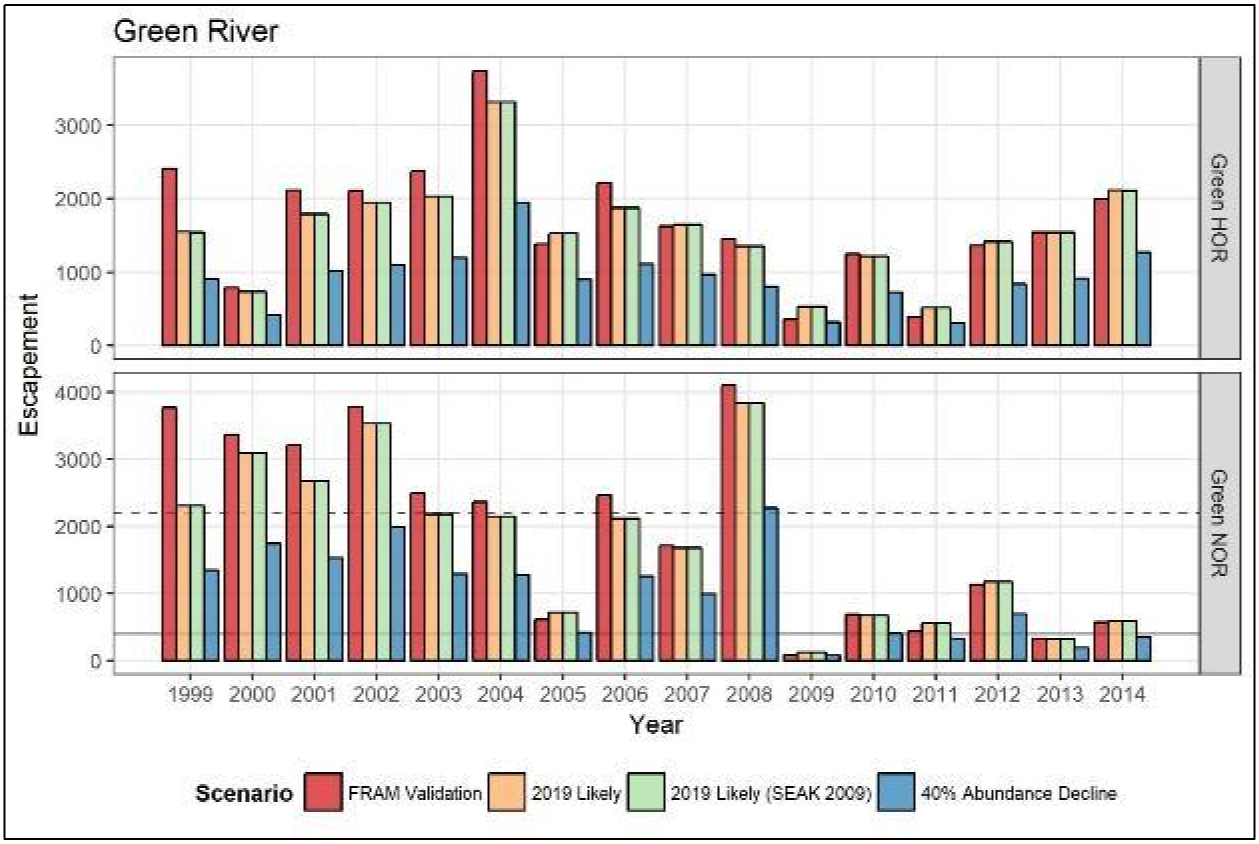

Figure 65. Escapement of Green River Chinook salmon populations based on retrospective analysis scenarios (dashed line represents UET, solid line represents CET, see Table 29 for population specific values).

Comparing the observed ERs from the FRAM Validation runs (scenario 1) with the Likely scenario 2 are captured in Figure 66 for White River Chinook salmon. The absolute change in the average ER is -5.8 percent in ocean fisheries and -0.01 percent in the SEAK fishery, but these represent relative changes of -22.9 percent and -3.2 percent, respectively (Table 87).

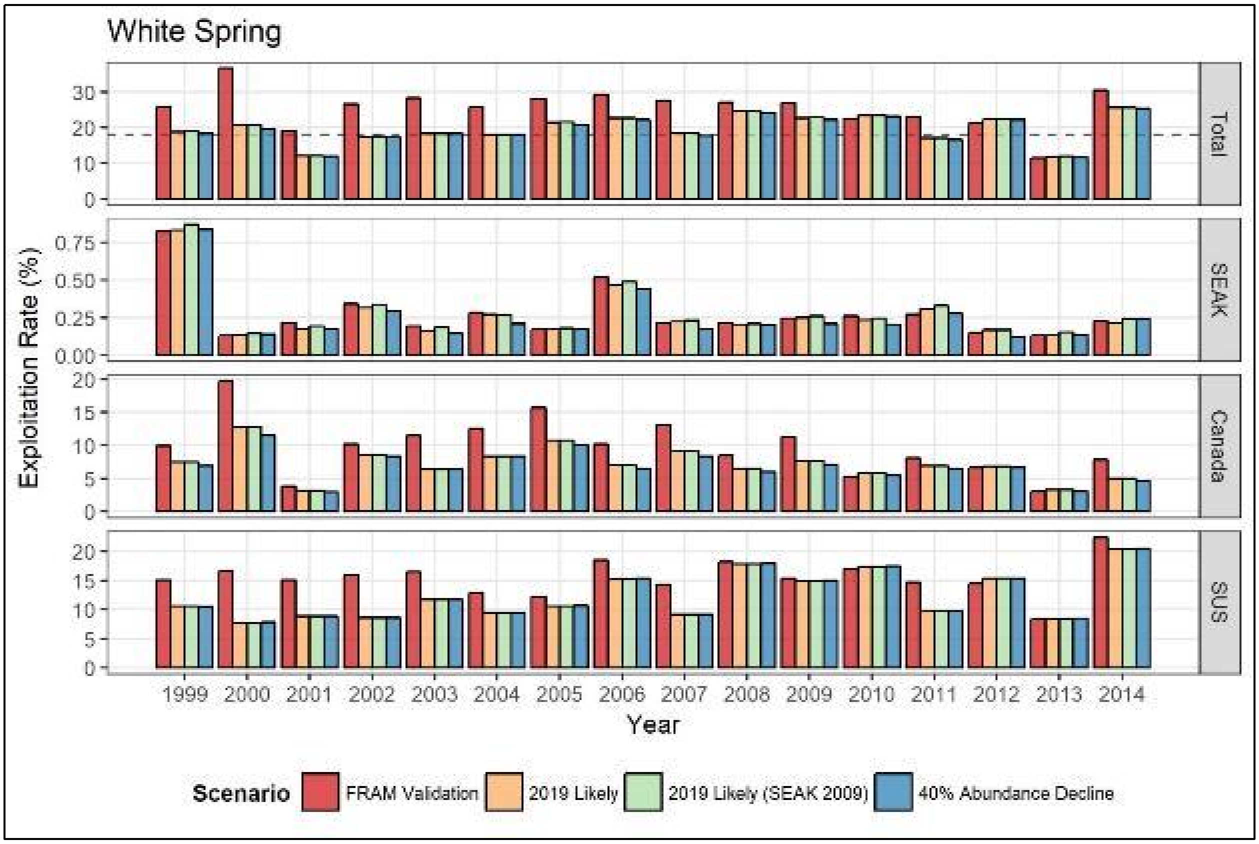

Figure 66. Comparison of ERs on White River Chinook salmon between scenarios 1 through 4 in the retrospective analysis (dashed line on total ER plot represents RER).

Table 87. ER changes between scenario 1 and scenario 2 in the retrospective analysis on White River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – White R	Scenario 1	0.3%	9.8%	1.6%	13.8%	25.6%
	Scenario 2	0.3%	7.2%	1.7%	10.6%	19.7%
	Abs ER Change	-0.01%	-2.6%	0.0%	-3.3%	-5.8%
	Rel ER Change	-3.2%	-26.5%	1.7%	-23.6%	-22.9%

Scenarios 2 and 3 provide a more direct comparison of how ER is expect to change as a result of the proposed reduction in the SEAK fishery from the 2009 Agreement (scenario 3) to the 2019 Agreement (scenario 2). The proposed change will result in an absolute reduction in the average ER of -0.02 percent and a relative change in the SEAK fishery of -5.7 percent (Table 88).

Table 88. ER changes between scenario 3 and scenario 2 in the retrospective analysis on White River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – White R	Scenario 3	0.3%	7.2%	1.7%	10.6%	19.7%
	Scenario 2	0.3%	7.2%	1.7%	10.6%	19.7%
	Abs ER Change	-0.02%	0.0%	0.0%	0.0%	-0.02%
	Rel ER Change	-5.7%	0.0%	0.0%	0.0%	-0.1%

A comparison of scenarios 2 and 4 examine how the fisheries will respond to a 40 percent reduction in coast wide abundance (scenario 4). The absolute change in the average ER is -0.4 percent in ocean fisheries and -0.02 percent in the SEAK fishery, but these represent relative changes of -2.0 percent and -6.4 percent, respectively (Table 89).

Table 89. ER changes between scenario 2 and scenario 4 in the retrospective analysis on White River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – White R	Scenario 2	0.3%	7.2%	1.7%	10.6%	19.7%
	Scenario 4	0.2%	6.8%	1.7%	10.6%	19.3%
	Abs ER Change	-0.02%	-0.4%	0.0%	0.0%	-0.4%
	Rel ER Change	-6.4%	-5.9%	0.4%	0.3%	-2.0%

Comparing the observed ERs from the FRAM Validation runs (scenario 1) with the Likely scenario 2 are captured in Figure 67 for Puyallup River Chinook salmon. The absolute change in the average ER is -5.3 percent in ocean fisheries and -0.02 percent in the SEAK fishery, but these represent relative changes of -9.8 percent and -14.2 percent, respectively (Table 90).

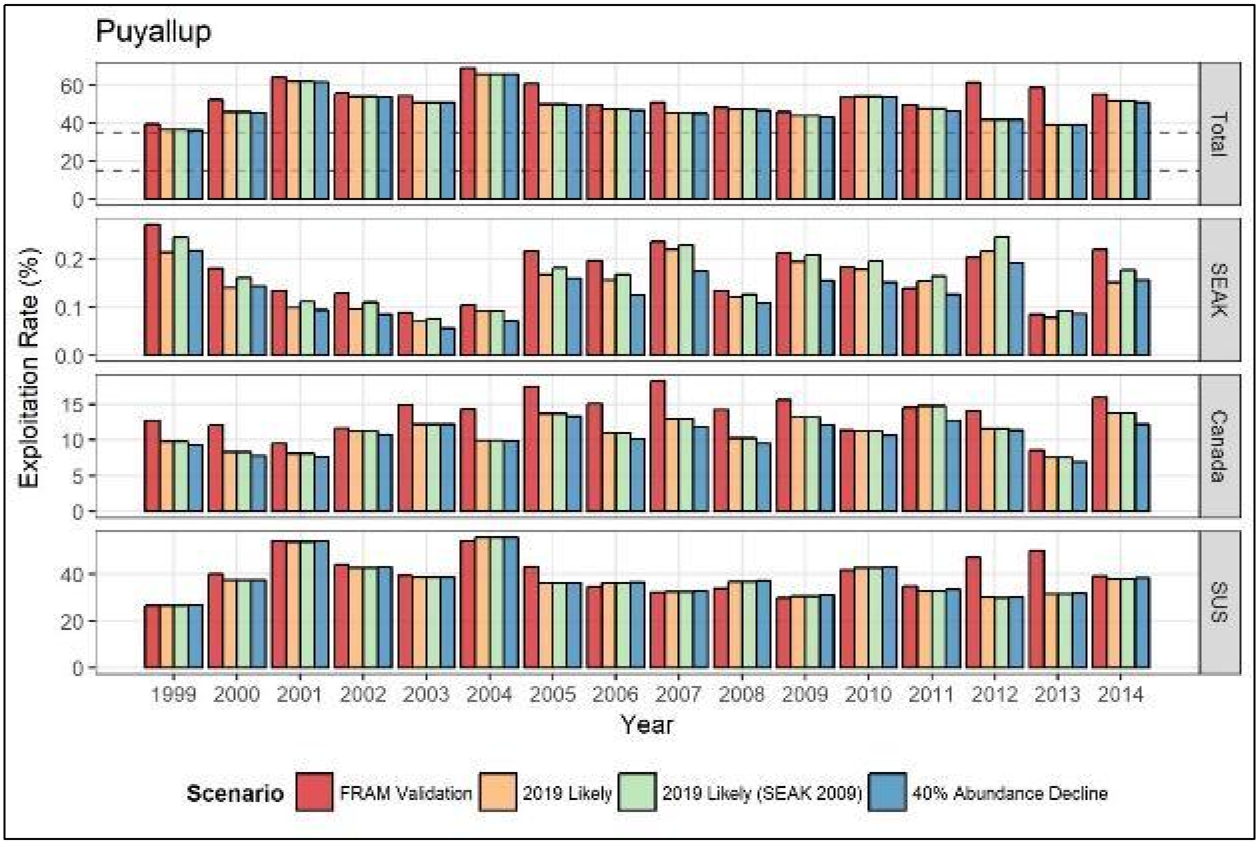

Figure 67. Comparison of ERs on Puyallup River Chinook salmon between scenarios 1 through 4 in the retrospective analysis (dashed lines on total ER plot represents RER range).

Table 90. ER changes between scenario 1 and scenario 2 in the retrospective analysis on Puyallup River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Puyallup R	Scenario 1	0.2%	13.8%	4.6%	35.7%	54.3%
	Scenario 2	0.1%	11.2%	4.9%	32.7%	49.0%
	Abs ER Change	-0.02%	-2.6%	0.3%	-3.0%	-5.3%
	Rel ER Change	-14.2%	-18.6%	6.4%	-8.4%	-9.8%

Scenarios 2 and 3 provide a more direct comparison of how ER is expect to change as a result of the proposed reduction in the SEAK fishery from the 2009 Agreement (scenario 3) to the 2019 Agreement (scenario 2). The proposed change will result in an absolute reduction in the average ER of -0.01 percent and a relative change in the SEAK fishery of -9.2 percent (Table 91).

Table 91. ER changes between scenario 3 and scenario 2 in the retrospective analysis on Puyallup River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Puyallup R	Scenario 3	0.2%	11.2%	4.9%	32.7%	49.0%
	Scenario 2	0.1%	11.2%	4.9%	32.7%	49.0%
	Abs ER Change	-0.01%	0.0%	0.0%	0.0%	-0.02%
	Rel ER Change	-9.2%	-0.1%	0.0%	0.0%	-0.04%

A comparison of scenarios 2 and 4 examine how the fisheries will respond to a 40 percent reduction in coast wide abundance (scenario 4). The absolute change in the average ER is -0.4 percent in ocean fisheries and -0.02 percent in the SEAK fishery, but these represent relative changes of -0.9 percent and -10.4 percent, respectively (Table 92).

Table 92. ER changes between scenario 2 and scenario 4 in the retrospective analysis on Puyallup River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Puyallup R	Scenario 2	0.1%	11.2%	4.9%	32.7%	49.0%
	Scenario 4	0.1%	10.5%	4.9%	33.0%	48.5%
	Abs ER Change	-0.02%	-0.7%	0.0%	0.2%	-0.4%
	Rel ER Change	-10.4%	-6.1%	0.4%	0.7%	-0.9%

Figure 68 captures the changes in expected escapements for the Puyallup and White River and Chinook salmon populations across each scenario. The Puyallup River natural-origin population exceeds the UET for each scenario in five separate years, and generally exceeds the CET except for one year. The White River population exceeds the UET every years, except for a few years under scenario 4. It exceeds the CET every year under all scenarios.

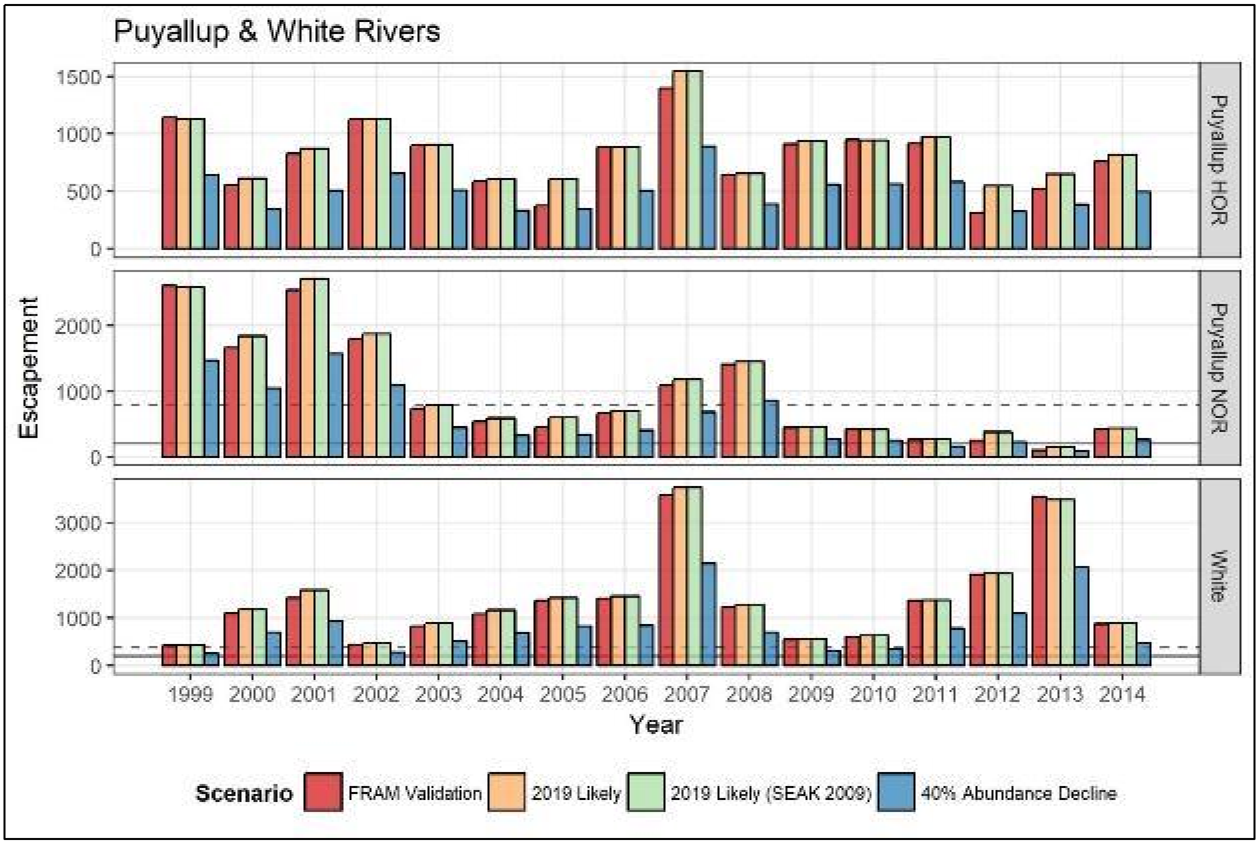

Figure 68. Escapement of Puyallup and White River Chinook salmon populations based on retrospective analysis scenarios (dashed line represents UET, solid line represents CET, see Table 29 for population specific values).

Comparing the observed ERs from the FRAM Validation runs (scenario 1) with the Likely scenario 2 are captured in Figure 69 for Nisqually River Chinook salmon. The absolute change in the average ER is -17.7 percent in ocean fisheries and -0.01 percent in the SEAK fishery, but these represent relative changes of -27.4 percent and -9.6 percent, respectively (Table 93).

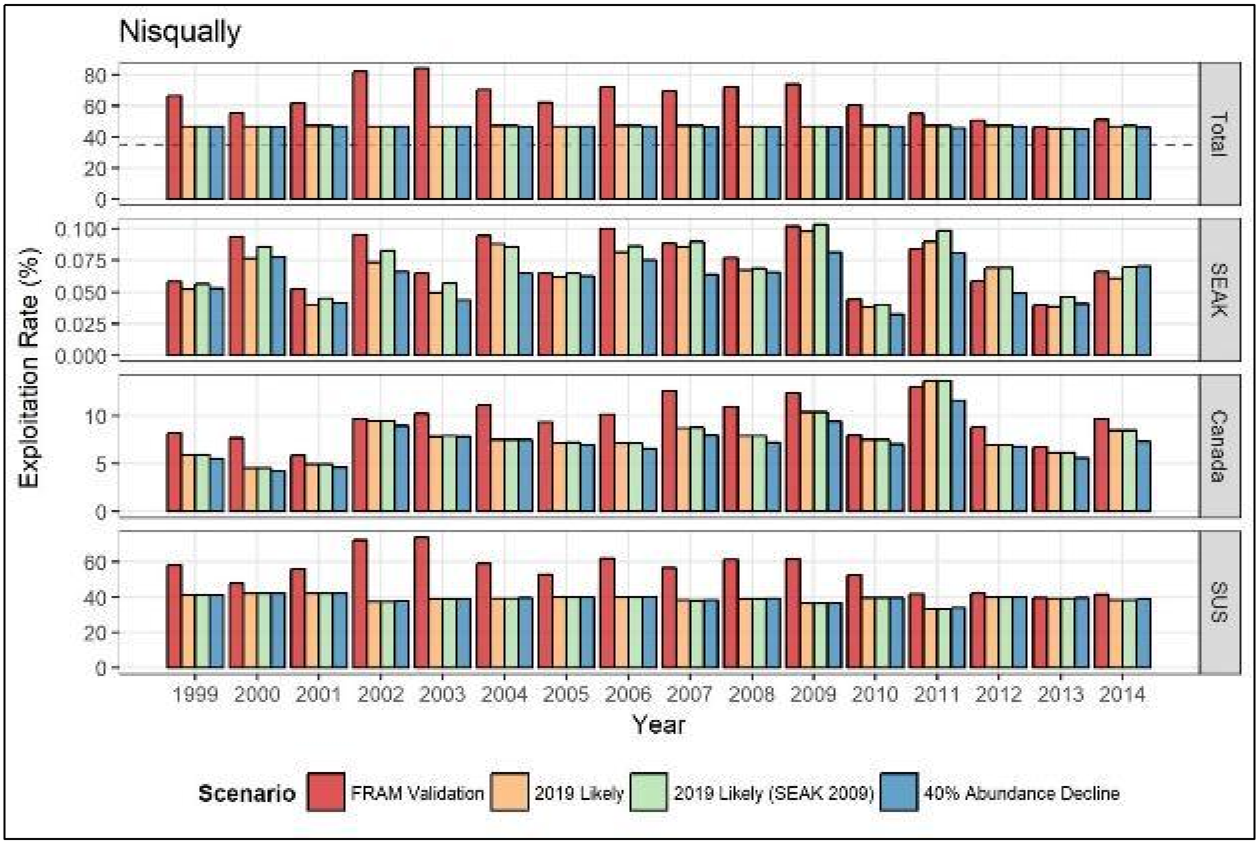

Figure 69. Comparison of ERs on Nisqually River Chinook salmon between scenarios 1 through 4 in the retrospective analysis (dashed line on total ER plot represents RER).

Table 93. ER changes between scenario 1 and scenario 2 in the retrospective analysis on Nisqually River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Nisqually R	Scenario 1	0.1%	9.7%	6.3%	48.6%	64.6%
	Scenario 2	0.1%	7.8%	6.5%	32.6%	46.9%
	Abs ER Change	-0.01%	-1.9%	0.2%	-16.1%	-17.7%
	Rel ER Change	-9.6%	-19.6%	3.5%	-33.0%	-27.4%

Scenarios 2 and 3 provide a more direct comparison of how ER is expect to change as a result of the proposed reduction in the SEAK fishery from the 2009 Agreement (scenario 3) to the 2019 Agreement (scenario 2). The proposed change will result in an absolute reduction in the average ER of -0.005 percent and a relative change in the SEAK fishery of -6.9 percent (Table 94).

Table 94. ER changes between scenario 3 and scenario 2 in the retrospective analysis on Nisqually River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Nisqually R	Scenario 3	0.1%	7.8%	6.5%	32.6%	46.9%
	Scenario 2	0.1%	7.8%	6.5%	32.6%	46.9%
	Abs ER Change	-0.005%	0.0%	0.0%	0.0%	-0.01%
	Rel ER Change	-6.9%	-0.1%	0.0%	0.0%	-0.02%

A comparison of scenarios 2 and 4 examine how the fisheries will respond to a 40 percent reduction in coast wide abundance (scenario 4). The absolute change in the average ER is -0.4 percent in ocean fisheries and -0.0006 percent in the SEAK fishery, but these represent relative changes of -0.8 percent and -9.5 percent, respectively (Table 95).

Table 95. ER changes between scenario 2 and scenario 4 in the retrospective analysis on Nisqually River Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Puget Sound Chinook Salmon – Nisqually R	Scenario 2	0.1%	7.8%	6.5%	32.6%	46.9%
	Scenario 4	0.1%	7.2%	6.5%	32.8%	46.5%
	Abs ER Change	-0.006%	-0.6%	0.0%	0.2%	-0.4%
	Rel ER Change	-9.5%	-7.4%	0.3%	0.6%	-0.8%

Figure 70 captures the changes in expected escapements for the Nisqually River salmon population across each scenario. All scenarios from 2009 forward fail to exceed the UET for the natural-origin populations but since 2010 all scenarios exceed the CET each year.

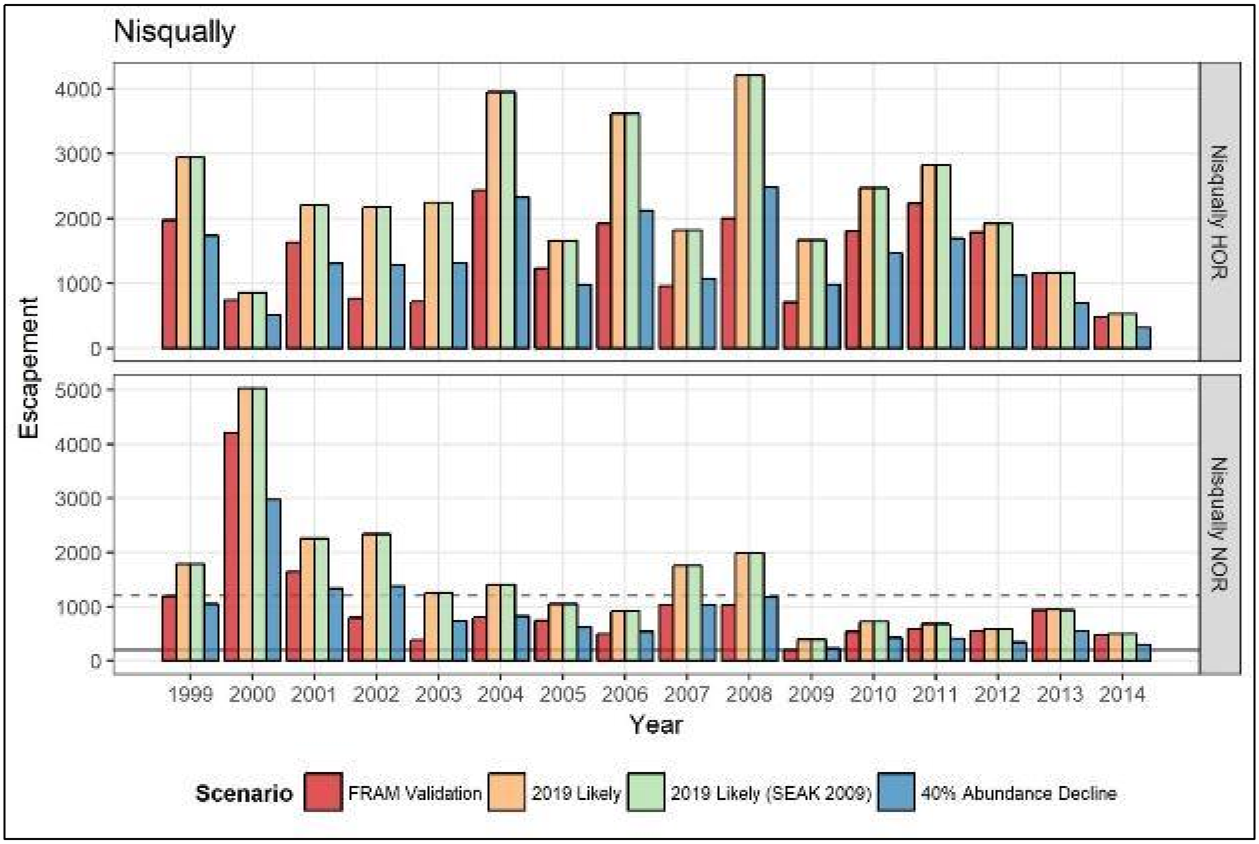

Figure 70. Escapement of Nisqually River Chinook salmon populations based on retrospective analysis scenarios (dashed line represents UET, solid line represents CET, see Table 29 for population specific values).

Effects to Critical Habitat

Designated critical habitat for Puget Sound Chinook includes estuarine areas and river reaches in specified subbasins. It also includes nearshore areas out to a depth of 30 meters adjacent these subbasins, but does not otherwise include offshore marine areas in Puget Sound or in the ocean (see section 2.2.4.1). As a consequence there is some overlap between the action area that is specified in section 2.3 and critical habitat for Puget Sound Chinook salmon. The overlap occurs in the nearshore marine areas in Puget Sound and the watersheds and tributaries of the Nooksack, Stillaguamish, Dungeness, and Mid-Hood Canal management units.

Recall that in this Section (2.5.2.4) we describe the effects on Puget Sound Chinook of the first two parts of the proposed action – the continued effect of the delegation of authority to manage salmon troll and sport fisheries in the EEZ to the State of Alaska, and funding for the implementation of the 2019 Agreement in SEAK. Because fishing that occurs as a result of the proposed actions occur in SEAK, there are no effects to critical habitat. The effects to critical habitat as a result of the funding initiative are discussed in Section 2.5.3.

2.5.3 Mitigation Funding Initiative

In this section we analyze the effects of the funding initiative, the third of the proposed actions discussed in section 1.3. The funding initiative has three components: (1) funding designed to support conservation hatchery programs in the Nooksack, Dungeness, and Stillaguamish and Mid-Hood Canal rivers; (2) funding designed to take immediate action to address limiting habitat conditions for these same four populations, in particular, through habitat restoration activities; and, (3) funding designed to increase hatchery Chinook salmon abundance to provide a meaningful increase in prey availability for SRKWs.

Some effects of the funding initiative can be described specifically and analyzed quantitatively now (e.g., increasing in prey abundance for SRKWs by 4-5 percent). Analyzing the other effects in detail will require more program and site specific information. Analyzing the detailed effects of new hatchery programs, for example, requires the specifics on location, broodstock, release size and so on. Analyzing the detailed effects of habitat restoration activities likewise requires site specific details that are not yet available. Therefore, the analysis of effects of these less well defined aspects of funding reflects a programmatic level review. NMFS plans to conduct site-specific consultations as needed when more detailed information becomes available. This will include a review of the effects to the species and its designated critical habitat.

2.5.3.1 Conservation Hatchery Program Effects

Conservation hatchery programs are currently operating in the Nooksack, Dungeness, and Stillaguamish rivers. A new program is proposed for Mid-Hood Canal. NMFS previously reviewed the Dungeness program through a section 7 consultation (NMFS 2016i). Consultation for the Stillaguamish program is ongoing and due to be completed in the next few months. Review of the Nooksack program is also ongoing. Information for these programs is considered in the environmental baseline of this opinion. However, the funding initiative would provide increased funding for all of the programs that would presumably result in modifications that have not yet been analyzed. As a consequence, NMFS expects that any modifications to the four of the conservation hatchery programs resulting from the funding initiative would be subject to further consultation once the site specific details are fully described, and for the three that have completed consultations it is likely modifications resulting from the funding initiative would trigger reinitiation of those site specific consultations. The likely effects of these modifications, which most likely include increased production, are described in general terms in the following.

Conservation programs are designed to preserve the genetic resources of salmon populations while the factors limiting anadromous fish viability are addressed. In this role, hatchery programs reduce the risk of extinction (NMFS 2005d; Ford et al. 2011a). However, hatchery programs that conserve vital genetic resources are not without risk to the natural salmonid populations. These programs can affect the genetic structure and evolutionary trajectory of the natural population that the hatchery program aims to conserve by reducing genetic diversity and fitness (HSRG 2014; NMFS 2014f). More details on how hatchery programs can affect ESA-listed salmon and steelhead can be found in Appendix C of NMFS (2018a), incorporated here by reference, and summarized below.

Generally speaking, effects of hatcheries range from beneficial to negative when programs use local fish[24] for hatchery broodstock, and from negligible to negative when programs use non-

[24] The term "local fish" is defined to mean fish with a level of genetic divergence relative to the local natural population(s) that is no more than what occurs within the ESU or steelhead DPS (70 FR 37215, June 28, 2005).

local fish[25]. From a risk perspective, NMFS is particularly interested in how effective the program would be at isolating hatchery fish from interactions with natural origin fish and at avoiding co-occurrence and effects that potentially put fish from natural populations at a disadvantage. NMFS identifies the types of circumstances and conditions that are unique to individual hatchery programs, then refines the range in effects for a specific hatchery program. Analysis of hatchery actions for effects on ESA-listed species and on designated critical habitat depends on six factors:

(1) Whether the hatchery program uses fish from the natural population for broodstock

(2) Whether hatchery fish and their naturally produced progeny interact on the spawning grounds, and whether encounters occur with natural-origin and hatchery fish at adult collection facilities

(3) Whether hatchery fish and their naturally produced progeny interact with natural-origin juveniles in rearing areas, the migration corridor, estuary, and ocean,

(4) Whether RM&E that exists because of the hatchery program affects natural-origin fish

(5) Effects of operation, maintenance, and construction of hatchery program facilities

(6) Effects of fisheries that exist because of the hatchery program, including terminal fisheries intended to limit the presences of hatchery-origin fish on the spawning grounds.

The analysis assigns an effect for each viability factor from the following categories: positive, negligible, and negative.

The effects of hatchery fish on an ESU will depend on which VSP criteria are currently limiting the ESU and how the hatchery program affects them (NMFS 2005d). The category of effect assigned to a factor is based on an analysis of each factor weighed against each affected population's current risk level for VSP parameters, the importance of the affected natural population(s) in the ESU, the target viability for the affected natural population(s), and the environmental baseline.

In the following section we review the factors NMFS uses to analyze hatchery programs during site-specific reviews. While this is explained in further detail in NMFS 2017, Appendix C, the following summary focuses on NMFS' approach for conservation programs, based on the assumption each of the programs considered in this opinion would use natural-origin local broodstock.

Factor 1. The hatchery program does or does not remove fish from the natural population and use them for hatchery broodstock

This factor considers the risk imposed by the removal of natural-origin fish for broodstock. The

[25] Exceptions include restoring extirpated populations and gene banks.

level of effect for this factor ranges from neutral to negative.

We anticipate each program will remove natural-origin fish for hatchery broodstock, and therefore range in effect from neutral to negative for each population based on the eventual size of each program (independently based on the level of funding awarded).

A primary consideration in analyzing and assigning effects for broodstock collection is the origin and number of fish collected. The analysis considers whether broodstock are of local origin and the biological pros and cons of using ESA-listed fish (natural or hatchery-origin) for hatchery broodstock. The physical process of collecting hatchery broodstock, and the effect of the process on ESA-listed species, is considered under Factor 2.

Factor 2. Hatchery fish and the progeny of naturally spawning hatchery fish on spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities

NMFS also analyzes the effects of hatchery fish and the progeny of naturally spawning hatchery fish on the spawning grounds. The level of effect for this factor ranges from positive to negative. Under this factor we anticipate each program will increase the level of hatchery-origin fish reaching the spawning grounds relative to if zero federal funds were awarded as part of the mitigation initiative, as each program will be designed to do so. Under this factor we expect this to be a positive effect for each population, so long as funding is awarded to programs that conserve each population’s genetic resources. Under this factor three potential impacts will be evaluated to determine the level of effect: Genetic Effects, Ecological Effects, and interaction at Adult Collection Facilities.

Factor 2.1 Genetic effects

NMFS recognizes there is considerable debate regarding genetic risk. The extent and duration of genetic change and fitness loss and the short- and long-term implications and consequences for different species remain unclear and should be the subject of further scientific investigation. As a result, NMFS believes that hatchery intervention is a legitimate and useful tool to alleviate short-term extinction risk, but otherwise managers should seek to limit interactions between hatchery and natural-origin fish, and implement hatchery practices that harmonize conservation with the implementation of treaty Indian fishing rights and other applicable laws and policies (NMFS 2011c).

Hatchery fish can have a variety of genetic effects on natural population productivity and diversity when they interbreed with natural-origin fish. Although there is biological interdependence between them, in the case of these four programs NMFS considers two major areas of genetic effects of hatchery programs: outbreeding effects, and domestication. In the case of conservation programs, within-population diversity is a minor concern.

Outbreeding effects occur as a result of gene flow from other populations. Gene flow from other populations can increase genetic diversity (e.g., Ayllon et al. 2006), which can be a benefit in small populations. But it can also alter established genetic architecture and thus reduce adaptation, a phenomenon called outbreeding depression (Edmands 2007; McClelland and Naish 2007). The greater the geographic separation between the source or origin of hatchery fish and the recipient population, the greater the potential for outbreeding depression. For this reason, NMFS advises hatchery operators to use locally derived broodstock as they would be for these four programs. Additionally, straying into other populations within or beyond the population's MPG can have an homogenizing effect, decreasing intra-population genetic variability (e.g.(Vasemagi et al. 2005), and increasing risk to population diversity. Reduction of within-population and among-population diversity can reduce adaptive potential. We expect each conservation Chinook salmon program, as a requirement of the funding, to use locally derived hatchery broodstock, decreasing this type of risk. Further, because these conservation hatchery programs would be small, we would not anticipate large number of Chinook from these programs straying into other watersheds.

The proportion of hatchery fish (pHOS)[26] among natural spawners is often used as a surrogate measure of gene flow, but cautions and qualifications should be considered when using this proportion to analyze outbreeding effects. Adult salmon may wander on their return migration, entering and then leaving tributary streams before spawning (Pastor 2004), and be detected and incorrectly counted as strays (Keefer et al. 2008). Caution must also be taken in assuming that strays contribute genetically in proportion to their abundance. Several studies demonstrate little genetic impact from straying despite a considerable presence of strays in the spawning population (Saisa et al. 2003; Blankenship et al. 2007).

Domestication (sometimes called hatchery-influenced selection) is the other major area of genetic effects of interest to NMFS with respect to these programs. Domestication occurs when selection pressures imposed by the hatchery environment differ greatly from those in the natural environment and causes genetic change that is passed on to natural populations through interbreeding with hatchery fish. Detail is provided in Appendix C. Much of the empirical evidence of fitness loss from domestication comes from relative reproductive success (RRS) studies of hatchery and natural fish. One especially well-publicized steelhead study (e.g., Araki et al. 2007; Araki et al. 2008), showed dramatic fitness declines in the progeny of naturally spawning Hood River hatchery steelhead. Lowered RRS in these studies is typically considered evidence of domestication. Besides the Hood River, a number of RRS studies are now available (e.g., Berntson et al. 2011; Theriault et al. 2011; Ford et al. 2012; Hess et al. 2012). All have shown that, generally, hatchery-origin fish have lower reproductive success; however, to date, only the Hood River steelhead (Araki et al. 2007; Christie et al. 2011) and Wenatchee spring Chinook salmon (Ford et al. 2012) and steelhead (Ford et al. 2016b) RRS studies have been able to address a genetic component of RRS.

Based on mathematical models (Lynch and O'Hely 2001; Ford 2002), gene-flow guidelines to limit domestication have been developed (HSRG 2009). Like outbreeding concerns, the metric of interest is pHOS, but for integrated hatchery programs a metric called proportionate natural influence (PNI), is also used which is a function of pHOS and the proportion of natural-origin fish in the broodstock (pNOB)[27]. PNI is, in theory, a reflection of the relative strength of

[26] It is important to reiterate that as NMFS analyzes them, outbreeding effects are a risk only when the hatchery fish are from a different population than the naturally produced fish. If they are from the same population, then the risk is from hatchery-influenced selection.

[27] PNI is computed as pNOB/(pNOB+pHOS). This statistic is really an approximation of the true proportionate natural influence, but operationally the distinction is unimportant.

selection in the hatchery and natural environments; a PNI value greater than 0.5 indicates dominance of natural selective forces. For integrated programs of high conservation importance, the guidelines are a pHOS no greater than 30 percent and PNI of at least 67 percent. Higher levels of hatchery influence are acceptable in the short term, however, when a population is at high risk or very high risk of extinction due to low abundance. In the proposed programs pHOS is expected to be high and PNI is expected to be low, at least in the short term, but the benefits of the programs in reducing extinction risk offset this.

Factor 2.2 Ecological effects

Ecological effects for this factor (i.e., hatchery fish and the progeny of naturally spawning hatchery fish on the spawning grounds) refer to effects from competition for spawning sites and redd superimposition, contributions to marine-derived nutrients, and the removal of fine sediments from spawning gravels. Ecological effects on the spawning grounds may be positive or negative. To the extent that hatcheries contribute added fish to the ecosystem, there can be positive effects. For example, when anadromous salmonids return to spawn, hatchery-origin and natural-origin alike, they transport marine-derived nutrients stored in their bodies to freshwater and terrestrial ecosystems. Their carcasses provide a direct food source for juvenile salmonids and other fish, aquatic invertebrates, and terrestrial animals, and their decomposition supplies nutrients that may increase primary and secondary production (Kline et al. 1990; Piorkowski 1995; Larkin and Slaney 1996; Gresh et al. 2000; Murota 2003; Quamme and Slaney 2003; Wipfli et al. 2003). As a result, the growth and survival of juvenile salmonids may increase (Hager and Noble 1976; Bilton et al. 1982; Holtby 1988; Ward and Slaney 1988; Hartman and Scrivener 1990; Johnston et al. 1990; Larkin and Slaney 1996; Quinn and Peterson 1996; Bradford et al. 2000; Bell 2001; Brakensiek 2002). We anticipate ecological effects under this factor to be positive for each hatchery program as each hatchery program will increase marine-derived nutrient inputs that would be at much lower levels without the additional hatchery adults.

Factor 2.3 Adult Collection Facilities

The analysis also considers the effects from encounters with natural-origin fish that are incidental to broodstock collection. Here, NMFS analyzes effects from sorting, holding, and handling natural-origin fish in the course of broodstock collection. Some programs collect their broodstock from fish voluntarily entering the hatchery, typically into a ladder and holding pond, while others sort through the run at large, usually at a weir, ladder, or sampling facility. Generally speaking, the more a hatchery program accesses the run at large for hatchery broodstock – that is, the more fish that are handled or delayed during migration – the greater the negative effect on ESA-listed species and natural-origin and hatchery-origin fish that are intended to spawn naturally. The information NMFS uses for this analysis includes a description of the facilities, practices, and protocols for collecting broodstock, the environmental conditions under which broodstock collection is conducted, and the encounter rate for ESA-listed fish. NMFS also analyzes the effects of structures, either temporary or permanent, that are used to collect hatchery broodstock, and remove hatchery fish from the river or stream and prevent them from spawning naturally, and on juvenile and adult fish from encounters with these structures. NMFS determines through the analysis whether the spatial structure, productivity, or abundance of a natural population is affected when fish encounter a structure used for broodstock collection, usually a weir or ladder.

We expect these effects to have a range of negligible to negative impacts on the recipient Chinook salmon populations in the Dungeness, Nooksack, Stillaguamish, and Mid-Hood Canal watersheds since the current abundances are already low, and effects are expected to be transitory.

Factor 3. Hatchery fish and the progeny of naturally spawning hatchery fish in juvenile rearing areas, the migratory corridor, estuary, and ocean

NMFS also analyzes the potential for competition and predation when the progeny of naturally spawning hatchery fish and hatchery releases share juvenile rearing areas. The level of effect for this factor ranges from neutral or negligible to negative. Under this factor four categories of potential impacts will be evaluated to determine the level of effect: Competition, Predation, Disease, and Acclimation.

Factor 3.1 Competition

Generally speaking, competition and a corresponding reduction in productivity and survival may result from direct or indirect interactions. The types of specific interactions are detailed in NMFS (2018a), Appendix C, but in general we expect the risk of adverse competitive interactions between hatchery- and natural-origin fish will be minimized by the proposed action awarding funding to programs that use the following strategies:

- Releasing hatchery smolts that are physiologically ready to migrate. Hatchery fish released as smolts emigrate seaward soon after liberation, minimizing the potential for competition with juvenile naturally produced fish in freshwater (Steward and Bjornn 1990; California HSRG 2012)
- Operating hatcheries such that hatchery fish are reared to a size sufficient to ensure that smoltification occurs in nearly the entire population
- Releasing hatchery smolts in lower river areas, below areas used for stream-rearing by naturally produced juveniles
- Monitoring the incidence of non-migratory smolts (residuals) after release and adjusting rearing strategies, release location, and release timing if substantial competition with naturally rearing juveniles is determined likely

Information on the quality and quantity of spawning and rearing habitat in the action area, including the distribution of spawning and rearing habitat by quality and best estimates for spawning and rearing habitat capacity, is critical to analyzing competition risk (NMFS 2018a, Appendix C). Additional important information includes the abundance, distribution, and timing for naturally spawning hatchery fish and natural-origin fish; the timing of emergence; the distribution and estimated abundance for progeny from both hatchery and natural-origin natural spawners; the abundance, size, distribution, and timing for juvenile hatchery fish in the action area; and the size of hatchery fish relative to co-occurring natural-origin fish.

Factor 3.2 Predation

NMFS expects the proposed action to reduce or avoid the threat of predation by awarding funding to hatchery programs that can implement the following strategies:

- Releasing all hatchery fish as actively migrating smolts so that the fish migrate quickly seaward, limiting the duration of interaction with any co-occurring natural-origin fish downstream of the release site.
- Ensuring that a high proportion of the population have physiologically achieved full smolt status. Juvenile salmon tend to migrate seaward rapidly when fully smolted, limiting the duration of interaction between hatchery fish and naturally produced fish present within, and downstream of, release areas.
- Operating hatchery programs and releases to minimize the potential for residualism.

Factor 3.3 Disease

The release of hatchery fish and hatchery effluent into juvenile rearing areas can lead to transmission of pathogens, contact with chemicals or altering of environmental parameters (e.g., dissolved oxygen) that can result in disease outbreaks.

We expect funding will only be awarded to operators which adhere to a number of state, Federal, and tribal fish health policies thereby limiting the disease risks associated with hatchery programs (IHOT 1995; ODFW 2003; USFWS 2004; NWIFC and WDFW 2006). Specifically, the policies govern the transfer of fish, eggs, carcasses, and water to prevent the spread of exotic and endemic reportable pathogens. For all pathogens, both reportable and non-reportable, pathogen spread and amplification are minimized through regular monitoring (typically monthly) removing mortalities, and disinfecting all eggs. Vaccines may provide additional protection from certain pathogens when available (e.g., Vibrio anguillarum). If a pathogen is determined to be the cause of fish mortality, treatments (e.g., antibiotics) will be used to limit further pathogen transmission and amplification. Some pathogens, such as infectious hematopoietic necrosis virus (IHNV), have no known treatment. Thus, if an epizootic occurs for those pathogens, the only way to control pathogen amplification is to cull infected individuals or terminate all susceptible fish. In addition, current hatchery operations often rear hatchery fish on a timeline that mimics their natural life history, which limits the presence of fish susceptible to pathogen infection and prevents hatchery fish from becoming a pathogen reservoir when no natural fish hosts are present.

Our expectation is the effects from potential disease under this factor are neutral to negligible from the future conservation Chinook salmon programs funded as part of the proposed action.

Factor 3.4 Acclimation

One factor the can affect hatchery fish distribution and the potential to spatially overlap with natural-origin spawners, and thus the potential for genetic and ecological impacts, is the acclimation (the process of allowing fish to adjust to the environment in which they will be released) of hatchery juveniles before release. Acclimation of hatchery juveniles before release increases the probability that hatchery adults will home back to the release location, reducing their potential to stray into natural spawning areas. A more detailed discussion on acclimation is found in (NMFS 2018a, Appendix C). Our expectation is that each future funded critical Chinook salmon program will maximize acclimation to limit risk to a negligible amount under this factor.

Factor 4. Research, monitoring, and evaluation that exists because of the hatchery program

NMFS also analyzes proposed research, monitoring, and evaluation for its effects on listed species and on designated critical habitat. The level of effect for this factor ranges from positive to negative.

Generally speaking, negative effects on the fish under this factor are weighed against the value or benefit of new information, particularly information that tests key assumptions and that reduces uncertainty. We expect any research, monitoring, and evaluation activities associated with each of the eventual hatchery programs to be evaluated for these effects during site-specific reviews, and the level of risk to be incorporated into the analysis.

Factor 5. Construction, operation, and maintenance of facilities that exist because of the hatchery program

The construction, installation, operation, and maintenance of hatchery facilities can alter fish behavior and can injure or kill eggs, juveniles, and adults. These actions can also degrade habitat function and reduce or block access to spawning and rearing habitats altogether. Here NMFS analyzes changes to: riparian habitat, channel morphology, habitat complexity, in-stream substrates, and water quantity and quality attributable to operation, maintenance, and construction activities. NMFS also confirms whether water diversions and fish passage facilities are constructed and operated consistent with NMFS criteria. The level of effect for this factor ranges from neutral or negligible to negative. At this time we do not anticipate additional effects above the baseline level of current facilities operating within the respective watersheds under this factor. If funding was awarded at a level that caused additional effects we expect this to be evaluated during subsequent site-specific consultation.

Factor 6. Fisheries that exist because of the hatchery program

Effects of fisheries intercepting natural-origin fish from these respective populations are analyzed in other sections of this opinion. These fisheries would exist regardless of the funding or propagation of these hatchery programs.

2.5.3.2 Habitat Restoration Program Effects

The funding designed to address limiting habitat conditions for specified populations is aimed at making progress toward recovery by improving abundance and productivity. These habitat related recovery projects are expected to be one time capital projects, with estimated costs of approximately $25 million, and are anticipated to be funded and initiated during the first several years of the Agreement. The funding request for the habitat program was informed by a list of approximately 15 high priority restoration projects developed by the Puget Sound co-managers and NMFS in consultation with recovery planners, and other local experts. Habitat restoration work in Puget Sound is dynamic and ongoing. As a consequence, the original project listed may change by the time the funding for the PST related mitigation program becomes available. For example, projects that were initially identified as high priority may be funded out of other revenue streams and thereby provide the opportunity to redirect the money to other projects. The funding request for the habitat projects is tied to a list of more than twenty priority projects, but the specifics could change by the time the funding actually becomes available. For example, there are ongoing efforts to fund many of these priority projects through other sources. If they are funded, the work would be done allowing the money to be redirected to other projects in the watershed. As a consequence, the initial project list may change and the specifics of each project proposal would be finalized once the funding is provided. We therefore describe below how the habitat projects would be reviewed once the site specific detail are finalized.

In 2017, NMFS conducted a programmatic consultation resulting in a biological opinion (NMFS 2017d) on the effects of the Seattle District Corps of Engineers permitting of fish passage and restoration actions in the state of Washington. We anticipate that most if not all of the projects funded through the initiative would require some form of Corps approval and will fall within the scope of the 2017 programmatic consultation, but in cases where they would not they would be subject to individual site-specific consultations. The habitat related recovery projects that would be funded under the second part of the funding initiative fall into the same category of activities considered in the programmatic review of Corps related projects. They would include riverine, lacustrine, wetland, estuarine and marine restoration activities designed to maintain, enhance, and restore aquatic functions as well as projects specifically designed to recover listed fishes. Design constraints for similar projects are found in Washington state technical guidelines (described in NMFS 2017d), and are informed by other programmatic consultations that are used to provide consistency across programs. Actions covered by NMFS' 2017 programmatic consultation are fish passage and habitat restoration projects that include one or a combination of the following restoration action categories:

1. Action Consistent with Limit 8 (Habitat Restoration activities likely to help conserve listed fish) but May Affect Endangered Species in Addition to Threatened Species.
2. Fish Passage Restoration or Improvement
3. Installation of In-Water Habitat Structures and Streambank Stabilization Features
4. Levee Removal, Levee Modification, and Public Access Facilities
5. Channel Restoration and Reconnection
6. Salmonid Spawning Gravel Restoration
7. Beach Nourishment, Bioengineered or Living Shorelines, and Beneficial Use of Landslide Material
8. Installation of Livestock Crossings
9. Irrigation Screen Installation and Replacement
10. Debris and Structure Removal
11. Mitigation and Conservation Bank Construction
12. Invasive Plant Control

Projects considered under the habitat restoration funding program would be reviewed using the for consistency with the design constraints specified in NMFS' opinion (NMFS 2017d).

Effects to Puget Sound Chinook ESU salmon

The potentially most intense adverse effects of the proposed action result from in- or-near-water construction necessary to accomplish restoration work or work on hatchery facilities, e.g., stream crossing replacement projects and channel reconstruction/relocation. Physical and chemical changes in the environment associated with construction, especially decreased water quality (e.g., increased total suspended solids, contaminants, and temperature, and decreased dissolved oxygen) likely affect a larger area than direct interactions between fish and construction personnel. Commonly used design criteria related to in-water work timing, sensitive area protection, fish passage, erosion and pollution control, choice of equipment, in-water use of equipment, and work area isolation are expected to be used to avoid or reduce these adverse effects. Those measures would ensure that projects will (1) not typically involve restoration at sites occupied by spawning adult fish or where occupied redds are present, (2) not involve construction until the time of year when the fewest fish are present, and (3) otherwise ensure that the adverse environmental consequences of construction are avoided or minimized.

It is unlikely that individual adult or embryonic salmon will be adversely affected by the proposed action because all in-water construction will likely be deferred until after spawning season has passed and fry have emerged from gravel, following design criteria. However, in some locations, this may not completely eliminate the possibility that adult salmon may be present during part of the in-water work, and juveniles may still be emerging from the gravel. If, for some reason, an adult fish is migrating in an action area during any phase of construction, it is likely to be able to successfully avoid construction disturbances by moving laterally or stopping briefly during migration, although spawning itself could be delayed until construction was complete (NMFS 2017d). At in- or near-water construction projects (e.g., stream crossing replacement projects, channel reconstruction/relocation), fish may be affected by the isolation of in-water work areas, although other combined lethal and sublethal effects would be greater without the isolation. Where isolation is necessary, an effort will be made to capture all juvenile fish present within the work isolation area and to release them at a safe location, although some juvenile fish will likely evade capture and later die when the area is dewatered. Fish that are captured and transferred to holding tanks can experience trauma if care is not taken in the transfer process.

The use of heavy equipment in-stream in spawning areas will likely disturb or compact spawning gravel. Upland erosion and sediment delivery will likely increase substrate embeddedness. These factors make it harder for fish to excavate redds, and decrease redd aeration (NMFS 2017d). However, the degree of instream substrate compaction and upland soil disturbance likely to occur under most of these actions is so small that significant sedimentation of spawning gravel is unlikely. To the extent that the proposed actions are successful at improving flow conditions and reducing sedimentation, future spawning success, and embryo survival in the action area will be enhanced.

Rapid changes and extremes in environmental conditions caused by construction are likely to cause a physiological stress response that will change the behavior of juvenile fish (NMFS 2017d). For example, reduced input of particulate organic matter to streams, addition of fine sediment to channels, and mechanical disturbance of shallow-water habitats are likely to cause displacement from, or avoidance of, preferred rearing areas. Actions that affect stream channel widths are also likely to impair local movements of juvenile fish for hours, days, or longer. Downstream migration will also likely be impaired. These adverse effects vary with the particular life stage, the duration and severity of the stressor, the frequency of stressful situations, the number and temporal separation between exposures, and the number of contemporaneous stressors experienced (NMFS 2017d).

Juvenile fish compensate for, or adapt to, some of these disturbances so that they continue to perform necessary physiological and behavioral functions, although in a diminished capacity. However, fish that are subject to prolonged, combined, or repeated stress by the effects of the actions, combined with poor environmental baseline conditions, will likely suffer metabolic costs that are sufficient to impair their rearing, migrating, feeding, and sheltering behaviors and thereby increase the likelihood of injury or death. Because juvenile fish in the project areas are already subject to stress as a result of degraded watershed conditions, it is likely that a small number of those individuals will die due to increased competition, disease, and predation, and reduced ability to obtain food necessary for growth and maintenance (NMFS 2017d).

In addition to the short-term adverse effects of construction on listed species described above, restoration projects are expected to have long-term effects to individual fish. Each project would be expected to increase the amount of habitat available and promote the development of more natural riparian and stream channel conditions to improve aquatic functions and become more productive. This will allow more complete expression of essential biological behaviors related to reproduction, feeding, rearing, and migration. Where habitat abundance or quality is a limiting factor for ESA-listed fish in streams, the long-term effects of access to larger or more productive habitat is likely to increase juvenile survival and adult reproductive success. However, individual response to habitat improvement will also depend on factors, such as the quality and quantity of newly available habitat, and the abundance and nature of the predators, competitors, and prey that reside there.

As discussed above, effects from this action to individual fish are expected to be limited in severity and duration due to the use of design criteria. Limited numbers of fish would be affected as a result of implementation of timing limitations on in-water work. Additionally, projects are not expected to occur in close proximity within watersheds. The likelihood of additive effects on species at the program level due to projects occurring in close proximity is very remote, whether those effects are adverse or beneficial.

Instantaneous measures of population characteristics, such as population abundance, population spatial structure and population diversity, are the sum of individual characteristics within a particular area, while measures of population change, such as population growth rate, are measured as the productivity of individuals over the entire life cycle (McElhany et al. 2000). Thus, although the expected loss of a small number of individuals will have an immediate effect on population abundance at the local scale, the effect will not extend to measurable population change unless it reaches a scale that can be observed over an entire life cycle.

Because the juvenile-to-adult survival rate for salmon and steelhead is generally very low, the effects of a proposed action would have to kill hundreds or even thousands of juvenile fish in a single population before those effects would be equivalent even to a single adult, and would have to kill many times more than that to affect the abundance or productivity of the entire population over a full life cycle. The adverse effects of each proposed individual action will be too infrequent, short-term, and limited to kill more than a small number of juvenile fish at a particular site or even across the range of a single population. Thus, the proposed actions will simply kill too few fish, as a function of the size of the affected populations and the habitat carrying capacity after each action is completed, to meaningfully affect the primary VSP attributes of abundance or population growth rate for any single population.

The remaining VSP attributes are within-population spatial structure, a characteristic that depends primarily on spawning group distribution and connectivity, and diversity, which is based on a combination of genetic and environmental factors (McElhany et al. 2000). Because the proposed actions are only likely to have short-term adverse effects to spawning sites, if any, and in the long term will improve spawning habitat attributes, they are unlikely to adversely affect spawning group distributions or within-population spatial structure. Actions that restore fish passage will improve population spatial structure. Similarly, because the proposed action does not affect basic demographic processes through human selection, alter environmental processes by reducing environmental complexity, or otherwise limit a population's ability to respond to natural selection, the action will not adversely affect population diversity.

At the species level, biological effects are synonymous with those at the population level or, more likely, are the integrated demographic response of one or more subpopulations (McElhany et al. 2000). Because the likely adverse effects of any action funded or carried out under this opinion will not adversely affect the VSP characteristics of any salmon or steelhead population, the proposed actions also will not have any a measurable effect on species-level abundance, productivity, or ability to recover.

The strong emphasis on use of proposed design criteria to minimize the short-term adverse effects of these actions, the small size of individual action areas, and the design of actions that are likely to result in a long-term improvement in the function and conservation value of each action area will ensure that individual fish will not suffer greater adverse effects if two or more action areas do overlap. Moreover, the rapid onset of beneficial effects from these types of actions is likely to improve the baseline for subsequent actions so that adverse effects are not likely to be additive at the population or watershed scale.

Effects to Puget Sound Chinook ESU Critical Habitat

Each individual project, completed as proposed, including full application of the design criteria, is likely to have effects on critical habitat PCEs or physical and biological features impacting fish themselves (e.g., turbidity, worksite isolation, noise disturbance, (NMFS 2017d)) . These effects would vary in degree because of differences in the scope of construction for each project and the current condition of PCEs and the factors responsible for those conditions. In general, ephemeral effects are likely to last for hours or days, short-term effects are likely to last for weeks, and long-term effects are likely to last for months, years or decades. The intensity of each effect, in terms of change in the PCE from baseline condition, and severity of each effect, measured as recovery time, will vary somewhat between projects due to differences in the scope of the work. As we receive detailed plans for individual projects, we will consider whether each project fits within the parameters of the 2017 programmatic consultation (NMFS 2017d), or whether it requires an individual consultation.

The area affected for individual projects is expected to be confined to independent watersheds (Dygert 2018). The intensity and severity of the effects associated with a given project are expected to be a onetime event, and regardless of scope, large or small, would dissipate with time, sooner for smaller projects and longer for larger projects. In the end each project would result in functioning habitat post completion. Any adverse effects on PCE conditions and conservation value of critical habitat at the site or reach level are likely to quickly return to, and improve beyond, critical habitat conditions that existed before the action. Moreover, projects completed under the proposed program are also reasonably certain to lead to some degree of ecological recovery within each action area, including the establishment or restoration of environmental conditions associated with functional aquatic habitat and high conservation value. Each action is likely to be designed and implemented in ways that will help to restore lost habitat, improve water quality, reduce upstream and downstream channel impacts, improve floodplain connectivity, and reduce the risk of structural failure. Improved fish passage through culverts and more functional floodplain connectivity, in particular, may have long-term beneficial effects.

In summary, projects proposed under the habitat restoration program will be reviewed in detail once the project and site-specific details become available. We expect that many if not all of the funded projects will fit within the scope of the 2017 programmatic (NMFS 2017d). Any that do not will likely be the subject of individual consultations. We will consider the adverse and beneficial effects of the projects, whether through application of the programmatic opinion or through individual consultations. We generally expect that the adverse effects will be limited because: (1) effects from construction-related activities are short-term and temporary, (2) a very small portion of the total number of fish in any one population will be exposed to the adverse effects of the proposed action, and (3) the geographic extent of the adverse effects is small when compared to the size of any watershed where an action will occur or the total area occupied by any of the species affected. As discussed above, we expect that projects completed under the proposed program will not affect the diversity of any populations or species because the effects of the action will not adversely affect factors that primarily influence population diversity, such as management of hatchery fish or selective harvest practices. Projects that improve fish passage may improve population spatial structure. By contributing to improved habitat conditions that will, over the long term, support populations with higher abundance and productivity, projects completed under the proposed program we expect they will be consistent with the recovery strategies of increasing productivity and spatial diversity, a critical step toward recovery of these species as whole.

2.5.3.3 SRKW Prey Increase Program

While the conservation hatchery and habitat programs would contribute to prey abundance for SRKWs over the intermediate and long term, the third element of the funding initiative is specifically designed to increase the production of hatchery Chinook salmon to provide an immediate and meaningful increase in prey availability for SRKWs.

We expect funds for new production to be distributed broadly to supplement prey abundance in Puget Sound in the summer and offshore areas in the winter, times and areas that have been identified as most limiting (Dygert et al. 2018). An initial analysis indicated that and additional 20 million Chinook salmon smolts would be needed to increase prey availability by 4-5 percent in areas that are most important to SRKWs (as described in Section 1.3).

Although NMFS conducted a preliminary analysis to approximate the number of smolts that would have to be released from broad geographic regions (e.g., Puget Sound and the Columbia River), the details needed to conduct site-specific assessments have not been worked out. Instead, NMFS expects to work collaboratively with the state and tribal co-managers, and other interested parties, to develop a program that meets the goal related to increasing prey abundance, minimizes the risk to listed salmon species, and provides coincident benefits for additional harvest. Once the details are known, NMFS would complete site-specific consultations on the each production program using the approach and considerations outlined in Section 2.5.3.1.

In summary, at a general level we would expect the effects of this component of the funding initiative to include positive effects to SRKW as described in the next section, and a range of effects from positive to negative on listed Puget Sound Chinook salmon and its designated critical habitat similar to those described above in Section 2.5.3.1.

2.5.4 Southern Resident Killer Whales

We examined the effects of the three proposed actions, the delegation of management authority in the EEZ to the State of Alaska, funding to implement the new 2019 PST Agreement in Southeast Alaska, and the funding to address limiting factors affecting Puget Sound Chinook salmon and Southern Resident killer whales. The first and second proposed actions relates specifically to the effects of fisheries in SEAK. Because the SEAK fisheries occur outside the Southern Residents' range, there is no potential for direct interaction between whales and fishing vessels/gear (i.e., there is no overlap in time and space). The effects from the proposed actions are indirect effects from changes to prey availability. This analysis considers whether effects of these changes in prey availability may reduce the reproduction, numbers, or distribution of Southern Resident killer whales. We evaluated the potential effects based on the best scientific information regarding metabolic needs of the whales, prey availability, and reductions in prey resulting from the SEAK fisheries under the 2019 Agreement.

Several studies have found correlations between Chinook salmon indices and Southern Resident killer whale demographic rates (Ford et al. 2005; Ford 2009; Ward et al. 2009; Ward et al. 2013). Although these studies examined different demographic responses related to different Chinook salmon abundance indices, they all found significant positive relationships (high Chinook salmon abundance coupled with high Southern Resident killer whale growth rates). However, there are several challenges to this relationship and uncertainty remains. This relationship is statistically challenging because of demographic stochasticity, Southern Residents have a small population size (not many births or deaths in a year to correlate with salmon abundance), these whales are long-lived making it more challenging to predict interactions with the environment, there are other primary threats (disturbance from vessels and sound and high levels of toxic pollutants) that can also influence demographic rates, the inherent uncertainties in the annual Chinook salmon abundance estimates, and there is currently no metric for prey accessibility (i.e., abundance and availability) to the whales.

Largely, attempts to compare the relative importance of any specific Chinook salmon stocks or stock groups using the strengths of these statistical relationships have not produced clear distinctions as to which are most influential and most Chinook salmon abundance indices are highly correlated with each other. It is also possible that different Chinook salmon populations may be more important in different years and that the relative importance of specific Chinook salmon stocks in the whales' diet changes over time. If anything, large aggregations of Chinook salmon stocks that reflect abundance on a coast-wide scale appear to be as equally or better correlated with Southern Resident killer whale vital rates than smaller aggregations of Chinook salmon stocks, or specific stocks such as Chinook originating from the Fraser River that have been positively identified as key sources of prey for Southern Residents during certain times of the year in specific areas (see Hilborn et al. 2012; Ward et al. 2013). Although it is clear Southern Residents need improvements to their prey base to have a higher chance of improving their own status, these challenges may mask our ability in some years to accurately predict the relationship between Southern Resident killer whale demographic rates and Chinook salmon abundance. In the absence of correlations between vital rates and specific Chinook salmon stocks, we have used other sources of information on geographic overlap, diet and body condition studies to develop a priority stock report as described in the Status of the Species. We are not able to quantify how reductions in prey will directly impact the growth, condition, survival or reproduction of individual whales and instead qualitatively consider annual percent reductions, prey ratios, and priority Chinook salmon stocks affected by the action to evaluate the likelihood and severity of behavioral and physiological effects.

When prey is scarce, whales likely spend more time foraging than when it is plentiful. Increased energy expenditure and prey limitation can cause nutritional stress. Nutritional stress is the condition of being unable to acquire adequate energy and nutrients from prey resources and as a chronic condition can lead to reduced body size and condition of individuals and lower birth and survival rates of a population (e.g., Trites and Donnelly 2003). Food scarcity could also cause whales to draw on fat stores, mobilizing contaminants stored in their fat and potentially affecting reproduction and immune function. Increasing time spent foraging during reduced prey availability also decreases the time spent socializing and reduces reproductive opportunities. Good fitness and body condition coupled with reproductive opportunities is important for reproductive success.

As described in the Status section, the Southern Resident killer whale population is expected to decline over the next 50 years if there is no change in their fecundity or survival (NMFS 2016n). Between 2011 and 2016, fecundity rates declined. There are currently 26 reproductive age females (aged 11 – 42 years), of which only 14 have successfully reproduced in the last 10 years, and there have been no viable calves since the beginning of 2016 (CWR unpubl. data). (Velez-Espino et al. 2014) estimated an extinction risk of 49% in 25 years, and an expected minimum abundance of 15 individuals during a 100-year period. They found the survival of young reproductive females has the largest influence on population growth and population variance. Recent evidence has indicated pregnancy hormones (progesterone and testosterone) can be detected in Southern Resident killer whale feces and have indicated several miscarriages, particularly in late pregnancy (Wasser et al. 2017). The authors suggest this reduced fecundity is largely due to nutritional limitation. Given killer whale gestation is approximately 18 months (Robeck et al. 2015), it is important to have multiple years of sufficient Chinook prey availability to improve fecundity.

Similar to past biological opinions where we assessed the effects of fisheries (e.g., NMFS 2008a; 2018b; 2018a) and the 2009 PST Agreement (NMFS 2008d), our analysis on SEAK fisheries focuses on effects to Chinook salmon availability because the best available information indicates that Southern Residents prefer Chinook salmon (as described in the Status of the Species). By focusing on Chinook salmon, we use a conservative approach to evaluate prey reduction, because the availability of all salmon and other potential prey species within the range of Southern Residents is orders of magnitude larger than Chinook salmon.

We evaluated the potential short-term (or annual) effects as well as the long-term effects of changes in prey availability from the proposed actions described further below. We analyzed the effects of prey reduction in two steps. First, we estimated the reduction in prey available to the whales from the proposed fisheries. Second, we considered information to help put the reduction in context. The pertinent information that helped us put the reduction caused by the proposed actions in context included: 1) assessing how the proposed SEAK fisheries compare to past fisheries, 2) considering the ratio of Chinook prey available compared to the whales' Chinook needs; and 3) evaluating effects of the SEAK fisheries with respect to priority prey stocks. This analysis highlights our level of confidence in the available data, and identifies where there is uncertainty in light of data gaps and where we made conservative assumptions. The proposed funding initiative described in the Proposed Action Section 1.3 as the third proposed action is not anticipated to be implemented immediately. Once implemented, it will take several years before any increases in prey availability will be fully realized because whales prefer older larger Chinook salmon prey. Thus, we analyze that particular funding mitigation as it relates to SRKW under the long-term effects section below.

Short-Term (annual) Effects

The SEAK fisheries take some ESA-listed Chinook salmon of both hatchery- and natural-origin Lower Columbia River Chinook salmon, Snake River fall-run Chinook salmon, Puget Sound Chinook salmon and Upper Willamette River Chinook salmon. Non-ESA-listed Chinook salmon will also be taken in the fisheries managed under the 2019 Agreement. As described in Section 1.3, provisions of the 2019 Agreement result in reductions in catch in SEAK relative to those allowed under the 2009 Agreement. In the SEAK fisheries, in most cases, catch is reduced by 7.5 percent relative to what was allowed in the 2009 Agreement, but at higher abundance levels catch reductions are either 3.25 or 1.5 percent. Because of these reductions to harvest, we anticipate reduced effects to prey availability under the 2019 Agreement compared to the previous regime.

In order to evaluate how prey reduction from SEAK fisheries affects Southern Residents, we needed to consider prey reduction specific to the whales' needs, which are dependent on when the whales occur in particular areas of their range. Therefore, the prey reduction was evaluated by time (FRAM time steps include October – April, May – June, and July – September) and area (coastal waters and inland; as described in the Environmental Baseline section). Our analysis is limited to these seasons and updated information on average number of days when the whales are in inland waters compared to coastal waters because more fine scale temporal and spatial stratification for whales and Chinook salmon stocks in not currently available.

Short-term effects of the SEAK fisheries under the 2019 Agreement on prey availability were evaluated by: 1) the percent reduction in Chinook salmon available as a result of SEAK fisheries (percent reduction), and 2) the remaining prey base of Chinook salmon available after removals from SEAK fisheries compared to the metabolic needs of the Southern Resident killer whale DPS (forage ratio). Here we provide the equations for percent reduction and forage ratio:

Percent Reduction = (prey available $_{\text{w/ SEAK fisheries}}$ – prey available $_{\text{w/o SEAK fisheries}}$)/prey available $_{\text{w/ SEAK fisheries}}$

Forage Ratio = prey available $_{\text{w/ SEAK fisheries}}$ / metabolic needs of whales

We evaluated the effects of the SEAK fisheries by comparing the "Likely" Scenario described in Section 2.5.1 with the "No SEAK Fisheries" scenario described in Section 2.4.5, which included estimated fishing levels under the 2019 Agreement in Canadian fisheries and U.S. fisheries but without the SEAK fisheries. Comparing these two scenarios allows us to isolate the reductions in prey availability of the proposed SEAK fisheries. As described in the Environmental Baseline, the forage ratio was estimated directly comparing available Chinook food energy (in kcals) to the metabolic needs of the whale population (in kcals). The ratios were likewise evaluated comparing available food energy with and without the SEAK fisheries.

Under the 2019 Agreement, the Parties are not required to harvest up to the allowable limit; either Party may harvest at levels less than the limits allowed by the regime. The U.S. fisheries, in particular the SUS fisheries, may be constrained to a greater degree than required by the bilateral agreement when, for example, more stringent constraints are necessitated by the ESA for ESA-listed salmon. This is reflected in our characterization of harvest under the proposed action at 2019 Likely fishing levels, which incorporates more stringent constraints than are required by the 2019 Agreement, a circumstance that occurs frequently for many U.S. fisheries due to ESA listings. Because currently-listed salmon ESUs are unlikely to be recovered and delisted in the next ten years, fishery constraints currently in place are unlikely to be relaxed for the duration of this opinion. However, there is some likelihood that fisheries may have to be constrained to an even greater degree as a result of new information and future consultations involving listed salmon or killer whales.

Percent Reductions

Fisheries in SEAK don't directly overlap with the range of the Southern Residents, but they do catch Chinook salmon that would have been available to the whales where they overlap with the whales off the coast or in inland waters during migration or when they enter natal streams. The reduced prey availability attributed to the SEAK fisheries is measured as the percent reduction (at 2019 Likely levels) in the total Chinook salmon prey available to them in different seasons and locations. In a retrospective analysis we used past levels of Chinook salmon abundance to represent the range of abundance we expect to see over the next 10 years in coastal and inland waters (Figure 71 and Figure 72)) and estimated the range of prey reductions we are likely to see over the next 10 years (Figure 73 and Figure 74). Lower and upper quartile boundaries were estimated for the inland and coastal abundance data to identify high and low abundance years (Table 96).

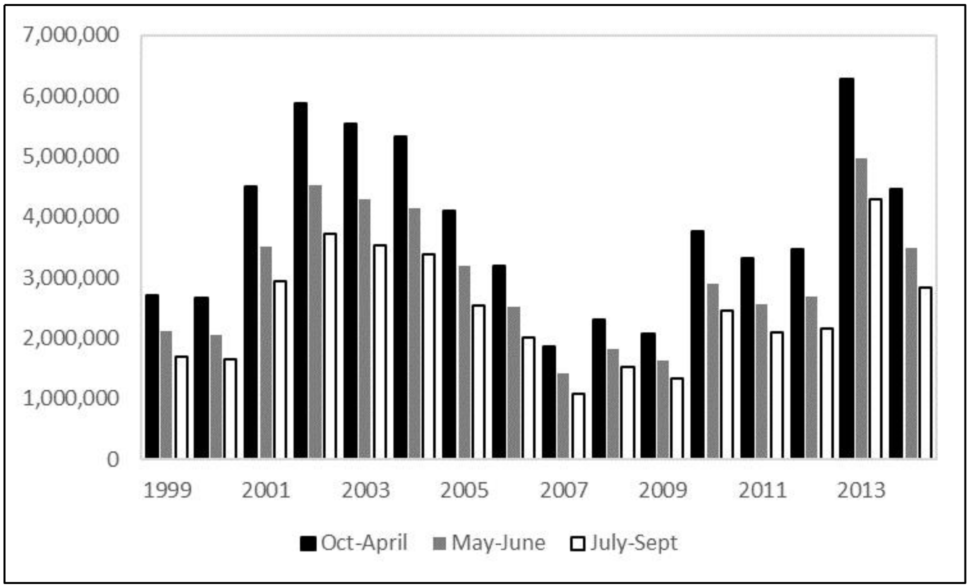

Figure 71. Coastal Chinook salmon abundance with the action per FRAM time step.

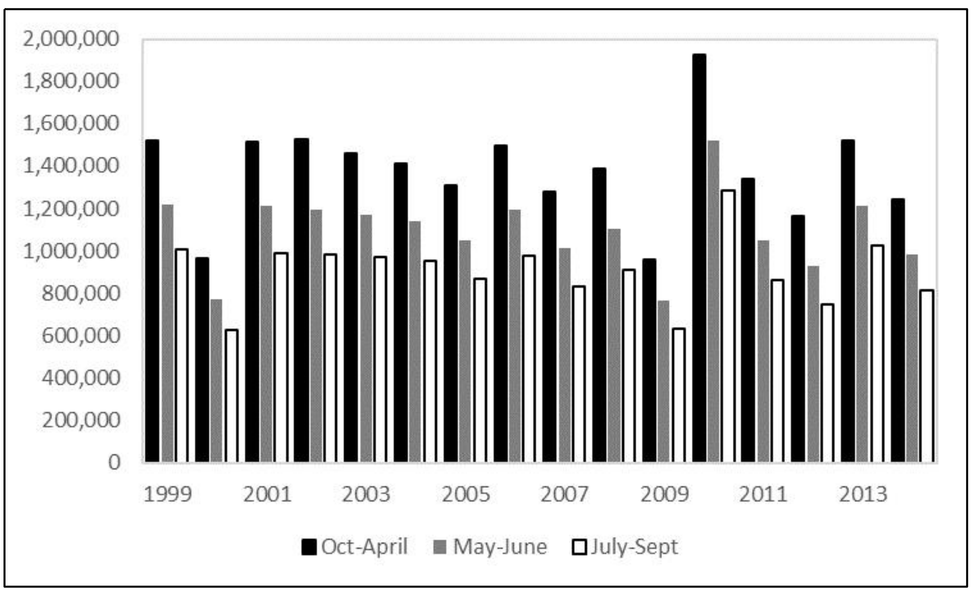

Figure 72. Inland Chinook salmon abundance with the action per FRAM time step.

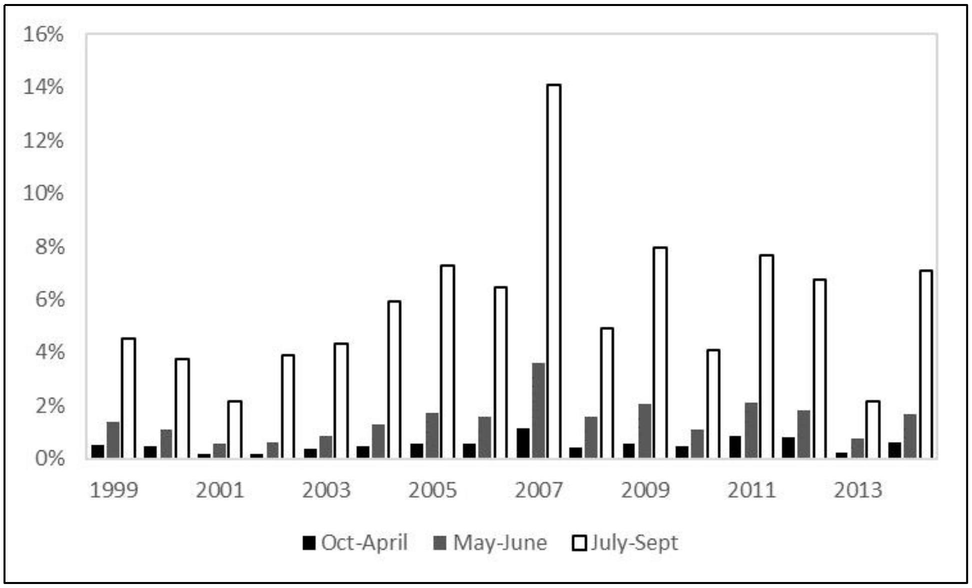

Figure 73. Percent reduction of coastal Chinook salmon from SEAK fisheries per FRAM time step.

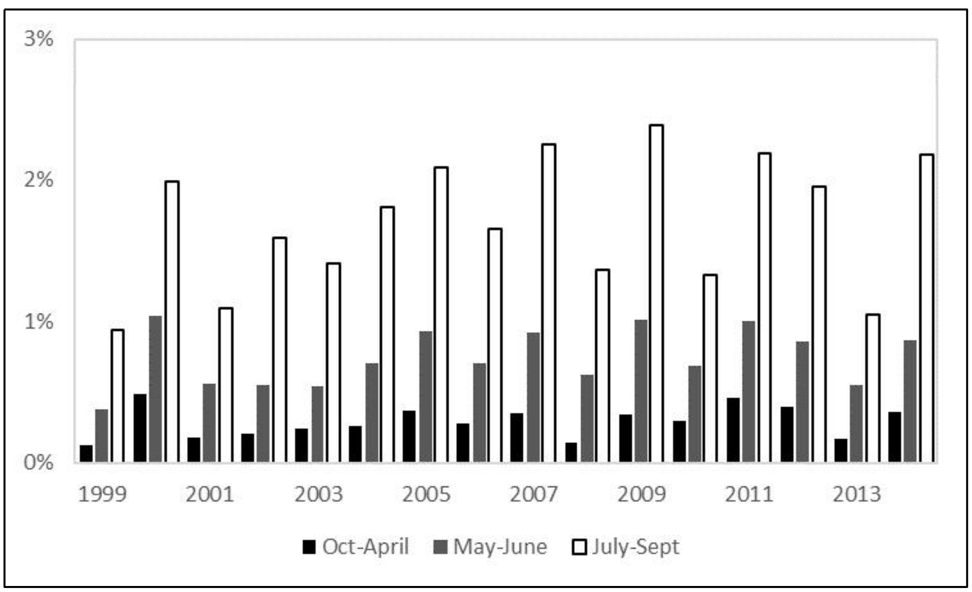

Figure 74. Percent reduction of inland Chinook salmon from SEAK fisheries per FRAM time step.

Table 96. Lower and upper quartile boundaries for coastal and inland Chinook salmon abundances.

Time Period	Quartile	Coastal Abundance	Inland Abundance
October-April	Lower	2,691,961	1,266,954
	Upper	4,711,036	1,517,495

Time Period	Quartile	Coastal Abundance	Inland Abundance
May-June	Lower	2,104,090	1,003,466
	Upper	3,669,997	1,200,390
July-September	Lower	1,690,008	826,710
	Upper	3,043,763	982,740

Figure 71 and Figure 73 above illustrates the coastal Chinook salmon abundances from Scenario 1 (from post-season estimates) and the projected annual percent reductions from the SEAK fisheries, respectively for each FRAM time period. Over the retrospective time period, relatively higher coastal Chinook salmon abundance (i.e. abundance levels above the upper quartile boundary) occurred in years 2002 – 2004 and in 2013 and 2014, whereas relatively lower coastal Chinook salmon abundance (i.e. abundance levels below the lower quartile boundary) occurred in 2000, and 2007 – 2009 (Figure 71). Relatively high inland Chinook salmon abundance occurred in 1999 (for October – April and May – June), 2001 (for May – June and July – September), as well as in 2010 and 2013. Relatively low inland Chinook abundance occurred in 2000, 2009, 2012, and 2014.

In general, the retrospective analysis suggests a relationship between growth of the SRKW population and multiple years of high Chinook abundance (i.e. levels in the upper quartile), and decline of the SRKW population with multiple years of low Chinook abundance (i.e. levels in the lower quartile). During the multiple years of relatively higher Chinook salmon abundance (e.g. 2002-2004 and 2013-2014), the SRKW population began to grow. For example, the total SRKW population abundance increased from 2002 - 2004, from 83 individuals to 88 (see Status of the Species Section 2.2.3.1, Figure 15). This increase in abundance overlapped with the multiple consecutive high abundance Chinook salmon years shown in Figures 71 and 72 above. As described in the Status of the Species, there was a "baby boom" in the SRKW population in 2014 and 2015 that was the result of multiple successful pregnancies that began in 2013 (i.e., a year when both coastal and inland Chinook abundance was relatively high, and was also the highest total Chinook salmon abundance that occurred over the retrospective time period). Similarly, Ward et al. (2009) found that after high salmon abundance years, the probability of calving is 50% higher than following low abundance salmon years. Years of multiple consecutive low Chinook salmon abundance (years below the lower quartile), the SRKW population declined. For example, in the late 1990s and early 2000s, the SRKW population declined almost 20 percent (Figure 15). This decline was largely driven by lower survival rates in L pod. The overall decline of the population was previously described as coinciding with years of low salmon abundance (Ward et al. 2009; Ford et al. 2010) and is also observed in the retrospective analysis.

For each FRAM time period, the percent reduction resulting from the SEAK fisheries in coastal waters is equal to or greater than in inland waters. For example, over the next 10 years if there are similar abundance levels to those observed in 1999, the analysis suggests that SEAK fisheries would reduce available prey in coastal waters by 5% and in inland waters by 1% (Table 97). However, it is important to consider the geographic differences between these areas because the effects of these greater prey reductions in coastal waters would be spread across a larger portion of the geographic range of Southern Residents. We expect the percent reduction in coastal waters in the three FRAM time steps to range from 0.2% – 12.9%, or approximately 7,433 – 211,915 Chinook salmon, with the greatest (or cumulative) reductions occurring in July – September (Table 97). Percent reductions in inland waters in the three FRAM time steps would be expected to range from 0.1% – 2.5% and similarly the greatest reductions would occur in July – September (Table 97).

Table 97. Percent reductions in prey available from the SEAK fisheries by region (inland and coastal waters) and by FRAM time step for each year of the retrospective analysis, based on Scenario 2. Low abundance years (years with abundance levels in the lower quartile) are highlighted in red; high abundance years (years with abundance levels in the upper quartile) are highlighted in green for each region in each year. Years with no highlights indicate abundance levels in the middle quartile range.

Year	Region	Oct - April	May - June	July - Sept
1999	Inland	0.1%	0.4%	1.0%
	Coastal	0.5%	1.4%	5.0%
2000	Inland	0.5%	1.0%	2.0%
	Coastal	0.5%	1.1%	4.0%
2001	Inland	0.2%	0.6%	1.2%
	Coastal	0.2%	0.6%	2.4%
2002	Inland	0.2%	0.5%	1.6%
	Coastal	0.2%	0.6%	3.9%
2003	Inland	0.2%	0.5%	1.4%
	Coastal	0.4%	0.9%	4.3%
2004	Inland	0.3%	0.7%	1.8%
	Coastal	0.5%	1.3%	5.9%
2005	Inland	0.4%	0.9%	2.1%
	Coastal	0.6%	1.7%	7.1%
2006	Inland	0.3%	0.7%	1.7%
	Coastal	0.6%	1.5%	6.4%
2007	Inland	0.3%	0.9%	2.3%
	Coastal	1.1%	3.5%	12.9%
2008	Inland	0.1%	0.6%	1.5%
	Coastal	0.4%	1.6%	5.2%
2009	Inland	0.3%	1.0%	2.5%
	Coastal	0.5%	2.0%	7.9%
2010	Inland	0.3%	0.7%	1.4%
	Coastal	0.5%	1.1%	4.3%
2011	Inland	0.5%	1.0%	2.2%
	Coastal	0.9%	2.1%	7.4%
2012	Inland	0.4%	0.9%	1.9%
	Coastal	0.8%	1.8%	6.5%

2013	Inland	0.2%	0.5%	1.1%
	Coastal	0.2%	0.8%	2.4%
2014	Inland	0.4%	0.9%	2.2%
	Coastal	0.6%	1.6%	6.9%

Whales are more often observed in coastal waters during the October to April and May to June FRAM time periods (i.e., when the percent reductions would be relatively low compared to summer months; Table 97). As described in the Status of the Species, on average the whales spend a substantial amount of time in the inland waterways during July through September. However, in recent years the whales have had late arrivals and fewer days present in inland waters indicating more time spent in coastal waters. If this pattern continues the whales may be more affected by the relatively greater percent reduction in coastal waters during the July – September FRAM time step than they were previous years.

In general, the model predicts that percent reductions from the SEAK fisheries in coastal waters will not necessarily be smaller during low Chinook salmon abundance years. For example, a high percent reduction in coastal waters (12.9%) could also occur during a period of low coastal Chinook salmon abundance (similar to 2007) (Table 97). In inland waters, larger percent reductions could also occur during low inland Chinook abundance (e.g. similar to 2000 and 2009 in May-June and July-Sept; Table 97). This pattern likely reflects the fishery management measures designed to limit catch of specific stocks, but which don't take into account the total Chinook abundance that is important to the Southern Resident killer whales.

Forage Ratio

We also consider the prey reduction from the SEAK fisheries in context by estimating the ratio of Chinook food energy available to the whales compared to needs and evaluating the ratio after those reductions (that is, with the proposed fishing). For example, ratios above 1 indicate there is more prey available than the whales need. Because there is no available information on the whales' foraging efficiency, it is difficult to evaluate the impact of prey reductions on the ratios. Although we have low confidence in the ratios and thus put low weight to them, we consider them as an indicator to help focus our analysis on the time and location where prey availability may be lowest and where the action may have the most significant effect on the whales. Using the same retrospective approach as with reductions, we used past levels of Chinook salmon abundance to represent the range of abundance we expect to see over the next 10 years and estimated the range of ratios we are likely to see over the next 10 years.

Table 98 summarizes the food energy from Chinook salmon available to Southern Residents compared to the whales' energy needs with and without the implementation of the proposed action in coastal and inland waters during the three FRAM time steps.

Table 98. Forage ratios with (w/SEAK) and without the SEAK fisheries (w/out SEAK) by region (inland and coastal waters) and by FRAM time step for each year of the retrospective analysis, based on Scenario 2. Low abundance (below the lower quartile) years are indicated in red; high abundance (above the upper quartile) years are indicated in green for each region.

Year	Region	Oct - April		May - June		July - Sept	
		w/out SEAK	w/SEAK	w/out SEAK	w/SEAK	w/out SEAK	w/SEAK
1999	Inland	24.0	23.4	23.6	23.5	12.7	12.6
	Coastal	11.7	11.6	57.6	56.5	69.0	64.9
2000	Inland	19.1	19.0	17.8	17.6	9.3	9.0
	Coastal	11.7	11.6	56.3	55.6	67.3	64.1
2001	Inland	26.2	26.1	25.0	24.8	13.2	13.0
	Coastal	17.3	17.3	85.3	84.7	105.1	102.1
2002	Inland	29.7	29.6	27.3	27.0	14.5	14.2
	Coastal	23.7	23.6	114.7	113.8	141.3	134.6
2003	Inland	32.8	32.7	30.0	29.8	15.9	15.7
	Coastal	24.7	24.6	117.8	116.5	143.8	136.5
2004	Inland	28.8	28.7	27.0	26.8	14.5	14.1
	Coastal	22.5	22.3	108.6	106.7	133.0	122.8
2005	Inland	24.3	24.2	22.8	22.5	12.1	11.8
	Coastal	18.0	17.9	87.0	85.2	104.8	95.9
2006	Inland	27.7	27.6	26.0	25.7	13.7	13.4
	Coastal	14.0	13.9	67.9	66.6	81.9	75.5
2007	Inland	21.8	21.7	20.3	20.0	10.7	10.4
	Coastal	8.3	8.2	39.1	37.4	46.1	38.7
2008	Inland	22.6	22.6	21.9	21.7	11.8	11.5
	Coastal	7.8	7.8	40.1	39.1	50.8	47.0
2009	Inland	19.2	19.1	17.8	17.6	9.4	9.2
	Coastal	7.9	7.8	39.3	38.2	49.4	44.5
2010	Inland	32.5	32.3	31.5	31.2	17.4	17.1
	Coastal	12.6	12.5	62.7	61.6	80.6	75.7
2011	Inland	27.1	26.9	24.8	24.5	13.1	12.7
	Coastal	12.9	12.8	62.8	61.1	78.6	71.4
2012	Inland	17.8	17.7	17.0	16.8	8.9	8.7
	Coastal	13.2	13.0	64.9	63.2	79.3	72.4
2013	Inland	26.7	26.7	25.6	25.4	14.0	13.8
	Coastal	20.7	20.6	106.8	105.7	137.5	133.2
2014	Inland	23.7	23.6	22.3	22.0	11.9	11.6
	Coastal	18.0	17.9	89.3	87.5	110.4	101.3

The proposed fishing would reduce the available prey and lower the ratio of available prey compared to needs of the whales. Because the ratios of Chinook salmon prey available to meet the whales' needs are relatively low for coastal waters from October through April compared to ratios in May through September, and are relatively low for inland waters from July through September compared to ratios in October through June (Table 98), any additional measurable reduction during these times and areas when the ratios are relatively low is a concern. However, due to the limitations in interpreting these ratios, we are unable to quantify how this reduction affects foraging efficiency of the whales. The ratios in coastal and inland waters would be generally greater in higher Chinook abundance years than in lower Chinook salmon abundance years.

As described in the Environmental Baseline, if Chinook salmon abundance over the next 10 years is similar to what was observed from 1999 – 2014, the forage ratios in coastal waters would be highest in the July – September time period, and lowest during the October – April time period. However, relatively smaller changes between the ratios would occur in coastal waters during the October-April and May – June time periods compared to July – September. For example, the forage ratios in coastal waters would range from 7.8 to 24.6 during October – April (compared to 7.8 to 24.6 without the action), 37.4 to 116.5 during May – June (compared to 39.1 to 117.8 without the action), and 38.7 to 136.5 during July – September (compared to 46.1 to 143.8 without the action) (Table 99). In contrast, the inland ratios would be highest during October – April and lowest during July – September. The forage ratios in inland waters would range from 17.7 to 32.7 during October – April (compared to 17.8 to 32.8 without the action), 16.8 to 31.2 during May – June (compared to 17.0 to 31.5 without the action), and 8.7 to 17.1 in July – September (compared to 8.9 to 17.4 without the action) (Table 99).

Priority Chinook Salmon Prey Stocks

As described in the Status of the Species section, NMFS and WDFW identified Chinook salmon stocks that are thought to be most important to Southern Resident killer whales. Some of these priority stocks are caught in the SEAK fisheries. The largest stocks contributing to the SEAK fisheries catch include the Columbia Upriver brights, North/Central B.C., WCVI hatchery, and Oregon coastal (contributing to over half the fishery catch; Table 99). Neither the North/Central BC, WCVI hatchery, or Oregon coastal stocks are currently considered at the top of the priority prey list for SRKWs (NOAA and WDFW 2018); however, the Columbia Upriver bright stock ranks as number three on the priority list.

Between 1985 and 2015, an average of 18.11% of the SEAK fisheries' catch was the Columbia Upriver brights stock (PSC 2018). On average, 13.04% of the stock's total return was caught in the SEAK fisheries (PSC 2018). Because these fish are caught outside the range of the whales and thus subject to predation and other natural mortality prior to becoming available prey, it is unlikely that Southern Residents would have encountered and consumed all the Columbia Upriver brights that would be made available in the absence of the proposed action. The 3-year geometric mean spawning escapement for the Columbia Upriver brights stock is 167,496 with a minimum stock size threshold (MSST) of 19,182 (PFMC 2018b). Thus, this stock is not considered an overfished stock (a stock is overfished if the 3-year geometric mean spawning escapement is less than the MSST; PFMC 2018b). The inriver run size for this priority stock ranged from 212,047 to 795,915 between 2009 and 2017 (refer to Table B-18 in PFMC 2018b).

Table 99. Fishery and stock catch from SEAK all gear ((PSC 2018); Appendix D1).

Fishery	Southeast Alaska All Gear				
	2016	Average (1985-2015)			
Model Stock	Percent of Fishery Catch	Percent of Fishery Catch	Percent of Stock Catch	Percent of Stock Total Return	Associated Escapement Indicator Stocks[28]
Columbia Upriver Bright	28.22%	18.11%	26.18%	13.04%	Columbia Upriver Bright, Deschutes
North/Central BC	10.61%	15.92%	20.40%	10.23%	Nass, Skeena, Yakoun, Dean, Rivers Inlet
WCVI Hatchery	16.06%	15.17%	52.51%	17.62%	NA
Oregon Coastal North Migrating	9.92%	13.68%	33.56%	15.09%	Nehalem, Siletz, Siuslaw
Mid-Columbia Brights	8.97%	6.64%	35.29%	13.83%	Not Represented
Upper Georgia Straight	6.48%	5.70%	34.01%	19.58%	Upper Georgia Strait
Fraser Early	3.37%	3.96%	24.76%	5.12%	Fraser Spring 1.2, Fraser Spring 1.3, Fraser Summer 1.3, Fraser Summer 0.3
Columbia Upriver Summer	6.03%	3.94%	27.57%	12.79%	Columbia Upriver Summer
Alaska South SE	1.08%	3.55%	96.58%	33.55%	Unuk, Chickamin
WCVI Wild	1.88%	2.88%	54.19%	17.73%	Artlish, Burman, Kaouk, Tahsis, Tashish, Marble
WA Coastal Wild	1.81%	2.72%	17.25%	9.11%	Grays Harbor Fall, Quillayute Fall, Hoh Fall, Queets Fall
WA Coastal Hatchery	1.95%	2.23%	16.95%	8.55%	NA
Willamette River Hatchery	0.74%	2.22%	12.81%	5.33%	NA
Fall Cowlitz Hatchery	0.93%	1.00%	5.33%	2.18%	NA
Lewis River Wild	0.86%	0.86%	19.19%	8.29%	Lewis River
Lower GS Hatchery	0.12%	0.32%	3.58%	1.79%	NA
PS Hatchery Fingerling	0.13%	0.21%	0.52%	0.28%	NA
Lower Georgia Strait	0.18%	0.19%	3.87%	2.01%	Lower Georgia Strait
Fraser Late	0.04%	0.15%	0.31%	0.11%	Harrison
Snake River Fall	0.32%	0.13%	6.66%	4.07%	Not Represented
Spring Cowlitz Hatchery	0.16%	0.10%	2.25%	1.05%	NA
Skagit	0.03%	0.09%	4.29%	1.15%	Skagit Summer/Fall

[28] NA=a hatchery stock; Not represented=a wild stock without an escapement indicator.

Fishery	Southeast Alaska All Gear				
	2016	Average (1985-2015)			
Model Stock	Percent of Fishery Catch	Percent of Fishery Catch	Percent of Stock Catch	Percent of Stock Total Return	Associated Escapement Indicator Stocks[28]
Summer/Fall					
Stillaguamish Summer/Fall	0.02%	0.06%	20.06%	6.69%	Stillaguamish
PS Yearling	0.04%	0.05%	0.53%	0.34%	NA
Nooksack Fall	0.01%	0.04%	0.18%	0.13%	NA
Puget Sound Natural	0.01%	0.03%	0.70%	0.29%	Green, Lake Washington
Snohomish Summer/Fall	0.02%	0.03%	4.45%	1.17%	Snohomish
Spring Creek Hatchery	0.00%	0.00%	0.00%	0.00%	NA
Lower Bonneville Hatchery	0.00%	0.00%	0.00%	0.00%	NA
Nooksack Spring	0.00%	0.00%	0.00%	0.00%	Nooksack Spring

There are also priority stocks that are not large contributors to the fishery catch, but a relatively moderate proportion of these stocks' total return are taken by the SEAK fisheries. These include mid-Columbia brights (13.83% of the total return are caught in the SEAK fisheries), upper Georgia Strait (19.58% of the total return are caught in the SEAK fisheries), and upper Columbia River summer stocks (12.79% of the total run are caught in the SEAK fisheries) (Table 99). The Puget Sound Chinook salmon and lower Columbia River fall stocks are ranked high on the priority list, but make up a smaller proportion of the fishery catch (approximately 2 to 3 percent of the total catch for the SEAK fisheries) and catch a relatively lower proportion of the total run size (Table 99).

In summary, the SEAK fisheries catch will be reduced by up to 7.5% relative to what was allowed under the 2009 Agreement. Although the proposed SEAK fisheries could result in up to 12.9% reduction in the prey available to the whales in their coastal range, this would likely occur rarely and during a time period when the whales are more often observed in inland waters. Furthermore, these greater prey reductions in coastal waters would be spread across a larger portion of the geographic range of Southern Residents. The maximum prey reductions in inland waters could be up to 2.5% during the summer months. The larger increases in prey reduction in coastal and inland waters would have the biggest impact in low abundance years. Lastly, some of the Chinook salmon caught in SEAK are priority runs for the whales. With the exception of the Columbia River brights, that have a relatively large run size, the largest stocks contributing to the SEAK fisheries catch are currently not considered at the top of the priority prey list for SRKWs (NOAA and WDFW 2018).

Long-Term Effects

Part of our analysis relies on the analysis of effects to salmon to assess the long-term effects of the proposed actions on Southern Residents. When the 2009 Agreement was finalized, recovery plans were not yet in place for most Chinook salmon ESUs, only the Puget Sound Chinook ESU had been completed (NMFS 2007). Currently, final recovery plans have been published for LCR Chinook Salmon (NMFS 2013c), Snake River fall-run (NMFS 2017f), and Upper Willamette River (NMFS and ODFW 2011) Chinook salmon ESUs. Therefore, the proposed actions and their impacts to listed Chinook salmon ESUs were evaluated in the context of the recovery plans and criteria. Based on the analysis for the listed Chinook salmon ESUs in this Opinion, the proposed actions are in line with recovery planning as it relates to eventual delisting criteria for each salmon ESU. For the salmon analysis, NMFS reviewed the status, environmental baseline, effects of the proposed actions, and cumulative effects for each listed Chinook ESU. As described in Section 2.7.1-2.7.4, NMFS' analysis concluded that the proposed actions are not likely to appreciably reduce the survival and recovery of the ESA-listed Chinook salmon ESUs.

The salmon analysis also considered the potential for an overall 40% reduction of Chinook salmon in the ocean by comparing the 40 percent abundance decline scenario to the 2019 Likely scenario (described further in Section 2.5.1). The comparison provides a perspective on how the fishery provisions in the 2019 Agreement will respond to reduced abundance in terms of effect on exploitation rates and resulting escapements. Although unlikely to occur, it was assessed to understand how the agreement would respond if a prolonged and broad scale down turn in productivity and abundance occurred as a consequence of long term cycles in ocean conditions or global climate change. The retrospective analysis indicates that the management regime compensates for reduced abundance as intended (see Section 2.7.1-2.7.4). However, the responsiveness of the regime (e.g. reduced exploitation rates) doesn't necessarily always equate to increases in prey availability to the whales. For example, as described above, on several occasions when Chinook abundance was relatively low (e.g. 2007), larger percent reductions in prey availability occurred (e.g. 12. 9%). NMFS has been developing a risk assessment and adaptive management framework relating Chinook salmon abundance to Southern Resident killer whale population dynamics that will help evaluate the impacts of salmon management on the whales. NMFS' work to develop the risk assessment for this purpose currently remains ongoing.

Although the effects from the SEAK fisheries include reducing prey available to the whales, the hatchery and habitat mitigation as described in Section 1.3 is anticipated to offset some of the loss from all fisheries managed under the PST, both Canadian and all U.S. salmon fisheries, including the SEAK fisheries. However, contributions of hatchery production to the prey base will be available to the whales several years after fish are released and have matured into older, larger adults that the whales prefer to consume and would also be available to other salmon predators. During this gap between the commencement of fishing under the proposed action and increase in prey availability due to funding for increased hatchery production and habitat mitigation, the whales may spend more time foraging than they otherwise would in the absence of the proposed fishing. However, the likelihood that relatively large percent reductions from the SEAK fisheries (e.g. 12.9%) coupled with multiple consecutive low abundance years will occur during this period is low. It is more likely that years in which low abundance coupled with relatively high impacts will be spread out over the course of the decade and not coupled together in the first few years, similar to that observed in the retrospective analysis between 1999 and 2014. For example, as described above, relatively lower coastal Chinook salmon abundance (i.e. abundance levels below the lower quartile boundary) occurred in 4 out of the 16 years and did not occur at once (e.g. 2000, and 2007 – 2009; Figure 71). Similarly, the relatively large percent reductions were spread out throughout the 16 years (Table 97).

Because the funding for a mitigation program would be received by NMFS and administered through a grant program in the future, we are limited in our ability to fully understand the efficacy or predict the performance of the program and the total resulting benefits to Southern Resident killer whales. It is anticipated that the conservation hatchery and habitat programs would focus on and contribute to prey abundance for Southern Residents in times and areas considered most important to Southern Resident killer whales. Based on the best available information on the Southern Resident killer whale diet, distribution, and body condition (as described in the Status of the Species), these important time-areas include inland waters in the summer months and coastal waters in the winter and spring months (October through May).

We used the FRAM to estimate the increase in prey abundance that could result from an increase in the hatchery production mitigation. We considered the list of priority Chinook salmon stocks (NOAA and WDFW 2018), and identified the hatchery production facilities with available capacity to increase Chinook salmon production (focusing on the important time-areas). Results of the analysis suggest that with the annual funding of 5 million dollars, approximately 20 million Chinook smolts can be produced (Dygert et al. (2018). Approximately 5 – 6 million smolts produced from facilities in the inland waters and the remaining from coastal waters (e.g. Columbia River and Washington coastal stocks), will increase prey abundance by 4-5% in inland waters in the summer and 4-5% in coastal waters in the winter and spring. This potential increase in inland waters in the summer months when prey availability is relatively low, offsets some of the loss estimated from fisheries managed under the PST, including SEAK harvest. The potential increase in hatchery production of Chinook salmon stocks overlapping in time and space during winter/spring months (October through May) when it is thought prey is most limiting were weighted as higher priority (NOAA and WDFW 2018) will also provide additional prey and more foraging opportunities during this period of lower prey availability.

Currently, hatchery production is a significant component of the salmon prey base returning to watersheds within the range of Southern Residents (Barnett-Johnson et al. 2007; NMFS 2008g). For example, hatchery programs on the Columbia River funded by the Mitchell Act (NMFS 2017e) and as part of the Federal Columbia River Power System (NMFS 2008j) produce significant numbers of Chinook salmon. Hatchery produced fish likely benefit Southern Residents by enhancing prey availability as scarcity of prey is identified as a threat to their survival and hatchery fish often contribute to the salmon stocks consumed by the whales (Hanson et al. 2010).

Healthy natural-origin salmon populations are important to the long-term maintenance of prey populations available to Southern Resident killer whales. Although hatchery production has contributed some offset of the historical declines in the abundance of natural-origin salmon within the range of the whales, hatcheries also pose risks to natural-origin salmon populations (Nickelson et al. 1986; Ford 2002; Levin and Williams 2002; Naish et al. 2007). However, hatchery programs are often modifying various program elements to be able to adaptively manage the program in ways that minimize effects on listed species and allow operators to achieve program goals.

The mitigation funding that is part of the third proposed action was also designed to take immediate action to address limiting habitat conditions for primarily four Chinook salmon populations (Nooksack, Dungeness, and Stillaguamish rivers, and a new program for the Mid-Hood Canal population), and make progress toward recovery by improving abundance and productivity. These habitat related recovery projects supports long term recovery of Chinook salmon stocks.

Effects to Southern Resident Critical Habitat

In addition to the indirect effects to the species discussed above, the proposed actions affect critical habitat designated for Southern Resident killer whales. Based on the natural history of the Southern Residents and their habitat needs, we identified three physical or biological features essential to conservation in designating critical habitat: (1) Water quality to support growth of the whale population and development of individual whales, (2) Prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth, and (3) Passage conditions to allow for migration, resting, and foraging. This analysis considers effects to these features.

The proposed actions have the potential to affect the quantity and availability of prey in critical habitat. We do not expect the proposed fisheries to impact water quality or passage because there is no overlap of the fisheries and Southern Resident killer whale critical habitat. We also do not expect the proposed funding to measurably impact water quality or passage. However, as described above, we do expect adverse effects of the proposed fishing by reducing prey quantity and availability in critical habitat resulting from the harvest of adult salmon. We also expect the conservation funding initiative to affect prey quantity and prey availability. As described previously, several studies have correlated Chinook salmon abundance indices with Southern Resident killer whale population growth rates (Ford et al. 2005; Ford 2009; Ward et al. 2009; Ward et al. 2013). However, uncertainty remains because there are several challenges to understanding this relationship. The reductions of age 3-5 Chinook salmon in designated critical habitat from the SEAK fisheries will range from 0.1% – 2.5%, with the greatest reductions expected to occur in July – September. The larger increases in prey reduction would have the biggest impact in low abundance years.

As described above, we also estimated the Chinook food energy available to the whales and compared available kilocalories to needs and evaluated the ratio after reductions from the proposed fishing. The baseline ratios in critical habitat ranged between 8.9 and 17.4 times the whales' estimated needs during July through September. With the proposed fishing, the ratios would be reduced to between 8.7 and 17.1. Because we consider the ratio of Chinook prey available to meet the whales' needs to be relatively low in critical habitat in July through September compared to ratios in October through June, an additional reduction in these ratios from any source is a likely concern. However, we are unable to quantify how this reduction affects the foraging efficiency of the whales due to the limitations in interpreting these ratios.

Although only a small proportion of the SEAK fisheries catch is from stocks that originate and return to Southern Resident killer whale critical habitat, and the range in reductions of age 3-5

Chinook salmon in critical habitat is relatively low compared to in coastal waters in July through September, the whales spend a substantial amount of time in the inland waterways of the their critical habitat during these months. When prey is scarce, whales likely spend more time foraging than when it is plentiful. Increased energy expenditure and prey limitation can cause nutritional stress, which can lead to reduced body size and condition of individuals and lower birth and survival rates of a population (e.g., Trites and Donnelly 2003). Food scarcity could also cause whales to draw on fat stores, mobilizing contaminants stored in their fat and potentially affecting reproduction and immune function. Increasing time spent foraging during reduced prey availability also decreases the time spent socializing and reduces reproductive opportunities. Good fitness and body condition coupled with reproductive opportunities is important for reproductive success.

It is difficult to assess how reductions in prey abundance may vary throughout critical habitat and we have less confidence in our understanding of how reductions could result in localized depletions in the three different core areas of designated critical habitat. However, the potential increase in hatchery production that will contribute to abundance in inland waters from the proposed funding mitigation will offset some of the loss from fisheries managed under the PST, including SEAK harvest in July – September (an anticipated increase of 4% prey availability). However, this offset by hatchery production will likely take several years after fish are released to be fully realized because Southern Residents prefer to consume larger (i.e. older) Chinook salmon. During the time it takes for these hatchery fish to return as adults to critical habitat areas, the proposed fishing is likely to adversely affect designated critical habitat. However, we do not expect multiple years of low Chinook abundance coupled with relatively high rates of fishery impacts as described above. Thus, we do not expect fishing to result in serious adverse impacts to critical habitat during this time period.

Therefore, we anticipate the adverse effects to prey quantity and availability from the SEAK fisheries will be partially mitigated by the funding package to increase habitat and hatchery efforts which help offset some loss in critical habitat (although it will take several years) and is not expected to appreciably diminish the value of critical habitat.

2.5.5 Effects Analysis of Humpback Whales and Steller Sea Lions

For the *Effects of the Action* analysis, we have identified the incidental capture or entanglement in salmon fishing gear (herein referred to generally as “interactions” as a potential adverse effect of SEAK salmon fisheries on ESA-listed humpback whales and Steller sea lions. Typical ESA-listed species interactions with SEAK salmon fisheries include entanglement in a net or other components of gear such as buoy extender lines or other types of salmon fishing lines that could result in or contribute to an entanglement. Interactions that include hooking injuries from troll gear, with or without entanglement of the fishing line, are also considered a primary mode of interaction. Other potential impacts could occur as a result of the fishery, such as vessel collisions with marine mammals or impacts related to any pollution or marine debris generated by fishing vessels. It is also conceivable that impacts to prey might affect ESA-listed species, or that avoidance of SEAK salmon fishing gear could lead to increased energetic expenditure or temporary exclusion from important foraging resources. Although competition with fisheries for prey was ranked as a potentially high threat in the recovery of the Western DPS of Steller sea lions (NMFS 2008i), substantial scientific debate surrounds the question about the impact of potential competition between fisheries and Steller sea lions.

At this time, the available information does not suggest that any of these additional factors are affecting ESA-listed species as a result of the continued operation of the SEAK salmon fisheries. Steller sea lions and humpback whales have a large foraging base and SEAK fisheries do not target their primary prey. Steller sea lions are generalist predators that eat a variety of fishes and cephalopods and humpback whales consume a range of prey types, such as small schooling fishes, krill, and other large zooplankton. While there are records of vessels strikes of humpback whales and Steller sea lions in SEAK, none of these encounters have been identified with or attributed to salmon fishing vessels or activity by the SARs (Helker et al. 2018; Muto et al. 2018a). Without evidence to support analyses of how these factors may affect ESA-listed species as a result of the proposed action, NMFS assumes these factors are insignificant and discountable. As a result, the effects analysis will concentrate on the impact of direct interactions between ESA-listed species and fishing gear used in the SEAK salmon fishery. For this *Effects of the Action* analysis, we summarize the available information that indicates humpback whales and Steller sea lions are subjected to interactions with SEAK salmon fisheries. Then we examine the available information that relates the relative exposure of ESA-listed populations of humpback whales and Steller sea lions to interactions with SEAK salmon fisheries (Mexico DPS humpback whales and Western Steller sea lions, respectively) and their anticipated response to these interactions. Finally, we consider and describe the potential extent of impacts that may occur for ESA-listed populations of humpback whales and Steller sea lions based on the available information on the extent of SEAK salmon fisheries.

2.5.5.1 Marine Mammals Interactions in SEAK Salmon Fisheries

Bycatch of marine mammals in all commercial fisheries is monitored and categorized according to relative risks of mortality and serious injury (M/SI) for marine stocks[29] by NMFS through the List of Fisheries (LOF) as required by the MMPA. The LOF lists U.S. commercial fisheries by categories (I, II, and III) according to the relative level of interactions (frequent, occasional, and remote likelihood of an interaction or no known interactions, respectively) that result in M/SI of marine mammals. In order to accomplish this task, NMFS often relies upon data provided by the use of fisheries observers. In addition, NMFS also documents and tracks evidence of fisheries interactions and injuries through records obtained from marine mammal strandings reported to NMFS, as well as any additional reporting to NMFS of interactions directly from fishermen or other individuals.

With respect to SEAK salmon fisheries, two commercial fisheries are currently listed on the 2018 LOF as Category II fisheries, signifying that occasional or moderate levels of interactions that result in M/SI of marine mammal stocks occur:[30] AK Southeast salmon drift gillnet (generally referred to as commercial SEAK drift gillnet herein) and AK Yakutat salmon set gillnet (generally referred to as commercial SEAK set gillnet herein). While the LOF indicates that a number of different marine mammal stocks interact with the commercial SEAK drift

[29] Stocks as defined under the MMPA. These may not necessarily coincide with ESA-listed populations of marine mammals (e.g., Central North Pacific stock of humpback whales is not an ESA-listed DPS of humpback whales).
[30] https://www.fisheries.noaa.gov/action/final-list-fisheries-2018

gillnet fishery, the Category II classification is driven by occasional interactions with CNP stock of humpback whales. In addition, the Eastern Steller sea lion population is included as a marine mammal stock that may be incidentally killed or injured by this fishery. The commercial SEAK set gillnet fishery Category II classification is driven by analogy,[31] and CNP humpback whales are listed as one of the stocks that may be incidentally killed or injured by this fishery.

A number of other SEAK salmon fisheries are listed individually or included as part of fisheries that are classified as Category III fisheries, signifying rare or low levels of interactions that result in M/SI of marine mammals stocks occur, including: AK Southeast salmon purse seine and AK Metlakatla salmon purse seine fisheries (collectively referred to as commercial SEAK purse seine herein); AK salmon troll (includes commercial SEAK troll fishing); and AK/WA/OR/CA commercial passenger fishing vessel fishery. It is worth noting that both the Eastern and Western Steller sea lion stocks are identified as stocks that may be incidentally killed or injured by the AK salmon commercial troll fishery, which includes trolling throughout the entire state of Alaska and not just within the action area of this proposed action.

To date, there has been limited deployment of fisheries observers to collect data on marine mammal bycatch in commercial SEAK salmon fisheries through the Alaska Marine Mammal Observer Program (AMMOP). In 2007 and 2008, observers were deployed in the SEAK set gillnet fishery. In 2008, there was a Steller sea lion interaction documented by AMMOP observer (offwatch) in this fishery (Manly 2009). During this period, where 6.3% of the total fishing effort was monitored by observers, no other marine mammal interactions were observed in the fishery. In 2012 and 2013, observers were deployed in a portion of the SEAK drift gillnet fishery; specifically in Districts 6, 7, and 8 (represented and referred to herein as Districts 106, 107, and 108; see Figure 75). During this period, approximately 6.5% of total fishing effort in these districts was monitored by observers. In 2013, one humpback whale was observed entangled and released alive with some gear remaining attached (Manly 2015), which was ultimately determined by NMFS to lead to a serious injury (CNP humpback whale SARs; Muto et al. (2018b)). Using these data, the bycatch (and serious injury/mortality) of humpback whales in this portion of the SEAK salmon drift gillnet fishery was estimated to be 5.5 individuals per year (Manly 2015). In addition, data were collected by observers in this fishery on the number of "blow-throughs" where sizeable portions of netting were damaged and/or missing when nets were retrieved. While the origins of blow-throughs were unknown, it was assumed these occurred primarily as a result of interactions with whales and Steller sea lions, with most of them being done by humpback whales (Manly 2015). There were 3 such blow-throughs that were recorded in both 2012 and 2013; all in District 106. Using these data, it was estimated that approximately 46 and 47 blow-throughs occurred in this portion of the SEAK salmon drift gillnet in 2012 and 2013, respectively.

[31] In the absence of reliable information indicating the frequency of incidental mortality and serious injury of marine mammals by a commercial fishery, NMFS will determine whether the incidental mortality or serious injury is ''frequent,'' ''occasional,'' or ''remote'' by evaluating other factors such as fishing techniques, gear used, methods used to deter marine mammals, target species, seasons and areas fished, qualitative data from logbooks or fishermen reports, stranding data, and the species and distribution of marine mammals in the area, or at the discretion of the Assistant Administrator for Fisheries (50 CFR 229.2).

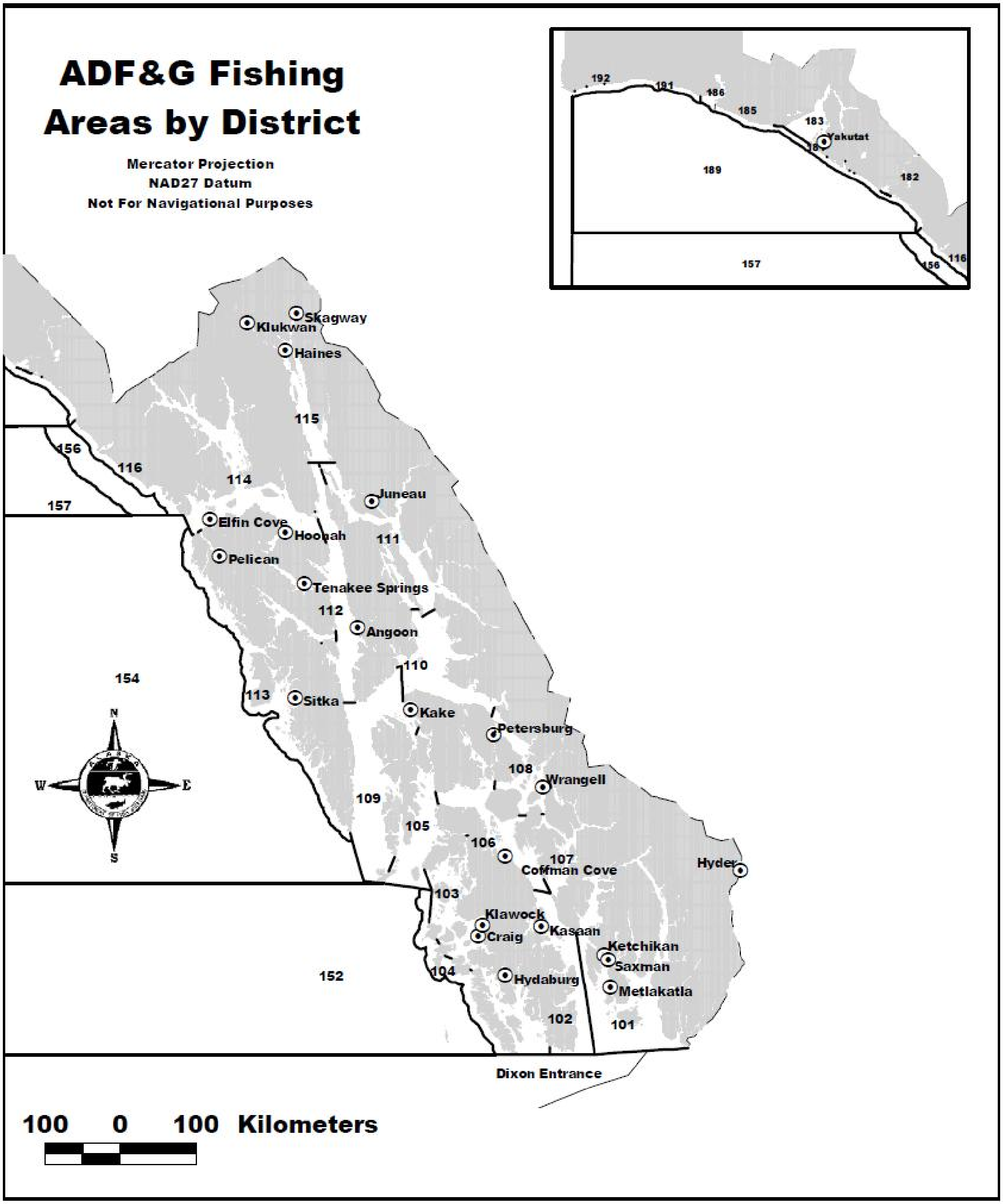

Figure 75. Map of ADFG salmon fishing districts.

Considering the limited extent of observer data that are available from many commercial fisheries, including SEAK salmon fisheries, NMFS also relies upon other records of entanglements/interactions that are reported to Marine Mammal Stranding Programs and/or NMFS MMAP (fishermen self-reports as required by the MMPA) to evaluate the relative impact of interactions by marine mammal stocks with commercial fisheries and other human sources. The most current information on these data from Alaska is available in the marine mammal SARs and a Serious Injury and Mortality Assessment Technical Memorandum published annually (Helker et al. 2018). These data are collected opportunistically and typically have not been extrapolated within the SARs into more comprehensive estimates of total strandings or human interactions that may have occurred, and we understand these totals to represent minimal totals of overall impacts. Below we describe the available information on all humpback whale and Steller sea lion interactions with SEAK salmon fisheries (not just those that lead to M/SI) that can be found in the most current drafts of these reports.

2.5.5.2 Summary of Humpback Whale Interactions with SEAK Fisheries

The most recent SARs for CNP humpback whales provide a summary accounting of human caused mortality and serious injuries for 2012-2016 (Muto et al. 2018b). With respect to fisheries and/or fishing gear that are confirmed to be or may be associated with SEAK salmon fisheries, the SARs describes the following information and totals for average annual M/SI:

- Estimate of 5.5 M/SI per year in Districts 106,107, and 108 in SEAK drift gillnet gear.
- References that there were 11 events assigned some fraction of M/SI[32] reported to the NMFS Stranding Program or MMAP through opportunistic reporting.
- Using this information, the SARs indicates that at least 1.8 humpback whale M/SI occurred in SEAK drift gillnet outside Districts 106, 107, and 108 (using all opportunistic reports regardless of location)
- Minimum total of 0.3 M/SI per year in the SEAK commercial purse seine fishery
- Minimum total of 0.3 M/SI per year in unidentified SEAK net fisheries (could be salmon net)
- Minimum total of 0.5 M/SI per year in unidentified SEAK fishing gear (could be salmon gear)

We note that the SARs only provide accounting of estimates of M/SI, and not the total number of interactions. In order to further understand the possible extent of interactions between humpback whales and SEAK salmon fisheries to include interactions that may not necessarily lead to M/SI, we reviewed all reports of interactions and human caused strandings of CNP humpback whales from 2011-2016 that are documented and evaluated for M/SI in Helker et al. (2018). In summary, this report describes:

- A total of 30 incidents of humpback whale interactions with fishing gear in SEAK reported to NMFS that may involve salmon fishing; an average of 5 per year.
- There were 18 incidents identified involving SEAK drift gillnet gear; of which 5 were ultimately deemed to involve non-serious injuries. The number of reported incidents range from 2-4 reports per year; with at least 2 reports received in every month from May to September during this period (8 of the reports were received in July)
- There were 4 incidents identified involving SEAK purse seine gear (including 1 incident involved in the SEAK Metlakatla purse seine fishery); of which 2 were ultimately

[32] Current guidance and practice for making mortality and serious injury determinations includes prorating certain types of human interactions (e.g., entanglements) as fractions of a M/SI based on the nature of the injuries and assumed likelihood these injuries may be serious or life-threatening (Helker et al. 2018).

deemed to involve non-serious injuries. Incidents were reported in 2013, 2015 (2), and 2016; 3 of them were reported in July, and 1 in August.
- In June, 2013, 1 non-serious injury incident involving the SEAK salmon troll fishery was reported; it was unspecified whether this involved commercial or recreational gear.
- In August, 2014, 1 non-serious injury incident involving an anchor line from a CPFV (Commercial Passenger Fishing Vessel) in SEAK was reported (unknown if CPFV was fishing for salmon or not).
- A total of 4 incidents involving M/SI associated with unknown nets/gillnets (could have been salmon nets) were reported. Incidents were reported in 2012, 2013, and 2015 (2); 1 in June, 1 in July, and 2 in August.
- A total of 2 incidents involving M/SI associated with unknown gear that reference leadlines (could have been salmon nets) were reported. Both incidents were related to each other as it appeared that both a mother and calf were entangled and seen together in August, 2015.

2.5.5.3 Summary of Steller sea lion Interactions with SEAK Fisheries

The most recent SARs for the Western stock of Steller sea lions (2012-2016) did not identify any M/SI for interactions with the Western stock of Steller sea lions associated with SEAK salmon fisheries. Because the Eastern stock and Western stock are designated based on the line at Cape Suckling (144º W) the SARs attribute Steller sea lion interactions that occur east of the line at Cape Suckling to the Eastern stock. However, a guidance memo issued by the NMFS Alaska Regional Office (NMFS 2013d) indicates that there is mixing of Western DPS Steller sea lions and Eastern DPS Steller sea lion east of Cape Suckling.[33] The area of mixing is generally considered to include the area north of Sumner Strait, which is located in SEAK in the vicinity of Kupreanoff and Kui Islands, near Petersburg. As a result, we examined the available information relating interactions with the Eastern stock of Steller sea lions to help understand Steller sea lion interactions with SEAK salmon fisheries in general.

The most recent SARs for the Eastern stock of Steller sea lions provides a summary accounting of human caused mortality and serious injuries for 2010-2014 (Muto et al. 2018a). With respect to fisheries and/or fishing gear that are confirmed to be or may be associated with SEAK salmon fisheries, the SAR describes the following information and totals for average annual M/SI:
- References that there were 111 incidents of interactions with SEAK troll fisheries reported to NMFS during this time period
- Using this data, the SARs indicates that at least 2.4 M/SI per year occurred in SEAK salmon troll (including recreational fishing)
- Minimum total of 25 M/SI per year occur in SEAK troll[34] (of unknown or unspecified origin; could be salmon gear)
- Combined, estimates 27.4 M/SI in SEAK troll gear
- Minimum total of 0.4 M/SI occur in SEAK monofilament gear (could be salmon gear)
- The SAR notes that (typically) it is not clear whether troll interactions documented involved recreational or commercial components of the fishery.

[33] The stock delineation under the MMPA for Steller sea lions matches with the DPS listing under the ESA.
[34] There was note in the SARs about a 4 year average due to lack of reporting by ADFG in 2013

Similar to the humpback whales above, we note that the SAR only provides accounting of estimates of mortality and serious injury. In order to further understand the possible extent of interaction between Steller sea lions and SEAK salmon fisheries including interactions that may not necessarily lead to mortality or serious injury, we reviewed all reports of interactions and human caused strandings of the Eastern stock of Steller sea lions from 2011-2016 that are evaluated for M/SI in Helker et al. (2018). In summary, this report describes:

- A total of 132 incidents of interactions reported to NMFS between Steller sea lions and fishing gear in SEAK that may involve salmon fishing; and average of 21.8 per year (acknowledging reporting on strandings in 2013 is considered limited).
- There were 124 incidents reported involving troll gear (~25 per year over 5 years the SAR evaluates) that could not be further assigned to commercial or recreational troll fishing gear based on the information provided; all which were ultimately deemed to result in serious injuries. With regard to annual activity, the totals are as follows:
    - 2011 - 30; June - 12, July - 16, August 2
    - 2012 - 29; June - 6, July - 18, August - 3, September - 2
    - 2013 - 3; June - 2, July - 1
    - 2014 - 49; May - 1, June - 9, July - 35, August - 2, October - 2
    - 2015 - 6; July - 5, September - 1
    - 2016 - 7; May - 1, July 3, August - 3

  In terms of overall monthly patterns of activity during this period, the totals are:
    - May 2
    - June 28
    - July 79
    - August 10
    - September 3
    - October 2
- Although typically it has not been possible to distinguish whether commercial or recreational gear is involved with troll interactions, there were 2 incidents of interactions reported involving recreational troll fishing in SEAK; both were ultimately deemed to have resulted in serious injuries. One incident occurred in 2014 and in 2016; both in July.
- There were 3 incidents involving unidentified “hook and line” fishing in SEAK (could have been salmon gear)[35]; 2 of which were ultimately deemed to have resulted in non-serious injuries. One incident was reported in September, 201; one was reported June, 2015; and another was reported in September, 2016.
- There were 2 incidents involving the SEAK drift gillnet fishery; 1 of which was ultimately deemed to have resulted in a non-serious injury. One incident was reported in August, 2012, and another was reported in June, 2014.

[35] We acknowledge in Alaska the term “hook and line” gear usually refers specifically to commercial long line gear used in groundfish fisheries. However, the attribution of unidentified “hook and line” gear to these specific incidents appears to be generally applied to unknown monofilament line/hooks including one specifically attributed to recreational hook and line fishing gear (Helker et al. 2018). To be conservative, we assume it is possible these 3 incidents may have involved recreational salmon fishing gear based on the available information. It is theoretically possible that this could have been commercial troll gear, or numerous other types of fishing gear as well, although flashers and other indications of troll gear were not apparently associated with these particular reports.

- There was 1 incident involving the SEAK set gillnet fishery; which was ultimately deemed a non-serious injury. This interaction was reported in April, 2011.

2.5.5.4 Exposure of ESA-listed Marine Mammals

As described earlier in the *Status of the Species* section, a relatively small portion of the humpback whales found in SEAK belong to the Mexico DPS - about 6.1%. Therefore, without any additional information regarding the specific origins of individual humpback whales that have been entangled, or additional understanding of relative interaction rates of the Mexico DPS in SEAK fishing gear, we assume that a small proportion (approximately 6%) of all humpback whale entanglements in SEAK salmon fisheries involve individuals from the Mexico DPS.

As described earlier in the *Status of the Species* and in this section above, mixing of the Western DPS Steller sea lions with Eastern DPS Steller sea lions occurs in SEAK within the action area. Using the map of ADFG salmon fishing districts (Figure 75), the “Steller sea lion mixing area” appears to generally represent the border of districts 105, 106, 108, and 152 below to the south with no mixing, and districts 109, 154, and higher above to the north with mixing. It is possible that a portion of district 108 could fall within the mixing zone, but this cannot be factored into the analysis given the available data on fishing effort and/or strandings are not locally specific enough to allow for such distinctions at this time. Given that only a small portion of that district may be in question, we will assume district 108 is not within the mixing zone.

Previously, NMFS has incorporated information on the movements and mixing rates of Western DPS Steller sea lions and Eastern Steller DPS sea lion in SEAK to support consultations on a number of proposed actions. When local information is available, such as construction of a ferry terminal in Haines, specific local mixing rates for that area (~2%) have been used to assume the relative proportion of Western Steller sea lion presence there (NMFS 2017a). In other situations where local information may be more limited, NMFS has assumed 50% of Steller sea lions in some areas of SEAK may belong to the Western Steller sea lion population (NMFS 2017c).

To date, NMFS has not previously made any assumptions regarding the overall percentage of Steller sea lions throughout the entire mixing area in SEAK that are Western Steller sea lions. Research by Jemison et al. (2013b) suggested that the probability of movement into the Eastern Steller sea lion territory by individual Western Steller sea lions from the Gulf of Alaska could be has high as 10% for females and 18% for males, depending on the season and age class. Research by (O’Corry-Crow et al. 2014)identified a variable percentage of mixing of populations throughout SEAK, with some high overlap of Western DPS individuals in rookery areas nearer the dividing line (e.g., Graves Rock area has 65% Western DPS animals), and more moderate rates in some areas located further east in the heart of SEAK (e.g., Hazy and Forrester areas have approximately 20% Western DPS animals in their rookery). While there is not a clear or comprehensive estimate of the proportion of Western Steller DPS sea lions across the broad range of the proposed action area throughout SEAK at this time, we conclude it is likely the relative proportion is highly variable throughout this area. Given the most recent scientific information available we assume that moderate mixing rates, such as approximately 20%, may constitute the best conservative overall general characterization of the percentage of Steller sea lions throughout the mixing area of SEAK that may be from the Western DPS. Thus, our analysis assumes that 20% of all Steller sea lion interactions with SEAK salmon fisheries within the mixing area involve animals from the Western DPS.

2.5.5.5 Response

Information on the anticipated response (i.e., M/SI rates) of ESA-listed humpback whales and Steller sea lions to interactions with SEAK salmon fisheries can be derived or inferred using data on M/SI that have been applied to previous incidents in the SARs process (Helker et al. 2018). For humpback whales, the anticipated M/SI rates for interactions that may involve SEAK salmon fisheries based on the most recent data from 2011-2016 described above evaluated by Helker et al. (2018) is as follows:

- SEAK salmon drift gillnet - 18 records of entanglement evaluated/ 10.5 total M/SI assigned = 58% M/SI rate
- SEAK salmon purse seine - 4 records / 1.5 total M/SI assigned = 38% M/SI rate
- Unknown gillnet/net - 4 records / 3.25 total M/SI assigned = 81% M/SI rate
- SEAK salmon troll - 1 record / 0 total M/SI assigned = 0% M/SI rate
- AK CPFV - 1 record / 0 total M/SI assigned = 0% M/SI rate

For Steller sea lions, the anticipated M/SI rates for interactions that may involve SEAK salmon fisheries based on the most recent data from 2011-2016 described above evaluated by Helker et al. (2018) is as follows:

- SEAK salmon troll (including recreational) - 126 records / 126 total M/SI assigned = 100% M/SI rate
- Unidentified hook and line fishing gear (considered to possibly be associated with salmon recreational fishery) - 3 records / 2 total M/SI assigned = 67%% M/SI rate
- SEAK drift gillnet - 2 records / 1 total M/SI assigned = 50% M/SI rate
- SEAK set gillnet - 1 record / 0 total M/SI assigned = 0% M/SI rate

2.5.5.6 Extent of ESA-listed Marine Mammal Interactions Anticipated

As described above, most all of the available data on the interactions between ESA-listed marine mammals and SEAK salmon fisheries comes from opportunistic reports provided to NMFS which ultimately provide a minimum accounting of what has occurred. Currently there aren't comprehensive or cumulative estimates of the total number of interactions that have or can occur in these fisheries. The only estimates generated to date beyond these minimum totals that are available involve estimates of humpback whale entanglements in a portion the SEAK salmon drift gillnet fishery based on limited sampling of only that portion of the fishery. In order to characterize the extent of interactions that may be anticipated based on the information that is available, we first described the extent of fishing effort in various SEAK salmon fisheries based on the available data provided by ADFG. Then we consider how these fisheries operate in context with the available data on ESA-listed species distribution and their anticipated interactions with SEAK salmon fisheries.

In the following sections, we will describe the available information and analysis of anticipated effects of the proposed action on ESA-listed humpback whales and Steller sea lions. Given that comprehensive estimates of interactions with SEAK salmon fisheries are not available, information will generally be presented in terms of the minimum levels known from stranding records, along with any additional evaluations that can be made based on what is reasonably certain to occur given relevant information at hand. There will also be some less certain assessments of potential impacts that might be occurring using assumptions and/or other information that may not be well established or subject to precise interpretation, but is useful in helping trying to gain insights into the general level of impacts that may be occurring but have not been documented. While these assessments may be less certain, they are based on the available information and we believe there is a possibility that the approximate levels described may occur. In summarizing the effects analysis, we specifically outline the minimum levels of interactions and M/SI expected, as well as levels that are reasonably certain to occur, for ESA-listed populations of humpback whales and Steller sea lions in each SEAK salmon fishery. Where possible, we also highlight less certain analysis presented. Then we combine these assessments into totals for all SEAK salmon fisheries for further integration in this biological opinion. We note there is not data available regarding the relative age/sex distribution of ESA-listed marine mammal interactions with SEAK salmon fisheries, and we assume that all interactions involving M/SI carry equal weight with respect to impacts to these respective populations.

Information on the number of active permits used within a fishing district associated with different gear types used in commercial SEAK salmon fisheries from 2011-2018 was provided by ADFG. These data are tracked for each statistical week. In order to characterize the relative amount of fishing effort in terms of permit activity in a district on a monthly basis, we identified the highest level of permit activity that occurred within a month (identified by all statistical weeks beginning in that month) for each district and each gear type. While this does not provide an explicit accounting of the amount of gear that is fished and for what duration (preferred metrics for evaluating interaction risks that are not available), it does provide a general index of spatial and temporal activity in terms of the maximum level of participation in the area during that time.

We further aggregated information from each individual district by adding the identified maximum permit activity level for each district together to generate totals for each fishery (Table 100), as well as within specific spatial aggregations to inform relative risks to ESA-listed populations as appropriate (see below). We understand that commercial SEAK salmon fisheries and fishermen are dynamic and mobile, so we acknowledge that participation by the same fishermen across many districts during a month is to be expected but we do not have data at hand to specifically account for this. Our assumption is that our aggregated view of permit activity does reflect some measure of relative effort (i.e., an index) useful at least for tracking and comparing patterns of effort over space and time across each fishery.

In addition, data were also provided by ADFG on the number of hours and/or days that various commercial SEAK salmon fisheries were open within each district each year 2011-2018. Similar to the permit activity measure of effort, we further aggregated information from each individual district by adding them together to generate totals for the amount of time fisheries were open across the entire fishery (Table 101 and Table 102), as well as to generate specific spatial aggregations to inform relative risks to ESA-listed populations as appropriate. Again, acknowledging the dynamic nature of participation across various fisheries and districts, we assume that our aggregated view of the amount of time fisheries are open does reflect some useful measure of relative effort at least for tracking and comparing patterns of fishing effort opportunity over space and time across each fishery.

Table 100. Summary of permit activity (in terms of number of active permits) in commercial SEAK salmon fisheries by month summed across all districts 2011-2018 (2018 data are preliminary).

Gear	Month	Years								Average	Min	Max
		2011	2012	2013	2014	2015	2016	2017	2018			
Drift Gillnet	5	29	84	38	19	12	35	14	15	31	12	84
	6	464	413	482	443	412	388	398	387	423	387	482
	7	586	556	661	537	533	534	534	610	568	524	661
	8	458	415	490	419	440	417	417	436	443	415	490
	9	304	284	371	344	323	335	335	310	323	284	371
	10	51	43	62	35	9	59	59	10	37	9	62
Purse Seine	5	5	0	4	1	1	0	0	0	1	0	5
	6	165	175	245	211	216	227	191	211	205	165	245
	7	447	496	575	499	537	469	637	522	523	447	637
	8	510	507	482	417	534	456	534	372	477	372	534
	9	118	98	95	56	150	77	178	149	115	56	178
	10	13	7	5	4	1	0	0	0	4	0	13
Set Gillnet	6	88	84	88	92	85	89	100	62	86	62	100
	7	111	100	91	87	87	86	92	15	84	15	111
	8	89	77	71	81	62	75	68	76	75	62	89
	9	92	70	74	80	69	84	79	74	78	69	92
	10	92	24	45	53	86	43	51	22	52	22	92
Troll	1	87	48	73	78	111	151	90	73	89	48	151
	2	105	98	73	99	187	230	128	104	128	73	230
	3	187	178	148	156	228	185	156	125	170	125	228
	4	324	331	266	277	37	118	271	1	203	1	331
	5	289	224	226	256	292	368	220	98	247	98	368
	6	528	473	556	464	533	482	359	201	450	201	556
	7	1045	1119	1143	1004	989	935	939	864	1005	864	1143
	8	1004	990	896	929	697	868	809	744	867	697	1004
	9	590	614	684	662	533	615	603	674	622	533	684
	10	221	156	185	184	237	161	167	91	175	91	237
	11	121	113	100	112	158	88	88	0	98	0	158
	12	84	50	68	92	113	83	69	0	70	0	113

Table 101. Summary of the number of hours of open fishing in commercial SEAK salmon fisheries summed across all districts over each year 2011-2018 (2018 data is preliminary).

Gear	Years								Average	Min	Max
	2011	2012	2013	2014	2015	2016	2017	2018			
Drift Gillnet	22,206	22,740	25,330	27,411	23,354	24,690	22,087	20,793	23,576	20,793	27,411
Purse Seine	74,858	45,454	68,218	65,685	62,766	54,529	68,219	54,536	61,783	45,454	74,858
Set Gillnet	21,629	17,260	20,068	19,894	19,515	19,647	17,277	16,032	18,915	16,032	21,629
Troll	183,339	186,411	191,004	189,684	184,544	193,884	200,449	156,679	185,749	156,679	200,449

Table 102. Number of days open for commercial SEAK salmon troll fishery by district 2011-2018 (2018 data is preliminary).

District	Years							
	2011	2012	2013	2014	2015	2016	2017	2018
101	365	363	365	365	365	365	365	365
102	309	322	326	345	345	345	314	314
103	285	292	293	309	309	309	311	311
104	285	292	293	290	290	290	294	294
105	311	318	315	306	306	306	311	311
106	346	353	354	330	330	330	333	333
107	365	353	365	365	365	365	365	365
108	305	262	285	289	289	289	302	302
109	343	353	354	351	351	351	355	355
110	346	353	354	351	351	351	338	338
111	285	298	293	290	290	290	294	294
112	365	353	354	365	365	365	365	365
113	349	353	354	355	355	355	355	355
114	346	353	350	351	351	351	322	322
115	285	291	293	290	290	290	294	294
116	203	92	92	88	88	88	92	92
150	83	92	92	88	88	88	x	x
152	83	92	92	88	88	88	92	92
154	83	92	92	88	88	88	92	92
156	83	71	92	88	88	88	92	92
157	83	40	6	88	88	88	82	82
181	83	92	92	88	88	88	92	92
183	285	292	300	298	298	298	302	302
186	83	92	92	88	88	88	92	92
189	83	92	92	88	88	88	92	92
191	83	92	92	88	88	88	92	92

SEAK Drift Gillnet Fishery

Permit activity and the total number of hours that the commercial SEAK drift gillnet fishery is open (summing across all districts) has been relatively consistent on an annual basis. It appears that there is a significant amount of effort starting in June and continuing into September each year, with July being the month of greatest activity (Table 103). We note this effort data include State-managed, hatchery terminal area, Annette Island, private hatchery, and test-run drift gillnet fishing effort.

With respect to data on humpback whale interactions with the SEAK drift gillnet fishery over the last 6 years as described above in Section 2.5.5.2 (Summary of Humpback Whale Interactions with SEAK Fisheries), a total of 18 entanglements attributed to SEAK drift gillnet gear have been reported to NMFS, or about 3 per year. There have also been a total of 6 entanglements of humpback whales with unknown gear identified as nets, gillnets, and/or involving leadlines (implying net of some kind), or about 1 per year, but it is unknown if any of these involve SEAK drift gillnet gear. Although more specific data on the locations of these entangled whales were not available in the reports, the AK Marine Mammal Stranding Program confirmed that entangled whales had been reported throughout SEAK (Kate Savage, NFMS, personal communication, October 31, 2018).

As mentioned previously, it has also been estimated that 5.5 humpback whales are entangled annually in Districts 106, 107, and 108, collectively. Looking at the relative extent of the drift gillnet fishery effort in those districts compared to the rest of the SEAK drift gillnet fishery (Table 103), it would appear that these districts constitute a moderate portion of the fishing effort during most months at the heart of the season (June - September) each year, but that substantial effort (and opportunity) exist in other districts (approximately 60% - 70% of the total effort). At this time we do not know if there are particular reasons that drift gillnet effort in Districts 106, 107, and 108 are more or less susceptible to interactions with humpback whales. However, if we make a general extrapolation with this information, it appears reasonably certain that between 2-3 times more humpback whale entanglements could be occurring than the estimated 5.5 from previous observer coverage of Districts 106, 107, and 108 alone (i.e., 11-16.5) per year). In addition, data from that program indicated that 46.5 blow-throughs are estimated to occur annually in these districts, with most of these likely associated with humpback whales (less certain). Acknowledging we do not understand if these districts are more or less susceptible to interactions with humpback whales that other districts, we could assume that 2-3 times more blow-throughs occur annually than what is estimated for Districts 106, 107, and 108, with most of these likely associated with humpback whales (less certain). If even half of these involve humpback whales, this could mean approximately 50 humpback whale interactions could occur annually.

As a result, we assume that there will be entanglements of humpback whales in the commercial SEAK drift gillnet fishery happening every year. There is no estimate available for the total number of interactions, but at a minimum the SAR estimates 7.3 M/SI occurs in this fishery. It also appears reasonably certain to expect that up to 16.5 entanglements may occur annually. While it's less certain, it also appear possible that up to approximately 50 incidents involving drift gillnet blow-throughs could occur annually as well. We acknowledge the outcome of blow-through events are unknown, but we assume that a blow-through event could lead to subsequent observation of humpback whales with netting attached, which is consistent with some of the entanglement observations that have been reported to NMFS. Based on information provided in the Status of the Species, we assume that about 6% of these humpback whale interactions with

SEAK drift gillnet gear occur with Mexico DPS individuals. Finally, in lieu of any other information regarding the severity of entanglements and/or blow-through events, we note that we expect about 58% of entanglements are likely to result in mortality and serious injury (see Section 2.5.5.5 Response above). A summary of the analysis of the extent of Mexico DPS humpback whale interactions with SEAK drift gillnet fishery is provided below:

- SEAK Drift Gillnet Fishery
  - Minimum: 5.5 entanglements per year (estimate from observer data Manly (2015)+ 3 per year (strandings from Helker et al. (2018)) = 8.5 total entanglements per year * 0.06 (% of Mexico DPS in SEAK) = 0.51 Mexico DPS entanglements per year
    - 7.3 M/SI per year (from SARs Muto et al. (2018a)) * 0.06 = .44 Mexico DPS M/SI per year
  - Reasonably certain: up to 16.5 entanglements per year (extrapolation of Manly (2015) interactions to entire fishery presented above) * .06 = 0.99 Mexico DPS entanglements per year
    - 1.0 entanglements per year * 0.58 M/SI rate (derived above) = 0.58 Mexico DPS M/SI per year
  - Less certain: ~50 per year (interactions including blow-throughs extrapolated from Manly (2015) and assumptions) * .06 = ~3.0 Mexico DPS interactions
    - ~3.0 interactions per year * 0.58 = ~1.74 Mexico DPS M/SI per year

Table 103. Proportion of annual permit activity by month (a) and hours (b) of open fishing by year in Districts 106-108 compared to total commercial SEAK drift gillnet fishery for 2011-2018.

(a)

Month	Years								Average	Min	Max
	2011	2012	2013	2014	2015	2016	2017	2018			
5	31.0%	58.3%	36.8%	94.7%	83.3%	60.0%	50.0%	93.3%	63.5%	31.0%	94.7%
6	31.7%	29.5%	26.1%	23.3%	29.4%	38.1%	30.9%	24.0%	29.1%	23.3%	38.1%
7	30.4%	27.3%	26.8%	26.6%	31.5%	33.2%	29.8%	32.1%	29.7%	26.6%	33.2%
8	39.1%	31.6%	29.4%	31.5%	37.7%	35.7%	36.5%	38.8%	35.0%	29.4%	39.1%
9	49.3%	36.3%	36.9%	41.9%	36.8%	33.0%	32.5%	38.4%	38.1%	32.5%	49.3%
10	0.0%	0.0%	9.7%	34.3%	0.0%	84.6%	33.9%	0.0%	20.3%	0.0%	84.6%

(b)

Years								Average	Min	Max
2011	2012	2013	2014	2015	2016	2017	2018			
31.9%	31.4%	36.1%	39.5%	33.8%	40.3%	39.8%	32.4%	35.7%	31.4%	40.3%

With respect to data on Steller sea lion interactions with the SEAK drift gillnet fishery over the last 6 years as described above in Section 2.5.5.3 (Summary of Steller Sea Lion Interactions with SEAK Fisheries), a total of 2 Steller sea lion interactions have been reported to NMFS, or about 1 every 3 years. There were no Steller sea lions observed taken during observer coverage of this fishery in Districts 106, 107, and 108. Although more specific data on the locations of these entangled Steller sea lions were not available in the reports, the AK Marine Mammal Stranding Program confirmed that Steller sea lion strandings are reported throughout SEAK (Kate Savage, NMFS, personal communication, October 31, 2018). Although we have no estimates of total number of Steller sea lion interactions to consider in addition to the opportunistic sightings from the SARs, we can assume that there are a small number of occasional interactions with Steller sea lion and this fishery.

Above, we described the portions of SEAK salmon fisheries that occur within an area where Western Steller sea lion DPS individuals mix with Eastern Steller sea lion DPS individuals according to location of certain districts. Similar to the comparison of the SEAK drift gillnet fishery within districts that were subject to observer coverage, we can also evaluate the relative fishing effort that occurs in this fishery within the Steller sea lion mixing area (Table 104). Although a relatively larger number of permits are active within the mixing area, it appears that a relatively smaller fraction of the SEAK drift gillnet fishery occurs within the mixing area based on the amount of open fishing time. Taken together, we will generally assume that approximately 50% of the effort in this fishery occurs within the Steller sea lion mixing area. Although we have no specific estimates of interactions with this fishery to consider in addition to the opportunistic sightings, we do note that some blow-throughs that may occur within Steller sea lion mixing area could involve Western Steller sea lion DPS individuals. Based on the information described by Manly (2015) that indicated blow-throughs were likely mostly attributable to whales, we will assume that less than half of the total estimated blow-throughs that could occur (as described above) would be attributable to Steller sea lion interactions. Thus (less certainly), we assume that less than 50 Steller sea lions may be entangled in the commercial SEAK drift gillnet fishery, about 50% of those occurring in the mixing area each year, and approximately 20% of these individuals are likely to be Western DPS Steller sea lions. We also assume that M/SI rates for these Steller sea lion interactions will be 50%. A summary of the analysis of the extent of Western DPS Steller sea lion interactions with the SEAK drift gillnet fishery is provided below:

- SEAK Drift Gillnet Fishery
  - Minimum: 2 out of 6 years, or .33 entanglements per year (strandings Helker et al. (2018)) * .50 (% of fishery in Steller sea lion mixing area; derived above) * .20 (% of Western DPS in mixing area; derived above) = 0.03 Western DPS entanglements per year
    - 0.03 entanglements per year * .50 M/SI (derived above) = 0.02 Western DPS M/SI per year
  - Reasonably certain: some number of occasional entanglements (undefined); same as minimum total
  - Less certain: < less than 50 (interactions including blow-throughs extrapolated from Manly (2015) and assumptions) * .50 * .20 = <5.0 Western DPS entanglements per year
    - <5.0 entanglements per year * .50 M/SI rate = <2.5 Western DPS M/SI per year

Table 104. Proportion of annual permit activity by month (a) and hours (b) of open fishing by year in Districts where Western Steller sea lion DPS mixes with Eastern Steller sea lion DPS, compared to total commercial SEAK drift gillnet fishery for 2011-2018.

(a)

Month	Years								Average	Min	Max
	2011	2012	2013	2014	2015	2016	2017	2018			
5	58.6%	40.5%	55.3%	0.0%	0.0%	34.3%	35.7%	0.0%	28.0%	0.0%	58.6%
6	55.4%	56.2%	59.1%	67.3%	60.4%	50.0%	55.5%	65.6%	58.7%	50.0%	67.3%
7	58.2%	62.8%	62.9%	64.1%	59.1%	55.9%	60.9%	60.8%	60.6%	55.9%	64.1%
8	47.8%	58.8%	60.2%	59.2%	52.0%	55.2%	54.4%	52.1%	55.0%	47.8%	60.2%
9	38.5%	50.4%	50.1%	45.3%	50.8%	52.8%	55.8%	49.4%	49.1%	38.5%	55.8%
10	80.4%	53.5%	61.3%	20.0%	0.0%	3.8%	64.4%	90.0%	46.7%	0.0%	90.0%

(b)

Years								Average	Min	Max
2011	2012	2013	2014	2015	2016	2017	2018			
25.7%	28.1%	29.5%	25.9%	27.0%	26.1%	23.6%	30.2%	27.0%	23.6%	30.2%

SEAK Purse Seine Fishery

Permit activity and the total number of hours that the commercial SEAK purse seine fishery is open (summing across all districts) has been somewhat variable in terms of the amount of total open fishing time on an annual basis. However, each year there is relative consistency in the patterns of permit activity at least during the heart of the fishery that occurs starting in June and continuing into August (Table 105). We note this effort data include State-managed, hatchery terminal area, Annette Island, private hatchery, and test-run purse seine effort.

With respect to data on humpback whale interactions with the SEAK purse seine fishery over the last 6 years as described above in Section 2.5.5.2, a total of 4 entanglements of humpback whales with SEAK purse seine gear have been reported to NMFS, or about 2 every 3 years. There have been a total of 6 entanglements of humpback whales with unknown gear identified as nets, gillnets, and/or involving leadlines (implying net of some kind), or about 1 per year, but it is unknown if any of these involve SEAK purse seine gear. There has not been any observer coverage of this fishery to generate any local or regional estimates of humpback whale interactions similar to what was done for Districts 106, 107, and 108 in drift gillnet gear (Manly 2015). Although we have no estimates of the total number of humpback whale interactions from the SARs to consider in addition to the opportunistic sightings, we can assume that there are a small number of occasional interactions with humpback whales and this fishery, with a small fraction (6%) of those occurring with Mexico DPS humpback whales.

In looking at the relative comparison of the number of SEAK drift gillnet entanglements documented each year from strandings (3; see Section 2.5.5.2 Summary of Humpback Whale Interactions with SEAK Fisheries above) to the general extrapolation of the limited observer data in that fishery above (up to 16.5), these data suggest that approximately 5 times more entanglements in the SEAK drift gillnet fishery may occur than what it is currently reported. While we acknowledge there are no available data to further evaluate the use of this type of generalized expansion factor for SEAK strandings across fisheries (e.g. drift gillnet and purse seine fisheries), we conclude it can provide some relative insight (less certain) into what might be happening in total beyond opportunistic reporting. For SEAK purse seine entanglements, this would equate to approximately 10 entanglements every 3 years, or 3.3 per year. We note that anticipated M/SI rates for interactions between humpback whales and purse seine gear is relatively low, at 38%. A summary of the analysis of the extent of Mexico DPS humpback whale interactions with the SEAK purse seine fishery is provided below:

- SEAK Purse Seine Fishery
  - Minimum: 2 entanglements every 3 years, or 0.67 per year (strandings from Helker et al. (2018)) * .06 = 0.04 Mexico DPS entanglements per year
    - 0.04 entanglements per year * .38 M/SI rate (derived above) = 0.02 Mexico DPS M/SI per year
  - Reasonably certain: small number of occasional (undefined); same as minimum total
  - Less certain: 10 entanglements every 3 years, or 3.3 per year (general expansion of strandings by a factor of 5 as described above) * .06 = 0.2 Mexico DPS entanglements per year
    - 0.20 entanglements per year * 0.38 M/SI rate (derived above) = .08 Mexico DPS M/SI per year

With respect to data on Steller sea lion interactions with the SEAK purse seine fishery over the last 6 years, there have been no entanglements of Steller sea lions in SEAK purse seine gear reported to NMFS. We note that a significant portion of permit activity and the total amount of open fishing time does occur in this fishery within the Steller sea lion mixing area (Table 105). Without any other information at hand, we anticipate that there will not be any entanglements or other interaction between Western Steller sea lions and purse seine gear. A summary of the analysis of the extent of Western DPS Steller sea lion interactions with the SEAK purse seine fishery is provided below:

- SEAK Purse Seine Fishery
  - Minimum: 0 entanglements per year (Helker et al. 2018)
  - Reasonably certain: no additional information; assume same as minimum total
  - Less certain: no additional information; assume same as minimum information

Table 105. Proportion of annual permit activity by month (a) and hours (b) of open fishing by year in Districts where Western Steller sea lion DPS mixes with Eastern Steller sea lion DPS, compared to total commercial SEAK purse seine fishery for 2011-2018.

(a)

Month	Years								Average	Min	Max
	2011	2012	2013	2014	2015	2016	2017	2018			
5	100.0%		100.0%	100.0%	100.0%				100.0%	100.0%	100.0 %
6	61.2%	38.3%	62.9%	64.0%	55.6%	19.8%	28.8%	33.6%	45.5%	19.8%	64.0%
7	72.5%	48.4%	65.9%	39.5%	57.4%	18.3%	68.4%	47.3%	52.2%	18.3%	72.5%

Month	Years								Average	Min	Max
	2011	2012	2013	2014	2015	2016	2017	2018			
8	59.2%	20.7%	36.7%	15.1%	41.4%	19.1%	61.6%	36.0%	36.2%	15.1%	61.6%
9	33.9%	29.6%	30.5%	69.6%	44.7%	77.9%	59.0%	79.2%	53.1%	29.6%	79.2%
10	7.7%	14.3%	20.0%	25.0%	0.0%				13.4%	0.0%	25.0%

(b)

Years								Average	Min	Max
2011	2012	2013	2014	2015	2016	2017	2018			
70.8%	59.2%	61.7%	56.9%	61.7%	55.3%	62.2%	57.1%	60.6%	55.3%	70.8%

SEAK Set Gillnet Fishery

Permit activity and the total number of hours that the commercial SEAK set gillnet fishery is open (summing across all districts) has been relatively consistent on an annual basis. It appears that there is a significant amount of effort each year starting in June continuing into October each year, with June and July being the months of greatest activity (Table 106). We note this effort data includes State-managed, private hatchery, and test run set gillnet effort.

With respect to data on humpback whale interactions with the SEAK set gillnet fishery over the last 6 years, there have not been any entanglements with humpbacks whales that have been attributed to SEAK set gillnet gear. There have been a total of 6 entanglements of humpback whales with unknown gear identified as nets, gillnets, and/or involving leadlines (implying a net of some kind), or about 1 per year, but it is unknown if any of these involve SEAK set gillnet gear. There was some observer coverage of this fishery in the Yakutat area about a decade ago, but no humpback whale interactions were observed. Ultimately, there is not sufficient data for this fishery to generate any local or regional estimates of humpback whale interactions. Although we have no estimates of the total number of humpback whale interactions from the SARs to consider and no confirmed opportunistic sightings of entanglement with the SEAK set gillnet fishery, we recognize that there are some humpback whale entanglements that involved nets that may come from this fishery, and the AK Yakutat salmon set gillnet fishery is listed as a Category II on the LOF by analogy resulting in part from potential risks of interactions with humpback whales. As a result, we assume that there may some number of occasional interactions with humpback whales and this fishery, with a small fraction (6%) of those occurring with Mexico DPS humpback whales. Given the limited amount of data on humpback whale mortality and serious injury with this fishery and the uncertain relationship to entanglements with unknown net gear, we recognize that there is a risk for M/SI with this gear type that may be somewhat analogous to the drift gillnet fishery. It is possible (but uncertain), that some portion of the unidentified net entanglements originate from the SEAK set gillnet fishery. In lieu of more information, we assume that M/SI rates for any humpback whale interactions with set gillnet gear will be around 58%, similar to what is expected from interactions with drift gillnet gear. A summary of the analysis of the extent of Mexico DPS humpback whale interactions with the SEAK set gillnet fishery is provided below:

- SEAK set gillnet
    - Minimum: 0 entanglements per year (Helker et al. 2018)
    - Reasonably certain: >0 undefined number of occasional entanglements over time

- Less certain: 1 per year (unidentified net entanglement)[36] * .06 = 0.06 Mexico DPS entanglements per year
  - 0.06 entanglements per year * 0.58 M/SI rate (derived above) = 0.04 Mexico DPS M/SI per year

With respect to data on Steller sea lion interactions with the SEAK set gillnet fishery over the last 6 years as described above, there was 1 incident of an interaction reported to NMFS involving the SEAK set gillnet gear; which was ultimately deemed a non-serious injury. Additionally, one Steller sea lion was observed offwatch during observation of the SEAK set gillnet fishery about a decade ago. Although we have no estimates of the total number of interactions from the SARs to consider in addition to the opportunistic sightings, given this information we can assume that occasionally Steller sea lions will be entangled in the commercial SEAK set gillnet fishery. Looking at the data on fishing effort that occurs in this fishery within the Steller sea lion mixing area (Table 106), virtually all of the open fishing hours and permit activity occur in the Steller sea lion mixing area, such that at least occasionally some of the individuals that may be entangled in this fishery are likely to involve Western DPS Steller sea lions. While the one recent interaction that was reported was ultimately deemed a non-serious injury, we recognize this is limited data and that there is a risk for mortality and serious injury with this gear type that may be somewhat analogous to the drift gillnet fishery. In lieu of more information, we assume that M/SI rates for these Steller sea lion interactions will be around 50%, similar to what is expected from interactions with drift gillnet gear. A summary of the analysis of the extent of Western DPS Steller sea lion interactions with the SEAK set gillnet fishery is provided below:

- SEAK Set Gillnet Fishery
  - Minimum: 1 out of 6 years, or 0.17 entanglements per year (strandings from Helker et al. (2018)) * 1.0 (% of fishery in Steller sea lion mixing area; derived above) * .20 = .03 Western DPS entanglements per year
    - 0.03 entanglements per year * .50 M/SI rate (derived above) = .02 Western DPS M/SI per year
  - Reasonably certain: some number of occasional entanglements (undefined) over time; same as minimum total
  - Less certain: 1 per year^ * 1.0 * .20 = 0.20 Western DPS entanglements per year
    - 0.20 entanglements per year * 0.50 M/SI rate = 0.10 Western DPS M/SI per year

Table 106. Proportion of annual permit activity by month (a) and hours (b) of open fishing by year in Districts where Western Steller sea lion DPS mixes with Eastern Steller sea lion DPS, compared to total commercial SEAK purse seine fishery for 2011-2018.

(a)

Month	Years								Average	Min	Max
	2011	2012	2013	2014	2015	2016	2017	2018			
6	100.0%	100.0%	100.0%	100.0%	100.0%	98.9%	100.0%	100.0%	99.9%	98.9%	100.0%
7	100.0%	100.0%	100.0%	100.0%	100.0%	98.8%	100.0%	100.0%	99.9%	98.8%	100.0%

[36] Where uncertain information suggests that the number of interactions are undefined but >0 and occasional, we assume that potentially 1 per year may be occurring - noted with ^ as necessary throughout.

Month	Years								Average	Min	Max
	2011	2012	2013	2014	2015	2016	2017	2018			
8	100.0%	100.0%	100.0%	100.0%	100.0%	98.7%	100.0%	100.0%	99.8%	98.7%	100.0%
9	100.0%	100.0%	100.0%	100.0%	100.0%	98.8%	100.0%	100.0%	99.9%	98.8%	100.0%
10	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

(b)

Years								Average	Min	Max
2011	2012	2013	2014	2015	2016	2017	2018			
100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

SEAK Troll Fishery

Permit activity and the total number of hours that the commercial SEAK troll fishery is open (summing across all districts; both hand troll and power gurdy troll combined) has been relatively consistent on an annual basis, at least during the peak of activity in the summer. It appears that there has been some effort occurring each year, with July, August, and September being the months of greatest activity (Table 107). We note this effort data includes State-managed, hatchery terminal area, Annette Island, spring troll, adipose clipped mark selective, and test-run troll effort.

With respect to data on humpback whale interactions with the SEAK troll fishery over the last 6 years as described above, there has been one incident reported to NMFS of a humpback whale being hooked and/or entangled with troll gear that ultimately broke free. Based on the data that are available, it is unclear if this involved the commercial troll fishery, or recreational gear. There has not been any observer coverage of this fishery to generate any local or regional estimates of humpback whale interactions. Although we have no estimates of the total number of humpback whale interactions from the SARs to consider in addition to the opportunistic sightings, we can assume that there are rare interactions with humpback whales and this fishery, with a small fraction (6%) of those occurring with Mexico DPS humpback whales. Given the lone incident that has been reported, we assume that the anticipated risk for M/SI from interactions between humpback whales and troll gear is very low, and we anticipate that M/SI resulting from a rare interaction with this gear will not occur. A summary of the analysis of the extent of Mexico DPS humpback whale interactions with the SEAK troll fishery is provided below:

- SEAK Troll Fishery
  - Minimum: 1 out of 6 years, or 0.17 hooking/entanglements per year (strandings Helker et al. (2018)) * .06 = 0.01 Mexico DPS hooking/entanglements per year
    - 0 Mexico DPS M/SI rate per year (derived above)
  - Reasonably certain: >0 undefined number of rare entanglements over time ; same as minimum total
  - Less certain: 1 per year^ * .06 = 0.06 Mexico DPS hooking/entanglements per year
    - 0 Mexico DPS M/SI rate per year (derived above)

With respect to data on Steller sea lion interactions with the SEAK troll fishery over the last 5 years of data as described above,[37] there have been 126 incidents of interactions reported to NMFS involving SEAK troll gear (commercial and recreational total), or about 25 per year.[38] The most recent SARs reported a total of 27.4 M/SI from SEAK troll gear per year. In most of these incidents, it has not been determined whether this gear originates from the commercial or recreational troll fishery, although there are 2 of these interactions identified as specifically involving recreational gear. There has not been any observer coverage of this fishery to generate any local or regional estimates of Steller sea lion interactions. Although we have no estimates of the total number of interactions from the SARs to consider in addition to the opportunistic sightings, given this information we can assume that Steller sea lions will regularly be hooked/entangled in the commercial SEAK troll fishery.

Although more specific data on the locations of these entangled Steller sea lions was not available in the SARs and Serious Injury reports, AK Marine Mammal Stranding Program confirmed that Steller sea lion strandings are reported throughout SEAK (Kate Savage, NMFS, personal communication, October 31, 2018). In addition, the AK Marine Mammal Stranding Program specifically provided some location information from a sub-set of these troll interactions involving hook ingestions that are directly reported to their office as opposed to other sources of stranding data that ultimately come to NMFS from other sources. These data indicate almost all of these stranding reports (56) originated from north of Sumner Strait in the Steller sea lion mixing area (NMFS unpublished stranding data), although the AK Marine Mammal Stranding Program generally acknowledges there are more eyes on the water and chances for observations of strandings in some areas north of Sumner Strait (Kate Savage, NMFS, personal communication, November 1, 2018). It is unclear where the origins of all 126 of the stranding reports for all the SEAK troll interactions occurred, but it appears reasonably certain at least half of them may come from within the mixing area where Western DPS Steller sea lions may occur based on information from the known locations of strandings (and likely a majority of them do) if the rest of the incidents reported are spread out across SEAK to some degree.

The fishing effort data for this fishery within the Steller sea lion mixing area (Table 107 and Table 108) suggests there is more permit activity (~65%) in the fishery within the Steller sea lion mixing area although the relative amount of time fishing is open (in hours and number of days) is roughly the same each year. Taken together, we will generally assume that approximately 60% of the effort in this fishery occurs within the Steller sea lion mixing area. Given the information from the SARs we conclude that there will be at least 27.4 interactions of Steller sea lion hooking/entanglement with SEAK troll gear each year, at least some, if not all, will involve the commercial troll fishery, and that at least occasionally some of the individuals that may be hooked/entangled in this fishery are likely to involve Western DPS Steller sea lions (20% in the mixing area). While we acknowledge there is no specific information on extrapolating Steller sea

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[37] The SARs doesn't consider 2013 to be a representative year (Muto et al. 2018a).

[38] We note that 3 additional interactions attributed as unidentified "hook and line" gear were reported during this time frame as well. We acknowledge one or more of these possibly could have been troll gear, although it may be more likely they were associated with other gear types or fisheries given the lack of association with troll gear that appears to be determinable in most circumstances. Even if these incidents were associated with troll gear, the overall level of anticipated effects to Western DPS Steller sea lions that are being described would be approximately the same.

lion strandings, or troll gear strandings with other species, we could assume that a similar general expansion factor of multiplying reported strandings by 5 used above for net fisheries and humpback whales can provide some relative insight (less certain) into what might be happening in total. For SEAK troll interactions with Steller sea lions, this would equate to approximately 125 hooking/entanglements every year. A summary of the analysis of the extent of Western DPS Steller sea lion interactions with the SEAK troll fishery is provided below:

- SEAK Troll Fishery
  - Minimum: 27.4 hooking/entanglements per year (from SARs (Muto et al. 2018b)) * .60 (% of fishery in Steller sea lion mixing area; derived above) * .20 = 3.29 Western DPS hooking/entanglements per year
    - 3.29 hooking/entanglements per year * 1.0 M/SI rate (derived above) = 3.29 Western DPS M/SI per year
  - Reasonably certain: no specific estimate available; with majority of interactions (~60%) coming from mixing area = >3.29 Western DPS hooking/entanglements per year
    - >3.29 Western DPS M/SI per year
  - Less certain: 125 hooking/entanglements per year (general extrapolation of strandings by a factor of 5 as described above) * .60 * .20 = 15.0 Western DPS hooking/entanglements per year
    - 15.0 hooking/entanglements per year * 1.0 M/SI rate = 15.0 Western DPS M/SI per year

Table 107. Proportion of annual permit activity by month (a) and hours (b) of open fishing by year in Districts where Western Steller sea lion DPS mixes with Eastern Steller sea lion DPS, compared to total commercial SEAK troll fishery for 2011-2018.

(a)

Month	Years								Average	Min	Max
	2011	2012	2013	2014	2015	2016	2017	2018			
1	50.6%	54.2%	35.6%	62.8%	66.7%	71.5%	63.3%	58.9%	58.0%	35.6%	71.5%
2	58.1%	59.2%	57.5%	64.6%	70.6%	73.0%	64.1%	58.7%	63.2%	57.5%	73.0%
3	67.4%	62.9%	65.5%	69.9%	75.9%	73.0%	73.1%	61.6%	68.7%	61.6%	75.9%
4	78.1%	76.4%	68.8%	80.1%	70.3%	51.7%	70.1%	0.0%	61.9%	0.0%	80.1%
5	70.2%	69.2%	61.9%	66.8%	58.2%	57.1%	52.3%	55.1%	61.4%	52.3%	70.2%
6	69.5%	67.2%	73.0%	64.4%	66.0%	62.2%	73.5%	62.7%	67.3%	62.2%	73.5%
7	60.1%	50.7%	62.1%	66.2%	66.3%	68.4%	67.0%	63.1%	63.0%	50.7%	68.4%
8	66.7%	62.5%	74.3%	65.7%	69.3%	70.7%	77.3%	70.4%	69.6%	62.5%	77.3%
9	72.7%	69.4%	68.7%	69.3%	70.0%	73.2%	72.6%	72.8%	71.1%	68.7%	73.2%
10	76.0%	68.6%	75.1%	78.3%	76.8%	82.6%	75.4%	59.3%	74.0%	59.3%	82.6%
11	70.2%	69.9%	75.0%	75.0%	72.8%	63.6%	75.0%	X	71.7%	63.6%	75.0%
12	64.3%	40.0%	57.4%	71.7%	69.0%	66.3%	72.5%	X	63.0%	40.0%	72.5%

(b)

Years								Average	Min	Max
2011	2012	2013	2014	2015	2016	2017	2018			
50.1%	50.4%	50.5%	50.9%	51.6%	52.3%	51.2%	53.4%	51.3%	50.1%	53.4%

Table 108. Number of days commercial SEAK troll fishery is open per district (a) outside of Steller sea lion mixing and (b) within, for 2011-2018.

(a)

Year	District									
	101	102	103	104	105	106	107	108	150	152
2011	365	309	285	285	311	346	365	305	83	83
2012	363	322	292	292	318	353	365	262	92	92
2013	365	326	293	293	315	354	365	285	92	92
2014	365	345	309	290	306	330	365	289	88	88
2015	365	345	309	290	306	330	365	289	88	88
2016	365	345	309	290	306	330	365	289	88	88
2017	365	314	311	294	311	333	365	302	X	92
2018	365	314	311	294	311	333	365	302	X	92

(b)

Year	District															
	109	110	111	112	113	114	115	116	154	156	157	181	183	186	189	191
2011	343	346	285	365	349	346	285	203	83	83	83	83	285	83	83	83
2012	353	353	298	353	353	353	291	92	92	71	40	92	292	92	92	92
2013	354	354	293	354	354	350	293	92	92	92	6	92	300	92	92	92
2014	351	351	290	365	355	351	290	88	88	88	88	88	298	88	88	88
2015	351	351	290	365	355	351	290	88	88	88	88	88	298	88	88	88
2016	351	351	290	365	355	351	290	88	88	88	88	88	298	88	88	88
2017	355	338	294	365	355	322	294	92	92	92	82	92	302	92	92	92
2018	355	338	294	365	355	322	294	92	92	92	82	92	302	92	92	92

Subsistence Fisheries

Data on subsistence salmon fisheries in SEAK are more limited than the commercial fisheries, although ADFG does receive information on the level of active permits that are used in each district. In Table 109 below, we use a similar methodology used with the commercial fisheries above to identify the highest number of active permits used in each district, and then sum across districts, to generate a relative index of fishing effort participation. For the subsistence fisheries, the data were not aggregated in a monthly scale so we used the highest number of active permits during any statistical week of the year to generate this table. What is evident from this information is that subsistence fisheries do generally use the same gear types as commercial fisheries, with drift gillnet fishing in particular being a common gear type used. We note that use of set gillnets in the subsistence fishery is also prevalent especially within the Steller sea lion mixing area, although the use of them outside the mixing area in the subsistence fishery is different than the commercial fishery. Finally, the use of troll gear appears to be very limited in the subsistence fishery, which is quite distinct from the commercial fishery.

Table 109. Summary of maximum permit activity in SEAK subsistence salmon fisheries in a

district during the year summed across all districts (a) outside of Steller sea lion mixing (b) within (c) outside and within Steller sea lion mixing and (d) proportion of effort occurring in Steller sea lion mixing area, for 2011-2018.

(a)

Gear	Years								Average	Min	Max
	2011	2012	2013	2014	2015	2016	2017	2018			
Drift Gillnet	77	61	73	62	53	88	70	18	63	18	88
Purse Seine	3	0	3	1	16	0	4	X	4	0	16
Set Gillnet	12	18	15	21	21	4	3	2	12	2	21
Troll	1	0	1	0	0	0	0	X	0	0	1
Unspecified Gillnet	0	1	1	0	0	2	0	1	1	0	2

(b)

Gear	Years								Average	Min	Max
	2011	2012	2013	2014	2015	2016	2017	2018			
Drift Gillnet	116	119	125	141	148	163	139	76	128	76	163
Purse Seine	1	6	6	4	4	2	1	X	3	1	6
Set Gillnet	93	110	112	94	120	105	51	43	91	43	120
Troll	0	2	2	3	4	4	4	X	3	0	4
Unspecified Gillnet	17	12	15	4	1	1	26	5	10	1	26

(c)

Gear	Years								Average	Min	Max
	2011	2012	2013	2014	2015	2016	2017	2018			
Drift Gillnet	193	180	198	203	201	251	209	94	191	94	251
Purse Seine	4	6	9	5	20	2	5	X	7	2	20
Set Gillnet	105	128	127	115	141	109	54	45	103	45	141
Troll	1	2	3	3	4	4	4	X	3	1	4
Unspecified Gillnet	17	13	16	4	1	3	26	6	11	1	26

(d)

Gear	Years								Average	Min	Max
	2011	2012	2013	2014	2015	2016	2017	2018			
Drift Gillnet	60%	66%	63%	69%	74%	65%	67%	81%	68%	60%	81%
Purse Seine	25%	100 %	67%	80%	20%	100%	20%	X	59%	20%	100%
Set Gillnet	89%	86%	88%	82%	85%	96%	94%	96%	89%	82%	96%
Troll	0%	100 %	67%	100 %	100 %	100%	100%	X	81%	0%	100%
Unspecified Gillnet	100 %	92%	94%	100 %	100 %	33%	100%	83%	88%	33%	100%

With respect to data on humpback whale interactions in the SEAK subsistence salmon fisheries over the last 6 years, one of the interactions with SEAK drift gillnet gear reported to NMFS in July of 2012 was associated with the subsistence fishery (Helker et al. 2018). As mentioned above, there have also been a total of 6 entanglements of humpback whales with unknown gear identified as nets, gillnets, and/or involving leadlines (implying net of some kind), or about 1 per year, but it is unknown if any of these involve SEAK subsistence net gear. In general, we expect that in many circumstances distinguishing subsistence gear from commercial gear in SEAK humpback whale entanglements may be difficult. It is likely that the stranding record review under the SEAK drift gillnet fishery section above (and for other SEAK salmon fisheries) reflects what is known about the minimum number of entanglement of humpback whales in all types of SEAK drift gillnet fisheries (and other SEAK salmon fisheries), including the subsistence fishery. However, with respect to any estimated totals of interactions resulting from observer data, additional effort from subsistence fisheries should be factored in. While there aren't comparable observer data on interactions with the subsistence fishery to analyze, we can use the available fishery effort data to make a general comparison.

Table 110. Summary comparison of maximum permit activity in the subsistence SEAK salmon drift gillnet fishery compared to the commercial SEAK drift gillnet fishery at any time during the year summed across all districts 2011-2018 (2018 data is preliminary).

Drift Gillnet Gear	Years							
	2011	2012	2013	2014	2015	2016	2017	2018
Subsistence	193	180	198	203	201	251	209	94
Commercial	586	556	661	537	533	524	534	610
Percent Subsistence	32.9%	32.4%	30.0%	37.8%	37.7%	47.9%	39.1%	15.4%
Average	34.2%		**Min**	15.4%		**Max**	47.9%	

While we are mindful that comparisons of fishing effort using these data may not explicitly relate to entanglement risks given the uncertainty associated with humpback whale interaction rates with this gear in general and the coarse nature of the effort data, the data in Table 110 would suggest that subsistence fisheries constitute a smaller, but relatively substantial amount to the number of active fishing vessels using this gear at certain times in SEAK. In considering the relative additional contribution of the subsistence SEAK drift gillnet fishery to possible humpback whale interactions from the commercial SEAK fishery, these data would reasonably suggest an additional 34% (or about one-third) may be an appropriate scale to add to any estimate of annual average humpback whale interactions with the commercial SEAK drift gillnet fishery. This would equate to a general estimate of 5.6 entanglements per year (16.5 extrapolated total in commercial SEAK drift gillnet * 0.34 scale of fishing effort in subsistence drift gillnet fishery). There may be differences in exactly how subsistence gear is distributed throughout SEAK compared to the commercial fishery that could influence relative risks and entanglement rates, but the available data do not provide that information. A review of the permit activity data confirms that the subsistence fishery does generally operate in the same districts as the commercial fishery, including Districts 106, 107, and 108 where humpback whale interactions have previously been observed. A summary of the analysis of the extent of Mexico DPS humpback whale interactions with the SEAK subsistence salmon fishery is provided below:

- Subsistence SEAK Salmon Fishery
  - Minimum: 0 additional drift and set gillnet entanglements beyond what is already reflected Helker et al. (2018) strandings; 0 entanglements in limited troll and purse seine fishing effort (effort data above)
    - 0 additional Mexico DPS M/SI per year
  - Reasonably certain: 5.6 entanglement per year in subsistence SEAK drift gillnet gear (derived above) * .06 = 0.34 Mexico DPS entanglements per year; >0 undefined number of occasional set gillnet entanglements over time, same as minimum total
    - 0.34 entanglements per year * .58 M/SI rate = 0.20 Mexico DPS M/SI per year in subsistence drift gillnet gear
  - Less certain: 1/3rd of less certain commercial SEAK drift gillnet totals (~3.0 Mexico DPS drift gillnet entanglement per year) = ~1.0 Mexico DPS drift gillnet entanglement per year; 1 set gillnet entanglement per year^ * .06 = 0.06 Mexico DPS set gillnet entanglements per year
    - ~1.0 drift gillnet entanglements per year * 0.58 = ~0.58 Mexico DPS drift gillnet M/SI per year; 0.06 set gillnet entanglement per year * 0.58 = 0.04 Mexico DPS set gillnet M/SI per year

With respect to data on Steller sea lion interactions with the SEAK subsistence salmon fisheries over the last 6 years, there have not been any interactions associated with subsistence salmon fishing gear reported to NMFS. As noted above, the use of troll gear in subsistence salmon fisheries is very limited, which likely limits the risk of subsistence fisheries for interactions with Steller sea lions to a large degree. If there are incidents of hooking/entanglement of Steller sea lions with subsistence troll gear, we expect those to ultimately be reflected by the stranding record on troll interactions reviewed under the SEAK troll fishery. Given the use of various nets, especially within the Steller sea lion mixing area, we assume there is some risk of interactions with Western Steller DPS individuals, similar to what has been characterized for commercial SEAK salmon drift and set gillnet fisheries, at a commensurate smaller scale. A summary of the analysis of the extent of Western DPS Steller sea lion interactions with the SEAK subsistence salmon fishery is provided below:

- Subsistence SEAK Salmon Fishery
  - Minimum: 0 additional drift and set gillnet entanglements beyond what is already reflected Helker et al. (2018) strandings; 0 entanglements in limited troll and purse seine fishing effort (effort data above)
  - Reasonably certain: >0 undefined number of occasional entanglements in gillnets over time; reflected in stranding data, same as minimum total
  - Less Certain: 1 interaction per year in drift gillnet gear * .67 (% of subsistence effort in Steller sea lion mixing area; derived from effort data above) * .20 = 0.13, 1 interaction per year in set gillnet gear * .90 (% of subsistence effort in Steller sea lion mixing area; derived from effort data above) * .20 = 0.18
    - 0.13 drift gillnet entanglements per year * .50 M/SI rate (derived above) = 0.07 drift gillnet Western DPS M/SI per year
    - 0.18 set gillnet entanglements per year * .50 M/SI rate = 0.09 set gillnet Western DPS M/SI per year

Recreational Fisheries

Data on recreational salmon fisheries in SEAK are also more limited than data on effort in the commercial SEAK salmon fisheries. Generally, data on recreational fishing effort in Alaska are collected through an annual survey conducted via mail by ADFG. Information that is available includes estimates generated from these data on the total number of angler days that occurred each year, by region (e.g., SEAK), by local fishing area (e.g., Sitka, Juneau), and by type of area (e.g., freshwater vs. saltwater) where the fishing occurs (Table 111). However, these data/estimates do not distinguish or differentiate recreational fishing effort as being specifically associated with salmon fishing vs. other targets for recreational fishing effort (e.g., halibut or rockfish). Yet there are data available that summarize estimates of the number of individual fish captured by recreational fishing in Alaska, including both salmon and significant sources of non-salmon[39] species catch (Table 111).

Table 111**.** Summary of the total number of angler days each year (a) that have occurred in recreational SEAK fisheries in each type of area; (b) by local fishing area (combined saltwater and freshwater); and (c) within the Steller sea lion mixing area, for 2011-2017.

(a)

Year	Freshwater	Saltwater	Total Number Angler Days	Percent Saltwater
2011	95332	352275	447607	78.7%
2012	91009	387998	479007	81.0%
2013	83871	462179	546050	84.6%
2014	95068	469242	564310	83.2%
2015	93345	501445	594490	84.3%
2016	92272	426434	518706	82.2%
2017	87734	470361	558095	84.3%

[39] Data provided by ADFG on non-salmon species included: halibut, lingcod, rockfish, sablefish, Dolly Varden, cutthroat trout, steelhead, and rainbow trout.

(b)

	Total Number Angler Days by Year						
Area	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
A	70926	68696	107493	103591	95979	86810	83969
B	80694	86255	81418	89175	101951	92390	88159
C	37699	49851	59976	54430	71658	59359	60235
D	63191	75131	82576	90545	77725	93426	86307
E	92562	98217	110444	114255	133071	112221	93087
F	31452	30358	27968	28143	29256	27152	23609
G	32573	39094	45796	42388	47582	47082	36851
H	38510	31405	30199	41783	37268	39655	46489

Area codes: (A) Ketchikan; (B) Prince of Wales Island; (C) Kake, Petersburg; Wrangell, Stikine; (D) Sitka; (E) Juneau; (F) Skagway, Haines; (G) Glacier Bay; (H) Yakutat

(c)

	Number of Angler Days			
Year	**Outside Mixing Area**	**Inside Mixing Area**	**Total**	**Percent in Mixing Area**
2011	189319	258288	447607	57.7%
2012	204802	274205	479007	57.2%
2013	248887	297163	546050	54.4%
2014	247196	317114	564310	56.2%
2015	269588	324902	594490	54.7%
2016	232363	286343	518706	55.2%
2017	238559	319536	558095	57.3%

Table 112. Summary of the total number of individual salmon and significant non-salmon species captured in recreational SEAK fisheries in each type of area, for 2011-2017.

	2011		2012		2013		2014		2015		2016		2017	
	Fresh	**Salt**	**Fresh**	**Salt**	**Fresh**	**Salt**	**Fresh**	**Salt**	**Fresh**	**Salt**	**Fresh**	**Salt**	**Fresh**	**Salt**
Total Number Salmon	60848	342198	44447	290184	54248	485014	51073	407647	53436	439461	47956	361482	54921	436655
Total Number Non-Salmon	6200	211916	7013	259179	9325	308247	12109	349534	8873	360029	5797	322891	322891	293839
Percent Salmon	90.8%	61.8%	86.4%	52.8%	85.3%	61.1%	80.8%	53.8%	85.8%	55.0%	89.2%	52.8%	93.0%	59.8%

Based on the available information in Table 111 and Table 112, we can draw several general assumptions and conclusions about recreational salmon fisheries in SEAK area:

- Recreation salmon fishing occurs throughout SEAK.
- Salmon fishing effort does vary to some degree annually at both the overall and local level, although it tends to be highest each year in the same areas over time (e.g., Juneau, Ketchikan).
- A significant portion of recreational fishing in saltwater (more than 50% of fish captured each year) is associated with the capture of salmon.
- While the vast majority of effort (angler days) are spent in saltwater areas, the proportion of recreational fishing effort associated with salmon fisheries is higher in freshwater areas.
- The risk of interactions with marine mammals is generally higher for recreational fishing in saltwater areas, although interactions are possible in freshwater areas for pinniped species in particular.

With respect to data on Steller sea lion interactions with recreational SEAK salmon fisheries over the last 6 years as described above, there have been 2 interactions identified as specifically involving recreational gear reported to NMFS (1 in July, 2014, and 1 in July, 2016). In addition, another 124 incidents of interactions with troll gear in SEAK have been reported to NMFS, and in most of these incidents, it has not been determined whether this gear originates from the commercial or recreational troll fishery. There are 3 other strandings of Steller sea lions in SEAK associated with unidentified "hook and line" gear (1 in September, 2011; 1 in June, 2015; and 1 in September, 2016) that could have involved salmon recreational fisheries, with two of those being deemed non-serious injuries. At this point it is unclear what proportion of these strandings might be associated with recreational fishing versus commercial troll fishing, and identification between the two is difficult. We conclude that it is likely that the stranding record review under the SEAK troll section above reflects what is known about the hooking/entanglement of Steller sea lions in all types of SEAK troll fisheries, including the recreational fishery. Using the information described in the SEAK troll fishery analysis above, we conclude that there will be at least 27.4 interactions of hooking/entanglement leading to M/SI with SEAK troll gear each year, and at least some, if not all, will involve the recreational troll fishery. Similar to the commercial troll fishery, we assume that a similar general expansion factor of multiplying reported strandings by 5 used above can provide some insight (less certain) into what might be happening in total. For troll interactions with Steller sea lions, this would equate to approximately 125 hooking/entanglements every year, with at least some of these involving the recreational fishery. Based on the information provided in Table 111 above, it appears that a little more than half of recreational fishing effort ~60%) occurs within the mixing area each year, with a substantial amount of this effort occurring in saltwater areas where interactions with marine mammals are likely highest. Although we don't have specific information on the distribution of interactions with Steller sea lions in recreational fishing effort at this time, we assume they are generally spread out throughout SEAK at that at least occasionally some of the individuals that may be hooked/entangled in the recreational fishery are likely to involve Western DPS Steller sea lions. We also consider the possibility (less certain) that unidentified hook and line interactions may occur with recreational salmon fishing, and that M/SI will occasionally be associated with these rare interactions (we assume a rate of 67%). A summary of the analysis of the extent of Western DPS Steller sea lion interactions with the SEAK recreational salmon fishery is provided below:

- SEAK Recreational Salmon Fisheries
  - Minimum: 1 every 3 years, or 0.33 hooking/entanglements per year (strandings from Helker et al. (2018)); 0 additional entanglements or mortality when considered in addition to commercial SEAK troll analysis^^
  - Reasonably certain: >0 undefined number of rare entanglements over time; same as minimum total
  - Less certain: the recreational fishery would be involved with some portion of the 15.0 Western DPS hooking/entanglements and M/SI that were extrapolated as described above for the commercial troll fishery; 0 additional entanglements or mortality when considered in addition to commercial SEAK troll analysis; 1 interaction per year with unidentified hook and line gear * .60 (% of effort in Steller sea lion mixing area * .2 = 0.12 hooking/entanglements of Western DPS per year with unidentified hook and line gear
    - 0.12 hooking/entanglement * .67 M/SI rate (derived above)= 0.08 Western DPS MSI with unidentified hook and line gear per year

2.5.5.7 Summary of Extent of ESA-listed Marine Mammal Interactions Anticipated from all SEAK Salmon Fisheries

In the preceding sections, we have described the available information and analysis of anticipated effects of the proposed actions on ESA-listed humpback whales and Steller sea lions. Given that comprehensive estimates of bycatch in SEAK salmon fisheries are not available, this information has been presented in terms of the minimum levels known from stranding records, and additional evaluations that can be made on what is reasonably certain to occur given relevant information at hand. There has also been some less certain assessment of potential impacts that might be occurring. In summarizing the effects analysis, we outline the minimum levels of bycatch and M/SI expected, as well as levels that we are reasonably certain to occur, for ESA-listed populations of humpback whales and Steller sea lions in each SEAK salmon fishery. Where possible, we also highlight less certain analysis presented above. Then we combine these assessments into totals as best we can for further integration in this biological opinion. We note their aren’t data available regarding the relative age/sex distribution of ESA-listed marine mammal bycatch in SEAK salmon fisheries, and assume that all interactions involving M/SI carry equal weight with respect to impacts to these respective populations.

Mexico DPS Humpback whales

Mexico DPS Humpback whales

- Minimum - Mexico DPS: 0.51 (SEAK drift gillnet) + 0.04 (SEAK purse seine) + 0 (SEAK set gillnet) + 0.01 (SEAK troll) + 0 (subsistence) + 0 (recreational fisheries) = 0.56 Mexico DPS entanglements per year in all SEAK fisheries

    - M/SI: 0.44 (SEAK drift gillnet) + 0.02 (SEAK purse seine) + 0 (SEAK set gillnet) + 0 (SEAK troll) + 0 (subsistence) + 0 (recreational fisheries) = 0.46 Mexico DPS M/SI per year in all SEAK fisheries

- Reasonably certain - Mexico DPS: 0.99 (SEAK drift gillnet) + 0.04 (SEAK purse seine) + >0 (SEAK set gillnet) + 0.01 (SEAK troll) + 0.34 (subsistence) + 0 (recreational fisheries) = >1.38 Mexico DPS entanglements per year in all SEAK fisheries
    - M/SI: 0.58 (SEAK drift gillnet) + 0.02 (SEAK purse seine) + >0 (SEAK set gillnet) + 0 (SEAK troll) + 0.20 (subsistence) + 0 (recreational fisheries) = >0.80 Mexico DPS M/SI per year in all SEAK fisheries

- Less certain - Mexico DPS: ~3.0 (SEAK drift gillnet) + 0.2 (SEAK purse seine) + 0.06 (SEAK set gillnet) + 0.06 (SEAK troll) + ~1.0 (subsistence) + 0 (recreational fisheries) = ~4.32 Mexico DPS entanglements per year in all SEAK fisheries
    - M/SI: ~1.74 (SEAK drift gillnet) + 0.08 (SEAK purse seine) + 0.04 (SEAK set gillnet) + 0 (SEAK troll) + 0.62 (subsistence) + 0 (recreational fisheries) = ~2.48 Mexico DPS M/SI per year in all SEAK fisheries

Western DPS Steller sea lions

- Minimum - Western DPS: 0.03 (SEAK drift gillnet) + 0 (SEAK purse seine) + 0.03 (SEAK set gillnet) + 3.29 (SEAK troll) + 0 (subsistence) + 0 (recreational fisheries) = 3.35 Western DPS entanglements per year in all SEAK fisheries
    - M/SI: 0.02 (SEAK drift gillnet) + 0 (SEAK purse seine) + 0.02 (SEAK set gillnet) + 3.29 (SEAK troll) + 0 (subsistence) + 0 (recreational fisheries) = 3.33 Western DPS M/SI per year in all SEAK fisheries

- Reasonably certain - Western DPS: 0.03 (SEAK drift gillnet) + 0 (SEAK purse seine) + 0.02 (SEAK set gillnet) + >3.29 (SEAK troll) + 0 (subsistence) + 0 (recreational fisheries) = >3.35 Western DPS entanglements per year in all SEAK fisheries
    - M/SI: 0.02(SEAK drift gillnet) + 0 (SEAK purse seine) + 0.02 (SEAK set gillnet) + >3.29 (SEAK troll) + 0 (subsistence) + 0 (recreational fisheries) = >3.33 Western DPS M/SI per year in all SEAK fisheries

- Less certain - Western DPS: <5.0 (SEAK drift gillnet) + 0 (SEAK purse seine) + 0.20 (SEAK set gillnet) + 15.0 (SEAK troll) + 0.31 (subsistence) + 0.12 (recreational fisheries) = <20.63 Western DPS entanglements per year in all SEAK fisheries
    - M/SI: <2.5 (SEAK drift gillnet) + 0 (SEAK purse seine) + 0.10 (SEAK set gillnet) + 15.0 (SEAK troll) + 0.16 (subsistence) + 0.08 (recreational fisheries) = <17.84 Western DPS M/SI per year in all SEAK fisheries

Extent of Fishing Effort Expected

As described above, there is uncertainty in the extent of interactions with all SEAK salmon fisheries covered by the proposed action. Largely we rely upon strandings data to characterize what is known about the minimum impacts to anticipate, combined with other available information to inform what is reasonably certain to occur, regarding expectations for the interactions of ESA-listed marine mammals in these fisheries over the course of the proposed action. Our expectations include a general assumption that interaction risks with SEAK salmon fisheries are related to the extent of fishing effort that occurs in these fisheries, and that the available data on interactions that have occurred in these fisheries in recent years is a reflection of the extent of effort, to some degree, that has occurred. As a result, we also aim to characterize the extent of fishing effort that may be expected during the proposed action to help characterize the anticipated effects of the proposed action on ESA-listed marine mammals. This assessment is provided in the *Incidental Take Statement* as part of the description of the extent of take that is anticipated.

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 action 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. If climate change reduces ocean or freshwater productivity, it may require tribes, states, and local governments to consider actions to mitigate those effects. 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 Section 2.2.5, Climate Change.

Cumulative effects occur in marine waters within the action area. Future tribal, state, and local government actions will likely be in the form of legislation, administrative rules, or policy initiatives and fishing permits. Activities in the ocean portion of the action area are primarily those conducted under state, tribal or federal government management. These actions may include changes in ocean policy and increases and decreases in the types of activities currently seen in the action area, including changes in the types of fishing activities, resource extraction, and designation of marine protected areas, any of which could impact listed species or their habitat. Government actions are subject to political, legislative and fiscal uncertainties. As a result any analysis of cumulative effects is difficult, particularly when taking into account the geographic scope of the action area, the various authorities involved in the action, and the changing economies of the region. 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. However, for the purpose of this analysis, NMFS assumes that effects of future tribal, state or private activities in the action area will have a neutral or positive effect for the duration of this opinion.

Activities occurring in the Puget Sound area were considered in the discussion of cumulative effects in the biological opinion on the Puget Sound Harvest Resource Management Plan (NMFS 2011a) and in the cumulative effects sections of several section 7 consultations on large scale habitat projects affecting listed species in Puget Sound including Washington State Water Quality Standards (NMFS 2008b), Washington State Department of Transportation Preservation, Improvement, and Maintenance Activities (NMFS 2013b), the National Flood Insurance Program (NMFS 2008c), and the Elwha River Fish Restoration Plan (Ward et al. 2008). We find it reasonably certain that state and private actions associated with marine pollution will continue into the future (e.g., state permits for effluent discharges and the status of currently contaminated sites) (NMFS 2011a). Additionally, as discussed in the above-cited opinions we expect forage, water quality, and rearing and spawning habitat to continue to be affected by forestry; grazing; agriculture; channel/bank modifications; road building/maintenance; urbanization; sand and gravel mining; dams; irrigation impoundments and withdrawals; river, estuary, and ocean traffic; wetland loss; forage fish/species harvest; and climate change. We anticipate that the effects described in these previous analyses will continue into the future and therefore we incorporate those discussions by reference here. Those opinions discussed the types of activities taken to protect listed species through habitat restoration, hatchery and harvest reforms, and water resource management actions and their likely negative effects.

Cumulative effects in four freshwater areas were considered for the purposes of this biological opinion. The Nooksack, Stillaguamish, Dungeness, and Mid-Hood Canal rivers are all part of the action area as part of the proposed actions. The federally approved Shared Strategy for Puget Sound recovery plan for Puget Sound Chinook Salmon (SSPS 2005b), describes, in detail, the on-going and proposed state, tribal, and local government actions that are targeted to reduce known threats to listed Puget Sound Chinook salmon in these watersheds. Future tribal, state, and local government actions will likely be in the form of legislation, administrative rules, policy initiatives, and land use and other types of permits. Government and private actions may include changes in land and water uses, including ownership and intensity, which could affect listed species or their habitat. Government actions are subject to political, legislative and fiscal uncertainties. Aside from the conservation hatcheries considered above and discussed in detail in the effects section, and the activities listed above, no other activities are expected to affect these freshwater areas. All neutral to moderately negative effects from activities currently taking place are considered within the Environmental Baseline of this opinion and are expected to continue to occur.

A Final Recovery Plan for Southern Resident killer whales was published January 24, 2008 (NMFS 2008g). There are multiple activities that are reasonably certain to occur within the inland waters of Washington (a part of the action area). Since the 1990s there has been a transboundary effort between the U.S. and Canada to develop and periodically revise voluntary guidelines for viewing marine wildlife in the Pacific Northwest, with a specific focus on Southern Resident killer whales. NMFS and partners developed the "Be Whale Wise" guidelines in 2002 to protect killer whales and all marine mammals, and they are available at www.bewhalewise.org. Despite these guidelines and outreach efforts, concern remained that the level of disturbance caused by vessels surrounding these popular whales may still have harmful effects on individuals and the population. Rules on vessel traffic to protect Southern Residents from vessel effects were adopted in 2011 (76 FR 20870). Outreach and enforcement of these regulations will reduce the vessel effects (as described in Ferrara et al. 2017) of recreational and whale watching vessels in the inland waters of Washington.

Regularly-occurring vessel traffic in Puget Sound can be generally characterized as ferries, cargo vessels, cruise ships, tugs and recreational craft. Admiralty Inlet provides shipping access to the ports of Seattle, Everett, and Tacoma as well as to U.S. Navy and Coast Guard facilities. In Haro Strait (a core use are visited by Southern Resident killer whales; Hauser et al. 2007), Veirs et al. (2016) estimated the average daily ship traffic is 19.5 ships per day. Tugs, cargo ships, vehicle carriers, and tankers were the most prevalent ship classes. Considering large ships pass through Haro Strait approximately every hour throughout the year (Erbe et al. 2012), concern over ship noise interfering with Southern Resident killer whale communication, foraging, and navigation has been identified as a concern (Veirs et al. 2016). A new effort based in Canada, the Enhancing Cetacean Habitat and Observation (ECHO) Program, is a Vancouver Fraser Port Authority-led initiative aimed at better understanding and managing the impact of shipping activities on at-risk whales throughout the southern coast of British Columbia (http://www.portvancouver.com/environment/water-land-wildlife/marine-mammals/echo-program/). NOAA participates in the advisory working group and technical working groups for ECHO.

There is currently a voluntary ¼ mile “Whale watch Exclusion Zone” along the West side of San Juan Island from Mitchell Bay to Eagle Point (and ½ mile around Lime Kiln) as part of their Marine Stewardship Area. In 2018 San Juan County expanded the area to include a ¼ mile no vessel zone to Cattle Point with additional recommendations for speed. In 2018 the Pacific Whale Watch Association updated their industry guidelines stating “Vessels will remain a minimum of 1⁄2 mile (880 yards) from the light beacon of the Light House at Lime Kiln State Park on San Juan Island when whales are in the vicinity. Vessels will remain a minimum of 1⁄4 mile (440 yards) from the main shoreline of the west side of San Juan Island when between Mitchell Point to Cattle Point (facing south).” WDFW also expanded outreach to boating and fishing communities to promote compliance with the expanded voluntary zone no-go in 2018 (NMFS 2018b). In addition, a new 200 meter approach regulations to protect killer whales were put into place in Canadian waters.

In April 2015, NMFS hosted a 2-day SRKW health workshop to assess the causes of decreased survival and reproduction in the killer whales. Following the workshop, a list of potential action items generated during the workshop was then reviewed and prioritized. A Priorities Report (http://www.westcoast.fisheries.noaa.gov/publications/protected_species/marine_mammals/killer_whales/srkw_healthpriority_dec2015.pdf) provides a prioritized list of the recommended action items to better understand what is causing decreased reproduction and increased mortality in this population of whales. The report also provides prioritized opportunities to establish important baseline information on SRKW and reference populations to better assess negative impacts of future health risks, as well as positive impacts of mitigation strategies on SRKW health.

Recently, a joint DFO-NOAA Prey Availability Workshop was held in November 2017 that focused on identifying short-term management actions that might be taken to immediately increase the abundance and accessibility of Chinook salmon in southern U.S. and Canadian waters. Priority management actions identified in the workshop that should be considered included 1) targeted, area-based fishery management measures designed to improve Chinook salmon availability, and 2) reducing acoustic and vessel disturbance in key Southern Resident foraging areas. There was little support for broad scale coast-wide reductions in fishing to increase the prey available to the whales, which was consistent with the findings of the previous transboundary panel. For the 2018 salmon fishing season, the Government of Canada imposed fishery management measures including reducing total harvest by 25-35%[40]. To increase Chinook salmon availability, closures in three specific Southern Resident foraging areas in Canadian waters including Strait of Juan de Fuca, Gulf Islands and the mouth of the Fraser River will protect key foraging areas for Southern Resident killer whales. Additional measures to support increased prey availability include reduced harvest and size limits, and reduced time restrictions[41].

On March 14, 2018, WA Governor's Executive Order 18-02 was signed and it orders state agencies to take immediate actions to benefit Southern Resident killer whales and established a Task Force to identify, prioritize, and support the implementation of a longer term action plan need for Southern Resident killer whale recovery. The Task Force provided recommendations in a final report in November 2018. Although it is likely that several of the recommended actions will occur, it is currently uncertain which ones will be implemented.

In southeast Alaskan waters, cumulative effects for humpback whales and Steller sea lions include vessel transportation, tourism, and community development. Regularly-occurring vessel traffic in the action area can be generally characterized as ferries, cargo vessels, or recreational craft. For example, Nuka (2012) reports that ferries (28%), passenger vessels with overnight accommodations (20%), and cruise ships (19%) comprise the majority of vessel activity in Southeast Alaska even though most of these vessels only operate during the five month period from May through September. Dry freight cargo barges and tank barges account for 19% and 11% of total vessel activity, respectively, while freight ships, both log and ore carriers, comprise less than 3% of the total (Nuka 2012).

Marine and coastal vessel traffic could contribute to potential cumulative effects through the disturbance of listed marine mammals associated with tourism. Tourism is a large industry in Southeast Alaska, as shown in a recent report on visitor statistics (McDowell Group 2016)

Although state, tribal and local governments have developed plans and initiatives to benefit marine fish species, ESA listed salmon, and the listed SRKW, they must be applied and sustained in a comprehensive way before NMFS can consider them "reasonably certain to occur" 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

[40] http://www.pac.dfo-mpo.gc.ca/fm-gp/maps-cartes/salmon-saumon/2018-skrw-ers-eng.html
[41] https://www.canada.ca/en/fisheries-oceans/news/2018/05/government-of-canada-takes-action-to-protect-southern-resident-killer-whales.html

add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed actions are 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 diminishes the value of designated or proposed critical habitat for the conservation of the species.

As discussed in more detail in Section 1.3, the proposed actions considered in the opinion are 1) reinitiation of prior consultations on the delegation of management authority over salmon fisheries in the EEZ in SEAK to the State of Alaska, 2) Federal funding, through grants to the State of Alaska, for the State's management of commercial and sport salmon fisheries in the EEZ and State of Alaska waters and transboundary river enhancement necessary to implement the 2019 Agreement, and 3) Federal funding of a conservation program for critical Puget Sound Chinook salmon stocks and SRKW consistent with the 2019 Agreement.

2.7.1 Lower Columbia River Chinook Salmon

The LCR Chinook ESU has a complex population structure that is described in more detail in Section 2.2.2.1. There are 32 extant natural-origin populations divided into three life history types and six MPGs. Fourteen hatchery-origin programs are also included as part of the listed ESU (Table 9). The life-histories are differentiated based on return timing to freshwater and include spring-run, early-fall (tules), and late-fall (brights) Chinook salmon (Table 9). Ocean distributions and timing for the three life-histories differ significantly and are therefore subject to very different patterns of harvest. As a consequence, we analyze the effect of the proposed actions on the ESU by considering the effect on each life-history and their component populations.

Spring Chinook salmon MPGs

There are nine natural-origin spring Chinook salmon populations including two in the Gorge MPG and seven in the Cascade MPG (Table 9). One of the Gorge populations is "extirpated" and the other is "extirpated or nearly so." The relative importance of each population to recovery is described in Table 10. Recovery efforts for both depend on reintroduction programs and other site specific recovery actions.

Spring Chinook populations in the Cowlitz basin (Upper Cowlitz, Cispus, and Tilton), Lewis and Kalama rivers on the Washington side of the Columbia River are managed to meet hatchery escapement objectives. The hatchery fish are used to support reintroduction programs in the Cowlitz and Lewis, in particular, since most of the historical habitat in the upper basins is blocked due to hydro development. The reintroduction programs provide access to otherwise vacant habitat, but the potential for recovery will continue to be limited until juvenile collection and transport problems are solved. Given the current circumstances, the first priority is to meet hatchery escapement goals and thereby preserve the genetic heritage of the population and the opportunity to make further progress on the reintroduction efforts. With some exceptions hatchery escapement objectives have been met and where not management actions have been taken inriver to address the anticipated shortfalls. Returns of natural-origin fish to the Sandy River, on the Oregon side of the Columbia River, have greatly exceeded the abundance related recovery objective in recent years (Table 12), although other aspects of the VSP criteria would have to improve for the populations to achieve the higher targeted persistence probability level, harvest is not considered a substantive limiting factor.

LCR spring Chinook salmon are caught in fisheries from Alaska to Oregon that are part of the environmental baseline, and in mainstem and tributary fisheries in the lower Columbia River that are not. The harvest of LCR spring Chinook salmon has declined significantly from the highs observed in the 1980s to lows in the late 1990s (Figure 5). Reductions occurred in both ocean and inriver fisheries as a consequence of conservation actions taken to protect LCR spring Chinook salmon and other spring stocks returning to the Columbia River including the specific actions taken for the UWR Chinook Salmon ESU which are discussed in Section 2.2.2.2 of this opinion.

The retrospective analysis was used to characterize the effects of the proposed actions including in particular the ongoing delegation of management authority to the State of Alaska in the EEZ and subsequent PST Implementation Program Support funding management of state fisheries operating under the auspice of the 2019 Agreement. Results of the retrospective analysis are described in Section 2.5.2. Scenario 1 provides estimates of the ERs that occurred since 1999 under the prior two PST Agreements. Scenario 2 provides estimates of the ERs that would have occurred in those same years if they had been managed subject to the terms of the 2019 Agreement. The ER in the SEAK fishery averaged 1.8 percent in Scenario 1 and 1.6 percent in Scenario 2 (Table 45). Exploitation rates in the marine area fisheries in the action area would be reduced from 18.7 percent under Scenario 1 to 17.7 percent in Scenario 2 (Table 45). LCR spring Chinook salmon are caught in the SEAK fishery, but the ER in the SEAK fishery (described above) and proportion of marine area fishery impacts that occur in SEAK is relatively low (9.7 percent) (Figure 26). The retrospective analysis indicates that harvest of LCR spring Chinook salmon in the action area is generally quite low and would be reduced further as intended by the Agreement.

The 40 percent Abundance Decline scenario (Scenario 4) assumes that the overall abundance of Chinook salmon in the ocean is reduced significantly. A comparison of the results from scenarios 2 and 4 is designed to assess how the Agreement would respond to a major reduction in abundance in terms of its likely effect on stock specific ERs. The ER in the SEAK fishery averaged 1.6 percent in Scenario 2 and 1.4 percent in Scenario 4 (Table 47). Exploitation rates in the marine area fisheries in the action area would be reduced from 17.7 percent under Scenario 2 to 17.0 percent in Scenario 4 (Table 47). The relative change in ER in the SEAK and marine area fisheries are -10.1 percent and -3.2 percent, respectively. Thus management of the SEAK fisheries is responsive to declines in abundance and very low fishery impacts would occur under a low abundance scenario.

Tule Chinook salmon MPGs

There 21 tule populations in the LCR Chinook salmon ESU including seven in the Coastal MPG, ten in the Cascade MPG, and four in the Gorge MPG (Table 9). The relative importance of each population to recovery is described in Table 10. Overall, there has been little change in the status of Chinook salmon populations in the LCR ESU since the prior status review (Ford et al. 2011a; NMFS 2016c). Increases in abundance were noted in about 70 percent of the fall-run populations and decreases in hatchery contribution were noted for several populations. Relative to baseline VSP levels identified in the recovery plan (NMFS 2013c) 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 (NMFS 2016c). These improved fall-run VSP scores reflect both changes in biological status and improved monitoring. Notwithstanding these improvements, the majority of the populations remain at high risk (Table 18). For many populations the high proportions of hatchery-origin spawners affects the VSP scores and otherwise compromises the status of the populations.

LCR tule Chinook salmon are caught in fisheries from Alaska to Oregon that are part of the environmental baseline and in mainstem and tributary fisheries in the lower Columbia River that are not. The harvest of LCR tule Chinook salmon has declined significantly from the highs observed in the 1980s to lows in the late 1990s (Figure 5). Reductions occurred in both ocean and inriver fisheries as a consequence of conservation actions taken to protect LCR tule Chinook and other fall Chinook stocks returning to the Columbia River and elsewhere.

The retrospective analysis was used to characterize the effects of the proposed actions including in particular the ongoing delegation of management authority to the State of Alaska in the EEZ and subsequent PST Implementation Program Support funding management of state fisheries operating under the auspice of the 2019 Agreement. Results of the retrospective analysis are described in Section 2.5.2. Scenario 1 provides estimates of the ERs that occurred since 1999 under the prior two PST Agreements. Scenario 2 provides estimates of the ERs that would have occurred in those same years if they had been managed subject to the terms of the 2019 Agreement. The ER on LCR tule Chinook salmon in the SEAK fishery averaged 2.4 percent in Scenario 1 and 2.1 percent in Scenario 2 (Table 45). Exploitation rates in the marine area fisheries in the action area would be reduced from 33.1 percent under Scenario 1 to 29.3 percent in Scenario 2 (Table 45). LCR tule Chinook are caught in the SEAK fishery which accounts for 7.1 percent of the marine area fishery impacts (Figure 28). The analysis indicates that harvest of LCR tule Chinook in the action area would be reduced as intended by the Agreement.

The 40 percent Abundance Decline scenario (Scenario 4) assumes that the overall abundance of Chinook salmon in the ocean is reduced significantly. A comparison of the results from scenarios 2 and 4 is designed to assess how the Agreement would respond to a major reduction in abundance in terms of its likely effect on stock specific ERs. The ER on LCR tule Chinook in the SEAK fishery averaged 2.1 percent in Scenario 2 and 1.9 percent in Scenario 4 (Table 47). Exploitation rates in the marine area fisheries in the action area would be reduced from 29.3 percent under Scenario 2 to 28.1 percent in Scenario 4 (Table 47). The relative change in ER in the SEAK and marine area fisheries are -10.0 percent and -4.0 percent, respectively.

There is an additional point that is relevant to NMFS' assessment of the proposed actions on the LCR tule Chinook salmon populations. LCR tule Chinook salmon have been managed off the U.S. West Coast and inland waters since 2012 using an abundance based management plan framework. The plan specifies a total ER that may vary from year-to-year between 30 and 41 percent depending on a particular run size indicator. The ER limit applies to all marine area salmon fisheries and inriver fisheries below Bonneville Dam. NMFS reviewed the proposed management framework in 2012 and concluded that it would not jeopardize LCR Chinook

(NMFS 2012b).

All fisheries, including those in SEAK, are accounted for in management subject to the tule management framework. In practice, the Abundance Indices are determined and catch limits are set for the SEAK and Canadian AABM fisheries early in the preseason process based provisions of the PST Agreement (described in section 1.3). Once those are set, southern U.S. fisheries in the PFMC areas and Columbia River are adjusted so as not to exceed the year specific total ER limit. The necessary coordination occurs through the PFMC preseason process. In 2018, for example, the total ER limit for LCR tule Chinook salmon was 38 percent. At the end of the preseason planning process, the projected total ER from all salmon fisheries on LCR tules was 37.7 percent (PFMC 2018a).

The retrospective analysis confirms that ERs of LCR tule Chinook salmon in the SEAK fishery would be reduced under the 2019 Agreement. Whether those reductions accrue to increased escapement would depend on how the southern U.S. fisheries are managed. As the majority of the harvest mortality occurs in southern fisheries (Figure 28), there is sufficient opportunity and discretion to reduce harvest as needed to meet the annual limit, or any other reasonably foreseeable ER limit. Given the circumstances, the effect of catch reductions in SEAK and other AABM fisheries on the tule component of the ESU would be neutral or positive, and therefore ERs will continue to be relatively low under the new agreement, such that SUS fisheries can continue to be managed consistent with the framework that has already been determined not to jeopardize the LCR Chinook ESU (NMFS 2012b).

Bright Chinook salmon MPGs

There are two bright Chinook salmon populations in the LCR Chinook Salmon ESU in the Sandy and Lewis rivers. Both populations are in the Cascade MPG (Table 9) and are considered primary populations for the purposes of recovery (Table 10). These populations are generally healthy and have met or nearly met their recovery objectives. The baseline persistence probabilities of the Lewis and Sandy populations are very high and high, respectively; both populations are targeted for very high persistence probability under the recovery scenario (Table 10). The spawning escapement of Lewis River brights has averaged 9,000 natural-origin fish over the last ten years and generally exceeded its escapement object of 5,700 by a wide margin since 1980 (Table 17). Escapements to the Sandy have averaged 728 natural-origin spawners since 1995 compared to an abundance target for delisting of 3,747.

LCR bright Chinook salmon are far north migrating and are caught in fisheries from Alaska to Oregon that are part of the environmental baseline and in mainstem and tributary fisheries in the lower Columbia River that are not. Because they have a more northerly migration pattern, they are subject to more harvest in the SEAK and northern Canadian fisheries. The harvest of LCR bright Chinook salmon declined significantly from highs in the 1980s to low levels in the late 1990s. Harvest impacts have increased since then to levels that, in some years, approach those observed early on (Figure 5).

The retrospective analysis was used to characterize the effects of the proposed actions including in particular the ongoing delegation of management authority to the State of Alaska. Results of the retrospective analysis are described in Section 2.5.2. Scenario 1 provides estimates of the

ERs that occurred since 1999 under the prior two PST Agreements. Scenario 2 provides estimates of the ERs that would have occurred in those same years if they had been managed subject to the terms of the 2019 Agreement. The ER in the SEAK fishery averaged 10.5 percent in Scenario 1 and 9.9 percent in Scenario 2 (Table 45). Exploitation rates in the marine area fisheries in the action area would be reduced from 50.7 percent under Scenario 1 to 45.7 percent in Scenario 2 (Table 45). LCR bright Chinook are caught in the SEAK fishery which accounts for 20.7 percent of the marine area fishery impacts (Figure 30). The analysis indicates that harvest of LCR bright Chinook in the action area would be reduced as intended by the Agreement.

The 40 percent Abundance Decline scenario (Scenario 4) assumes that the overall abundance of Chinook salmon in the ocean is reduced significantly. A comparison of the results from scenarios 2 and 4 is designed to assess how the Agreement would respond to a major reduction in abundance in terms of its likely effect on stock specific ERs. The ER in the SEAK fishery averaged 9.9 percent in Scenario 2 and 9.1 percent in Scenario 4 (Table 47). Exploitation rates in the marine area fisheries in the action area would be reduced from 45.7 percent under Scenario 2 to 44.1 percent in Scenario 4 (Table 47). The relative change in ER in the SEAK and marine area fisheries are -7.7 percent and -3.5 percent, respectively.

As discussed is Section 2.2.5, the status of LCR Chinook salmon is likely to be affected by changes in climate. Climate change is expected to impact Pacific Northwest anadromous fish during all stages of their complex life cycle. The magnitude and timing of the effects to LCR Chinook salmon are uncertain, but it is reasonable to expect that the effects will be negative. As indicated in the recovery plan (NMFS 2013c) and elsewhere, it is essential that we make continued progress on all fronts to address factors that are limiting the status of LCR Chinook salmon so that the species improves and is more resilient to the challenges of climate change. Harvest management systems are no exception. They too must be flexible and able to respond to future circumstances. In particular, it is important that harvest management be responsive to changes in abundance. As indicated in section 1.3, the fishery management regime is designed to be responsive to significant changes in the productivity of Chinook salmon stocks associated with environmental conditions. In this opinion, we focus on the proposed actions and how the SEAK fishery in particular would respond to changing circumstances. The Retrospective Analysis, and our consideration of Scenario 4, indicates that the management framework contained in the Agreement would be responsive to a significant reduction in abundance (e.g., 40 percent), a reduction that exceeds what we can reasonably expect to see over the ten year term of the Agreement.

Cumulative effects are future state and private activities that are reasonably certain to occur in the action area (see Section 2.6). Although inshore marine areas in Puget Sound are part of the action area, the distribution of LCR Chinook salmon is such that they are not likely to be affected by activities in Puget Sound. After review of the available information, NMFS did not identify any qualifying activities in offshore marine areas that are likely to influence LCR Chinook salmon in a way that further informs NMFS' assessment of the proposed actions.

A determination regarding the effects of the proposed actions related to the SEAK fishery to the LCR Chinook ESU requires comment on each of the life history types. For the spring Chinook populations, hatchery escapement objectives necessary to support reintroduction programs into what is otherwise inaccessible habitat are generally being met and, where not, additional management actions have been taken inriver to address the anticipated shortfalls. These programs support the populations prioritized for recovery on the Washington side of the Cascade MPG in particular. Impacts of the SEAK fishery to the spring component of the ESU have been low (1.8 percent) under the past PST Chinook management regimes and will be reduced further as a consequence of reductions that will occur under the proposed 2019 Agreement.

For LCR tule populations, southern fisheries are managed according to the framework described above which requires those fisheries to ensure that total fishery exploitation rates do not exceed a year-specific framework objective. Impacts to the tule populations in the SEAK fishery have been relatively low (2.4 percent) and will be reduced further under the proposed 2019 Agreement, but in any case southern fisheries will continue to be managed to avoid exceeding the year-specific management objective that accounts for all northern fishery impacts.

Both populations of the LCR bright life history are generally considered healthy. The Lewis River population in particular routinely exceeds its escapement objective by a wide margin. Impacts to the bright populations in the SEAK fishery have been higher than for the other components of the ESU (10.5 percent), but, as with the other components of the ESU, will be reduced as a consequence of reductions in the SEAK fishery that will occur under the proposed 2019 Agreement.

In short, escapement goals and other management objectives have generally been met for the various life history components of the LCR Chinook ESU during the term of the current PST Agreement including, in particular, provisions related to the SEAK fishery that are the subject of this opinion. Under the new Agreement, SEAK fishery impacts to the ESU will be reduced further thus reinforcing the expectation that management objectives will continue to be met. Climate change and other factors may negatively affect this outcome in the future, however, the proposed management framework for the SEAK fishery and other marine and freshwater fisheries to the south are designed to be responsive to changes in abundance. The retrospective analysis indicates that the SEAK fishery would be responsive to those changes in overall abundance, even a significant change that goes beyond what we can reasonably expect to occur over the ten year term of the new agreement. Thus we expect that the proposed action will not prevent the LCR Chinook ESU components from meeting objectives which are designed to further the survival and recovery of this species.

After reviewing and analyzing 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 appreciably reduce the likelihood of both survival and recovery of the LCR Chinook Salmon ESU or destroy or adversely modify its designated critical habitat.

2.7.2 Upper Willamette Chinook Salmon

There are seven demographically independent populations in the ESU (Table 19), four of which are considered "core" populations including the Clackamas, North Santiam, McKenzie, and

Middle Fork Willamette. In order to meet the biological criteria for delisting, the NMFS recommended four out of the seven populations achieve viable status (NMFS and ODFW 2011).

According to the most recent status review (NMFS 2016f) 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. Abundances, in terms of adult returns, in the North and South Santiam Rivers have risen since the previous five year status review (Ford et al. 2011a), but still range only in the high hundreds of fish (Table 22). The proportion of natural-origin spawners has also improved in the North and South Santiam Basins. Improvements in the status of the MF Willamette River population are reflected by the returns of natural-origin adults to Fall Creek, a tributary to the MF Willamette; however, the capacity of the Fall Creek basin alone is insufficient to achieve the recovery goals for the MF Willamette River individual population. Additionally, the Clackamas and McKenzie rivers have previously been viewed as natural population strongholds, but both individual populations have experienced declines in abundance in recent years (NMFS 2016f).

The population status of UWR Chinook is characterized relative to persistence (which combines the abundance and productivity criteria), spatial structure, diversity, and also habitat characteristics. Based on the status review, NMFS concluded that there has been relatively little net change in the VSP score for the ESU since the last review, and reaffirmed that the status of this ESU remains threatened (NMFS 2016f).

UWR Chinook salmon is a far north migrating stock that is harvested in ocean fisheries (primarily in Canada and Alaska) that are part of the environmental baseline, and in lower mainstem Columbia River fisheries, fisheries in the mainstem Willamette River, and other tributary fisheries in the Willamette Basin. Freshwater fisheries occur outside the action area and were therefore considered in the status section. Marine area fisheries other than those attributable to the proposed action occur in the action area and were considered as part of the Environmental Baseline. The effect of freshwater fisheries on UWR spring Chinook were considered previously through an ESA evaluation, pursuant Section 4(d), of an FMEP from the state of Oregon (NMFS 2001b). In the late 1990s ODFW began mass marking all hatchery production, and recreational and commercial freshwater fisheries were changed to only allow the retention of marked hatchery fish, with mandatory release of unmarked fish. The FMEP proposed to limit the harvest rate on natural-origin fish in all freshwater fisheries to no more than 15 percent. NMFS concluded in that review that managing UWR spring Chinook salmon according to the provisions of the FMEP is not likely to jeopardize the continued existence of the ESU (NMFS 2001b). Since implementation of the FMEP, the annual harvest rate on natural-origin UWR Chinook salmon in freshwater fisheries has been significantly less than that allowed by the plan averaging 10.1 percent (ODFW 2017).

The exploitation rate on UWR Chinook in marine area fisheries since 1999 has been relatively stable and averaged 10.2 percent (Figure 31 and Table 34), but this also represents a significant decrease harvest in marine area fisheries that occurred over time. Exploitation rates in marine area fisheries in the 1980s averaged on the order of 20 percent (Figure 7).

The recovery plan for UWR Chinook salmon (NMFS and ODFW 2011) reviewed the limiting factors and threats and describes strategies for addressing each of them (Chapter 5 in NMFS and ODFW 2011). At the time of listing, harvest was identified as a factor for decline. However, as described above, changes in management of the freshwater fisheries and reduction in harvest in the ocean have resulted in significant reductions in harvest. From 1980 to 1995 the total ER in ocean and inriver fisheries averaged 51 percent (Figure 7). From 1996 to 2006 the total ER for all fisheries averaged 21 percent. As a consequence, and particularly because of the management reforms in freshwater fisheries, the recovery plan concluded that harvest was neither a primary or secondary limiting factor and that other limiting factors are the key bottlenecks currently impeding the recovery of UWR Chinook salmon populations (NMFS and ODFW 2011).

The retrospective analysis was used to characterize the effects of the proposed actions including in particular the ongoing delegation of management authority to the State of Alaska in the EEZ and subsequent PST Implementation Program Support funding management of state fisheries operating under the auspice of the 2019 Agreement. Results of the retrospective analysis are described in Section 2.5.2. Scenario 1 provides estimates of the ERs that occurred since 1999 under the prior two PST Agreements. Scenario 2 provides estimates of the ERs that would have occurred in those same years if they have been managed subject to the terms of the 2019 Agreement. The ER in the SEAK fishery averaged 4.3 percent in Scenario 1 and 3.8 percent in Scenario 2 (Table 48). Exploitation rates in the marine area fisheries in the action area would be reduced from 10.2 percent under Scenario 1 to 9.0 percent in Scenario 2 (Table 48). UWR Chinook are a far north migrating stock so a relatively large proportion of the marine area fishery impacts do occur in the SEAK fishery (42.7 percent) (Figure 32). The analysis indicates that harvest of UWR Chinook in the action area would be reduced as intended by the Agreement.

The 40 percent Abundance Decline scenario (Scenario 4) assumes that the overall abundance of Chinook salmon in the ocean is reduced significantly. A comparison of the results from scenarios 2 and 4 is designed to assess how the Agreement would respond to a major reduction in abundance in terms of its likely effect on stock specific ERs. The ER in the SEAK fishery averaged 3.8 percent in Scenario 2 and 3.4 percent in Scenario 4 (Table 45). Exploitation rates in the marine area fisheries in the action area would be reduced from 9.0 percent under Scenario 2 to 8.4 percent in Scenario 4 (Table 50). The relative change in ER in the SEAK and marine area fisheries are -10.4 percent and -7.1 percent, respectively.

The analysis indicates that exploitation rates would be reduced in response to a significant decline in overall abundance, primarily due to reductions in exploitation rates in AABM fisheries as the Abundance Indices declines. This would also result in a proportional reduction in catch that is greater than the corresponding reduction in abundance. This indicates that provisions of the Agreement related to the SEAK fishery in particular and fisheries in general will be responsive to significant reductions in abundance. In addition, it is worth noting, that the Retrospective Analysis did not try to anticipate additional fishery reductions that would likely be required in the southern marine area fisheries or freshwater fisheries to respond to the stock specific circumstances that would accompany an overall reduction in abundance that is on the order of 40 percent.

As discussed is Section 2.2.5, the status of UWR Chinook salmon is also likely to be affected by changes in climate. Climate change is expected to impact Pacific Northwest anadromous fish during all stages of their complex life cycle. The magnitude and timing of the effects to UWR Chinook salmon are uncertain, but it is reasonable to expect that the effects will be negative. As indicated in the recovery plan (NMFS and ODFW 2011) and elsewhere, it is essential that we make continued progress on all fronts to address factors that are limiting the status of UWR Chinook salmon so that the species improves and is more resilient to the challenges of climate change. Harvest management systems are no exception. They too must be flexible and able to respond to future circumstances. In particular, it is important that harvest management be responsive to changes in abundance. As indicated in Section 1.3, the fishery management regime is designed to be responsive to significant changes in the productivity of Chinook salmon stocks associated with environmental conditions. In this opinion, we focus on the proposed actions and how the SEAK fishery in particular would respond to changing circumstances. The Retrospective Analysis, and our consideration of Scenario 4 in particular, indicates that the management framework contained in the Agreement would be responsive to a significant reduction in abundance (40 percent), even beyond what we can reasonably expect to see over the ten year term of the Agreement.

Cumulative effects are future state and private activities that are reasonably certain to occur in the action area (see Section 2.6). Although inshore marine areas in Puget Sound are part of the action area, the distribution of UWR Chinook salmon is such that they are not likely to be affected by activities in Puget Sound. After review of the available information, NMFS did not identify any qualifying activities in offshore marine areas that are likely to influence UWR Chinook salmon in a way that further informs NMFS' assessment of the proposed actions.

In summary, the most recent review of the status of UWR Chinook gave mixed results. Some populations showed signs of improvement, but others have declined since the last review and the overall conclusion was that there was little net change in the ESU's VSP score. However, fishery impacts on the ESU have been reduced substantially since the 1980s, such that the recovery plan for UWR Chinook salmon concluded that harvest was no longer either a primary or secondary limiting factor. The state of Oregon has dramatically reduced the impacts of freshwater fisheries on natural origin UWR Chinook salmon. Marine harvest has likewise been significantly reduced. While over 40 percent of the marine area harvest of the ESU occurs in the SEAK fishery due to the ESU's far north migratory path, the magnitude of harvest in the SEAK fishery that is the subject of the first two proposed actions has been relatively low (4.3 percent) and would be reduced further as a consequence of the proposed 2019 PST Agreement. Climate change and other factors may negatively affect the status of UWR Chinook salmon in the future, however, the proposed management framework for the SEAK fishery and other marine and freshwater fisheries to the south are designed to be responsive to changes in abundance. The retrospective analysis indicates that the SEAK fishery would be responsive to those changes in overall abundance, even a significant change that goes beyond what we can reasonably expect to occur over the ten year term of the new agreement.

Although there is uncertainty about the magnitude and timing of the effects of climate change, we expect that the direction of that change will ultimately be negative. However, the proposed management framework for the SEAK fishery and other marine and freshwater fisheries to the south are designed to be responsive to changes in abundance. The retrospective analysis indicates that the SEAK fishery would be responsive to those changes in overall abundance, even a significant change that goes beyond what we can reasonably expect to occur over the ten year term of the new agreement.

After reviewing and analyzing 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 appreciably reduce the likelihood of both survival and recovery of the UWR Chinook Salmon ESU or destroy or adversely modify its designated critical habitat.

2.7.3 Snake River Fall-Run Chinook Salmon

Historically there were two populations within the Snake River fall-run Chinook Salmon ESU one of which is now extirpated. The extant population 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.

The status of the species is determined based on measures of abundance, productivity, spatial structure, and diversity of its constituent populations. Spawner abundance has increased substantially in recent years. The return of natural-origin adults to Lower Granite Dam averaged 3,203 from 2000 to 2004 and 14,815 from 2012 to 2016 (Table 25). This compares to minimum escapement threshold of natural-origin spawners of 4,200. Productivity, defined as the expected replacement rate at low to moderate abundance relative to a population's minimum abundance threshold, also increased to 1.5 since the last status review. The overall risk rating for abundance and productivity was designated low (Table 27).

The risk rating for spatial structure and diversity is moderate (Table 27). For spatial structure/diversity, 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.

Overall, the status of Snake River fall-run Chinook salmon has clearly improved compared to the time of listing and even 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 (Table 27), but the ESU as a whole is not meeting the recovery goals described in the recovery plan for the species, which requires a single population ESU to be "highly viable with high certainty" and/or reintroduction and development of a second viable population above the Hells Canyon Dam complex (NWFSC 2015).

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 et al. 2011a). 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 2017f). Harvest as a limiting factor has been addressed through reductions that have occurred in both ocean and inriver fisheries.

Snake River fall-run Chinook salmon have a broad ocean distribution and are caught in ocean fisheries from Alaska to Oregon that are part of the environmental baseline. They are also caught in fisheries in the mainstem Columbia River. Freshwater fisheries occur outside the action area and were therefore considered as part of the overall assessment of the species status. Inriver fisheries are currently managed subject to an abundance based harvest rate limit that ranges from 21.5 percent to 45 percent (NMFS 2018a). Harvest rates have averaged 33.9 percent since 2009 when the current management framework was first implement.

Marine area fisheries have been managed since the mid-1990's to achieve a 30 percent reduction relative to the 1988 to 1993 base period. The 30 percent reduction standard is reported as a proportion (referred to as the Snake River fall-run Chinook index (SRFI)). A 30 percent reduction in the average base period ER equates to an index value of 0.70. Post season estimates of the index averaged 0.51 since 1994 indicating that ocean exploitation rates have been reduced over the long term by nearly half (Figure 33).

The retrospective analysis was used characterize the effects of the proposed actions including in particular the ongoing delegation of management authority to the State of Alaska. Results of the retrospective analysis are described in Section 2.5.2. Scenario 1 provides estimates of the ERs that occurred since 1999 under the prior two PST Agreements. Scenario 2 provides estimates of the ERs that would have occurred in those same years if they had been managed subject to the terms of the 2019 Agreement. The ER in the SEAK fishery averaged 2.0 percent in Scenario 1 and 1.7 percent in Scenario 2 (Table 51). Exploitation rates in the marine area fisheries in the action area would be reduced from 38.9 percent under Scenario 1 to 34.4 percent in Scenario 2 (Table 51). Snake River fall-run Chinook salmon are present in the SEAK fishery, but a relatively small proportion (5.1%) of the marine area fishery impacts occur in the SEAK fishery (Figure 35). The analysis indicates that harvest of Snake River fall-run Chinook salmon in the action area would be reduced as intended by the Agreement.

The 40 percent Abundance Decline scenario (Scenario 4) assumes that the overall abundance of Chinook salmon in the ocean is reduced significantly. A comparison of the results from scenarios 2 and 4 is designed to assess how the Agreement would respond to a major reduction in abundance in terms of its likely effect on stock specific ERs. The ER in the SEAK fishery averaged 1.7 percent in Scenario 2 and 1.5 percent in Scenario 4 (Table 53). Exploitation rates in the marine area fisheries in the action area would be reduced from 34.6 percent under Scenario 2 to 33.6 percent in Scenario 4 (Table 53). The relative change in ER in the SEAK and marine area fisheries are -11.7 percent and -2.5 percent, respectively.

The analysis indicates that exploitation rates would be reduced in response to a significant decline in overall abundance due to reductions in ERs in AABM fisheries as the Abundance Indices decline. This would also result in a proportional reduction in catch that is greater than the corresponding reduction in abundance. This indicates that provisions of the Agreement related to the SEAK fishery in particular and fisheries in the action area in general would be responsive to significant reductions in abundance. In addition, it is worth noting, that the Retrospective Analysis did not try to anticipate additional fishery reductions that would likely be required in the southern marine area fisheries or freshwater fisheries to respond to the stock specific circumstances that would accompany an overall reduction in abundance that is on the order of 40 percent.

As discussed is Section 2.2.5, the status of Snake River fall-run Chinook salmon is likely to be affected by changes in climate. Climate change is expected to impact Pacific Northwest anadromous fish during all stages of their complex life cycle. The magnitude and timing of the effects to Snake River fall-run Chinook salmon are uncertain, but it is reasonable to expect that the effects will be negative. As indicated in the recovery plan (NMFS 2017f) and elsewhere, it is essential that we make continued progress on all fronts to address factors that are limiting the status of Snake River fall-run Chinook so that the species improves and is more resilient to the challenges of climate change. Harvest management systems are no exception. They too must be flexible and able to respond to future circumstances. In particular, it is important that harvest management be responsive to changes in abundance. As indicated in section 1.3, the fishery management regime is designed to be responsive to significant changes in the productivity of Chinook salmon stocks associated with environmental conditions. In this opinion, we focus on the proposed actions and how the SEAK fishery in particular would respond to changing circumstances. The Retrospective Analysis, and our consideration of Scenario 4, indicates that the management framework contained in the Agreement would be responsive to a significant reduction in abundance (e.g., 40 percent), a reduction that is beyond what we can reasonably expect to see over the ten year term of the Agreement.

Cumulative effects are future state and private activities that are reasonably certain to occur in the action area (see Section 2.6). Although inshore marine areas in Puget Sound are part of the action area, the distribution of Snake River fall-run Chinook salmon is such that they are not likely to be affected significantly by activities in Puget Sound. After review of the available information, NMFS did not identify any qualifying activities in offshore marine areas that are likely to influence Snake River fall-run Chinook salmon in a way that further informs NMFS' assessment of the proposed actions.

As indicated above, the status of Snake River fall-run Chinook has improved markedly since the time of listing and in recent years in particular. The single population is currently meeting the criteria for a rating of viable, although the ESU as a whole is not meeting the recovery goals described in the recovery plan for the species. Prior reductions in harvest that have occurred throughout their range have contributed to the species' improved status. The magnitude of harvest in the SEAK fishery that is the subject of the first two proposed actions is low (2.0 percent) and would be reduced further as a consequence of the proposed 2019 PST Agreement. This low level of harvest, especially in light of measures to limit harvest in other fisheries to the south outside of SEAK, is not likely to affect the status of this ESU.

Climate change and other factors may affect the abundance of Snake River fall-run Chinook in the future, and we expect that the direction of that change will ultimately be negative. However, the proposed management framework for the SEAK fishery and other marine and freshwater fisheries to the south are designed to be responsive to changes in abundance. The retrospective analysis indicates that the SEAK fishery would be responsive to those changes in overall abundance, even a significant change that goes beyond what we can reasonably expect to occur over the ten year term of the new agreement.

After reviewing and analyzing 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 appreciably reduce the likelihood of both survival and recovery of the Snake River fall-run Chinook Salmon ESU or destroy or adversely modify its designated critical habitat.

2.7.4 Puget Sound Chinook Salmon

The Puget Sound Chinook salmon ESU has a complex population structure that is described in more detail in section 2.2.2.4. There are 22 extant populations grouped into five major geographic regions, based on consideration of historic distribution, geographic isolation, dispersal rates, genetic data, life history information, population dynamics, and environmental and ecological diversity (Table 28). The populations are aggregated into 14 management units (Table 36) for management purposes and, in part, because of similarities in the marine distribution of neighboring populations in a single basin. For example the North Fork Nooksack and South Fork Nooksack populations are combined into one management unit. Because of differences in run timing and life history, the management units are subject to very different patterns of harvest.

In this summary of considerations we need to distinguish between the effects of the SEAK fishery that are the subject of the first two proposed actions – delegation of management authority and funding for management of the fisheries, and the effects of the third proposed action, the conservation funding initiative. In this section we focus on five of the 14 Puget Sound management units that are subject to higher ERs in the SEAK fishery and thereby seek to focus the discussion on the management units that are subject to the greatest impact. This includes the Nooksack, Skagit River summer/fall, Stillaguamish, Dungeness, and Elwha management units. Populations in these units are all subject to ERs in the SEAK fishery that range from of 1.4 percent to 8.3 percent (Table 37). The proportion of marine area harvest that occurs in the SEAK fishery for these populations is also higher than for other populations in the ESU ranging from 8.3 percent to 20.3 percent (Table 38). ERs on the nine other management units in the SEAK fishery are quite low ranging from 0.1 to 0.5 percent (Table 37). The proportion of marine area harvest that occurs in the SEAK fishery for these management units is also quite low ranging from 0.1 percent to 2.2 percent (Table 38).

The effects of harvest as a limiting factor to Puget Sound Chinook salmon began to decline even before they were listed in 1999. Estimates of harvest available from the 2008 biological opinion on the 2009 PST Agreement summarize the long term trends in ER through 2006 (NMFS 2008d). Exploitation rates on the Dungeness and Elwha Chinook salmon populations in the Strait of Juan de Fuca region averaged 53 percent from 1987 to 1997 and 28 percent from 1998 to 2006 ERs on Strait of Juan de Fuca and Mid-Hood Canal Chinook salmon populations have declined since the early 1990s. Total ERs for Strait of Juan de Fuca populations, which averaged 25 percent from 1992 to 1994, have since decreased to an average of 14 percent between 2009 and

2016 (Figure 12). Total ERs for the Mid-Hood Canal population averaged 41 percent between 1992 and 1994 but have since decreased to an average of 23 percent between 2009 and 2016 (Figure 12). Total ERs for the Skokomish population averaged 58 percent between 1992 and 1994. After a period of decline through 2000 where the ER averaged 31 percent, the ER on the Skokomish population increased and has since been similar to the levels observed in the early 1990s. Exploitation rates on the Nooksack populations from the Georgia Basin declined from an average of 30 percent from 1983 to 1997 to 21 percent thereafter (Figure 13). Total ERs for Stillaguamish Chinook salmon and Skagit River summer/fall stocks averaged 46 percent and 57 percent respectively, compared to rates of 23 percent and 40 percent thereafter (Figure 13). For these five management units, the majority of harvest impacts occurred in fisheries to the north of the U.S. border, particularly in Canada. The proportion of the total harvest that occurs in northern fisheries ranges from 66 percent for the Skagit summer/fall populations to 84 percent for the Nooksack (Table 38).

In this opinion we have used the retrospective analysis to help characterize the effects of the SEAK fishery. Results of the retrospective analysis are described in Section 2.5.2. Scenario 1 provides estimates of the ERs that occurred since 1999 under the prior two PST Agreements. Scenario 2 provides estimates of the ERs that would have occurred in those same years if they had been managed subject to the terms of the 2019 Agreement.

For Stillaguamish Chinook, the ER in the SEAK fishery averaged 1.9 percent in Scenario 1 and 1.7 percent in Scenario 2 (Table 75). The retrospective analysis indicates that exploitation rates in the action area would be reduced from 23.3 percent under Scenario 1 to 18.6 percent in Scenario 2 (Table 75). Stillaguamish Chinook caught in the SEAK fishery account for 8.3 percent of the fishery impacts (Table 38). The analysis indicates that harvest of Stillaguamish Chinook in the action area would be reduced as intended by the Agreement.

The 40 percent Abundance Decline scenario (Scenario 4) assumes that the overall abundance of Chinook salmon in the ocean is reduced significantly. A comparison of the results from scenarios 2 and 4 is designed to assess how the Agreement would respond to a major reduction in abundance in terms of its likely effect on stock specific ERs. The ER in the SEAK fishery for Stillaguamish Chinook averaged 1.7 percent in Scenario 2 and 1.5 percent in Scenario 4 (Table 77). Exploitation rates in the action area would be reduced from 18.6 percent under Scenario 2 to 17.8 percent in Scenario 4 (Table 77). The relative change in ER in the SEAK and action fisheries are -10.7 percent and -4.0 percent, respectively.

The preceding discussion briefly summarizes the results of the retrospective analysis for Stillaguamish Chinook. Results for the Dungeness, Elwha, Nooksack and Skagit summer/fall are substantively the same. Rather than repeating the numerical results for these management units here, we refer back to the results that are described in more detail in the Effects section 2.5.2.4.

Past effects of hatchery programs that may be ongoing due to prior funding actions are captured in the environmental baseline section of this biological opinion for freshwater area of Puget Sound that are included in the description of the Action Area (Section 2.3). As described above, the funding initiative that comprises the third component of the proposed action is expected to be used in part for additional production in conservation hatchery programs in the Dungeness, Stillaguamish, Nooksack, and Mid-Hood Canal watersheds. There are ongoing conservation hatchery programs for the Dungeness, Stillaguamish, and Nooksack management units and those are proposed to continue and to be enhanced through the funding initiative. A new program is proposed through the conservation funding initiative for the Hood Canal management unit. While we anticipate subsequent site-specific biological opinions will fully analyze the effects of this additional production, for purposes of this consultation we evaluated our general expectation of the likely effects of providing funding to operate conservation Chinook salmon programs in these watersheds. In general, the four hatchery programs expected to be funded as part of the third component of the proposed action will supplement the number and spatial distribution of naturally spawning fish with hatchery adults returns. We anticipate each program will remove natural-origin fish for hatchery broodstock, and therefore range in effect from neutral to negative for each population based on the eventual size of each program (independently based on the level of funding awarded) including encountering wild fish during broodstock collection. In the case of genetic effects, within-population diversity is a minor concern. Although the site specific details for each program will be considered once the programs are fully described, we generally expect that outbreeding effects from straying will be minor due to the use of locally derived hatchery broodstock limiting the size of the programs. However, for intra-population genetic effects from the likely programs we expect high levels of pHOS and PNI to be low, at least in the short term, but the benefits of the programs in reducing extinction risk offset this. We expect ecological effects to be positive for each hatchery program as each will increase marine-derived nutrient inputs that would be at much lower levels without the additional hatchery adults. The potential for competition and predation when the progeny of naturally spawning hatchery fish and hatchery releases share juvenile rearing areas is expected to range from neutral or negligible to negative. Our expectation is the effects from potential disease transmission are neutral to negligible and will be mitigated to a certain extent by maximizing the potential acclimation possibilities. We do not expect effects above baseline levels to critical habitat within these watersheds since we anticipate the programs utilizing current facilities, but if new construction is performed as a result of a high level of funding awards it would have short term neutral to negative effects.

Additionally, as part of the conservation funding initiative, habitat restoration funding designed to address limiting habitat conditions for these four populations, in particular, is aimed at making progress toward recovery by improving abundance and productivity. Projects that may target other populations will have similar benefits. These projects are clearly intended to be beneficial, but the benefits need to be weighed against any adverse effects that may occur. Projects proposed under the habitat restoration program will be reviewed in detail once the project and site-specific details become available using the processes and consideration described in Section 2.5.3.2. However, we generally expect that the adverse effects will be limited because: (1) effects from construction-related activities are short-term and temporary, (2) a very small portion of the total number of fish in any one population will be exposed to the adverse effects of the proposed action, and (3) the geographic extent of the adverse effects is small when compared to the size of any watershed where an action will occur or the total area occupied by any of the species affected.

As discussed is Section 2.2.5, the status of Puget Sound Chinook salmon is likely to be affected by changes in climate. Climate change is expected to impact Pacific Northwest anadromous fish during all stages of their complex life cycle. The magnitude and timing of the effects to Puget Sound Chinook salmon are uncertain, but it is reasonable to expect that the effects will be negative. As indicated in the recovery plan and elsewhere, it is essential that we make continued progress on all fronts to address factors that are limiting the status of Puget Sound Chinook salmon so that the species improves and is more resilient to the challenges of climate change. Harvest management systems are no exception. They too must be flexible and able to respond to future circumstances. In particular, it is important that harvest management be responsive to changes in abundance. As indicated in Section 1.3, the fishery management regime is designed to be responsive to significant changes in the productivity of Chinook salmon stocks associated with environmental conditions. In this opinion, we focus on the proposed actions and how the SEAK fishery in particular would respond to changing circumstances. The Retrospective Analysis, and our consideration of Scenario 4, indicates that the management framework contained in the Agreement would be responsive to a significant reduction in abundance (e.g., 40 percent), a reduction that exceeds what we can reasonably expect to see over the ten year term of the Agreement.

Cumulative effects are future state and private activities that are reasonably certain to occur in the action area (see Section 2.6). After review of the available information, NMFS did not identify any qualifying activities in offshore marine areas that are likely to influence Puget Sound Chinook salmon in a way that further informs NMFS' assessment of the proposed actions.

Designated critical habitat for Puget Sound Chinook salmon includes estuarine areas and river reaches in specified subbasins. It also includes nearshore areas out to a depth of 30 meters adjacent to these subbasins, but does not otherwise include offshore marine areas in Puget Sound or in the ocean (see section 2.2.4.1). As a consequence there is some overlap between the action area that is specified in section 2.3 and critical habitat for Puget Sound Chinook salmon. The overlap occurs in the nearshore marine areas in Puget Sound and the watersheds and tributaries of the Nooksack, Stillaguamish, Dungeness, and Mid-Hood Canal management units. In Section 2.5.2.4 we describe the effects on Puget Sound Chinook from the first two parts of the proposed action and concluded that fishing in SEAK that occurs as a result of those actions will have no effects to critical habitat. The effects of projects implemented as a result of the third proposed action, the conservation initiative, will be reviewed once the details of the site specific projects are known using the procedures and considerations described in Section 2.5.3. However, we conclude that the adverse effects are likely to be limited because: (1) effects from construction-related activities are short-term and temporary, (2) a very small portion of the total number of fish in any one population will be exposed to the adverse effects of the proposed action, and (3) the geographic extent of the adverse effects is small when compared to the size of any watershed where an action will occur or the total area occupied by any of the species affected. Any adverse effects that may occur will be offset by the beneficial effects of the hatchery and habitat conservation projects that designed to promote survival and recovery.

In summary, we consider in this opinion the effects of the SEAK fishery that are the subject of the first two proposed actions and the effects of the conservation funding initiative. Exploitation rates in the SEAK fishery for nine of the 14 management units in Puget Sound are quite low ranging between 0.1 percent and 0.5 percent. Exploitation rates for the other five management units range from 1.4 percent (Dungeness and Elwha) to 8.3 percent (Skagit River summer/fall).

Exploitation rates for the Stillaguamish and Nooksack have averaged 1.9 percent and 4.1 percent, respectively (Table 37). The exploitation rate on the Skagit River summer/fall management unit in the SEAK fishery has been higher than for the others, but this is also one of the stronghold management units in the ESU with escapements that routinely approach or exceed rebuilding escapement thresholds (Table 29). Exploitation rates for all of the management units will be reduced further, though modestly, as a consequence of changes to the SEAK fishery under the proposed 2019 PST Agreement. Four of the management units will also benefit directly from projects implemented through the conservation funding initiative, through both habitat restoration projects and additional conservation-oriented hatchery production. Adverse effects of the habitat projects are expected to be minor and temporary. In the long term, these habitat projects are expected to result in increased abundance and productivity of the affected management units. Additional hatchery production for the four management units of concern will also likely have some adverse effects as described above but greater conservation benefits to the four management units are expected. Taken together, the adverse effects of the proposed actions are relatively small, and positive effects are expected to result from the conservation funding.

Climate change and other factors in the environmental baseline and cumulative effects may negatively affect the status of Puget Sound Chinook salmon in the future, however, the proposed management framework for the SEAK fishery and other marine and freshwater fisheries to the south are designed to be responsive to changes in abundance. The retrospective analysis indicates that the SEAK fishery would be responsive to those changes in overall abundance, even a significant change that goes beyond what we can reasonably expect to occur over the ten year term of the new agreement. Thus, given the relatively low effects of the SEAK fisheries to Puget Sound Chinook salmon, their responsiveness to changes in abundance, the relatively small adverse effects of the projects funded through the conservation initiative, and the expected benefits from those projects, we do not expect the proposed actions to reduce appreciably the likelihood of both the survival and recovery of the Puget Sound Chinook Salmon ESU.

Effects to critical habitat from the proposed actions, specifically the conservation funding initiative, would vary in degree because of differences in the scope of construction for each project and the current condition of PCEs and the factors responsible for those conditions. However, we expect most adverse effects to be relatively minor and temporary in duration. As we receive detailed plans for individual projects, we will consider whether each project fits within the parameters of our prior programmatic consultation on such projects, or whether it requires an individual consultation (NMFS 2017d). But at this programmatic level, we do not expect adverse effects to appreciably diminish the value of critical habitat for the conservation of Puget Sound Chinook, and in fact we expect the habitat restoration projects to improve that value.

After reviewing and analyzing 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 appreciably reduce the likelihood of both survival and recovery of the Puget Sound Chinook Salmon ESU or destroy or adversely modify its designated critical habitat.

2.7.5 Southern Resident Killer Whales

This section discusses the effects of the action in the context of the status of the species and designated critical habitat, the environmental baseline, and cumulative effects, and offers our opinion as to whether the effects of the proposed actions are likely to jeopardize the continued existence of the Southern Residents or adversely modify or destroy Southern Residents' designated critical habitat.

The Southern Resident killer whale DPS is composed of one small population that is currently at most half of its likely previous size (140 to an unknown upper bound). We have high confidence in the annual census and population trends. The overall population increased slightly from 2002 to 2010 (from 83 whales to 86 whales). Since then, the population has decreased to only 74 whales, a historical low in the last 30 years. Based on an updated pedigree from new genetic data, most of the offspring in recent years were sired by two fathers, meaning that less than 30 individuals make up the effective reproducing portion of the population. Some offspring were the result of matings within the same pod raising questions and concerns about inbreeding effects.

The NWFSC continues to evaluate changes in fecundity and mortality rates, and has updated their population viability analyses. The data now suggest a downward trend in population growth projected over the next 50 years and the uncertainty in the projections increases the further out the analysis projects. This downward trend is in part due to the changing age and sex structure of the population, but also related to the relatively low fecundity rate observed over the period from 2011 to 2016. With such a small population, even small changes in this rate and other parameters can affect the projections.

Several factors identified in the final recovery plan for Southern Residents may be limiting recovery. These are quantity and quality of prey, toxic chemicals that accumulate in top predators, and disturbance from sound and vessels. Oil spills are also a risk factor. It is likely that multiple threats are acting together. New comparisons of the contribution of different threats (Lacy et al. 2017), support an approach to address all of the threats.

Critical habitat includes approximately 2,560 square miles of inland waters of Washington in three specific areas: 1) the Summer Core Area in Haro Strait and waters around the San Juan Islands; 2) Puget Sound; and 3) the Strait of Juan de Fuca. Based on the natural history of the Southern Residents and their habitat needs, we identified three physical or biological features essential to conservation in designating critical habitat: (1) Water quality to support growth of the whale population and development of individual whales, (2) Prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth, and (3) Passage conditions to allow for migration, resting and foraging. Revisions to the critical habitat designation to include coastal areas are currently in development. The proposed action for this opinion has the potential to affect prey quantity and availability.

During the late spring, summer, and early fall months, the whales spend a substantial amount of time in the inland waters of Washington, with strong site fidelity shown to the region as a whole and high occurrence in the San Juan Island area. In the winter and spring, several sightings, acoustic recordings, and satellite tracks have been obtained in the coastal waters of the action area. We have high confidence in the data on distribution, particularly in inland waters in summer months and have updated the information in our analysis regarding where the whales spend their time. Although less is known about the diet in coastal waters in the winter and spring compared to the diet in inland waters in the summer, over a decade of scale, tissue and more recent fecal sampling give us high confidence that the whales' diet consists of a high percentage of Chinook salmon throughout their geographic range. Moreover, NOAA Fisheries and WDFW recently released a priority stock report identifying the Chinook salmon stocks believed to be of most importance to the health of the Southern Resident populations along the West Coast (NOAA and WDFW 2018).

When prey is scarce, Southern Residents likely spend more time foraging than when prey is plentiful. Increased energy expenditure and prey limitation can cause poor body condition and nutritional stress. Nutritional stress is the condition of being unable to acquire adequate energy and nutrients from prey resources. Since 2008, aerial photogrammetry studies from SWFSC and partners have been used to assess the body condition and the health of Southern Resident killer whales. More recent annual aerial surveys of the population have provided evidence of a general decline in Southern Resident killer whale body condition since 2008, and documented members of J pod being in poorer body condition in May compared to September. Although body condition in whales can be influenced by a number of factors, including disease, physiological or life history status, prey limitation is the most likely cause of observed changes in body condition in wild mammalian populations. The methods for detecting changes in body condition have been well established and we will continue to refine our understanding of annual and seasonal changes as indicators of the nutritional status and overall health of individual whales and the status of the population. Additional studies to link body condition to mortality, reproduction and variables, such as Chinook salmon abundance, are ongoing and may provide new tools for evaluating changes in actions, including fisheries, which affect prey abundance for the whales.

Under the existing management and recovery regimes over the last decade, salmon availability has not been sufficient to support Southern Resident population growth. Several studies have found correlations between Chinook salmon indices and Southern Resident killer whale demographic rates (e.g. high Chinook abundance coupled with high Southern Resident killer whale growth rates). Recent evidence has indicated the whales have experienced several miscarriages, particularly in late pregnancy; this reduced fecundity was suggested to be largely due to nutritional limitation but we are not able to quantify effects to reproduction from changes in Chinook salmon abundance. There are several challenges to this relationship and uncertainty remains because of demographic stochasticity. The small population size makes correlating births and deaths with salmon abundance challenging and the whales are long-lived making it more challenging to predict interactions with the environment. There are other primary threats that can also influence demographic rates, uncertainties in the annual Chinook salmon abundance estimates, and no clear quantitative metric for assessing prey accessibility (i.e., abundance and availability) to the whales. A recent population viability assessment found that over the range of scenarios tested, the effects of prey abundance on fecundity and survival had the largest impact on the population growth rate (Lacy et al. 2017).

Following the independent science panel approach on the effects of salmon fisheries on Southern Resident killer whales (Hilborn et al. 2012), NMFS and partners have actively engaged in research and analyses to fill gaps and reduce uncertainties raised by the panel in their report. While in the past we have used correlations to estimate the effects of an action on population growth (NMFS 2011a), the data and analyses do not currently support a quantitative process for killer whales that directly links effects of an action, such as a reduction in prey, to survival and recovery (i.e., mortality and reproduction). In the absence of a comprehensive quantitative tool to evaluate proposed actions, we use a weight of evidence approach to consider all of the information we have- identifying a variety of metrics or indicators (some quantitative and some qualitative) with varying degrees of confidence (or weight)- in order to formulate our biological opinions.

Based on the biological information described in the Status and Environmental Baseline sections, our effects analysis focused on the likely reduction in Chinook prey available to the whales as a result of the SEAK fisheries in the short and long term. To put those reductions in context, we assessed how the proposed SEAK fisheries compared to past fisheries, considered the ratio of Chinook prey available compared to the whales' Chinook needs, and evaluated effects of the SEAK fisheries with respect to priority prey stocks. As described in the Effects Section, we focused our analysis on those periods and locations where the reduction in available prey from the SEAK fisheries would be measurable or the ratio of prey available compared to prey needed appears to be relatively small. These areas include the coastal and inland waters during July through September and in coastal waters during October through April.

Under the 2019 Agreement, the SEAK fisheries catch will be reduced in most cases by 7.5% relative to what was allowed in the 2009 Agreement. In the WCVI fishery, in most cases, catch will be reduced by 12.5% relative to what was allowed in the 2009 Agreement. Because of these reductions to harvest, we anticipate reduced effects to prey availability under the 2019 Agreement than under the previous regime.

Fisheries in the environmental baseline also affect prey availability for the whales as described under past PST Agreements in the Environmental Baseline section and under the 2019 Agreement in the Effects section of this opinion. Based on the FRAM retrospective analysis of the baseline fisheries (Canadian and U.S. fisheries without the SEAK fisheries), if the future Chinook salmon abundance levels are similar to those observed from 1999-2014, under the 2019 Agreement the baseline fisheries would result in meaningful reductions in prey availability and the largest reductions in prey availability would occur during July through September. Under the 2019 Agreement, we anticipate the Canadian fisheries would reduce prey availability in coastal waters by 0.1% to 13.2%. Similar reductions from Canadian fisheries would occur in inland waters, ranging from 0.2% to 12.9%. Although percent reductions from Canadian fisheries in coastal and inland waters have similar ranges, the reductions in coastal waters would be spread out over a larger area, and thus might differ in their effects on prey availability. Of the U.S. fisheries, the PFMC fisheries would reduce prey available to the whales substantially in coastal waters during July – September (4.8% - 14.8%) and minimally in October – April (less than 1%), whereas reductions from the PFMC fisheries in inland waters would range up to 3.0%. Puget Sound fisheries would reduce prey in coastal waters by less than 1% in all seasons and would have a greater impact on prey availability in inland waters during July – September than the

PFMC fisheries (reducing prey by up to 8.1%).

During the months of July through September, the SEAK fisheries are expected to reduce the abundance of prey by 1.0% - 2.5% in inland waters and by up to 12.9% in coastal waters, however, the higher reductions occur when the whales are less often observed in coastal waters. The highest percent reduction (12.9%) only occurred in one year for the range of abundance evaluated in the retrospective analysis and we would expect reductions to be lower for most years in the future (all other years were below 8% reductions). During October through April in coastal waters when the whales are more often present, the SEAK fisheries would reduce prey availability by 0.2 – 1.1%. These are improvements over the impact of the SEAK fisheries in the past. For example, under the prior agreements, the SEAK fisheries reduced prey availability in coastal waters by up to 15.1% in July through September (compared to up to 12.9%) and in inland waters in July through September by 2.9% (compared to up to 2.5%) (Table 41). The reduction in food energy in the coastal and inland waters applies to broad areas with varying overlap with the whales. The reduction in prey is calculated using a robust model, but it is extremely unlikely that the whales would have consumed all fish caught in the fishery absent the action. It is difficult to assess how reductions in prey abundance may vary throughout inland and coastal waters and have low confidence in our understanding of how reductions from SEAK fisheries could result in localized depletions later in time and far away from where the fisheries occur. Percent reductions would have greater impacts in years of low Chinook salmon abundance.

We also estimated the Chinook food energy available to the whales and compared available kilocalories to needs and evaluated the ratio after reductions from the proposed SEAK fisheries. We have low confidence in the ratios, but consider them as an indicator to help focus our analysis on the time and location where prey availability may be lowest and where the action may have the most significant effect on the whales. We have used updated information to refine the bioenergetics including metabolic needs of the whales and caloric content of different runs of Chinook salmon. We have medium level confidence in the metabolic needs estimates for the whales since they have not yet been validated by prey consumption rates and use the maximum estimates which may be an overestimate.

Because the ratios of Chinook prey available to meet the whales' needs are relatively low for inland waters during July through September compared to ratios in October through June, and relatively low for coastal waters during October through April compared to ratios in May through September, any additional measurable reduction during these times and areas is a concern. The baseline ratios ranged between 8.9 and 17.4 times the whales' estimated needs during July through September in inland waters, and with the proposed fishing the ratios would reduce the available prey and lower the ratio of available prey compared to the whales needs to between 8.7 and 17.1. The baseline ratios in coastal waters would be expected to be lowest during October through April (ranging between 7.8 to 24.7 times the whales' estimated needs), and the proposed fishing would reduce the ratios by a small amount. The largest changes in forage ratios expected from the SEAK fisheries would occur in coastal waters during July through September (ratios ranging from 38.7 to 136.5 with the action and 46.1 to 143.8 without the action). Although the whales spend a substantial amount of time in the inland waterways during this time when coastal prey would be most affected, the whales' distribution patterns may be changing with whales spending more time in coastal waters during the summer than in previous years thus the reductions from the SEAK fisheries may affect the whales more than in the past.

Lastly, we compared the Chinook salmon stocks caught in the SEAK fisheries with the priority stocks identified. With the exception of the Columbia River brights, the largest stocks contributing to the SEAK fisheries catch are currently not considered at the top of the priority prey list for SRKWs (NOAA and WDFW 2018). The stocks ranked high on the priority list (e.g. Puget Sound Chinook salmon and lower Columbia River fall stocks) make up a smaller proportion of the fishery catch (approximately 2 to 3 percent of the total catch for the SEAK fisheries) and catch a relatively lower proportion of the total run size of those stocks.

In addition to the reductions in prey, we also considered potential long-term impacts on Chinook salmon. This Opinion concludes that the action will not jeopardize the listed salmon that the whales depend on over the long term. Although unlikely to occur, in evaluating a potential 40 percent reduction in overall salmon abundance, the analysis on fishery impacts for salmon indicates that the management regime would compensate for reduced abundance as intended. However, we note that these changes to the management regime do not necessarily fully offset reductions in prey availability to the whales because the percent reductions in prey availability from the SEAK fisheries do not always change in proportion to the overall reduction in abundance of Chinook salmon. For example, on several occasions when the abundance of Chinook salmon was relatively low (e.g. 2007), fisheries had larger percentage impacts to prey availability (12.9%) than in higher abundance years.

Our evaluation of long-term impacts also included the proposed mitigation package intended to address key conservation concerns for Puget Sound Chinook salmon and SRKW through hatchery production and habitat restoration. Results of the analysis suggest that with the annual funding of 5 million dollars, approximately 20 million Chinook smolts can be produced and increase prey abundance by 4-5% in both inland waters in the summer and in coastal waters in the winter and spring. This potential increase in inland waters helps to offset some of the reduction in prey abundance from fisheries managed under the PST including SEAK fisheries as well as the baseline fisheries. As described above, in July – September SEAK fisheries will remove 0.1% – 2.5% in designated critical habitat during a period of relatively low prey availability. The potential increase in hatchery production of Chinook salmon would include stocks overlapping in time and space with the whales during the winter and spring (October through May) when it is thought prey is most limiting supports the stocks considered a higher priority (NOAA and WDFW 2018). The increased hatchery production will provide additional prey and more foraging opportunities during this period of the year when prey availability is low.

As described above, contributions of hatchery production to the prey base will be available to the whales several years after fish are released and have matured into older, larger adults. However, we anticipate over the long term, the abundance of Chinook will be similar to that observed in the retrospective analysis, with some low abundance years and high abundance years spread throughout the next decade. We also anticipate the proposed SEAK fisheries could result in a range of 0.2% to 12.9% reduction in the prey available to the whales in their coastal range and 0.1% to 2.5% in their inland range throughout the next decade. We do not anticipate that the highest impacts of the fisheries coupled with multiple consecutive low abundance years will occur in the first few years of the proposed action during the period of maturation of hatchery salmon, but rather spread out over the course of the decade.

It will be important to monitor and evaluate the effectiveness of actions from the mitigation to ensure they are effective in increasing prey available to the whales. Habitat actions would also support increased availability of Puget Sound Chinook available to the whales in coastal and inland waters although we were not able to quantify how those increases might offset fishery harvest in the fisheries managed under the PST. NMFS has been developing a risk assessment framework relating Chinook salmon abundance to Southern Resident killer whale population dynamics that will help evaluate the impacts of salmon management on the whales. At this time, development of the framework is on a coast-wide scale and intended for broad applicability across actions that impact salmon. NMFS' work to develop the risk assessment for this purpose currently remains ongoing.

Critical habitat includes water quality, prey and passage as features that are essential to the conservation of Southern Residents. We do not expect the SEAK fisheries or mitigation funding to impact water quality or passage, however, we do expect the fisheries to affect the availability of prey, as described above. The reductions of age 3-5 Chinook salmon in designated critical habitat from the SEAK fisheries will range from 0.1% – 2.5%, with the greatest reductions expected to occur in July – September when the forage ratio is relatively low. This impact to critical habitat may cause Southern Residents to spend more time foraging than when prey is plentiful and increase the risk of poor body condition and nutritional stress. However, as mentioned the increase in hatchery production in inland waters from the proposed funding mitigation will offset some of the loss from PST fisheries, including SEAK harvest in July – September (an anticipated increase of 4% prey availability in critical habitat). This partial offset by hatchery production will likely take several years after fish are released to be fully realized because Southern Residents prefer to consume larger (i.e. older) Chinook salmon. During the time it takes for these hatchery fish to return as adults to critical habitat areas, the proposed fishing is likely to adversely affect designated critical habitat. However, larger reductions in prey are not expected to occur in multiple consecutive years or in conjunction with low Chinook abundance in consecutive years during the period before we expect hatchery fish to be available as prey.

We have evaluated the best available information on the status of the species, the environmental baseline, the effects of the action and cumulative effects status of the whales. The status of the whales is compromised and multiple factors and threats are limiting their population growth. In summary, although the SEAK fisheries catch will be reduced by up to 7.5% relative to what was allowed under the 2009 Agreement, the effects of the action add a measurable adverse effect in addition to the existing conditions. The proposed SEAK fisheries could result in up to 12.9% reduction in the prey available to the whales in their coastal range, but this would likely occur rarely (most years the percent reduction is anticipated to be lower than 8%), during a time period when the whales are more often observed in inland waters, and is spread across a large area where the whales would not have access to all of the Chinook salmon or be expected to experience localized prey depletion. The larger percent reductions in prey (i.e., percent reductions at the higher end of the ranges estimated) in coastal and inland waters would have the biggest impact on the whales if they occur in low abundance years. With the exception of the Columbia River brights that have relatively large run sizes, the whales' priority stocks are not a high proportion of the SEAK fisheries catch. Due to the mitigation funding, the loss of prey availability from PST harvest, both Canadian and all U.S. salmon fisheries, including the SEAK fisheries, will be partially offset by increased hatchery production in their designated critical habitat. Although there is a gap between increasing hatchery production and increased prey availability, we anticipate the impacts from multiple consecutive low abundance years coupled with relatively large percent reductions to be spread throughout the course of the decade and not compacted into the first few years of the proposed action. The hatchery production will increase abundance of Chinook salmon in coastal and inland waters, which will reduce impacts from the action during times of low prey availability for the whales. Habitat mitigation will also support increases in prey availability over a longer time frame. In addition, starting in 2018 additional protective measures in U.S. and Canadian waters are being implemented to reduce impacts from fisheries and vessels in key foraging areas. Additional protections are under consideration as part of the WA Governor's Task Force recommendations and other ongoing recovery programs. The whales have declined in recent years likely in part due to reduced prey. The reductions in harvest levels in SEAK fisheries and other fisheries under the 2019 PST Agreement in addition to hatchery and harvest mitigation as part of this and other recovery actions are intended to improve the overall conditions for the whales' Chinook salmon prey, increase prey abundance available to the whales, and reduce impacts to the whales' survival and reproduction.

After reviewing and analyzing 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 appreciably reduce the likelihood of both survival and recovery of Southern Resident killer whales or destroy or adversely modify their designated critical habitat. In addition, the action will not jeopardize the listed salmon that the whales depend on over the long term. We will continue to monitor the abundance of Chinook salmon prey, the condition and health of individual whales, and overall population status to evaluate the effectiveness of the proposed actions, including mitigation, along with other recovery actions, in improving conditions for listed Chinook salmon and Southern Resident killer whales compared to recent years.

2.7.6 Mexico DPS Humpback whales

The humpback whale was listed as endangered under the ESCA on December 2, 1970 (35 FR 18319). The original listing was because of past commercial whaling. Additional threats to the species include ship strikes, fisheries interactions (including entanglement) and noise. Since their initial listing, NMFS has conducted a global status review and changed the status of humpback whales under the ESA and recognized 14 DPSs of humpback whales (81 FR 62260; September 8, 2016). There is no critical habitat designated for the any of the listed humpback whale DPSs.

Humpback whales are present in the action area in all months of the year. All adverse effects to humpback whales from the proposed actions occur in SEAK waters; we do not anticipate adverse effects to humpbacks in coastal and inland waters off Washington and Oregon. The whales in SEAK waters may belong to the Hawaii DPS (not listed) or the Mexico DPS (threatened). The

Hawaii DPS is more common in SEAK waters and the probability of encountering a whale from this DPS is approximately 93.9%, whereas the probability of encountering a whale from the Mexico DPS is approximately 6.1%. The most current SARs for humpback whales (Carretta et al. 2018; Muto et al. 2018a) has not modified the MMPA definition of humpback whale stocks in response to the new ESA listings. Thus, CNP and CA/OR/WA stocks consist of humpbacks whales from the Mexico DPS and we refer to these stocks throughout our analysis.

A potential adverse effect of the SEAK fisheries on humpback whales is incidental capture or entanglement in salmon fishing gear in SEAK waters. Other potential impacts that are insignificant or discountable that could occur as a result of the proposed action include vessel collisions, impacts related to any pollution or marine debris generated by fishing vessels, and impacts to prey. Entanglement in fishing gear is a documented source of injury and mortality to humpback whales and may result in only minor injury or may potentially significantly affect individual health, reproduction, or survival (Fleming and Jackson 2011). In 2003 and 2004, at least 53% of humpback whales observed in SEAK showed some kind of scarring from entanglement (Neilson et al. 2005). Bettridge et al. (2015) report that fishing gear entanglements may moderately reduce the population size or the growth rate of the Mexico DPS.

When assessing the impact of proposed or ongoing projects on marine mammals under the MMPA, NMFS relies upon the concept of potential biological removal level, or PBR, to assist or guide decision making about acceptable or appropriate levels of impact that marine mammal stocks can withstand. As described in the MMPA, PBR[42] is defined as "the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population (OSP; 16 U.S.C. 1362 (20)." PBR is an approach developed to assess incidental take of marine mammals under the MMPA. It uses conservative minimum population estimates and a recovery factor based on the population status and is also comprehensive because it calculates take (total take) per stock. The underlying analysis supporting the PBR concept examined the impact of population removals for a period of 100 years in terms of the time delay in populations reaching carrying capacity. Given this long term simulation approach used to support this concept, the levels established under the PBR are most appropriate for examining the impact of annual average removals over a long period of time and are not an indicator of some point beyond which the stock could not reach OSP at all, over shorter time periods, or within a given year. It is important to note that while PBR serves as a useful metric for gauging the relative level of impact on marine mammal stocks as defined in the MMPA, PBR by itself does not equate to a species or population level assessment under the ESA where analyses are conducted at the level of the species as listed as threatened or endangered. However, the concept of managing impacts to marine mammal populations to levels that do not significantly affect recovery times shares the general intent of the jeopardy standard of the ESA in terms of looking at both the continued existence and recovery of a population. Therefore, we use the PBR concept from the MMPA to help characterize the relative impact of the SEAK fisheries on the Mexico DPS humpback whales likely to be adversely affected by the fishery, and then relate those findings to the species as a whole under the jeopardy standard of the ESA.

[42] Included in the 1994 amendments to the MMPA.

As has been described earlier in this biological opinion, the current stock structure for humpback whales as defined under the MMPA does not match up with the DPS structure as defined under the ESA, which presents challenges in directly relating between the two statutes. In keeping with our general convention to look at the status of marine mammal stocks under the MMPA to help inform our ESA analyses where appropriate (but not necessarily dictate the outcomes), we will review and incorporate information about current estimates of human impact relative to PBR from each MMPA stock that is relevant to the ESA-listed DPS to ultimately assist with characterizing the relative impact of the SEAK fisheries on the Mexico DPS humpback whales in our overall integration and synthesis of the anticipated effects from the proposed action on the ESA-listed DPS.

The PBR allocation for U.S. waters is 83 whales per year for the CNP stock and 16.7 for the CA/OR/WA stock (Carretta et al. 2018; Muto et al. 2018a). It is unlikely that the total level of human-caused mortality and serious injury (26) exceeds the PBR level for the CNP stock (Muto et al. 2018a); however, the minimum estimate of the mean annual U.S. commercial fishery-related mortality and serious injury rate for this stock (9.9 whales) is more than 10% of the calculated PBR for the entire stock and, therefore, cannot be considered to be insignificant and approaching a zero mortality and serious injury rate. Based on the probabilities of occurrence of humpback whales from each DPS in the North Pacific (Table 32), a small portion of this stock likely includes whales from the Mexico DPS. In contrast, the observed annual mortality and serious injury of CA/OR/WA humpback whales due to commercial fishery entanglements, non-fishery entanglements, recreational crab pot fisheries, serious injuries assigned to unidentified whale entanglements, plus observed ship strikes, equals 18.8 animals, which exceeds the PBR of 16.7 animals (Carretta et al. 2018). Mexico DPS humpback whales constitute a significant portion of the humpback whales in the CA/OR/WA stock, although the specific proportion varies along the coast (Wade et al. 2016). Observed annual humpback whale M/SI in commercial fisheries (14.1/yr.) is greater than 10% of the PBR; therefore, total fishery mortality and serious injury is not approaching zero mortality and serious injury rate (Carretta et al. 2018). This stock likely includes a significant proportion of whales from the Mexico DPS based on the probabilities of occurrence (Table 32). In total, it appears that Mexico DPS humpback whales have been experiencing relatively high rates of documented M/SI in some portions of their range, and relatively less in other portions including SEAK.

NMFS monitors bycatch of marine mammals in commercial fisheries by relying upon data provided by the use of fisheries observers, records obtained from marine mammal strandings, as well as directly from fisherman or other individuals. To date, there has been limited deployment of fisheries observers to collect data on marine mammal interactions in commercial SEAK salmon fisheries. Furthermore, strandings, entanglement, and interactions data are collected opportunistically and represent minimal totals of overall impacts.

We reviewed all the available information including the most recent SARs for CNP humpback whales, which provides a summary accounting of estimated human caused M/SI (Muto et al. 2018a). Given the data available, we assumed M/SI rates for humpback whale interactions with SEAK fisheries. In addition to those interactions that may not necessarily lead to M/SI, we also reviewed all reports of interactions and human caused strandings of CNP humpback whales that are documented and evaluated for M/SI in Helker et al. (2018), and AMMOP observer reports.

As described in the Status Section, we assumed approximately 6% of all humpback whale entanglements in SEAK salmon fisheries involve individuals from the Mexico DPS. We characterized the extent of interactions that may be anticipated by first describing the extent of fishing effort in various SEAK salmon fisheries, and then we considered how these fisheries operate in context with the available data on humpback whale distribution and their anticipated interactions with SEAK salmon fisheries. Lastly, we presented and outlined the available information in terms of the minimum levels of interactions and M/SI expected, as well as levels that are reasonably certain to occur, and also some less certain assessments of potential impacts that might be occurring for humpback whales in each SEAK salmon fishery.

Given the available data on humpback whale interactions with the SEAK fisheries, including from fishery observer coverage, we assume that there will be entanglements of humpback whales in the commercial SEAK drift gillnet fishery happening every year. We assume a minimum estimate of at least 0.51 Mexico DPS entanglements per year (0.44 M/SI annual rate) and we are reasonably certain up to 0.99 Mexico DPS entanglements happen per year (0.58 M/SI annual rate). While it's less certain, there is a possibility that approximately 3 interactions with Mexico DPS humpback whales occur per year (1.74 M/SI annual rate) given the assumed number of blow-throughs that may occur.

Entanglements of humpback whales with SEAK purse seine gear have been previously reported to NMFS. However, there has not been any observer coverage of this fishery to generate any local or regional estimates of humpback whale interactions similar to what was done in drift gillnet gear. We are reasonably certain there will be a small number of entanglements of humpback whales in the SEAK purse seine fishery, with a minimum estimate of 0.04 Mexico DPS entanglements per year (0.2 M/SI per year). Although less certain, it is a possibility that approximately 0.2 Mexico DPS whales interact with the fishery per year (0.08 M/SI per year).

There have not been any entanglements with humpbacks whales that have been attributed to SEAK set gillnet gear. There was some observer coverage of this fishery, but no humpback whale interactions were observed. Although there are limited data on humpback whale interactions in the SEAK set gillnet fishery, it is listed as a Category II on the LOF by analogy resulting in part from potential risks of interactions with humpback whales. Given the limited amount of data, we recognize that there is a risk for M/SI with this gear type that may be somewhat analogous to the drift gillnet fishery. As a result, we are reasonably certain that there are occasional humpback whale entanglements. Although less certain, we assume 0.06 Mexico DPS entanglements per year with a 0.04 Mexico DPS M/SI per year.

One incident has been reported to NMFS of a humpback whale being hooked and/or entangled with troll gear. There has not been any observer coverage of this fishery to generate any local or regional estimates of humpback whale interactions. Given this lone incident, we assume that the anticipated risk for M/SI from interactions between humpback whales and troll gear is very low, and we anticipate that M/SI resulting from a rare interaction with this gear will not occur. We assume a minimum of 0.01 Mexico DPS hooking/entanglements per year, and assume, with less certainty 0.06 Mexico DPS hooking/entanglements per year.

There are less data available on subsistence salmon fisheries in SEAK than for the commercial fisheries. In general, subsistence fisheries use the same gear types as commercial fisheries, with drift gillnet fishing in particular being a common gear type used. Distinguishing subsistence gear from commercial gear in SEAK humpback whale entanglements may be difficult. The limited data available suggest that subsistence fisheries constitute a smaller, but relatively substantial amount to the number of active fishing vessels using this gear at certain times in SEAK. We are reasonably certain that 0.34 Mexico DPS entanglements in the drift gillnet occur per year (0.20 M/SI annual rate), and an undefined number of occasional set gillnet entanglements occur over time. While it's less certain, there is a possibility that the subsistence interactions is about 1/3 of the commercial SEAK drift gillnet totals. We are also less certain that 0.06 Mexico DPS set gillnet entanglements occur per year (0.04 annual M/SI rate).

There have been two interactions with humpback whales reported to NMFS that may have involved recreational gear but neither resulted in serious injury. We assume these interactions that might have occurred with recreational salmon fishing in SEAK are rare. We are reasonably certain an undefined number of rare entanglements occur over time, at a minimum, we assume 0.17 hooking/entanglements occur in the recreational salmon fisheries. While it's less certain, there is a good possibility that 0.06 Mexico DPS hooking/entanglements occur per year.

In summary, we are reasonably certain that up to 2 Mexico DPS humpback whale interactions with all SEAK fisheries occur on average each year, including ~1 M/SI occurring on average each year, and we will authorize take of 2 Mexico DPS humpback whales per year. With respect to considering available information that is less certain, we could anticipate that up to 5 Mexico DPS interactions could occur on average each year from the SEAK fisheries, including up to 3 M/SI occurring on average each year. In our analysis, we assumed fishing effort under the 2019 Agreement will be similar to past fishing effort under the 2009 Agreement. However, as described in the Proposed Action, provisions of the 2019 Agreement result in reductions in catch in SEAK relative to those allowed under the 2009 Agreement. In the SEAK fisheries, in most cases, catch is reduced by 7.5 percent relative to what was allowed in the 2009 Agreement. Although this reduction in catch is specific to Chinook salmon fisheries, we anticipate reductions in the length of time SEAK fisheries are likely to be open under the 2019 Agreement in general if effort remains the same, as they will obtain expected lower catch limits under the same effort level in shorter durations, and our assumptions on impacts accrued are likely therefore a conservative assessment.

The most recent estimate of the abundance of Mexico DPS humpback whales is 3,264, and likely growing. Considering the prospect of 1 M/SI (reasonably certain) to 3 M/SI (less certain) from the population in any given year, this represents less than 0.1 percent (0.00031 – 0.00092) of the total Mexico DPS population during a single year. This is a very small proportion of the total population. In this biological opinion, we expect the SEAK fisheries will occur each year in the foreseeable future and likely at lower levels than we analyzed. Over the long-term, we expect that the Mexico DPS humpback whale population will lose at least 1, and possibly up to 3 individuals every year as a result of the proposed actions. However, any take over 2 Mexico DPS humpback whales per year would be unauthorized. Despite the relative high levels of M/SI that appear to be occurring in parts of the range of Mexico DPS humpback whales, the Mexico DPS population appears to be increasing, including impacts experience under the previous SEAK salmon fisheries regime. Ultimately we conclude that the level of impact that may be reasonably certain to occur, and even the less certain level of impact that could occur, would be undetectable for such a robust population that has been showing signs of improvement in recent decades, as indicated by the recent listing as threatened as opposed to the formal global listing as endangered.

After reviewing and analyzing 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's biological opinion that the proposed actions regarding the SEAK salmon fisheries are not likely to appreciably reduce the likelihood of both survival and recovery of the Mexico DPS of humpback whales.

2.7.7 Western DPS Steller sea lions

In 1997, NMFS reclassified Steller sea lions as two DPSs (62 FR 24345); at that time the eastern DPS was listed as threatened and the western DPS was listed as endangered. On November 4, 2013, the eastern DPS was removed from the endangered species list (78 FR 66139). Factors affecting the western DPS at the time of its listing included changes in the availability or quality of prey, removals of Steller sea lions from the wild, and possible adverse effects of contaminants was also noted. Additional threats to the species include environmental variability, competition with fisheries, predation by killer whales, toxic substances, incidental take due to interactions with active fishing gear, illegal shooting, entanglement in marine debris, disease and parasites, and disturbance from vessel traffic, tourism, and research activities. Using data collected through 2017, there is strong evidence that non-pup and pup counts of western DPS Steller sea lions in Alaska were at their lowest levels in 2002 and increased at ~2% per year between 2002 and 2017 (Muto et al. 2018a), although we recognize that recent counts in some areas have declined over the last few years (Sweeney et al. 2017). The minimum population estimate of Western DPS Steller sea lions in Alaska is 54,267 individuals and the minimum population estimate of the eastern DPS Steller sea lions is 41,638.

Within the SEAK portion of the action area, Steller sea lions are anticipated to be predominantly from the eastern DPS. However, studies have confirmed regularly occurring and temporary movement of Steller sea lions across the 144° W longitude boundary (Raum-Suryan et al. 2002; Pitcher et al. 2007; Fritz et al. 2013; Jemison et al. 2013a). A guidance memo issued by the NMFS Alaska Regional Office (NMFS 2013d) indicates that there is mixing of Western DPS Steller sea lions and Eastern DPS Steller sea lion east of Cape Suckling. The area of mixing is generally considered to include the area north of Sumner Strait, which is located in SEAK. Previously, NMFS has incorporated information on the movements and mixing rates of Western DPS Steller sea lions and Eastern Steller DPS sea lion in SEAK to support consultations on a number of proposed actions. To date, NMFS has not previously made any assumptions regarding the overall percentage of Steller sea lions throughout the entire mixing area in SEAK that are Western Steller sea lions. Given the most recent scientific information available, and the rates of mixing are extremely variable depending on location, we assume that a moderate mixing rate of 20% of all Steller sea lion interactions with SEAK salmon fisheries within the mixing area involve animals from the Western DPS.

A potential adverse effect of the SEAK fisheries on Western Steller sea lions is incidental capture or entanglement in salmon fishing gear in SEAK waters. Although the Steller Sea Lion Recovery Plan (NMFS 2008h) ranked interactions with fishing gear and marine debris as a low threat to the recovery of the WDPS, Helker et al. (2016) reported Steller sea lions to be the most common species of human-caused mortality and serious injury between 2011 and 2015. Because Eastern and Western DPS animals overlap in SEAK, some of the takes assigned to the Eastern DPS may have occurred to Western DPS animals.

When assessing the impact of proposed or ongoing projects on marine mammals under the MMPA, NMFS relies upon the concept of PBR to assist or guide decision making about acceptable or appropriate levels of impact that marine mammal stocks can withstand. It uses conservative minimum population estimates and a recovery factor based on the population status and is also comprehensive because it calculates take (total take) per stock. The underlying analysis supporting the PBR concept examined the impact of population removals for a period of 100 years in terms of the time delay in populations reaching carrying capacity. Given this long term simulation approach used to support this concept, the levels established under the PBR are most appropriate for examining the impact of annual average removals over a long period of time and are not an indicator of some point beyond which the stock could not reach OSP at all, over shorter time periods, or within a given year. It is important to note that while PBR serves as a useful metric for gauging the relative level of impact on marine mammal stocks as defined in the MMPA, PBR by itself does not equate to a species or population level assessment under the ESA where analyses are conducted at the level of the species as listed as threatened or endangered. The PBR allocation for U.S. waters is 326 Western DPS Steller sea lions, and the PBR is 2,498 for Eastern DPS Steller sea lions (Muto et al. 2018b).

Similar to our humpback whale analysis, NMFS monitors bycatch of marine mammals in commercial fisheries by relying upon data provided by the use of fisheries observers, records obtained from marine mammal strandings, as well as directly from fisherman or other individuals. To date, there has been limited deployment of fisheries observers to collect data on marine mammal interactions in commercial SEAK salmon fisheries. Furthermore, strandings, entanglement, and interactions data are collected opportunistically and represent minimal totals of overall impacts.

We reviewed all the available information including the most recent SARs for Steller sea lions, which provides a summary accounting of estimated human caused M/SI (Muto et al. 2018a). Given the data available, we assumed M/SI rates for Steller sea lions interactions with SEAK fisheries. In addition to those interactions that may not necessarily lead to M/SI, we also reviewed all reports of interactions and human caused strandings of Steller sea lions that are documented and evaluated for M/SI in Helker et al. (2018). We assumed approximately 20% of all Steller sea lion entanglements in SEAK salmon fisheries involve individuals from the Western DPS. We characterized the extent of interactions that may be anticipated by first describing the extent of fishing effort in various SEAK salmon fisheries, and then we considered how these fisheries operate in context with the available data on Steller sea lion distribution and their anticipated interactions with SEAK salmon fisheries. Lastly, we presented and outlined the available information in terms of the minimum levels of interactions and M/SI expected, as well as levels that are reasonably certain to occur, and also some less certain assessments of potential impacts that might be occurring for Steller sea lions in each SEAK salmon fishery.

Given the available data on Steller sea lion interactions with the SEAK fisheries, we are reasonably certain that some number of occasional entanglements will occur in the commercial SEAK drift gillnet fishery. We assume a minimum estimate of at least 0.03 Western DPS entanglements per year (0.02 M/SI annual rate). While it's less certain, there is a possibility that less than 5 interactions with Western DPS Steller sea lions occur per year (less than 2.5 M/SI annual rate) given the assumed number of blow-throughs that may occur.

There have been no Steller sea lion interactions or entanglements with the SEAK purse seine fishery reported over the last 6 years. Without any other information at hand, we anticipate that there will not be any entanglements or other interactions between Western Steller sea lions and purse seine gear.

Given the interactions reported and opportunistic sightings, we are reasonably certain that occasionally Steller sea lions will be entangled in the commercial SEAK set gillnet fishery. Because virtually all of the fishing effort that occurs in this fishery is within the Steller sea lion mixing area, we can assume that at least occasionally some individuals that may be entangled in this fishery are likely to be Western DPS Steller sea lions. Although there are limited data, there is a risk for mortality and serious injury with this gear type that may be somewhat analogous to the drift gillnet fishery. In lieu of more information, we assume that M/SI rates for these Steller sea lion interactions will be around 50%, similar to what is expected from interactions with drift gillnet gear. As a result, we assume a minimum estimate of 0.03 Western DPS entanglements would occur per year (with a 0.02 M/SI per year). Although less certain, we assume 0.20 Western DPS entanglements would occur per year with a 0.10 M/SI per year.

There have been 126 incidents of Steller sea lion interactions reported to NMFS involving the SEAK troll gear (although it is unknown if this gear from 124 of these incidents originates from the commercial or recreational troll fishery). There has not been any observer coverage of this fishery to generate any local or regional estimates of Steller sea lion interactions. There is some location information from a sub-set of these troll interactions that indicate almost all of these stranding reports (56) originated from north of Sumner Strait in the Steller sea lion mixing area. Given this information, we assume that Steller sea lions will regularly be hooked/entangled in the commercial SEAK troll fishery. We are reasonably certain that 3.29 (minimum) or more Western DPS hooking/entanglements may occur per year (including 3.29 Western DPS M/SI per year). We assume, with less certainty, 15.0 Western DPS hooking/entanglements may occur per year (including 15.0 Western DPS M/SI per year).

As described above for humpback whales, there are less data available on subsistence salmon fisheries in SEAK than for the commercial fisheries. There have not been any interactions associated with subsistence salmon fishing gear reported to NMFS. In general, subsistence fisheries use the same gear types as commercial fisheries, with drift gillnet fishing in particular being a common gear type used and troll gear is very limited. Given the use of various nets, especially within the Steller sea lion mixing area, we assume there is some risk of interactions with Western Steller DPS individuals, similar but at a smaller scale to what has been characterized for commercial SEAK salmon drift and set gillnet fisheries. We are reasonably certain that an undefined number of occasional entanglements in gillnets (a minimum of 0) of Western DPS may occur. While it's less certain, there is a possibility that the subsistence interactions is about 0.13 Western DPS in drift gillnet gear (0.07 M/SI per year) and 0.18 Western DPS in set gillnet gear (0.09 M/SI per year).

There have been two interactions with Steller sea lions reported to NMFS in the last 6 years that have specifically involved recreational gear. In addition, there were 124 incidents of interactions with troll gear in SEAK where it was not determined whether the gear originates from the commercial or recreational troll fishery. Furthermore, the 3 strandings of Steller sea lions in SEAK associated with unidentified "hook and line" gear could have involved salmon recreational fisheries. It is likely that the stranding record review under the SEAK troll section above reflects what is known about the hooking/entanglement of Steller sea lions in all types of SEAK troll fisheries, including the recreational fishery. We also conclude rare additional interactions with other hook and line recreational fishing for salmon may occur. Thus, we are reasonably certain an undefined number of rare entanglements occur over time, and at a minimum, we assume 0.33 hooking/entanglements occur in the recreational salmon fisheries per year and no entanglement in recreational troll gear. While it's less certain, there is a good possibility that the recreational fishery would be involved with some portion of the 15.0 Western DPS hooking/entanglements and M/SI that were extrapolated as described above for the commercial troll fishery. We assume, with less certainty, 0.12 hooking/entanglements of Western DPS per year with unidentified hook and line gear (including 0.08 Western DPS MSI per year with unidentified hook and line).

In summary, we are reasonably certain approximately 4 Western DPS Steller sea lion interactions occur on average each year, including approximately 4 M/SI occurring on average each year in all SEAK fisheries, and we will authorize take of 4 Western DPS Steller sea lions per year. With respect to considering available information that is less certain, we could anticipate that less than 21 Western DPS interactions could occur on average each year, including less than 18 M/SI occurring on average each year. Although we rely upon information to describe the impacts (and extent of take) we are reasonably certain to occur in this biological opinion, we will consider the possibility that, and the implications of, impacts potentially occurring at levels that are less certain described.

In our analysis, we assumed fishing effort under the 2019 Agreement will be similar to past fishing effort under the 2009 Agreement. However, as described in the Proposed Action, provisions of the 2019 Agreement result in reductions in catch in SEAK relative to those allowed under the 2009 Agreement. In the SEAK fisheries, in most cases, catch is reduced by 7.5 percent relative to what was allowed in the 2009 Agreement. Although this reduction in catch is specific to Chinook salmon fisheries, we anticipate reduction in catch is specific to Chinook salmon fisheries, we anticipate reductions in the length of time SEAK fisheries are likely to be open under the 2019 Agreement in general if effort remains the same, as they will obtain expected lower catch limits under the same effort level in shorter durations, and our assumptions on impacts accrued are likely therefore a conservative assessment.

The most recent minimum estimate of the abundance of Western Steller sea lion DPS is 54,267. Over the long-term, we expect that the Western Steller sea lion DPS will lose 4 to 18 individuals every year as a result of the proposed actions. However, any take over 4 Western DPS Steller sea lions per year would be unauthorized. Considering the prospect of 4 M/SI (reasonably certain to occur) to 18 M/SI (less certain but could occur) from the population in any given year, this represents less than 1 percent (0.000074 – 0.00033) of the total Western DPS population during a single year. This is a very small proportion of the total population. Furthermore, there is strong evidence that western DPS Steller sea lions in Alaska have increased overall at ~2% per year under the 2009 Agreement. In this biological opinion, we expect the SEAK fisheries will occur each year in the foreseeable future and likely at lower levels than we analyzed. Although the minimum mean annual U.S. commercial fishery-related mortality and serious injury rate (40 sea lions) is more than 10% of the PBR, based on available data, the total estimated annual level of human-caused mortality and serious injury (252 sea lions) is below the PBR level for this stock. Thus the additional individuals removed from this population by the proposed action is not anticipated to substantially increase M/SI rates to be above this potential biological removal level.

After reviewing and analyzing 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's biological opinion that the proposed actions regarding the SEAK salmon fisheries are not likely to appreciably reduce the likelihood of both survival and recovery of the Western DPS of Steller sea lion.

2.8 Conclusion

After reviewing and analyzing 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 action is not likely to jeopardize the continued existence of the LCR Chinook Salmon, UWR Chinook Salmon, Snake River fall-run Chinook Salmon, and Puget Sound Chinook Salmon ESUs, and the SRKW DPS, the Mexico Humpback whale DPS, and the western Steller sea lion DPS or destroy or adversely modify their designated critical habitats.

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.

Section 7(b)(4)(C) of the ESA provides that if an endangered or threatened marine mammal is involved, the taking must first be authorized by Section 101(a)(5) of the MMPA. Accordingly, regarding Mexico DPS humpback whales and the western Steller sea lion DPS, the terms of this incidental take statement and the exemption from Section 9 of the ESA become effective only upon the issuance of MMPA authorization to take the marine mammals identified here. Absent such authorization, the portions of this incidental take statement concerning marine mammals are inoperative.

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 as follows:

For purposes of this consultation NMFS assumed that fisheries in SEAK will be managed up to the limits of allowable catch specified in Chapter 3 the PST Agreement. As indicated in the description of the proposed actions, the approval of the PST Agreement establishes upper limits on allowable catch that may be authorized by U.S. domestic management authorities, but does not itself authorize the conduct of any fishery. Fisheries in the EEZ in SEAK occur as a consequence of NMFS' delegation to the State of Alaska and regulations issued by the ADFG conforming with the Treaty agreement. Fisheries in state waters in SEAK are conducted in conformity with the PST, and the State of Alaska manages the salmon fisheries with assistance through federal grants to implement the PST. The expected take in the SEAK salmon fishery in both federal and state waters is therefore described in the following incidental take statement for ESA-listed species adversely affected the proposed actions, four Chinook salmon ESUs and three marine mammal DPSs.

2.9.1.1 Chinook Salmon

The incidental take of listed Chinook salmon from the various ESUs in the SEAK fisheries will vary from year to year depending on the stock abundances, annual variation in migratory patterns, and fishery management measures used to set and implement fishing levels in the PST Agreement. The incidental take of ESA-listed Chinook salmon in SEAK fisheries will be limited on an annual basis by the provisions of Chapter 3, Annex IV of the PST Agreement that define the limits of catch and total mortality or exploitation rate for each fishery (see Table 2 through Table 4). Measures of Chinook catch, total mortality and exploitation rate are used as surrogates for the incidental take of ESA listed Chinook salmon because they can be monitored directly and readily assessed for compliance.

As discussed in the Effects analysis, we do anticipate limited adverse effects to listed Chinook salmon as a result of increased hatchery production and habitat restoration work associated with the mitigation funding initiative that is the third component of the proposed action.

However, this consultation constitutes a programmatic review of the funding action, thus we do not provide an exemption from the take prohibition for those actions in this take statement. This will be addressed in future project-specific consultations, 4(d) rule approvals, or determinations of coverage by existing biological opinions. See 50 CFR § 402.14(i)(6).

2.9.1.2 Southern Resident Killer Whales

The harvest of salmon that may occur under the proposed actions is likely to result in some level of harm constituting take to SRKW by reducing prey availability, which may cause animals to forage for longer periods, travel to alternate locations, or abandon foraging efforts. All individuals of the SRKW DPS have the potential to be adversely affected across their range. NMFS cannot quantify impacts to foraging behavior or any changes to health of individual killer whales in the population from a specific amount of removal of potential prey resulting from the SEAK fisheries because we do not have data needed to establish quantitative relationships between prey availability and these effects to SRKW. Therefore NMFS is using the level of Chinook salmon catch in SEAK as a surrogate for incidental take of SRKW. Chinook salmon catch in SEAK, which we can quantify, relates directly to the extent of effects on prey availability from the proposed actions related to the SEAK fisheries, as we would expect catch to be proportional to the reduction in prey in a given year. In particular, we expect the percentage reduction in removal of potential prey to vary according to SEAK catch levels allowed under the 2019 agreement, as described in the analysis of effects. The extent of take for SRKW is therefore the same as the extent of take for Chinook salmon and is described by the provisions of Chapter 3, Annex IV of the PST Agreement that define annual catch or total mortality limits on Chinook salmon (including ESA-listed and non ESA-listed Chinook salmon), as described above in Section 2.9.1.1.

2.9.1.3 Mexico DPS Humpback Whales and Western DPS Steller Sea Lions

In the biological opinion, NMFS determined that the incidental take of Mexico DPS humpback whales and Western DPS Steller sea lions is reasonably certain to occur as a result of interaction with SEAK salmon fisheries under the proposed action. ESA-listed species interactions with SEAK salmon fisheries considered as take in the biological opinion include entanglement in a net or other components of gear such as buoy extender lines or other types of salmon fishing lines that could result in or contribute to an entanglement. Interactions that include hooking injuries from troll gear, with or without entanglement of the fishing line, are also considered a primary mode of interaction. These interactions may lead to M/SI, but not necessarily in all cases. We conclude that the amount of take that is reasonably certain to occur in the SEAK fisheries and authorized in this ITS is ~ 2 Mexico DPS humpback whale interactions on average each year, including ~1 M/SI occurring on average each year, and ~ 4 Western DPS Steller sea lion interactions on average each year, including ~ 4 M/SI on average each year.[43] There is information that suggests additional take may be occurring, but at levels that are less certain.

While we are able to describe an amount of take that we expect to occur, monitoring of ESA

[43] The anticipated take of ESA-listed humpback whales and Steller sea lions described in the *Effects Analysis* have been rounded up to the nearest whole number and represented as approximate numbers (~) here.

listed humpback and Steller sea lion interactions in the SEAK salmon fisheries does not occur at a level that allows us to directly and effectively monitor those interactions. Fishery observers are not required for most of these fisheries, and much of the existing data regarding interactions is opportunistic. Further, ESA listed and non-listed humpbacks and Steller sea lions co-occur in the action area and are not readily distinguishable, and not likely identified in opportunistic reports. Because we cannot directly monitor take, we use a surrogate for the extent of take, which is capable of being monitored for purposes of determining when the surrogate has been exceeded. We will use opportunistic reports, identified at the species level, as one component of a surrogate for the amount of take that occurs in the SEAK salmon fisheries under the proposed action. However, because these opportunistic reports do not represent a systematic monitoring effort, we consider them to represent the minimum totals of interactions that have likely occurred. Therefore, we don't rely on them alone as surrogate for the extent of take. We consider them in combination with information about fishery effort to ensure that the surrogate effectively tracks the likelihood of takes of ESA listed animals likely occurring.

Below we describe the anticipated annual average (over any 6 year period), and maximum annual total, of opportunistic reports describing interactions of each species by SEAK fishery gear type. Because there is uncertainty around how closely opportunistic reports reflect the number of takes of ESA listed animals occurring, in determining appropriate surrogates for the extent of take, we also look for a significant change in the nature of the fishery that significantly departs from the assumptions of the analysis; such a significant change would result in exceedance of take. To determine if such a significant change is occurring, we will look to the average effort over any six year period during the life of this opinion to see if that average exceeds the maximum fishing effort described in tables below. Using a six year period allows us to distinguish between temporary fluctuations and a longer term trend representing significant change in rates of interactions or in fishing effort.

Based on the historical record of the opportunistic reports described in the *Effect Analysis* above, Table 113 summarizes the average and maximum number of interactions of each species (not the ESA-listed unit) by SEAK salmon fishery gear type that have been reported to NMFS annually (detailed in Section 2.5.5). We would consider the extent of take to be exceeded if, the annual average over any 6 year period exceeds the average for that gear type; or if in any one year, the number of reported interactions for either species for any gear type exceeded the maximum for that gear type.

Table 113. Description of the anticipated six year average and annual maximum number of interactions reported to NMFS.

Species	**Anticipated Average and (Maximum) Number of Annually Reported Interactions in SEAK Fisheries**					
	Drift Gillnet	Purse Seine	Set Gillnet	Unknown Net[1]	Troll[44]	Unidentified Hook and Line
Humpback Whale	3 (4)	0.8 (2)	0.2[2] (1)	1 (2)	0.2 (1)	0 (0)
Steller Sea Lion	0.3 (1)	0 (0)	0.2 (1)	0.2[2] (1)	27.4 (49)	0.5 (1)

[1] We recognize that reports may involve unknown nets/gillnets as opposed to being attributed to a specific SEAK salmon fishery.
[2] We recognize that we should anticipate one such interaction could occasionally occur over time, and use this average value consistent with other interactions with other gear types that are expected to occasionally occur.

In the Effects analysis, we determined it is reasonable to assume that the total take that occurs is related to the amount of fishing effort. While we don't have the information to describe that relationship explicitly, we assume that higher levels of fishing effort generally increase the risk of interactions. In order to characterize our expectations for anticipated fishing effort, we draw from the data on fishing effort that have been provided by ADFG from 2011-2018, with a general understanding that this time period reflects a reasonable range of fishing seasons based on expected returns for most salmon species (low-to-high), current permitting and regulation of these fisheries, and other applicable factors that likely influence the amount of effort that may occur. We specifically assume that average fishing effort over any six year period during the term of this Opinion will not exceed maximums for the various measures of fishing effort described in the Effects analysis for the 2011-2018 time period. In the tables that follow, we identify the overall average extent of fishing effort (over any 6 year period) above which we would conclude that fishing effort had changed to such an extent that it was clearly higher than the levels of fishing effort reflected in the *Effects Analysis* of this Opinion.

To monitor changes in commercial salmon fishing effort, we use three different measures of effort, since no one measures completely captures changes in the fishery that would be likely to change effects to humpbacks and Steller sea lions. Table 114 describes the average extent of permit activity by month, for all commercial SEAK salmon fisheries (over any 6 year period) that signifies the threshold above which we would consider the extent of take to be exceeded. In other words, if the average over any six year period during the term of the Opinion for any month for any gear type exceeds the value for that month and gear type, the extent of take will have been exceeded. Table 115 describes the average extent of hours of open fishing seasons for all commercial SEAK salmon fisheries (over any 6 year period) that signifies the threshold above which we would consider the extent of take to be exceeded. In other words, if the average over any six year period during the term of the Opinion for any gear type exceeds the amounts in the table, the extent of take would have been exceeded.

Table 114. Average extent of annual permit activity in commercial SEAK salmon fisheries, by

[44] Troll includes both recreational and commertial fisheries.

month, summed across all districts.

Month	Drift Gillnet	Purse Seine	Set Gill Net	Troll
	Average	Average	Average	Average
1	0	0	0	151
2	0	0	0	230
3	0	0	0	228
4	0	0	0	331
5	84	2	0	368
6	482	245	100	556
7	661	637	111	1,143
8	490	534	89	1,004
9	371	178	92	684
10	62	13	57	237
11	0	0	0	158
12	0	0	0	113

Table 115. Annual average extent of open fishing, in hours, in commercial SEAK salmon fisheries summed across all districts.

Gear	Average
Drift Gillnet	27,411
Purse Seine	74,858
Set Gillnet	21,629
Troll	200,449

The final piece of our surrogate relating to total effort in the commercial SEAK fisheries is the distribution of this effort within the Steller sea lion mixing area, which may influence the extent of interactions with Western DPS Steller sea lions for these fisheries. Table 116 describes the average permit activity (over any 6 year period), by month, for all commercial SEAK salmon fisheries, within the Steller sea lion mixing area during the proposed action, above which we would consider the extent of take to be exceeded. In other words, if the six year average amount for any gear type in any month during the term of this Opinion exceeds the value for that month shown in the table, we would consider the extent of take to have been exceeded. Table 117 describes the average number of hours of open fishing seasons (over any 6 year period), for all commercial SEAK salmon fisheries, within the Steller sea lion mixing area, above which we would consider the extent of take to be exceeded. In other words if the average amount for any gear type over any six year period during the term of this Opinion exceeds the value for that gear in the table, we would consider the extent of take to be exceeded.

Table 116. Average annual percentage of permit activity in commercial SEAK salmon fisheries, by month, summed across all districts, that is expected to occur within the Steller sea lion mixing area during the proposed action.

Month	Drift Gillnet	Purse Seine	Set Gill Net	Troll
	Average	Average	Average	Average
1	0	0	0	71.5%
2	0	0	0	73.0%
3	0	0	0	75.9%
4	0	0	0	80.1%
5	58.6%	100.0%	0	70.2%
6	67.3%	64.0%	100.0%	73.5%
7	64.1%	72.5%	100.0%	68.4%
8	60.2%	61.6%	100.0%	77.3%
9	55.8%	79.2%	100.0%	73.2%
10	90.0%	25.0%	100.0%	82.6%
11	0	0	0	75.0%
12	0	0	0	72.5%

Table 117. Average percentage of open fishing in commercial SEAK salmon fisheries, summed across all districts that is expected to occur with Steller sea lion mixing during the proposed action.

Gear	Average
Drift Gillnet	53.4%
Purse Seine	100.0%
Set Gillnet	30.2%
Troll	70.8%

For subsistence and recreational fisheries we rely on measures for which data is available. Table 118 describes the average extent of annual permit activity (over any 6 year period) in subsistence SEAK salmon fisheries, as well as the distribution of this effort within the Steller sea lion mixing area, above which we would consider the extent of take to be exceeded. In other words, if the average over any six year period during the term of this Opinion exceeds the value in the table for a gear type, we would consider the extent of take to be exceeded.

Table 118. Average annual permit activity and distribution of effort in subsistence SEAK salmon fisheries, summed across all districts and within the Steller sea lion mixing area (maximums from Table 109 (c and d)).

Gear	Active Permits	Percent in Steller Mixing Area
	Average	Average
Drift Gillnet	251	80.9%
Purse Seine	20	100.0%
Set Gillnet	141	96.3%

Gear	Active Permits	Percent in Steller Mixing Area
	Average	Average
Troll	4	100.0%
Unspecified Gillnet	26	100.0%

Table 119 describes the annual average number of angler days in saltwater, the percent of saltwater angler days in the Steller sea lion mixing area, and the relative proportion of salmon caught in freshwater/saltwater (over any 6 year period) in recreational SEAK salmon fisheries above which we would consider the extent of take to be exceeded. In other words, if the average over any six year period during the term of this Opinion exceeds the values shown in the table, the extent of take will have been exceeded.

Table 119. Annual average (a) of angler days in recreational SEAK fisheries by fishing area type and percentage within the Steller sea lion mixing area (maximums from Table 111(a)), and (b) percentage of recreational fish that are salmon by fishing area type (maximums from Table 112).

(a)

Number of Angler Days					
	Freshwater	Saltwater	Total Angler Days	Percent Saltwater	Percent in Steller Mixing Area
Average	95332	501145	594490	84.6%	57.7%

(b)

Percent Salmon Captured		
	Freshwater	Saltwater
Average	93.0%	61.8%

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).

NMFS concludes that the following reasonable and prudent measures are necessary and appropriate to minimize the impacts to listed species from fisheries considered in this biological opinion:

1. Management objectives established preseason will be consistent with the terms of the

2019 PST Agreement.

2. Inseason management actions taken during the course of the State of Alaska's implementation of the fisheries will be consistent with the 2019 PST Agreement.
3. Catch and other management measures used to control fisheries will be monitored adequately to ensure compliance with management objectives.
4. The fisheries will be sampled for stock composition and other biological information.
5. Monitor the extent of fishery interactions with ESA-listed marine mammals.
6. NMFS shall design the prey increase program using the best available information to provide for the best chance of increasing prey availability to SRKWs from the funding initiative.

2.9.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the NMFS or any applicant must comply with them in order to implement the RPMs (50 CFR 402.14). The 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 this 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, protective coverage for the proposed action would likely lapse.

1. The following terms and conditions implement reasonable and prudent measure 1:

1a. NMFS, in cooperation with ADFG shall ensure that management objectives established by ADFG preseason for the SEAK fisheries are consistent with all applicable provisions of Annex IV of the Pacific Salmon Treaty.

2. The following terms and conditions implement reasonable and prudent measure 2:

2a. NMFS, in cooperation with ADFG shall ensure that all in-season management actions taken by ADFG during the course of and following the SEAK fisheries are consistent with all applicable provisions of Annex IV of the Treaty.

3. The following terms and conditions implement reasonable and prudent measures 3:

3a. NMFS, in cooperation with ADFG shall ensure that all catch limits described in Tables 2 through 4 will be adhered to by ADFG while conducting all SEAK fisheries.

3b. NMFS, in cooperation with ADFG shall ensure that all limits on incidental mortality specified in paragraph and subsections 4(a) and 4(f) of the Chapter 3 of the 2019 Agreement will be adhered to by ADFG while conducting all SEAK fisheries.

4. The following terms and conditions implement reasonable and prudent measure 4:

4a. NMFS, in cooperation with ADFG shall review sampling programs for stock composition and other biological information in SEAK fisheries to evaluate whether sufficient information is being collected to provide for a thorough post-season analysis of fishery impacts on listed species, providing feedback for consideration.

5. The following terms and conditions implement reasonable and prudent measure 5:

5a. NMFS in cooperation with ADFG, develop a plan/schedule for annual monitoring and reporting of salmon fishing effort in all SEAK salmon fisheries, consistent with extent of effort described in the Biological Opinion (Tables 100 - 112).

5b. NMFS shall require an annual report describing all salmon fishery interactions with humpback whales and Steller sea lions in SEAK, including information on the gear that maybe attributable to SEAK salmon fisheries. For each interaction, to the extent practicable the information should include the location (latitude and longitude), gear type, nature of the interaction, and disposition of the whale or sea lion following the interaction (e.g., seen swimming away with flasher in mouth, or seen diving with no gear attached).

5c. NMFS, in cooperation with ADFG, shall evaluate the feasibility of deploying observers in priority fisheries to generate more reliable estimates of fishery interactions with ESA-listed marine mammals.

5d. NMFS, in cooperation with ADFG, shall develop a plan to continue/enhance documentation of incidental observations of entangled humpback whales and Steller sea lions during ADFG surveys in areas of SEAK.

6. The following terms and conditions implement reasonable and prudent measure 6:

6a. NMFS, through its administration of the prey increase program, will prioritize improvements to Chinook salmon stocks that have been identified as a priority for SRKWs.

6b. NMFS, through its administration of the prey increase program, will annually report increases in smolt' releases and anticipated adult equivalents to monitor contributions to Chinook salmon abundance goals.

6c. NMFS will endeavor to develop a metric or metrics that will help assess the performance of the increased prey program on prey availability for SRKWs.

7. NMFS, in cooperation with ADFG shall ensure reports and notifications required by the Biological Opinion and this incidental take statement are electronically available for review by the NMFS point of contact on this consultation:

Jeromy Jording (360-753-9576, jeromy.jording@noaa.gov)

If the parties prefer, then written materials may also be

submitted to:

NMFS – West Coast Region
Sustainable Fisheries Division
510 Desmond Drive, SE, Suite 103, Lacey, WA 98506-1263

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 should continue to evaluate through research and further analysis the effects of prey availability on the ability of SRKW to survive and recover, given the totality of impacts that affect prey availability. To this end, NMFS will engage the appropriate technical committees of the PSC to provide technical expertise, data, and cooperation on analysis to assess the overall effects of fishing on Southern Residents. Analysis should assess the potential for local depletion effects. Where a significant potential is identified, the Parties to the agreement and the co-managers should use the discretionary provisions of the agreement to the maximum extent possible to achieve necessary reductions in the impacts of fisheries that are concentrated in time and space.

2. NMFS will continue development of a Risk Assessment and Adaptive Management Framework to continue developing analytic methods for assessing fishery effects to SRKW through prey removal, and to provide a method for managing these effects. An adaptive management framework should:
   - be responsive to the status of SRKWs and Chinook salmon, and
   - identify thresholds for Chinook salmon abundance and prey reductions from fisheries to inform fishery adjustments in order to increase prey availability.

3. In cooperation with ADFG and other knowledgeable entities, develop more specific estimates of eastern and western DPS Steller sea lion mixing rates in specific areas of

SEAK salmon fisheries; with priority on high effort and interaction areas.

4. For humpback whales and Steller sea lions entangled in gear in SEAK and the adjacent portion of the EEZ, establish enhanced protocols for data collection (photography and/or biological sampling with genetic analysis) to improve the chances of determining whether the animal is from an ESA-listed DPS.

5. NMFS will continue to work with the state, tribes and other partners to collect additional information and evaluate management options for pinniped predation on salmonids.

2.11 Reinitiation of Consultation

This concludes formal consultation for the delegation of management authority over salmon troll fishery and the sport salmon fishery in the SEAK EEZ to the State of Alaska, Federal funding to the State of Alaska to monitor and manage salmon fisheries in State and Federal waters to meet the obligations of the PST through 2028, and Federal funding of a conservation program for critical Puget Sound salmon stocks and SRKW.

As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

2.12 "Not Likely to Adversely Affect" Determinations

NMFS concludes that the proposed actions are not likely to adversely affect species or critical habitat of the species listed in Table 6. The applicable standard to find that a proposed action is "not likely to adversely affect" ESA listed species or critical habitat is that all of the effects of the action are expected to be discountable, insignificant, or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects on the species. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are extremely unlikely to occur. The information NMFS considered in making these determinations is summarized below.

Chinook Salmon
The proposed actions likely only affect ESA-listed anadromous fish species with far north ocean migration patterns. Upper Columbia River spring-run and Snake River spring/summer Chinook salmon are rarely caught in ocean fisheries (NMFS 2018a). The effects of PFMC fisheries on these ESUs were reviewed in biological opinions in 1996 (NMFS 1996) and 2001 (NMFS 2001b). NMFS (2001b) concluded that the expected take from the PFMC ocean and Fraser Panel salmon fisheries of Upper Columbia River Spring Chinook salmon is at most an occasional event. NMFS (2001b) found it would be impossible to measure or detect potential effects of the proposed actions on Upper Columbia River Spring Chinook Salmon ESU (which, according to

the Interagency Section 7 Handbook, is considered an "insignificant effect") and therefore came to the conclusion that PFMC ocean fisheries were not likely to adversely affect Upper Columbia River Spring Chinook Salmon.

Although the available information for Snake River spring/summer Chinook salmon is limited, there are three lines of evidence related to timing. First, CWT and GSI studies that suggest that mature Snake River spring Chinook are not likely to be affected significantly by ocean salmon fisheries in the action area. Spring Chinook salmon bound for the upper Columbia River, including the Snake River, begin entering the Columbia River in late February and early March, and reach peak abundance in the lower river below Bonneville Dam in April and early May. The majority of the PFMC's ocean fisheries occur within the May 1 to October 31 time period. As a result, most mature spring Chinook salmon have entered the river prior to the start of ocean fishing (NMFS 1996). Approximately 2.8 million Snake River spring Chinook salmon were tagged with CWTs from the 1976 to 1987 brood releases at the Rapid River and Sawtooth hatcheries. There were only 4 observed CWT recoveries in ocean fisheries compared to the 622 observed recoveries from in-river fisheries and escapement (NMFS 1996). Finally, the available GSI studies concluded that some small fraction of less than 1 percent of the catch in Washington area ocean fisheries may be naturally spawned spring Chinook salmon from the Snake River (NMFS 1996). Similar data sources were reviewed in an effort to assess the likely magnitude of impacts on Snake River summer Chinook salmon component of the ESU. The estimated number of recoveries from all release groups combined were only 12 by Washington ocean fisheries, 8 by Oregon ocean fisheries and 7 by Canadian ocean fisheries. There were no CWT recoveries in Alaskan fisheries. The CWT and GSI analyses for Snake River summer Chinook salmon showed similar results to the spring Chinook salmon analysis, but were less conclusive due to the smaller amount of data available.

In summary, the opinions discussed above (NMFS 2001b), which are still relevant, concluded that fish from these ESUs are rarely, if ever, caught in ocean fisheries and are not likely to be affected adversely by fisheries managed under the NPFMC's FMP. Although these opinions focused on the Council action area (the U.S. Pacific Coast EEZ), the analysis considered ocean harvest coast wide. NMFS reiterated this conclusion more recently in its biological opinion on the 2018-2027 *U.S. v. Oregon* Management Agreement (NMFS 2018a) and likely capture of either the Upper Columbia River spring-run or Snake River spring/summer Chinook salmon ESUs in SEAK fisheries is discountable.

NMFS reviewed the effects of fisheries in SEAK on the three ESA-listed California Chinook Salmon ESUs in the biological opinion on the 2009 PST Agreement (NMFS 2008d). These stocks reside primarily off California and the southern U.S. and are even more rarely caught in northern fisheries than the Columbia River origin fish discussed above (NMFS 2008d). These ESUs are caught primarily in PFMC fisheries based on their known ocean migration patterns, the effects of which were also considered in prior biological opinions (see NMFS (1996)) (NMFS 2001b). The likely capture of any ESA-listed California Coastal, Central Valley spring-run, and Sacramento winter-run Chinook salmon in SEAK fisheries is discountable due to their respective ocean migration patterns.

Coho Salmon

There are four ESA-listed coho salmon ESUs that may range into northern waters: Central California Coast, Southern Oregon/Northern California Coast, Oregon Coast, and Lower Columbia River coho salmon. Based on prior biological opinions, which analyzed the effects of marine fisheries on ESA-listed coho salmon (NMFS 1999b; 2015a), they are distributed off the west coast and rarely migrate as far north as Canada. The most recent available information (Joint Coho Technical Committee 2013) indicates, through use of CWT studies, that none of the ESA-listed coho salmon ESUs on the west coast are likely to range into SEAK fisheries. Given the results of these analyses, the effects of the proposed action are discountable to these ESUs.

Chum Salmon
There are two ESA-listed chum salmon ESUs that may range into northern waters: Columbia River chum and Hood Canal summer-run chum salmon. NMFS reviewed the effects of fisheries in SEAK on both of these salmon ESUs in the biological opinion on the 2009 PST Agreement (NMFS 2008d), and determined that no take in the SEAK fishery was expected. Hood Canal summer-run chum are rarely caught in ocean fisheries (NMFS 2008d). Furthermore, Hood Canal summer-run chum salmon return timing suggests that they are unlikely to be encountered in SEAK fisheries as any adults that may have migrated far to the north will have exited Alaskan EEZ marine areas prior to the start of the proposed summer fisheries (July-September), and we could find no reports indicating they were caught in winter fisheries. NMFS also found that there were no reports of Columbia River chum harvest in northern or PFMC fisheries (NMFS 2008d). Based on the considerations summarized here the likely impact of capture on either ESA-listed chum salmon ESU in SEAK fisheries is discountable.

Sockeye Salmon
There are two ESA-listed sockeye salmon ESUs to be considered, Snake River and Lake Ozette sockeye salmon. The ocean distribution and migration patterns of Snake River sockeye salmon are not well understood. There are no CWT data, as with Chinook or coho salmon, which could be used to determine the distribution of Snake River sockeye. However, timing considerations and other recent information evaluating their marine distribution are discussed in Tucker et al. (2015).These data suggest that a majority of juvenile Snake River sockeye do migrate northward in the ocean, but mainly remain close to Vancouver Island (Tucker et al. 2015). Research indicates that the migration path and ocean distribution of Snake River Sockeye Salmon is such that the fish are not present in near shore areas where ocean salmon fisheries traditionally occur (NMFS 2017f). Snake River Sockeye Salmon may be exposed to incidental take as bycatch in the ocean troll, purse seine, and gill net salmon fisheries off the coasts of Alaska, British Columbia, and Washington. However, these ocean fisheries are believed to pose minimal threat to the species since sockeye salmon are not attracted to baits or lures and, thus, are rarely caught in commercial troll or recreational fisheries (NMFS 2015c). Sockeye salmon are also not targeted, and rarely if ever caught in PFMC area fisheries. NMFS confirmed the conclusion that ocean fisheries have little or no impact on Snake River sockeye most recently in their biological opinion on the 2018-2027 U.S. v. Oregon Management Agreement (NMFS 2018a). These considerations suggest that it is unlikely that Snake River sockeye salmon are encountered in the SEAK fisheries.

Similar information was used to analyze the likely effect of ocean harvest on Lake Ozette sockeye salmon. As with Snake River sockeye salmon, distribution and migration patterns for

Lake Ozette sockeye salmon are not well understood, and no marine harvest data for Lake Ozette Sockeye exist (Haggerty et al. 2009). Commercial net and troll fisheries extending from Dixon Entrance in southeast Alaska to the Strait of Juan de Fuca were reviewed for the timing and duration of fishery openings relative to the estimated migration time of Ozette sockeye through harvest areas (NMFS 2009b). The evaluation of these ocean fisheries in the Lake Ozette sockeye limiting factors analysis concluded that there are no directed commercial sockeye fisheries in the marine environment when and where the Ozette sockeye population is present during the ocean rearing and migration period (NMFS 2009b). These timing considerations indicate that Lake Ozette sockeye salmon are gone from fishing areas, or largely out of the ocean, before the onset of intercepting fisheries where they might be caught (NMFS 2009b). Based on the considerations summarized here, and discussed in more detail in prior biological opinions and incorporated by reference here, the likely impact of capture on either ESA-listed sockeye salmon ESU in SEAK fisheries is discountable.

Steelhead

NMFS has reviewed available information related to the distribution of steelhead from the listed DPSs from California, the Columbia River basin, and Puget Sound. We then reviewed information related to the catch of steelhead in the action area in Alaska, Canada, PFMC areas, and Puget Sound. Steelhead are not targeted in ocean fisheries and are rarely caught (NMFS 2001b; 2018b). In most cases, regulations prohibit the retention of steelhead in marine area fisheries. As a consequence, information that could be used to quantify species specific harvest is quite limited. Some limited harvest of steelhead in ocean fisheries does occur mostly in the form of catch-and-release mortality or illegal retention of misidentified fish. However, status reviews, recovery plans, NPFMC documents, and previous biological opinions were reviewed to determine the impact of ocean fisheries on each steelhead DPS. In each case, these documents concluded that steelhead catches were inconsequential, very rare, an insignificant source of mortality, or at very low levels (NMFS 2001b; UCSRB 2007; NMFS 2009a; NMFS and ODFW 2011; NPFMC 2012; NMFS 2013c; 2014a; 2016l; 2016m; 2016g; 2016b; 2016a; 2017f; 2018b). With respect to the SEAK fishery, the NPFMC FMP for Salmon (NPFMC 2012) states that bycatch of steelhead makes up a small part of overall catch. NMFS concluded that the catch of steelhead in PFMC area fisheries was on the order of a few tens of fish, but not likely more than a hundred fish per year (NMFS 2001b). Our expectation is that steelhead ocean migrations do not extend far north and so these discountable effects in more southern marine fisheries provide context to how unlikely SEAK fisheries would have any measurable effects to ESA-listed steelhead DPSs. NMFS confirmed the conclusion that few steelhead are caught in ocean fisheries most recently in their biological opinion on the 2018-2027 *U.S. v. Oregon* Management Agreement (NMFS 2018a). From these sources it is apparent that the catch of steelhead in marine area fisheries including those in SEAK is a rare event and that the overall impact is low. Based on the considerations summarized here, and in prior biological opinions that are incorporated by reference, NMFS concludes that the effect of the proposed action is discountable for the ESA-listed steelhead DPSs listed in Table 6.

Designated critical habitat for the ESA-listed DPSs includes specified freshwater areas and the adjacent estuaries. SEAK fisheries that occur as a result of the proposed actions are therefore outside the limits of designated critical habitat.

Marine Mammals
The proposed action is not likely to adversely affect the blue whale (*Balaenoptera musculus*), fin whale (*B. physalus*), North Pacific right whale (*Eubalaena japonica*), Western North Pacific gray whale (*Eschrichtius robustus*), sei whale (*B. borealis*), sperm whale (*Physeter microcephalus*), or Western Steller sea lion DPS critical habitat.

Below we discuss the likelihood of occurrence for ESA-listed marine mammals and critical habitat in the action area.

Blue whale: Blue whales in the Eastern North Pacific stock range from the northern Gulf of Alaska to the eastern tropical Pacific (Muto et al. 2018a). Nine biologically important areas for blue whale feeding have been identified off the California coast (Calambokidis et al. 2015). Although there is the possibility of blue whale occurrence within the action area, their presence is most likely rare.

Fin whale: Fin whales in the Northeast Pacific stock are found seasonally off the coast of North America and in the Bering Sea during the summer. They are also regularly seen in the Gulf of Alaska throughout summer months (Stafford et al. 2007). Although there is the potential for fin whales to be present in the action area, available data indicate that occurrence is likely to be rare.

North Pacific right whale: Sightings of North Pacific right whales are rare, but most sightings in the past 20 years have occurred in the southeastern Bering Sea, with a few in the Gulf of Alaska near Kodiak (Waite et al. 2003; Shelden et al. 2005; Wade et al. 2011a; Wade et al. 2011b; Muto et al. 2017). North Pacific right whale migratory patterns are unknown, although it is thought that they migrate from high-latitude feeding grounds in summer to more temperate waters during winter (Scarff 1986; Clapham et al. 2004)(Braham and Rice 1984). Given the fact that sightings have been very rare in the Gulf of Alaska, right whales are not expected to be found in the action area. Additionally, there is no overlap between the action area and right whale critical habitat.

Western North Pacific gray whale: Gray whales from this population feed off Russia and the Bering Sea in the summer and fall (Carretta et al. 2015). Recent tagging, photo-identification, and genetic studies have demonstrated that some Western North Pacific gray whales migrate across the northern Gulf of Alaska and along the west coast of British Columbia, the US, and Mexico. While there is the potential for a Western North Pacific gray whale to be in the action area, their occurrence is most likely rare.

Sei whale: Sei whale surveys have shown that sei whales are generally distributed far out to sea in temperate regions and therefore do not appear to be associated with coastal features (Carretta et al. 2014). As such, their occurrence is likely to be rare in the action area.

Sperm whale: Sperm whales from the North Pacific stock have been detected year-round in the Gulf of Alaska, although they appear to be more common in summer than in winter (Mellinger et al. 2004). However, sperm whales are generally not distributed near shore (Carretta et al. 2014) and therefore their occurrence in the majority of the action area is rare.

Western Steller sea lion critical habitat: On August 27, 1993, NMFS designated critical habitat for Steller sea lions based on the location of terrestrial rookery and haulout sites, spatial extent of foraging trips, and availability of prey items (58 FR 45269). Critical habitat in Southeast Alaska (east of 144° W. longitude) includes a terrestrial zone, an aquatic zone, and an air zone that extend 3,000 feet landward, seaward, and above, respectively, at each major rookery and haulout (see Figure 22) (50 CFR 226.202(a)). In general, the physical and biological features of critical habitat essential to the conservation of Steller sea lions are those items that support successful foraging, rest, refuge, and reproduction.

Effects

Below we have analyzed effects for all of the species listed above, as well as for designated critical habitat for the Western DPS Steller sea lion. Potential effects due to the SEAK fisheries may occur through gear entanglement, prey reduction, and vessel disturbance or collision.

Gear Entanglement

The gear types used in the SEAK fisheries include net, troll, and sport fisheries. Entanglement in commercial fishing gear poses a significant threat to large whales. Although sperm whales and gray whales have all been documented as entangled in drift gillnet gear off SEAK and the U.S. West Coast, no mortalities or serious injuries have been documented in any of these species in troll, net, or sport fisheries in Alaska in recent years (Saez et al. 2013; Muto et al. 2018a). Additionally, the majority of entanglements of large whales on the U.S. West Coast are associated with fixed pot/trap gear (Saez et al. 2013). No serious injuries or mortalities of sperm whale have been reported in association with the net, troll, or sport fisheries considered under the proposed action (Helker et al. 2017). Because of the lack of reported entanglements in these types of fishing gear, and because many of these species are rare within the action area, we consider the risk of entanglement to be discountable.

Prey Reduction

Many of these cetacean species target zooplankton as their primary prey (Shelden and Clapham 2006; Coyle et al. 2007). North Pacific right whale and blue whale distribution are linked to zooplankton aggregations, and large aggregations of blue whales have been found feeding off the coast of California in the summer months (Burtenshaw et al. 2004). While some gray whales feed off the coast of SEAK, most are from the unlisted Eastern North Pacific stock. Giant squid comprise about 80% of the sperm whale diet and the remaining 20% is comprised of octopus, fish, shrimp, crab and even small bottom-living sharks. Fin whales eat small schooling fish such as herring, but are rare within the action area (Dahlheim et al. 2009). The prey consumed by these species are not targeted by these fisheries, and there is little temporal or spatial overlap between the fisheries, prey, and important feeding areas. We therefore expect the risk of prey reduction to be insignificant for these species. As described above in Section 2.5.5., Steller sea lions have a large foraging base and SEAK fisheries do not target their primary prey. Steller sea lions are generalist predators that eat a variety of fishes and cephalopods. Thus, we anticipate prey reductions caused in critical habitat (i.e., aquatic zone) will be insignificant.

Vessel Collision

Collisions of ships and large whales can cause significant wounds, which may lead to the death of the animal. Jensen and Silber (2003) summarized large whale ship strikes world-wide from 1975 to 2003 and found that most collisions occurred in the open ocean involving large vessels.

Commercial fishing vessels were responsible for four of 134 records (3%), and one collision (0.75%) was reported for a research boat, pilot boat, whale catcher boat, and dredge boat.

There have been minimal vessel collisions with ESA-listed whales resulting in mortality or serious injury, particularly in Alaska waters. Most collisions with blue whales have occurred off the coast of Southern California. There have been no documented vessel collisions with sei, sperm, North Pacific right, or WNP gray whales in Alaska waters in recent years. However, there was one reported fin whale mortality due to a ship strike in Alaska waters in 2014 (Muto et al. 2018a). While no vessel collisions with North Pacific right whales have been observed, vessel collisions are a significant source of mortality for North Atlantic right whales, and therefore it is likely that North Pacific right whales are also vulnerable to this threat.

Because encounters with whales and vessels largely occur with shipping vessels and co-occurrence between these species and fishing vessels in SE Alaska is rare, we consider the risk of vessel collision to be discountable. As described in Section 2.2.5., none of the records of vessels strikes with Steller sea lions in critical habitat in the action area have been identified or attributed to salmon fishing vessels or activity. In addition, NMFS guidelines for approaching marine mammals discourages vessels approaching within 100 yards of marine mammals.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT RESPONSE

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (Section 3) defines EFH as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

The action area is described in detail above in Section 2.3, and species managed by the PFMC are discussed here as a result of possible effects from the third proposed action, Federal funding of a conservation program for critical Puget Sound stocks and SRKW related to the 2019 Agreement. Pursuant to the MSA, EFH is designated for three species of Federally-managed Pacific salmon: Chinook salmon (*O. tshawytscha*); coho salmon (*O. kisutch*); and Puget Sound pink salmon (*O. gorbuscha*) (odd-numbered years only) (PFMC 2016). The PFMC (2016) indicates marine EFH for salmon consists of three components, (1) estuarine rearing; (2) ocean rearing; and (3) juvenile and adult migration. Harvest related activities from the other proposed actions do affect adult migration, as fish bound for these more southern areas are intercepted by northern fisheries, but those adverse effects are accounted for explicitly in the ESA analyses and have therefore already been considered for biologically appropriate standards. While the third proposed action results in hatchery and habitat restoration projects in Puget Sound, any adverse effects were similarly explicitly accounted for in the ESA analyses in Section 2 and have therefore already been considered for biologically appropriate standards. The Reasonable and Prudent Measures and Terms and Conditions included in Section 2.9, the ITS, therefore constitute NMFS recommendations to address potential EFH effects. With NMFS ensuring that the ITS, including Reasonable and Prudent Measures and implementing Terms and Conditions, are carried out we are not identifying any additional conservation recommendations and therefore no detailed response is required. This concludes our EFH consultation.

The NMFS must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH (50 CFR 600.920(l)) not previously considered.

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (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.

4.1 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 and funding/action agencies listed on the first page. Other interested users could include the agencies, applicants, and the American public. Individual copies of this opinion were provided to the NMFS. The document will be available through the NOAA Institutional Repository (https://repository.library.noaa.gov/), after approximately two weeks. The format and naming adheres to conventional standards for style.

4.2 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.

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion and EFH consultation 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 MSA implementation and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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Appendix A. Modeling Inputs and Results for Retrospective Analysis Scenarios

In the following tables the four model scenarios in the retrospective analysis are referenced as follows:

Scenario	Description
S1	Scenario 1: FRAM Validation
S2	Scenario 2: 2019 Likely
S3	Scenario 3: 2019 Likely (SEAK 2009)
S4	Scenario 4: 40 percent Abundance Decline

List of Appendix Tables

Section 1: Summary of Model Scenario Inputs

Table 120: TACs associated with the three model scenarios that attempt to capture effects of the 2019 agreement

	Scenario 2: 2019 Likely			Scenario 3: 2019 Likely (SEAK 2009)			Scenario 4: 40% Abundance Decline		
Year	SEAK	NBC	WCVI	SEAK	NBC	WCVI	SEAK	NBC	WCVI
1999	150,780	76,597	59,742	176,045	76,597	59,742	92,679	45,821	30,724
2000	130,245	125,268	37,498	149,822	125,268	37,498	79,488	75,161	19,047
2001	126,291	107,832	83,297	145,274	107,832	83,297	77,075	64,488	43,271
2002	263,197	145,076	157,091	299,143	145,076	157,091	138,540	85,163	86,631
2003	280,479	195,096	128,194	327,431	195,096	128,194	147,636	114,543	76,916
2004	367,911	170,114	89,455	358,605	170,114	89,455	154,355	90,769	53,673
2005	344,501	214,572	136,886	364,565	214,572	136,886	211,320	114,267	82,442
2006	250,837	220,984	83,853	277,362	220,984	83,853	132,034	118,404	43,125
2007	293,655	172,890	74,837	308,413	172,890	74,837	123,189	102,277	38,297
2008	146,726	49,920	101,887	151,049	49,920	101,887	85,058	30,160	52,859
2009	207,899	76,741	94,321	221,705	76,741	94,321	98,588	46,044	48,283
2010	196,412	82,747	134,438	212,359	82,747	134,438	94,314	49,507	74,653
2011	306,572	85,728	196,012	338,991	85,728	196,012	161,371	50,713	92,257
2012	272,214	140,600	79,582	272,468	140,600	79,582	114,194	83,178	47,392
2013	172,597	110,524	85,384	216,418	110,524	85,384	109,862	66,314	43,722
2014	368,202	227,940	169,696	433,856	227,940	169,696	263,212	121,458	79,871

Section 2: Summary of Stock Specific Exploitation Rates

Table 121: Lower Columbia River Spring Chinook Exploitation Rates

	Marine Exploitation				SEAK Exploitation				Canadian Exploitation				SUS Exploitation (Marine Only)			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	14.5%	17.7%	17.9%	17.3%	1.8%	1.4%	1.6%	1.4%	3.5%	5.6%	5.6%	5.1%	9.2%	10.7%	10.7%	10.7%
2000	14.7%	12.8%	13.1%	12.5%	2.2%	1.6%	1.9%	1.7%	6.6%	3.7%	3.7%	3.3%	5.9%	7.6%	7.5%	7.6%
2001	18.7%	18.5%	18.7%	18.2%	1.5%	1.0%	1.2%	1.1%	4.6%	3.9%	3.9%	3.5%	12.6%	13.6%	13.6%	13.6%
2002	13.1%	10.5%	10.7%	10.1%	2.2%	1.7%	1.9%	1.5%	4.2%	4.3%	4.3%	4.0%	6.7%	4.5%	4.5%	4.5%
2003	16.3%	13.6%	13.8%	13.5%	1.5%	1.2%	1.4%	1.0%	4.3%	3.5%	3.5%	3.5%	10.4%	8.9%	8.9%	8.9%
2004	14.9%	11.3%	11.3%	10.8%	1.7%	1.6%	1.5%	1.1%	6.5%	3.6%	3.6%	3.5%	6.8%	6.1%	6.1%	6.2%
2005	23.4%	17.7%	17.8%	17.6%	1.7%	1.6%	1.7%	1.6%	7.4%	6.4%	6.4%	6.3%	14.3%	9.6%	9.6%	9.7%
2006	12.9%	11.7%	11.8%	11.0%	1.9%	1.4%	1.5%	1.2%	7.0%	4.8%	4.8%	4.2%	4.0%	5.5%	5.5%	5.6%
2007	9.8%	9.1%	9.2%	8.3%	2.0%	1.9%	2.0%	1.3%	4.3%	3.3%	3.3%	3.1%	3.5%	3.9%	3.9%	3.9%
2008	39.2%	40.4%	40.4%	39.6%	1.7%	1.4%	1.4%	1.4%	18.9%	11.8%	11.8%	10.6%	18.6%	27.2%	27.2%	27.6%
2009	25.4%	28.9%	29.0%	27.9%	2.4%	2.1%	2.2%	1.7%	9.9%	8.4%	8.4%	7.6%	13.2%	18.4%	18.4%	18.6%
2010	13.0%	12.2%	12.3%	11.7%	2.0%	1.8%	1.9%	1.5%	5.0%	4.1%	4.1%	3.9%	6.0%	6.3%	6.3%	6.3%
2011	29.8%	29.6%	29.8%	28.1%	1.7%	1.8%	2.0%	1.7%	10.5%	10.8%	10.8%	9.1%	17.6%	17.0%	16.9%	17.3%
2012	18.2%	15.6%	15.6%	14.9%	2.0%	2.4%	2.4%	1.7%	5.7%	4.7%	4.7%	4.7%	10.5%	8.4%	8.4%	8.5%
2013	13.3%	14.2%	14.4%	14.1%	1.1%	1.1%	1.3%	1.1%	2.7%	2.5%	2.5%	2.3%	9.5%	10.6%	10.6%	10.6%
2014	22.6%	19.5%	19.8%	18.7%	1.8%	1.7%	1.9%	2.0%	7.6%	7.3%	7.3%	6.0%	13.2%	10.5%	10.5%	10.7%
'99-'14 Avg	**18.7%**	**17.7%**	**17.8%**	**17.1%**	**1.8%**	**1.6%**	**1.7%**	**1.4%**	**6.8%**	**5.6%**	**5.6%**	**5.1%**	**10.1%**	**10.6%**	**10.5%**	**10.6%**

Table 122: Lower Columbia River Tule Chinook Exploitation Rates

	Marine Exploitation				SEAK Exploitation				Canadian Exploitation				SUS Exploitation (Marine Only)			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	23.4%	30.4%	30.6%	29.2%	2.6%	1.8%	2.1%	1.9%	10.0%	15.6%	15.7%	14.3%	10.8%	12.9%	12.9%	13.0%
2000	33.2%	25.7%	26.0%	25.0%	2.5%	2.1%	2.4%	2.1%	17.8%	10.3%	10.3%	9.5%	12.8%	13.3%	13.3%	13.4%
2001	30.4%	25.8%	26.0%	25.0%	2.1%	1.6%	1.8%	1.6%	12.3%	11.0%	11.0%	10.0%	16.0%	13.3%	13.3%	13.4%
2002	35.9%	28.7%	29.0%	27.8%	2.4%	1.9%	2.2%	1.7%	13.6%	13.7%	13.7%	13.0%	19.9%	13.0%	13.0%	13.1%
2003	34.2%	27.3%	27.5%	27.0%	2.1%	1.6%	1.9%	1.4%	14.8%	12.5%	12.5%	12.4%	17.3%	13.2%	13.2%	13.2%
2004	38.3%	27.8%	27.8%	27.0%	2.4%	2.4%	2.3%	1.7%	20.2%	12.3%	12.3%	12.1%	15.7%	13.2%	13.2%	13.3%
2005	44.3%	33.6%	33.7%	33.5%	2.0%	2.1%	2.2%	2.1%	21.2%	18.9%	18.9%	18.7%	21.0%	12.6%	12.6%	12.6%
2006	33.9%	30.7%	30.9%	29.2%	2.5%	1.9%	2.0%	1.7%	22.5%	15.9%	15.9%	14.5%	8.9%	13.0%	13.0%	13.1%
2007	38.3%	32.0%	32.2%	29.9%	3.2%	3.2%	3.4%	2.3%	22.0%	16.0%	16.0%	14.7%	13.0%	12.8%	12.8%	12.9%
2008	31.2%	29.7%	29.8%	28.4%	2.3%	2.0%	2.1%	2.0%	22.3%	14.5%	14.5%	13.1%	6.6%	13.2%	13.2%	13.3%
2009	27.9%	30.9%	31.0%	29.1%	2.8%	2.5%	2.6%	2.0%	17.8%	15.4%	15.5%	14.0%	7.3%	12.9%	12.9%	13.1%
2010	30.6%	27.9%	28.1%	26.9%	2.4%	2.2%	2.3%	1.8%	14.2%	12.5%	12.5%	11.9%	14.0%	13.3%	13.3%	13.3%
2011	32.1%	34.0%	34.3%	31.1%	2.2%	2.3%	2.5%	2.1%	19.2%	19.1%	19.1%	16.2%	10.7%	12.6%	12.6%	12.8%
2012	32.6%	29.1%	29.1%	28.1%	2.4%	2.9%	2.9%	2.0%	15.8%	12.9%	12.9%	12.7%	14.3%	13.3%	13.3%	13.3%
2013	24.2%	23.2%	23.6%	22.7%	1.6%	1.5%	1.8%	1.5%	8.9%	8.2%	8.2%	7.6%	13.7%	13.6%	13.5%	13.6%
2014	39.0%	32.3%	32.7%	30.2%	2.2%	2.0%	2.3%	2.4%	18.0%	17.5%	17.5%	14.8%	18.8%	12.9%	12.9%	13.0%
'99-'14 Avg	**33.1%**	**29.3%**	**29.5%**	**28.1%**	**2.4%**	**2.1%**	**2.3%**	**1.9%**	**16.9%**	**14.1%**	**14.2%**	**13.1%**	**13.8%**	**13.1%**	**13.1%**	**13.1%**

Table 123: Lower Columbia River Bright Chinook Exploitation Rates

	Marine Exploitation				SEAK Exploitation				Canadian Exploitation				SUS Exploitation (Marine Only)			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	55.3%	59.0%	59.7%	58.4%	20.1%	17.1%	17.9%	17.4%	20.9%	22.3%	22.3%	21.1%	14.4%	19.6%	19.5%	19.9%
2000	58.1%	45.5%	46.3%	44.9%	9.7%	9.5%	10.5%	9.7%	22.0%	16.9%	16.8%	15.9%	26.4%	19.1%	19.0%	19.3%
2001	47.3%	41.0%	41.6%	40.3%	9.3%	7.7%	8.4%	7.9%	15.4%	15.4%	15.4%	14.4%	22.6%	17.9%	17.8%	18.1%
2002	52.7%	41.8%	42.6%	40.4%	11.3%	10.1%	11.1%	9.3%	16.2%	17.5%	17.4%	16.8%	25.2%	14.2%	14.1%	14.3%
2003	51.2%	39.3%	40.2%	38.5%	8.7%	7.5%	8.6%	6.8%	17.6%	17.0%	16.9%	16.9%	24.9%	14.8%	14.7%	14.9%
2004	52.3%	42.3%	42.1%	40.0%	8.7%	8.7%	8.5%	6.6%	26.5%	18.1%	18.1%	17.6%	17.1%	15.5%	15.5%	15.7%
2005	58.3%	45.8%	46.2%	45.4%	8.1%	8.6%	9.0%	8.8%	25.7%	24.5%	24.4%	23.8%	24.5%	12.8%	12.7%	12.8%
2006	41.1%	36.8%	37.5%	34.2%	11.4%	8.5%	9.3%	7.7%	24.1%	19.5%	19.5%	17.6%	5.6%	8.8%	8.8%	8.9%
2007	58.0%	54.4%	54.9%	50.8%	14.7%	14.3%	14.8%	11.1%	29.4%	24.4%	24.3%	23.4%	13.9%	15.8%	15.7%	16.3%
2008	48.9%	46.8%	46.9%	45.5%	10.3%	9.5%	9.7%	9.4%	31.8%	20.9%	20.8%	19.4%	6.8%	16.4%	16.4%	16.6%
2009	47.6%	50.7%	51.1%	48.2%	12.0%	10.9%	11.4%	9.3%	27.9%	22.9%	22.9%	21.6%	7.7%	16.9%	16.8%	17.4%
2010	49.5%	44.6%	45.0%	42.9%	9.8%	9.3%	9.9%	8.0%	22.6%	19.1%	19.1%	18.5%	17.1%	16.1%	16.1%	16.3%
2011	45.8%	47.6%	48.3%	44.7%	9.0%	9.3%	10.2%	8.6%	26.0%	24.1%	24.0%	21.6%	10.9%	14.1%	14.0%	14.6%
2012	56.1%	52.0%	52.1%	49.2%	10.4%	12.8%	12.8%	9.3%	22.1%	20.7%	20.7%	20.8%	23.7%	18.6%	18.6%	19.1%
2013	40.8%	42.4%	43.1%	41.8%	5.6%	5.2%	6.1%	5.5%	19.7%	17.1%	17.1%	16.1%	15.4%	20.0%	19.9%	20.2%
2014	48.8%	41.7%	42.8%	40.9%	9.4%	8.7%	10.0%	10.3%	18.7%	19.1%	19.0%	16.5%	20.8%	13.9%	13.8%	14.1%
'99-'14 Avg	**50.7%**	**45.7%**	**46.3%**	**44.1%**	**10.5%**	**9.9%**	**10.5%**	**9.1%**	**22.9%**	**20.0%**	**19.9%**	**18.9%**	**17.3%**	**15.9%**	**15.8%**	**16.2%**

Table 124: Upper Willamette River Chinook Exploitation Rates

	Marine Exploitation				SEAK Exploitation				Canadian Exploitation				SUS Exploitation (Marine Only)			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	7.0%	8.9%	9.3%	8.5%	3.9%	3.1%	3.6%	3.2%	1.6%	3.7%	3.7%	3.3%	1.6%	2.0%	2.0%	2.0%
2000	12.1%	9.4%	10.0%	9.2%	6.3%	4.6%	5.3%	4.7%	4.7%	2.6%	2.6%	2.3%	1.1%	2.2%	2.2%	2.2%
2001	9.5%	8.0%	8.4%	7.8%	3.9%	2.8%	3.2%	2.8%	3.2%	2.8%	2.8%	2.5%	2.5%	2.5%	2.4%	2.5%
2002	9.6%	8.0%	8.3%	7.5%	3.7%	2.9%	3.2%	2.5%	3.1%	3.2%	3.2%	3.0%	2.8%	1.9%	1.9%	1.9%
2003	9.5%	7.7%	8.2%	7.3%	4.0%	3.0%	3.5%	2.7%	3.2%	2.6%	2.6%	2.6%	2.2%	2.0%	2.0%	2.0%
2004	9.4%	7.2%	7.1%	6.3%	3.6%	3.3%	3.2%	2.3%	4.1%	2.2%	2.2%	2.1%	1.7%	1.8%	1.8%	1.8%
2005	13.3%	10.4%	10.7%	10.5%	4.9%	4.5%	4.8%	4.6%	4.7%	4.0%	4.0%	3.9%	3.7%	1.9%	1.9%	1.9%
2006	10.4%	7.9%	8.2%	7.2%	4.2%	3.1%	3.4%	2.7%	4.4%	2.9%	2.9%	2.6%	1.8%	1.8%	1.8%	1.8%
2007	12.2%	10.4%	10.6%	8.5%	6.2%	5.7%	6.0%	4.0%	4.3%	3.0%	3.0%	2.7%	1.7%	1.7%	1.7%	1.7%
2008	13.2%	11.7%	11.7%	11.1%	3.7%	3.3%	3.4%	3.2%	7.2%	4.7%	4.7%	4.2%	2.3%	3.7%	3.7%	3.8%
2009	9.1%	9.6%	9.8%	8.5%	4.0%	3.8%	4.0%	3.1%	3.7%	3.2%	3.2%	2.9%	1.4%	2.5%	2.5%	2.6%
2010	9.8%	8.7%	9.0%	7.8%	4.7%	4.2%	4.6%	3.4%	2.8%	2.4%	2.4%	2.2%	2.3%	2.1%	2.1%	2.1%
2011	10.0%	10.5%	10.9%	9.3%	4.6%	4.9%	5.4%	4.4%	3.5%	3.5%	3.5%	2.9%	1.8%	2.0%	2.0%	2.0%
2012	10.3%	10.0%	10.0%	8.4%	5.0%	5.8%	5.8%	4.1%	2.6%	2.1%	2.1%	2.1%	2.7%	2.1%	2.1%	2.2%
2013	6.3%	6.6%	7.2%	6.6%	2.6%	2.5%	3.1%	2.7%	1.7%	1.7%	1.7%	1.5%	2.0%	2.5%	2.4%	2.5%
2014	11.3%	9.5%	10.1%	9.7%	4.3%	3.8%	4.5%	4.6%	3.4%	3.3%	3.3%	2.7%	3.6%	2.4%	2.4%	2.4%
'99-'14 Avg	**10.2%**	**9.0%**	**9.4%**	**8.4%**	**4.3%**	**3.8%**	**4.2%**	**3.4%**	**3.6%**	**3.0%**	**3.0%**	**2.7%**	**2.2%**	**2.2%**	**2.2%**	**2.2%**

Table 125: Snake River Fall-Run Chinook Exploitation Rates

	Marine Exploitation				SEAK Exploitation				Canadian Exploitation				SUS Exploitation (Marine Only)			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	31.2%	35.1%	35.3%	34.5%	1.6%	1.3%	1.5%	1.3%	5.7%	8.9%	8.9%	8.1%	23.9%	25.0%	25.0%	25.2%
2000	39.2%	32.1%	32.5%	31.7%	3.4%	2.6%	3.0%	2.7%	10.5%	6.4%	6.5%	5.9%	25.4%	23.0%	23.0%	23.1%
2001	39.3%	30.8%	30.9%	30.3%	1.4%	1.1%	1.2%	1.1%	7.3%	6.3%	6.3%	5.7%	30.5%	23.4%	23.4%	23.5%
2002	46.2%	35.7%	35.9%	35.0%	1.7%	1.4%	1.6%	1.2%	10.8%	11.0%	11.0%	10.3%	33.7%	23.3%	23.3%	23.4%
2003	48.0%	35.5%	35.8%	35.3%	1.9%	1.5%	1.7%	1.3%	12.6%	10.3%	10.3%	10.3%	33.5%	23.7%	23.7%	23.7%
2004	44.7%	31.2%	31.1%	30.1%	3.0%	2.8%	2.8%	2.0%	14.2%	8.3%	8.3%	8.1%	27.4%	20.0%	20.0%	20.1%
2005	53.0%	36.2%	36.4%	36.1%	2.0%	2.0%	2.1%	2.0%	13.5%	11.6%	11.6%	11.4%	37.5%	22.7%	22.7%	22.7%
2006	33.4%	33.6%	33.8%	32.3%	3.0%	2.2%	2.4%	2.0%	14.9%	10.6%	10.6%	9.5%	15.5%	20.7%	20.7%	20.9%
2007	44.3%	38.4%	38.5%	36.6%	3.2%	3.1%	3.2%	2.2%	16.6%	11.9%	11.9%	10.9%	24.5%	23.3%	23.3%	23.6%
2008	26.5%	31.0%	31.1%	30.2%	1.9%	1.6%	1.6%	1.6%	14.5%	9.0%	9.0%	8.1%	10.1%	20.5%	20.4%	20.6%
2009	28.0%	40.3%	40.5%	39.1%	2.0%	1.8%	1.9%	1.5%	12.7%	10.6%	10.6%	9.5%	13.3%	28.0%	28.0%	28.2%
2010	30.5%	30.8%	31.0%	30.2%	1.9%	1.7%	1.8%	1.4%	9.9%	8.3%	8.3%	7.8%	18.8%	20.9%	20.9%	21.0%
2011	35.8%	39.6%	39.8%	37.5%	1.3%	1.3%	1.5%	1.2%	14.2%	14.1%	14.2%	11.7%	20.3%	24.2%	24.1%	24.5%
2012	41.5%	34.9%	34.9%	34.2%	1.5%	1.9%	1.9%	1.3%	9.7%	8.1%	8.1%	8.0%	30.3%	24.8%	24.8%	24.9%
2013	27.6%	27.6%	27.8%	27.3%	0.6%	0.5%	0.7%	0.6%	5.1%	4.8%	4.8%	4.3%	21.9%	22.3%	22.3%	22.4%
2014	52.8%	38.1%	38.3%	36.5%	1.3%	1.2%	1.4%	1.4%	11.5%	11.4%	11.4%	9.3%	40.1%	25.5%	25.5%	25.7%
'99-'14 Avg	**38.9%**	**34.4%**	**34.6%**	**33.6%**	**2.0%**	**1.7%**	**1.9%**	**1.5%**	**11.5%**	**9.5%**	**9.5%**	**8.7%**	**25.4%**	**23.2%**	**23.2%**	**23.3%**

Table 126: Nooksack River Spring Chinook Exploitation Rates

	Total Exploitation Rate				SEAK Exploitation Rate				Canadian Exploitation Rate				SUS Exploitation Rate			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	60.4%	52.3%	52.9%	50.4%	7.3%	6.8%	7.8%	7.2%	49.2%	36.2%	35.9%	33.7%	4.0%	9.2%	9.1%	9.5%
2000	55.4%	45.7%	46.1%	43.4%	4.2%	3.5%	4.0%	3.7%	43.3%	32.5%	32.4%	29.7%	7.8%	9.7%	9.7%	10.0%
2001	35.9%	34.7%	35.0%	33.2%	3.6%	2.6%	3.0%	2.5%	25.9%	22.9%	22.8%	21.4%	6.4%	9.2%	9.2%	9.4%
2002	44.8%	42.7%	43.0%	41.5%	4.2%	3.2%	3.7%	2.9%	35.6%	31.8%	31.7%	30.8%	5.0%	7.7%	7.6%	7.8%
2003	47.3%	38.7%	38.9%	38.1%	3.5%	3.3%	3.5%	2.5%	39.9%	28.0%	28.0%	28.1%	3.9%	7.4%	7.4%	7.5%
2004	49.9%	42.0%	42.0%	41.5%	3.2%	3.1%	3.1%	2.6%	39.8%	32.8%	32.8%	32.8%	6.9%	6.1%	6.1%	6.1%
2005	37.9%	31.1%	31.3%	30.1%	4.1%	3.4%	3.7%	3.3%	28.8%	21.0%	21.0%	20.0%	5.0%	6.6%	6.6%	6.7%
2006	41.0%	31.3%	31.5%	29.0%	4.1%	3.4%	3.7%	2.8%	30.1%	21.1%	21.1%	19.3%	6.8%	6.8%	6.8%	6.9%
2007	40.0%	30.4%	30.6%	27.7%	4.7%	4.5%	4.7%	3.5%	29.6%	20.8%	20.8%	18.9%	5.7%	5.1%	5.1%	5.3%
2008	36.5%	31.3%	31.4%	29.4%	3.5%	3.2%	3.4%	2.9%	28.3%	21.3%	21.3%	19.5%	4.8%	6.8%	6.8%	6.9%
2009	36.8%	34.7%	34.9%	32.4%	4.3%	4.0%	4.3%	3.3%	26.5%	22.3%	22.3%	20.7%	6.0%	8.3%	8.3%	8.5%
2010	37.4%	38.1%	38.5%	36.2%	4.9%	4.8%	5.3%	4.2%	25.7%	25.0%	25.0%	23.5%	6.7%	8.2%	8.2%	8.4%
2011	46.1%	44.6%	44.9%	40.1%	3.7%	4.2%	4.4%	3.4%	35.1%	35.4%	35.5%	31.5%	7.3%	5.0%	5.0%	5.3%
2012	33.1%	28.3%	28.6%	27.2%	3.8%	4.1%	4.5%	3.4%	20.1%	16.5%	16.4%	16.1%	9.2%	7.7%	7.6%	7.7%
2013	33.0%	29.3%	29.8%	28.2%	3.1%	2.8%	3.3%	3.2%	17.5%	16.9%	16.9%	15.2%	12.4%	9.7%	9.6%	9.8%
2014	50.2%	40.1%	40.6%	37.2%	4.2%	3.1%	3.6%	3.3%	35.0%	29.5%	29.5%	26.2%	11.1%	7.5%	7.5%	7.7%
'99-'14 Avg	**42.9%**	**37.2%**	**37.5%**	**35.3%**	**4.1%**	**3.8%**	**4.1%**	**3.4%**	**31.9%**	**25.9%**	**25.8%**	**24.2%**	**6.8%**	**7.6%**	**7.5%**	**7.7%**

Table 127: Skagit River Spring Chinook Exploitation Rates

	Total Exploitation Rate				SEAK Exploitation Rate				Canadian Exploitation Rate				SUS Exploitation Rate			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	17.0%	26.8%	26.9%	26.4%	0.7%	0.6%	0.7%	0.6%	12.1%	8.2%	8.3%	7.7%	4.3%	17.9%	17.9%	18.0%
2000	30.3%	26.1%	26.2%	25.1%	0.3%	0.3%	0.3%	0.3%	20.0%	14.4%	14.4%	13.2%	10.0%	11.5%	11.5%	11.6%
2001	10.7%	14.3%	14.3%	14.0%	0.3%	0.2%	0.2%	0.2%	6.1%	4.9%	4.9%	4.6%	4.4%	9.2%	9.2%	9.2%
2002	16.7%	20.8%	20.9%	20.7%	0.3%	0.3%	0.3%	0.2%	10.8%	8.5%	8.5%	8.3%	5.6%	12.1%	12.1%	12.1%
2003	16.6%	20.2%	20.2%	20.1%	0.3%	0.2%	0.2%	0.2%	11.9%	7.7%	7.7%	7.7%	4.4%	12.2%	12.2%	12.2%
2004	19.2%	22.3%	22.3%	22.2%	0.3%	0.3%	0.3%	0.2%	13.4%	9.7%	9.7%	9.7%	5.6%	12.3%	12.3%	12.3%
2005	21.2%	24.2%	24.2%	23.6%	0.3%	0.3%	0.3%	0.3%	16.2%	11.7%	11.7%	11.0%	4.8%	12.2%	12.2%	12.3%
2006	13.7%	17.1%	17.1%	16.7%	0.4%	0.3%	0.3%	0.3%	8.4%	6.1%	6.1%	5.7%	4.9%	10.7%	10.7%	10.7%
2007	29.5%	33.6%	33.6%	32.7%	0.3%	0.3%	0.4%	0.3%	20.6%	15.3%	15.3%	14.2%	8.5%	18.0%	17.9%	18.2%
2008	16.0%	16.6%	16.6%	16.2%	0.4%	0.3%	0.3%	0.3%	7.9%	6.1%	6.1%	5.7%	7.7%	10.2%	10.2%	10.2%
2009	23.5%	22.2%	22.2%	21.6%	0.4%	0.4%	0.4%	0.3%	10.5%	8.6%	8.6%	8.0%	12.7%	13.2%	13.2%	13.3%
2010	16.1%	16.3%	16.3%	15.9%	0.3%	0.3%	0.3%	0.2%	7.4%	7.2%	7.2%	6.8%	8.3%	8.8%	8.8%	8.8%
2011	28.2%	25.1%	25.2%	23.9%	0.4%	0.4%	0.4%	0.3%	15.5%	14.9%	14.9%	13.6%	12.3%	9.8%	9.8%	10.0%
2012	19.9%	19.9%	19.9%	19.7%	0.3%	0.3%	0.4%	0.3%	9.2%	7.7%	7.7%	7.6%	10.4%	11.9%	11.9%	11.9%
2013	16.6%	16.1%	16.1%	15.8%	0.2%	0.2%	0.2%	0.2%	4.8%	4.2%	4.2%	3.9%	11.6%	11.6%	11.6%	11.7%
2014	21.4%	17.3%	17.3%	16.7%	0.3%	0.2%	0.3%	0.3%	10.9%	8.2%	8.2%	7.5%	10.2%	8.9%	8.9%	8.9%
'99-'14 Avg	**19.8%**	**21.2%**	**21.2%**	**20.7%**	**0.3%**	**0.3%**	**0.3%**	**0.3%**	**11.6%**	**9.0%**	**9.0%**	**8.5%**	**7.8%**	**11.9%**	**11.9%**	**12.0%**

Table 128: Skagit River Summer/Fall Chinook Exploitation Rates

	Total Exploitation Rate				SEAK Exploitation Rate				Canadian Exploitation Rate				SUS Exploitation Rate			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	36.8%	41.3%	42.3%	41.0%	11.5%	9.1%	10.4%	9.2%	18.1%	15.3%	15.2%	14.8%	7.3%	17.0%	16.8%	17.0%
2000	29.6%	41.6%	42.3%	41.4%	8.6%	6.2%	7.1%	6.3%	15.4%	14.6%	14.6%	14.1%	5.5%	20.8%	20.6%	20.9%
2001	26.6%	39.0%	39.6%	38.7%	7.3%	5.1%	5.8%	5.0%	12.4%	13.2%	13.1%	12.8%	7.0%	20.8%	20.6%	20.9%
2002	27.0%	40.2%	40.7%	39.4%	7.2%	5.3%	6.1%	4.7%	15.1%	14.5%	14.5%	14.2%	4.7%	20.3%	20.2%	20.5%
2003	34.1%	43.1%	43.5%	42.3%	7.4%	6.1%	6.5%	4.8%	19.7%	15.9%	15.9%	16.0%	7.0%	21.1%	21.0%	21.4%
2004	36.1%	43.0%	42.9%	41.8%	7.2%	6.6%	6.6%	5.3%	21.9%	16.4%	16.4%	16.2%	7.0%	20.0%	20.0%	20.3%
2005	41.0%	44.0%	44.4%	43.5%	9.2%	7.6%	8.2%	7.4%	20.3%	16.4%	16.3%	15.8%	11.6%	20.0%	19.9%	20.2%
2006	37.4%	44.7%	45.0%	43.2%	7.7%	5.9%	6.4%	4.9%	18.8%	15.8%	15.8%	15.0%	10.9%	22.9%	22.8%	23.3%
2007	49.6%	45.5%	45.9%	43.1%	9.8%	9.2%	9.7%	7.2%	24.3%	19.3%	19.3%	18.5%	15.5%	17.0%	16.9%	17.4%
2008	47.3%	44.9%	45.1%	43.9%	8.3%	7.5%	7.8%	6.8%	21.1%	15.8%	15.8%	15.0%	17.8%	21.6%	21.6%	22.0%
2009	61.6%	41.9%	42.3%	40.0%	8.6%	8.0%	8.6%	6.5%	20.2%	16.9%	16.9%	16.1%	32.8%	17.0%	16.9%	17.4%
2010	39.0%	38.1%	38.7%	36.6%	9.2%	8.6%	9.4%	7.3%	15.5%	14.5%	14.4%	14.1%	14.2%	15.0%	14.9%	15.2%
2011	61.7%	47.5%	47.9%	44.7%	8.3%	9.3%	9.8%	7.4%	21.7%	21.2%	21.2%	19.5%	31.8%	17.0%	16.9%	17.9%
2012	40.4%	46.6%	46.9%	45.2%	7.3%	7.9%	8.5%	6.4%	18.7%	16.2%	16.1%	16.1%	14.4%	22.4%	22.2%	22.7%
2013	41.3%	41.1%	41.9%	41.0%	5.9%	5.6%	6.8%	6.1%	14.3%	12.2%	12.1%	11.7%	21.0%	23.3%	23.0%	23.3%
2014	43.0%	39.7%	40.6%	38.8%	8.9%	6.6%	7.6%	7.0%	19.8%	18.1%	18.0%	16.5%	14.3%	15.0%	14.9%	15.3%
'99-'14 Avg	**40.8%**	**42.6%**	**43.1%**	**41.5%**	**8.3%**	**7.2%**	**7.8%**	**6.4%**	**18.6%**	**16.0%**	**16.0%**	**15.4%**	**13.9%**	**19.5%**	**19.3%**	**19.7%**

Table 129: Stillaguamish River Chinook Exploitation Rates

	Total Exploitation Rate				SEAK Exploitation Rate				Canadian Exploitation Rate				SUS Exploitation Rate			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	26.7%	23.9%	24.3%	23.5%	4.1%	3.2%	3.6%	3.3%	15.9%	12.5%	12.5%	12.0%	6.7%	8.2%	8.2%	8.3%
2000	20.1%	13.3%	13.5%	13.0%	1.6%	1.3%	1.4%	1.3%	11.4%	6.9%	6.9%	6.6%	7.0%	5.1%	5.1%	5.1%
2001	19.7%	16.0%	16.1%	15.6%	1.3%	1.0%	1.1%	0.9%	9.8%	7.5%	7.5%	7.2%	8.6%	7.5%	7.5%	7.5%
2002	26.5%	23.3%	23.5%	22.7%	2.1%	1.7%	1.9%	1.5%	15.1%	12.8%	12.8%	12.3%	9.4%	8.9%	8.8%	8.9%
2003	28.1%	22.8%	22.9%	22.5%	2.0%	1.8%	1.8%	1.3%	18.3%	12.9%	12.9%	12.9%	7.8%	8.2%	8.2%	8.3%
2004	30.1%	17.7%	17.7%	17.4%	1.4%	1.4%	1.4%	1.2%	14.6%	10.1%	10.1%	10.0%	14.0%	6.2%	6.2%	6.2%
2005	21.8%	18.5%	18.7%	18.2%	2.3%	1.8%	2.0%	1.7%	14.4%	11.6%	11.6%	11.3%	5.1%	5.1%	5.1%	5.1%
2006	10.6%	8.3%	8.4%	7.9%	0.8%	0.7%	0.7%	0.5%	6.6%	4.7%	4.8%	4.5%	3.2%	2.9%	2.9%	2.9%
2007	36.2%	23.9%	24.0%	22.4%	2.9%	3.0%	3.1%	2.5%	23.1%	18.4%	18.4%	17.4%	10.2%	2.5%	2.5%	2.5%
2008	20.8%	18.0%	18.0%	17.1%	1.5%	1.4%	1.5%	1.3%	15.1%	11.0%	11.0%	10.3%	4.2%	5.5%	5.5%	5.5%
2009	21.1%	18.4%	18.5%	17.2%	1.9%	1.8%	1.9%	1.4%	14.3%	11.1%	11.1%	10.3%	4.9%	5.5%	5.5%	5.5%
2010	15.0%	15.4%	15.5%	14.8%	1.5%	1.5%	1.6%	1.3%	8.6%	8.3%	8.3%	8.0%	4.9%	5.6%	5.6%	5.6%
2011	31.8%	24.0%	24.1%	21.6%	2.2%	2.7%	2.8%	2.1%	18.7%	18.8%	18.8%	16.9%	10.9%	2.6%	2.6%	2.6%
2012	19.1%	18.1%	18.3%	17.7%	1.6%	1.7%	1.9%	1.5%	11.9%	10.4%	10.4%	10.2%	5.7%	6.0%	6.0%	6.0%
2013	12.7%	11.6%	11.8%	11.3%	0.9%	0.8%	0.9%	0.9%	5.8%	6.0%	6.0%	5.5%	6.0%	4.9%	4.9%	4.9%
2014	32.2%	23.9%	24.2%	22.4%	2.6%	1.9%	2.2%	1.9%	17.2%	15.2%	15.2%	13.6%	12.4%	6.8%	6.8%	6.9%
'99-'14 Avg	**23.3%**	**18.6%**	**18.7%**	**17.8%**	**1.9%**	**1.7%**	**1.9%**	**1.5%**	**13.8%**	**11.1%**	**11.1%**	**10.6%**	**7.6%**	**5.7%**	**5.7%**	**5.7%**

Table 130: Snohomish River Chinook Exploitation Rates

	Total Exploitation Rate				SEAK Exploitation Rate				Canadian Exploitation Rate				SUS Exploitation Rate			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	21.7%	19.5%	19.6%	19.2%	0.4%	0.3%	0.4%	0.3%	12.0%	10.1%	10.1%	9.8%	9.3%	9.1%	9.1%	9.1%
2000	24.4%	15.4%	15.4%	15.1%	0.3%	0.3%	0.3%	0.3%	11.4%	7.8%	7.8%	7.5%	12.7%	7.3%	7.3%	7.3%
2001	18.4%	14.1%	14.1%	13.8%	0.3%	0.2%	0.2%	0.2%	9.1%	7.3%	7.3%	7.0%	9.0%	6.6%	6.6%	6.6%
2002	22.5%	18.9%	18.9%	18.5%	0.4%	0.3%	0.3%	0.3%	11.9%	10.8%	10.8%	10.4%	10.2%	7.8%	7.8%	7.8%
2003	24.9%	20.7%	20.7%	20.6%	0.3%	0.2%	0.3%	0.2%	14.1%	11.2%	11.2%	11.2%	10.5%	9.2%	9.2%	9.2%
2004	22.0%	15.4%	15.4%	15.3%	0.3%	0.3%	0.3%	0.2%	13.6%	9.8%	9.8%	9.8%	8.1%	5.3%	5.3%	5.3%
2005	19.5%	17.0%	17.0%	16.8%	0.4%	0.3%	0.3%	0.3%	12.1%	10.1%	10.1%	10.0%	7.0%	6.5%	6.5%	6.5%
2006	18.3%	14.5%	14.6%	14.1%	0.3%	0.2%	0.3%	0.2%	11.4%	9.0%	9.0%	8.5%	6.6%	5.3%	5.3%	5.3%
2007	25.4%	16.6%	16.6%	15.7%	0.5%	0.5%	0.5%	0.4%	16.4%	12.2%	12.3%	11.5%	8.5%	3.8%	3.8%	3.8%
2008	16.2%	15.5%	15.5%	15.0%	0.3%	0.3%	0.3%	0.3%	10.6%	9.3%	9.3%	8.8%	5.3%	5.9%	5.9%	5.9%
2009	23.1%	17.9%	18.0%	17.2%	0.3%	0.3%	0.3%	0.3%	15.6%	11.4%	11.5%	10.8%	7.2%	6.2%	6.2%	6.2%
2010	12.5%	13.9%	13.9%	13.5%	0.3%	0.3%	0.3%	0.2%	8.2%	8.9%	8.9%	8.5%	4.0%	4.7%	4.7%	4.7%
2011	21.3%	18.1%	18.2%	16.5%	0.4%	0.4%	0.4%	0.4%	13.0%	14.1%	14.1%	12.5%	7.9%	3.6%	3.6%	3.6%
2012	18.7%	17.0%	17.0%	16.8%	0.3%	0.3%	0.3%	0.2%	11.5%	9.5%	9.5%	9.4%	6.9%	7.1%	7.1%	7.1%
2013	14.0%	13.2%	13.3%	12.9%	0.2%	0.2%	0.2%	0.2%	7.4%	7.0%	7.1%	6.7%	6.4%	6.0%	6.0%	6.0%
2014	22.6%	17.8%	17.9%	16.8%	0.3%	0.3%	0.3%	0.3%	12.8%	11.4%	11.4%	10.2%	9.5%	6.2%	6.2%	6.3%
'99-'14 Avg	**20.3%**	**16.6%**	**16.6%**	**16.1%**	**0.3%**	**0.3%**	**0.3%**	**0.3%**	**11.9%**	**10.0%**	**10.0%**	**9.5%**	**8.1%**	**6.3%**	**6.3%**	**6.3%**

Table 131: Lake Washington Chinook Exploitation Rates

	Total Exploitation Rate				SEAK Exploitation Rate				Canadian Exploitation Rate				SUS Exploitation Rate			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	25.2%	21.4%	21.4%	20.9%	0.3%	0.2%	0.2%	0.2%	12.8%	9.8%	9.8%	9.2%	12.2%	11.4%	11.4%	11.4%
2000	30.5%	20.4%	20.4%	19.9%	0.2%	0.1%	0.2%	0.1%	12.0%	8.3%	8.3%	7.8%	18.3%	11.9%	11.9%	12.0%
2001	24.4%	20.0%	20.0%	19.6%	0.1%	0.1%	0.1%	0.1%	9.5%	8.1%	8.1%	7.6%	14.8%	11.8%	11.8%	11.9%
2002	25.2%	21.8%	21.9%	21.4%	0.1%	0.1%	0.1%	0.1%	11.7%	11.2%	11.2%	10.7%	13.4%	10.5%	10.5%	10.6%
2003	29.1%	21.9%	21.9%	21.9%	0.1%	0.1%	0.1%	0.1%	14.9%	12.2%	12.2%	12.2%	14.1%	9.6%	9.6%	9.6%
2004	29.9%	21.9%	21.9%	21.8%	0.1%	0.1%	0.1%	0.1%	14.3%	10.0%	9.9%	9.9%	15.5%	11.8%	11.8%	11.8%
2005	35.6%	30.0%	30.0%	29.6%	0.2%	0.2%	0.2%	0.2%	17.5%	13.7%	13.7%	13.3%	17.9%	16.1%	16.1%	16.2%
2006	33.7%	29.1%	29.1%	28.4%	0.2%	0.2%	0.2%	0.1%	15.1%	10.9%	11.0%	10.2%	18.4%	18.0%	18.0%	18.1%
2007	33.1%	25.7%	25.7%	24.8%	0.2%	0.2%	0.2%	0.2%	18.3%	12.9%	12.9%	11.9%	14.6%	12.6%	12.6%	12.7%
2008	29.9%	29.5%	29.5%	28.9%	0.1%	0.1%	0.1%	0.1%	14.2%	10.3%	10.3%	9.5%	15.5%	19.1%	19.1%	19.3%
2009	38.5%	37.7%	37.7%	36.9%	0.2%	0.2%	0.2%	0.2%	15.6%	13.1%	13.2%	12.1%	22.7%	24.4%	24.4%	24.6%
2010	20.5%	21.9%	22.0%	21.4%	0.2%	0.2%	0.2%	0.2%	11.4%	11.2%	11.2%	10.6%	8.9%	10.6%	10.6%	10.6%
2011	32.9%	30.2%	30.3%	28.5%	0.1%	0.2%	0.2%	0.1%	14.5%	14.8%	14.8%	12.8%	18.2%	15.3%	15.3%	15.6%
2012	32.0%	29.1%	29.1%	28.9%	0.2%	0.2%	0.2%	0.2%	14.1%	11.6%	11.6%	11.4%	17.7%	17.3%	17.3%	17.3%
2013	22.5%	20.1%	20.1%	19.6%	0.1%	0.1%	0.1%	0.1%	8.6%	7.5%	7.6%	7.0%	13.8%	12.5%	12.5%	12.5%
2014	33.9%	28.9%	29.0%	27.5%	0.2%	0.2%	0.2%	0.2%	15.9%	13.8%	13.8%	12.2%	17.7%	15.0%	15.0%	15.2%
'99-'14 Avg	**29.8%**	**25.6%**	**25.6%**	**25.0%**	**0.2%**	**0.1%**	**0.2%**	**0.1%**	**13.8%**	**11.2%**	**11.2%**	**10.5%**	**15.9%**	**14.2%**	**14.2%**	**14.3%**

Table 132: Duwamish-Green River Chinook Exploitation Rates

	Total Exploitation Rate				SEAK Exploitation Rate				Canadian Exploitation Rate				SUS Exploitation Rate			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	33.2%	56.0%	56.0%	55.7%	0.3%	0.2%	0.2%	0.2%	12.8%	9.8%	9.8%	9.2%	20.2%	46.0%	46.0%	46.2%
2000	53.3%	56.0%	56.0%	55.7%	0.2%	0.1%	0.2%	0.1%	12.0%	8.3%	8.3%	7.8%	41.1%	47.6%	47.5%	47.8%
2001	46.8%	56.0%	56.0%	55.7%	0.1%	0.1%	0.1%	0.1%	9.5%	8.1%	8.1%	7.6%	37.2%	47.8%	47.8%	48.0%
2002	52.7%	56.0%	56.0%	55.7%	0.1%	0.1%	0.1%	0.1%	11.7%	11.2%	11.2%	10.7%	40.9%	44.7%	44.7%	44.9%
2003	50.1%	56.0%	56.0%	56.0%	0.1%	0.1%	0.1%	0.1%	14.9%	12.2%	12.2%	12.2%	35.1%	43.8%	43.7%	43.8%
2004	51.4%	56.0%	56.0%	56.0%	0.1%	0.1%	0.1%	0.1%	14.3%	10.0%	9.9%	9.9%	37.0%	46.0%	46.0%	46.0%
2005	40.9%	31.8%	31.8%	31.5%	0.2%	0.2%	0.2%	0.2%	17.5%	13.7%	13.7%	13.3%	23.2%	18.0%	18.0%	18.1%
2006	49.1%	56.0%	56.0%	55.6%	0.2%	0.2%	0.2%	0.1%	15.1%	10.9%	10.9%	10.2%	33.8%	44.9%	44.9%	45.3%
2007	56.0%	56.0%	56.0%	55.4%	0.2%	0.2%	0.2%	0.2%	18.3%	12.9%	12.9%	11.9%	37.5%	42.9%	42.8%	43.3%
2008	52.4%	56.0%	56.0%	55.5%	0.1%	0.1%	0.1%	0.1%	14.2%	10.3%	10.3%	9.5%	38.1%	45.6%	45.5%	45.9%
2009	51.8%	25.2%	25.2%	24.2%	0.2%	0.2%	0.2%	0.2%	15.6%	13.1%	13.1%	12.1%	36.0%	11.9%	11.9%	12.0%
2010	22.8%	25.0%	25.0%	24.5%	0.2%	0.2%	0.2%	0.2%	11.4%	11.2%	11.2%	10.6%	11.3%	13.6%	13.6%	13.7%
2011	48.4%	32.9%	33.0%	31.3%	0.1%	0.2%	0.2%	0.1%	14.5%	14.8%	14.8%	12.8%	33.7%	18.0%	18.0%	18.4%
2012	29.9%	27.2%	27.2%	27.0%	0.2%	0.2%	0.2%	0.2%	14.1%	11.6%	11.6%	11.4%	15.6%	15.4%	15.4%	15.4%
2013	22.1%	21.5%	21.6%	21.0%	0.1%	0.1%	0.1%	0.1%	8.6%	7.5%	7.6%	7.0%	13.4%	13.9%	13.9%	14.0%
2014	33.0%	29.2%	29.2%	27.8%	0.2%	0.2%	0.2%	0.2%	15.9%	13.8%	13.8%	12.2%	16.9%	15.3%	15.2%	15.4%
'99-'14 Avg	**43.4%**	**43.5%**	**43.6%**	**43.0%**	**0.2%**	**0.1%**	**0.2%**	**0.1%**	**13.8%**	**11.2%**	**11.2%**	**10.5%**	**29.4%**	**32.2%**	**32.2%**	**32.4%**

Table 133: Puyallup River Chinook Exploitation Rates

	Total Exploitation Rate				SEAK Exploitation Rate				Canadian Exploitation Rate				SUS Exploitation Rate			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	39.5%	36.6%	36.6%	36.2%	0.3%	0.2%	0.2%	0.2%	12.8%	9.8%	9.8%	9.2%	26.4%	26.6%	26.6%	26.7%
2000	52.3%	45.9%	45.9%	45.5%	0.2%	0.1%	0.2%	0.1%	12.0%	8.3%	8.3%	7.8%	40.1%	37.4%	37.4%	37.6%
2001	63.9%	62.0%	62.0%	61.8%	0.1%	0.1%	0.1%	0.1%	9.5%	8.1%	8.1%	7.6%	54.3%	53.8%	53.8%	54.1%
2002	55.8%	53.9%	54.0%	53.7%	0.1%	0.1%	0.1%	0.1%	11.7%	11.2%	11.2%	10.7%	44.0%	42.6%	42.6%	42.9%
2003	54.5%	50.9%	50.9%	50.9%	0.1%	0.1%	0.1%	0.1%	14.9%	12.2%	12.2%	12.2%	39.5%	38.6%	38.6%	38.6%
2004	68.8%	65.8%	65.8%	65.8%	0.1%	0.1%	0.1%	0.1%	14.3%	10.0%	9.9%	9.9%	54.4%	55.7%	55.7%	55.8%
2005	60.9%	50.0%	50.0%	49.8%	0.2%	0.2%	0.2%	0.2%	17.5%	13.7%	13.7%	13.3%	43.2%	36.2%	36.1%	36.3%
2006	49.8%	47.3%	47.3%	46.8%	0.2%	0.2%	0.2%	0.1%	15.1%	10.9%	11.0%	10.2%	34.5%	36.2%	36.2%	36.5%
2007	50.9%	45.6%	45.6%	44.9%	0.2%	0.2%	0.2%	0.2%	18.3%	12.9%	12.9%	11.9%	32.3%	32.4%	32.4%	32.8%
2008	48.2%	47.2%	47.2%	46.7%	0.1%	0.1%	0.1%	0.1%	14.2%	10.3%	10.3%	9.5%	33.9%	36.8%	36.8%	37.1%
2009	45.8%	43.9%	44.0%	43.2%	0.2%	0.2%	0.2%	0.2%	15.6%	13.1%	13.2%	12.1%	30.0%	30.6%	30.6%	30.9%
2010	53.4%	54.1%	54.1%	53.7%	0.2%	0.2%	0.2%	0.2%	11.4%	11.2%	11.2%	10.6%	41.8%	42.7%	42.7%	43.0%
2011	49.5%	47.5%	47.6%	46.2%	0.1%	0.2%	0.2%	0.1%	14.5%	14.8%	14.8%	12.8%	34.9%	32.6%	32.6%	33.3%
2012	61.4%	41.8%	41.8%	41.6%	0.2%	0.2%	0.2%	0.2%	14.1%	11.6%	11.6%	11.4%	47.1%	30.0%	30.0%	30.1%
2013	58.6%	39.2%	39.3%	38.9%	0.1%	0.1%	0.1%	0.1%	8.6%	7.5%	7.6%	7.0%	49.9%	31.6%	31.6%	31.8%
2014	55.1%	51.8%	51.8%	50.8%	0.2%	0.2%	0.2%	0.2%	15.9%	13.8%	13.8%	12.2%	39.0%	37.8%	37.8%	38.5%
'99-'14 Avg	**54.3%**	**49.0%**	**49.0%**	**48.5%**	**0.2%**	**0.1%**	**0.2%**	**0.1%**	**13.8%**	**11.2%**	**11.2%**	**10.5%**	**40.3%**	**37.6%**	**37.6%**	**37.9%**

Table 134: Nisqually River Chinook Exploitation Rates

	Total Exploitation Rate				SEAK Exploitation Rate				Canadian Exploitation Rate				SUS Exploitation Rate			
Year	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4	S1	S2	S3	S4
1999	66.4%	47.0%	47.0%	46.7%	0.1%	0.1%	0.1%	0.1%	8.2%	5.9%	5.9%	5.5%	58.1%	41.0%	41.0%	41.1%
2000	55.3%	46.7%	46.7%	46.5%	0.1%	0.1%	0.1%	0.1%	7.7%	4.5%	4.5%	4.2%	47.6%	42.1%	42.0%	42.2%
2001	61.7%	47.0%	47.0%	46.8%	0.1%	0.0%	0.0%	0.0%	5.9%	5.0%	5.0%	4.6%	55.8%	42.0%	42.0%	42.2%
2002	82.1%	47.0%	47.0%	46.6%	0.1%	0.1%	0.1%	0.1%	9.7%	9.5%	9.5%	9.0%	72.3%	37.4%	37.4%	37.6%
2003	84.2%	47.0%	47.0%	47.0%	0.1%	0.0%	0.1%	0.0%	10.2%	7.9%	7.9%	7.9%	73.9%	39.0%	39.0%	39.0%
2004	70.2%	47.0%	47.0%	47.0%	0.1%	0.1%	0.1%	0.1%	11.1%	7.5%	7.5%	7.5%	59.0%	39.4%	39.4%	39.4%
2005	62.2%	47.0%	47.0%	46.8%	0.1%	0.1%	0.1%	0.1%	9.3%	7.2%	7.2%	6.9%	52.8%	39.7%	39.7%	39.8%
2006	72.2%	47.1%	47.1%	46.7%	0.1%	0.1%	0.1%	0.1%	10.2%	7.1%	7.2%	6.6%	62.0%	39.9%	39.9%	40.1%
2007	69.3%	47.0%	47.0%	46.5%	0.1%	0.1%	0.1%	0.1%	12.6%	8.7%	8.8%	8.0%	56.6%	38.2%	38.2%	38.5%
2008	72.2%	47.0%	47.0%	46.5%	0.1%	0.1%	0.1%	0.1%	11.0%	7.9%	7.9%	7.2%	61.2%	39.0%	39.0%	39.2%
2009	73.9%	47.0%	47.0%	46.3%	0.1%	0.1%	0.1%	0.1%	12.3%	10.4%	10.4%	9.4%	61.5%	36.5%	36.5%	36.8%
2010	60.4%	47.0%	47.0%	46.8%	0.0%	0.0%	0.0%	0.0%	8.0%	7.5%	7.5%	7.0%	52.4%	39.5%	39.5%	39.7%
2011	55.0%	47.0%	47.0%	45.7%	0.1%	0.1%	0.1%	0.1%	13.0%	13.6%	13.6%	11.6%	41.9%	33.3%	33.3%	34.0%
2012	50.9%	47.0%	47.0%	46.9%	0.1%	0.1%	0.1%	0.0%	8.8%	6.9%	6.9%	6.8%	42.0%	40.0%	40.0%	40.0%
2013	46.4%	45.5%	45.5%	45.1%	0.0%	0.0%	0.0%	0.0%	6.8%	6.1%	6.2%	5.6%	39.6%	39.3%	39.3%	39.5%
2014	51.2%	47.0%	47.0%	46.2%	0.1%	0.1%	0.1%	0.1%	9.7%	8.5%	8.5%	7.3%	41.5%	38.4%	38.4%	38.8%
'99-'14 Avg	**64.6%**	**46.9%**	**46.9%**	**46.5%**	**0.1%**	**0.1%**	**0.1%**	**0.1%**	**9.7%**	**7.8%**	**7.8%**	**7.2%**	**54.9%**	**39.0%**	**39.0%**	**39.3%**

Table 135: White River Spring Chinook Exploitation Rates

	Total Exploitation Rate				SEAK Exploitation Rate				Canadian Exploitation Rate				SUS Exploitation Rate			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	25.8%	18.8%	18.9%	18.3%	0.8%	0.8%	0.9%	0.8%	9.9%	7.5%	7.5%	6.9%	15.0%	10.5%	10.5%	10.5%
2000	36.5%	20.6%	20.7%	19.5%	0.1%	0.1%	0.1%	0.1%	19.7%	12.7%	12.8%	11.5%	16.7%	7.8%	7.8%	7.9%
2001	19.1%	12.1%	12.1%	12.0%	0.2%	0.2%	0.2%	0.2%	3.8%	3.1%	3.1%	2.9%	15.0%	8.8%	8.8%	8.8%
2002	26.5%	17.4%	17.4%	17.2%	0.3%	0.3%	0.3%	0.3%	10.2%	8.5%	8.6%	8.4%	15.9%	8.6%	8.6%	8.6%
2003	28.2%	18.3%	18.3%	18.3%	0.2%	0.2%	0.2%	0.1%	11.5%	6.4%	6.4%	6.4%	16.5%	11.7%	11.7%	11.7%
2004	25.7%	18.1%	18.0%	18.0%	0.3%	0.3%	0.3%	0.2%	12.5%	8.4%	8.4%	8.4%	12.9%	9.4%	9.4%	9.4%
2005	28.1%	21.5%	21.5%	20.8%	0.2%	0.2%	0.2%	0.2%	15.7%	10.7%	10.7%	10.0%	12.2%	10.6%	10.6%	10.7%
2006	29.1%	22.7%	22.7%	22.2%	0.5%	0.5%	0.5%	0.4%	10.1%	7.0%	7.0%	6.5%	18.5%	15.3%	15.2%	15.3%
2007	27.5%	18.5%	18.5%	17.7%	0.2%	0.2%	0.2%	0.2%	13.0%	9.1%	9.1%	8.4%	14.3%	9.1%	9.1%	9.2%
2008	26.9%	24.5%	24.5%	24.0%	0.2%	0.2%	0.2%	0.2%	8.5%	6.5%	6.5%	6.0%	18.2%	17.8%	17.8%	17.9%
2009	26.9%	22.7%	22.7%	22.2%	0.2%	0.2%	0.3%	0.2%	11.3%	7.6%	7.6%	7.1%	15.3%	14.8%	14.8%	14.9%
2010	22.5%	23.4%	23.4%	23.1%	0.3%	0.2%	0.2%	0.2%	5.3%	5.8%	5.9%	5.5%	17.0%	17.3%	17.3%	17.4%
2011	23.0%	17.1%	17.1%	16.6%	0.3%	0.3%	0.3%	0.3%	8.1%	6.9%	6.9%	6.5%	14.7%	9.8%	9.8%	9.8%
2012	21.3%	22.3%	22.3%	22.1%	0.1%	0.2%	0.2%	0.1%	6.7%	6.8%	6.8%	6.7%	14.5%	15.3%	15.3%	15.3%
2013	11.5%	11.8%	11.9%	11.6%	0.1%	0.1%	0.2%	0.1%	3.0%	3.3%	3.3%	3.0%	8.4%	8.4%	8.4%	8.5%
2014	30.4%	25.6%	25.7%	25.3%	0.2%	0.2%	0.2%	0.2%	7.8%	5.0%	5.0%	4.6%	22.4%	20.4%	20.4%	20.4%
'99-'14 Avg	**25.6%**	**19.7%**	**19.7%**	**19.3%**	**0.3%**	**0.3%**	**0.3%**	**0.2%**	**9.8%**	**7.2%**	**7.2%**	**6.8%**	**15.5%**	**12.2%**	**12.2%**	**12.3%**

Table 136: Skokomish River Chinook Exploitation Rates

	Total Exploitation Rate				SEAK Exploitation Rate				Canadian Exploitation Rate				SUS Exploitation Rate			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	38.4%	35.9%	35.9%	35.6%	0.5%	0.4%	0.5%	0.4%	9.8%	7.6%	7.6%	7.2%	28.1%	27.9%	27.9%	28.0%
2000	43.8%	37.5%	37.6%	37.3%	0.8%	0.6%	0.7%	0.6%	8.2%	5.6%	5.7%	5.4%	34.8%	31.2%	31.2%	31.3%
2001	55.9%	50.0%	50.0%	49.7%	0.5%	0.3%	0.4%	0.3%	8.0%	6.9%	6.9%	6.4%	47.4%	42.7%	42.7%	42.9%
2002	52.1%	50.0%	50.0%	49.6%	0.5%	0.4%	0.5%	0.4%	12.1%	12.1%	12.1%	11.4%	39.4%	37.5%	37.5%	37.8%
2003	57.5%	50.0%	50.0%	49.9%	0.4%	0.3%	0.4%	0.3%	13.0%	10.3%	10.3%	10.3%	44.1%	39.3%	39.3%	39.4%
2004	55.6%	49.3%	49.2%	49.1%	0.4%	0.4%	0.4%	0.3%	13.8%	9.4%	9.3%	9.3%	41.5%	39.5%	39.5%	39.6%
2005	56.8%	49.9%	50.0%	49.8%	0.4%	0.3%	0.4%	0.3%	11.0%	8.7%	8.7%	8.5%	45.4%	40.9%	40.9%	41.0%
2006	63.9%	50.0%	50.0%	49.6%	0.6%	0.4%	0.4%	0.4%	11.1%	8.1%	8.1%	7.5%	52.3%	41.4%	41.4%	41.7%
2007	68.6%	41.4%	41.5%	40.6%	0.7%	0.7%	0.7%	0.5%	15.5%	10.8%	10.8%	9.9%	52.3%	29.9%	29.9%	30.3%
2008	64.7%	50.0%	50.0%	49.5%	0.5%	0.5%	0.5%	0.4%	13.2%	9.6%	9.6%	8.8%	50.9%	39.9%	39.9%	40.2%
2009	62.5%	50.0%	50.1%	49.4%	0.6%	0.5%	0.6%	0.4%	13.5%	11.4%	11.4%	10.3%	48.4%	38.0%	38.1%	38.6%
2010	55.0%	50.0%	50.0%	49.6%	0.5%	0.4%	0.5%	0.4%	10.9%	10.2%	10.2%	9.7%	43.5%	39.3%	39.3%	39.6%
2011	55.2%	50.0%	50.0%	48.5%	0.5%	0.5%	0.6%	0.5%	14.9%	15.3%	15.3%	13.0%	39.8%	34.2%	34.2%	35.0%
2012	61.0%	50.0%	49.9%	49.8%	0.4%	0.4%	0.4%	0.3%	11.3%	9.2%	9.2%	9.0%	49.3%	40.4%	40.3%	40.4%
2013	49.3%	48.7%	48.7%	48.3%	0.4%	0.3%	0.4%	0.3%	8.3%	7.6%	7.6%	6.9%	40.7%	40.8%	40.7%	41.0%
2014	58.8%	50.0%	50.0%	49.2%	0.5%	0.4%	0.4%	0.4%	11.0%	10.0%	10.0%	8.7%	47.3%	39.6%	39.6%	40.1%
'99-'14 Avg	**56.2%**	**47.6%**	**47.7%**	**47.2%**	**0.5%**	**0.4%**	**0.5%**	**0.4%**	**11.6%**	**9.5%**	**9.6%**	**8.9%**	**44.1%**	**37.7%**	**37.7%**	**37.9%**

Table 137: Mid-Hood Canal Chinook Exploitation Rates

	Total Exploitation Rate				SEAK Exploitation Rate				Canadian Exploitation Rate				SUS Exploitation Rate			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	22.1%	19.2%	19.3%	18.9%	0.6%	0.4%	0.5%	0.4%	9.9%	7.6%	7.6%	7.2%	11.7%	11.2%	11.2%	11.2%
2000	23.8%	18.1%	18.2%	17.8%	0.9%	0.6%	0.7%	0.6%	8.5%	5.7%	5.7%	5.4%	14.4%	11.7%	11.7%	11.7%
2001	23.6%	20.0%	20.1%	19.6%	0.5%	0.4%	0.4%	0.3%	8.0%	7.0%	7.0%	6.5%	15.1%	12.7%	12.7%	12.8%
2002	24.6%	22.6%	22.7%	21.9%	0.5%	0.4%	0.5%	0.4%	12.4%	12.2%	12.2%	11.5%	11.7%	10.0%	10.0%	10.1%
2003	25.6%	21.2%	21.3%	21.2%	0.4%	0.3%	0.4%	0.3%	13.3%	10.4%	10.4%	10.4%	11.8%	10.5%	10.5%	10.5%
2004	29.5%	21.6%	21.6%	21.5%	0.4%	0.4%	0.4%	0.3%	14.3%	9.4%	9.4%	9.4%	14.7%	11.8%	11.8%	11.8%
2005	24.2%	19.6%	19.7%	19.5%	0.4%	0.4%	0.4%	0.3%	11.3%	8.7%	8.7%	8.5%	12.5%	10.6%	10.6%	10.6%
2006	22.6%	19.5%	19.5%	18.8%	0.6%	0.4%	0.5%	0.4%	11.4%	8.2%	8.2%	7.6%	10.7%	10.9%	10.9%	10.9%
2007	27.0%	20.0%	20.0%	18.9%	0.8%	0.7%	0.7%	0.5%	16.2%	10.9%	10.9%	10.0%	10.1%	8.4%	8.4%	8.4%
2008	24.2%	22.3%	22.3%	21.6%	0.6%	0.5%	0.5%	0.4%	13.4%	9.7%	9.7%	8.9%	10.3%	12.2%	12.2%	12.3%
2009	22.2%	21.2%	21.3%	20.1%	0.6%	0.5%	0.6%	0.4%	13.6%	11.5%	11.5%	10.4%	8.0%	9.2%	9.2%	9.3%
2010	20.6%	21.7%	21.7%	21.1%	0.5%	0.4%	0.5%	0.4%	11.0%	10.3%	10.3%	9.8%	9.0%	10.9%	10.9%	11.0%
2011	25.1%	23.6%	23.7%	21.4%	0.5%	0.5%	0.6%	0.5%	15.1%	15.4%	15.4%	13.2%	9.5%	7.7%	7.7%	7.7%
2012	25.3%	21.7%	21.7%	21.4%	0.4%	0.4%	0.4%	0.3%	11.4%	9.2%	9.2%	9.1%	13.5%	12.0%	12.0%	12.0%
2013	20.0%	18.5%	18.6%	17.9%	0.4%	0.3%	0.4%	0.3%	8.3%	7.7%	7.7%	7.0%	11.3%	10.6%	10.6%	10.6%
2014	25.9%	20.3%	20.4%	19.1%	0.5%	0.4%	0.4%	0.4%	11.1%	10.1%	10.1%	8.8%	14.3%	9.8%	9.8%	9.9%
'99-'14 Avg	**24.2%**	**20.7%**	**20.7%**	**20.0%**	**0.5%**	**0.4%**	**0.5%**	**0.4%**	**11.8%**	**9.6%**	**9.6%**	**9.0%**	**11.8%**	**10.6%**	**10.6%**	**10.7%**

Table 138: Dungeness River Chinook Exploitation Rates

	Total Exploitation Rate				SEAK Exploitation Rate				Canadian Exploitation Rate				SUS Exploitation Rate			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	16.2%	12.9%	13.2%	12.6%	2.9%	2.3%	2.6%	2.3%	10.8%	8.2%	8.2%	7.8%	2.5%	2.5%	2.5%	2.5%
2000	10.4%	7.0%	7.1%	6.8%	1.1%	0.8%	0.9%	0.8%	6.9%	3.9%	3.9%	3.7%	2.5%	2.3%	2.3%	2.3%
2001	7.3%	6.1%	6.1%	5.8%	0.7%	0.5%	0.6%	0.5%	4.8%	3.6%	3.6%	3.4%	1.8%	1.9%	1.9%	1.9%
2002	6.3%	5.9%	6.0%	5.7%	0.6%	0.5%	0.5%	0.4%	4.4%	3.8%	3.8%	3.6%	1.3%	1.7%	1.7%	1.7%
2003	11.5%	8.9%	9.0%	8.8%	1.0%	0.8%	0.9%	0.6%	8.4%	5.8%	5.8%	5.8%	2.2%	2.4%	2.4%	2.4%
2004	11.9%	7.4%	7.4%	7.2%	0.8%	0.7%	0.7%	0.6%	7.8%	4.8%	4.8%	4.8%	3.4%	1.8%	1.8%	1.8%
2005	8.3%	7.2%	7.3%	7.1%	1.0%	0.8%	0.8%	0.7%	5.8%	4.4%	4.4%	4.3%	1.6%	2.0%	2.0%	2.0%
2006	6.1%	4.8%	4.8%	4.4%	0.8%	0.6%	0.7%	0.5%	4.2%	2.8%	2.8%	2.6%	1.2%	1.4%	1.4%	1.4%
2007	17.8%	11.8%	11.9%	10.9%	1.7%	1.6%	1.7%	1.3%	12.7%	9.0%	9.0%	8.4%	3.4%	1.2%	1.2%	1.2%
2008	26.0%	20.9%	21.0%	19.8%	1.9%	1.9%	2.0%	1.6%	18.1%	13.2%	13.2%	12.2%	6.0%	5.9%	5.9%	6.0%
2009	15.8%	12.3%	12.4%	11.6%	1.1%	1.0%	1.1%	0.8%	7.1%	5.6%	5.6%	5.1%	7.5%	5.7%	5.7%	5.7%
2010	20.1%	19.2%	19.4%	18.4%	2.4%	2.4%	2.7%	2.1%	12.1%	11.1%	11.1%	10.6%	5.7%	5.7%	5.6%	5.7%
2011	25.3%	21.9%	22.0%	19.2%	2.2%	2.6%	2.7%	2.0%	17.9%	17.8%	17.8%	15.7%	5.3%	1.5%	1.5%	1.5%
2012	17.2%	16.2%	16.4%	15.8%	1.8%	1.8%	2.1%	1.6%	11.7%	10.0%	9.9%	9.8%	3.7%	4.4%	4.4%	4.4%
2013	10.4%	10.0%	10.2%	9.7%	1.0%	0.9%	1.1%	1.1%	5.8%	5.8%	5.8%	5.4%	3.6%	3.2%	3.2%	3.2%
2014	15.0%	11.2%	11.4%	10.2%	1.5%	1.0%	1.2%	1.0%	9.2%	7.9%	7.9%	6.9%	4.3%	2.3%	2.3%	2.3%
'99-'14 Avg	**14.1%**	**11.5%**	**11.6%**	**10.9%**	**1.4%**	**1.3%**	**1.4%**	**1.1%**	**9.2%**	**7.4%**	**7.4%**	**6.9%**	**3.5%**	**2.9%**	**2.9%**	**2.9%**

Table 139: Elwha River Chinook Exploitation Rates

	Total Exploitation Rate				SEAK Exploitation Rate				Canadian Exploitation Rate				SUS Exploitation Rate			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	16.3%	13.0%	13.4%	12.7%	2.9%	2.3%	2.6%	2.3%	10.7%	8.1%	8.1%	7.8%	2.7%	2.6%	2.6%	2.6%
2000	13.3%	8.6%	8.8%	8.3%	1.3%	1.0%	1.1%	1.0%	8.5%	4.8%	4.8%	4.5%	3.5%	2.9%	2.8%	2.9%
2001	9.5%	7.7%	7.8%	7.3%	0.9%	0.7%	0.8%	0.7%	6.2%	4.8%	4.8%	4.5%	2.3%	2.2%	2.2%	2.2%
2002	9.9%	8.8%	8.9%	8.5%	0.9%	0.7%	0.8%	0.6%	7.0%	6.1%	6.1%	5.8%	1.9%	2.0%	2.0%	2.0%
2003	12.1%	9.4%	9.4%	9.2%	1.0%	0.8%	0.9%	0.6%	8.9%	6.2%	6.2%	6.2%	2.2%	2.4%	2.4%	2.4%
2004	10.2%	6.4%	6.4%	6.3%	0.7%	0.7%	0.7%	0.6%	7.2%	4.5%	4.5%	4.4%	2.2%	1.3%	1.3%	1.3%
2005	5.8%	4.8%	4.9%	4.7%	0.7%	0.6%	0.6%	0.5%	4.2%	3.3%	3.3%	3.2%	0.9%	1.0%	1.0%	1.0%
2006	5.6%	4.3%	4.3%	4.0%	0.6%	0.5%	0.5%	0.4%	3.9%	2.6%	2.6%	2.5%	1.2%	1.2%	1.2%	1.2%
2007	18.4%	12.1%	12.2%	11.2%	1.8%	1.7%	1.8%	1.4%	13.3%	9.4%	9.4%	8.7%	3.3%	1.0%	1.0%	1.0%
2008	24.6%	19.4%	19.5%	18.3%	2.0%	1.9%	2.0%	1.7%	18.3%	13.3%	13.3%	12.3%	4.3%	4.2%	4.2%	4.3%
2009	10.0%	8.4%	8.5%	7.8%	1.0%	0.9%	1.0%	0.7%	6.6%	5.1%	5.1%	4.7%	2.4%	2.4%	2.4%	2.4%
2010	19.5%	18.6%	18.8%	17.8%	2.3%	2.4%	2.6%	2.1%	11.7%	10.8%	10.8%	10.3%	5.5%	5.5%	5.5%	5.5%
2011	25.6%	22.1%	22.3%	19.5%	2.3%	2.6%	2.7%	2.0%	18.1%	18.0%	18.1%	15.9%	5.3%	1.5%	1.5%	1.5%
2012	18.0%	17.0%	17.2%	16.6%	1.8%	1.9%	2.2%	1.7%	12.3%	10.5%	10.4%	10.3%	3.9%	4.6%	4.6%	4.6%
2013	11.0%	10.5%	10.7%	10.1%	1.1%	1.0%	1.2%	1.1%	6.1%	6.1%	6.1%	5.6%	3.8%	3.4%	3.4%	3.4%
2014	15.9%	11.8%	11.9%	10.7%	1.6%	1.1%	1.3%	1.1%	10.0%	8.6%	8.6%	7.6%	4.3%	2.0%	2.0%	2.0%
'99-'14 Avg	**14.1%**	**11.4%**	**11.6%**	**10.8%**	**1.4%**	**1.3%**	**1.4%**	**1.2%**	**9.6%**	**7.6%**	**7.6%**	**7.1%**	**3.1%**	**2.5%**	**2.5%**	**2.5%**

Section 3: Summary of Puget Sound Chinook Escapements

Table 140: Projected natural escapement by scenario for Dungeness and Elwha River Chinook

	Dungeness				Elwha			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	75	75	75	45	1,554	1,553	1,551	917
2000	218	224	224	134	1,851	1,909	1,906	1,145
2001	453	460	459	276	2,207	2,248	2,246	1,348
2002	633	639	639	383	2,375	2,405	2,403	1,444
2003	639	645	645	386	2,224	2,248	2,246	1,345
2004	1,005	1,028	1,028	615	3,400	3,476	3,476	2,084
2005	1,070	1,099	1,099	657	2,231	2,291	2,290	1,370
2006	1,511	1,526	1,525	916	1,920	1,938	1,937	1,162
2007	392	405	405	242	1,137	1,177	1,176	705
2008	222	230	230	135	1,131	1,172	1,172	698
2009	189	194	194	114	2,176	2,190	2,188	1,318
2010	435	445	445	266	1,266	1,295	1,295	772
2011	649	652	651	392	1,766	1,774	1,772	1,062
2012	614	627	627	375	2,492	2,544	2,544	1,520
2013	271	269	269	161	3,913	3,892	3,886	2,332
2014	198	199	199	119	3,806	3,832	3,827	2,299
'99-'14 Avg	**536**	**545**	**545**	**326**	**2,216**	**2,247**	**2,245**	**1,345**

Table 141: Projected natural escapement by scenario for Mid-Hood Canal Chinook

	Mid-Hood Canal			
Year	**S1**	**S2**	**S3**	**S4**
1999	881	888	888	521
2000	467	513	512	306
2001	322	332	332	197
2002	96	99	99	59
2003	201	212	212	126
2004	135	147	147	87
2005	47	51	51	31
2006	32	33	33	20
2007	77	88	88	52
2008	307	316	316	187
2009	145	148	148	89
2010	92	92	92	55
2011	325	328	328	199
2012	489	507	507	300
2013	756	760	759	453
2014	170	178	178	107
'99-'14 Avg	**284**	**293**	**293**	**174**

Table 142: Projected natural escapement by scenario for Skokomish River Chinook

	Skokomish HOR				Skokomish NOR			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	1,520	1,525	1,525	891	173	174	174	102
2000	833	909	907	518	95	104	104	59
2001	1,610	1,792	1,791	1,042	183	205	205	119
2002	1,322	1,366	1,365	812	150	156	156	93
2003	1,009	1,168	1,167	675	115	133	133	77
2004	2,154	2,334	2,335	1,340	245	266	266	153
2005	1,894	2,183	2,183	1,268	215	249	249	145
2006	1,091	1,481	1,480	850	124	169	169	97
2007	388	721	721	416	44	82	82	47
2008	1,028	1,436	1,436	783	117	165	165	90
2009	960	1,290	1,287	708	109	146	146	81
2010	943	1,101	1,101	614	190	214	214	119
2011	1,244	1,450	1,449	807	69	76	76	42
2012	1,369	1,875	1,878	1,010	147	187	187	99
2013	1,564	1,581	1,580	866	172	173	173	92
2014	759	970	968	509	101	120	120	61
'99-'14 Avg	**1,231**	**1,449**	**1,448**	**819**	**141**	**164**	**164**	**92**

Table 143: Projected natural escapement by scenario for Nooksack River Spring Chinook

	North Fork Nooksack Spring				South Fork Nooksack Spring			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	85	74	73	42	32	28	28	16
2000	160	193	192	117	152	183	182	111
2001	263	273	272	165	208	215	215	131
2002	223	221	221	132	187	186	185	111
2003	209	213	212	125	68	69	69	40
2004	317	373	373	221	58	68	68	40
2005	209	239	238	140	74	85	85	50
2006	273	320	319	194	161	189	188	114
2007	330	396	394	243	63	76	76	47
2008	301	334	334	201	182	202	202	122
2009	268	270	269	163	102	102	102	62
2010	204	209	208	125	64	66	65	39
2011	97	97	96	59	147	146	145	89
2012	277	303	303	183	281	308	308	186
2013	96	99	99	59	47	49	48	29
2014	86	92	91	55	73	78	78	47
'99-'14 Avg	**212**	**232**	**231**	**139**	**119**	**128**	**128**	**77**

Table 144: Projected natural escapement by scenario for Skagit River Spring Chinook

	Suiattle				Upper Cascade				Upper Sauk			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	207	173	173	103	83	69	69	41	179	149	149	89
2000	360	354	353	211	273	268	268	160	388	381	381	227
2001	681	662	662	396	618	602	602	360	537	523	523	313
2002	262	244	244	145	337	314	313	186	455	424	424	252
2003	386	354	354	210	325	299	299	177	211	194	194	115
2004	523	488	488	288	401	375	375	221	739	690	690	407
2005	531	500	500	296	430	406	406	240	316	298	298	176
2006	370	357	357	211	472	455	455	270	1,029	993	993	588
2007	113	100	100	59	233	207	207	122	295	262	262	155
2008	206	208	208	124	288	292	292	173	996	1,009	1,009	600
2009	279	280	280	164	345	347	347	203	375	377	377	220
2010	260	263	263	157	326	330	330	197	759	768	768	458
2011	212	211	210	124	261	260	259	152	340	338	338	198
2012	459	464	464	275	486	492	492	292	1,821	1,843	1,843	1,092
2013	616	611	611	363	308	306	306	181	1,073	1,065	1,064	632
2014	464	472	472	281	227	231	231	137	932	948	947	564
'99-'14 Avg	**370**	**359**	**359**	**213**	**338**	**328**	**328**	**195**	**653**	**641**	**641**	**380**

Table 145: Projected natural escapement by scenario for Skagit River Summer/Fall Chinook

	Upper Skagit				Lower Skagit				Lower Sauk			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	3,518	3,017	2,990	1,710	1,023	878	870	497	289	248	246	141
2000	12,882	11,350	11,210	6,708	3,210	2,828	2,793	1,671	567	499	493	295
2001	10,158	8,579	8,499	5,082	2,625	2,217	2,196	1,313	1,111	938	930	556
2002	12,532	10,272	10,191	6,085	4,414	3,618	3,590	2,143	825	677	671	401
2003	6,832	5,741	5,694	3,357	1,114	936	928	547	1,432	1,203	1,194	704
2004	18,832	16,547	16,577	9,793	2,885	2,535	2,540	1,500	416	366	366	216
2005	15,700	15,023	14,943	8,650	3,139	3,003	2,987	1,729	827	791	787	456
2006	14,138	12,833	12,735	7,373	3,068	2,785	2,764	1,600	958	869	863	499
2007	8,087	8,535	8,486	4,853	865	913	908	519	315	332	330	189
2008	7,479	7,833	7,818	4,536	2,379	2,492	2,487	1,443	477	499	498	289
2009	5,030	7,517	7,471	4,378	1,368	2,045	2,032	1,191	238	355	353	207
2010	6,152	6,308	6,258	3,658	942	966	958	560	330	338	335	196
2011	4,071	5,488	5,438	3,209	745	1,005	995	587	191	257	255	150
2012	9,211	8,191	8,191	4,776	3,094	2,752	2,752	1,604	671	597	597	348
2013	8,595	8,498	8,359	4,877	1,514	1,497	1,473	859	518	512	504	294
2014	8,186	8,228	8,118	4,682	1,782	1,790	1,767	1,019	359	360	356	205
'99-'14 Avg	**9,463**	**8,997**	**8,936**	**5,233**	**2,135**	**2,016**	**2,002**	**1,174**	**595**	**553**	**549**	**322**

Table 146: Projected natural escapement by scenario for Stillaguamish River Chinook

	North Fork Stillaguamish				South Fork Stillaguamish			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	569	569	568	333	145	145	145	85
2000	731	757	756	452	187	194	193	115
2001	588	608	607	363	150	155	155	93
2002	607	621	621	370	155	159	159	95
2003	450	458	458	270	115	117	117	69
2004	597	616	616	366	153	157	157	94
2005	479	507	507	299	122	130	130	77
2006	490	501	501	300	125	128	128	77
2007	242	257	257	153	62	66	66	39
2008	694	716	716	426	178	183	183	109
2009	305	309	308	184	78	79	79	47
2010	433	439	439	263	111	112	112	67
2011	344	354	354	210	88	91	90	54
2012	708	724	724	430	181	185	185	110
2013	717	714	713	424	183	182	182	108
2014	207	211	211	126	53	54	54	32
'99-'14 Avg	**510**	**523**	**522**	**311**	**130**	**134**	**133**	**79**

Table 147: Projected natural escapement by scenario for Snohomish River Chinook

	Skykomish				Snoqualmie			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	1,368	1,379	1,378	820	2,266	2,283	2,282	1,357
2000	1,756	1,847	1,847	1,103	3,757	3,953	3,951	2,359
2001	3,021	3,243	3,242	1,936	4,634	4,973	4,972	2,969
2002	2,239	2,338	2,337	1,398	3,289	3,434	3,433	2,055
2003	1,805	1,862	1,861	1,102	2,821	2,911	2,910	1,723
2004	5,584	5,896	5,896	3,510	5,215	5,506	5,507	3,279
2005	2,203	2,379	2,379	1,415	2,128	2,298	2,298	1,367
2006	4,096	4,204	4,202	2,511	4,331	4,445	4,444	2,655
2007	1,498	1,617	1,617	970	1,965	2,120	2,120	1,273
2008	4,616	4,690	4,689	2,798	3,210	3,262	3,262	1,946
2009	1,140	1,188	1,188	711	744	776	776	464
2010	1,784	1,813	1,813	1,086	2,024	2,057	2,057	1,232
2011	858	858	858	518	730	730	730	440
2012	2,422	2,523	2,523	1,505	1,376	1,433	1,433	855
2013	1,847	1,828	1,827	1,094	1,162	1,150	1,149	688
2014	1,595	1,617	1,617	973	1,372	1,392	1,391	837
'99-'14 Avg	**2,365**	**2,455**	**2,455**	**1,466**	**2,564**	**2,670**	**2,670**	**1,594**

Table 148: Projected natural escapement by scenario for Lake Washington Chinook

	Cedar HOR				Cedar NOR				Sammamish NOR			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	60	59	59	35	364	362	362	213	380	378	378	222
2000	18	20	20	10	103	115	115	68	487	544	543	322
2001	136	148	147	72	754	806	806	478	1,381	1,476	1,476	876
2002	126	130	130	77	533	557	557	328	704	737	737	434
2003	135	140	140	80	628	686	686	406	694	758	758	448
2004	299	316	316	185	734	823	823	487	2,254	2,527	2,527	1,493
2005	161	170	169	100	510	566	566	334	1,530	1,697	1,697	1,002
2006	179	182	182	98	1,158	1,232	1,232	731	3,376	3,593	3,592	2,131
2007	129	150	150	57	1,972	2,147	2,147	1,278	1,220	1,329	1,329	791
2008	43	42	42	1	1,362	1,385	1,385	824	734	747	747	445
2009	83	84	84	49	569	566	566	337	112	111	111	66
2010	67	66	66	35	551	549	549	328	146	145	145	87
2011	111	120	120	70	648	660	660	398	56	57	57	34
2012	96	102	102	40	938	974	974	578	544	565	565	335
2013	218	224	223	127	1,579	1,607	1,606	958	458	467	466	278
2014	246	264	264	157	306	317	317	191	138	143	143	86
'99-'14 Avg	**132**	**138**	**138**	**75**	**794**	**835**	**834**	**496**	**888**	**955**	**954**	**566**

Table 149: Projected natural escapement by scenario for Green River Chinook

	Green HOR				Green NOR			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	2,409	1,547	1,546	905	3,768	2,307	2,306	1,348
2000	786	735	735	416	3,363	3,088	3,087	1,747
2001	2,118	1,793	1,792	1,023	3,204	2,678	2,678	1,530
2002	2,113	1,949	1,948	1,098	3,785	3,531	3,530	1,991
2003	2,375	2,033	2,032	1,198	2,492	2,178	2,178	1,288
2004	3,746	3,315	3,316	1,954	2,364	2,151	2,151	1,271
2005	1,382	1,530	1,530	903	610	719	719	425
2006	2,217	1,875	1,875	1,112	2,462	2,119	2,119	1,257
2007	1,626	1,649	1,648	971	1,714	1,680	1,680	988
2008	1,449	1,350	1,350	800	4,094	3,831	3,831	2,270
2009	352	532	532	317	82	126	126	75
2010	1,251	1,218	1,218	726	682	673	673	401
2011	393	517	517	312	435	554	554	334
2012	1,365	1,415	1,415	838	1,136	1,174	1,174	696
2013	1,540	1,542	1,541	918	327	326	325	194
2014	1,996	2,114	2,113	1,269	573	585	584	351
'99-'14 Avg	**1,695**	**1,570**	**1,569**	**922**	**1,943**	**1,733**	**1,732**	**1,011**

Table 150: Projected natural escapement by scenario for White River Spring Chinook

	White Spring			
Year	**S1**	**S2**	**S3**	**S4**
1999	417	426	426	257
2000	1,096	1,167	1,167	700
2001	1,417	1,583	1,583	930
2002	444	464	464	278
2003	829	877	876	505
2004	1,080	1,164	1,164	684
2005	1,361	1,422	1,422	826
2006	1,408	1,456	1,456	833
2007	3,574	3,731	3,730	2,140
2008	1,221	1,276	1,276	698
2009	546	556	556	313
2010	605	623	623	341
2011	1,363	1,369	1,369	781
2012	1,900	1,933	1,933	1,086
2013	3,533	3,481	3,479	2,052
2014	865	884	884	458
'99-'14 Avg	**1,354**	**1,401**	**1,401**	**805**

Table 151: Projected natural escapement by scenario for Puyallup River Chinook

	Puyallup HOR				Puyallup NOR			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	1,139	1,129	1,128	643	2,612	2,585	2,584	1,472
2000	551	609	609	346	1,666	1,844	1,843	1,046
2001	828	871	870	506	2,545	2,709	2,709	1,571
2002	1,125	1,133	1,132	656	1,801	1,878	1,878	1,087
2003	901	903	903	508	738	790	790	449
2004	585	603	603	332	540	595	595	331
2005	373	605	605	345	458	598	598	341
2006	886	886	886	506	671	701	701	405
2007	1,399	1,548	1,548	890	1,088	1,182	1,182	686
2008	645	656	656	388	1,408	1,451	1,451	860
2009	911	941	941	557	453	460	460	273
2010	950	941	941	561	428	428	428	255
2011	917	971	970	584	265	270	270	163
2012	312	548	548	325	253	379	379	225
2013	524	647	647	385	106	154	154	92
2014	762	820	820	493	423	439	438	263
'99-'14 Avg	**800**	**863**	**863**	**502**	**966**	**1,029**	**1,029**	**595**

Table 152: Projected natural escapement by scenario for Nisqually River Chinook

	Nisqually HOR				Nisqually NOR			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	1,970	2,940	2,940	1,729	1,186	1,786	1,786	1,050
2000	742	855	855	507	4,212	5,031	5,031	2,975
2001	1,628	2,206	2,206	1,308	1,637	2,254	2,254	1,336
2002	765	2,170	2,170	1,282	787	2,334	2,334	1,379
2003	719	2,249	2,248	1,315	378	1,250	1,249	731
2004	2,432	3,950	3,950	2,322	798	1,400	1,400	823
2005	1,228	1,652	1,652	971	739	1,047	1,047	616
2006	1,920	3,611	3,610	2,121	490	916	916	539
2007	957	1,819	1,819	1,070	1,033	1,753	1,753	1,032
2008	2,002	4,201	4,200	2,472	1,024	1,987	1,987	1,171
2009	711	1,662	1,662	982	194	390	390	230
2010	1,801	2,468	2,468	1,460	533	719	719	426
2011	2,229	2,817	2,816	1,693	582	679	679	408
2012	1,783	1,924	1,924	1,115	545	585	585	345
2013	1,149	1,162	1,162	688	932	939	939	559
2014	481	531	531	318	470	498	498	299
'99-'14 Avg	**1,407**	**2,264**	**2,263**	**1,335**	**971**	**1,473**	**1,473**	**870**