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 in the EEZ to the State of Alaska and Federal Funding to the State of Alaska to Implement the 2019 Pacific Salmon Treaty Agreement

NMFS Consultation Number: WCRO-2024-02314

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	No	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?
Salmon Fisheries in the EEZ Off Alaska	No	No
Scallop Fishery Off Alaska	No	No
Groundfish of the Gulf of Alaska	No	No
Pacific Coast Salmon	No	No
Coastal Pelagic Species	No	No
Pacific Coast Groundfish	No	No
U.S. West Coast Fisheries for Highly Migratory Species	No	No

Consultation Conducted By: National Marine Fisheries Service, West Coast and Alaska Regions

Issued By:

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Date: September 25, 2024

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ACRONYMS AND ABBREVIATIONS

µPa Micropascal
4NP Contaminant 4-nonylphenol
AABM Aggregate Abundance-Based Management
Abs Absolute
ADF&G Alaska Department of Fish and Game
Adj Needs Adjusting
AK Alaska
AMHS Alaska Marine Highway System
AMMOP Alaska Marine Mammal Observer Program
A/P Abundance and Productivity
APs Alkylphenols
Avg Average
BC British Columbia
BIA Bureau of Indian Affairs
BIAs Biologically Important Areas
BOF Alaska Board of Fisheries
BP British Petroleum
BRT Biological Review Team
BSAI Bering Sea/Aleutian Islands
C Core
CA California
CET Critical Escapement Thresholds
CFD Cape Flattery Deep
CFI Cape Flattery Inshore
CFM Cape Flattery Mid Shelf
CFO Cape Flattery Offshelf
CFR Code of Federal Regulations
CI Confidence Interval
CIF Central Incubation Facility
CNP Central North Pacfic
CO_2 Carbon Dioxide
CPBD Catch per Boat Day
CPFV Commercial Passenger Fishing Vessel
CPS Coastal Pelagic Species
CPUE Catch per Unit Effort
CTC Chinook Technical Committee
CV Coefficient of Variation
CWA Clean Water Act
CWR Center for Whale Research
CWT Coded-wire Tag
CYER Calendar Year Exploitation Rate
dB Decibels
DDT Dichlorodiphenyltrichloroethane
DFO Fisheries and Oceans Canada
DITs Double Index Tags
DIP Demograpically Independent Population
DNA Deoxyribonucleic acid
DPERs Daily Prey Energy Requirements
DPS Distinct Population Segment
DQA Data Quality Act
EARs Ecological Acoustic Readers
ECHO Enhancing Cetacean Habitat and Observation Program
E Endangered
EEZ Exclusive Economic Zone
EFH Essential Fish Habitat
EFP Exempted Fishing Permit
ENSO El Niño Southern Oscillation
EPA Environmental Protection Agency
ER Exploitation Rate
ESA Endangered Species Act
ESU Evolutionarily Significant Unit
FA Fall-run
FMEP Fishery Management Evaluation Plan
FMP Fishery Management Plan
FR Federal Register
FRAM Fisheries Regulation Assessment Model
Ft Feet
FY Fiscal Year
G Genetic
GOA Gulf of Alaska
GHL Guideline Harvest Level
GSI Genetic Stock Identification
H High
H+ Very High
HGMP Hatchery and Genetic Management Plan
HMS Highly Migratory Species
HPA Hydraulic Project Approval
HR Harvest rate
HRIs Harvest Rate Indices
HV Highly Viable
Hz Hertz
ICTRT Interior Columbia Technical Recovery Team
IHA Incidental Harassment Authorization
IPCC Independent Panel on Climate Change
IQR Interquartile Range
ISAB Independent Scientific Advisory Board
ISBM Individual Stock-Based Management
ITS Incidental take statement

JF Juan de Fuca
kcal/kg kilocalorie/kilogram
kg kilogram
kHz kilohertz
km kilometers
km^2 square kilometers
Kt knots
L Low
LCR Lower Columbia River
LFH Lyons Ferry Hatchery
LFR Late Fall-run
LOF List of Fisheries
M/A/G Mill/Abernathy/Germany
MaSa Major Spawning Area
MCR Middle Columbia River
MEF Mideye to fork of the tail length
MF Middle Fork
mi miles
mi^2 square miles
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
MSY Maximum Sustainable Yield
MU Management Unit
MUP Management Unit Profile
N North
NA Not Available
NAS Naval Air Station
NBC North British Columbia
NCBC North/Central British Columbia
NEPA National Environmental Policy Act
NF North Fork
NFH National Fish Hatchery
NMFS National Marine Fisheries Service
nm Nautical Miles
NOAA National Oceanic and Atmospheric Administration
NOF North of Falcon
NPDES National Pollutant Discharge Elimination System
NPEA Natural Production Emphasis Area
NPFMC North Pacific Fishery Management Council
NPS National Park Service
NRKW Northern Resident Killer Whale
NWFSC Northwest Fisheries Science Center
NWTRC U.S. Navy's Northwest Training Range Complex
ODFW Oregon Department of Fish and Wildlife
ONI Oceanic Niño Index
Opinion Biological Opinion
OR Oregon
PAHs Polycyclic Aromatic Hydrocarbons
PALs Passive Aquatic Listeners
Parties U.S. and Canada as it pertains to the Pacific Salmon Treaty
PBFs Physical or biological features
PCE Primary constituent element
PDO Pacific Decadal Oscillation
PFAs Polyfluoroalkyl substances
PFMC Pacific Fishery Management Council
pHOS Proportion Hatchery Origin Spawners
PIT Passive Integrated Transponder
PNI Proportion Natural Influence
ppb parts per billion
PRA Population Recovery Approach
PSC/Commission Pacific Salmon Commission
PSIT Puget Sound Indian Tribes
PST/Treaty Pacific Salmon Treaty
PSTRT Puget Sound Technical Recovery Team
QCI Queen Charlotte Islands
QD Quinault Deep
Rel Relative
RER Rebuilding Exploitation Rates
RKM River Kilometer
RMP Resource Management Plan
rms root mean square
ROD Record of Decision
RPA Reasonable and Prudent Alternative
RPMs Reasonable and Prudent Measures
SAR Stock Assessment Report
SEAK Southeast Alaska
SF South Fork
SP Spring-run
SP/LP Sand Point and La Push
SR3 SeaLife Response, Rehabilitation, and Research
SRFC Snake River Rall-run Chinook
SRFI Snake River Rall-run Chinook Index
SRKW Southern Resident Killer Whale
SPLASH Structure of Populations, Levels of Abundance, and Status of Humpbacks
SS/D Spatial Structure and Diversity
SSPS Shared Strategy for Puget Sound
SUS Southern United States
SWFSC Southwest Fisheries Science Center

SWWCVI Southwest Coast of Vancouver Island
T Threatened
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
UME Unusual Mortality Event
U.S. United States
U.S.C. United States Code
USCG United States Coast Guard
USFWS United States Fish and Wildlife Service
USGCRP United States Global Change Research Program
UWR Upper Willamette River
V Viable
VIDA Vessel Incidental Discharge Act
VH Very High
VL Very Low
VSP Viable salmonid population
W West
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

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 U.S.C. 1531 et seq.), as amended, and implementing regulations at 50 CFR part 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 part 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 within 2 weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at Lacey, Washington.

This opinion considers the effects of two federal actions on four ESA-listed species of Chinook salmon and three ESA-listed marine mammals, shown in Table 1. 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 Distinct Population Segment(s) (DPS). In Section 2.13 we also provide information supporting the determinations that the proposed actions (described in Section 1.3) are not likely to adversely affect other ESA-listed species.

Table 1. *Federal Register* (FR) notices for the final rules that list ESUs or DPSs under the ESA, designate critical habitat, or apply protective regulations to a listed entity 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 52630, 9/2/05	70 FR 37160, 6/28/05
Lower Columbia River	T: 79 FR 20802, 4/14/14	70 FR 52630, 9/2/05	70 FR 37160, 6/28/05
Upper Willamette River	T: 79 FR 20802, 4/14/14	70 FR 52630, 9/2/05	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
Killer Whale (*Orcinus orca*)			

Species	Listing Status	Critical Habitat	Protective Regulations
Southern Resident DPS	E: 70 FR 69903; 11/18/05	71 FR 69054; 11/29/06	Section 9 statutory prohibition applies automatically pursuant to the ESA
		86 FR 41668; 8/2/21	
Humpback Whale (*Megaptera novaeangliae*)			
Mexico DPS	T: 81 FR 62260; 9/8/16	86 FR 21082; 4/21/21	81 FR 62260, 9/8/16
Steller Sea Lion (*Eumetopias jubatus*)			
Western DPS	E: 62 FR 24345; 5/5/97	58 FR 45269; 8/27/1993	Section 9 statutory prohibition applies automatically pursuant to the ESA

The proposed actions, described below in Section 1.3, are related to implementation of the Pacific Salmon Treaty, and therefore it is necessary to review its construction and general components. 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, 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[1]. 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

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[1] Chapter 7 describes General Obligations of the Parties. Chapter 8 was added in December 2002 with regard to the conservation, enhancement, harvest sharing and management of Yukon River salmon between the Parties. While part of the PST, the provisions of Chapter 8 are governed by the Parties with recommendations by the Yukon River Panel under bylaws and procedural rules separate from the Pacific Salmon Commission. The chapter pertains only to salmon originating in the Yukon River, none of which are listed under the ESA and Yukon River salmon fisheries do not intercept ESA-listed salmon from other regions.

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 PST Agreement) came to fruition through a government-to-government process rather than within the normal PSC process established under the Treaty. The 1999 PST 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 PST Agreement was coming to an end. The resulting 2009 PST Agreement revised key provisions of each Chapter and again set a ten-year term for the PST Agreement. The 2009 PST Agreement therefore expired at the end of 2018 except for Chapter 4, which extended for one additional year, expiring at the end of 2019.

Anticipating the expiration of the fishing regimes established in the 2009 PST 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 PST 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 salmon 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, while an individual stock-based management (ISBM) approach is used for all other Treaty-area fisheries in Canada and the Pacific Northwest.

As mentioned above, each Party must implement the fisheries management framework domestically, and in the North Pacific Exclusive Economic Zone (EEZ) the U.S. does this through implementation of the MSA and the recommendations of the North Pacific Fishery Management Council (NPFMC). Under the MSA, the Council is authorized to prepare and submit to the Secretary of Commerce for approval, disapproval, or partial approval, a fishery management plan (FMP) and any necessary amendments for each fishery under its authority that requires conservation and management. For federal salmon fisheries in the Southeast Alaska (SEAK) area the "FMP for the Salmon Fisheries in the EEZ off Alaska" applies (Salmon FMP). In 1990, the Secretary of Commerce approved Amendment 3 to the Salmon FMP and issued implementing regulations (55 FR 47773, November 15, 1990), which was done to (a) update the FMP to contain the best available scientific information, (b) correct minor errors, (c) increase management flexibility, and (d) make the plan consistent with the 1985 Treaty between the Government of Canada and the Government of the United States of America Concerning Pacific Salmon (PST) and the PST Act (16 U.S.C. 3631 *et seq*.). Amendment 3 deferred regulation of sport and commercial troll salmon fisheries to the State of Alaska in the area of the EEZ in the Gulf of Alaska east of the longitude of Cape Suckling (143°53.6' W) [East Area] (Figure 1) as long as the State law and regulations are consistent with the FMP, the MSA, and other applicable federal law, notably in this case, the PST.

Alaska statehood in 1959 until 1979, the salmon fisheries were conducted and managed with little recognition of the boundary separating federal from state waters. Upon implementation of the FMP in 1979, the portion of the fisheries in the EEZ came under federal management (North Pacific Fishery Management Council 2021). Under the Salmon FMP, commercial salmon troll fishing is only authorized east of the longitude of Cape Suckling (143°53.6' W), and a sport fishery also occurs in the East Area of the EEZ (Figure 1). Because the Salmon FMP delegates management of the commercial troll fishery and the sport fishery in federal waters to the State of Alaska, in addition to the state's authority to manage state waters, the fisheries are consequently managed as a single unit throughout federal and state waters.

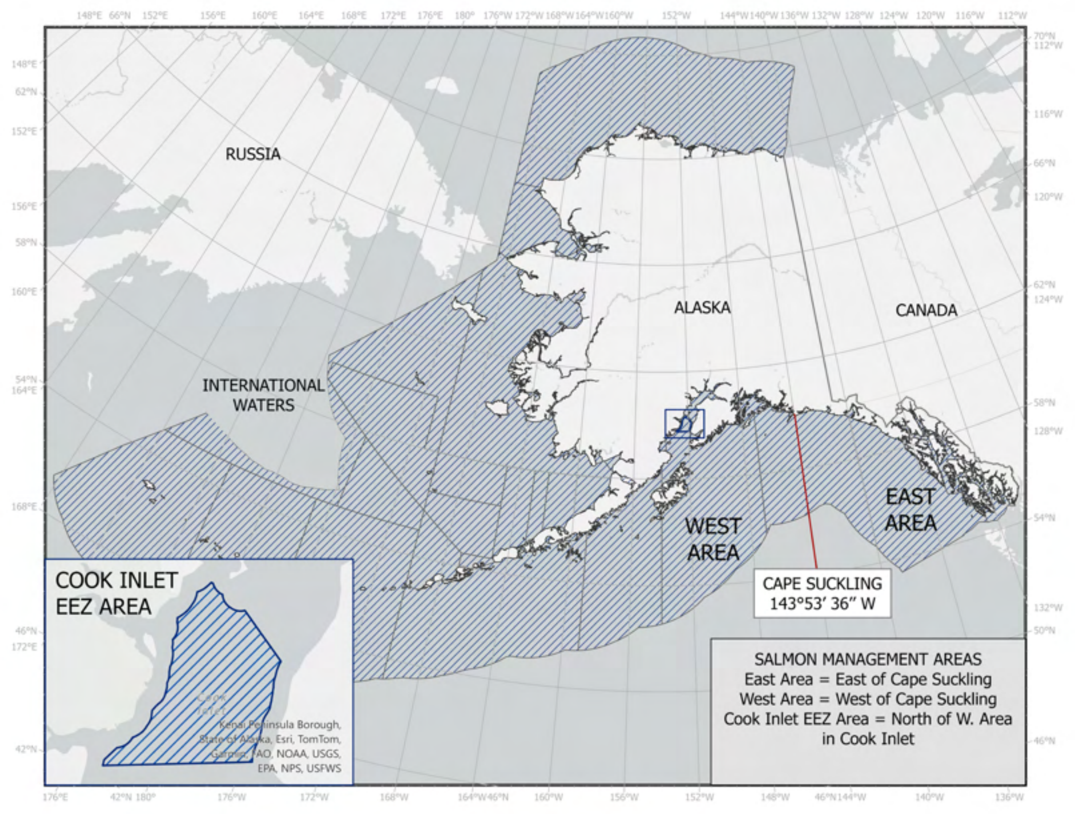

Figure 1. The Geographic Scope of the North Pacific Fishery Management Council's Salmon FMP, showing the East, West, and Cook Inlet Areas. The area east of Cape Suckling is where the SEAK salmon fisheries occur.

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 consideration of the SEAK fisheries by means of annual consultations through 1998 (NMFS 1993; 1998). The Parties tentatively concluded the 1999 PST Agreement in June of 1999. Funding for implementation of the 1999 PST Agreement by the U.S. was subject to a determination that the fisheries managed under the Agreement and entry into the Agreement were not likely to cause jeopardy to or adversely modify designated critical habitat of any listed salmonid species, PST Act, 16 U.S.C. 3645(b)(1), thus the U.S. did not approve the agreement until this occurred. It was understood that the ESA review would take several months. The proposed PST 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 PST Agreement. There was little time between the announcement of the PST 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 1999a). 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 PST Agreement on November 18, 1999 (NMFS 1999a). Once the ESA and funding contingencies were satisfied, the 1999 PST 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 that PST Agreement.

Section 7 consultations covering southern west coast 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 (PFMC), 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 PST Agreement, NMFS generally tried to anticipate the effect of Canadian fisheries on the species status. But absent an agreement with Canada that required specific fishing provisions, Canadian fisheries were not in the baseline or part of a proposed action. The consultation on the 1999 PST 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 NPFMC's recommendation of deferral to Alaska Department of Fish and Game (ADF&G) management of the SEAK fisheries in the U.S. 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 PST Agreement (NMFS 1999a).

The Opinion on the 1999 PST 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 1999a).

NMFS again consulted on the proposed 2009 PST Agreement. The scope of the consultation in this Opinion differed somewhat from that of the Opinion on the 1999 PST Agreement (NMFS 1999a). In the 1999 Opinion the action area was limited to all marine and freshwater fishing areas in SEAK and BC subject to provisions of Annex IV of the PST. Southern fishing areas were not included as part of the action area because their effects were under consideration as part of associated future federal actions. However, because of the integrated and comprehensive nature of management of northern and southern fisheries, particularly as a result of the new PST agreement, southern U.S. (SUS) salmon fisheries were discussed in the environmental baseline and the likely impacts associated with the southern fisheries were considered along with those anticipated from the fisheries to the north in the effects analysis in the 1999 opinion (NMFS 1999a). The opinion on the 2009 PST Agreement consulted on the same federal actions as those in the 1999 opinion and considered fishery impacts in SUS salmon fisheries but expanded its action area to include all marine and freshwater fishing areas in SEAK, BC, as well as all marine and freshwater areas in the southern west coast U.S. subject to provisions of the PST. Additionally, by 2009 NMFS had also been starting to consult on salmon fishery regimes and their effects on Southern Resident Killer Whales (SRKWs), which were listed in 2005 (70 FR 69903) after the 1999 opinion was issued. Therefore, the 2009 opinion considered the effects of fishing on killer whales over the broad geographic area that is subject to provisions of the PST. The 2009 opinion again addressed the effects on the same four Chinook salmon ESUs and Hood Canal summer-run chum, and for the first time, SRKWs. NMFS concluded in the 2009 opinion on the proposed 2009 PST 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 2008a).

In 2012, NMFS Alaska Region approved the NPFMC's recommendation to adopt Amendment 12 to the FMP for the Salmon Fisheries in the EEZ off Alaska (Salmon FMP). Amendment 12[2] delegated management of the East Area EEZ (the area of the EEZ in the Gulf of Alaska east of the longitude of Cape Suckling (143°53.6' W)) to the State of Alaska consistent with 16 U.S.C. 1856(a)(3)(B), continued the existing prohibition on net fishing in the East Area EEZ, and continued the authorization of commercial troll fishing and sport fishing in the East Area EEZ, which as described above, had all been in place since 1990. At that time, NMFS conducted ESA Section 7 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 2012a). 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 2012c).

Since listing the SRKW DPS, NMFS has conducted a series of consultations to evaluate effects of southern west coast U.S. fisheries off the coast of Washington, Oregon, and California

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[2] The NPFMC and NMFS first deferred management to State in 1990 under Amendment 3 to the Salmon FMP and then updated the Salmon FMP in Amendment 12 to reflect the MSA's authority to delegate management. Under deferral or delegation, the effect has been the same: the State of Alaska has managed the commercial troll and sport fisheries in SEAK as a single fishery in federal and state waters.

managed by the PFMC (2006-2007, 2007-2008, 2009, 2020, and 2021(NMFS 2006a; 2007d; 2009e; 2020e; 2021c)) and the U.S. Fraser Panel fisheries (NMFS 2007b; 2008j; 2009b) on this species. NMFS also consulted on the effects of Columbia River fisheries on SRKW in conjunction with the conclusion of the 2008 (2008-2017) (NMFS 2008c) and 2018 *U.S. v. Oregon* Agreement (2018-2027) (NMFS 2018b), and salmon fishing in Puget Sound and its associated U.S. tributaries, which is detailed below.

From 2001 through 2014, NMFS received, evaluated, and approved a series of jointly developed resource management plans (RMPs) from the Puget Sound Treaty Indian Tribes (PSIT) and the Washington Department of Fish and Wildlife (WDFW) (collectively the co-managers) under Limit 6 of the ESA 4(d) Rule (65 FR 42422, July 10, 2000; 70 FR 37160, June 28, 2005). These RMPs provided the framework within which the tribal and state jurisdictions jointly managed all recreational, commercial, ceremonial, subsistence and take-home salmon fisheries, and steelhead gillnet fisheries impacting listed Chinook salmon within the greater Puget Sound area. These fisheries are included in the provisions for ISBM fisheries under the PST. NMFS approved these plans under its ESA 4(d) rule for listed salmon following consultations under ESA Section 7. Following expiration of the RMP approved in 2010, NMFS issued one-year Opinions annually from 2014 through 2023[3] for Puget Sound fishery cycles that considered BIA's, USFWS' and NMFS' actions related to the implementation of the PSIT and WDFW plans for managing the Puget Sound fisheries and the Fraser Panel fisheries (NMFS 2014a; 2015a; 2016g; 2016f; 2016c; 2017o; 2018g; 2019g; 2020f; 2021d; 2022a; 2023a). In February 2022, NMFS received a new draft ten-year RMP from PSIT and WDFW, for consideration under Limit 6 of the ESA 4(d) Rule. NMFS is currently reviewing this plan for consistency with the 4(d) Rule. However, the process leading to a decision on approval of the plan under the 4(d) Rule takes significant time, and thus was not complete in time for the May 15, 2024-May 14, 2025 fishery season, thus NMFS issued a single-year Opinion to cover these fisheries.

In 2019, NMFS prepared one biological opinion to address the federal actions relating to the SEAK salmon fisheries and the prey increase program for SRKW (NMFS 2019e). At that time, NMFS reinitiated consultation on the federal actions related to the SEAK salmon fisheries in light of the new 2019 PST Agreement and new information on the effects of the SEAK salmon fisheries and the condition of ESA-listed species (consistent with 50 CFR 402.16). NMFS also engaged in ESA Section 7 consultation on federal funding for conservation activities to benefit ESA-listed species, a proposal that was developed in connection with the 2019 PST Agreement. The conservation funding proposal included three components, one of which is a proposal for funding to produce hatchery fish to increase prey for SRKW, or "the prey increase program". Although the prey increase program is meant to mitigate all salmon fisheries subject to the 2019 PST Agreement, NMFS determined that consultation on the other U.S. fisheries managed subject to the PST was unnecessary because NMFS had already consulted on fishery-specific plans for those fisheries (the Pacific Fishery Management Council (PFMC) and Puget Sound fisheries). Because the re-initiated consultation on federal actions related to the SEAK salmon fisheries and the proposed conservation funding would have effects in similar geographic areas, to some of the same species, and were both connected to the PST Agreement, NMFS decided in 2019 to

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[3] In 2016 a total of three Biological Opinions related to the 2016-2017 Puget Sound fisheries were issued – NMFS (NMFS 2016g; 2016f; 2016c).

consider in one biological opinion the effects of these actions. NMFS's prior approach did not reflect a decision on the part of NMFS that it was required under the National Environmental Policy Act (NEPA) or the ESA to consider the effects of those two actions in one Environmental Impact Statement (EIS) and one biological opinion.

NMFS concluded in the 2019 opinion 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 2019e).

In 2020, the Wild Fish Conservancy, a 501(c)3 nonprofit organization, filed a lawsuit in the U.S. District Court for the Western District of Washington alleging that the issuance of the 2019 opinion violated the ESA and the NEPA. On August 8, 2022, the district court found that NMFS violated both the ESA and NEPA. With respect to the ESA, the court determined that NMFS improperly relied on uncertain mitigation (the conservation funding) to reach its conclusion that the federal actions related to the SEAK fisheries were not likely to jeopardize ESA listed Chinook salmon and SRKW, and that NMFS failed to evaluate whether the prey increase program) would jeopardize the continued existence of ESA-listed Chinook salmon. With respect to NEPA, the court concluded NMFS failed to conduct necessary NEPA analyses for the issuance of the ITS exempting take associated with the SEAK salmon fisheries, and for the prey increase program. The court remanded the biological opinion to NMFS to remedy the flaws it had identified. The court also partially vacated the portions of the ITS exempting take of SRKW and Chinook salmon resulting from harvest in the winter and summer seasons of the commercial troll salmon fishery. The vacatur was stayed by the U.S. Court of Appeals for the Ninth Circuit on June 21, 2023. The court did not vacate the findings of the biological opinion with regard to the SRKW prey increase program or enjoin the program. On August 16, 2024, the U.S. Court of Appeals for the Ninth Circuit issued a decision that reversed the district court's partial vacatur of the ITS. This Opinion responds to the district court's order on the merits regarding the ESA violations, as explained below.

Updates to the regulations governing interagency consultation (50 CFR part 402) were effective on May 6, 2024 (89 Fed. Reg. 24268). We are applying the updated regulations to this consultation. The 2024 regulatory changes, like those from 2019, were intended to improve and clarify the consultation process, and, with one exception from 2024 (offsetting reasonable and prudent measures), were not intended to result in changes to the Services' existing practice in implementing section 7(a)(2) of the Act. 89 Fed. Reg. at 24268; 84 Fed. Reg. at 45015. We have considered the prior rules and affirm that the substantive analysis and conclusions articulated in this Opinion and incidental take statement would not have been any different under the 2019 regulations or pre-2019 regulations.

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 (see 50 CFR 402.02). We considered, under the ESA, whether or not the proposed action would cause any other activities and determined that it would not. Under the MSA, "federal action" means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a federal agency (see 50 CFR 600.910).]

This Opinion is intended to address the effects of two of the three federal actions analyzed in the 2019 Opinion on ESA-listed species and designated critical habitat. Specifically, this Opinion analyzes the effects of the federal actions related to the SEAK salmon fisheries—the delegation of authority to manage salmon fisheries in the SEAK EEZ to the State of Alaska, and funding to the State for implementation of the PST. We have completed and issued additional documents responding to the court's order, specifically 1) an EIS on issuance of the ITS we are issuing with this Opinion, 2) a programmatic EIS on the expenditure of funding to increase hatchery Chinook salmon production in order to increase prey available to SRKWs to mitigate the effects of the salmon fisheries managed under the 2019 PST Agreement ("prey increase program"), and 3) a biological opinion on the prey increase program. Taken together, these documents comply with the court's remand order.

In responding to the district court's remand order to reassess the impacts of the SEAK salmon fisheries and the prey increase program under the ESA and to prepare NEPA analyses for both the issuance of the ITS for the SEAK salmon fisheries and the implementation of the prey increase program, NMFS determined that it would be more appropriate to prepare two sets of NEPA and ESA analyses for the SEAK salmon fisheries actions and the SRKW prey increase program. NMFS made this decision in light of the different scope and purposes, and the independent utility, of the federal actions related to the SEAK salmon fisheries and the SRKW prey increase program that mitigates all the PST fisheries. The actions are distinct and serve different purposes, and although there is a relationship between them, the two actions are not connected such that use of one NEPA document or one biological opinion is required. The prey increase program EIS evaluates alternative uses of federal funding to increase prey availability for SRKWs and mitigate the effects of all of the PST fisheries, and therefore had broader applicability in terms of the scope of effects. Preparing a prey increase program-specific EIS (and biological opinion) allowed NMFS to fully and more holistically analyze the impacts of the prey increase program across all fisheries. It also provides more clarity that the prey increase program mitigates all of the PST fisheries, not just the SEAK fisheries. Finally, NMFS prepared an EIS and biological opinion focused on the federal actions related to the SEAK salmon fisheries, which allowed for a robust and detailed analysis of the impacts of those fisheries on ESA-listed and non-listed salmon and marine mammals (among other resource components). This is the same approach NMFS has taken for the other U.S. marine fisheries managed subject to the PST, which have their own specific biological opinions (including the PFMC and Puget Sound fisheries). Ultimately, NMFS determined preparing separate NEPA and ESA analyses for the SEAK salmon fisheries actions and the prey increase program would facilitate more robust analyses, improving the substance while also being more practical and less confusing.

Although NMFS prepared separate analyses for the SEAK salmon fisheries actions and the prey increase program, NMFS has been careful to consider and account for all of the environmental impacts and relevant information for the actions, as well as the relationship between the actions (i.e., the role of the prey increase program in mitigating impacts from all the salmon fisheries managed subject to the 2019 PST Agreement, including the SEAK salmon fisheries). The NEPA and ESA analyses for both actions have been prepared concurrently, and the responsible offices within NMFS have coordinated extensively to ensure that no relevant information or impacts have been overlooked and that the analyses are complete.

This biological opinion is responsive to the court's decision with respect to the fisheries actions. First, the jeopardy analysis in this opinion does not rely on uncertain or unspecified future conservation funding and efforts (a deficiency the court identified in the 2019 Opinion). The prey increase program has now been implemented for four years (2020-2023), and Congress has appropriated funds that NMFS has included in its spend plan for this purpose in fiscal year (FY) 2024. Details regarding the implementation of the program – the criteria for selecting hatchery programs for funding, specific hatchery programs likely eligible for funding, and the specific locations of many of the programs likely to receive funding in the coming years – are available. The program, which at this point has resulted in the production and release of Chinook salmon since 2020 that have been returning and will continue to return as adults, contributing to the SRKW prey base, is part of the environmental baseline in this opinion, consistent with regulations implementing the ESA, which define environmental baseline to include "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 C.F.R. 402.02. This approach is consistent with the analysis for biological opinions covering actions related to the West Coast and Puget Sound salmon fisheries. Second, with the issuance of the EIS and biological opinion for the prey increase program referenced above, the program has been fully analyzed under the ESA and NEPA at both the program and site-specific level. At the site-specific level, NMFS has completed biological opinions and, where appropriate, NEPA analyses on the production from each individual hatchery program that has received funding through the prey increase program, and this biological opinion for the SEAK fisheries considers these analyses as well as the program-level analysis in the biological opinion for the program, which speak to the effects on ESA-listed salmon. NMFS is considering those impacts as part of its overall determinations on whether the SEAK fisheries-related actions are likely to jeopardize the continued existence of listed-Chinook ESUs or destroy or adversely modify their designated critical habitat addressed in this opinion. Finally, the EIS for issuance of the ITS addresses the court's ruling that NEPA analysis on the ITS is necessary.

The following describes the two federal actions analyzed in this Opinion in more detail. First, this Opinion considers the effects of the delegation of management authority over commercial troll and sport salmon fisheries (the only authorized fisheries currently occurring in the SEAK EEZ) in the SEAK EEZ to the State of Alaska. The FMP for the Salmon Fisheries in the EEZ off Alaska, as recommended 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 (North Pacific Fishery Management Council 2021). The FMP prohibits commercial fishing for salmon with nets in the EEZ. The fishery management regimes, i.e., the FMP and PST, that apply to the salmon fisheries in the SEAK EEZ are detailed in NMFS' EIS (NMFS 2024b), incorporated here by reference, and described here.

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 manage the salmon troll fishery and the sport salmon fishery in the EEZ. If NMFS determines that a State management measure is inconsistent with the FMP, the MSA, or other applicable law, NMFS must notify the NPFMC and the State and provide the State the opportunity to correct any inconsistencies. If the State does not correct the inconsistencies identified by NMFS, NMFS must, among other things, determine whether federal regulations are required in the East Area given the absence of the inconsistent state management measure. Any delegation of fishery management authority that is withdrawn will not be restored to the State until the NPFMC and NMFS determine that the State has corrected the 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 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. As with the commercial salmon troll fishery, the FMP governs sport fishing for salmon in the East Area with management delegated to the State of Alaska, and the State manages the fishery without differentiating between the EEZ and State waters. However, the sport fishery for salmon takes place almost entirely within State waters (the FMP indicates there is little reason for sport fishermen to fish for salmon seaward of State waters). In the East Area, the sport harvest of salmon from the EEZ is estimated to be a few thousand salmon, less than 1% of the combined state and federal marine waters sport harvest. Chinook and coho salmon are taken primarily in the charter boat fishery.

This Opinion assumes that the State of Alaska manages its SEAK salmon fisheries consistent with provisions of the 2019 PST Agreement as required under the FMP. Provisions of the PST Agreement establish an integrated management framework that also applies to fisheries in Canada and the southern west coast U.S.[4]. 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 PST Agreement and how it has been implemented coast-wide.

The primary chapters of the PST germane to salmon fisheries in SEAK are Chapter 1: Transboundary Rivers, Chapter 2: Northern British Columbia and Southeastern Alaska, and Chapter 3: Chinook Salmon. All SEAK Chinook salmon fisheries are subject to the PST. These primarily include commercial troll, gillnet, and purse seine, sport, and Metlakatla Indian Community Annette Island Reserve fisheries, but also include personal use and subsistence fisheries. Other salmon species are also subject to the PST but the relevant PST provisions are fishery and area specific. These fisheries include commercial troll and sport coho salmon fisheries; sockeye and chum salmon in the District 101 (Tree Point) drift gillnet fishery; sockeye and coho salmon the Districts 106 (Prince of Wales), 108 (Stikine), and 111 (Taku) drift gillnet fisheries; sockeye salmon in the District 104 purse seine fishery; sockeye salmon harvest in the Alsek River set gillnet fishery; and sockeye salmon in the Taku River personal use fishery. Annette Island Reserve fisheries within the Metlakatla Indian Reserve are managed by the Metlakatla Indian Community and are not under the purview of the State of Alaska. Federal subsistence fishing for salmon in SEAK is managed by the Departments of the Interior and

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[4] This area is the 3-200 nautical miles off the West Coast states of California, Oregon, and Washington.

Agriculture as part of the Federal Subsistence Management Program (which the Federal Subsistence Board administers) and includes the Stikine River federal subsistence fishery for Chinook, sockeye, and coho (36 C.F.R. § 242.27(e)(13)).

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.

The grants that NMFS disburses to the State of Alaska include funds for the State of Alaska to manage and monitor the salmon fisheries that are subject to the 2019 PST Agreement. The Treaty establishes a process through which the Parties interact to establish, implement, and monitor science-based fishery management regimes applicable to their respective jurisdictions. U.S. obligations under the PST are fundamentally a federal commitment, and the State of Alaska has the responsibility for the majority of the U.S. fishery and stock assessments in Alaska. Federal funding is used by the State to prepare the fishery and stock assessments required to implement the international obligations of the PST, to gather and analyze the vast amount of data routinely needed to effectuate the fishing regimes under the PST and sustain the shared salmon resources, and provide for the participation of ADF&G in the committee, panel, and commission implementation meetings. As a salmon management regime, funding is used to ensure basic required elements include the following: counting, enumerating, or indexing annual salmon spawning escapement by species and stock; harvest accounting (numbers of each species caught by area and date); harvest apportionment (using coded wire tag recovery, otolith recovery, or genetic stock identification to ascribe the harvest to a particular stock or population and/or using biological data to ascribe the harvests and escapements by age and size composition); and run reconstruction and brood table development (using the age of the fish to ascribe the harvest and escapement to the year of parental spawning).

The funds are used by the State for management and research programs to provide accurate and timely forecasting, catch, effort, escapement, stock identification, and run timing data for salmon stocks. The funds support a variety of research programs that include, but are not limited to, supporting surveys (at weirs and aerial and foot surveys) and mark-recapture experiments, maintaining and expanding coded wire tag (CWT) sampling, and collecting scale and genetic tissue samples from Chinook salmon. The collected information is used by the State for estimating salmon fishery catch, harvest, stock composition, and distribution; estimating smolt abundance, marine harvest, exploitation, and marine survival estimates; preparing stock assessments on the status of salmon stocks; and examining exploitation rate indicator stocks for escapement indicator stocks. Funds also support transboundary enhancement projects developed between the U.S. and Canada.

In disbursing funds for the implementation of the PST Agreement, NMFS considers whether to approve grants to the State. NMFS reviews whether the State's proposed use of funds are reasonable and allowable under federal law and have scientific merit. Once NMFS approves the grants to the State, NMFS awards the funds each year.

More context on the type of funding initiatives awarded to the State is described below:

1) The PST Transboundary River (TBR) Enhancement initiative, is a three-year, multi-disciplinary initiative grant to the ADF&G that ranges from $415K to $460K per year. Although this initiative began under the 2009 PST Agreement, it has continued 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.[5] At that time it was determined that the 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 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 the U.S. and Canada meet their allocation goals as specified in Chapter 1 (Transboundary Rivers) and other applicable provisions of the PST Agreement.

2) The PST Sport Harvest Monitoring and Wild Chinook Stock Assessment is funded by a three-year grant at approximately $1.5 million, which covers 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 allow smolt abundance, marine harvest, exploitation, and marine survival estimates. This project also supports key activities of the sport harvest monitoring program strategically focusing on Chinook salmon, which is given an additional $512,630 annually in a separate supplementary award. 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 are used in support of multiple PSC Chinook Technical Committee Chinook salmon analyses and in abundance-based management of these stocks, as directed by the 2019 PST

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[5] See Appendix to Annex IV, Chapter 1: Understandings on the Joint Enhancement of Transboundary River Sockeye Stocks.

Agreement. Although goals and objectives for this element may change over time, representative goals and objectives currently used 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 and 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) estimating the exploitation rate (expected CV = 20% or less), total adult production, and the marine survival rate (smolt to adult). Other tasks and objectives associated with the marine sport harvest monitoring component of this project include: 1) increasing 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-sampling adipose-intact Chinook salmon from the marine sport fisheries at a rate of 1 in 10 for double index tags (DITs); 3) collecting matched scales and tissues; and 4) estimating 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 by a three-year award at approximately

$7.3 million per year. The PST Implementation grant funds several programs including administrative, management, research, and information technology services required to implement the 2019 PST Agreement in SEAK as well as State of Alaska participation in the various PST panels and technical committees. Along with domestic obligations, numerous abundance-based management provisions of the PST directly influence the harvest of salmon from Yakutat to Ketchikan in five gillnet, one purse seine, and three seasonal troll fisheries. These provisions of the PST Agreement 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 the PST Implementation 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, Petersburg, Sitka, and Yakutat. Regional Treaty Support covers personnel involved in the design, development, maintenance, and analytical capabilities of the regional catch and effort database. Programs under the PST Transboundary Annex (Alsek, Taku, and Stikine Rivers) support: 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 Alaska fisheries near the mouths of rivers to pass sufficient fish for Canadian in-river fisheries while also ensuring adequate escapement to spawning grounds to achieve the bilaterally-agreed spawning objectives. Implementation of the Transboundary Rivers chapter of the PST requires extensive bilateral cooperation and coordination. Successful enhancement programs currently return large numbers of sockeye salmon to both the Taku and Stikine rivers. Inseason programs that 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 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, and inseason catch and effort monitoring programs needed to manage consistent with abundance-based provisions of the PST, as well as support bilateral cooperation and coordination to reconstruct total returns, evaluate compliance with agreed harvest shares, and develop run forecasts. 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 and required by the Chinook Chapter of the PST, as well as participation in the PSC's Chinook Technical Committee.

4) The PST Genetics Program Support is also funded by a three-year award at approximately $832K per year. The PST Genetics grant funds genetic mixed stock analysis required to implement provisions of the PST in SEAK. Numerous abundance-based PST agreements directly influence the harvest levels of salmon in SEAK fisheries, and provisions in Chapters 1, 2, and 3 of Annex IV of the PST Agreement include abundance-based fishery management frameworks that determine the harvest levels of salmon in SEAK fisheries. Domestic and PST obligations rely on the collection and analysis of catch, escapement, recruitment information, and stock composition to forecast indices of abundance in PST fisheries on which the fisheries are managed. Stock contribution estimates are critical to assess compliance with the harvest sharing agreements, reconstruct runs of wild stocks, estimate the return of enhanced fish, forecast upcoming returns, and support sustainable management. This program provides information necessary for the successful implementation of the PST as it relates to the Transboundary Rivers, the Northern Boundary Area, and SEAK Chinook salmon harvest (the provisions and principles of Chapters 1, 2 and 3 of the PST Agreement).

5) The Southeast Alaska (SEAK) Chinook Mitigation grant program is a single year grant for $682,107 and is used to compensate for, to the extent possible, the economic impact of a 7.5% harvest reduction of Chinook salmon in SEAK fisheries agreed upon in the 2019 PST Agreement. Program priorities include: hatchery fish marking, tagging, and evaluation; hatchery enchantment projects; and hatchery research. These priorities were identified to provide economic benefits to compensate for the losses in SEAK harvest as a result of the negotiated reductions in the SEAK Chinook fishery under the 2019 PST Agreement by increasing production of, and access to, hatchery produced salmon in the SEAK region. These objectives include increasing hatchery production and conducting hatchery related research in support of increased harvest opportunities. The hatchery fish marking, tagging, and evaluation priority provides funding to assist Alaska in expanding its hatchery marking and tagging rate. Increased marking and tagging allows Alaska to reduce information gaps while expanding access to hatchery-produced fish. Hatchery enhancement projects may include construction and development of infrastructure and operations and management costs to accommodate increases in hatchery production. The hatchery research priority can be used to produce brood stocks and/or to conduct critical hatchery related research into marine survival, alternate life history traits, migration, and other information that can increase fishing opportunity.

6) The Chinook Salmon Sound Science programs are single year awards for $86,537. The main goal is to improve data quality and availability for Chinook salmon in a manner that provides for scientifically defensible stock assessments and promotes a sustainable abundance-based management system. The primary project goal for the Chinook Salmon Sound Science program has focused on maintaining and increasing CWT sampling rates in SEAK sport fisheries with a coastwide target rate of 20% for all Chinook salmon caught. Funding is also used to collect scale and genetic tissue samples from Chinook salmon. Increased sampling provides data and improves accuracy in estimating Chinook salmon fishery catch, harvest, stock composition, and distribution.

7) The PST Coded Wire Tag program is an annual award at $758,500, which is designed to

improve precision and accuracy of CWT-based statistics used by Pacific Salmon Commission (PSC) committees in fulfilling Chapter 3 of the Treaty. It also looks to increase and examine exploitation rate indicator stocks for escapement indicator stocks while developing analytical tools that involve the analysis of CWT data instrumental in the implementation of Chapter 3 of the Treaty. The Coded Wire Tag program is organized into two projects: 1) Southeast Alaska Commercial Chinook Port Sampling, and 2) Alaska Department of Fish and Game Coded-Wire Tag Recovery Support. SEAK Commercial Chinook Port Sampling supports maintaining or increasing the coded-wire tag sampling rates for Chinook salmon caught in SEAK commercial fisheries with an objective sampling rate of 20% coastwide. Scale and tissue samples are also collected from Chinook salmon harvested in SEAK troll and select net fisheries. Sampling efforts are made more efficient by utilizing handheld tag detection wands to identify Chinook salmon that have an adipose fin clip but no CWT. Funding is used to meet these objectives by covering personnel costs for commercial samplers and the transportation of samples to the ADF&G Mark, Tag, and Age (MTA) Lab. The ADF&G Coded-Wire Tag Recovery Support project primary objectives are to recover, examine, and disseminate CWT information recovered from Chinook salmon in the SEAK commercial fisheries.

Chinook Salmon Management Regime

The SEAK PSC salmon fisheries are currently managed under the terms of the 2019 PST Agreement, which are tied to the biological aspects of the respective species they encounter. Therefore, this section provides some background information related to the biology of Chinook salmon, how Chinook fisheries are managed under the PST, and a description of the 2019-2028 Chinook salmon regime.

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.

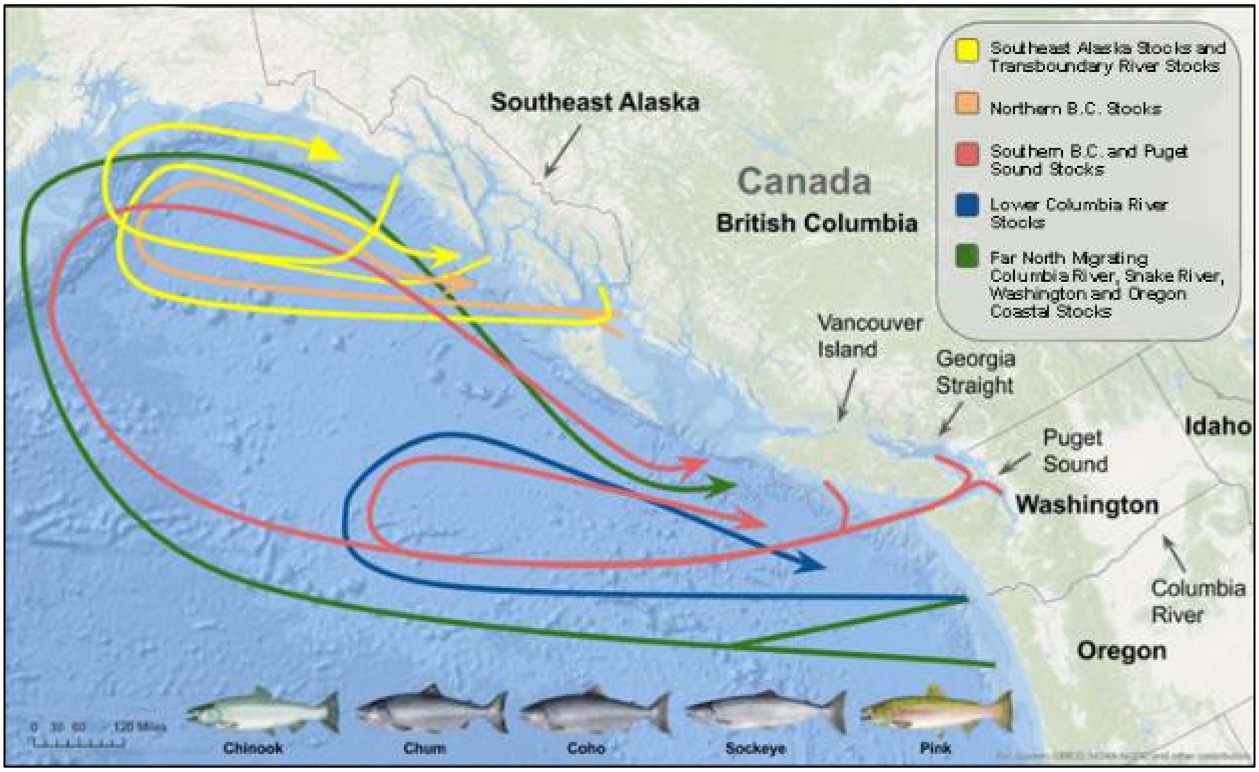

Figure 2. Migratory patterns of major Chinook salmon stock groups.

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 U.S. and Canada have agreed, among other things that:

> *"fishery management measures that are implemented under this Treaty are intended to be appropriate for recovering, sustaining, and protecting Chinook salmon stocks in Canada and the United States and are responsive to changes in productivity of Chinook salmon stocks associated with environmental conditions (Chapter 3, 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 to Annex IV, Chapter 3 of the 2019 PST 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% greater than the 1979-1982 base period. AABM fisheries are managed by setting limits on the landed catch, but the PST 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 PST Agreement; any changes to the calculation of the annual AI or HRI metrics will require a recalculation of the proportional constants, catch equations and HRI levels contained in Appendix C.).

Southeast Alaska All Gear	North BC Troll & QCI Sport	WCVI Troll & Outside Sport
Proportionality Constant (PC) = 12.611	Proportionality Constant (PC) = 11.931	Proportionality Constant (PC) = 12.544
Harvest Rate Index (HRI) = EXP(LN(Troll Catch / AI) - PC)	Harvest Rate Index = EXP(LN(Troll Catch / AI) - PC)	Harvest Rate Index = EXP(LN(Troll Catch / AI) - PC)
Troll Catch = (Total Catch - Net Catch) * 0.8 = EXP(PC + LN(HRI * AI))	Troll Catch = Total Catch * 0.8 = EXP(PC + LN(HRI * AI))	Troll Catch = Total Catch * 0.8 = EXP(PC + LN(HRI * AI))
Total Catch = Net Catch + Troll Catch / 0.8	Total Catch = Troll Catch / 0.8	Total Catch = Troll Catch / 0.80
Reduction in Total Catch from 2009 PST Agreement:	Reduction in Total Catch from 2009 PST Agreement: 0%	Reduction in Total Catch from 2009 Agreement:
AIs less than 1.875 - 7.5%, Net Catch = 15,725		AIs less than 1.08 - 12.5%
AIs between 1.875 and 2.28 - 3.25%, Net Catch = 16,448		AIs between 1.08 and 1.32 - 4.8%
AIs greater than 2.28 - 1.5%, Net Catch = 16,745		AIs greater than 1.32 - 2.4%
For AIs less than 1.035	For AIs less than 1.295	For AIs less than 0.545
Total Catch = 17,748.1 + 97554.54 * AI	Total Catch = 14,961.96 + 109,287.75 * AI	Total Catch = 6,510.71 + 90,706.71 * AI
Troll Catch = (2,023 + 97554.54* AI) * 0.8	Troll Catch = (14.961.96 + 109,287.75 * AI) * 0.8	Troll Catch = (6,510.71 + 90,706.71 * AI) * 0.8
HRI = 0.271[1] to 0.266	HRI = 0.733[1] to 0.637	HRI = 0.296[1] to 0.293
For AIs between 1.035 and 1.245	For AIs between 1.295 and 1.655	For AIs between 0.545 and 1.075
Total Catch = -101,708.76 + 213,868.28 * AI	Total Catch = -3,119.8 + 123,299.28 * AI	Total Catch = 7,595.81 + 105,824.22 * AI
Troll Catch = (-117,433.76 + 213,868.28 * AI) * 0.8	Troll Catch = (-3,119.8 + 123,299.28 * AI) * 0.8	Troll Catch = (7,595.81 + 105,824.22 * AI) * 0.8
HRI = 0.269 to 0.318	HRI = 0.637 to 0.639	HRI = 0.341 to 0.322
For AIs between 1.245 and 1.555	For AIs greater than 1.655	For AIs between 1.075 and 1.175
Total Catch = 18,502.79 + 133,945.77 * AI	Total Catch = 16,791 + 122,647.76 * AI	Total Catch = 8,264.25 + 115,136.87 * AI

Southeast Alaska All Gear	North BC Troll & QCI Sport	WCVI Troll & Outside Sport
Troll Catch = (2,777.79 + 133,945.77 * AI) * 0.8	Troll Catch = (16,791 + 122,647.76 * AI) * 0.8	Troll Catch = (8,264.25 + 115,136.87 * AI) * 0.8
HRI = 0.363 to 0.362	HRI = 0.699 to 0.675[2]	HRI = 0.350 to 0.349
For AIs between 1.555 and 1.875		For AIs between 1.175 and 1.325
Total Catch = 18,734.27 + 145,107.76 * AI		Total Catch = 9,444.89 + 131,585.46 * AI
Troll Catch = (3,009.27 + 145.107.76 * AI) * 0.8		Troll Catch = (9,444.89 + 131,585.46 * AI) * 0.8
HRI = 0.392 to 0.391		HRI = 0.398 to 0.396
For AIs between 1.875 and 2.285		For AIs greater than 1.325
Total Catch = 19,595.54 + 151,775.37 * AI		Total Catch = 9,682.99 + 134,902.64 * AI
Troll Catch = (3,147.54 + 151,775.37 * AI) * 0.8		Troll Catch = (9,682.99 + 134,902.64 * AI) * 0.8
HRI = 0.409		HRI = 0.406 to 0.394[2]
For AIs greater than 2.285		
Total Catch = 19,949.47 + 154,520.29 * AI		
Troll Catch = (3,204.47 + 154,520.29 * AI) * 0.8		
HRI = 0.416 to 0.415[2]		

1 Assumes a minimum AI of 0.5
2 Assumes a minimum AI of 3.0

Three fishery complexes are designated for management as AABM fisheries: 1) the SEAK salmon sport, net, and troll fisheries; 2) the Northern British Columbia (NBC) salmon troll fishery (Canada's Pacific Fishery Management Areas 1-2, 101-105 and 142) and the Queen Charlotte Islands (QCI) sport fishery (Canada's Pacific Fishery Management Areas 1-2, 101, 102 and 142); and 3) the West Coast Vancouver Island (WCVI) salmon troll and outside sport fisheries (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).

Under the PST Agreement, catch limits for the AABM fisheries are determined in relation to estimates of overall abundance in the areas where the fisheries take place. Abundance indices for the NBC and WCVI are calculated by the PSC's Chinook Technical Committee (CTC) using the PSC Chinook Model. Abundance levels for the SEAK fishery, as described in the PST Agreement as of 2019, were 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 PST Agreement allows that the PSC may modify the approach for estimating the abundances including, for example, the use of inseason data for the NBC or WCVI fisheries, or reliance on the PSC

Chinook Model for the SEAK fisheries (e.g., Chapter 3, paragraphs 6 and 7). As described in Appendix G, consistent with the provisions of the 2019 PST Agreement, the PSC has made changes to the approach used to estimate abundance levels used to set the catch limits for the SEAK fishery since the adoption of the Agreement. However, in 2024, the PSC did not reach agreement on an alternative methodology for setting the SEAK AABM catch limit for 2024; therefore, per Chapter 3, subparagraph 7(e), the PSC Chinook Model estimate of the AI and Table 1 in Chapter 3 of the 2019 Agreement was used, and as of the 2024 annual meeting of the PSC, this approach is expected to continue for the remainder of the current Agreement (CTC 2024). NMFS assumes they will continue to use catch limits associated with the year specific estimates of abundance for any AABM fisheries set forth in Table 3 (referred to as Table 1 in Chapter 3 of the 2019 PST Agreement).

Table 3. Catches of Chinook salmon specified for AABM fisheries at levels of the Chinook abundance index - (Referred to as Table 1 in the 2019 PST Agreement)[1,2].

Abundance Index	SEAK	NBC	WCVI
0.25	42,100	42,300	29,200
0.3	47,000	47,700	33,700
0.35	51,900	53,200	38,300
0.4	56,800	58,700	42,800
0.45	61,600	64,100	47,300
0.5	66,500	69,600	51,900
0.55	71,400	75,100	65,800
0.6	76,300	80,500	71,100
0.65	81,200	86,000	76,400
0.7	86,000	91,500	81,700
0.75	90,900	96,900	87,000
0.8	95,800	102,400	92,300
0.85	100,700	107,900	97,500
0.9	105,500	113,300	102,800
0.95	110,400	118,800	108,100
1	115,300	124,200	113,400
1.05	122,900	129,700	118,700
1.1	133,500	135,200	134,900
1.15	144,200	140,600	140,700
1.2	154,900	146,100	167,300
1.25	185,900	151,600	173,900
1.3	192,600	157,200	180,500
1.35	199,300	163,300	191,800
1.4	206,000	169,500	198,500
1.45	212,700	175,700	205,300
1.5	219,400	181,800	212,000

Abundance Index	SEAK	NBC	WCVI
1.55	226,100	188,000	218,800
1.6	250,900	194,200	225,500
1.65	258,200	200,300	232,300
1.7	265,400	225,300	239,000
1.75	272,700	231,400	245,800
1.8	279,900	237,600	252,500
1.85	287,200	243,700	259,300
1.9	308,000	249,800	266,000
1.95	315,600	256,000	272,700
2	323,100	262,100	279,500
2.05	330,700	268,200	286,200
2.1	338,300	274,400	293,000
2.15	345,900	280,500	299,700
2.2	353,500	286,600	306,500
2.25	361,100	292,700	313,200

1. Values for catch at levels of abundance between those stated may be linearly interpolated between adjacent values.
2. The PSC adopted a new Chinook model October 17, 2019; revisions to Chapter 3 Table 1, Table 2 and Appendix C were required to maintain relationships between AIs and catch limits, see Appendix G for more details.

Chapter 3 of the PST Agreement requires management responses when Chinook salmon total catch and/or total mortality in SEAK AABM fisheries exceeds their limits (2019 PST Agreement, Chapter 3, paragraphs 4, 6, 7(b)). The responses are specific to the circumstances but share a common goal, i.e., to result in fisheries that do not exceed the PST catch limits or to reduce the difference between preseason fishery planning and performance as evaluated postseason.

Provisions of the 2019 PST Agreement have resulted in reductions in catch in the SEAK and WCVI AABM fisheries relative to those allowed under the 2009 PST Agreement, but the magnitude of the reduction depends 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% relative to what was allowed in the 2009 PST Agreement, but at higher abundance levels catch reductions are either 3.25 or 1.5 %. In the WCVI fishery, in most cases, catch is reduced by 12.5% relative to what was allowed in the 2009 PST Agreement, but is either 4.8 or 2.4 % 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 % in three out of four years, and at 3.25 and 4.8 %, respectively in most remaining years. The reductions would be 1.5 and 2.4 % in the SEAK and WCVI fisheries only if abundance exceeded the maximum levels observed since the implementation of AABM fishery regimes in 1999.

All Chinook salmon fisheries subject to the PST 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 PST 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 4. 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% avg. 09-15); for other stocks the limit is expressed as a reduction from the 2009-2015 average (e.g., 85% 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 4. 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 PST 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]

Stock Region	Escapement Indicator Stock (CWT Indicator Stock[8])	Canadian ISBM CYER Limit	US ISBM CYER Limit	Management Objective
	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 [10]	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
	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.

[10] The CTC will be reporting on CWT recoveries for the Phillips River stock until 2024, when all age classes from the last tagged brood (2019) recruit to fisheries, however as the criteria for calculations of mortality distribution (which are the basis for CYERs) are: (1) recoveries available for three ages at least, and (2) minimum of 35 estimated recoveries per age, the CYER for Phillips cannot be calculated past 2022. The Phillips River will continue

as an escapement indicator and Canada is continuing to assess options for a potential CWT indicator stock that is representative of Mainland Inlet Chinook stocks.

There are several points to be made that help clarify key features of the PST 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: SEAK, NBC, and WCVI. The ISBM fisheries include the remaining coastal marine and inland marine and freshwater fisheries that affect any of the designated indicator stocks. 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 PST Agreement. In the 2009 PST Agreement, ISBM fisheries were also managed using an index of relative change. For example, U.S. ISBM fisheries were managed subject to a 60% reduction in total adult equivalent mortality relative to the 1979 to 1982 base period. The 2019 PST Agreement uses 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. Unlike AABM fisheries, for which catch limits are set using the abundance indices produced by the PSC Chinook model that is rooted in a 1979 to 1982 base period, ISBM fisheries are assessed post-season using CYERs produced from CWT cohort reconstructions[6] independent from management models. As a result, they are not tied to the 1979 to 1982 base period. The update to the 2009 to 2015 base period for evaluating ISBM fishery CYERs represents a more contemporary set of fishing years, during which sampling and tagging of Chinook exploitation rate indicator stocks was more consistent compared to the period between 1979 and 1982.

Third, the limits for the ISBM fisheries are established and monitored relative to a specific list of natural stock or stock groups (indicator stocks) identified in Table 4. 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 PST 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 PST Agreement. In fact, it was clearly understood throughout the negotiations leading to the Agreement that U.S. ISBM fisheries have been and

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[6] Cohort reconstruction is used to rebuild the total abundance of a stock using information gathered from coded-wire tag recoveries representative of a specific stock. The reconstruction starts with the estimated number of fish on the spawning ground and is then back calculated sequentially using estimates of natural mortality and harvest, i.e., spawning escapement + river harvest+ natural mortality in the river. The process is then repeated through each fishery getting farther from the spawning area until the preharvest abundance is calculated.

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 and ISBM fisheries, Canadian fisheries and U.S. fisheries, and Alaskan fisheries and southern west coast 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 understood that the United States might 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 2019 PST Agreement includes a number of changes relative to the regime it replaced. 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 % (in most years), respectively, compared to the previous PST Agreement. This comes on top of the reductions of 15 and 30 % for those same fisheries that occurred as a result of the 2009 PST Agreement. ISBM fisheries are also subject to greater limits than those in the 2009 PST Agreement. CYER obligations are set relative to the 2009-2015 average (Table 4). 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 %, the average is 15%. If future fisheries are now subject to a 15% ER limit, it is no longer possible to manage in any particular year for rates that are higher than 15% and the average from future fisheries will be less. Although provisions of the 2019 PST 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.

General SEAK Fishery Overview

ADF&G manages the sport and commercial fisheries for Chinook salmon in accordance with the annual harvest ceiling established by the PSC under the PST, as described previously, and gear allocation guidelines established by the Alaska Board of Fisheries (BOF) (5 AAC 29.060). The annual harvest limit is allocated through regulations established by the BOF to provide certain percentages of the Chinook salmon catch limit to the purse seine fleet and to the drift gillnet fleet, and a set number of fish to the set gillnet fleet (North Pacific Fishery Management Council 2021). The total net gear allocation is then subtracted from the all-gear harvest, and the remainder of the allocation is divided between the commercial troll and sport fisheries in an 80/20 split (5 AAC 29.060(b)) (North Pacific Fishery Management Council 2021). Chinook salmon retained in the commercial troll fisheries must be equal to or greater than 28 inches in total length and the heads of all adipose-fin clipped salmon must remain attached until the fish is offloaded from a vessel in order to facilitate recoveries of CWTs (5 AAC 29.140). In recent years, the State of Alaska has reallocated remaining catch among the gear sectors. For additional information, such as the permitting levels and past performance of the fishery, see North Pacific Fishery Management Council (2021).

Seasons

The commercial troll salmon fishery is divided into three seasons: a winter season, a spring season, and a summer season. Accounting of Chinook salmon harvested by the commercial troll fleet begins with the start of the winter fishery and ends with the close of the summer fishery (5 AAC 29.060 (d)).

The winter troll season opens October 11 through April 30 or until the guideline harvest level (GHL) is reached, and is managed not to exceed a GHL of 45,000 non-Alaska hatchery-produced Chinook salmon (with a guideline range of 43,000 to 47,000 fish) (5 AAC 29.070(b)(1) & 5 AAC 29.080(a)). Any Chinook salmon stocks subject to the PST obligations not harvested during the winter fishery will be available for harvest during the spring and summer fisheries. By regulation, the open area during the winter fishery is restricted to those areas lying east of the "surf line" south of Cape Spencer, and the waters of Yakutat Bay (5 AAC 29.080(b) & 5 AAC 29.020(b)). All outer coastal areas, including the EEZ, are closed during the winter troll fishery. More information on the winter troll fishery can be found in ADF&G Fishery Management Plans (e.g., see: Salmon Fishery Management Plans, ADF&G website). Because the winter troll fishery does not occur in the EEZ, the fishery is outside the scope of the federal Salmon FMP.

The spring troll fishery begins after the winter fishery closes, may start prior to May 1 if the winter fishery closes early when the harvest cap of 45,000 Chinook salmon is reached, and closes June 30 (5 AAC 29.070(b)(2)). The spring troll and terminal area troll fisheries are designed to target Alaska hatchery-produced Chinook salmon (though Chinook salmon from across the Treaty area are also harvested) (5 AAC 29.090) and occur primarily in inside waters near hatchery release sites or along the migration routes of early returning hatchery fish. The spring fishery also does not occur in the EEZ and so is outside the scope of the Salmon FMP.

The general summer troll fishery opens July 1 and targets the remainder of the allowable catch limit in two open periods during the July 1- September 30 timeframe (5 AAC 29.070(b)(3) & 5 AAC 29.100(b)). The summer troll fishery generally comprises the majority of the annual treaty Chinook salmon quota. During the summer season, most waters of the Southeast Alaska/Yakutat area are open to commercial trolling, including outer coastal waters in the EEZ, except for those waters described in 5 Alaska Administrative Code 29.150 and State waters closed by emergency order (5 AAC 29.100(a) & 5 AAC 29.010). The primary objectives for management of the summer Chinook salmon fishery are as follows (taken from Hagerman and Vaughn 2024):

- Comply with provisions and regulations established by the BOF, NPFMC, NMFS, and the PSC.
- Comply with the conservation goals of the PST and BOF.
- Achieve harvest allocations among user groups as directed by the BOF.
- Achieve the annual all-gear PSC allowable catch associated with the appropriate tier of the Chinook model abundance index output.

Maximize the harvest of Alaska hatchery-produced Chinook salmon.
A harvest control limit is set for management of Chinook salmon during the general summer fishery. ADF&G manages the summer fishery by targeting harvest of 70% of the annual summer Chinook salmon quota in an initial opening beginning July 1, and the remainder of the Chinook salmon quota is harvested in August through September (5 AAC 29.100(c)(1)). Due to the time lag between when fish are harvested and when the harvest information is received through receipt of fish landing tickets, ADF&G conducts a fisheries performance data program to estimate the catch per unit effort (catch per boat day (CPBD)) inseason during the summer

fishery. Confidential interviews are conducted with trollers to obtain detailed CPBD data. Aerial vessel surveys are conducted to obtain an immediate estimate of fishing effort. Total harvest to date is estimated by multiplying vessel counts observed during weekly overflights with the CPBD data obtained from the interviews. Daily tallies from processors are also an important tool in tracking harvest.

Following the first Chinook opening, the waters of high Chinook salmon abundance (5 AAC 29.025) will be closed unless ADF&G determines that less than 30% of the Chinook salmon harvest goal for the initial opening was taken in that opening (5 AAC 29.100(c)(2)). In addition, during the second Chinook salmon opening, if ADF&G determines after 10 days that the annual troll Chinook salmon harvest ceiling might not be reached by September 20 with those waters closed, ADF&G shall reopen the waters of high Chinook salmon abundance by emergency order (5 AAC 29.100(c)(2)). Following the closure of the initial summer Chinook salmon period, all Chinook salmon must be offloaded prior to trolling for other species. Further information on the spring and summer troll fisheries can be found in ADF&G Fishery Management Plans (North Pacific Fishery Management Council 2021).

In summary, in this opinion we analyze the effects of the federal actions specified above on ESA-listed species, the delegation of authority to manage salmon fisheries in the SEAK EEZ to the State of Alaska and funding to the State of Alaska for implementation of the PST. As effects of those actions we analyze the effect of the SEAK salmon fisheries, as implemented by ADF&G under the current PST regime specified in the 2019 Agreement.

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 to 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 provide 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 reasonable and prudent measures (RPMs) and terms and conditions to minimize and monitor such impacts.

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

NMFS determined the proposed actions described in Section 1.3 are not likely to adversely affect ESA species shown in Table 5 or their critical habitat. Our concurrence is documented in the "Not Likely to Adversely Affect" Determinations section (Section 2.13).

Table 5. Species not likely adversely affected by the proposed actions described in Section 1.3.

Species	**Listing Status1**	**Critical Habitat**	**Protective Regulations**
Chinook salmon *(O. tshawytscha)*			
Upper Columbia River spring-run	E: 70 FR 20816, 4/14/14	70 FR 52630, 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	78 FR 79622, 12/31/2013
Sacramento River winter-run	E: 59 FR 440, 01/04/94; reaffirmed 70 FR 37160, 6/28/05	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 Section 9
Chum salmon *(O. keta)*			
Columbia River	T: 79 FR 20802, 4/14/14	70 FR 52630, 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 52630, 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 52630, 9/02/05	70 FR 37160, 6/28/05
Upper Willamette River	T: 79 FR 20802, 4/14/14	70 FR 52630, 9/02/05	70 FR 37160, 6/28/05
Middle Columbia River	T: 79 FR 20802, 4/14/14	70 FR 52630, 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 52630, 9/02/05	70 FR 37160, 6/28/05
Northern California	T: 71 FR 834, 1/05/06	70 FR 52488, 9/02/05	70 FR 37160, 6/28/05
California Central Valley	T: 79 FR 20802, 4/14/14	70 FR 52488, 9/02/05	70 FR 37160, 6/28/05
Central California Coast	T: 79 FR 20802, 4/14/14	70 FR 52488, 9/02/05	70 FR 37160, 6/28/05
South-Central California Coast	T: 79 FR 20802, 4/14/14	70 FR 52488, 9/02/05	70 FR 37160, 6/28/05
Southern California	E: 79 FR 20802, 4/14/14	70 FR 52488769, 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 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 Opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This Opinion also relies on the regulatory definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR 402.02).

The designation(s) of critical habitat for Lower Columbia River Chinook Salmon, Snake River Fall-run Chinook Salmon, Upper Willamette River Chinook Salmon, Upper Columbia River spring-run Chinook Salmon, Southern Resident Killer Whales, the Mexico Distinct Population Segment of Humpack Whales, and the Western Distinct Population Segment of Stellar Sea Lions uses the terms primary constituent element (PCE) or essential features. The 2016 final rule (81 FR 7414; February 11, 2016) that revised the critical habitat regulations (50 CFR 424.12) replaced 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.

The ESA Section 7 implementing regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the final rule revising the definition and adding this term (84 FR 44976, 44977; August 27, 2019), that revision does not change the scope of our analysis or how we analyze effects, and in this Opinion we use the terms "effects" and "consequences" interchangeably.

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

- *Evaluate 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.
- *Evaluate the environmental baseline of the species and critical habitat.* 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.

- *Evaluate the effects of the proposed action on species and their critical habitat using an exposure–response 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.
- *Evaluate cumulative effects.* 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.
- *In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to:* (1) directly or indirectly 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; or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.
- *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 reasonable and prudent alternative to the proposed action.* If, in completing the last step in the analysis, we determine that the action under consultation is likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat, we must identify a reasonable and prudent alternative (RPA) to the action in Section 2.8. The RPA must not be likely to jeopardize the continued existence of listed species nor adversely modify their designated critical habitat and it must meet other regulatory requirements (50 CFR 402.02).

2.2 Rangewide Status of the Species and Critical Habitat

This Opinion examines the status of each species that is likely to 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' "reproduction, numbers, or distribution" for the jeopardy analysis. The Opinion also examines the condition of designated critical habitat, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated critical habitat, and discusses the function of the PBFs that are essential for the species' conservation.

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 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 3).

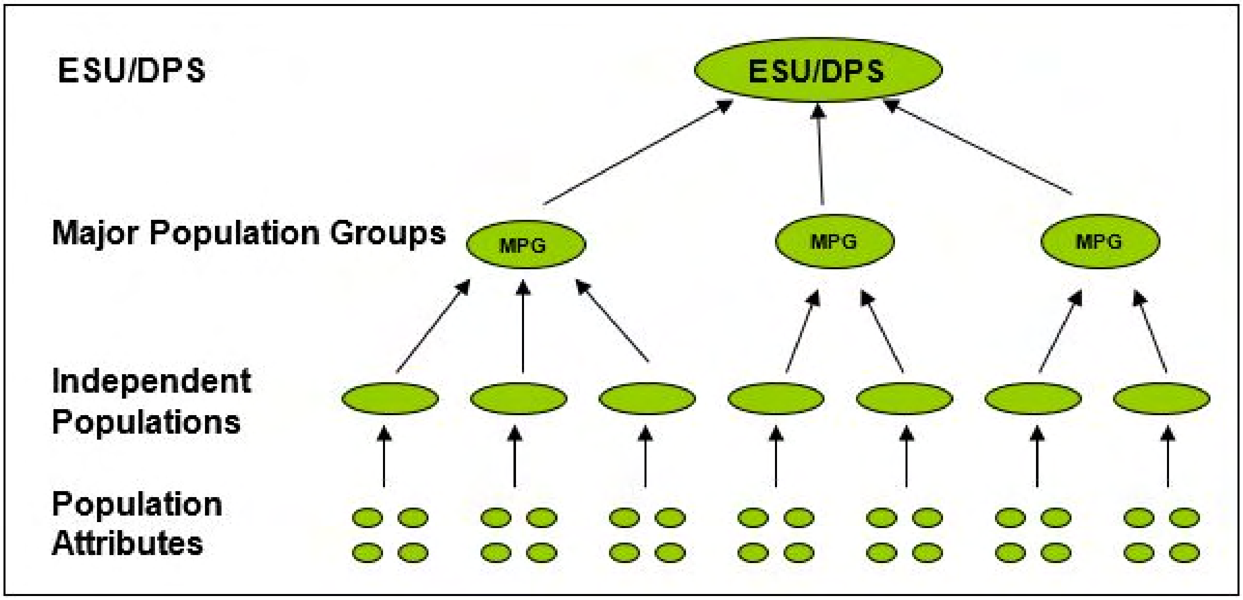

Figure 3. Hierarchical approach to ESU viability criteria.

Briefly, an ESU or DPS is divided into natural populations (McElhany et al. 2000). The risk of extinction of each population is evaluated, considering 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 salmon, 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 (SSDC 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 consultations, permits and 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, productivity, spatial structure, 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, and 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.

The NMFS has divided the West Coast into eight recovery domains to help plan for the recovery of salmon and steelhead. The recovery domains portray the approximate range of watersheds currently accessible to ESA-listed salmon and steelhead. Historical habitats that are no longer accessible to the listed species are not depicted as part of recovery domains, but may be considered critical for the recovery of an ESU or DPS. The listed salmon species analyzed in the consultation occur in three recovery domains (Table 6).

Table 6. 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.[7]

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 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

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[7] 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 (56 FR 58612, November 20, 1991). 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.

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 the proposed actions 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 LCR Chinook salmon, UWR Chinook salmon, Snake River Fall-Run Chinook Salmon, and Puget Sound Chinook salmon. The TRTs identified 62 demographically independent populations (DIPs) of Pacific Chinook salmon (Table 7). 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 7. 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 June 28, 2005 (70 FR 37160) and on April 14, 2014 (79 FR 20802). Critical Habitat for LCR Chinook salmon was designated on September 2, 2005 (70 FR 52630).

On February 6, 2015, we announced the initiation of five-year reviews for 17 ESUs of salmon and 11 DPSs of steelhead in Oregon, California, Idaho, and Washington (80 FR 6695). We requested that the public submit new information on these species that has become available since our original listing determinations or since the species' status was last updated. In response to our request, we received information from federal and state agencies, Native American Tribes, conservation groups, fishing groups, and individuals. We considered this information, as well as information routinely collected by our agency, to complete these five-year reviews. The most recent five-year status review of the LCR Chinook Salmon ESU was released October 21, 2022 (NMFS 2022j), and this section summarizes the current findings of that review.

The LCR Chinook Salmon ESU includes natural populations in Oregon and Washington from the ocean upstream to, and including, the White Salmon River (river mile 167.5) in Washington and Hood River (river mile 169.5) in Oregon, except for salmon in the Willamette River (which enters the Columbia River at river mile 101). Within the Willamette River Chinook salmon are listed separately as the Upper Willamette River Salmon ESU, and not as part of the LCR Chinook Salmon ESU.

Thirty-two historical populations, within six MPGs, comprise the LCR Chinook Salmon ESU. These are distributed through three ecological zones[8]. 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, Figure 4, and Figure 5).

Within the geographic range of the LCR Chinook Salmon ESU, during the period since the 2015 status review update, there have been a number of changes in both the quality and quantity of hatchery production in the lower Columbia River (Ford 2022). Currently 19 of these hatchery programs are included in the ESU (Table 8), while the remaining programs are excluded (70 FR 37160; (NMFS 2022j)). 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 2005a). For a detailed description of how NMFS evaluates and determines whether to include hatchery fish in an ESU or DPS, see NMFS (2005a).

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[8] 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 8. LCR Chinook Salmon ESU description and MPGs (Ford 2022; NMFS 2022j).

ESU Description[1]	
Threatened	Listed under ESA in 1999; reaffirmed in 2022.
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	
Hatchery programs included in ESU (18)	Big Creek Tule Fall Chinook; Astoria High School Salmon-Trout Enhancement Program (STEP) Tule Chinook Program; Warrenton High School (STEP) Tule Chinook Program; Cowlitz Tule Chinook Program; North Fork Toutle Tule Chinook Program; Kalama Tule Chinook Program; Washougal River Tule Chinook Program; Spring Creek National Fish Hatchery (NFH) Tule Chinook Program; Cowlitz Spring Chinook Program in the Upper Cowlitz River and in the Cispus River; Friends of the Cowlitz Spring Chinook Program; Kalama River Spring Chinook Program; Lewis River Spring Chinook Program; Fish First Spring Chinook Program; Sandy River Hatchery Program; Deep River Net Pens-Washougal Program; Klaskanine Hatchery Program; Bonneville Hatchery Program; and the Cathlamet Channel Net Pens Program.
Hatchery programs not included in ESU (12)	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.[9]

*The ongoing Hood River Spring Chinook Salmon Program is currently integrating returning natural-origin spring Chinook salmon into the broodstock. The program had been using only spring Chinook salmon returning to the Hood River for broodstock since the release year 2013 when the last release of out-of-basin Deschutes River spring Chinook salmon occurred (NMFS 2022j). NMFS will continue to monitor the status of the natural-origin population to determine if the Hood River spring Chinook salmon artificially propagated stock is no more divergent relative to

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[9] 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).

the local natural population(s) than what would be expected between closely related natural populations within the ESU (70 FR 37204, June 28, 2005).

Table 9. LCR Chinook salmon populations and recommended status under the recovery scenario (NMFS 2013f).

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

Major Population Group	Population (State)	Contribution[2]	Recovery Scenario[1]	
			Target Persistence Probability	Abundance Target[3]
	Hood (OR)	Primary[4]	H[4]	1,245
Cascade Late Fall	North Fork Lewis (WA)	Primary	VH	7,300
	Sandy (OR)	Primary	VH	3,561

[1] Overall persistence probability of the population under the delisting scenario to achieve VSP criteria, including abundance target. VL = very low, L = low, M = moderate, H = high, VH = very high. These are adopted in the recovery plan (NMFS 2013f).

[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 2013f).

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

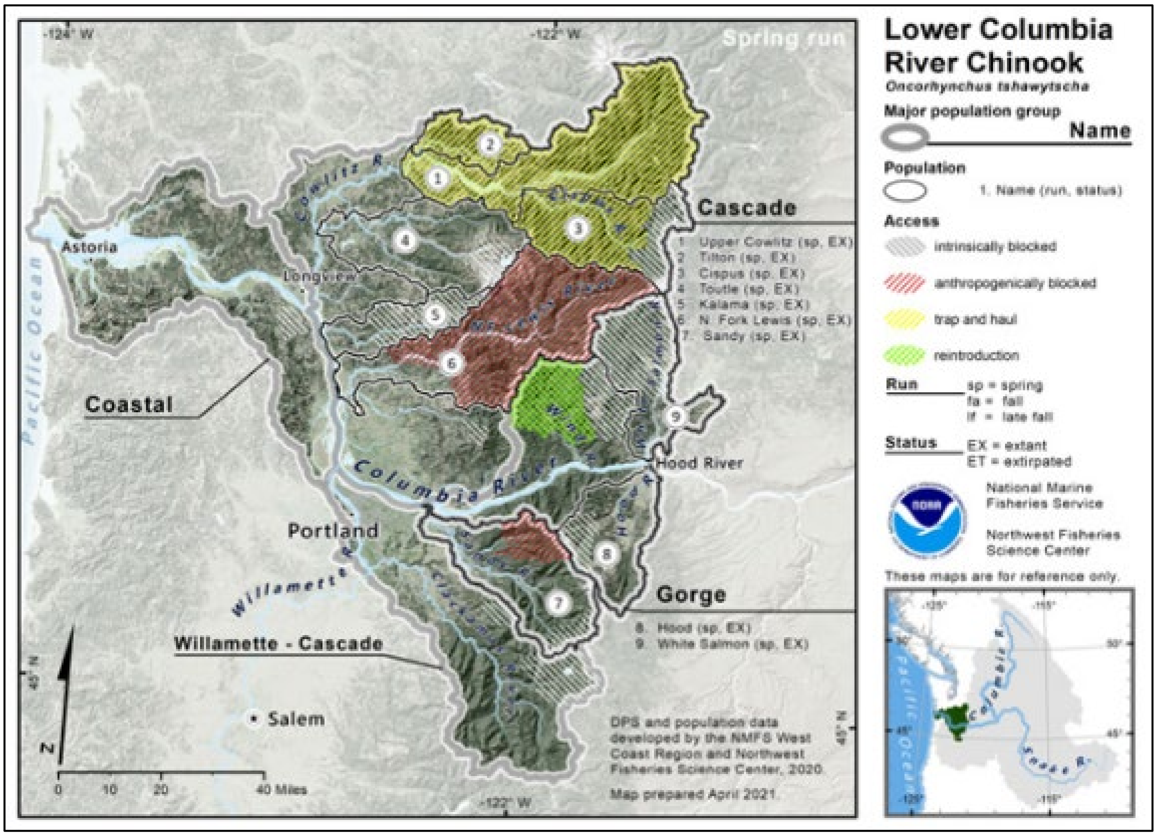

Figure 4. Map of the LCR Chinook Salmon ESU's spawning and rearing areas for spring Chinook salmon Demographically Independent Populations (DIPs or 'populations'), illustrating

populations and MPGs. Several watersheds contain or historically contained both fall and spring runs; only the spring-run populations are illustrated here (Ford 2022).

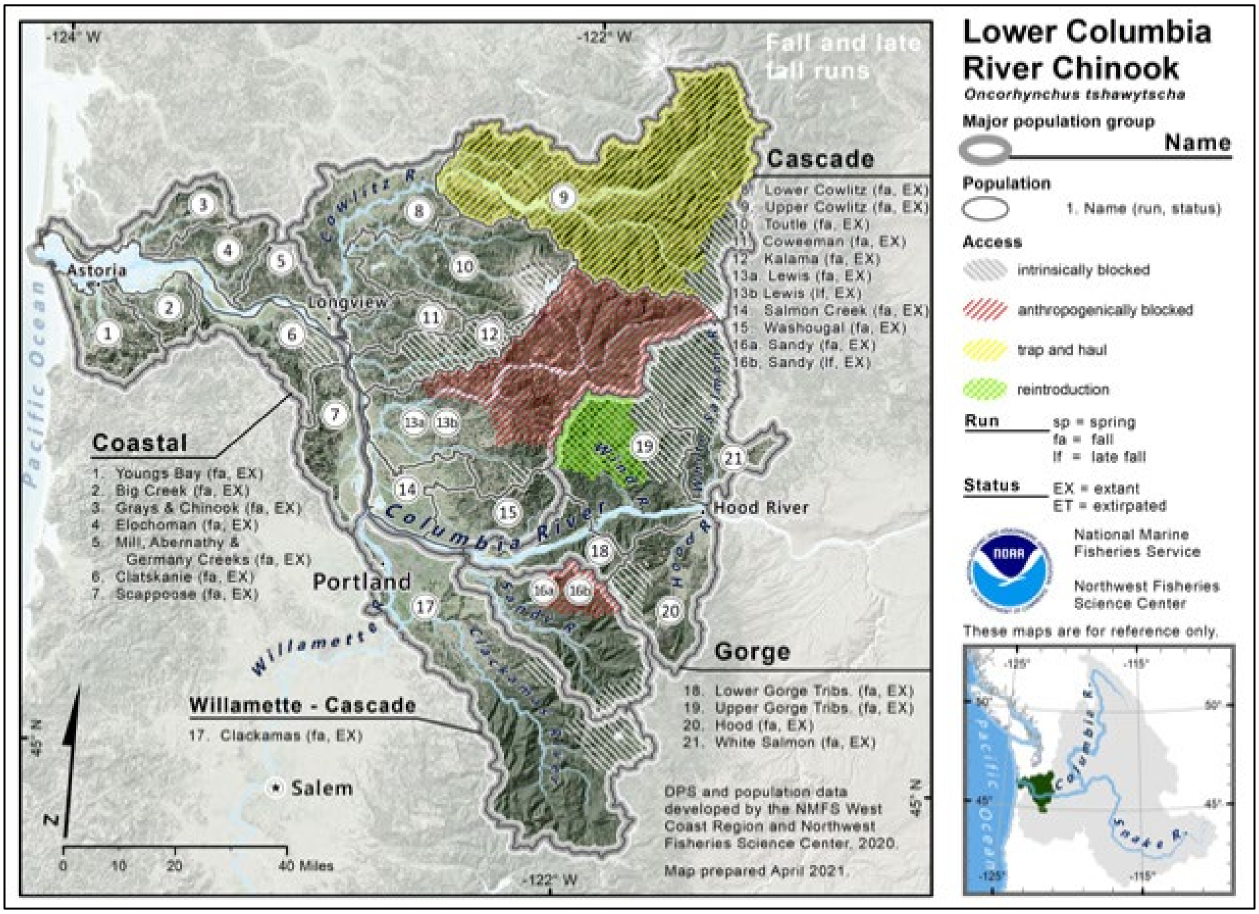

Figure 5. Map of the LCR Chinook Salmon ESU's spawning and rearing areas for fall Chinook salmon populations, illustrating populations and MPGs. Several watersheds contain or historically contained both fall and spring runs; only the fall-run populations are illustrated here (Ford 2022).

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 10). 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 2013f). 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 pounds). Chinook salmon require clean gravels for spawning, and pool and side-channel habitats for rearing. All Chinook salmon die after spawning once (NMFS 2013f).

Table 10. 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

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 2013f). 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 (Ford 2022).

Populations with different run timings share similar ER patterns, but differ in absolute harvest rates. With each run timing, tributary-specific harvest rates may differ. All populations saw a drop in ERs in the early 1990s in response to decreases in abundance. There has been a modest increase since then (Figure 6). Ocean fishery impact rates have been relatively stable in the past few years, with the exception of the bright (late fall) component of the ESU. The different MPGs are subject to different in-river fisheries (mainstem and tributary) because of differences in life histories and therefore river entry timing, but share relatively similar ocean distributions.

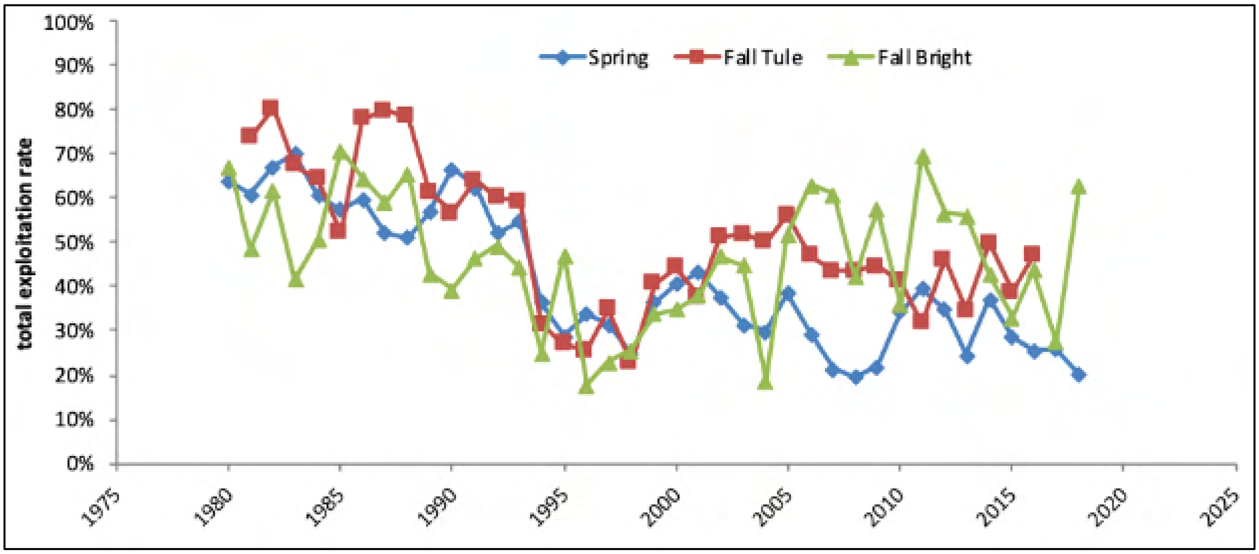

Figure 6. Total ERs on the three components of the Lower Columbia River Chinook salmon ESU (Ford 2022) (see environmental baseline for geographic distribution of the ERs).

2.2.2.1.1 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. Each LCR Chinook salmon natural population target persistence probability level is summarized in Table 9. Additionally, Table 9 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%).

The WLC TRT established recovery criteria as two primary populations with high target persistence probability in each MPG to achieve ESU viability. If the recovery scenario in Table 9 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 in Table 9 for the Gorge spring and Gorge MPGs does not meet WLC TRT criteria. Within each of these MPGs, the scenario targets only one population (the Hood) for high persistence probability because Bonneville Dam spans the Gorge fall and spring MPGs affecting passage of fish to these areas. Exceeding the WLC TRT criteria, particularly in the Cascade fall and Cascade spring Chinook salmon MPG, was intentional on the part of 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 (2013f) 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. 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 9) 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.

Expanded spawner surveys began after the 2010 review, especially in regard to abundance time series and hatchery contribution to the naturally spawning adults. Presently, there is some level of monitoring for all Chinook salmon populations except those that are functionally extinct (Ford 2022). Table 11 captures the geometric mean of natural spawner counts available, indicating that more recent years have more populations being monitored.

Table 11. Five-year geometric mean of raw natural spawner counts (Ford 2022). SP = spring-run, FA = fall-run, LFR = late fall-run. In parentheses, 5-year geometric mean of raw total spawner counts is shown. A value only in parentheses means that a total spawner count was available but no or only one estimate of natural spawners available.

Population	MPG	1990-94	1995-99	2000–04	2005–09	2010–14	2015–19	% change
Upper Cowlitz/Cispus Rivers SP	Spring-run Cascade	—	—	—	—	—	171 (5,435)	—
Kalama River SP	Spring-run Cascade	-121	-127	-337	57 (405)	82 (82)	43 (43)	–48 (–48)
North Fork Lewis River SP	Spring-run Cascade	-1,127	-308	-556	-130	-145	-112	(–23)
Sandy River SP	Spring-run Cascade	—	—	—	—	1,778 (2,000)	3,359 (3,667)	89 (83)
Big White Salmon River SP	Spring-run Gorge	—	—	—	—	18 (138)	8 (50)	–56 (–64)
Grays River Tule FA	Fall-run Coastal	-53	-81	-214	83 (188)	79 (448)	228 (579)	189 (29)
Youngs Bay FA	Fall-run Coastal	—	—	—	—	201 (5,105)	145 (1,635)	–28 (–68)
Big Creek FA	Fall-run Coastal	—	—	—	—	0 (1,389)	0 (2,206)	-59
Elochoman River/ Skamokawa Tule FA	Fall-run Coastal	-530	-661	-2771	-778	91 (612)	95 (238)	4 (–61)
Clatskanie River FA	Fall-run Coastal	—	—	27 (273)	13 (91)	8 (82)	3 (76)	–62 (–7)
Mill/Abernathy/Germany Creeks Tule FA	Fall-run Coastal	-1,160	-602	-2,416	-727	67 (688)	28 (151)	–58 (–78)
Lower Cowlitz River Tule FA	Fall-run Cascade	-2,492	-1,827	-5,818	-2,367	2,562 (3,711)	3,208 (4,161)	25 (12)
Coweeman River Tule FA	Fall-run Cascade	-877	-796	-805	-526	683 (840)	543 (595)	–20 (–29)
Toutle River Tule FA	Fall-run Cascade	-211	-788	-4,689	-1,826	330 (1,290)	280 (514)	–15 (–60)
Upper Cowlitz River Tule FA	Fall-run Cascade		-42	-724	-2,485	2,646 (7,779)	1,761 (2,188)	–33 (–72)

Population	MPG	1990-94	1995-99	2000–04	2005–09	2010–14	2015–19	% change
Kalama River Tule FA	Fall-run Cascade	-2,714	-4,192	-6,911	-6,156	540 (7,529)	2,142 (3,808)	297 (–49)
Lewis River Tule FA	Fall-run Cascade	—	-1,423	-3,487	-1,599	1,521 (2,256)	2,003 (3,637)	32 (61)
Clackamas River FA	Fall-run Cascade	—	—	—	—	144 (292)	236 (366)	64 (25)
Sandy River FA	Fall-run Cascade	—	—	—	—	-1,176	-2,074	-76
Washougal River Tule FA	Fall-run Cascade	-2,932	-3,227	-4,391	-2,355	609 (2,486)	914 (1,643)	50 (–34)
Lower Gorge Tributaries Tule FA	Fall-run Gorge	—	-1,822	-1,157	-941	928 (1,048)	4,528 (4,708)	388 (349)
Upper Gorge Tributaries Tule FA	Fall-run Gorge	—	-277	-916	-621	561 (1,563)	537 (999)	–4 (–36)
Big White Salmon River Tule FA	Fall-run Gorge	-127	-151	-2,129	-939	759 (962)	283 (502)	–63 (–48)
Lewis River Bright LFR	Late fall-run Cascade	-8,353	-6,647	-11,694	-5,758	11,671	-8,353	-6,647
Sandy River Bright LFR	Late fall-run Cascade	852 (3,594)	815 (3,440)	555 (2,340)	1,097 (4,629)	—	—	—

In 2017 NMFS adopted a Record of Decision ("Mitchell Act ROD") that would be used to guide NMFS' decision on the distribution of funds for hatchery production under the Mitchell Act (16 U.S.C. 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 2017m). The Mitchell Act ROD directs NMFS to strengthen 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 than was the practice at the time. While this action is expected to decrease multiple MPGs high relative dominance of hatchery-origin spawners (Table 12), this will take some time to occur, and is not likely to show up in the data until the middle of this decade (mid 2020s at the earliest).

Table 12. Five-year mean of fraction natural-origin spawners (sum of all estimates divided by the number of estimates) for Lower Columbia River Chinook salmon ESU populations (Ford 2022).

Population	MPG	1995-99	2000-04	2005-09	2010-14	2015-19
Upper Cowlitz/Cispus Rivers SP	Spring-run Cascade	—	—	—	0.08	0.06
Kalama River SP	Spring-run Cascade	—	—	—	1	1
North Fork Lewis River SP	Spring-run Cascade	—	—	—	—	—
Sandy River SP	Spring-run Cascade	—	—	—	0.89	0.92
Big White Salmon River SP	Spring-run Gorge	—	—	—	0.13	0.18
Grays River Tule FA	Fall-run Coastal	—	—	0.36	0.22	0.43
Youngs Bay FA	Fall-run Coastal	—	—	—	0.04	0.14
Big Creek FA	Fall-run Coastal	—	—	—	0.03	0.04
Elochoman River/ Skamokawa Tule FA	Fall-run Coastal	—	—	—	0.17	0.45
Clatskanie River FA	Fall-run Coastal	—	0.1	0.19	0.09	0.05
Mill/Abernathy/Germany Creeks Tule FA	Fall-run Coastal	—	—	—	0.11	0.22
Lower Cowlitz River Tule FA	Fall-run Cascade	—	—	—	0.7	0.77
Coweeman River Tule FA	Fall-run Cascade	—	—	—	0.82	0.91
Toutle River Tule FA	Fall-run Cascade	—	—	—	0.31	0.55
Upper Cowlitz River Tule FA	Fall-run Cascade	—	—	—	0.35	0.82
Kalama River Tule FA	Fall-run Cascade	—	—	—	0.08	0.57
Lewis River Tule FA	Fall-run Cascade	—	—	—	0.67	0.56
Clackamas River FA	Fall-run Cascade	—	—	—	0.6	0.68
Sandy River FA	Fall-run Cascade	—	—	—	—	—
Washougal River Tule FA	Fall-run Cascade	—	—	—	0.3	0.58
Lower Gorge Tributaries Tule FA	Fall-run Gorge	—	—	—	0.89	0.96

Population	MPG	1995-99	2000-04	2005-09	2010-14	2015-19
Upper Gorge Tributaries Tule FA	Fall-run Gorge	—	—	—	0.4	0.58
Big White Salmon River Tule FA	Fall-run Gorge	—	—	—	0.8	0.57
Lewis River Bright LFR	Late fall-run Cascade	—	—	—	1	1
Sandy River Bright LFR	Late fall-run Cascade	0.24	0.24	0.24	—	—

The information presented in the following section is a review of updated status information available for each MPG from the most recent status review (NMFS 2022j).

Cascade Spring-run MPG

LCR spring Chinook salmon natural populations occur in both the Gorge and Cascade MPGs (Table 8). There are seven LCR spring Chinook salmon populations in the Cascade MPG. Of the seven spring-run populations in this MPG, there are only abundance estimates for five populations, the Upper Cowlitz/Cispus Rivers (two populations combined), Kalama River, North Fork Lewis River, and Sandy River populations. Of these, only the Sandy River population appears to be sustaining natural-origin abundance at near-recovery levels based on the most recent data. The most-recent five-year geomean abundance for the Sandy River was 3,359, which represents an 89% increase over 2010–14 (Table 11). The removal of Marmot Dam on the Sandy River in 2007, in conjunction with other restoration efforts including reductions in the contribution of hatchery-origin fish, has facilitated the improved natural-origin abundance of spring-run Chinook salmon in that basin, an impressive result given the poor ocean conditions experienced during the period examined in the most recent status review (NMFS 2022j). This abundance is greater than the recovery target of 1,230 listed in Table 9.

Elsewhere in this MPG natural-origin abundances for spring-run Chinook salmon were very low, with negative trends. The combined estimate for the Upper Cowlitz/Cispus River of 171 fish for the last five-year geomean (Table 11) is much lower than the independent recovery target of 1,800 for either population (Table 9). The North Fork Lewis River recent five-year geomean of 112 and corresponding Kalama River estimate of 43 fish are also much lower than their respective recovery abundance targets of 1,500 and 300. For the Upper Cowlitz/Cispus Rivers, Kalama River, and North Fork Lewis River populations, hatchery returns currently constitute the vast majority of fish returning to the river (Ford 2022). 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 2013f).

The Cowlitz, Lewis, Sandy 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 (HGMPs; Table 13). 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. Escapement to the Cowlitz, Lewis, and Sandy river hatcheries are essential for recovery, given each population is designated a primary population. This, particularly in case of the Cowlitz and Lewis River hatcheries because passage for the populations within those systems is still a limiting factor, 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 2013f). 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 9; NMFS (2013f)).

Table 13. Hatchery escapement for LCR spring Chinook populations (TAC 2017).

Year	**Cowlitz**	**Kalama**	**Lewis**	**Sandy**
	Hatchery Escapement (rack return goal: 1,337)[1]	Hatchery Escapement (rack return goal: 300)[2]	Hatchery Escapement (rack return goal: 1,380)[3]	Hatchery Escapement (rack return goal: 150)
2003	11,043	3,881	3,037	1,197
2004	12,865	3,665	4,235	2,800
2005	7,646	3,125	2,053	1,877
2006	5,470	4,373	4,134	1,429
2007	3,159	4,769	3,939	2,420
2008	1,968	1,018	1,386	136
2009	3,703	268	1,068	203
2010	6,032	579	1,896	535
2011	2,066	454	1,037	307
2012	5,826	366	1,336	191
2013	4,074	844	1,762	591
2014	4,615	765	1,009	701
2015	17,605	2,678	885	218
2016	14,795	2,682	446	78
2017	8,844	1,958	2,418	1,376
2018	2,745	1,254	2,343	1,400
2019	1,271	703	882	451
2020	841	922	1,471	1,562
2021	3,220	1,343	2,175	1,136
2022	5,855	1,924	4,551	2,827
2023	4,080	1,557	2,544	n/a

[1] Cowlitz River Spring Chinook salmon brood origin hatchery returns are collected on-station at the Cowlitz Salmon Hatchery.

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

A reintroduction program 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, the first priority of fish returning to these areas, both natural-origin and hatchery-origin, is to achieve the integrated 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.

In the Upper Cowlitz River, surplus hatchery-origin fish are transported around the dams to contribute to reintroduction of fish above the dams, whereas in the Kalama and Lewis Rivers, hatchery fish are intercepted at Lower Kalama River Falls and Merwin Dam, respectively to maximize hatchery production. The reintroduction efforts in the Upper Cowlitz River facilitate the use of otherwise vacant habitat, but cannot be self-sustaining until downstream juvenile collection problems are solved. Efforts are underway to improve juvenile collection facilities to achieve 95% juvenile outmigrant survival, which was last estimated for passage survival probability for juvenile Chinook salmon as 83% in 2013-14 (Liedtke et al. 2016). Currently, downstream passage has not attained sufficient efficiencies for the populations to sustain themselves, although considerable progress has been made in recent years (PacifiCorp 2020). Given the circumstances, fisheries are managed to achieve the hatchery escapement goals and thereby preserve the genetic heritage of the populations, maintain use of the habitat, and retain the option for the reintroduction program and eventual recovery of these populations. Reintroduction efforts have not yet begun to reestablish spring-run Chinook salmon in the Tilton River population.

Legacy effects of the 1980 Mount St. Helens eruption are still a fundamental limiting factor for the Toutle spring Chinook salmon natural population (NMFS 2013f). 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 was constructed to manage the ongoing input of fine sediments into the lower river. Nonetheless, the sediment retention structure 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 sediment retention structure. The transport program provides access to 50 miles of anadromous fish habitat located above the structure (NMFS 2013f), but that habitat is still in very poor condition. WDFW does not recognize the continued existence of the Toutle River spring-run DIP, and adult spawner surveys are not undertaken (Ford 2022). 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 9).

In summary: in this MPG, only the Sandy River Chinook salmon population has attained moderate abundance levels (Table 10); three other populations have very low abundances, and the remaining three have few if any naturally spawning individuals, although the populations may persist as hatchery stocks in some cases (Ford 2022).

Gorge Spring-run MPG

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

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. The delisting persistence probability target is listed as very high, but NMFS (2013f) believes that the prospects for meeting that target are uncertain. The only data we have are for estimates of spring Chinook salmon returning to the Hood River are in Table 14, indicating a declining trend in the proportion of presumed natural-origin returns as time went on with the reintroduction program. With the removal of Powerdale Dam, it has not been possible to estimate the abundance of returning adults with any certainty. Earlier reports of unmarked spring-run Chinook salmon returning to the Hood River (NWFSC 2015) may suggest the persistence of some native fish, but there is no verification of this. The last estimate of natural abundance, 18 adults, was in 2017 (Ford 2022).

Table 14. Total, hatchery, and natural-origin spring Chinook returns to the Hood River (TAC (2017), Table 2.1.11).

Year	Total Run Size [1]	Clipped Hatchery Run Size	Unclipped Presumed Natural-origin Run Size	Proportion Presumed Natural-origin
2001	602	560	42	7.0%
2002	170	101	69	40.6%

Year	Total Run Size [1]	Clipped Hatchery Run Size	Unclipped Presumed Natural-origin Run Size	Proportion Presumed Natural-origin
2003	400	338	62	15.5%
2004	242	98	144	59.5%
2005	696	589	107	15.4%
2006	1,236	939	297	24.0%
2007	460	327	133	28.9%
2008	997	936	61	6.1%
2009	1,314	1,248	66	5.0%
2010	635	507	128	20.2%
2011	1,377	1,377	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 Oregon Department of Fish and Wildlife (ODFW). Powerdale dam counts prior to 2010.

The White Salmon River natural population is 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). Although some spring-run fish have spawned in the basin subsequent to the dam removal, the origin of those fish is not known and spawner surveys have been limited (Ford 2022). The most recent five-year data indicate substantial fish abundance has not yet become established. The current five-year geomean is only eight fish (Table 11) compared to the recovery target of 500 (Table 9). 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 9).

In summary: there is considerable uncertainty whether this MPG now persists, and whether the low abundances observed represent native natural-origin abundances (Ford 2022).

Coast Fall-run MPG

There are seven natural populations in the Coast Fall Chinook salmon MPG. None are considered genetic legacy populations, but 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 9).

Populations in this MPG are subject to significant levels of hatchery straying (Table 12). Only in the Grays River Tule population was there a considerable increase in five-year and longer-term abundance, from 79 to 228 (Table 11), although hatchery-origin fish still constitute the majority of natural spawners (Table 12). There was a Chinook salmon hatchery on the Grays River, but that program was closed in 1997 with the last hatchery returns from that facility 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. The weir however is no longer functional and current levels of strays from the out-of-ESU Rogue River brights have decreased due to the program downsizing its release size.

The Elochoman River/Skamokawa Tule population was largely stable, with a five-year geomean abundance of 95 (Table 11). The tule hatchery program operating in the Elochoman River was closed in 2009 (NMFS 2013f). 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. This population has experienced a slight uptick in the abundance geomean (Table 11), but it is very small, and the last five-year geomean of spawning abundance of 95 fish is still far short of the recovery plan's recovery target of 1,500 fish.
Of the remaining populations, downward trends were observed in the Youngs Bay, Clatskanie River, and M/A/G Creeks Tule populations, all of which have low abundances (Table 11). Spawning surveys for Youngs Bay and Big Creek are incomplete. The most recent data for the Youngs Bay population indicate a negative trend with the recent five-year geomean of 145 fish falling short of the 505 abundance expected under the delisting scenario (Table 9). Big Creek surveys are not done every year, and returns are dominated by returns to the hatchery. Presently, unmarked fall-run Chinook salmon are passed over the Big Creek weir to spawn naturally in the upper basin, as there is limited spawning habitat below the weir; the most recent estimate for natural-origin spawners was 118 in 2018. 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. 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 Clatskanie River surveys are strongly influenced by large numbers of hatchery-origin fish being attracted to Plympton Creek, whereas the mainstem Clatskanie River has a few natural-origin spawners (>10), but almost no hatchery fish (Table 11 and Table 12). The most recent data indicates very low numbers of fish in the Clatskanie River populations, as the five-year geomeans for the last two five-year periods indicate less than ten fish versus the delisting scenario expecting annual abundances of over 1,200 (Table 9).

In summary: the populations in this MPG are dominated by hatchery-origin spawners from one of the many large production hatcheries in the area. The abundance of naturally produced adults is low to very low for all populations, and overall productivity estimates were negative (Ford 2022).

Cascade Fall-run MPG

There are ten natural populations of fall Chinook salmon in the Cascade MPG. The Lower Cowlitz, Kalama, Clackamas, and Sandy populations are targeted for medium persistence probability (Table 9). The Toutle, Coweeman, Lewis, and Washougal populations are targeted for high-plus persistence probability in the ESA recovery plan (Table 9). Of these, only the Coweeman and Lewis are considered genetic legacy populations. 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 2013f) (Table 9).

Within this MPG, five of the nine populations for which we have information show short-term positive trends (Table 11). Natural-origin spawner abundances were in the high hundreds to low thousands of fish, with the majority of the fish on the spawning grounds being natural-origin, except for the Toutle, Kalama, and Washougal Rivers, where hatchery programs strongly influence the composition of naturally-spawning fish (Table 12). The Lower Cowlitz River Tule population had the highest five-year abundance (3,208), a 25% increase over the previous period (Table 11) and is above the delisting abundance goal of 3,200 (Table 9).

Annual variability in the proportion of hatchery-origin spawners is very high in the Clackamas River (Table 12), although only a few years of data are available. Recent improvements in natural adult returns to the Tilton River (part of the Upper Cowlitz River Tule population) suggest that the trap-and-haul program at Mayfield Dam has been successful (Ford 2022). 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.

In summary: the majority of the populations in this MPG have exhibited stable or slightly positive natural-origin abundance trends. Overall, most of the fall-run populations in this MPG are improving, even approaching recovery levels in some cases, and while the level of hatchery contribution to naturally spawning adults is relatively better than in other MPGs in this ESU, most populations are still far above the hatchery contribution target of 10% identified in NMFS' lower Columbia River recovery plan (NMFS 2013f).

Gorge Fall-run 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 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 9). There is some uncertainty regarding the historical role of the Gorge populations in the ESU, and whether they truly functioned historically as populations (NMFS 2013f). 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 (Appendix C in NMFS (2013f)). Natural-origin returns for most populations are in the hundreds of fish, with decreases in abundance noted for those populations for which we have abundance estimates. Recent five-year geomean for the Big White Salmon River was 282, a 63% decline in abundance (Table 11), compared to the delisting goal of 500 (Table 9). 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[10]. 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. 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 (Ford 2022). 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 of the Lower Gorge populations has been steadily increasing in recent years (Table 11). 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 Proportion Hatchery Origin Spawners (pHOS) levels (Table 12). 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.

In summary: Natural-origin returns for most populations are in the hundreds of fish, with many of the populations in this MPG having limited spawning habitat available, either because of inundation of historical habitat in the upper gorge or the loss of access.

Cascade Late Fall-run 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

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

9). Both populations are targeted for very high persistence probability under the recovery scenario (Table 9).

The Lewis River population is the principal indicator stock for management within the Cascade Late Fall-run MPG. It is a natural-origin population with little or no hatchery influence. The escapement goal, based on estimates of maximum sustainable yield (MSY), is 5,700 (PFMC 2022). The natural-origin abundance mean is 8,725 (Table 11) over the last five years and has generally exceeded the goal by a wide margin since at least 1980. While the pattern shows a slight negative trend, 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. NMFS (2013) identifies an abundance target under the recovery scenario of 7,300 natural-origin fish (Table 9), 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 five years therefore is exceeding the abundance objective in the recovery plan. 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.

The Sandy River bright run is no longer directly monitored with the removal of Marmot Dam in 2007 as a counting station; the most recent estimate was 373 spawners in 2010 (Ford 2022). It is unclear if the value is composed of only natural-origin fish, however there is no hatchery program operated in the tributary for tule or bright Chinook salmon. Abundance estimates for Sandy River fall-run (tule) and bright-run Chinook salmon are combined by ODFW into a single Sandy River fall-run data series, which increased during the recent review period (five-year geomean = 2,074, a 76% increase) (Ford 2022). The abundance target for delisting is 3,747 natural-origin fish (Table 9), and although there is some uncertainty to the exact status of the Sandy River bright run, the population currently appears to be at relatively low risk.

In summary: this MPG is the most viable in the ESU. The Lewis River bright population is sustaining abundances above its recovery target, and both populations in this MPG maintain their abundances with no hatchery supplementation.

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. There have been a number of large-scale efforts to improve accessibility, one of the primary metrics for spatial structure, in this ESU. Passage efforts on the Cowlitz River at Cowlitz Falls began in 1996 for Chinook salmon and other salmonids (Ford 2022). In addition, the collection of juvenile fall-run Chinook salmon from the Tilton River at Mayfield Dam appears to be relatively successful, with increasing numbers of fall-run Chinook salmon returning in the last few years. Spring-run reintroductions are not planned for the Tilton River. As explained above, the sediment retention structure remains an impediment to fish passage in the North Fork Toutle River. On the Hood River, Powerdale Dam was removed in 2010, and while this dam previously allowed fish passage, removal of the dam is thought to have eliminated passage delays and injuries. Condit Dam, on the White Salmon River, was removed in 2011, providing access to previously inaccessible habitat. Spawner surveys of the White Salmon River indicate that both hatchery-origin and unmarked (presumed natural-origin) Chinook salmon are colonizing the newly accessible habitat (Ford 2022). Fish passage operations for spring-run Chinook salmon (trap-and-haul) were begun on the Lewis River in 2012, reestablishing access to historically occupied habitat above Swift Dam (River Kilometer (RKM) 77.1). These efforts are anticipated to improve spatial structure for each of these respective populations, and, by opening up access to blocked spawning habitat, increase future abundances.

Figure 7 provides recently updated information about the productivity for each population within the LCR Chinook Salmon ESU. 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 2010). Releases of out-of-ESU upper Willamette River spring-run Chinook salmon into Oregon tributaries near the mouth of the Columbia River may not pose a long-term genetic risk, due to the absence of spring-run spawning habitat in the Coastal stratum, but may pose a risk to natural-origin juveniles due to competition and predation (Ford 2022). There have been some reductions in the number of fall-run Chinook salmon in an effort to decrease the contribution of hatchery-origin fish to naturally spawning adults. Spring-run Chinook salmon production has continued, in part, due to the inaccessibility of historical spring-run spawning and rearing habitat, particularly in subbasins like the Cowlitz and Lewis rivers, to preserve this life history. The termination of the non-native late fall-run Chinook salmon below Bonneville Dam has decreased the risk of introgression between native natural- and hatchery-origin fish (Ford 2022). The estimated proportion of hatchery-origin spawners is still well in excess of the limits set in the recovery plan for many of the primary populations throughout the ESU (Table 12).

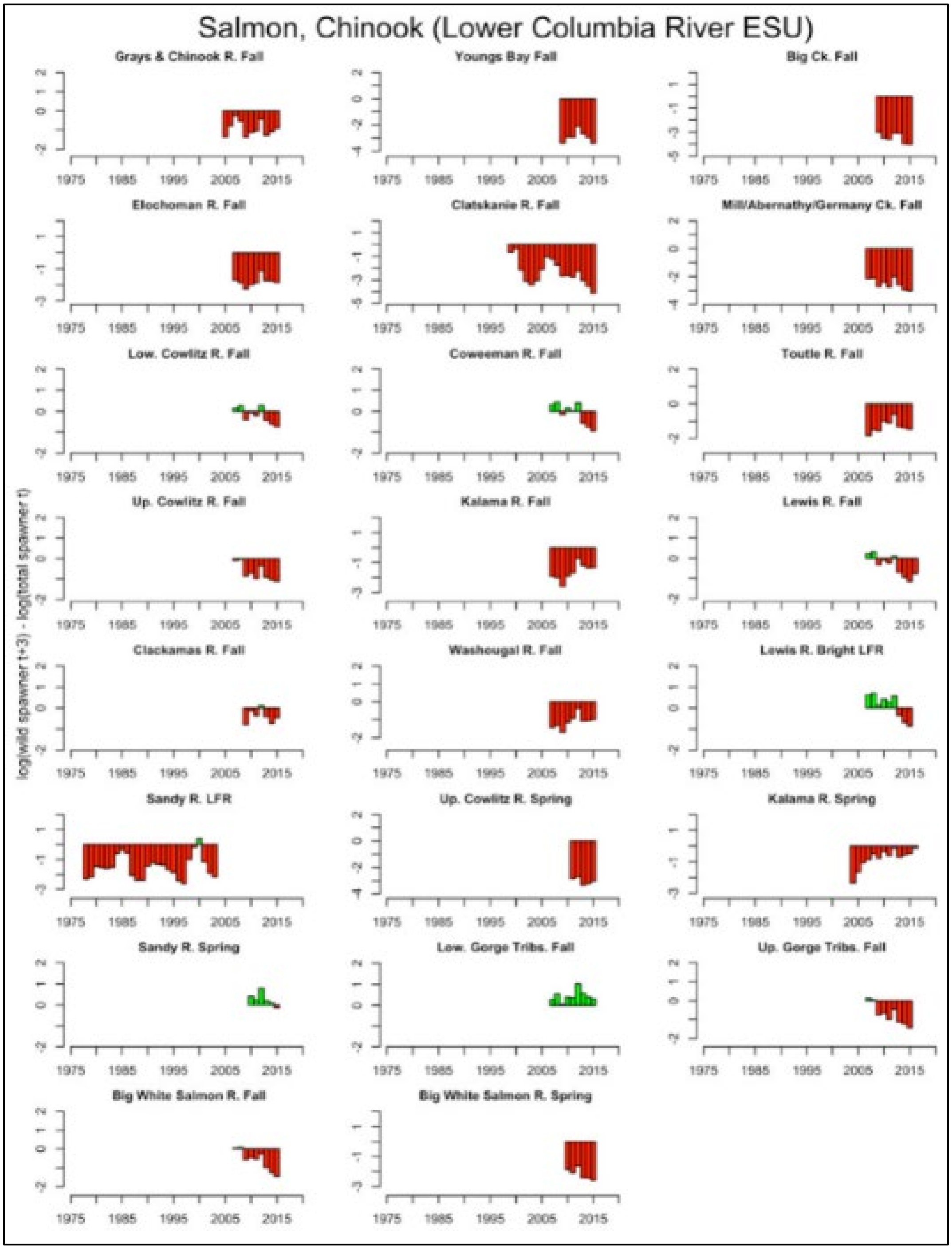

Figure 7. Trends in population productivity, estimated as the log of the smoothed natural spawning abundance in year t minus the smoothed natural spawning abundance in year (t – 4). Spawning years on x-axis (Ford 2022).

Out of the 32 populations that make up this ESU, only seven populations are at or near the recovery viability goals (Table 15) set in the recovery plan (refer above to Table 9). Six of these seven populations are located in the Cascade stratum; most of the populations in the Coast and Gorge strata are doing rather poorly (Ford 2022).

Table 15. Current 5-year geometric mean of raw natural-origin spawner abundances compared to the recovery scenario presented in the recovery plan (NMFS 2013f) for LCR Chinook salmon populations (Ford 2022).

MPG	**Population**	**Abundance**	
		2015-19	**Recovery Target**
Coast	Grays River Tule FA (WA)	228	1,000
	Youngs Bay FA (OR)	145	505
	Big Creek FA (OR)	0	577
	Elochoman River/Skamokawa Tule FA (WA)	95	1,500
	Clatskanie River FA (OR)	3	1,277
	Mill/Abernathy/Germany Creeks Tule FA (WA)	28	900
	Scappoose Creek FA (OR)	n/a	1,222
Cascade	Upper Cowlitz/Cispus Rivers SP (WA)	171	1,800
	Kalama River SP (WA)	43	300
	North Fork Lewis River SP (WA)	-112	1,500
	Sandy River SP (OR)	3,359	1,230
	Toutle River SP (WA)	n/a	1,100
	Cispus River SP (WA)	n/a	1,800
	Tilton River SP (WA)	n/a	100
	Lower Cowlitz River Tule FA (WA)	3,208	3,000
	Coweeman River Tule FA (WA)	543	900
	Toutle River Tule FA (WA)	280	4,000
	Upper Cowlitz River Tule FA (WA)	1,761	n/a
	Kalama River Tule FA (WA)	2,142	500
	Lewis River Tule FA (WA)	2,003	1,500
	Clackamas River FA (OR)	236	1,551
	Sandy River FA (OR)	-2,074	1,031
	Washougal River Tule FA (WA)	914	1,200
	Salmon Creek FA (WA)	n/a	n/a
	Lewis River Bright LFR (WA)	8,725	7,300
	Sandy River Bright LFR (OR)	n/a	3,561
Gorge	Big White Salmon River SP (WA)	8	500
	Hood River SP (OR)	n/a	1,493
	Lower Gorge Tributaries Tule FA (WA & OR)	4,528	1,200
	Upper Gorge Tributaries Tule FA (WA & OR)	537	1,200
	Big White Salmon River Tule FA (WA)	283	500

MPG	Population	Abundance	
		2015-19	Recovery Target
	Hood River FA (OR)	n/a	1,245

Colors indicate the relative proportion of the recovery target currently obtained: red = <10%, orange = 10% > x < 50%, yellow = 50% > x < 100%, green = >100%

Overall, there has been modest change since the last status review in the biological status of Chinook salmon populations in the Lower Columbia River Chinook salmon ESU (Ford 2022). Increases in abundance were noted in about half of the fall-run populations, and in 75% of the spring- run populations for which data were available. Decreases in hatchery contribution were also noted for several populations. Relative to baseline VSP levels identified in the recovery plan (NMFS 2013f), there has been an overall improvement in the status of a number of spring and fall-run populations (Table 15), although most are still far from the recovery plan goals.

Many of the populations in this ESU remain at “high risk,” with low natural-origin abundance levels. Hatchery contributions remain high for a number of populations (Table 13), and it is likely that many returning unmarked adults are the progeny of hatchery-origin parents, especially where large hatchery programs operate. While overall hatchery production has been reduced slightly, hatchery-produced fish still represent a majority of fish returning to the ESU. Although many of the populations in this ESU are at “high” risk, it is important to note that poor ocean and freshwater conditions existed during the 2015–19 period and, despite these conditions, the status of a number of populations improved, some remarkably so from the previous status review (Grays River Tule, Lower Cowlitz River Tule, and Kalama River Tule fall runs) (Ford 2022). Overall, the viability of the LCR Chinook salmon ESU has increased since the last status review, although the ESU remains at “moderate” risk of extinction (Ford 2022).

2.2.2.1.2 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 2013f).

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 2013f) 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 2013f) 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 2013f) 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.

In our recent five-year status review (NMFS 2022j), based on Section 4(a)(1) of the ESA, we determine if the listed species listing factors have changed. While there have been improvements in the abundance of some populations, we found that the overall viability trends remain low, and well below abundance recovery objectives for LCR Chinook Salmon ESU. Some improvements have been made in listing factors, though slight increases in risk in some listing factors are contemporaneous with restoration work and some regulatory improvements, and the recent improvements (particularly habitat restoration work) require time to manifest measurable increases in population viability. The risk from predation and disease to LCR Chinook Salmon ESU remains. For harvest, the risk is increasing for LCR Chinook salmon due to a modest upward trend in harvest impacts on fall and bright fall-run components of the ESU (NMFS 2022j). Additionally, the risk to the species persistence from climate change is an increasing concern (NMFS 2022j).

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. To comply with the National Environmental Policy Act with respect to its hatchery funding decisions under the Mitchell Act, NMFS released a final environmental impact statement (FEIS) to inform its decisions regarding what kind of hatchery programs to fund with federal appropriations provided under the Mitchell Act. In its NEPA Record of Decision, NMFS made a final decision in 2017 after careful consideration of a range of comments received during public review of the final EIS. The Biological Opinion on the majority of hatchery production affecting this ESU (NMFS 2017m) expected federal funding guidelines to require reductions in limiting factors relative to hatchery effects over the course of the next decade. Further analysis revealed the need for an increase in hatchery reform actions, as evident in the 2017 Mitchell Act Opinion which sought to determine the efficacy of these reform actions over time. The Opinion set an unprecedented hatchery policy that aimed to futurize federally funded programs with a goal of monitoring programs' success with regard to their intended increases in harvest opportunities and the programs' regional impacts on ESA-listed populations. The proposed action for the Mitchell Act Opinion looked to a pulse-checking approach to see how effective hatchery program reforms would work under the short duration ofa few salmon and steelhead generations. Several reform measures were implemented including the following:

- NMFS suggested programs look to eliminate the collection and transfer of brood from other MPGs and instead focus on integrating programs with localized broodstock from within the population's MPG. The intent was to better align hatchery production broodstock with the diversity of the natural-origin populations that could be potentially affected by the hatchery programs.
- CWT analyses and new modeling techniques provided helpful insight into Lower Columbia River hatchery programs, leading to a phased impact reduction approach, eliminating some programs and reducing production for others. NMFS aimed to measure these hatchery reforms over time to evaluate the new management approach.
- NMFS also looked to weirs as a potential tool to reduce the number of hatchery-origin adults spawning naturally and/or integrating into natural-origin populations. Co-managers agreed to implement and operate weirs in key tributaries to reduce the impacts of local hatchery programs and determine the effectiveness of weirs as a tool in the LCR. This pulse-check approach would also provide a more in-depth look into the abundance and productivity of natural populations. For weir operations, not all of the weirs have been implemented as expected.
- NMFS also identified the need for hatchery facilities to comply with new standards for water intake screens to minimize adverse impacts to ESA-listed fish, which were also not all fully implemented.

As a result of some of the reforms not being fully implemented in the timeline NMFS anticipated, we have since reinitiated consultation on our funding action of Mitchell Act hatchery programs. It is our expectation to have a new Opinion on funding Mitchell Act hatchery programs complete by 2025.

When all listing factors and current viability are considered, specific to the LCR Chinook Salmon ESU, our recent five-year status review indicates that the collective risk to the persistence of the LCR Chinook Salmon ESU has not changed significantly since our original listing determination in 1999 and should remain listed as threatened (Ford 2022; NMFS 2022j).

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 September 2, 2005 (70 FR 52630). The most recent 5-year status review, completed in 2024, found that no new information has become available since the previous review (NMFS 2016h), and that the UWR Chinook salmon ESU should remain listed as threatened (NMFS 2024d). The ESU includes all naturally spawned populations of spring-run Chinook salmon in the Clackamas River, the Willamette River and its tributaries above Willamette Falls, Oregon, (Figure 8). Critical habitat encompasses 60 watersheds within the range of this ESU’s critical habitat as well as the lower Willamette/Columbia River rearing/migration corridor, occurring in the counties of Benton, Clackamas, Clatsop, Columbia, Lane, Linn, Marion, Multnomah, Polk, and Yamhill, in the State of Oregon, and Clark, Cowlitz, Pacific, and Wahkiakum in the State of Washington (70 FR 52630). 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 (2005a). The ESU contains seven historical populations, within a single MPG, as well as several artificial propagation programs (western Cascade Range, Table 16).

Table 16. UWR Chinook Salmon ESU description and MPG (Jones 2015; NWFSC 2015).

ESU Description	
Threatened	Listed under ESA in 1999; reaffirmed in 2024.
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, Middle Fork (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

The UWR Chinook Salmon ESU only has one MPG (Table 16), containing the seven populations listed in Table 16. While the UWR conservation and recovery plan for Chinook salmon and steelhead (ODFW and NMFS 2011) adopts the WLC TRT guidelines for viability as sound, comprehensive, and conservative, the approach for the recovery scenario, given this ESU only has one MPG, was to achieve a broad sense recovery goal. The broad sense recovery goal for the ESU is to achieve for all UWR salmon populations a “very low” extinction risk, and would therefore be a “highly viable” population over 100 years throughout their range. In the LCR Chinook salmon ESU, this type of population designation is termed “primary”, but no such designation or stratification was done for the UWR Chinook Salmon ESU and the adopted approach treats all populations in the ESU as if they were primary populations. This, along with the majority of UWR salmon populations being capable of contributing social, cultural, economic and aesthetic benefits on a regular and sustainable basis are the delisting criteria.

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 (ODFW and NMFS 2011).

The generalized life history traits of UWR Chinook salmon are summarized in Table 17. 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).

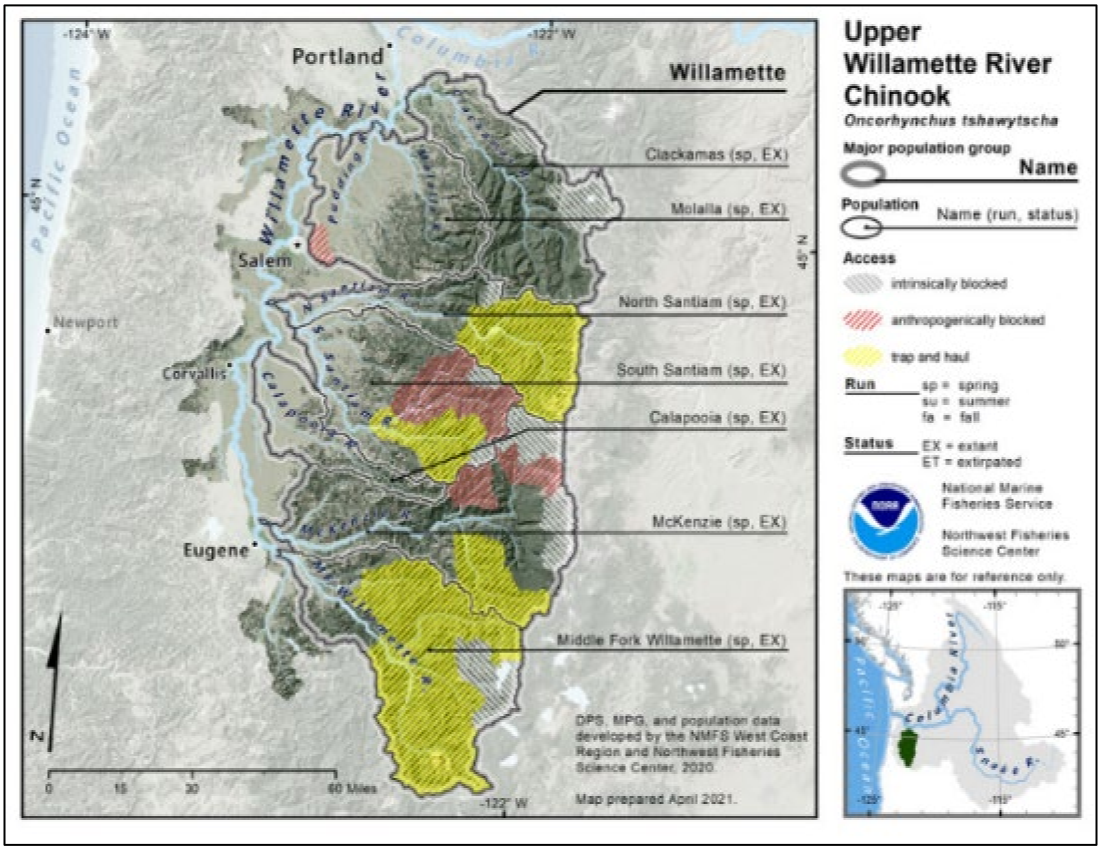

Figure 8. Map of the seven populations within the UWR Chinook salmon ESU. Areas that are accessible (green), accessible only via trap-and-haul programs (yellow), or blocked (cross-hatched), are indicated accordingly (Ford 2022).

Chinook salmon now ascend the falls via a fish ladder at Willamette Falls. Through 2017, ODFW conducted comprehensive spawner surveys (redds and carcasses) both below and above dams in the North Santiam, South Santiam, McKenzie, and Middle Fork Willamette Rivers. Direct adult counts are also made at Willamette Falls, Bennett Dam, and Minto Fish Facility (North Santiam River), Foster Fish Facility (South Santiam River), Leaburg and Cougar Dams and the McKenzie Hatchery (McKenzie River), and Fall Creek Dam and Dexter Fish Facility (Middle Fork Willamette River). Intermittent spawner surveys have been conducted in the Molalla and Calapooia Rivers, but are insufficient to estimate population abundance. Beginning in 2018, there has been a transition in the methodology and extent of adult spawner surveys. In 2018 and 2019, parallel spawner survey efforts were undertaken by ODFW and Environmental Assessment Services (Ford 2022).

Table 17. 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	
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 (ODFW and NMFS 2011).

UWR spring-run Chinook salmon are taken in ocean fisheries primarily in Canada and Alaska. They are also taken in lower mainstem Columbia River commercial gillnet fisheries, and in recreational fisheries in the mainstem Columbia River and the Willamette River. The distribution of mortality accrued in marine fisheries is described in detail in the environmental baseline (Section 2.4). The in-river fisheries are directed at hatchery production, but historically could not discriminate between natural and hatchery fish. In the late 1990s, ODFW began mass-marking the hatchery production, and recreational fisheries within the Willamette River switched over to retention of only hatchery fish, with mandatory release of unmarked fish. ERs in ocean fisheries, with the exception of 2016, have been low (Figure 9). The Fishery Management and Evaluation Plan (FMEP) for the Willamette River sets the maximum freshwater mortality rate for naturally produced Chinook salmon at 15% (ODFW and WDFW 2020). The FMEP proposed to limit the harvest rate on natural-origin fish in all freshwater fisheries to no more than 15%. 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 2001).

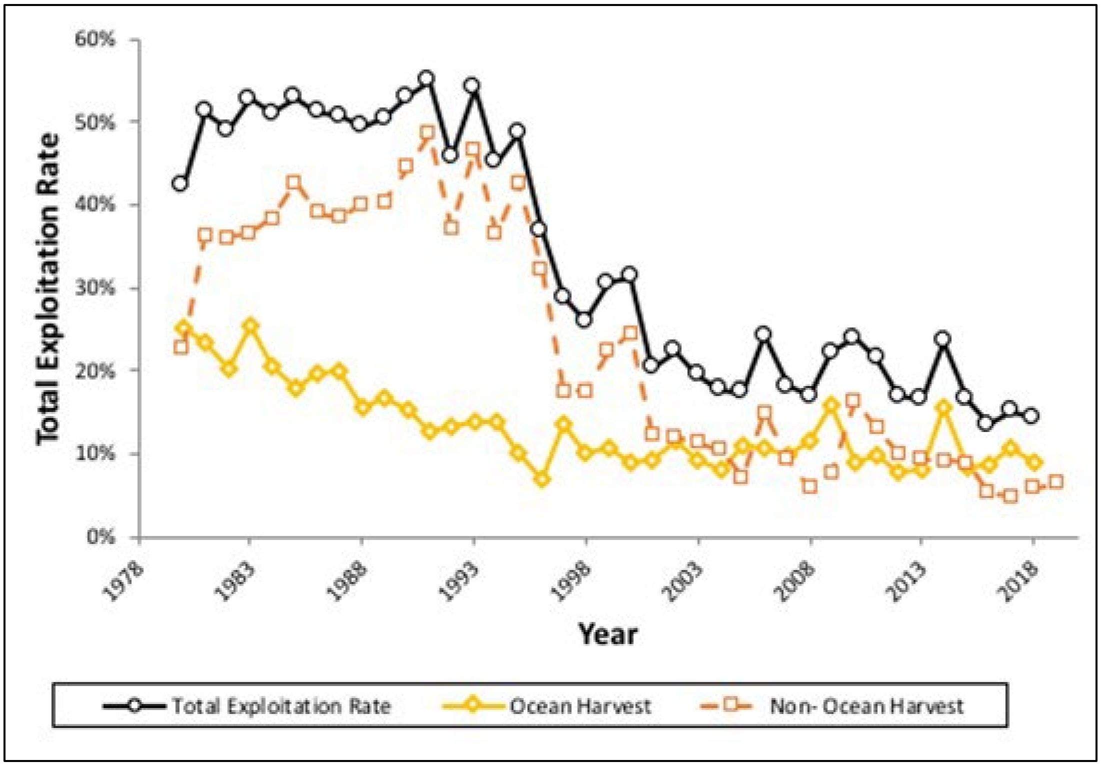

Figure 9. Ocean harvest, terminal harvest, and escapement rates for spring-run UWR Chinook salmon, based on coded-wire tag recoveries (Ford 2022). Ocean harvest rates for hatchery and unmarked naturally produced fish are assumed to be comparable; terminal fisheries have been mark-selective since 2001, and unmarked fish mortality rates will be considerably lower: hooking mortality in the Willamette River is assumed to be 12.2% (Ford 2022).

2.2.2.2.1 Abundance, Productivity, Spatial Structure, and Diversity

Status of the species is determined based on the abundance, productivity, spatial structure, and diversity of its constituent natural populations. The 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 (ODFW and NMFS 2011).

According to the most recent viability assessment (Ford 2022), abundance levels for five of the seven natural-origin populations in this ESU decreased relative to the prior status review (Table 18, % change column). Chinook salmon counts at Willamette Falls have been undertaken since

1946, when 53,000 Chinook salmon were counted; however, not until 2002, with the return of the first cohort of mass-marked hatchery-reared fish, was it possible to inventory naturally produced fish with any accuracy. Cohorts returning from 2015–19 outmigration were strongly influenced by warmer-than-normal and less-productive ocean conditions, in addition to warmer- and drier-than-normal freshwater conditions. The five-year average abundance geomean for 2015–19 was 6,916 natural-origin (unmarked) adults, a 31% decrease from the previous period (Table 18). Abundances, in terms of adult returns, in the Clackamas and McKenzie Rivers have risen since the last review (Ford 2022). Improvements in the status of the Middle Fork Willamette River population is due to the sole return of natural-origin adults to Fall Creek basin. However, the capacity of the Fall Creek basin alone is insufficient to achieve the recovery goals for the Middle Fork Willamette River individual population.

Table 18. Five-year geometric mean of raw natural spawner counts from five-year status reviews (Ford 2022); SP = spring-run.

Population	MPG	1990-94	1995-99	2000-04	2005-09	2010-14	2015-19	% change
Willamette Falls SP	Willamette	(42,031)	(27,817)	21,833 (68,324)	8,482 (26,529)	9,975 (40,236)	6,916 (32,189)	–31 (–20)
Clackamas River SP	Willamette	1,291 (3,961)	466 (1,430)	2,110 (3,920)	1,482 (1,906)	1,894 (2,013)	3,617 (3,722)	91 (85)
North Santiam River SP	Willamette				333 (1,064)	401 (1,584)	354 (1,424)	–12 (–10)
South Santiam River SP	Willamette				416 (1,281)	613 (1,685)	337 (1,856)	–45 (–10)
McKenzie River SP	Willamette				1,794 (2,856)	1,479 (2,750)	1,664 (2,916)	13 (6)
Middle Fork Willamette River SP	Willamette					92 (1,209)	20 (407)	–78 (–66)

In parentheses, 5-year geometric mean of raw total spawner counts is shown. A value only in parentheses means that a total spawner count was available but no or only one estimate of natural spawners available. The geometric mean was computed as the product of counts raised to the power 1 over the number of counts available (2 to 5). A minimum of 2 values were used to compute the geometric mean. Percent change between the 2 most recent 5-year periods is shown on the far right.

While there was a substantial downward trend in total and natural-origin spring-run abundance at Willamette Falls from 2003 to just before 2010 (Figure 10), there were some indications of improving abundance in 2019 and 2020. Improvements in abundance corresponded with improved ocean and freshwater conditions, as well as changes in pinniped predation. In recent years, counts of spring-run Chinook salmon at Willamette Falls have been impacted by pinniped predation at the base of the falls. For the return years 2014–18, pinnipeds were estimated to consume 6–10 % of the unmarked Chinook salmon escapement; however, in 2019, when a pinniped removal program was initiated, the rate dropped to approximately 4% (Ford 2022). Over the last 15 years, the long-term trend for natural-origin returns was negative 4% (Ford 2022), suggesting an overall decline in those populations above Willamette Falls.

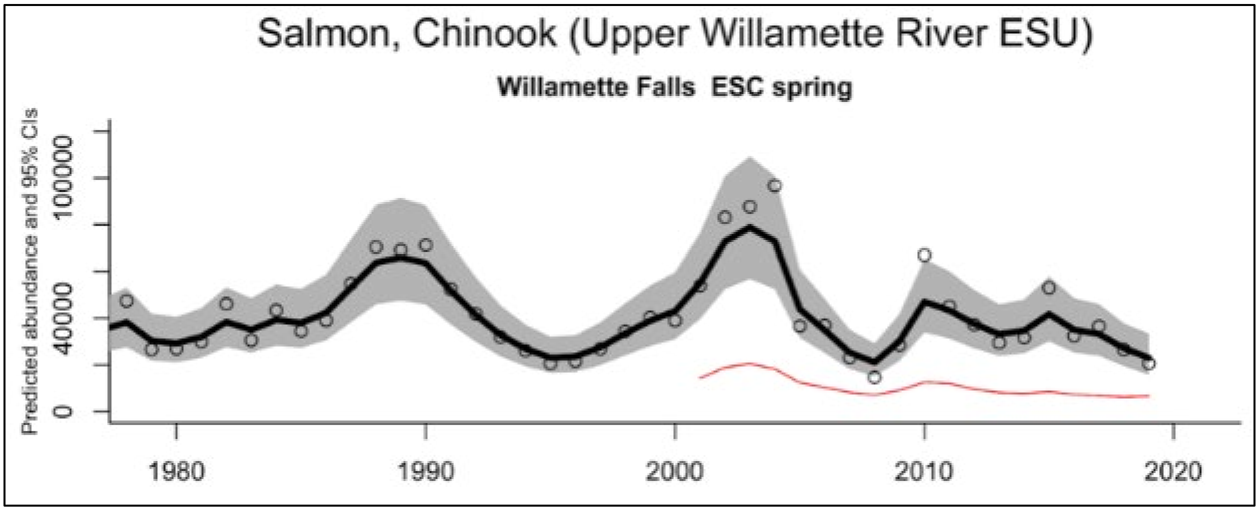

Figure 10. Smoothed trend in estimated total (thick black line, with 95% confidence interval in gray) and natural (thin red line) population spawning abundance (1975 - 2018) (Ford 2022). Points show the annual raw spawning abundance estimates.

For UWR Chinook salmon, diversity and productivity concerns include interaction and introgression with hatchery-origin Chinook salmon (Ford 2022). There have been a number of changes in hatchery operations since the initial status review (Myers et al. 1998). In general, production levels are based on mitigation agreements related to the construction of dams in the Willamette River basin. Mass marking of hatchery-origin Chinook salmon began in 1997, with all returning adults being marked by 2002. Off-station releases within some basins have been curtailed in an effort to limit natural spawning by hatchery-origin fish. More recently, NMFS finalized a biological opinion on hatchery operations in the UWR basin evaluating a number of changes to minimize the potential influence of hatchery-origin fish on natural-origin Chinook salmon and steelhead (NMFS 2019b). Through the provisions of the Opinion and individual HGMPs, hatcheries in the UWR have reduced releases of spring-run Chinook salmon in the McKenzie and North Santiam Rivers, while shifting production to other basins (Ford 2022). In addition, the Opinion calls for further action in the McKenzie River to further reduce the number of hatchery fish spawning naturally.

Table 19. Five-year mean of fraction natural-origin Chinook salmon spawning naturally in the UWR Chinook Salmon ESU (populations for which information is available, sum of all estimated divided by the number of estimates). Blanks (—) mean no estimate available in that 5-year range (Ford 2022).

Population	MPG	1995-99	2000-04	2005-09	2010-14	2015-19
Willamette Falls	Willamette	—	0.24	0.30	0.24	0.22
Clackamas River	Willamette	0.33	0.58	0.79	0.94	0.97
North Santiam River	Willamette	—	—	0.33	0.26	0.26
South Santiam River	Willamette	—	—	0.39	0.40	0.21
McKenzie River	Willamette	—	—	0.64	0.55	0.57
Middle Fork Willamette River	Willamette	—	—	—	0.08	0.07

In concert with improvements in collection efficiency at various dams throughout the Willamette River basin, the number of hatchery fish released has decreased in most basins where there is natural spawning, with increased releases in westside tributaries (Ford 2022). In general, the influence of hatchery-origin Chinook salmon on the spawning grounds has shown a slight improvement (meaning less influence), with the exception of the South Santiam River, where fish collection at the new facility has been poor, leaving more hatchery-origin fish to spawn below Foster Dam (Ford 2022).

Spatial structure issues remain a major concern in the Willamette River basin. Major dams block volitional passage to historical Chinook salmon habitat in five of the seven populations in the ESU. In most cases, effective passage programs are limited by low collection rates for emigrating juveniles.

A recovery plan was finalized for this species on August 5, 2011 (ODFW and NMFS 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 (Ford 2022). Furthermore, limited data are available for natural-origin spawner abundance for UWR Chinook salmon populations. Table 20 includes the most up-to-date available data for natural-origin Chinook salmon spawner estimates from UWR subbasins relative to their recovery scenario expectation in the recovery plan.

Table 20. Current 5-year geometric mean of raw natural-origin spawner abundances compared to the recovery scenario presented in the recovery plan (ODFW and NMFS 2011) for UWR Chinook salmon populations (Ford 2022).

MPG	**Population**	**Abundance**	
		2015-19	**Recovery Target**
Willamette	Clackamas River SP	3,617	2,317
	Molalla River SP	n/a	696
	North Santiam River SP	354	5,400
	South Santiam River SP	337	3,100
	Calapooia River SP	n/a	590
	McKenzie River SP	1,664	8,376
	Middle Fork Willamette River SP	20	5,820

Colors indicate the relative proportion of the recovery target currently obtained: red = <10%, orange = 10% > x < 50%, yellow = 50% > x < 100%, green = >100%

In summary, access to historical spawning and rearing areas is still restricted by high-head dams in five of the historically most-productive tributaries. Only in the Clackamas River does the current system of adult trap-and-haul and juvenile collection appear to be effective enough to sustain a naturally spawning population (although current juvenile passage efficiencies are still below NMFS criteria). In the McKenzie River, the spring-run Chinook salmon population appears to be relatively stable, having reversed a short-term downward abundance trend that was of concern during the last review. The McKenzie River remains well below its recovery goal, despite having volitional access to much of its historical spawning habitat. The North and South Santiam River DIPs both experienced declines in abundance. The Calapooia and Molalla Rivers are constrained by habitat conditions, and natural reproduction is likely extremely low.

Demographic risks remain “high” or “very high” for most populations, except the Clackamas and McKenzie Rivers, which are at “low” and “low-to-moderate” risk, respectively. The Clackamas River spring-run Chinook salmon population maintains a low pHOS through the removal of all marked hatchery-origin adults at North Fork Dam. Elsewhere, hatchery-origin fish comprise the majority or, in the case of the McKenzie River, nearly half of the naturally spawning population. Diversity risks continue to be a concern (Ford 2022).

Overall, there has likely been a declining trend in the viability of the UWR Chinook salmon ESU since the last review. The magnitude of this change is not sufficient to suggest a change in risk category, and the UWR Chinook salmon ESU remains at “moderate” risk of extinction (Ford 2022).

2.2.2.2.2 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. Overall ERs reflect changes in fisheries to more conservative management regimes. ERs dropped from a range of 50-60 % in the 1980s and early 1990s, to around 30% since 2000, with reductions observed in both ocean and freshwater fisheries. Post-release mortality from hooking is generally estimated at 10% in the Willamette River, although river temperatures likely affect this rate. Illegal take of unmarked fish is thought to be low (NWFSC 2015).

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 (Ford 2022). Improvements have been made in operations and fish passage at tributary dams, and numerous habitat restoration projects have been completed in many UWR tributaries. These actions eventually will provide benefit to the UWR Chinook salmon ESU (Ford 2022). However, the scale of habitat improvements needed is greater than the scale of habitat actions implemented to date, and we remain concerned about impaired passage at multiple dams and degraded habitat through-out the watershed. Most land in the UWR is in private ownership, making successful efforts to protect and restore habitat on private lands key to recovery in the upper Willamette, particularly in the face of continuing development. There are also substantial portions of federal land in the upper Willamette, so the protection and restoration of salmon habitat on federal lands is also crucial to recovery. Harvest rates on UWR Chinook salmon have remained stable and relatively low since the last status review (Ford 2022).

The recovery plan for UWR Chinook salmon (ODFW and NMFS 2011) provides a detailed discussion of limiting factors and threats, and describes strategies for addressing each of them

(Chapter 5 in ODFW and NMFS (2011)). Rather than repeating the extensive discussion from the recovery plan, it is incorporated here by reference.

Additionally, the Northwest Fisheries Science Center Ford (2022) 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
- Historic ocean harvest rates of approximately 30%.

There has likely been an overall decrease in population VSP scores since the last review for the North Santiam, Calapooia, and Middle Fork Willamette rivers populations. However, the magnitude of this change is not sufficient to suggest a change in risk category for the ESU, as the other three populations for which we have data have shown slight improvements in abundance during the last five years (Table 19). Given current climatic conditions, and the prospect of long-term climatic change, the inability of many populations to access historical headwater spawning and rearing areas may put this ESU at greater risk in the near future. The collective risk to the UWR salmon persistence has not changed significantly since our previous status review for the UWR Chinook salmon ESU, and they remain listed as threatened (Ford 2022).

2.2.2.3 Snake River Fall-Run Chinook Salmon ESU

On April 22, 1992, NMFS listed the Snake River Fall-Run Chinook (SRFC) Salmon ESU as a threatened species (57 FR 14653). 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). It includes spawning and rearing areas limited to the Snake River below Hells Canyon Dam, and within the Clearwater, Hells Canyon, Imnaha, Lower Grand Ronde, Lower North Fork Clearwater, Lower Salmon, Lower Snake, Lower Snake-Asotin, Lower Snake-Tucannon, and Palouse hydrologic units. However, this critical habitat designation includes all river reaches presently or historically accessible to this species (except reaches above impassable natural falls, and Dworshak and Hells Canyon Dams). On October 4, 2019, NMFS announced the initiation of a new 5-year status review process including review of the SRFC Salmon ESU (84 FR 53117), which it completed and published on August 16, 2022 (NMFS 2022k).

The SRFC 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 (Ford 2022). As NMFS (2005a) 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 2005a). Table 21 lists the natural and hatchery populations included in the ESU.

Table 21. SRFC Salmon ESU description and MPGs (Ford 2022).

ESU Description	
Threatened	Listed under ESA in 1992; reaffirmed in 2022
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 National Fish Hatchery (LFH) fall, Acclimation Ponds Program fall, Nez Perce Tribal Hatchery fall, Idaho Power fall.

Two historical populations (1 extirpated) within one MPG comprise the SRFC Salmon ESU. The extant natural population spawns and rears in the mainstem Snake River, and its tributaries, below Hells Canyon Dam. The Interior Columbia River Technical Recovery Team (ICTRT) identified five major spawning areas (MaSAs) which are: Upper Hells Canyon MaSA (Hells Canyon Dam on Snake River downstream to confluence with Salmon River); Lower Hells Canyon MaSA (Snake River from Salmon River confluence downstream to Lower Granite Dam pool); Clearwater River MaSA; Grande Ronde River MaSA; and Tucannon River MaSA (Ford 2022). Figure 11 shows a map of the ESU area. The recovery plan (NMFS 2017q) provides three scenarios that represent a range of potential strategies that can be pursued simultaneously that addresses the entire life cycle of the species that would achieve delisting criteria (Table 22).

Table 22. Potential ESA Viability Scenarios for SRFC salmon (NMFS 2017q).

Viability Scenarios and Viability Criteria	Abundance and Productivity Metrics	Spatial Structure and Diversity Metrics
Scenario A – Two Populations: Achieve highly viable status for the extant Lower Snake River population and viable status for the currently extirpated Middle Snake River population.	a. Lower Snake River population most recent 10-year geometric mean > 3,000 natural origin spawners and 20-year geometric mean intrinsic productivity > 1.5 b. Middle Snake River population most recent 10-year geometric mean > 3,000 natural origin spawners and 20-year geometric mean intrinsic productivity > 1.27	a. Four of five MaSAs in the Lower Snake River population and one or more spawning areas in the Middle Snake River population are occupied. b. Hatchery influence on spawning grounds is low (e.g., pHOS < 30%) for at least one population and hatchery programs are operated to limit genetic risk (e.g., the proportion of natural influence [PNI] > 67%). c. Numbers of fish showing the historically dominant subyearling life-history pattern are stable or increasing. d. Adult and juvenile run timing patterns are stable or adaptive. e. Indicators of genetic substructure are trending toward patterns expected for a natural origin dominated population.

Viability Scenarios and Viability Criteria	Abundance and Productivity Metrics	Spatial Structure and Diversity Metrics
Scenario B ─ Single Population: Achieve highly viable status for Lower Snake River population (measured in the aggregate).	a. Most recent 10-year geometric mean abundance > 4,200 natural-origin spawners. b. Most recent 20-year geometric mean intrinsic productivity > 1.7	a. Four of five MaSAs in the Lower Snake River population are occupied. b. Recent (2 or more brood cycles) hatchery influence on spawning ground is low (e.g., pHOS < 30%) for the population as a whole and hatchery program is operated to limit genetic risk (e.g., PNI > 67%). c. Numbers of fish showing the historically dominant subyearling life-history pattern are stable or increasing. d. Adult and juvenile run timing patterns are stable or adaptive. e. Indicators of genetic substructure are trending toward patterns expected for a natural origin dominated population
Scenario C ─ Single Population: Achieve highly viable status for Lower Snake River population (with Natural Production Emphasis Areas [NPEAs])	a. Population-level abundance metrics under Scenario C would need to be higher than under Scenario B to accommodate meeting the NPEA requirements. Metrics will vary depending on the proportion of natural production coming from NPEAs and the level of hatchery influence remaining in the NPEAs. b. Population-level productivity metrics for Scenario B would apply: most recent 20-year geometric mean intrinsic productivity > 1.7	a. Four of five MaSAs in the Lower Snake River population are occupied. b. NPEA PNI ≥ 0.67 and NPEA production accounting for at least 40% of the natural production in the population. c. Numbers of fish showing the historically dominant subyearling life-history pattern are stable or increasing. d. Adult and juvenile run timing patterns are stable or adaptive. e. Indicators of genetic substructure are trending toward patterns expected for a natural origin dominated population.

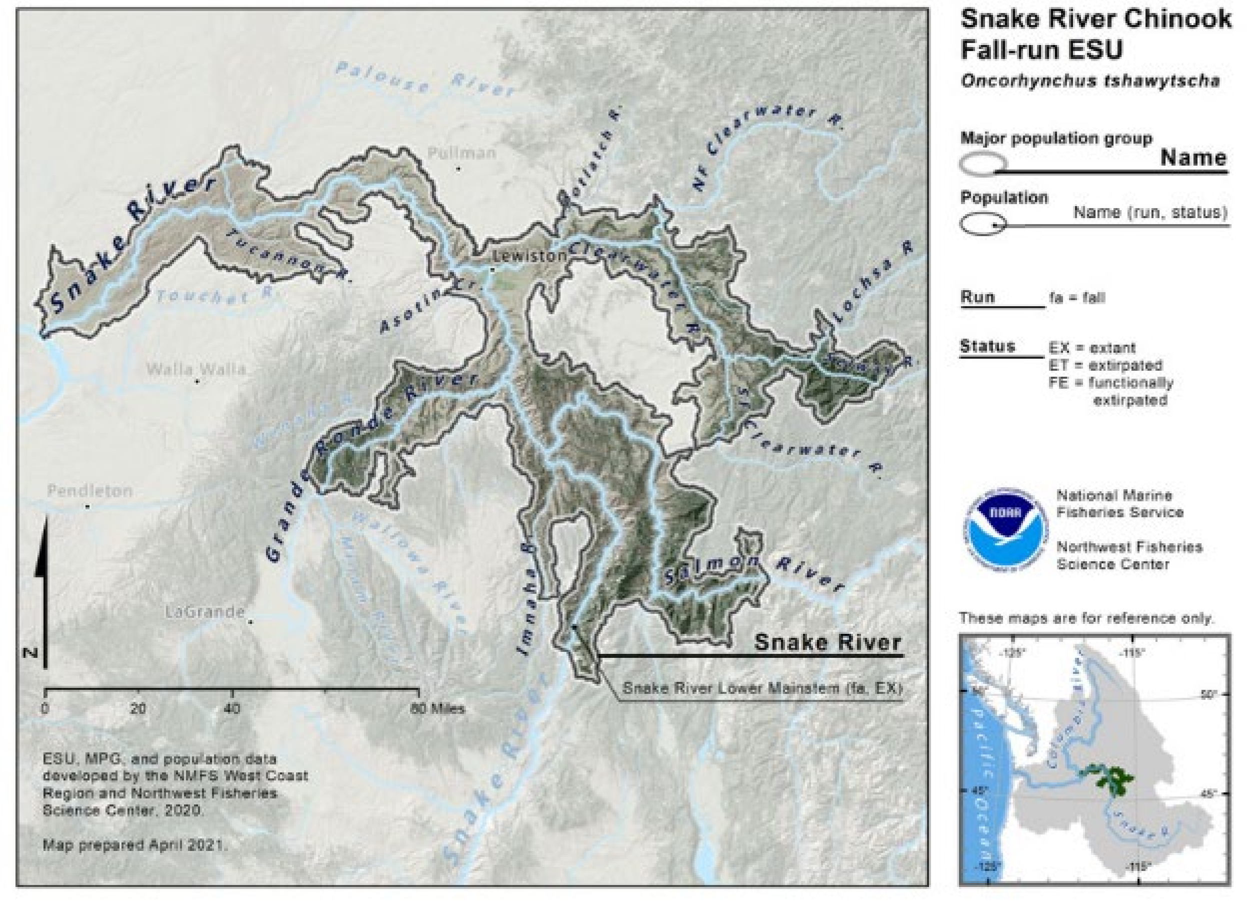

Figure 11. Map of the SRFC Salmon ESU's spawning and rearing areas, illustrating populations and MPGs (Ford 2022).

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 SRFC salmon since the 1980s (NMFS 2022k). Since the species were originally listed in 1992, fishery impacts have been reduced in both ocean and river fisheries (Figure 12). Total ER has been relatively stable in the range of 40% to 50% since the mid-1990s (Ford 2022). Ocean fisheries are currently managed to achieve a minimum of a 30.0% reduction in the age-3 and age-4 adult equivalent total ER in ocean salmon fisheries relative to the 1988-1993 base period standard; approximately equivalent to an ocean ER limit of 29% on age-3 and age-4 SRFC salmon. NMFS evaluated this approach under the ESA and found it not likely to jeopardize the continued existence of the SRFC Salmon ESU or destroy or adversely modify its designated critical habitat (NMFS 1996). Freshwater harvest rates have averaged 31.8% since 2009 when the current management framework was first implemented under the 2008-2017 *U.S. v. Oregon* Management Agreement (TAC 2022).

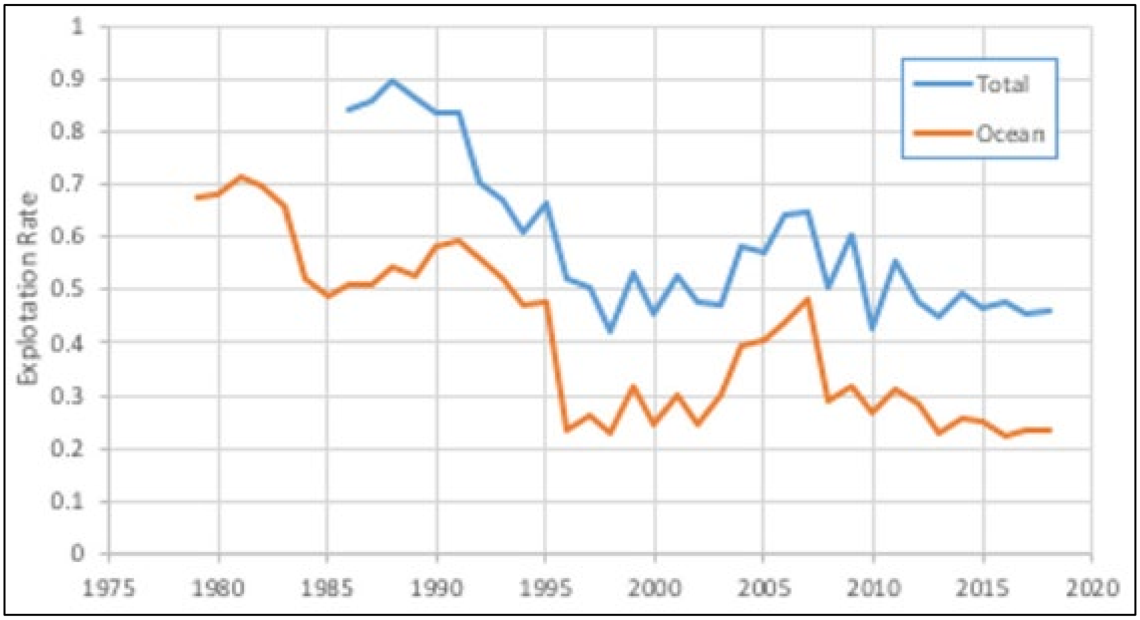

Figure 12. Total ER for SRFC salmon. Data for marine ERs from the CTC model (Calibration 1503) and for in-river harvest rates from the Columbia River Technical Advisory Committee (Ford 2022).

SRFC 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 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 the ESU's spawning and rearing habitat (NMFS 2022k). 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 Lower Granite River to Hells Canyon Dam, the lower reaches of the Imnaha, Grande Ronde, Clearwater, Salmon, and Tucannon rivers, and small areas in the tailraces of the Lower Snake River hydroelectric dams (NMFS 2022k).

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. However, annual redd surveys show that fall Chinook salmon spawning occurs in all five of the historical MaSAs that are accessible within the current range of the population (Ford 2022). Parental Based Tagging of the hatchery fish has allowed for spawning-ground sampling for parentage analysis. Fidelity studies have indicated there is spawner dispersal within the population from different release sites (Ford 2022). SRFC 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 SRFC salmon. Some limited spawning occurs in all of these areas, although returns to the Tucannon River are predominantly releases and strays from the LFH program (NMFS 2012b). The fraction of natural-origin fish on the spawning grounds has remained relatively stable for the last ten years, with five-year means of 31% (2010–14) and 33% (2015–19, Table 23).

Table 23. Five-year mean of fraction natural-origin fish in the population (sum of all estimates divided by the number of estimates) (Ford 2022).

Population	1995-99	2000-04	2005-09	2010-14	2015-19
Lower Snake River Fall-run Chinook	0.58	0.34	0.37	0.31	0.33

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, SRFC salmon now reside in waters that may have thermal regimes which differ from historical regimes (Ford 2022). 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 SRFC salmon survival. Before alteration of the Snake River Basin by dams, SRFC 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.

2.2.2.3.1 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.

Spawner abundance, productivity, and proportion of natural-origin fish abundance estimates for the Lower Mainstem Snake River population are based on counts and sampling at Lower Granite Dam. Separate estimates of the numbers of adult (age 4 and older) and jack (age 3) fall-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. Historically, the data from trap sampling, including CWT recovery results, passive integrated transponder (PIT) tag detections, and the incidence of fish with adipose-fin clips, were used to construct daily estimates of hatchery proportions in the run (Ford 2022). At present, estimates of natural-origin returns are made from a Parental Based Genetic Tagging (PBT)[11] program (Ford 2022), which is a more direct assessment of natural returns and ESU abundance risk (Ford 2022).
Sampling methods and statistical procedures used in generating the estimated escapements have improved substantially over the past 10 to 15 years. Natural-origin return levels declined substantially following the completion of the three-dam Hells Canyon Complex (1959–67), which completely blocked access to major production areas above Hells Canyon Dam, and the construction of the lower Snake River dams (1962–75). Based on extrapolations from sampling

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[11] 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.

at Ice Harbor Dam (1977–90), the LFH (1987–present), and at Lower Granite Dam (1990–present), hatchery strays made up an increasing proportion of returns at Lower Granite Dam (the uppermost Snake River mainstem dam) through the 1980s (Bugert et al. 1990). Strays from out-planting Priest Rapids hatchery-origin fall-run Chinook salmon (an out-of-ESU stock from the mid-Columbia River) and SRFC salmon from the LFH program (on-station releases initiated in the mid-1980s) were the dominant contributors. Estimated natural-origin returns reached a low of less than 100 fish in 1990. The initiation of the supplementation program in 1998 increased returns allowed to naturally spawn. 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 (Ford 2022).

In 2013, adult spawner abundance reached over 20,000 fish (Figure 13). From 2012–15, natural-origin returns were over 10,000 adults. Spawner abundance has declined since 2016 to 4,998 adult natural-origin spawners in 2019 (Figure 13). In 2018, natural-origin spawner abundance was 4,916, a quarter of the return in 2013. This appears as a high negative percent change in the five-year geometric mean (Table 24), but, when looking at the trend in longer time frames, across more than one brood cycle, it shows an increase in the ten-year geometric mean relative to the last status review, and a near-zero population change for the 15-year trend in abundance (Ford 2022). The geometric mean natural adult abundance for the most recent ten years (2010–19) is 9,034 (0.15 standard error), higher than the ten-year geomean reported in the most recent status review (6,418, 0.19 standard error, 2005–14; Ford (2022)). While the population has not been able to maintain the higher returns it achieved in 2010 and 2013–15, abundance has maintained at or above the ICTRT defined Minimum Abundance Threshold (3,000)[12] during climate challenges in the ocean and rivers. Escapements have been increasing since 2020 and have continued through 2022 (WDFW and ODFW 2022).

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[12] The ICBTRT (2007) incorporated minimum abundance thresholds into population viability curves to "promote achieving the full range of abundance objectives across the recovery scenarios including utilization of multiple spawning areas, avoiding problems associated with low population densities (e.g. Allee effects) and maintaining populations at levels where compensatory processes are functional." The ICTRT recommended using 10-year geometric means of recent natural-origin spawners as a measure of current abundance. It also recommended that current intrinsic productivity should be estimated using spawner-to-spawner return pairs from low-to-moderate escapements over a recent 20-year period. The ICTRT adopted a recommendation from Bevan et al. (1994) as the minimum abundance threshold for the extant Lower SRFC salmon population.

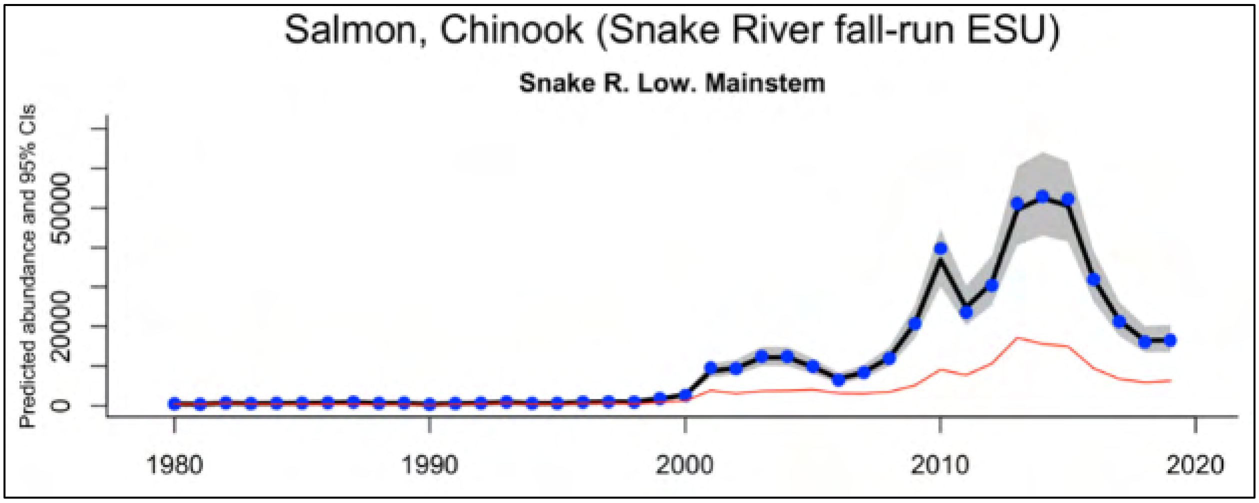

Figure 13. Smoothed trend in estimated total (thick black line, with 95% confidence interval in gray) and natural (thin red line) population spawning abundance (Ford 2022). Points show the annual raw spawning abundance estimates.

Table 24. Five-year geometric mean of raw natural spawner counts for SRFC salmon (Ford 2022).

Population	1990-94	1995-99	2000-04	2005-09	2010-14	2015-19	% change
Lower SRFC salmon	331 (581)	548 (980)	3,014 (8,398)	3,645 (10,581)	11,254 (37,812)	7,252 (22,141)	-36 (-41)

This is the raw total spawner count times the fraction natural estimate, if available. In parentheses is the 5-year geometric mean of raw total spawner counts, computed as the product of counts raised to the power 1 over the number of counts available (2 to 5). A minimum of 2 values was used to compute the geometric mean. Percent change between the 2 most recent 5-year periods is shown on the far right.

Productivity, defined in the 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 (ICBTRT 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. SRFC salmon have been above the ICTRT defined minimum abundance threshold since 2001 (Ford 2022). Productivity, as seen in broodyear returns-per-spawner, has been below replacement (1:1) in recent years.

The NMFS Snake River Fall-run Chinook Recovery Plan (NMFS 2017q) proposes that a single population viability scenario could be possible given the unique spatial complexity of the Lower Mainstem SRFC salmon population (Table 22). 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 distributed among the MaSAs as described in Table 22 above (while meeting total specific pHOS criteria; see Table 22 above), 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).

In terms of spatial structure and diversity, the Lower Mainstem SRFC salmon population was rated at low risk for recovery Scenario A (allowing natural rates and levels of spatially mediated processes) and moderate risk for recovery Scenario B (maintaining natural levels of variation) in the status review update (Ford 2022), resulting in an overall spatial structure and diversity rating of moderate risk (Table 25). Annual redd surveys show that fall Chinook salmon spawning occurs in all five of the historical MaSAs, and that the natural origin fraction has remained relatively stable during the last 10 years across the ESU (Figure 14).

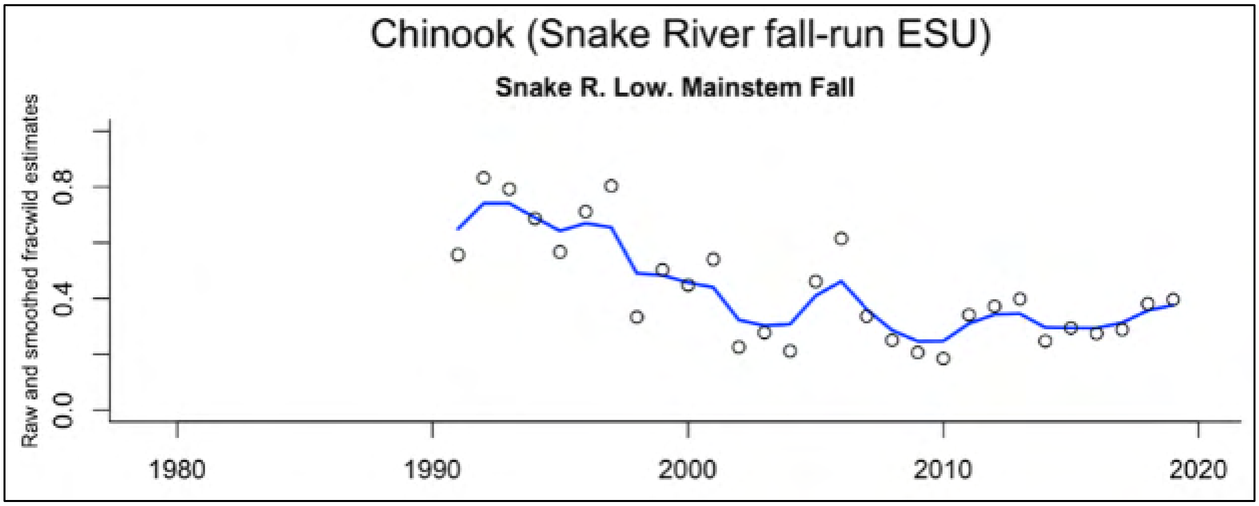

Figure 14. Smoothed trend in the estimated fraction of the natural spawning population consisting of fish of natural origin. Points show the annual raw estimates (Ford 2022).

The overall current risk rating for the Lower Mainstem SRFC salmon population is viable, as indicated by the bold outlined cell in Table 25. 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 of viable 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. To achieve "highly viable" status with a high degree of certainty, the SS/D rating needs to be "low risk." For abundance/productivity, the rating reflects remaining uncertainty that current increases in abundance can be sustained over the long run. While natural-origin spawning levels are above the highest delisting criteria (the minimum abundance threshold of 4,200 under recovery Scenario B) 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 (Ford 2022).

Table 25. Matrix used to assess natural population viability risk rating across VSP parameters for the Lower Mainstem SRFC 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 R.	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.

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 for the ESU, assuming that natural-origin abundance of the single extant SRFC salmon population remains relatively high.

2.2.2.3.2 Limiting Factors

Understanding the limiting factors and threats that affect the SRFC 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 2017q).

There are many factors that affect the abundance, productivity, spatial structure, and diversity of the SRFC 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. 2011b). Ocean conditions have also affected the status of this ESU. Ocean conditions affecting the survival of SRFC salmon were generally poor during the early part of the last 20 years (NMFS 2017q).

The recovery plan (NMFS 2017q) 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 2017q) describes the changes in current impacts on SRFC 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 single extant population in the ESU is currently meeting the criteria for a rating of "viable" developed by the ICTRT, but the ESU as a whole is not meeting the recovery goals described in the 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 Complex (Ford 2022). The SRFC Salmon ESU therefore is considered to be at a moderate-to-low risk of extinction, with viability largely unchanged from the prior review (Ford 2022).

2.2.2.4 Puget Sound Chinook Salmon ESU

This ESU was listed as a threatened species in 1999 (64 FR 14308, March 24, 1999). Its threatened status was reaffirmed June 28, 2005 (70 FR 37160), and again on April 14, 2014 (79 FR 20802). Critical Habitat for Puget Sound Chinook salmon was designated on September 2, 2005 (70 FR 52630). There are 61 watersheds within the range of this ESU. Habitat areas for this ESU include 2,216 mi (3,566 km) of stream and 2,376 mi (3,824 km) of nearshore marine areas, which include the zone from extreme high water out to a depth of 30 meters. The Puget Sound Chinook Salmon ESU includes all naturally spawned populations of Chinook salmon from rivers and streams flowing into Puget Sound including the Strait of Juan de Fuca from the Elwha River, westward, including rivers and streams flowing into Hood Canal, South Sound, North Sound and the Strait of Georgia in Washington (64 FR 14308).

On October 4, 2019, NMFS published notice of NMFS's intent to initiate a new 5-year status review for 28 listed species of Pacific salmon and steelhead and requested updated information from the public to inform the status review (84 FR 53117). The NWFSC finalized its updated biological viability assessment for Northwest Pacific salmon and steelhead listed under the ESA (Ford 2022) in January of 2022. NMFS's WCR is currently preparing the 5-year status-review document for Puget Sound Chinook salmon.

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) (SSDC

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. 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[13];

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.

2.2.2.4.1 Abundance, Productivity, Spatial Structure, and Diversity

The Puget Sound ESU includes all naturally spawned Chinook salmon originating from rivers flowing into Puget Sound from the Elwha River (inclusive) eastward, including rivers in Hood Canal, South Sound, North Sound and the Strait of Georgia. The PSTRT determined that 22 of the historical populations within the Puget Sound ESU 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 26). 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[14] (Ruckelshaus et al. 2006).

The ESU also includes Chinook salmon from certain artificial propagation programs. Artificial propagation (hatchery) programs (26) were added to the listed Puget Sound Chinook Salmon ESU in 2005, as part of the final listing determinations for 16 ESUs of West Coast Salmon and Final 4(d) Protective Regulations for Threatened Salmonid ESUs (70 FR 37160, June 28, 2005). In October of 2016, NMFS proposed revisions to the hatchery programs included as part of some Pacific salmon ESUs and steelhead DPSs listed under the ESA (81 FR 72759, October 21, 2016). NMFS issued its final rule in December of 2020 (85 FR 81822, December 17, 2020). This final

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[13] The number of populations required to be at low-risk status 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.

[14] 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.

rule includes 25 hatchery programs as part of the listed Puget Sound Chinook Salmon ESU: Kendall Creek Hatchery Program; Marblemount Hatchery Program (spring-run); Marblemount Hatchery Program (summer-run); Brenner Creek Hatchery Program (fall-run); Harvey Creek Hatchery Program (summer-run); Whitehorse Springs Hatchery Program (summer-run); Wallace River Hatchery Program (yearlings and subyearlings); Issaquah Creek Hatchery Program; White River Hatchery Program; White River Acclimation Pond Program; Voights Creek Hatchery Program; Clarks Creek Hatchery Program; Clear Creek Hatchery Program; Kalama Creek Hatchery Program; George Adams Hatchery Program; Hamma Hamma Hatchery Program; Dungeness/Hurd Creek Hatchery Program; Elwha Channel Hatchery Program; Skookum Creek Hatchery Spring-run Program; Bernie Kai-Kai Gobin (Tulalip) Hatchery-Cascade Program; North Fork Skokomish River Spring-run Program; Soos Creek Hatchery Program (subyearlings and yearlings); Fish Restoration Facility Program; Bernie Kai-Kai Gobin (Tulalip) Hatchery-Skykomish Program; and Hupp Springs Hatchery-Adult Returns to Minter Creek Program.

Table 26. Extant Puget Sound Chinook salmon populations in each geographic region (Ruckelshaus et al. 2006).

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

NOTE: NMFS has determined that the **bolded** populations, in particular, are essential to recovery of the Puget Sound Chinook Salmon 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) identified by the PSTRT 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 PSTRT did not define the relative roles of the remaining populations in the Whidbey and Central/South Sound Basins for ESU recovery. Therefore, NMFS developed additional guidance (NMFS 2010c) 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 ESU. In assessing these risks, it is important to consider whether the genetic legacy of the particular population is intact or if it is no longer distinct within the ESU, a condition which is usually due to use of non-local stocks in historic hatchery practices. Populations are defined by their relative isolation from each other and by the unique genetic characteristics that evolve, as a result of that isolation, and adaptation to their specific habitats. If these populations still retain their historic genetic legacy, then the appropriate course, to ensure the survival and recovery of the ESU, 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 rebuild 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' guidance further classified Puget Sound Chinook salmon populations into three tiers based on a systematic framework that considers the genetic legacy of the population, the population's life history, and production and watershed characteristics (NMFS 2010c) (Figure 15). This framework, termed the *Population Recovery Approach (PRA)*, 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 with respect 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 first evaluate impacts at the individual population scale, then consider how those population-level impacts affect the survival and recovery of the ESU. We expect that impacts to Tier 1 populations would be more likely to affect the survival and recovery 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 survival and recovery. 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; 2008c; 2008a; 2010b; 2011d; 2013f; 2014a; 2015a; 2016g; 2017o; 2018g; 2019g; 2020f; 2021d).

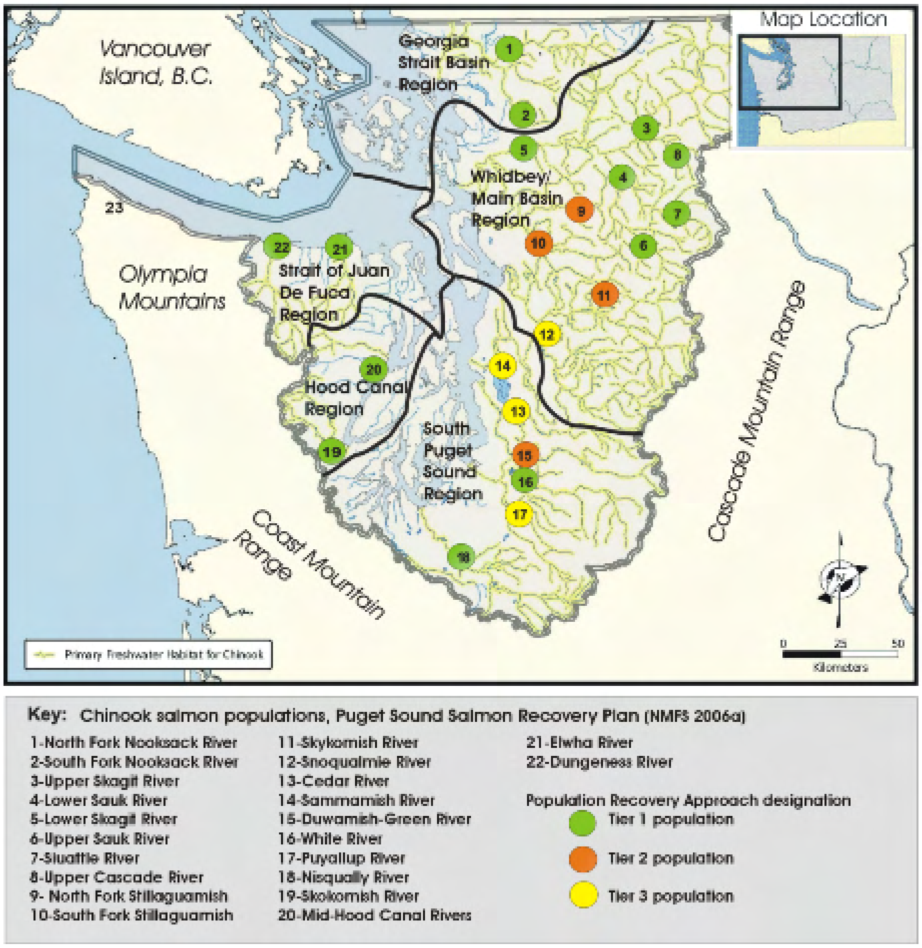

Figure 15. Map of Puget Sound Chinook salmon populations.

Measures of spatial structure and diversity can give some indication of the resilience of a population to sustain itself. Spatial structure can be measured in various ways, but here we assess the proportion of natural-origin spawners (wild fish) vs. hatchery-origin spawners on the spawning grounds (Ford 2022).

Over the long-term (since 1990), there is a general declining trend in the proportion of natural-origin spawners across the ESU (Table 27). While there are several populations that have maintained high levels of natural-origin spawner proportions, mostly in the Skagit and Snohomish basins, many others have continued the trend of high proportions of hatchery-origin spawners in the most recent available period (Table 27). It should be noted that the pre-2005-2009 estimates of mean natural-origin fractions occurred prior to the widespread adoption of mass marking of hatchery produced fish for key populations in Hood Canal and South Puget Sound. Estimates of hatchery and natural-origin proportions of fish since the implementation of mass marking are considered more robust. Several of these populations have long-standing or more recent conservation hatchery programs associated with them—North Fork (NF) and South Fork (SF) Nooksack, NF and SF Stillaguamish, White River, Dungeness, and the Elwha. These conservation programs are in place to maintain or increase the overall abundance of these populations which are in critical status; helping to conserve the diversity and increase the spatial distribution of these populations in the absence of properly functioning habitat. These conservation hatchery programs culture the extant, native Chinook salmon stock in these basins. With the exception of the NF and SF Stillaguamish, the populations included in these conservation programs are identified in NMFS (2006b) as essential for the recovery of the Puget Sound Chinook Salmon ESU (Table 27).

Table 27. Five-year mean of fraction of natural-origin Chinook salmon spawners[15] (sum of all estimates divided by the number of estimates) (Ford 2022).

Population	1995-1999	2000-2004	2005-2009	2010-2014	2015-2019
NF Nooksack R. spring*	0.28	0.11	0.19	0.14	0.13
SF Nooksack R. spring*	0.26	0.55	0.57	0.42	0.45
Low. Skagit R. fall	0.94	0.91	0.86	0.92	0.84
Up. Skagit R. summer	0.91	0.87	0.84	0.95	0.91
Cascade R. spring*	0.98	0.92	0.89	0.94	0.86
Low. Sauk R. summer	0.94	0.97	0.95	0.91	0.98
Up. Sauk R. spring	0.99	1.00	0.98	0.97	0.99
Suiattle R. spring	0.99	0.97	0.99	0.99	0.97
NF Stillaguamish R. summer/fall*	0.59	0.70	0.40	0.43	0.45
SF Stillaguamish R. summer/fall*	0.59	0.70	0.40	0.54	0.46
Skykomish R. summer	0.49	0.52	0.76	0.69	0.62
Snoqualmie R. fall	0.81	0.89	0.81	0.78	0.75
Sammamish R. fall	0.29	0.36	0.16	0.07	0.16
Cedar R. fall	0.61	0.59	0.82	0.78	0.71
Green R. fall	0.55	0.47	0.43	0.39	0.30
White R. spring*	0.54	0.79	0.43	0.32	0.15
Puyallup R. fall	0.88	0.79	0.52	0.41	0.32
Nisqually R. fall	0.80	0.61	0.30	0.30	0.47
Skokomish R. fall	0.40	0.46	0.45	0.10	0.16
Mid-Hood Canal fall	0.76	0.79	0.61	0.33	0.89
Dungeness R. summer*	1.00	0.32	0.43	0.25	0.25
Elwha R. fall*	0.41	0.53	0.35	0.06	0.05

*Denotes populations with conservation hatchery programs in place.

In addition, spatial structure, or geographic distribution, of the White, Skagit, Elwha[16] and Skokomish populations have been substantially reduced or impeded by the loss of access to the

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[15] Estimates of hatchery and natural-origin spawning abundances, prior to the 2005-2009 period are based on pre-mass marking of hatchery-origin fish and, as such, may not be directly comparable to the 2005-2009 forward estimates.

[16] Removal of the two Elwha River dams and restoration of the natural habitat in the watershed began in 2011. Dam removal was completed in 2014.

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 2005c; SSDC 2007; NMFS 2008g; 2008f; 2008e). It is likely that genetic and life history diversity has been significantly adversely affected by this habitat loss.

Puget Sound Chinook salmon are harvested in ocean salmon fisheries, in Puget Sound fisheries, and in terminal fisheries in the rivers. They migrate to the north, so for most Puget Sound Chinook salmon populations, the majority of the ocean fishery impacts occur in Canada, and for some populations, additional small to moderate impacts occur in Alaska (see *Puget Sound Chinook ESU* in Section 2.4.1.1). The fisheries in these areas are subject to the PST. Some populations are also harvested at lower rates in the coastal fisheries off Washington and Oregon. Chinook salmon populations in Puget Sound generally show a similar pattern: declining ERs in the 1990s, and relatively stable-to-increasing ERs since then (Figure 16 through Figure 18). Long term trends in ER for Puget Sound stocks are available for 1992 through 2018 from recently completed postseason Fishery Regulation Assessment Model (FRAM) model runs (Oct 2022) (pers. comm. J. Carey, NMFS West Coast Region (WCR)). That information is incorporated into the region-specific discussions that follow.

ERs on Strait of Juan de Fuca and Mid-Hood Canal Chinook salmon populations have generally declined since the early 1990s. Total ERs for Strait of Juan de Fuca populations, which averaged 35% from 1992 to 1999, have since decreased to an average of 26% between 2009 and 2018 (Figure 16). Total ERs for the Mid-Hood Canal population averaged 34% between 1992 and 1999 but have since decreased to an average of 25% between 2009 and 2018 (Figure 16). Total ERs for the Skokomish population averaged 42% between 1992 and 1999. After a period of increased harvest from 2000 through 2008 where the ER averaged 58%, the ER on the Skokomish population decreased slightly, and has averaged 56% since 2009 (Figure 16). The distribution of mortality accrued in marine fisheries is described in detail in the environmental baseline (Section 2.4).

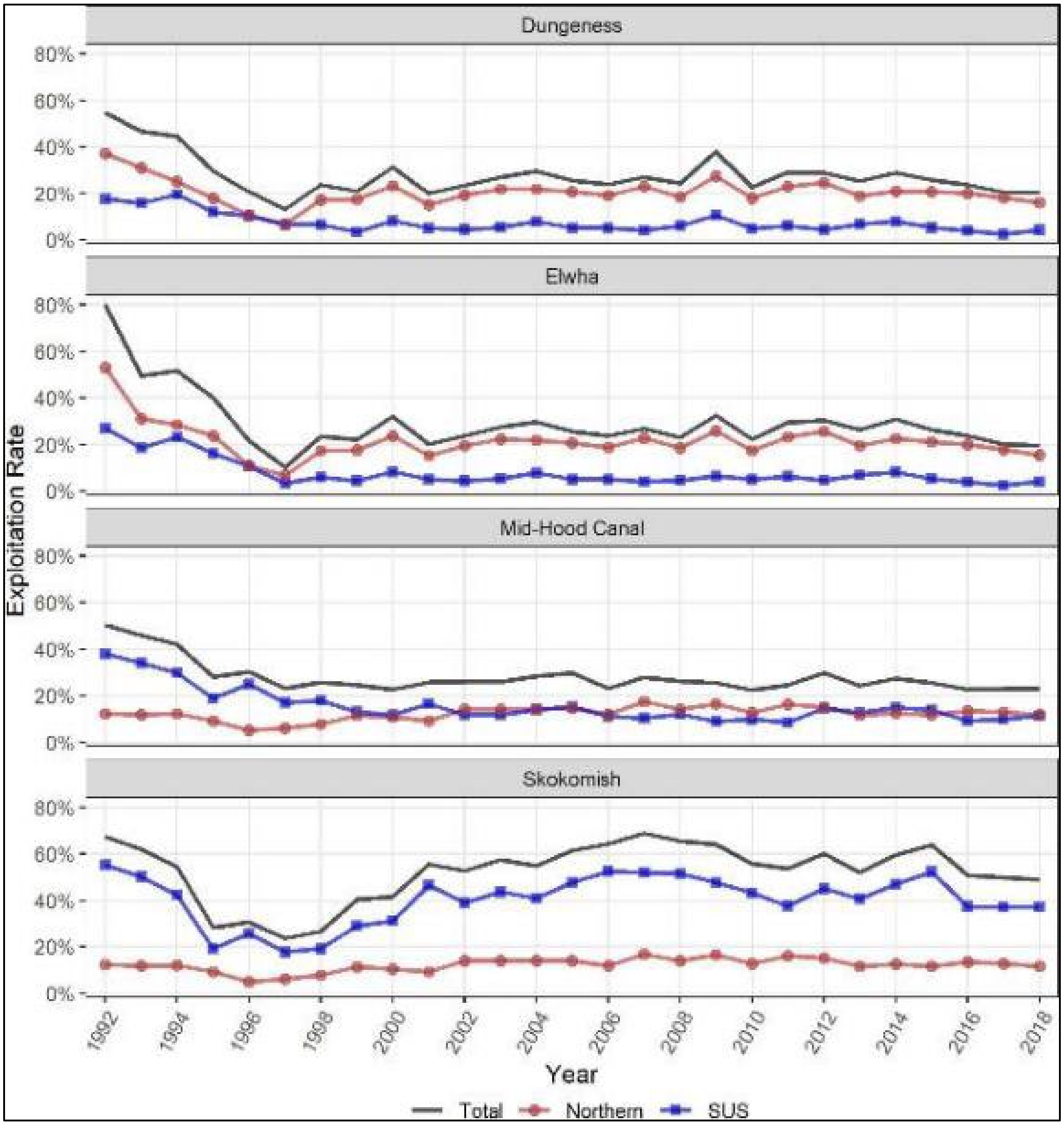

Figure 16. Total harvest exploitation of Hood Canal and Strait of Juan de Fuca Puget Sound Chinook salmon populations from (pers. comm. J. Carey, NMFS WCR). SUS=Southern United States.

ERs on populations in northern Puget Sound have steadily declined since the mid-1980s (Figure 17). From 1992 to 1999 the total ER on Nooksack River spring Chinook salmon averaged 41% (Figure 17). Between 2009 and 2018 the total ER for all fisheries declined to an average of 31% (Figure 17). From 1992 to 1999, average total ERs were 41% for Stillaguamish River Chinook salmon and 45% for Skagit River summer/fall stocks (Figure 17). Between 2009 and 2018, total ERs declined to averages of 31% for Stillaguamish River Chinook salmon and 44% for Skagit River summer/fall stocks (Figure 17) (see environmental baseline for geographic distribution of the ERs).

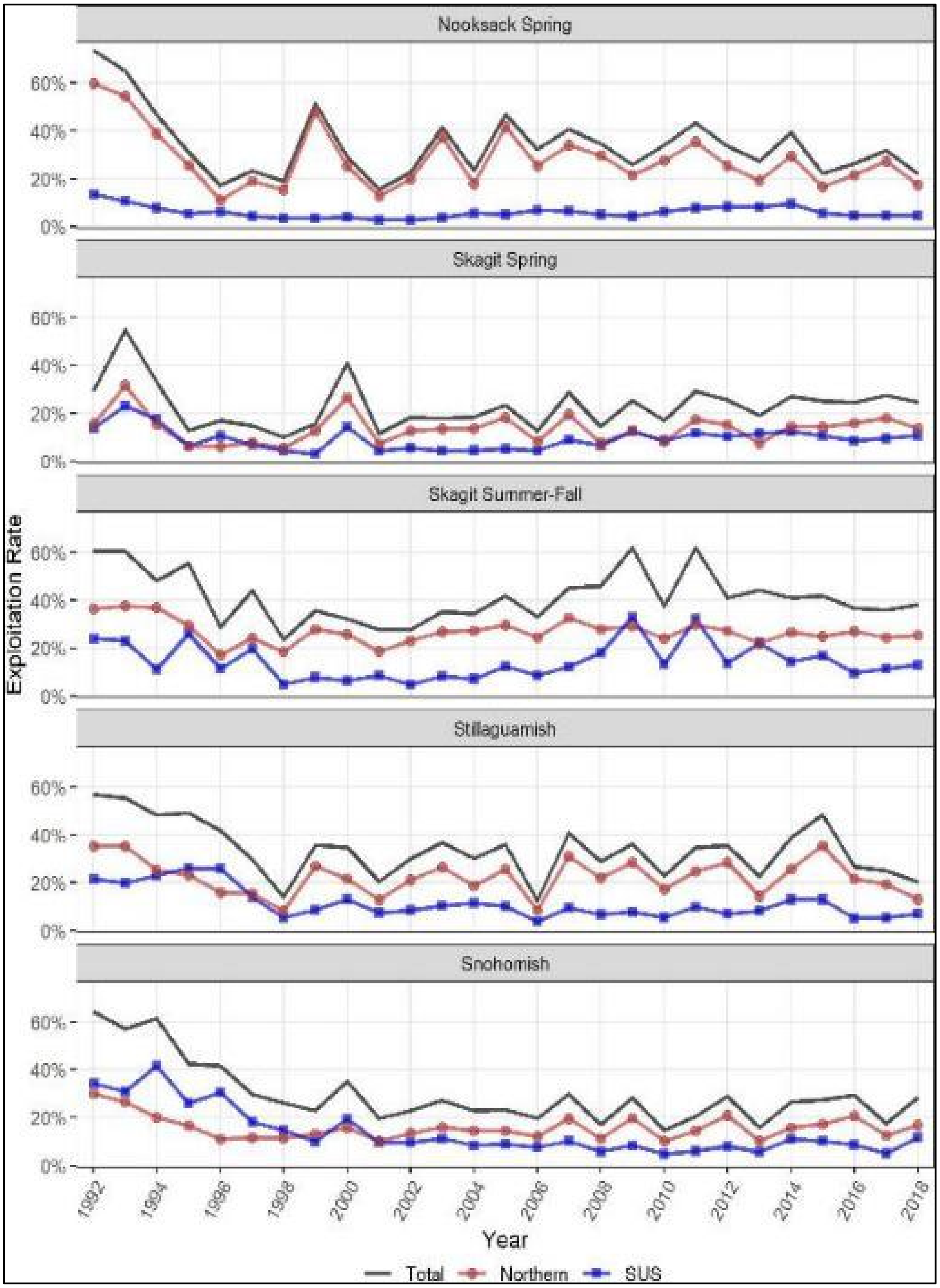

Figure 17. Total harvest exploitation of northern Puget Sound Chinook salmon populations from (pers. comm. J. Carey, NMFS WCR).

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 18). Figure 18 depicts the changes in ER over time for the populations in these regions. From 1992 to 1999, average total ERs ranged from 30% (White River Spring) to 74% (Nisqually). Between 2009 and

2018, total ERs averaged 24% (White River Spring) to 52% (Nisqually) representing a decrease of 28% to 55% in ERs (Figure 18) (see environmental baseline for geographic distribution of the ERs).

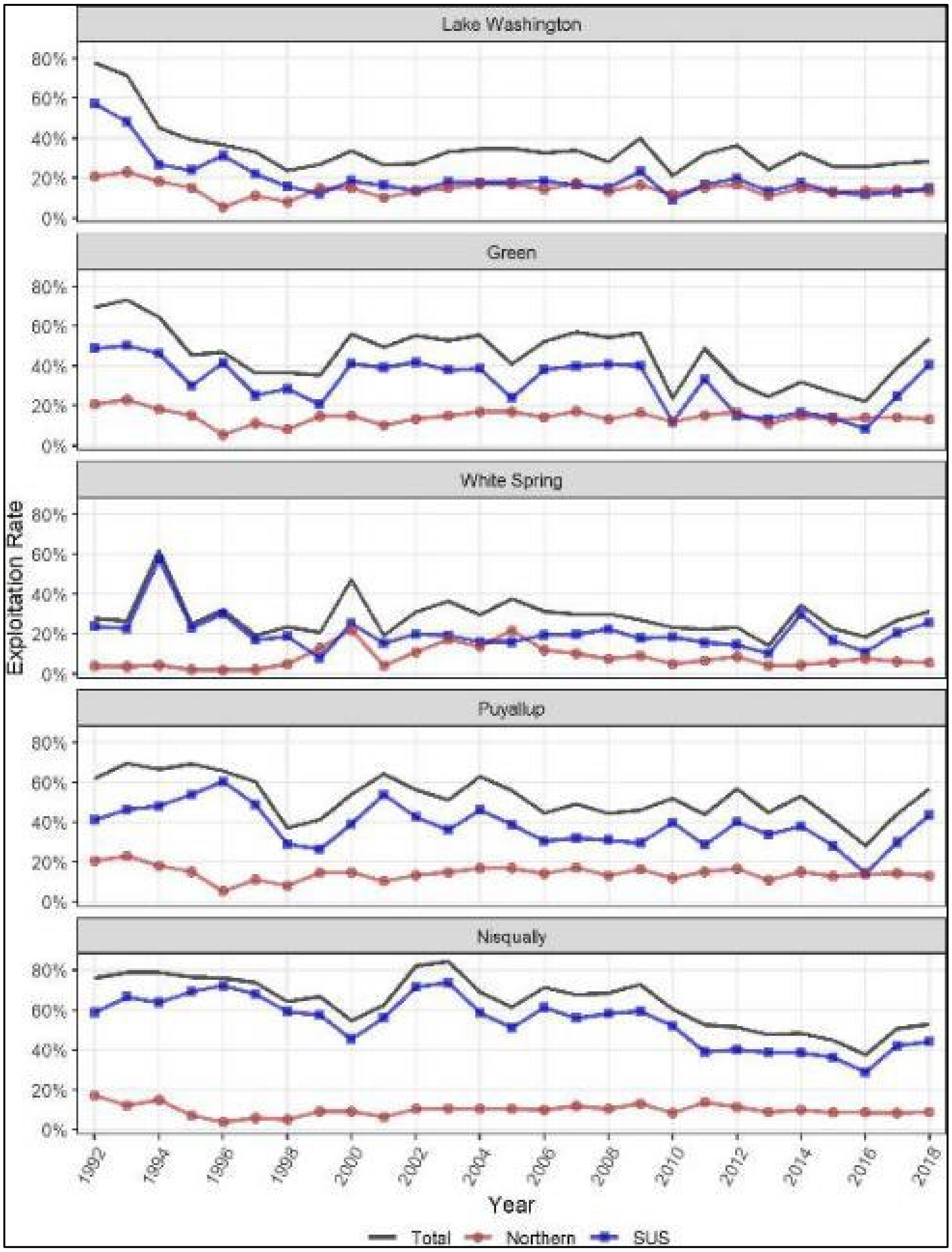

Figure 18. Total harvest exploitation of mid- and south-Puget Sound Chinook salmon populations from (pers. comm. J. Carey, NMFS WCR).

Total abundance in the ESU over the entire time series shows that trends for individual populations are mixed. Generally, many populations experienced increases in total abundance during the years 2000-2008, and more recently in 2015-2017, but general declines during 2009-2014, and a downturn again in the two most recent years for which data are available, 2018-2019

(Figure 19, below). The downturn in the most recent years was likely associated with the period of anomalously warm sea surface temperatures in the northeast Pacific Ocean that developed in 2013 and continued to persist through much of 2015; this phenomenon was termed “the Blob.” During the persistence of the Blob, distribution of marine species was affected (e.g., tropical and subtropical species were documented far north of their usual ranges), marine mammals and seabirds starved, and a coastwide algal bloom that developed in the summer of 2015 resulted in domoic acid poisoning of animals at various trophic levels, from crustaceans to marine mammals. Chinook salmon returning in 2017 and 2018 would have reached maturation in the ocean during these years, experiencing lower marine survival as a result of the hostile ocean conditions.

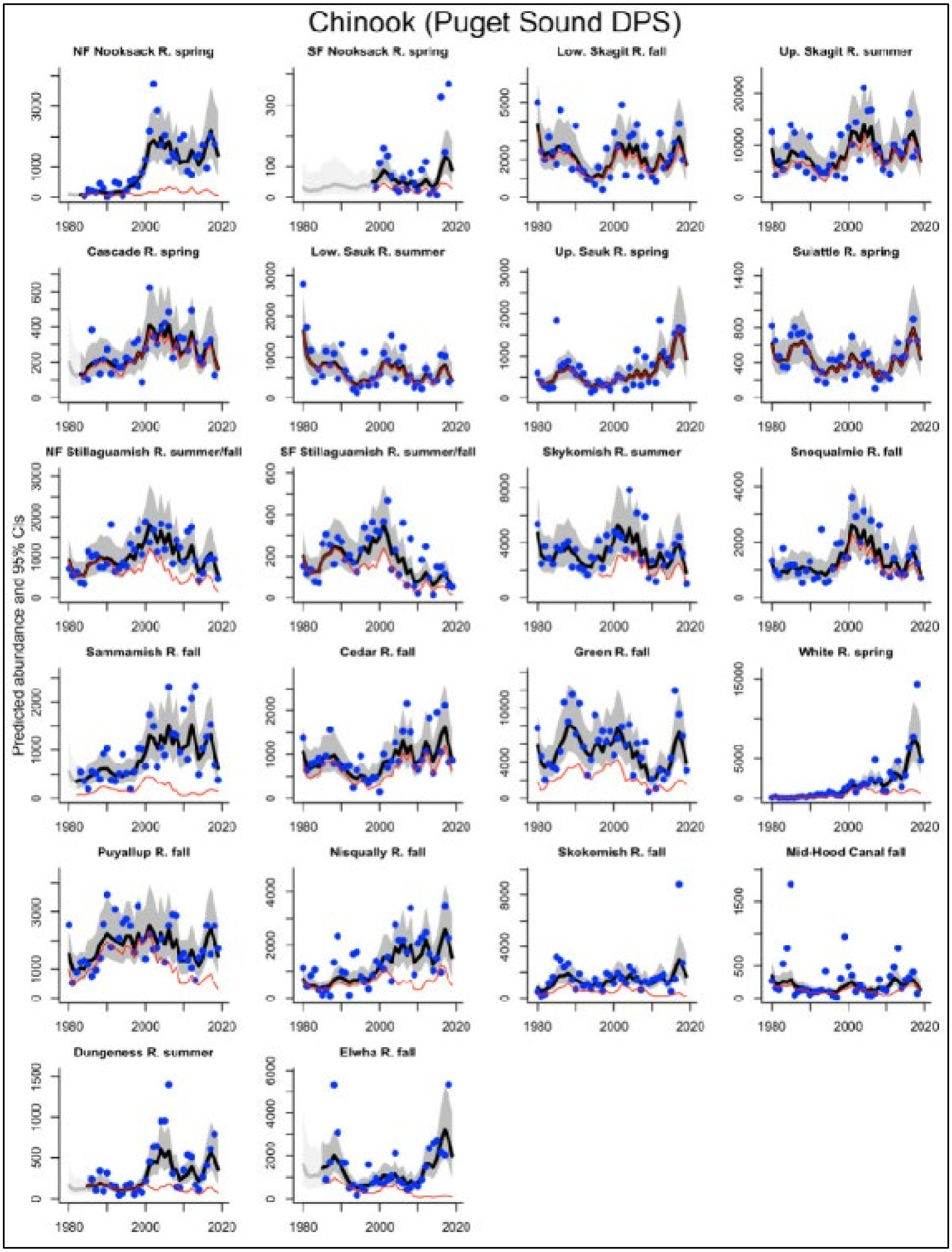

Figure 19. Smoothed trend in estimated total (thick black line) and natural-origin (thin red line) Puget Sound Chinook Salmon ESU individual populations spawning abundance. Points show the annual raw spawning abundance estimates (Ford 2022).

Abundance across the Puget Sound ESU has generally increased since the last status review (NMFS 2016n), with only 2 of the 22 populations (Cascade and North Fork Stillaguamish) showing a negative percent change in the 5-year geometric mean natural-origin spawner abundances compared with the prior status review (Table 28). Several populations (North Fork and South Fork Nooksack, Sammamish, Green, White, Puyallup, Nisqually, Skokomish, Dungeness and Elwha) are dominated by hatchery returns. Fifteen of the remaining 20 populations with positive percent change in the 5-year geometric mean natural-origin spawner abundances since the prior status review have relatively low natural spawning abundances of < 1000 fish, so some of these increases represent small changes in total abundance (Ford 2022). As with the table above (Table 27), showing the 5-year mean proportions of natural-origin spawners, it should be noted again that the pre-2005-2009 estimates of mean natural-origin fractions occurred prior to the widespread adoption of mass marking of hatchery produced fish, likely overestimating the proportion of natural-origin spawners. Estimates of hatchery and natural-origin proportions of fish since the implementation of mass marking are considered more robust (NMFS 2022a).

Table 28. Five-year geometric mean of raw natural-origin Chinook salmon spawner counts. This is the raw total spawner estimate times the fraction natural-origin estimate, if available. In parentheses, 5-year geometric mean of raw total spawner estimates (i.e., hatchery and natural) are shown. A value only in parentheses means that a total spawner estimate was available but no (or only one) estimate of natural-origin spawners was available. The geometric mean was computed as the product of estimates raised to the power 1 over the number of counts available (2 to 5). A minimum of 2 values were used to compute the geometric mean. Percent change between the most recent two 5-year periods is shown on the far right (Ford 2022).

Population	Region	1990-1994	1995-1999	2000-2004	2005-2009	2010-2014	2015-2019	Percent Change
NF Nooksack R. spring	Strait of Georgia	51 (102)	95 (471)	229 (2,186)	275 (1,536)	136 (1,205)	137 (1,553)	1 (29)
SF Nooksack R. spring	Strait of Georgia	-	-	44 (87)	22 (41)	13 (35)	42 (106)	223 (203)
Low. Skagit R. fall	Whidbey Basin	1,332 (1,474)	971 (1,035)	2,531 (2,774)	1,916 (2,228)	1,416 (1,541)	2,130 (2,640)	50 (71)
Up. Skagit R. summer	Whidbey Basin	3,970 (5603)	5,641 (6,185)	10,723 (12,410)	8,785 (10,525)	7,072 (7,457)	9,568 (10,521)	35 (41)
Cascade R. spring	Whidbey Basin	151 (188)	209 (213)	340 (371)	302 (342)	298 (317)	185 (223)	-38 (-30)
Low. Sauk R. summer	Whidbey Basin	384 (409)	403 (429)	820 (846)	543 (569)	376 (416)	635 (649)	69 (56)
Up. Sauk R. spring	Whidbey Basin	404 (408)	265 (267)	427 (427)	506 (518)	854 (880)	1,318 (1,330)	54 (51)
Suiattle R. spring	Whidbey Basin	288 (302)	378 (382)	402 (415)	258 (261)	376 (378)	640 (657)	70 (74)
NF Stillaguamish R. summer/fall	Whidbey Basin	731 (913)	677 (1,177)	1,089 (1,553)	493 (1,262)	417 (996)	302 (762)	-28 (-23)
SF Stillaguamish R. summer/fall	Whidbey Basin	148 (185)	176 (305)	196 (280)	51 (131)	34 (68)	37 (96)	9 (41)
Skykomish R. summer	Whidbey Basin	(2,398)	1,497 (3,331)	2,377 (4,849)	2,568 (3,378)	1,689 (2,462)	1,736 (2,806)	3 (14)
Snoqualmie R. fall	Whidbey Basin	(963)	1,427 (1,279)	2,036 (2,477)	1,308 (1,621)	839 (1,082)	856 (1,146)	2 (6)

Population	Region	1990-1994	1995-1999	2000-2004	2005-2009	2010-2014	2015-2019	Percent Change
Sammamish R. fall	Central/ South PS	197 (576)	149 (564)	336 (1,031)	171 (1,278)	82 (1,289)	126 (879)	54 (-32)
Cedar R. fall	Central/ South PS	385 (562)	276 (497)	379 (646)	1,017 (1,249)	699 (914)	889 (1,253)	27 (37)
Green R. fall	Central/ South PS	2,697 (5,420)	3,856 (7,274)	2,800 (6,542)	1,305 (3,149)	785 (2,109)	1,822 (6,373)	132 (202)
White R. spring	Central/ South PS	269 (378)	242 (616)	1,159 (1,461)	839 (2,099)	652 (2,161)	895 (6,244)	37 (189)
Puyallup R. fall	Central/ South PS	2,146 (2,547)	2,034 (2,348)	1,378 (1,794)	1,006 (2,054)	450 (1,134)	577 (1,942)	28 (71)
Nisqually R. fall	Central/ South PS	610 (781)	577 (723)	689 (1,296)	551 (1,899)	481 (1,823)	766 (1,841)	59 (1)
Skokomish R. fall	Hood Canal	505 (993)	478 (1,233)	479 (1,556)	500 (1,216)	136 (1,485)	265 (2,074)	95 (40)
Mid-Hood Canal fall	Hood Canal	94 (120)	78 (103)	169 (217)	47 (88)	80 (295)	196 (222)	145 (-25)
Dungeness R. summer	SJF	117 (117)	104 (104)	99 (520)	151 (374)	66 (279)	114 (476)	73 (71)
Elwha R. fall	SJF	428 (673)	275 (735)	491 (995)	140 (605)	71 (1,349)	134 (2,810)	89 (108)

Since 1999, most Puget Sound Chinook populations have mean natural-origin spawner escapement levels well below levels identified as required for recovery to low extinction risk (Table 29). Long-term, natural-origin mean escapements for eight populations are at or below their critical thresholds[17]. Both populations in three of the five biogeographical regions 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. Additionally, hatchery spawners help two of the remaining three of these populations achieve total spawner abundances above their critical threshold, reducing demographic risk. Nine populations are above their rebuilding thresholds[18], seven of them in the Whidbey/Main Basin Region. In 2018, NMFS and the NWFSC updated the rebuilding thresholds for several key Puget Sound populations. These thresholds represent the MSY estimate of spawners (S_{MSY}) based on updated estimates of population productivity (adult recruits/spawner) and capacity and error associated with that estimation. 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 1,700 spawners compared to the previous rebuilding escapement threshold of 5,523[19] spawners. Although several populations are above the updated rebuilding thresholds, indicating that escapement is sufficient for the available habitat in many cases, the overall estimated natural-origin abundance has declined.

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[17] After considering uncertainty, the critical threshold is defined as a point below which: (1) depensatory processes are likely to reduce the population below replacement; (2) the population is at risk from inbreeding depression or fixation of deleterious mutations; or (3) productivity variation due to demographic stochasticity becomes a substantial source of risk (NMFS 2000b).

[18] The rebuilding threshold is defined as the escapement that will achieve MSY under current environmental and habitat conditions (NMFS 2000b), 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.

[19] The historic Green River escapement goal was established in 1977 as the average of estimated natural spawning escapements from 1965-1974. This goal does not reflect the lower productivity associated with the current condition of habitat. Reference the source for the historical objective from Management Unit Profile (MUP) (PSIT and WDFW 2017) (Green River MUP).

Table 29. Long-term 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. Populations exceeding their rebuilding natural-origin escapement threshold are underlined.

Region	**Population (MU=Management Unit)**	**1999 to 2018 Run Year Geometric mean Escapement (Spawners)**		**NMFS Escapement Thresholds**		**Recovery Planning Abundance Target in Spawners (productivity)**	**Average % hatchery fish in escapement 1999-2018 (min-max)[5]**
		Natural [1]	**Natural-Origin (Productivity[2])**	**Critical[3]**	**Rebuilding[4]**		
Georgia Basin	Nooksack MU	1,798	236	400	500		
	NF Nooksack	1, 532	**180** (0.3)	*200*[6]	-	3,800 (3.4)	86 (63-97)
	SF Nooksack	266	**56** (1.9)	*200*[6]	-	2,000 (3.6)	51 (19-82)
Whidbey/Main Basin	Skagit Summer/Fall MU						
	Upper Skagit River	9,349	8,314 (2.7)	738	5,740	5,380 (3.8)	11 (2-36)
	Lower Sauk River	560	531 (3.1)	*200*[6]	371	1,400 (3.0)	5 (0-33)
	Lower Skagit River	2,090	1,845 (2.8)	281	2,131	3,900 (3.0)	9 (0-23)
	Skagit Spring MU						
	Upper Sauk River	633	624 (2.2)	130	470	750 (3.0)	1 (0-5)
	Suiattle River	379	372 (2.0)	170	223	160 (2.8)	2 (0-7)
	Upper Cascade River	289	260 (1.5)	130	148	290 (3.0)	7 (0-25)
	Stillaguamish MU						
	NF Stillaguamish R.	1,029	472 (0.9)	300	550	4,000 (3.4)	51 (25-80)
	SF Stillaguamish R.	122	**58** (1.2)	*200*[6]	300	3,600 (3.3)	48 (9-79)
	Snohomish MU						
	Skykomish River	3,193	2,212 (1.5)	400	1,491	8,700 (3.4)	28 (0-62)
	Snoqualmie River	1,449	1,182 (1.3)	400	816	5,500 (3.6)	18 (0-35)
Central/South Sound	Cedar River	924	659 (2.7)	*200*[6]	*282*[7]	2,000 (3.1)	28 (10-50)
	Sammamish River	1,073	**161** (0.5)	*200*[6]	*1,250*[6]	1,000 (3.0)	80 (36-96)
	Duwamish-Green R.	4,014	1,525 (1.4)	400	1,700	-	59 (27-79)
	White River[9]	1,859	625 (0.8)	*200*[6]	410[7]	-	59 (14-90)
	Puyallup River[10]	1,646	784 (1.2)	*200*[6]	1,170[7]	5,300 (2.3)	54 (19-83)
	Nisqually River	1,670	621 (1.5)	*200*[6]	1,200[8]	3,400 (3.0)	56 (17-87)
Hood Canal	Skokomish River	1,398	**282** (0.8)	452	1,160	-	71 (7-96)
	Mid-Hood Canal Rivers[11]	**187**		*200*[6]	*1,250*[6]	1,300 (3.0)	36[11] (2-87)
Strait of Juan de Fuca	Dungeness River	411	**98**(1.0)	*200*[6]	925[8]	1,200 (3.0)	72 (39-96)
	Elwha River[12]	1,231	**171**(1.02)	*200*[6]	*1,250*[6]	6,900 (4.6)	74 (31-98)

[1] Includes naturally spawning hatchery fish (estimates represent 1999-2019 geo-mean for: NF and SF Stillaguamish, Skykomish, Snoqualmie, Cedar, Duwamish-Green, White, Puyallup, and Elwha).

[2] Source productivity is Abundance and Productivity Tables from NWFSC database; measured as the mean of observed recruits/observed spawners through brood year 2015, except: SF Nooksack through brood year 2013; and NF and SF Stillaguamish, Sammamish, Cedar, Duwamish-Green, Puyallup, White, Snoqualmie, Skykomish, through brood year 2016. 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 2006b); 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 2000b; 2018f).

[4] Rebuilding natural-origin escapement thresholds under current habitat and environmental conditions (McElhany et al. 2000; NMFS 2000b; 2018f).

[5] Estimates of the fraction of hatchery fish in natural spawning escapements are from the Abundance and Productivity Tables from NWFSC database; measured as mean and range for 1999-2018. Estimates represent hatchery fraction through 2019 for: NF and SF Stillaguamish, Skykomish, Snoqualmie, Cedar, Duwamish-Green, White, Puyallup, and Elwha.

[6] Based on generic VSP guidance (McElhany et al. 2000; NMFS 2006b).

[7] Based on spawner-recruit assessment (PSIT and WDFW 2022).

[8] Based on alternative habitat assessment.

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

[10] 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).

[11] The PSTRT 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; total abundance estimates primarily based on returns to the Hamma Hamma River.

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

[13] Differences in results reported in Table 30 and Table 35 from those in the NWFSC Biological Viability Assessment (Ford 2022) (Table 28 and Table 29, above) are related to the data source, method, and time period analyzed (e.g., 5-year vs 20-year estimates).

Long-term growth rates of natural-origin escapement are generally higher than growth rates 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). Since 1990, 13 populations show long-term growth rates that are at or above replacement for natural-origin escapement including populations in four of five regions. Currently, only five populations, in two regions, show long-term neutral to positive growth rates in natural-origin recruitment (Table 30). Additionally, most populations are consistently well below the productivity goals identified in the recovery plan (Table 29). Although long-term trends (1990 forward) vary for individual populations across the ESU, currently 20 populations exhibit a stable or increasing long-term trend in total natural escapement (Table 30). Thirteen of 22 populations show a growth rate in the 18-year geometric mean natural-origin spawner escapement that is greater than or equal to 1.00 (Table 30).

Table 30. Long-term trends[20] in abundance and productivity for Puget Sound Chinook salmon populations. Long-term, reliable data series for natural-origin contribution to escapement are limited in many areas.

Region	Population	Total Natural Escapement Trend[1] (1990-2018)		Natural Origin Growth Rate[2] (1990-2018)	
		NMFS		Recruitment (Recruits)	Escapement (Spawners)
Georgia Basin	NF Nooksack (early)	1.10	increasing	0.99	1.00
	SF Nooksack (early)	1.06	stable	0.96	0.96
Whidbey/Main Basin	Upper Skagit River (moderately early)	1.02	stable	1.01	1.00
	Lower Sauk River (moderately early)	1.01	stable	0.99	1.00
	Lower Skagit River (late)	1.02	stable	1.00	1.00
	Upper Sauk River (early)	1.05	increasing	0.97	1.02
	Suiattle River (very early)	1.02	stable	0.96	1.00
	Upper Cascade River (moderately early)	1.01	stable	0.96	1.00
	NF Stillaguamish R. (early)	0.99	stable	0.92	0.98
	SF Stillaguamish R (moderately early)	0.95	**declining**	0.90	0.96
	Skykomish River (late)	1.00	stable	0.99	0.99
	Snoqualmie River (late)	1.00	stable	1.00	1.00
Central/South Sound	Cedar River (late)	1.04	increasing	0.99	1.00
	Sammamish River[3] (late)	1.03	increasing	1.01	0.99
	Duwamish-Green R. (late)	0.98	stable	0.98	1.00
	White River[4] (early)	1.10	increasing	1.07	1.07
	Puyallup River (late)	0.98	stable	0.96	0.98
	Nisqually River (late)	1.05	increasing	0.97	1.00
Hood Canal	Skokomish River (late)	1.02	stable	0.93	0.97
	Mid-Hood Canal Rivers (late)	1.05	increasing	0.98	1.04

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[20] Differences in results reported in Tables 5 and 6 from those in the NWFSC Biological Viability Assessment (Ford 2022) (Table 28 and Table 29, above) are related to the data source, method, and time period analyzed (e.g., 5-year vs 20-year estimates).

Region	**Population**	**Total Natural Escapement Trend[1] (1990-2018)**		**Natural Origin Growth Rate[2] (1990-2018)**	
		NMFS		**Recruitment (Recruits)**	**Escapement (Spawners)**
Strait of Juan de Fuca	Dungeness River (early)	1.05	increasing	0.96	0.98
	Elwha River (late)	1.05	increasing	0.89	0.92

[1] Total natural 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 spawning in each river system. Directions of trends defined by statistical tests. Trends for NF and SF Stillaguamish, Skykomish, Snoqualmie, Cedar, Sammamish, Duwamish-Green, White, Puyallup, and Elwha are from 1999-2019.
[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] Median growth rate estimates for Sammamish has not been revised to include escapement in Issaquah Creek.
[4] 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.

Even given some of the incremental increases in natural-origin spawner abundances in the most recent five-year period (Table 28), the long-term trends in both abundance and productivity, in most Puget Sound populations, are well below the levels necessary for recovery (Table 30).

Conservation Hatcheries in Puget Sound

The goals of conservation programs are to restore and maintain natural populations. Hatchery supplementation programs implemented as conservation measures to recover returning Chinook salmon currently operate in the Dungeness (NMFS 2016b; 2022l), North and South Fork Nooksack rivers, and the North and South Fork Stillaguamish Rivers (NMFS 2019d). A Chinook salmon supplementation program in the Hamma Hamma River operated for 20 years but ceased in 2015. The Dungeness, Nooksack, and Stillaguamish programs have received funding associated with the 2019 PST Agreement and prior Agreements (e.g., 2009 PST Agreement), and these funds supported a feasibility study for a potential new conservation hatchery program for the mid-Hood Canal population. These programs are intended to be consistent with NMFS' recovery plan for Puget Sound Chinook.

These conservation hatchery programs 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.

2.2.2.4.2 Limiting Factors and Other Areas of Concern

Limiting factors described in the recovery plan (Shared Strategy for Puget Sound (NMFS 2006b)) and reiterated in NMFS (2016n) relate to present or threatened set of conditions within certain habitat parameters that inhibit the viability of salmon as defined by the VSP criteria, including:

- 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.

Additional factors affecting Puget Sound Chinook salmon viability:

- 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 (NWFSC 2015). Improvements in hatchery operations associated with on-going ESA review and determination processes are expected to further reduce hatchery-related risks.
- Salmon harvest management: Total fishery ERs on most Puget Sound Chinook salmon populations have decreased substantially since the late 1990s when compared to years prior to listing – 1992-1998 (average reduction = -21%, range = -49 to +33%), FRAM base period validation results, version 7.1.1) but weak natural-origin Chinook salmon populations in Puget Sound still require protective measures to reduce the risk of overharvest. The risk to the species' persistence because of harvest remains the same since the last status review, meaning that for some of the populations with minimal abundance, even low rates of harvest impact can pose demographic and genetic risks. However, there has been greater uncertainty associated with this threat due to shorter term harvest plans for Puget Sound fisheries (uncertainty about future harvest plans) and exceedance of Rebuilding Exploitation Rates (RERs) for many Chinook salmon populations essential to recovery.
- 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, and certain federal, state, and local land and water use actions continue to occur without protective measures for ESA listed Chinook. State and local actions often have no federal nexus to trigger the ESA Section 7 consultation requirement, and thus measures to protect listed species and their habitat are left to state and local government decisions.

2.2.3 Status of the Marine Mammal DPSs

2.2.3.1 Status of the Southern Resident Killer Whale DPS

Southern Resident killer whales (SRKWs) are an ecotype of fish-eating killer whales in the eastern North Pacific. 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 2021 concluded that SRKWs should remain listed as endangered and includes recent information on the population, threats, and new research results and publications (NMFS 2021m). NMFS considers SRKWs to be currently among nine species at high risk of extinction as part of NMFS's Species in the Spotlight initiative[21] because of their endangered status, their declining population trend, and because they are considered high priority for recovery due to conflict with human activities and based on current recovery programs addressing those threats. The population has relatively high mortality and low reproduction, unlike other resident killer whale populations, which have generally been increasing since the 1970s (Carretta et al. 2023b). Current management priorities are outlined in the 2021-2025 Species in the Spotlight Action Plan.[22]

The factors limiting SRKW recovery as described in the final recovery plan include reduced prey availability and quality, high levels of contaminants from pollution, and disturbances from vessels and sound (NMFS 2008b). This section summarizes the status of SRKW throughout their range and information taken largely from the recovery plan (NMFS 2008b), the most recent 5-year review (NMFS 2021m), and the PFMC SRKW Ad Hoc Workgroup's report (PFMC 2020), as well as new data that became available more recently.

2.2.3.1.1 Abundance, Productivity, and Trends

Killer whales, including SRKWs, are a long-lived species and sexual maturity can occur at age 10 (review in NMFS (2008b)). Females produce a low number of surviving calves (n < 10, but generally fewer) over the course of their reproductive lifespan (Bain 1990; Olesiuk et al. 1990). Compared to Northern Resident killer whales (NRKWs), which are a resident killer whale population with a sympatric geographic distribution ranging from coastal waters of Washington State and British Columbia north to SEAK, SRKW females appear to have reduced fecundity (Ward et al. 2013; Vélez-Espino et al. 2014), and all age classes of SRKWs have reduced survival compared to other fish-eating populations of killer whales in the Northeast Pacific (Ward et al. 2013).

Since the early 1970s, annual summer censuses have occurred in the Salish Sea using photo-identification techniques (Bigg et al. 1990; CWR 2023). The population of SRKW was at its lowest known abundance (n = 67) in the early 1970s following live-captures for aquaria display and highest recorded abundance (98 animals) in 1995. Subsequently, the population declined from 1995-2001 (from 98 whales in 1995 to 81 whales in 2001). Although the population experienced growth between 2001 and 2006 and a brief increase from 78 to 81 whales as a result

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[21] https://www.fisheries.noaa.gov/feature-story/recovering-threatened-and-endangered-species-report-congress-2019-2020

[22] https://www.fisheries.noaa.gov/resource/document/species-spotlight-priority-actions-2021-2025-southern-resident-killer-whale

of multiple successful pregnancies (n = 9) in 2013 and 2014, the population has been declining since 2006. At the time of the 2023 summer census, the Center for Whale Research (CWR) reported 75 SRKWs in the population, including two calves that were born in 2023 (CWR 2023) (Figure 20). Since the 2023 census, one adult male is presumed dead, along a calf born in late 2023, bringing the population size to 74. The previously published historical estimated abundance of SRKWs was 140 animals (NMFS 2008b), which included the number of whales killed or removed for public display in the 1960s and 1970s (summed across all years) added to the remaining population at the time the captures ended.

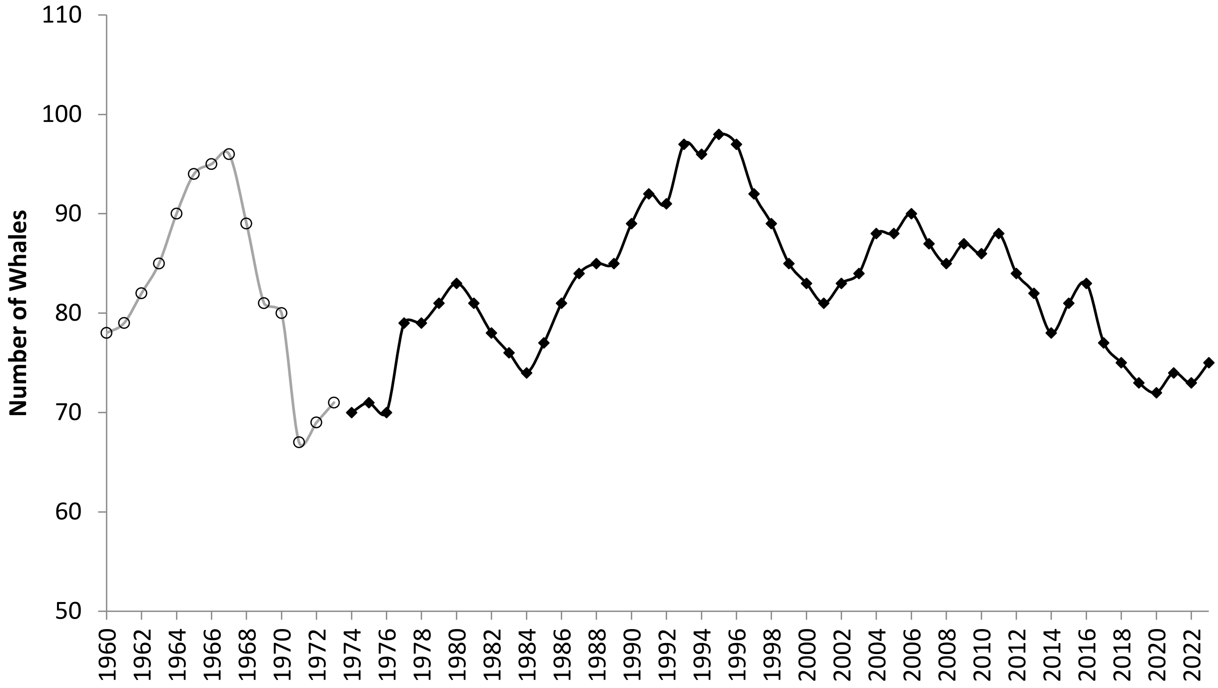


Figure 20. Population size and trend of SRKWs, 1960-2023. Data from 1960-1973 (open circles, gray line) are number projections from the matrix model of Olesiuk et al. (1990). Data from 1974-2023 (diamonds, black line) were obtained through photo-identification surveys of the three pods (J, K, and L) and were provided by the CWR (unpublished data) and NMFS (2008b). Data for these years represent the number of whales present at the end of each calendar year, or after the summer census for 2012 onwards.

Seasonal mortality rates among SRKWs and NRKWs may be highest during the winter and early spring, based on strandings data and the number of animals missing from pods returning to inland waters each spring. Olesiuk et al. (2005) reported that high neonate mortality occurred outside of the summer season. Additionally, multiple new calves have been documented in winter months that did not survive to the following summer season (CWR unpublished data). Stranding rates are higher in winter and spring for all killer whale ecotypes in Washington and Oregon (Norman et al. 2004) and a recent review of killer whale strandings in the northeast Pacific provided insight into health, nutritional status and causes of mortality for all killer whale ecotypes (fish- and mammal-eating) (Raverty et al. 2020).

The NWFSC continues to evaluate changes in fecundity and survival rates, and has updated population viability analyses conducted for the 2004 Status Review of Southern Resident Killer Whales (Krahn et al. 2004b), the science panel review (Hilborn et al. 2012; Ward et al. 2013), and previous 5-year status reviews (NMFS 2011a; 2016e). Subsequently, population estimates, including data from the most recent five years (2017-2021), project a downward trend over the next 25 years (Figure 21). The declining trend is, in part, due to the changing age and sex structure of the population (the sex ratio at birth was estimated in the model at 55% male and 45% female following current trends), but also related to the relatively low fecundity rate observed from 2017 to 2021. Though these fecundity rates are declining, average SRKW survival rates estimated by the NWFSC have been slowly increasing since the late 1990s. The population projection indicates the strongest decline if future fecundity rates are assumed to be similar to 2017-2021, and higher but still declining if average fecundity and survival rates over all years (1985-2021) are used (Figure 21). The projection using the highest fecundity and survival rates (1985-1989) shows some stability and even a slight increase over the next decade before severely declining. A 25-year projection was selected because as the model projects out over a longer time frame (e.g., 50 years), there is increased uncertainty around the estimates (also see Hilborn et al. (2012)).

The scenario using the most recent (2017-2021) survival and fecundity rates may be a more reliable estimation if current levels of survival and poor reproduction continue. This predicted downward trend in the model is driven by the current age and sex structure of young animals and number of older animals in the population. The range of population trajectories reflects the endangered status of the SRKWs and variable periods of decline experienced over the long and short term and is based on a limited data set for the small population. The analysis does not link population growth or decline to any specific threat, but reflects the combined impacts of all past threats. As a long-lived species with a low reproductive rate, it will take time for SRKWs to respond to a reduction in threats. It will be difficult to link specific actions to potential future improvements in the population trajectory. One assumption shared across all scenarios presented here is that female reproduction will be similar to the average (given the age of animals and time period). Because many reproductive-aged females have not produced a calf in the last decade, we would expect the SRKW population to decline even more rapidly if the number of females not reproducing continues to increase, or these females continue to fail to produce calves.

Another factor to consider is the potential effects of inbreeding (generally a risk for any small population). Many 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 (Ford et al. 2011a; Ford et al. 2018). Additionally, several offspring that were tested for paternity resulted from matings between parents and their own offspring (Ford et al. 2018). While these inbreeding effects are estimated to be slightly negative, they are difficult relationships to estimate given the small sample size. Recent genomic analyses indicate that the SRKW population has greater inbreeding and carries a higher load of deleterious mutations than do Alaska resident or transient killer whales, and that inbreeding depression is likely impacting the survival and growth of the population (Kardos et al. 2023). These factors likely contribute to the SRKW's poor status.

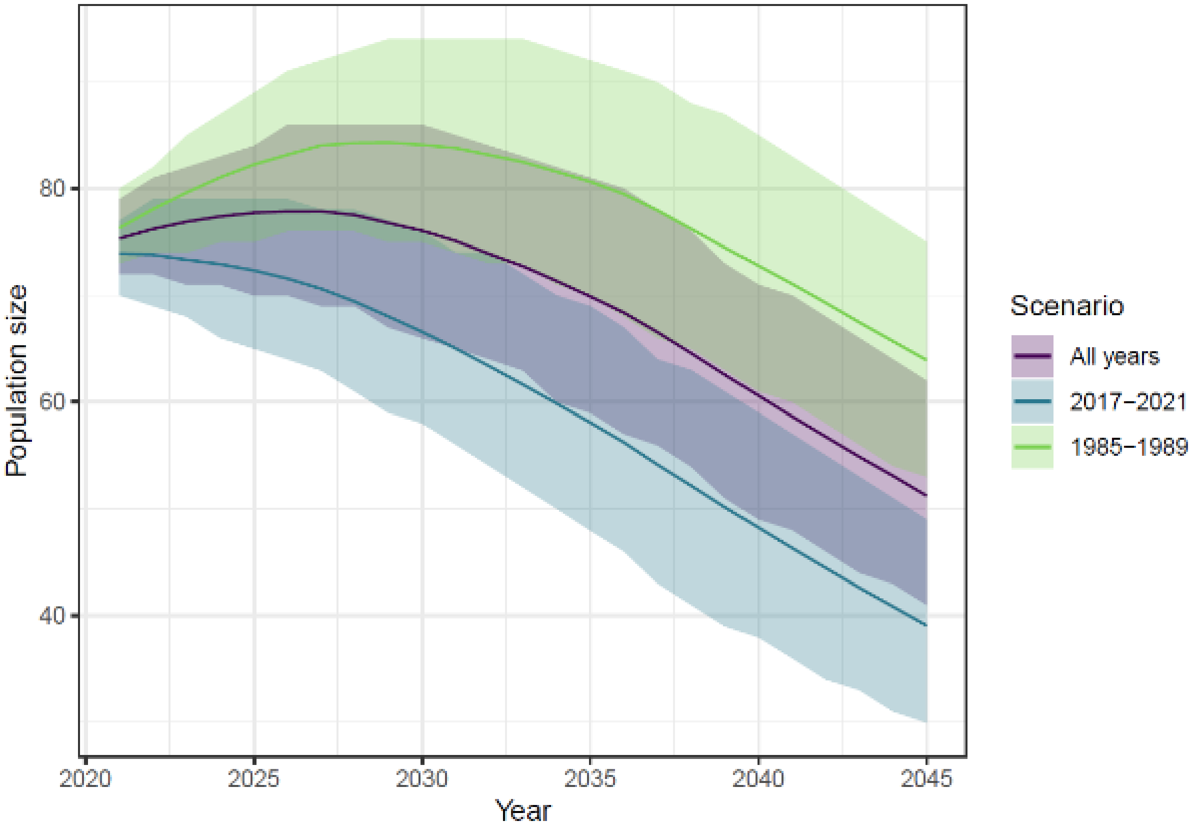


Figure 21. SRKW population size projections from 2020 to 2045 using three scenarios: (1) projections using fecundity and survival rates estimated over the entire time series (1985-2021), (2) projections using rates estimated over the last five years (2017-2021), and (3) projections using the highest survival and fecundity rates estimated, during the period 1985-1989 (figure from NMFS (2021m)).

Because of this population's small abundance, it is also susceptible to demographic stochasticity, or randomness in the pattern of births and deaths among individuals in a population. Several sources of demographic variance (e.g., differences between or within individuals) can affect small populations and contribute to variance in a population's growth and increased extinction risk. Sources of demographic variance can include environmental stochasticity, or fluctuations in the environment that drive changes 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 (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.

Individual variation in reproductive success can influence broader population growth or decline, especially for smaller, more isolated populations such as the SRKW (Coulson et al. 2006; Hochachka 2006). Additionally, whether a female produces a son or daughter may influence her lifetime reproductive success (Weiss et al. 2023). Similarly, the number of reproducing females in a population can signal potential growth or decline. In the SRKW population, the number of reproductive aged females was at its lowest point in the late 1970s, in part because of the prior removals for aquaria that occurred into the early 1970s (Figure 22). Though the overall number of reproductive females has fluctuated between 25-35 for most of the last 40 years, there have been contrasting changes by pod, with declines in L pod females and increases in J pod (Ward 2021) (Figure 22). At the start of the survey in 1976, the distribution of females was skewed toward younger ages with few older, post-reproductive females. In recent years, the distribution is more uniform across female ages (in other words, more females in their 30s). Relatedly, female fecundity at age 20 has declined in recent years, while survival for females and males at age 20 has stayed relatively constant (Ward 2021) (Figure 23). This suggests that reduced fecundity may be the driver for the population decline, rather than reduced adult survival. However, given that both high and low fecundity rates have been observed at low total SRKW population sizes (Ward 2021), and that inbreeding depression may be influencing survival (Kardos et al. 2023), there is not a clear relationship between declining fecundity rates and SRKW population size.

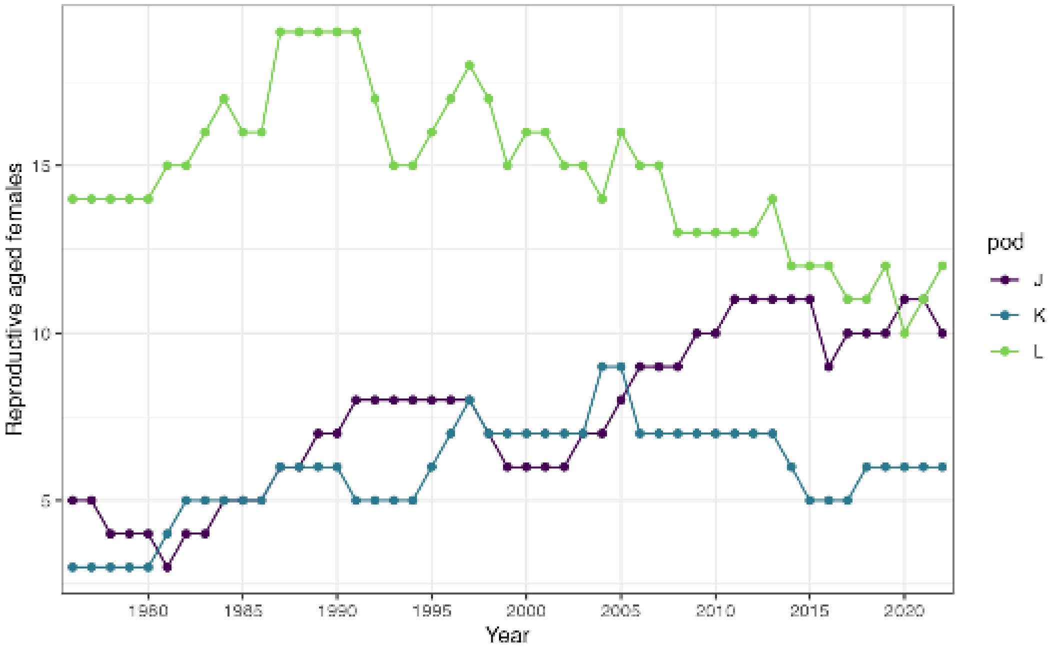


Figure 22. Time series of reproductive age females (10-42, inclusive) for SRKWs by year since 1976 (reproduced from Ward (2021)).

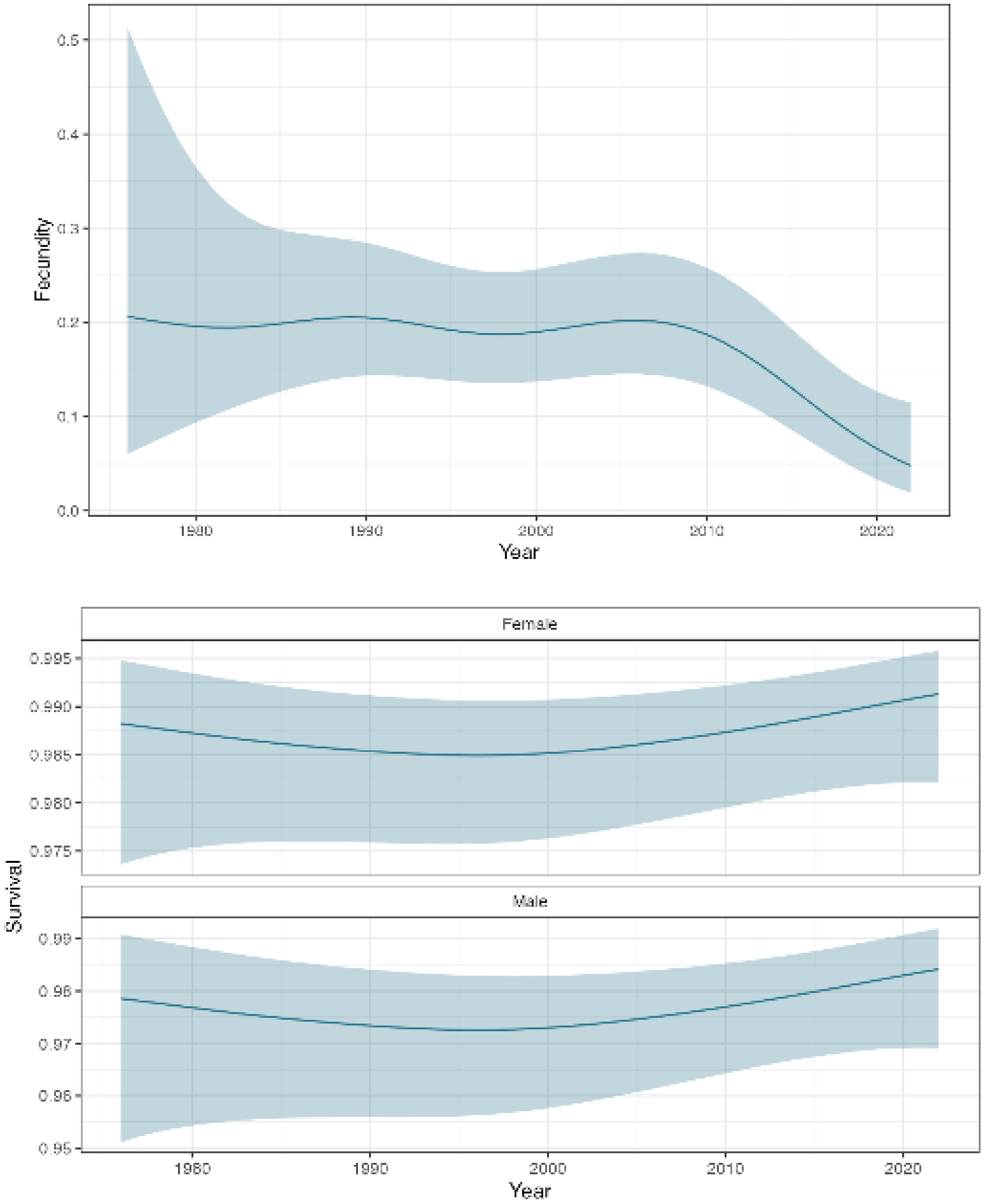


Figure 23. Time series of predicted fecundity rates for a 20-year old SRKW and survival rates for a 20-year old female and male. Estimates are generated from the Bayesian logistic regression models, using priors from the NRKW population. Ribbons represent 95% CIs (reproduced from Ward (2021)).

Previous work using fecal hormone data from SRKWs showed that up to 69% of detected pregnancies do not produce a documented calf, and an unprecedented half of those occurred relatively later in the pregnancy when energetic costs and physiological risk to the mother are higher (Wasser et al. 2017). Recent aerial imagery corroborates this high rate of loss (Fearnbach and Durban 2021). The congruence between the rate of loss estimates from fecal hormones and aerial photogrammetry suggests the majority of the loss is in the latter half of pregnancy when photogrammetry can detect anomalous shape after several months of gestation (Durban et al. 2016). Although the rates of successful pregnancies in wild killer whale populations is generally unknown, a relatively high level of reproductive failure late in pregnancy is uncommon in mammalian species and suggests there may be cause for concern.

2.2.3.1.2 Geographic Range and Distribution

SRKWs occur throughout the coastal waters off Washington, Oregon, and Vancouver Island, Canada and are known to travel as far south as central California and as far north as SEAK (NMFS 2008b; Hanson et al. 2013; Carretta et al. 2023b) (Figure 24), though there has only been one sighting of a SRKW in SEAK. SRKWs 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; Olson et al. 2018; NMFS 2021m; Ettinger et al. 2022; Thornton et al. 2022). During fall and early winter, SRKWs, and J pod in particular, expand their routine movements into Puget Sound, likely to take advantage of chum, coho, and Chinook salmon runs (Osborne 1999; Hanson et al. 2010b; Ford et al. 2016; Olson et al. 2018). Although seasonal movements are somewhat predictable, there can be large inter-annual variability in arrival time and days present in inland waters from spring through fall (Figure 25) (Olson et al. 2018; NMFS 2021m), with late arrivals and fewer days present in recent years (NMFS 2021m; Ettinger et al. 2022) (though see J pod occurrence in 2022). A recent paper showed a shift in SRKW peak occurrence in the central Salish Sea of 1-5 days later per year (depending on pod, time period, or location) between 1994-2017, and the SRKW timing shift is consistent with shifts in peak and first likely occurrence of Fraser River Chinook salmon (Ettinger et al. 2022). Similarly, a recent paper by Stewart et al. (2023) showed a decline in visitation to core inland summer habitat (north Puget Sound) for all pods from 2004 to 2020 and that the occurrence of SRKW may be related to annual Fraser Chinook returns.

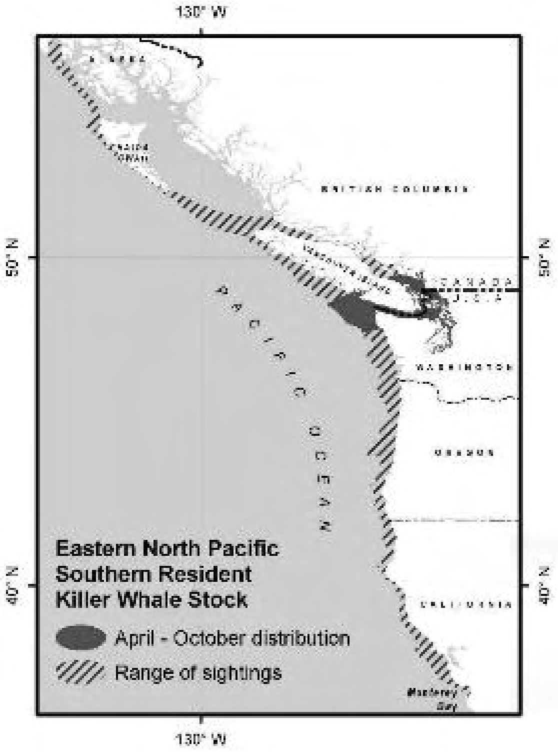
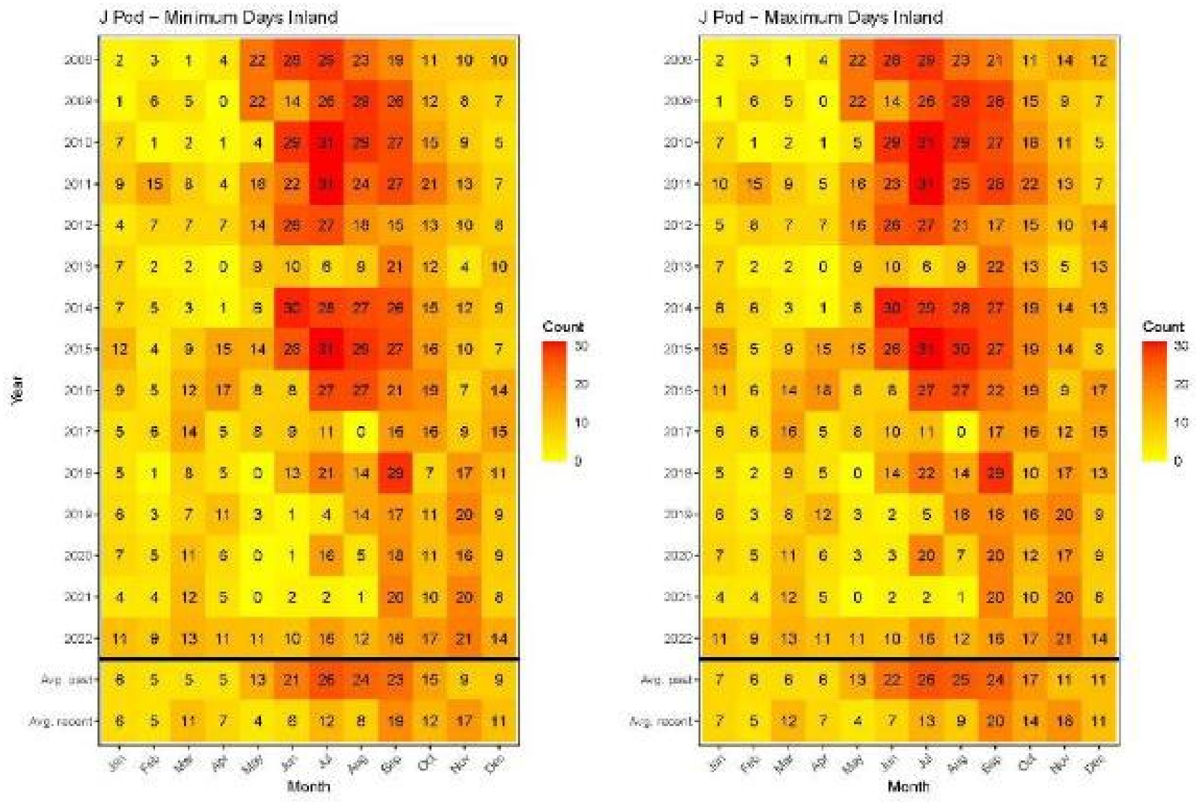
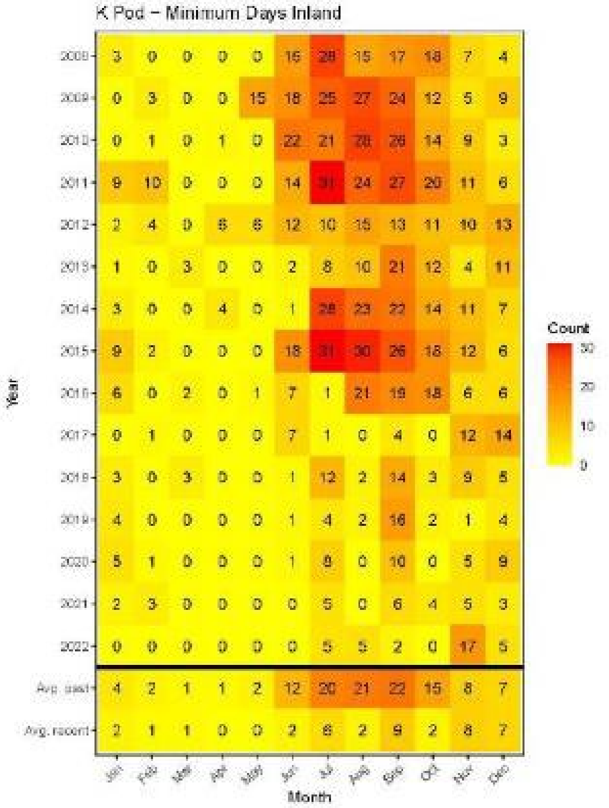
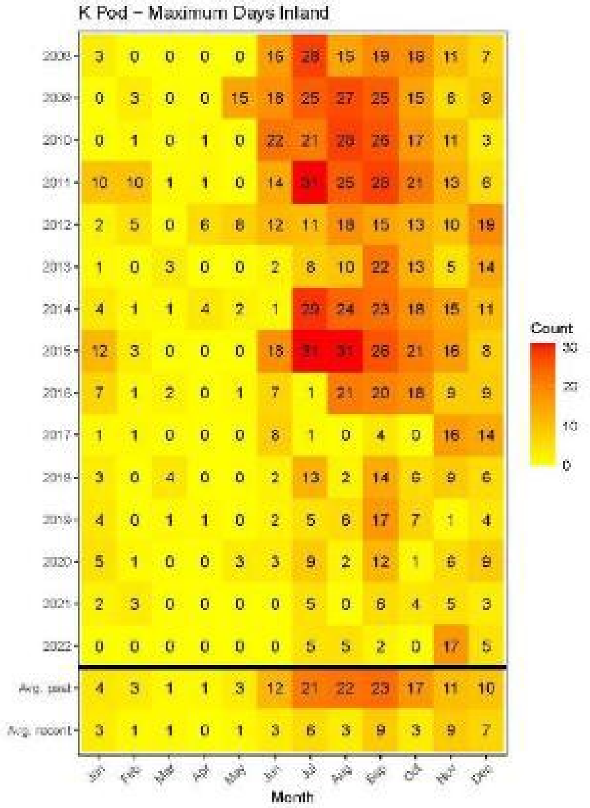
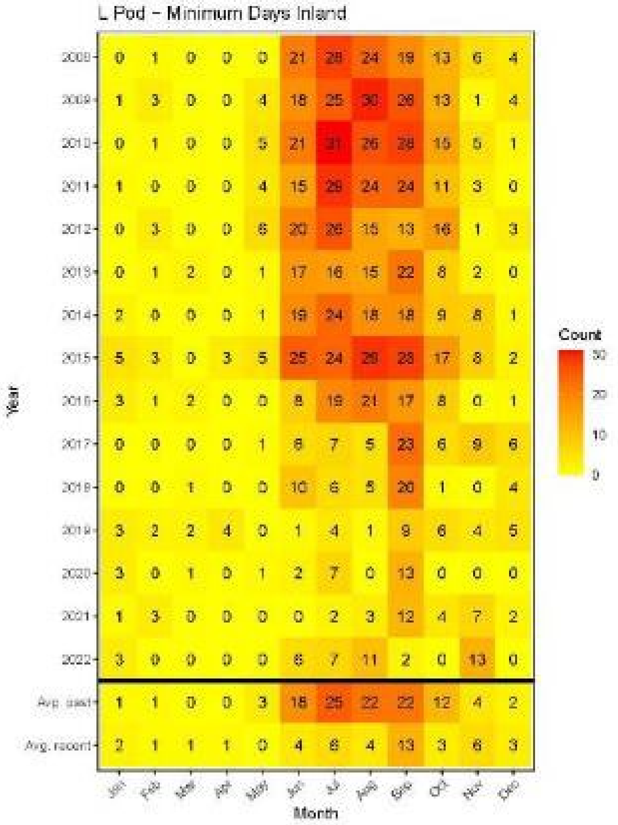


Figure 24. Geographic range of SRKWs (reprinted from Carretta et al. (2023b)).




K Pod – Minimum Days Inland


K Pod – Maximum Days Inland


L Pod – Minimum Days Inland

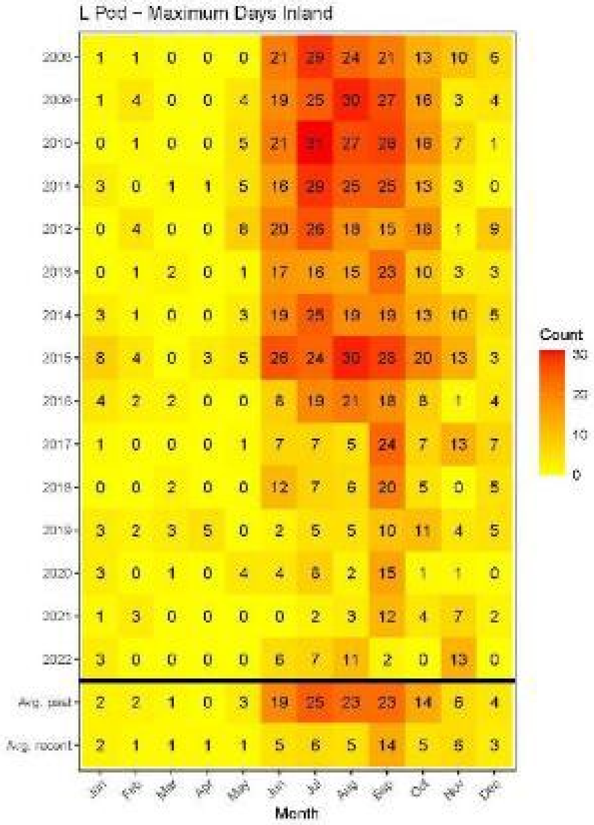

L Pod – Maximum Days Inland

Figure 25. Minimum and maximum number of days that each SRKW pod (J, K, or L) was present in inland waters of the Salish Sea by year and month based on opportunistic sightings (NMFS 2021m) (Whale Museum, unpubl. data). “Avg past” is the average before 2017 (2008-2016) and “Avg recent” is the average from 2017-2022. Data are available prior to 2008 but we used the past 15 years to represent more recent history. Minimum Days Inland includes only sightings where pod was specified and known with certainty. Maximum Days Inland includes sightings where pod was specified, including when there was uncertainty, and also includes counts of sightings of SRKWs (without pod specified) if no specific pod was listed as sighted any time that day. The area of the Salish Sea included in this figure encompasses both U.S. and Canadian waters, using the quadrant area defined by The Whale Museum (see Figure 1 in Olson et al. (2018)) and extending further west into the Strait of Juan de Fuca to the edge of inland SRKW critical habitat at the Cape Flattery-Tattoosh-Bonilla Point line.

Land- and vessel-based opportunistic and survey-based visual sightings, satellite tracking, and passive acoustic research have provided an updated estimate of the whales’ coastal range. Since 1975, confirmed and unconfirmed opportunistic SRKW sightings from the general public or researchers have been collected off British Columbia, Washington, Oregon, and California. Because of the limitations of not having controlled and dedicated sampling efforts, these confirmed opportunistic sightings have provided only general information on the whales’ potential geographic range during this period of time (*i.e.,* there are no data to describe the whales’ general geographic range prior to 1975). Together, these SRKW sightings have confirmed their presence as far north as Chatham Strait, SEAK and as far south as Monterey Bay, California (NMFS 2021a). Fisheries and Oceans Canada (DFO) models of SRKW occurrence based on sightings data show hotspots of occurrence off the west side of Vancouver Island at Swiftsure Bank, the west side of San Juan Island, and near the mouth of the Fraser River (Thornton et al. 2022). Additionally, the Pacheedaht First Nation has conducted surveys for SRKW occurrence in the Strait of Juan de Fuca and Swiftsure areas from 2020-2022.

As part of a collaborative effort between NWFSC, Cascadia Research Collective, and the University of Alaska, satellite-linked tags were deployed on eight male SRKWs (three tags on J pod members, two on K pod, and three on L pod) from 2012 to 2016 in Puget Sound or in the coastal waters of Washington and Oregon (Table 31). The tags transmitted multiple locations per day to assess winter movements and occurrences of SRKW (Hanson et al. 2017).

Over the course of the study, the eight satellite tags deployed were monitored for a range of signal contact durations from 3 days to 96 days depending on the tag, with deployment from late December to mid-May (Table 31). The winter locations of the tagged whales included inland and coastal waters. The inland waters range occurs across the entire Salish Sea, from the northern end of the Strait of Georgia and Puget Sound, and coastal waters from central west coast of Vancouver Island, British Columbia, to northern California (Hanson et al. 2017). The tagging data from 2012 to 2016 provided general information on the home range and overlap of each pod, and areas that are used more frequently than others by each pod. Specifically, J pod had high use areas or hot spots (defined as 1 to 3 standard deviations based on a duration of occurrence model of the tagging data) in the northern Strait of Georgia and the west entrance to the Strait of Juan de Fuca where they spent approximately 30% of their time, but they spent relatively little time in other coastal areas (Figure 26). K/L pods on the other hand occurred almost exclusively on the continental shelf during December to mid-May, primarily on the Washington coast, with a hot spot area between Grays Harbor and the Columbia River and off Westport, spending approximately 53% of their time there (Figure 27) (Hanson et al. 2017; Hanson et al. 2018). These differences resulted in generally minimal overlap between J pod and K/L pods, with overlap in high use areas near the Strait of Juan de Fuca western entrance for only a total area of approximately 200 km^2, which comprised only 0.5% of the three pods' ranges (Figure 26 and Figure 27).

Satellite tagging can also provide details on preferred depths and distances from shore. Approximately 95% of the SRKW locations were within 34 kilometers (km) of the shore and 50% of these were within 10 km of the coast (Hanson et al. 2017). Only 5% of locations were greater than 34 km from the coast, but no locations exceeded 75 km. Almost all (96.5%) outer coastal locations of satellite-tagged SRKWs occurred in continental shelf waters of 200 m (656.2 feet (ft)) depth or less, 77.7% were in waters less than 100 m (328.1 ft) depth, and only 5.3% were in waters less than 18 m (59 ft).

Table 31. Satellite-linked tags deployed on SRKWs 2012-2016 (Hanson et al. 2018). This study was part of a collaborative effort between NWFSC, Cascadia Research Collective, and the University of Alaska.

Whale ID	Pod association	Date of tagging	Duration of signal contact (days)
J26	J	20-Feb-12	3
L87	J	26-Dec-13	31
J27	J	28-Dec-14	49
K25	K	29-Dec-12	96
L88	L	8-Mar-13	8
L84	L	17-Feb-15	93
K33	K	31-Dec-15	48
L95	L	23-Feb-16	3

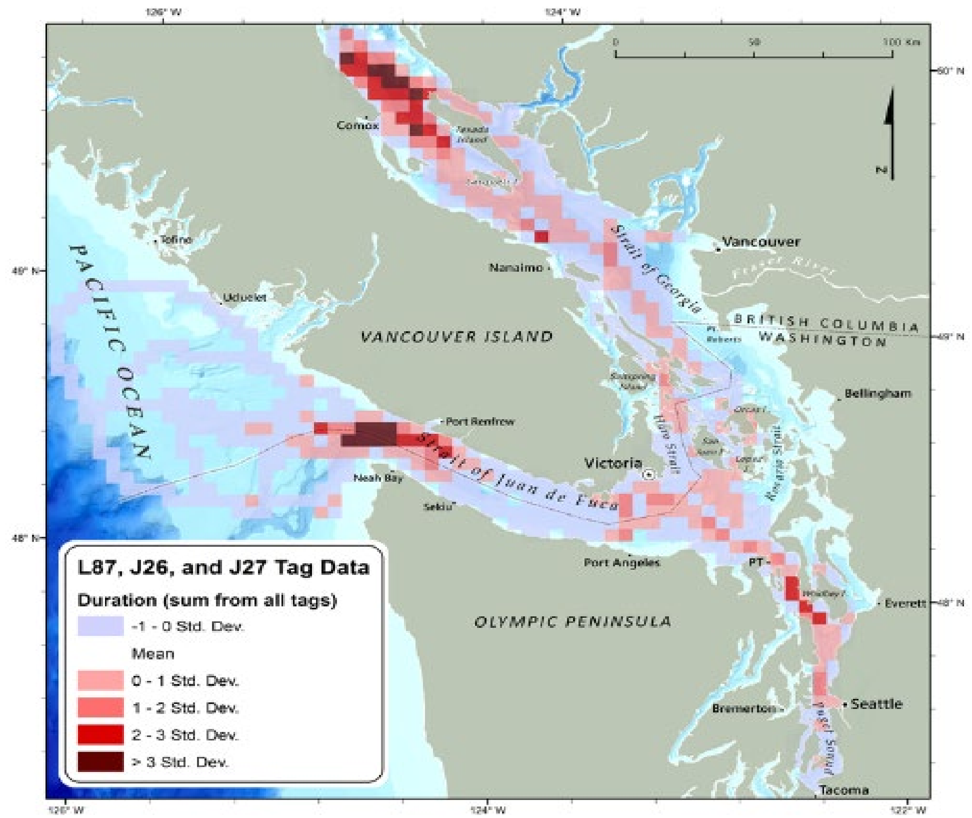


Figure 26. Duration of occurrence model output for J pod tag deployments (Hanson et al. 2017).

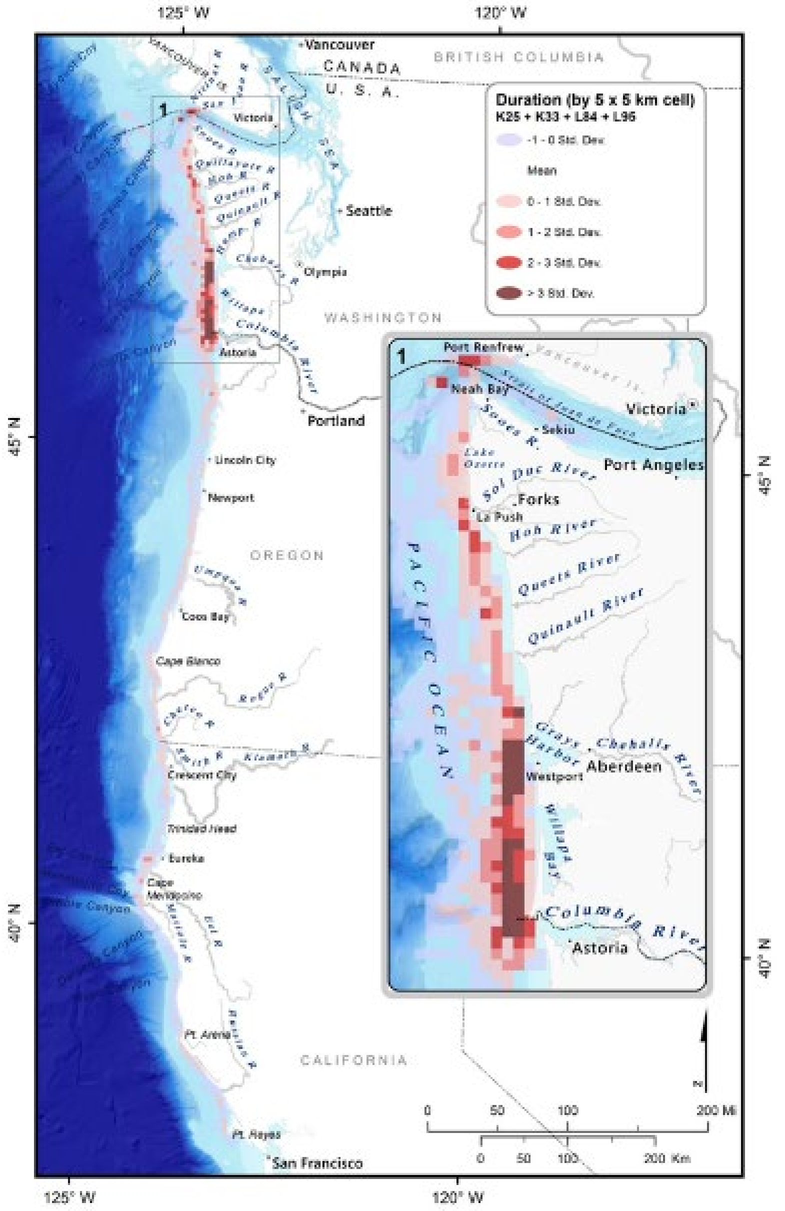


Figure 27. Duration of occurrence model for K and L pod tag deployments (Hanson et al. 2017).

Passive acoustic recorders were deployed off the coasts of California, Oregon, and Washington in most years since 2006 to assess SRKW seasonal uses of these areas via the recording of stereotypic calls of the SRKWs (Hanson et al. 2013; Emmons et al. 2019). Two types of passive acoustic recorders have been deployed; passive aquatic listeners (PALs) were deployed from 2006-2008, and since 2008 ecological acoustic recorders (EARs) have been deployed, with up to seven deployed from 2008-2011 (depending on year), with additional deployments beginning in 2014, including 17 sites off the Washington coast in the fall of 2014 (Figure 28, Figure 29). From 2006-2011, PALs and EARs were deployed in areas thought to be used frequently by SRKWs based on previous sightings (Figure 28) (Hanson et al. 2013). The number of recorder sites off the Washington coast increased from 7 to 17 in the fall of 2014 and locations (Figure

29) were selected based on "high use areas" or hot spots identified in the duration of an occurrence model developed from the SRKW tagging information from Hanson et al. (2017) and sites within the U.S. Navy's Northwest Training Range Complex (NWTRC) in order to determine if SRKWs used these areas in seasons other than winter when satellite-linked tags were not deployed (Hanson et al. 2017; Emmons et al. 2019). Three primary hot spots identified through the winter satellite tagging data were used to place multiple additional recorders; specifically 1) the Washington coast, particularly between Grays Harbor and the mouth of the Columbia River (primarily for K/L pods); 2) the west entrance to the Strait of Juan de Fuca (primarily for J pod); and 3) the northern Strait of Georgia (primarily for J pod). It is important to note that recorders deployed within the NWTRC were designed to assess spatial use off Washington coast and thus the effort was higher in this area (*i.e.* the number of recorders increased in this area) compared to off Oregon and California.

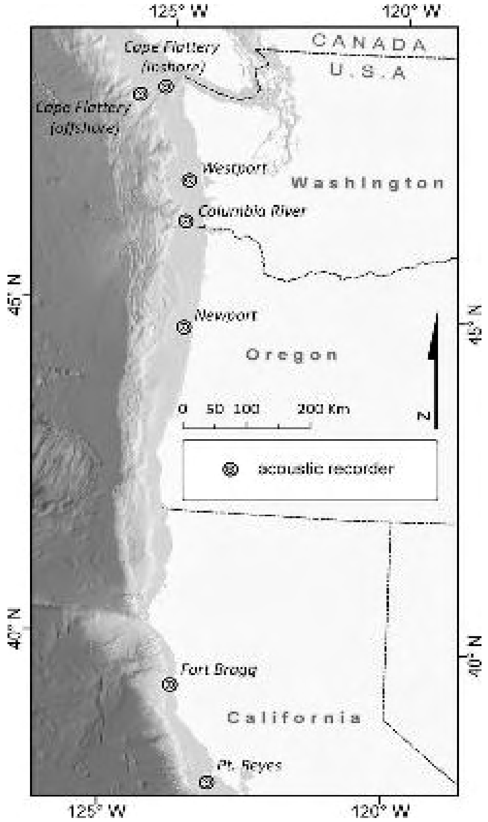


Figure 28. Deployment locations of acoustic recorders on the U.S. west coast from 2006 to 2011 (Hanson et al. 2013).

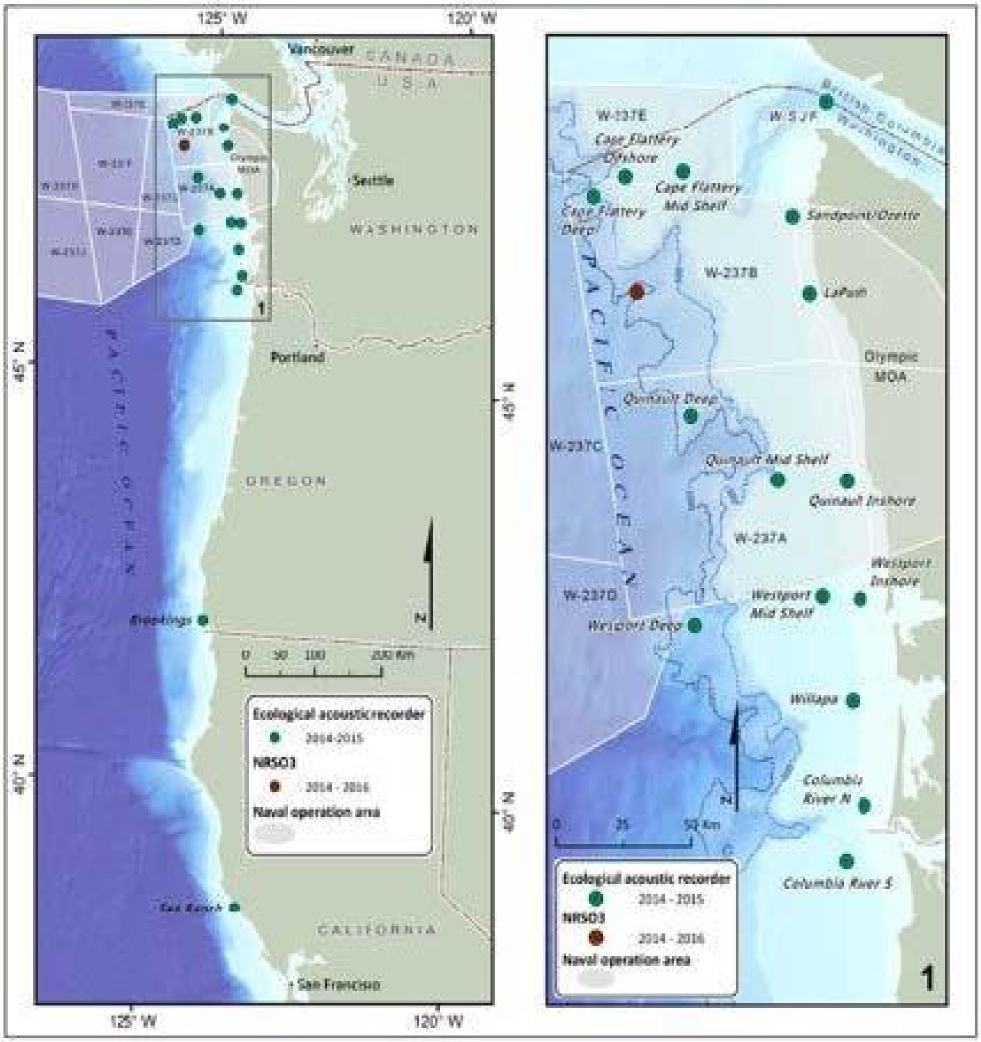


Figure 29. Locations of passive acoustic recorders deployed beginning in the fall of 2014 (Hanson et al. 2017).

There were acoustic detections off of the Washington coast in all months of the year (Figure 30), with greater than 2.4 detections per month from January through June and a peak of 4.7 detections per month in both March and April, indicating that the SRKW may be present in Washington coastal waters at nearly any time of year, more often than previously believed (Hanson et al. 2017; Emmons et al. 2021). Acoustic recorders were deployed off Newport, Fort Bragg, and Port Reyes from 2008-2013 and SRKW were detected 28 times (Emmons et al. 2019). From 2014-2017, all three SRKW pods were detected in Northern acoustic recorder sites (sites in Figure 29), but only K and L pods were detected in more Southern sites (Emmons et al. 2021). Also, SRKW were more frequently detected at inshore sites as compared to mid-shelf and offshore sites.

From August 2009 to July 2011, researchers collected data using an autonomous acoustic recorder deployed at Swiftsure Bank to assess how this area is used by NRKW and SRKW as shown in Figure 31 (Riera et al. 2019). SRKWs were detected on 163 days with 175 encounters (see Figure 32 for number of days of acoustic detections by month). All three pods were detected at least once per month except for J pod in January and November and L pod in March. K and L pods were heard most often between May and September, while J pod was heard most often during winter and spring (Riera et al. (2019). K pod had the longest encounters in June, with 87% of encounters longer than 2 hours occurring between June and September. L pod had the longest encounters in May, with 79% of encounters longer than 2 hours occurring during the summer (May through September). The longest J pod encounters were during winter, with 72% of encounters longer than 2 hours occurring between December and May (Riera et al. 2019).

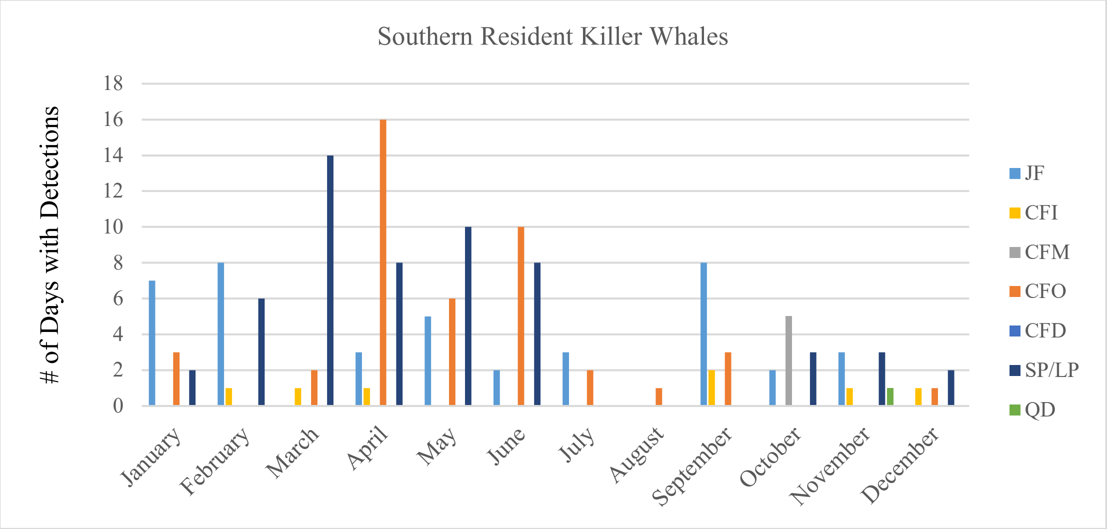


Figure 30. Counts of detections at each northern recorder site by month from 2014-2017 (Emmons et al. 2019). Areas include Juan de Fuca (JF); Cape Flattery Inshore (CFI); Cape Flattery Mid Shelf (CFM); Cape Flattery Offshelf (CFO); Cape Flattery Deep (CFD); Sand Point and La Push (SP/LP); and Quinault Deep (QD).

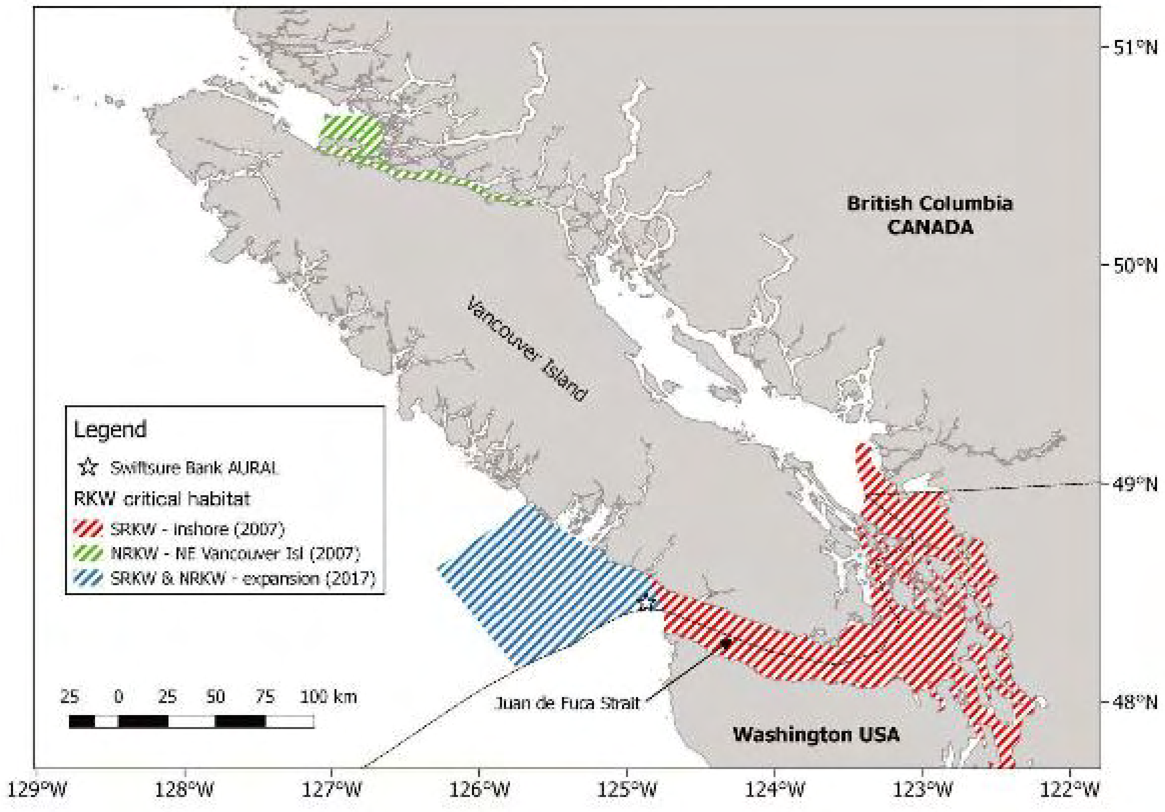


Figure 31. Swiftsure Bank study site off the coast of British Columbia, Canada in relation to critical habitat as designated under Canada's Species at Risk Act (SARA): the 2007 Northern Resident critical habitat (Northeast Vancouver Island) and 2007 SRKW critical habitat (inshore waters) and the 2017 Northern Resident and Southern Resident expansion of critical habitat (Riera et al. 2019).

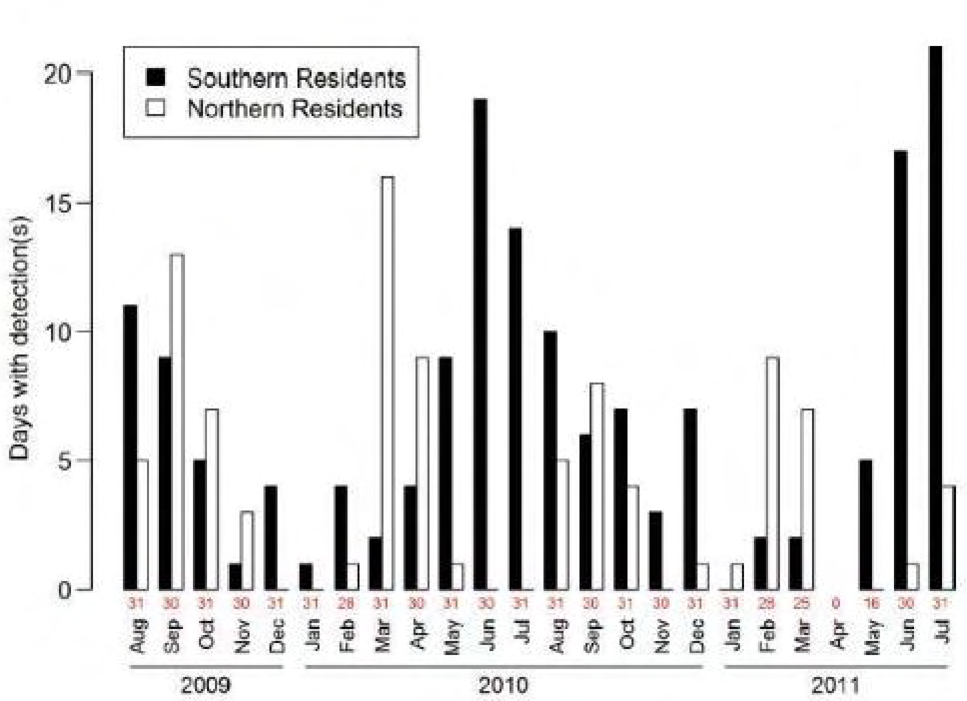


Figure 32. Number of days with acoustic detections of SRKWs at Swiftsure Bank from August 2009-July 2011. Red numbers indicate days of effort (Riera et al. 2019).

A recent publication fit latent Gaussian process models to observational behavioral data for Southern Residents to generate spatially-explicit predictions of SRKW foraging behavior (Stredulinsky et al. 2023). This study uses data from Noren et al. (2009) from 2006, Holt et al. (2013) from 2007 to 2009 for the Haro Strait region, and Thornton et al. (2022) from 2018 to 2021 for the Swiftsure Bank region. The results show that frequent foraging areas occur throughout the southern Haro Strait region and near Salmon Bank, as well as in specific locations within the Swiftsure Bank region (see Figure 5 in Streulinksky et al. (2023)).

2.2.3.1.3 Limiting Factors and Threats

Several factors identified in the final recovery plan for SRKWs may be limiting recovery. The recovery plan identifies three major threats including (1) quantity and quality of prey, (2) toxic chemicals that accumulate in top predators, and (3) impacts from sound and vessels. Oil spills, disease, and the small population size are also risk factors. 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 (e.g. Lacy et al. (2017); Murray et al. (2021)), and available data suggests that all of the threats are potential limiting factors (NMFS 2008b; Murray et al. 2021; NMFS 2021m).

Recent work by Williams et al. (2024) supports these assertions. In an updated population viability assessment (PVA) model (drawing from work in Lacy et al. (2017)), Williams et al. (2024) showed that several factors are affecting the SRKW population growth rate, such as Chinook salmon abundance, PCB accumulation, noise from vessels, and inbreeding, among others. While this work indicates that Chinook salmon abundance may have the largest influence on population growth rate, it is unclear how inbreeding depression (Kardos et al. 2023) may temper this response found by the authors, as the Williams paper does not appear to have taken into account the Kardos results. As a result, it is hard to predict if the results of the population growth projected by Williams concomitant with a prey increase would change if inbreeding depression was considered more thoroughly. There are many limitations to interpreting the specific results, and unquantified uncertainty in the model (see Effects Section 2.5.3.1 for more detail), but in general, the findings by Williams et al. (2024) support the large body of knowledge (see Abundance, Productivity, and Trends, above) projecting population decline over the long term, and the importance of Chinook salmon prey abundance, as well as the impact of other limiting factors, on the recovery of SRKWs.

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. 2010b; Ford et al. 2016), but salmon are identified as their primary prey. The best available information suggests an overall preference for Chinook salmon (*Oncorhynchus tshawytscha)* during the summer and fall. Chum salmon (*O. keta)*, coho salmon (*O. kisutch)*, and steelhead (*O. mykiss*) may also be important in the SRKW diet at particular times and in specific locations. Rockfish (*Sebastes* spp.), Pacific halibut (*Hippoglossus stenolepis*), and Pacific herring (*Clupea pallasi*) were also observed during predation events (Ford and Ellis 2006), however, these data may underestimate the extent of feeding on bottom fish (Baird 2000). A number of smaller flatfish, lingcod (*Ophiodon elongatus*), greenling (*Hexagrammos* spp.), and squid have been identified in stomach content analysis of resident whales (Ford et al. 1998).

SRKWs are the subject of ongoing research, the majority of which has occurred in inland waters of Washington State and British Columbia, Canada, during summer months and includes direct observation, scale and tissue sampling of prey remains, and fecal sampling. The diet data suggest that SRKWs are consuming mostly larger (i.e., generally age 3 and up) Chinook salmon. Chinook salmon is their primary prey despite the much lower abundance in comparison to other salmonids in some areas and during certain time periods. Factors of potential importance include the Chinook salmon's large size, high fat and energy content, and year-round occurrence in the SRKW 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 (kilocalorie per kilogram (kcal/kg)) (O'Neill et al. 2014). For example, in order for a killer whale to obtain the total energy value of one average Chinook salmon, they would need to consume, on average, approximately 2.7 coho, 3.1 chum, 3.1 sockeye, or 6.4 pink salmon (O'Neill et al. 2014). Research suggests that killer whales are capable of detecting, localizing, and recognizing Chinook salmon through their ability to distinguish Chinook salmon echo structure as different from other salmon (Au et al. 2010). Though SRKW do not only consume Chinook salmon, the degree to which killer whales are able to or willing to switch to non-preferred prey sources from their primary prey (i.e., Chinook salmon) in all times and locations is unknown and likely variable depending on time and location.

Recent stable isotope analyses of opportunistically collected scale samples (Warlick et al. 2020) continue to support and validate previous diet studies (Ford et al. 2016) and what is known of SRKW seasonal movements (Olson et al. 2018), but highlight temporal variability in isotopic values. Warlick et al. (2020) continued to find that Chinook salmon is the primary prey for all pods in summer months, followed by coho and then other salmonids. Carbon signatures in samples varied by month, which could indicate variation in Chinook and coho salmon consumption between months or differences in carbon signatures across salmon runs and life histories. Peaks in carbon signatures in samples varied between K/L pod and J pod. Though Chinook salmon was the primary prey across years, there was inter-annual variability in nitrogen signatures, which could indicate variation in Chinook salmon nitrogen content from year to year or greater Chinook salmon consumption in certain years versus others and/or nutritional stress in certain years, but this is difficult to determine.

Over the last forty years, predation on Chinook salmon off the West Coast of North America by marine mammals has been estimated to have more than doubled (Chasco et al. 2017a). In particular, southern Chinook salmon stocks ranging south from the Columbia River have been subject to the largest increases in predation, which Chasco et al. (2017a) suggest may be potentially due to large subsidies of hatchery produced fish. Due to Chinook salmon's northward migratory pathway and assumptions about their ocean residence, Chasco et al. (2017a) suggested that SRKWs may be at a competitive disadvantage to other resident killer whales and marine mammals that also prey on Chinook salmon. In other regions such as the Salish Sea, the combined mammal predation of Chinook salmon likely exceeds removal by fishery harvest after accounting for the growth and survival of juvenile fish consumed (Chasco et al. 2017a; Chasco et al. 2017b). However, for modeled northern Chinook salmon stocks (specifically off Washington, the WCVI and coastal British Columbia, and SEAK), predation by marine mammals is near or below fishery harvest (Chasco et al. 2017a), and coastal Washington is an area of high use by SRKWs within their coastal habitat. As recommended by the Orca Task Force Report, evaluation of pinniped predation on salmonids is ongoing (see WSAS 2022).

May – September

Prey scale and tissue sampling from May to September in inland waters of Washington and British Columbia, indicate that the SRKW diet consists of a high percentage of Chinook salmon (monthly proportions as high as >90%) (Hanson et al. 2010b; Ford et al. 2016). Genetic analysis of samples from 2006-2010 indicate that when SRKWs are in inland waters from May to September, they primarily consume Chinook salmon stocks that originate from the Fraser River (80-90% of the diet in the Strait of Juan de Fuca and San Juan Islands; including Upper Fraser, Mid Fraser, Lower Fraser, North Thompson, South Thompson and Lower Thompson), and to a lesser extent consume stocks from Puget Sound (North and South Puget Sound), the Central British Columbia Coast and West and East Vancouver Island (Hanson et al. 2010b). This is not unexpected as all of these stocks are returning to streams proximal to these inland waters during this timeframe. Few diet samples have been collected in summer months outside of the Salish Sea.

Deoxyribonucleic acid (DNA) quantification methods are also used to estimate the proportion of different prey species in the diet of SRKWs from fecal samples (e.g., Deagle et al. 2005). Ford et al. (2016) confirmed the importance of Chinook salmon to SRKWs in the early- to mid-summer months (May to August) by sequencing DNA from whale feces collected in inland waters of Washington and British Columbia. Salmon and steelhead made up to 98% of the inferred diet, of which almost 80% were Chinook salmon. Coho salmon and steelhead are also found in the diet in inland waters of Washington and British Columbia during spring and fall months when Chinook salmon are less abundant. Specifically, coho salmon contribute to over 40% of the diet in September in inland waters, which is evidence of prey-shifting by SRKWs at the end of summer towards coho salmon (Ford et al. 1998; Ford and Ellis 2006; Hanson et al. 2010b; Ford et al. 2016). Less than 3% each of chum salmon, sockeye salmon, and steelhead were observed in fecal DNA samples collected from May to September in inland waters.

October – December

Prey remains and fecal samples collected in inland waters from October through December indicate Chinook and chum salmon are primary contributors of the whales' diet (Hanson et al. 2021). Diet data for the Strait of Georgia and coastal waters is limited.

January – April

Collection of prey and fecal samples have also occurred in coastal waters in the winter and spring months, as well as observations of SRKWs overlapping with salmon runs (Wiles 2004; Zamon et al. 2007; Krahn et al. 2009). Although fewer predation events have been observed and fewer fecal samples collected in coastal waters compared to inland waters, recent data indicate that salmon, and Chinook salmon in particular, remains an important dietary component when the SRKWs occur in outer coastal waters during these timeframes. Prior to 2013, only three prey samples for SRKW on the U.S. outer coast had been collected (Hanson et al. 2021). From 2013 to 2016, researchers used satellite tags to locate and follow the whales to obtain predation and fecal samples. They collected a total of 57 prey sample items from northern California to northern Washington (Figure 33). The samples indicate that, as is the case in inland waters, Chinook salmon are the primary species detected in diet samples on the outer coast, although steelhead, chum salmon, and Pacific halibut were also detected in the samples. Foraging on chum and coho salmon, steelhead, Big skate (*Rana binoculata*), and lingcod was also detected in recent fecal samples (Hanson et al. 2021). These data indicate that the whale diet diversifies when Chinook salmon are less abundant seasonally (Hilborn et al. 2012; Ford et al. 2016; Hanson et al. 2021). Despite J pod utilizing much of the Salish Sea, including the Strait of Georgia, in winter months (Hanson et al. (2018), few diet samples have been collected in this region in winter.

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 salmon genetic stock identification from samples collected in winter and spring in coastal waters from California through Washington included 12 U.S. West Coast stocks, and showed that over half the Chinook salmon consumed originated in the Columbia River (Hanson et al. 2021). Columbia River, Central Valley, Puget Sound, and Fraser River Chinook salmon collectively comprised over 90% of 33 Chinook salmon prey samples collected (for which genetic stock origin was determined, of a total 44 prey samples collected) for SRKWs in coastal areas.

As noted, most of the Chinook salmon prey samples opportunistically collected in coastal waters were determined to have originated from the Columbia River basin, including Lower Columbia Spring, Middle Columbia Tule, and Upper Columbia Summer/Fall. In general, we would expect to find these stocks given the diet sample locations (Figure 33). However, the Chinook salmon stocks included fish from as far north as the Taku River (Alaska and British Columbia stocks) and as far south as the Central Valley of California (Hanson et al. 2021).

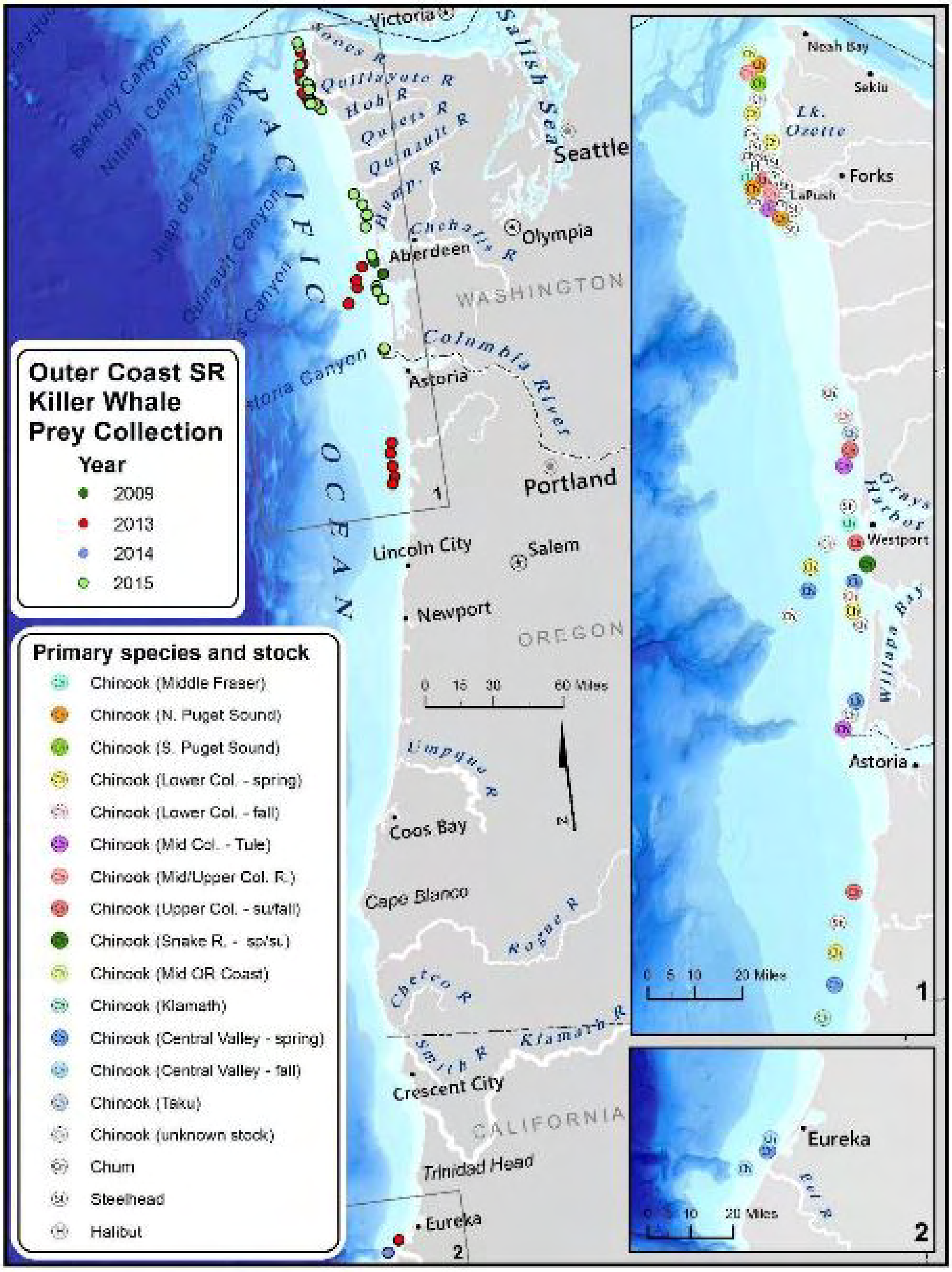


Figure 33. Location and species for scale/tissue samples collected from SRKW predation events in outer coastal waters (stock IDs are considered preliminary) (NMFS 2021a).

Priority Prey Stocks

In an effort to prioritize recovery efforts such as habitat restoration and help inform efforts to use fish hatcheries to increase the SRKW prey base, NMFS and WDFW developed a priority stock report identifying the important Chinook salmon stocks along the West Coast (NOAA Fisheries and WDFW 2018).[23] The list was created using information on (1) Chinook salmon stocks found in SRKW diet through fecal and prey scale/tissue samples, (2) SRKW body condition over time through aerial photographs, and (3) SRKW spatial and temporal overlap with Chinook salmon stocks ranging from SEAK to California. Extra weight was given to the salmon runs that support SRKWs during times of the year when the whales' body condition is more likely reduced and when Chinook salmon may be less available, i.e. winter months. This priority stock report will be updated over time as new data become available. The first 15 salmon stocks on the priority list include fall, spring, and summer Chinook salmon runs in rivers spanning from British Columbia to California, including the Fraser, Columbia, Snake, and Sacramento Rivers, as well as several rivers in Puget Sound watersheds (NOAA Fisheries and WDFW (2018), and see Table 11 replicated in NMFS (2021d).

Hatchery Production

Hatchery production is a significant component of the salmon prey base returning to watersheds within the range of SRKWs (Barnett-Johnson et al. 2007; NMFS 2008b). The release of hatchery fish has not been identified as a threat to the survival or persistence of SRKWs and there is no evidence to suggest the whales prefer wild salmon over hatchery salmon. Increased Chinook salmon abundance, including hatchery fish, benefit this endangered population of whales by enhancing prey availability to SRKWs, and hatchery fish often contribute significantly to the salmon stocks consumed (Hanson et al. 2010b). Currently, hatchery fish play a mitigation role of helping sustain Chinook salmon numbers while other, longer term, recovery actions for natural fish are underway. Although hatchery production has contributed to offset some 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, measures have been implemented to mitigate these risks (see section Chinook Hatchery Production in Section 2.4.2). The Priority Chinook Stocks report (referenced above) has been used in federal and state decision-making for prioritizing Chinook salmon stock production to increase the SRKW prey base.

Nutritional Limitation and Body Condition

When prey are scarce or in low density, SRKWs likely spend more time foraging than when prey are plentiful or in high density. Increased energy expenditure and prey limitation can cause poor body condition and nutritional stress, which is the condition of being unable to acquire adequate energy and nutrients from prey resources. As a chronic condition, it can lead to reduced body size of individuals and lower reproductive and survival rates in 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 SRKWs (males and females across a range of ages) were observed from boats to have a pronounced "peanut-head," or sunken neck, and all but two subsequently died (Durban et al. 2009, CWR unpublished data). None of the whales that died were subsequently recovered, and therefore the definitive cause of death could not be identified.

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[23] https://media.fisheries.noaa.gov/dam-migration/srkw_priority_chinook_stocks_conceptual_model_report___list_22june2018.pdf

Since 2008, NMFS' Southwest Fisheries Science Center (SWFSC) has used aerial photogrammetry to assess the body condition and health of SRKWs, initially in collaboration with the Center for Whale Research and the Vancouver Aquarium and, more recently, with SeaLife Response, Rehabilitation, and Research (SR3). Aerial photogrammetry studies have provided finer resolution for detecting poor condition, before malnutrition manifests in the "peanut heads" 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 SRKWs (L52 and J8 as reported in Fearnbach et al. (2018); J14, J2, J28, J54, and J52 as reported in Trites and Rosen (2018)). However, these studies used a body condition metric that is variable across the growth stages and may not accurately represent improving or declining health (Fearnbach et al. 2020). Furthermore, morphometric body condition assessments do not provide information on the cause of reduced body condition. In one study, a hormone analysis from fecal samples suggested that prey availability may be a greater physiological stressor on SRKW than vessel presence due to differences in concentrations of glucocorticoids and a thyroid hormone (Ayres et al. 2012). However, hormone concentrations vary naturally by season, as do vessels and prey availability, which potentially confounds interpretation of these results.

The most recent photogrammetry work by Fearnbach and Durban (2023) for pod body conditions in 2023 show that out of five body condition groups, 40% of L pod are in the poorest body condition (an increase in the percent in poorest condition from 13% in 2022) and that 32% of J pod are in the poorest body condition (an slight increase in the percent in poorest condition from 20% in 2022); this is less for K pods at 6% (assuming no change for K pod since they were not measured in 2023). With this and the number of whales in the second lowest body condition group at 27%, J pod has the lowest proportion of individuals above normal body condition (below 35%, vs. ~50% and ~80% for L and K pods).

A recent study utilized seven years of aerial photographs and documented body condition in individual SRKWs over time (99 individuals across all three pods) (Stewart et al. 2021), using the eye patch ratio, which measures the fatness behind the cranium and is robust to variation in surfacing orientation and changes in body proportions with growth (Fearnbach et al. 2020). Importantly, the authors used age- and sex-normalized body condition classes to account for variability in size and nutritive condition. Generally, Stewart et al. (2021) found that whales in poor body condition had mortality probabilities two to three times higher than whales in more robust condition. The authors also examined several variables to estimate the probability that an individual whale's body condition would improve, decline, or remain stable across years, given the estimated Chinook salmon abundance of the previous year. Fraser River and Salish Sea Chinook salmon stocks showed the greatest predictive power with J pod body condition, showing a strong negative relationship between the probability of body condition decline and Chinook salmon abundance (Stewart et al. 2021). L pod body condition was better explained by Puget Sound Chinook salmon abundance, though the relationship was weaker than the relationship between J pod body condition and Fraser Chinook salmon abundance. The relationship with L pod was difficult to interpret. L pod spends less time in the Salish Sea than J pod (especially in the most recent decade) and Puget Sound Chinook salmon are outnumbered by other Chinook salmon stocks in the North of Falcon[24] (NOF) areas. For K pod, the best model

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[24] The NOF management area encompasses the Washington coast and northern Oregon (the coastal waters from U.S./Canadian border to Cape Falcon, OR).

did not include any Chinook salmon abundance covariates, and body condition was relatively constant over time. However, the models including Chinook salmon abundance generally performed only marginally better than the null model, suggesting other factors may contribute to body condition shifts. In another recent paper, the probability of prey capture was reduced for SRKWs when salmon abundance was lower and when the speed of nearby vessels was faster (Holt et al. 2021b), suggesting that there may be multiple pathways to nutritional stress when prey are limited.

A new publication used annual birth and death rates for SRKW to produce an integrated population model to assess the relationship between Chinook salmon abundance, SRKW survival, and SRKW reproduction (Nelson et al. 2024). Nelson et al. (2024) found that the best fit model was one that combined abundance of SRKW and NRKW to make a joint carrying capacity, which suggests that the population of NRKW may be limiting the population growth of SRKW. This model also included Chinook salmon abundance index lagged by 1 year in the fecundity submodel and no lag in the survival submodel (Nelson et al. 2024). After explicitly accounting for several sources of uncertainty in the population dynamics of SRKWs, the study found modest evidence that Chinook salmon abundance is positively associated with SRKW survival/mortality rates, and minimal evidence of an association with birth rates (Nelson et al. 2024).

A recent paper aimed to quantify differences in prey availability between the declining SRKW population and the growing NRKW population, both of which rely heavily on Chinook salmon but occupy adjacent and minimally overlapping habitats. Acoustic methods were used to identify the prey field along predetermined transects (Sato et al. 2021). In the summer months (July-August) of 2018 and 2019, the study found comparable prey patch frequencies and prey size between the two habitats, but that that prey density within patches was higher in SRKW habitat compared to NRKW habitat (Sato et al. 2021). The portion of SRKW habitat surveyed in this study includes areas in the Strait of Juan de Fuca where some prey samples have been collected along Vancouver Island, B.C. (Hanson et al. 2010a), and where recent observations have identified travel as the predominant behavior (DFO Canada 2021). Sato et al. (2021) identified challenges in using acoustic methods to evaluate prey fields and noted other factors that were not analyzed, such as prey energy content or how vessel presence or sound may influence accessibility of prey. A recent paper by Couture et al. (2022) modeled bioenergetics of SRKW and found the population to be in an energetic deficit in six of the last 40 years, looking at Chinook as well as chum and coho salmon, and that abundance of age-4 and 5 Chinook salmon was the most important factor (of what was modeled) in whether SRKW energetic needs were met. Prey availability is highly variable and the dynamics of prey limitation for SRKW are still unclear; for example, times or locations where prey are most limiting, and whether prey patch frequency or prey patch density is more important for killer whale foraging ecology, are unknown.

Foraging ecology of SRKW and NRKW populations also differs in several ways, which may be tied to prey availability, social differences, or other factors. Tennessen et al. (2023) found that SRKW females foraged less (spent less time and captured less prey) than SRKW males, but the opposite was true for NRKWs. Additionally, females with calves captured less prey in both populations, but the pattern was stronger for SRKW (Tennessen et al. 2023). It is unclear what the drivers and outcomes are of these different behavioral strategies, and if they relate to broader population trends.

A scientific review investigating nutritional stress as a cause of poor body condition for SRKWs concluded "unless a large fraction of the population experienced poor condition in a particular year, and there was ancillary information suggesting a shortage of prey in that same year, malnutrition remains only one of several possible causes of poor condition" (Hilborn et al. 2012). Recent work has suggested that SRKW condition may deteriorate during the winter months. Aerial photogrammetry analyses from 2015-2017 found reduced body condition for J pod whales in May as compared to the previous September, soon after SRKW have foraged on summer salmon runs (Fearnbach et al. 2020). While prey limitation during the winter has been hypothesized as one reason for greater diversity seen in the diet (Hanson et al. 2021), there may be several reasons for seasonal body condition changes (and poor body condition has also been observed in September; Stewart et al. (2021)). Ford and Ellis (2006) report that resident killer whales engage in prey sharing about 76% 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), so that effects of low prey availability may not be seen until prey is extremely low and may be observed in multiple individuals at the same time. Body condition and malnutrition in whales can be influenced by a number of factors, including reduced prey availability, reduced ability to successfully forage, increased energy demands, physiological or life history status, disease, or reduced intestinal absorption of nutrients (Raverty et al. 2020).

It is possible that poor nutrition could contribute to mortality through a variety of mechanisms. To exhibit 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. Malnutrition and persistent or chronic stress can induce changes in immune function in mammals and may be associated with increased bacterial and viral infections (Neale et al. 2005; Mongillo et al. 2016; Maggini et al. 2018).

Reduced body condition and body size has been observed in the NRKW population as well. For example, Groskreutz et al. (2019) used aerial photogrammetry from 2014-2017 to measure growth and length in adult NRKWs, which prey on similar runs of Chinook salmon. Given that killer whales physically mature at age 20 and the body stops growing (Noren 2011), we would expect adult male killer whales to all have similar body lengths and all adult female killer whales to have similar body lengths. However, Groskreutz et al. (2019) found that whales aged 20-40 years have significantly shorter body lengths than those older than 40 years of age, suggesting the younger mature adults had experienced inhibited growth. Similarly, adult SRKWs under 30 years of age that were measured in 2008 by the same photogrammetric technique were also shorter on average than older individuals, suggesting reduced growth in more recent years (Fearnbach et al. 2011).

High mortality occurred in both resident killer whale populations in the 1990s, which was a time when range-wide abundance of Chinook salmon in multiple subsequent years fell below the 1979-2003 average (Figure 34) (Ford et al. 2010). The low Chinook salmon abundance and smaller growth in whale body size coincided with an almost 20% decline from 1995 to 2001 (from 98 whales to 81 whales) in the SRKW population (NMFS 2008b). During this period of decline, multiple deaths occurred in all three SRKW pods and relatively poor survival occurred in nearly all age classes and in both males and females. NRKWs also experienced population declines during the late 1990s and early 2000s. Hilborn et al. (2012) stated that periods of decline across killer whale populations “suggest a likely common causal factor influencing their population demographics” (Hilborn et al. 2012). Overall, evidence of reduced growth and poor survival in SRKW and NRKW populations at a time when Chinook salmon abundance was low suggests that low prey availability may have contributed to nutritional deficiency with serious effects on individual whales.

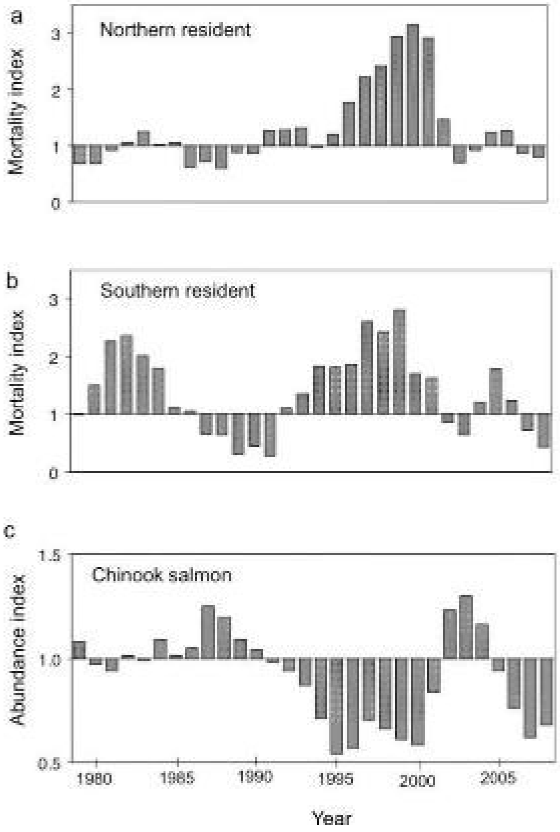

Figure 34. Annual mortality indices for a) Northern Resident and b) SRKWs and c) abundance index of Chinook salmon from 1979 to 2003 (reprinted from Ford et al. (2010)).

During this same general period of time of low Chinook salmon abundance, declining body size in whales, and declining resident killer whale populations, all three SRKW pods experienced substantially low social cohesion (Parsons et al. 2009). This temporal shift in SRKW social cohesion may reflect a response to changes in prey. Similarly, Foster et al. (2012) found that from 1984-2007, the SRKW social network was more interconnected in years of higher Chinook salmon abundance. The authors suggest that years with higher Chinook salmon abundance may lead to more opportunities for mating and information transfer between individuals.

For many animals, the distribution and abundance of prey is one of the most important factors influencing social structure (refer to Parsons et al. 2009). In social animals at optimal group size, “group fissioning,” or splitting, could be one response to reduced prey abundance. However, the benefits of cooperative care or food sharing might outweigh the cost of the large group size. Parsons et al. (2009) note that smaller divisions within the pod’s matrilines may temporarily occur in SRKWs as opposed to true fission, but this warrants further investigation. Given the highly social nature of SRKWs, socially-mediated fitness outcomes of nutritional limitation could be important.

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). SRKWs are exposed to a mixture of pollutants, some of which may interact synergistically and enhance toxicity, influencing their health and reproduction. Relatively high levels of these pollutants have been measured in blubber biopsy samples from SRKWs compared to other resident killer whales in the North Pacific (Ross et al. 2000; Krahn et al. 2007; Krahn et al. 2009; Lawson et al. 2020). More recently, these pollutants were measured in fecal samples collected from SRKWs, and fecal toxicants matched those of blubber samples, which provides another resource to evaluate exposure to these pollutants (Lundin et al. 2016a; Lundin et al. 2016b). Recent work by Lee et al. (2022) quantified the presence of multiple emerging contaminants in the tissues of stranded SRKW and Bigg’s (transient) killer whales, including in fetuses and calves of SRKW. Alkylphenols (APs) and polyfluoroalkyl substances (PFAS) were the most prevalent compounds. Concentration of the contaminant 4-nonylphenol (4NP) was significantly higher in SRKW calf samples than in Bigg’s, and a major source of 4NP is toilet paper, which could be related to proximity to sewage effluent. Another publication from Lee et al. (2023) conducted analysis on polycyclic aromatic hydrocarbons (PAH) composition from stranded SRKW and Bigg’s killer whales. On average, SRKW had higher levels of low molecular weight PAHs than Bigg’s killer whales (Lee et al. (2023). Low molecular weight PAHs are generally associated with pyrogenic sources such as petroleum and liquid fossil fuel combustion (Lee et al. 2023). A new publication analyzed fecal samples of SRKW for the amount and composition of microparticles (Harlacher et al. 2023). Of the 18 SRKW samples analyzed, there was an average of 165 microparticles per gram of feces (Harlacher et al. 2023). They examined 10% of the microparticles to determine their material, and found that 22% of microparticles in SRKW feces were verified synthetic microplastics (Harlacher et al. 2023). Chemical properties of microplastics combine with persistent organic pollutants so that pollutants enter into biological tissues when microplastics are ingested (Harlacher et al. 2023). However, modeling exercises indicate that cetacean microplastic consumption has a limited contribution to the bioaccumulation of toxic contaminants (Alava 2020).

SRKWs 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 blubber and can later be released; when the pollutants are released, they are redistributed to other tissues when the whales metabolize the blubber, for example, in response to food shortages or reduced acquisition of food energy. The release of pollutants can also occur during gestation or lactation, exposing calves to contaminants (and temporarily reducing the burden for lactating females). Once the pollutants mobilize into circulation, they have the potential to cause a toxic response. Fecal samples showed that toxicants were highest in concentration when prey availability was low, and the possibility of toxicity was therefore highest with low prey (Lundin et al. 2016b). Therefore, nutritional stress from reduced prey, including Chinook salmon populations, that may occur or may be occurring, may act synergistically with high pollutant levels in SRKWs and result in adverse health effects.

Disturbance from Vessels and Sound

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, SRKWs 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 2008b). There is a growing body of evidence documenting effects from vessels on small cetaceans and other marine mammals (NMFS 2010d; 2018e; 2021m). Research has shown that SRKWs spend more time traveling and performing surface active behaviors and less time foraging in the presence of all vessel types, including kayaks (Holt 2008; Lusseau et al. 2009; Noren et al. 2009; Williams et al. 2010). Further, noise from and/or presence of motoring vessels up to 400 meters away has the potential to affect the echolocation abilities of foraging whales and their foraging dives and success (Holt 2008; Lusseau et al. 2009; Noren et al. 2009; Williams et al. 2010; Holt et al. 2021b; Holt et al. 2021a), or the probability of being in a foraging state (Williams et al. 2021). New models of SRKW behavioral states showed that both males and females spent less time in foraging states, with fewer prey-capture dives and less time spent in prey capture dives, when vessels were near (within 400 yds on average) (Holt et al. 2021a). The impact was greater for females, who were more likely than males to switch from deep and intermediate dive foraging behaviors to travel/respiration states when vessels were near (Holt et al. 2021a).

Individual energy balance may be impacted when vessels are near the whales because of the increase in energetic costs resulting from (1) changes in activity, and (2) the decrease in prey consumption resulting from reduced foraging opportunities (Williams et al. 2006a; Lusseau et al. 2009; Noren et al. 2009; Noren et al. 2012; Noren and Hauser 2016; Holt et al. 2021b; Holt et al. 2021a). Some evidence indicates there is a higher energetic cost of surface active behaviors and vocal effort resulting from vessel disturbance in the Salish Sea (Williams et al. 2006b; Noren et al. 2012; Noren et al. 2013; Holt et al. 2015). However, reduced prey consumption is likely the more important factor impacted by vessels. In a recent study, SRKWs had a lower predicted probability of capturing prey when vessel speeds were higher nearby (within 1.5 km) (Holt et al.

2021b). Given that vessel speed is one of the strongest predictors of underwater noise (Houghton et al. 2015), faster moving vessels appear to have a greater impact on energy intake in SRKW, including vessels located farther than the closest allowed distance (200-400 yds) for viewing the whales, and those beyond the current speed restriction distance (half nautical mile). However, it is difficult to determine the cumulative impacts of multiple vessel approaches on individual whales and the population. Further, the study found that prey capture dive duration and the speed of descent varied in the presence of echosounders emitted by vessels with received levels of noise, and with vessel distance (Holt et al. 2021b). Importantly, the authors found that the probability of prey capture was positively correlated with prey abundance, suggesting that in years of low prey abundance, vessel impacts may compound the stressor of food availability. In another study, vessel speed did not predict foraging behavior, but estimated levels of sound impacted the probability of foraging (Williams et al. 2021).

At the time of the SRKWs' 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 SRKWs. 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) (50 C.F.R. § 224.103(e)). 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 implementing these regulations, NMFS committed to (1) review the regulations to evaluate effectiveness, and (2) study the impact of the regulations on the viability of the local whale watch industry. Education, enforcement, and monitoring efforts were documented to support the review, and the results were analyzed and published in a 2017 NMFS Technical Memo (Ferrara et al. 2017). The 2017 analysis evaluated the effectiveness of the vessel regulations using five key measures: education and outreach efforts, enforcement, vessel compliance, biological effectiveness, and economic impacts. For each measure, the analysis focused on the five years leading up to the regulations (2006-2010) and compared trends and observations to the five years following their implementation (2011-2015). Ferrara et al. (2017) concluded that the regulations have provided some benefits to the whales; however, additional measures may be necessary to reduce the impacts of vessels on SRKWs. Although robust education and outreach efforts were in place in the years following the implementation of the regulations, awareness of the regulations among recreational boaters remained low, fluctuating around 45% of the boaters contacted by Soundwatch from 2011-2015. This was reflected in the compliance trends, which showed higher rates of incidents of noncompliance among recreational boaters than commercial whale watch operators (which remains true in 2022; see Frayne (2023)). Despite this trend in awareness, compliance with the regulations in the five years following the codification of the regulations was significantly higher in the presence of enforcement vessels, indicating an effective enforcement program. Although these regulations required commercial whale watch operators to change their behaviors around the whales, they did not result in adverse economic impacts to the industry from 2011 through 2015.

In 2019, Washington State regulations were updated to increase vessel viewing distances from 200 to 300 yards to the side of the whales and reduce vessel speed within ½ nautical mile of the whales to seven knots over ground (see RCW 77.15.740). In January 2025, the Washington state regulations will increase to 1000 yards. Also in 2019, NMFS conducted a scoping meeting and public comment period to gather input on whether existing regulations and other measures adequately protect killer whales from the impacts of vessels and noise in the inland waters of Washington State and, if not, what actions NMFS should take (84 FR 57015; October 24, 2019).

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. 1995; Gordon and Moscrop 1996; NRC 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).

Oil Spills

In the Northwest, SRKWs are the most vulnerable marine mammal population to the risks imposed by an oil spill due to their overall small population size, strong site fidelity to areas with high oil spill risk, large groups of individuals together at once, 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 SRKWs in the past, most recently in August 2022 when a commercial fishing vessel sank near San Juan Island, but no SRKW were seen near the oil sheen that was spilled. 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 SRKWs remains at risk from serious spills because of the heavy volume of shipping traffic and proximity to petroleum refining centers.

If repeated ingestion of petroleum hydrocarbons by killer whales occurs, it would likely cause adverse effects, though 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 St. Aubin 1990; Schwacke et al. 2013; Venn-Watson et al. 2015; de Guise et al. 2017; Kellar et al. 2017). Exposure can also result in 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 (UME) (Ziccardi et al. 2015). Previous Polycyclic Aromatic Hydrocarbon (PAH) exposure estimates suggested SRKWs 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. In addition, oil spills have the potential to adversely impact habitat and prey populations, and, therefore, may adversely affect SRKWs by reducing food availability.

Health, Strandings, and Causes of Mortality

Information collated on strandings for all killer whale ecotypes (Raverty et al. 2020) have also contributed to our knowledge of the impact of the threats on mortality. Across the Northeast Pacific, causes of death for stranded killer whales of various ages and ecotypes have included congenital defects, malnutrition and emaciation, infectious disease, bacterial infections, and injury from blunt force trauma (Raverty et al. 2020). The authors examined stranding reports from 2004-2013 within the North Pacific Ocean and Hawaii and determined cause of death for 53 stranded whales, 22 of which had a definitive diagnosis for cause of death. They reported on both proximate (process, disease, or injury that led to death) and ultimate (final process that led to death) causes of death. They confirmed that three whales died from vessel strikes, including one SRKW (L98 who was habituated to humans), one transient, and one NRKW. Three others died of blunt force trauma with unknown origin (including L112 discussed below). In addition, one Alaskan resident killer whale calf died of sepsis as a result of ingestion and impalement of a halibut fishing hook (Raverty et al. 2020). A previous paper reported fishing hooks and/or lures in the stomachs of four stranded resident whale carcasses (two with hooks/lures for salmon fishing, two with Pacific halibut hooks) (Ford et al. 1998). Nutritional causes were identified in 11 whales as either the proximate (n = 5) or ultimate cause of death (n = 6) (Raverty et al. 2020), though none of these whales were identified as SRKWs.

SRKW strandings in the last decade have contributed to our understanding of the health of the population. Transboundary partnerships have supported thorough necropsies of L112 in 2012, J32 in 2014, and L95 and J34 in 2016, which included testing for contaminant load, disease and pathogens, organ condition, and diet composition[25]. The cause of death of L112 was determined to be blunt force trauma to the head, however the source of the trauma (vessel strike, intraspecific aggression, or other unknown source) could not be established. In 2014, J32, an adult late to near term female killer whale, had stranded with moderate to fair body condition and had suffered in utero fetal loss and infection. In spring 2016, a young adult male, L95, was found to have died of a fungal infection related to a satellite tag deployment approximately 5 weeks prior to its death. In fall 2016 another young adult male, J34, found in the northern Georgia Strait died of blunt force trauma to the head, consistent with vessel strike (Raverty et al. 2020; Carretta et al. 2023b).

In addition to aerial photogrammetry and stranding data, noninvasive sample collection may contribute to our understanding of health in the SRKW population. A recent study used 12 years of expelled mucus and exhaled breath samples collected noninvasively to study the microbiome communities (Rhodes et al. 2022). Several taxa were found to be unique in mucus and breath samples, and not found in seawater samples, indicating the likely makeup of the SRKW microbiome. While some bacterial taxa included pathogenic species, future assessment is needed to determine the presence of infection (Rhodes et al. 2022). Also, a recent study by Gaydos et al. (2023) that utilized digital photographs of SRKWs determined that 99% of the population alive

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[25] Reports for those necropsies are available at: http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/killer_whale/rpi_strandings.html.

during 2004-2016 at some point had evidence of skin lesions. Additionally, the prevalence of the two most prominent skin lesion types increased in all three pods from 2004-2016, but it is currently unclear the health significance of these lesions.

The only known case of SRKW mortality due to fisheries is an adult male, L8, who entangled in gillnet fishing gear and drowned in 1977 (CWR 2015; Carretta et al. 2023b). The entanglement occurred near southeastern Vancouver Island (Ford et al. 1998), and upon necropsy two pounds of recreational fishing lures and lines were found in the stomach. It was noted that some of the fishing gear found did not appear to be used locally at the time and the ingestion of the gear did not cause the death of the animal (CWR 2015; Carretta et al. 2023b).

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, which subsequently fell out with no signs of injury or infection (CWR 2015; Carretta et al. 2023b).

Killer whale entanglements from other ecotypes have also been reported. One killer whale was reported interacting with a salmon gillnet in British Columbia in 1994, but did not get entangled (Guenther et al. 1995). Two killer whales have been recorded entangled in Dungeness crab commercial trap fishery gear off California (one in 2015 and one in 2016)[26]. In 2018, DFO disentangled a transient killer whale entangled in commercial prawn gear near Salt Spring Island, British Columbia (NMFS strandings data, unpubl.). In 2013, a NRKW stranded in British Columbia and a fish hook was observed in its colon, but had no evidence of perforation or mucosal ulceration (Raverty et al. 2020).

2.2.3.1.4 Climate Change and Other Ecosystem Effects on SRKW

The potential impacts of climate and oceanographic change on marine mammals would likely involve effects on habitat availability and food availability. Although few predictions of climate impacts on SRKWs have been made, it seems likely that any changes in weather and oceanographic conditions resulting in effects on salmon populations would have consequences for the whales (for climate change effects on salmon, see Section 2.2.4). SRKWs might shift their distribution in response to climate-related changes in their salmon prey. Persistent pollutant bioaccumulation may also change because of changes in the food web (e.g., Alava et al. (2018); Carretta et al. (2023a)).

Climatic conditions affect salmonid abundance, productivity, spatial structure, and diversity through direct and indirect impacts at all life stages (e.g., ISAB (2007); Lindley et al. (2007); Crozier et al. (2008b); Moyle et al. (2013); Wainwright and Weitkamp (2013); (Crozier et al. 2021). Studies examining the effects of long-term climate change to salmon populations have identified a number of common mechanisms by which climate variation is likely to influence salmon sustainability. These include direct effects of temperature such as mortality from heat stress, changes in growth and development rates, and disease resistance. Changes in the flow regime (especially flooding and low flow events) also affect survival and behavior. Expected behavioral responses include shifts in seasonal timing of important life history events, such as

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[26] See: https://media.fisheries.noaa.gov/dam-migration/wcr_2016_whale_entanglements_3-26-17_final.pdf

the adult migration, spawn timing, fry emergence timing, and the juvenile migration. Indirect effects on salmon mortality, growth rates and movement behavior are also expected to follow from changes in the freshwater habitat structure and the invertebrate and vertebrate community, which governs food supply and predation risk (ISAB 2007; Crozier et al. 2008b).

In the marine ecosystem, salmon may be affected by warmer water temperatures (in both marine and freshwater environments), increased stratification of the water column, intensity and timing changes of coastal upwelling, loss of coastal habitat due to sea level rise, ocean acidification, and changes in water quality and freshwater inputs (ISAB 2007; Mauger et al. 2015). Salmon marine migration patterns could be affected by climate-induced contraction of thermally suitable habitat (Crozier et al. 2021). Abdul-Aziz et al. (2011) modeled changes in summer thermal ranges in the open ocean for Pacific salmon under multiple Independent Panel on Climate Change (IPCC) warming scenarios. For chum, pink, coho, sockeye and steelhead, they predicted contractions in suitable marine habitat of 30-50% by the 2080s, with an even larger contraction (86-88%) for Chinook salmon under the medium and high emissions scenarios. Northward range shifts are a climate response expected in many marine species, including salmon (Cheung et al. 2015). However, salmon populations are strongly differentiated in the northward extent of their ocean migration, and hence would likely respond individualistically to widespread changes in sea surface temperature.

Recent analysis ranked the vulnerability of West Coast salmon stocks to climate change and, of the top priority stocks for SRKWs (NOAA Fisheries and WDFW 2018), California Central Valley Chinook stocks, Snake river fall and spring/summer Chinook, Puget Sound Chinook, and spring-run Chinook stocks in the interior Columbia and Willamette River basins were ranked as “high” or “very high” vulnerability to climate change (Crozier et al. 2019). In general, Chinook, coho, and sockeye runs were more vulnerable, and this stemmed from exposure to higher ocean and river temperatures as well as exposure to changes in flow regimes (including in relation to snowpack, upwelling, sea level rise, and flooding). However, certain Chinook salmon runs do have higher ability to adapt and/or cope with climate change due to high life history diversity in juveniles and adults (including both subyearling and yearling smolts, multiple migration timings), but diversity may be lost with future climate change. Overall, chum and pink salmon were less vulnerable to climate change because they spend less time in fresh water than other salmonids, and certain steelhead runs had more moderate vulnerability than many Chinook and coho runs because of higher resilience (Crozier et al. 2019). Additionally, substantial declines in abundance due to climate change are predicted for Snake River spring/summer Chinook over the next 2-3 decades based on recent life-cycle modeling (NMFS 2020j; Zabel and Jordan 2020; Crozier et al. 2021). Furthermore, recent modeling research has shown variation in the impacts of marine warming on fall-run Chinook salmon distribution depending on stock, resulting in future regional declines or increases in salmon abundance. Shelton et al. (2021) used a Bayesian state-space model to model ocean distribution of fall-run Chinook salmon stocks in the Northeast Pacific, paired with data on sea surface temperature associated with each stock and future ocean climate predictions to predict future distribution of Chinook salmon related to changing sea surface temperature in 2030-2090. In warm years (compared to cool), modeled Klamath, Columbia River (upriver bright run, lower, middle), and Snake River stocks shifted further North, while California Central Valley stocks shifted south. Notably, Columbia River and Snake River fall-run Chinook are in the top 10 priority stocks for SRKWs (NOAA Fisheries and WDFW 2018). Predicted future shifts in distributions due to warming led to future increases in ocean salmon abundance off northern British Columbia and central California, minimal changes off Oregon, Southern British Columbia, and Alaska, and declines in abundance off Washington and northern California (Shelton et al. 2021).

In addition to long-term anthropogenic climate change, cyclic and year-to-year natural climate variability can also impact SRKWs by way of impacts on their prey and this natural climate variability is likely heightened by climate change. For example, evidence suggests that marine survival among salmonids fluctuates in response to 20 to 30-year cycles of climatic conditions and ocean productivity. Naturally occurring climatic patterns, such as the Pacific Decadal Oscillation, El Niño and La Niña events, and North Pacific Gyre Oscillation, can cause changes in ocean productivity that can affect productivity and survival of salmon (Mantua et al. 1997; Francis and Hengeveld 1998; Beamish et al. 1999; Hare et al. 1999; Benson and Trites 2002; Dalton et al. 2013; Kilduff et al. 2015), affecting the prey available to SRKWs (though relationships may be weakening, see Litzow et al. (2020)). Prey species such as salmon are most likely to be affected through changes in food availability and oceanic survival (Benson and Trites 2002), with biological productivity increasing during cooler periods and decreasing during warmer periods (Hare et al. 1999; NMFS 2008b). Also, range extensions were documented in many marine 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).

The frequency of these extreme climate conditions associated with El Niño events or "blobs" are predicted to increase in the future with climate change (greenhouse forcing) (Di Lorenzo and Mantua 2016) and therefore, it is likely that long-term anthropogenic climate change would interact with inter-annual climate variability. Multiple modeling studies have predicted increases in the frequency of extreme El Niño Southern Oscillation (ENSO) events and increased ENSO variability due to climate change (Cai et al. 2014; Cai et al. 2015; Wang et al. 2017; Cai et al. 2018). Modeled projections of future marine heat waves similar to "the Blob" have predicted decreases in salmon biomass and distribution shifts for salmon, particularly sockeye, in the Northeast Pacific (Cheung and Frölicher 2020). Evidence suggests that early marine survival for juvenile salmon is a critical phase in their survival and development into adults. The correlation between various environmental indices that track ocean conditions and salmon productivity in the Pacific Ocean, both on a broad and a local scale, provides an indication of the role they play in salmon survival in the ocean.

Despite a lack of research on direct impacts of climate change on SRKWs, we expect there would be impacts to prey availability and habitat suitability via the mechanisms discussed above.

2.2.3.2 Southern Resident Killer Whale Critical Habitat

Critical habitat for the SRKW DPS was first designated on November 29, 2006 (71 FR 69054) in inland waters of Washington State (Figure 35). NMFS published a final rule to revise SRKW critical habitat in 2021 (86 FR 41668; August 2, 2021). This rule, which became effective on September 1, 2021, maintains the previously designated critical habitat in inland waters of Washington (Puget Sound, see 71 FR 69054; November 29, 2006) and expands it to include six additional coastal critical habitat areas off the coast of Washington, Oregon, and California (additional approximately 15,910 sq. miles) (Figure 36). 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 (Figure 35), as well as 15,910 square miles (mi^2) (41,207 square kilometers (km^2)) of marine waters along the U.S. west coast variably between the 20-feet (ft) (6.1-m) depth contour and the 656.2-ft (200-m) depth contour from the U.S. international border with Canada south to Point Sur, California. Based on the natural history of SRKWs and their habitat needs, NMFS identified the following physical or biological features essential for the conservation of SRKWs: (1) Water quality to support growth and development; (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.

Additional information on the physical or biological features essential to conservation can be found in the 2006 critical habitat final rule (71 FR 69054, November 29, 2006) and the recent 2021 critical habitat expansion final rule (86 FR 41668, August 2, 2021), and is incorporated into information provided in the status for the species (Section 2.2.3.1). We briefly summarize information on each of the three features here and more detailed descriptions based on recent research findings are also included in the Final Biological Report that supports the 2021 critical habitat rule (NMFS 2021a).

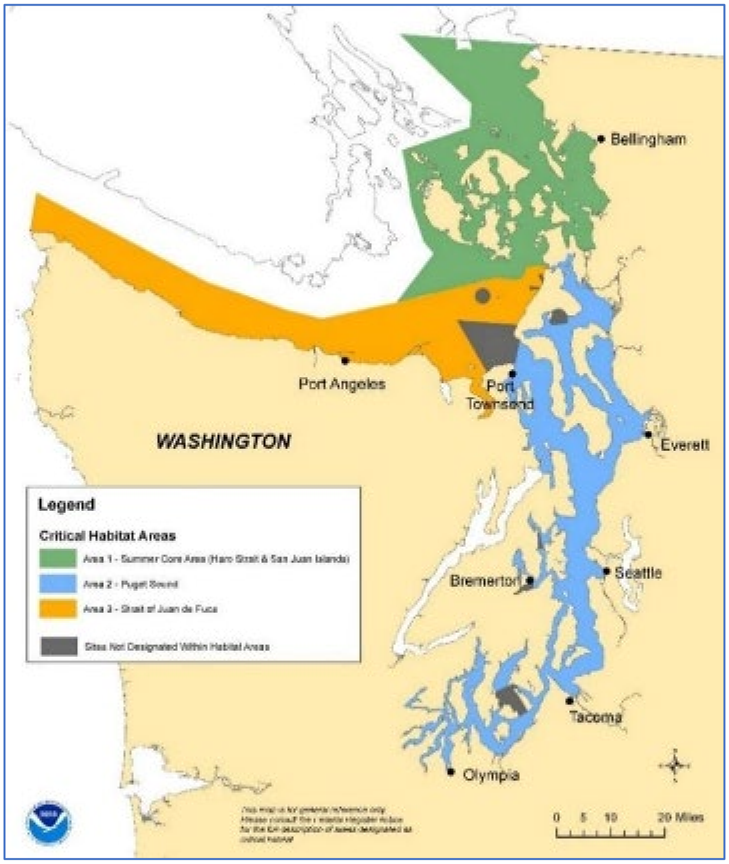

Figure 35. SRKW 2006 critical habitat designation. Note: Areas less than 20 ft deep (relative to extreme high water) are not designated as SRKW critical habitat.

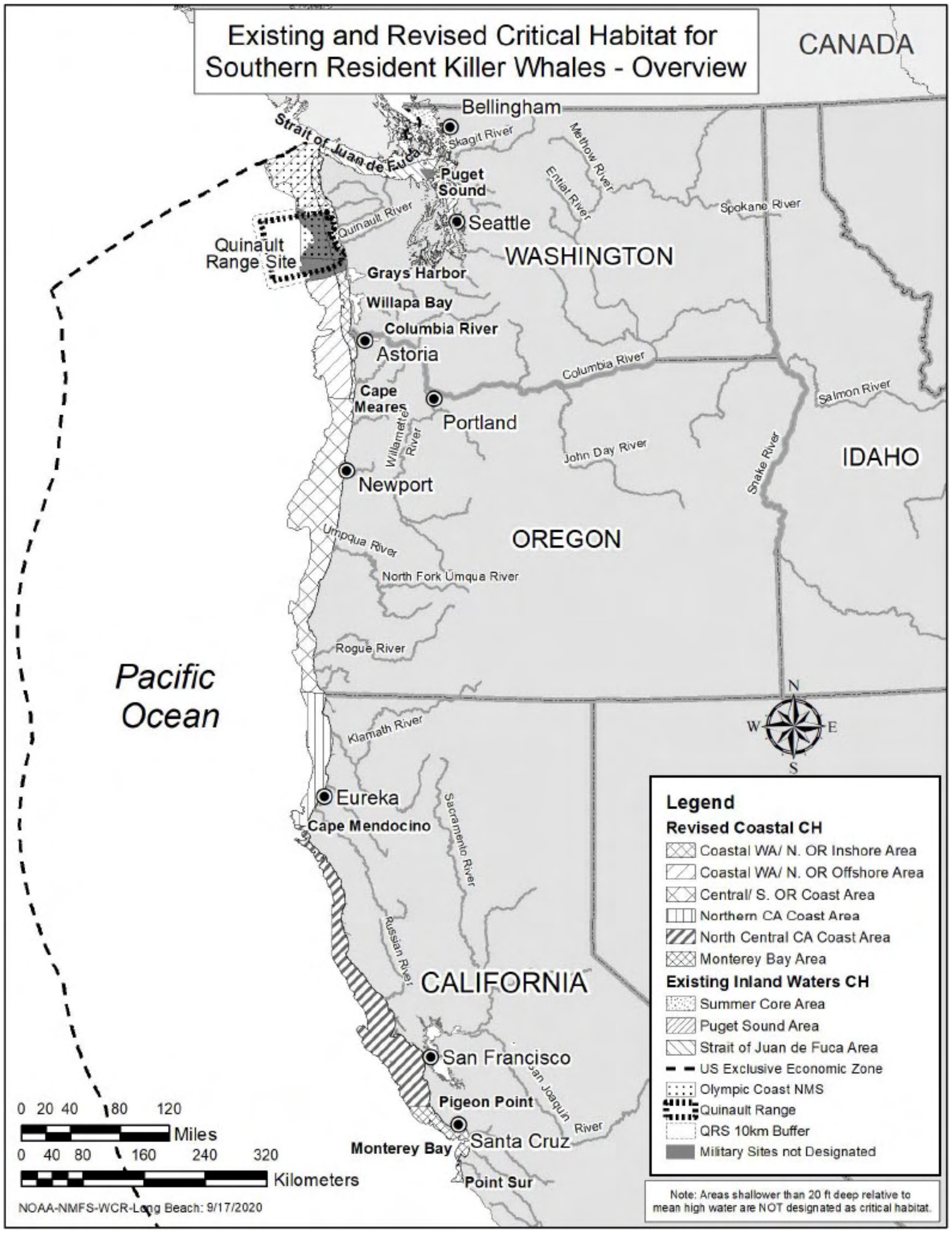

Figure 36. Specific areas of coastal critical habitat containing essential habitat features (86 FR 41668, August 2, 2021).

2.2.3.2.1 Water Quality

Water quality is essential to SRKW conservation, given the population's present contamination levels, small population numbers, increased extinction risk caused by any additional mortalities, and geographic range (and range of their primary prey) which includes highly populated and industrialized areas. Water quality is especially important in high-use areas where foraging behaviors occur and contaminants can enter the food chain. Water quality in Puget Sound, in general, is degraded as described in the Puget Sound Partnership 2022-2026 Action Agenda (PSP

2022). For example, toxicants in Puget Sound persist and build up in marine organisms including SRKWs and their prey resources, despite bans in the 1970s of some harmful substances and cleanup efforts. Also, oil spill risk exists throughout the SRKW's coastal and inland range. The Environmental Protection Agency and U.S. Coast Guard (USCG) 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 2019, the Washington State Department of Ecology published a new Spill Prevention, Preparedness, and Response Program Annual Report describing the Spills Program as well as tracked performance measures from 2009-2019 (WDOE 2019). In August 2022, a commercial fishing vessel sank off the west side of San Juan Island and an oil sheen was seen[27]. SRKW were not seen directly near the sheen but existing oil spill response plans were implemented and the Wildlife Branch of the Incident Command activated a Killer Whale Deterrence Team to prevent exposure.

2.2.3.2.2 Prey Quantity, Quality, and Availability

Prey species of sufficient quantity, quality, and availability are essential to conservation as SRKWs need to maintain their energy balance all year long to support daily activities (foraging, traveling, resting, socializing), as well as gestation, lactation, and growth. Most wild salmon stocks throughout the whales' geographic range are at fractions of their historic levels and 28 ESUs and DPSs of salmon and steelhead are 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. In addition to sufficient quantity of prey, fish need to be accessible and available to the whales, which can be related to the density and distribution of salmon, and competition from other predators and fisheries.

Vessels and sound may reduce the effective zone of echolocation and also reduce availability of fish for the whales in their critical habitat (Holt 2008). As mentioned above, contaminants and pollution also affect the quality of SRKW prey in Puget Sound and in coastal waters of Washington, Oregon, and California. The size of Chinook salmon is also an important aspect of prey quality (i.e., SRKWs primarily consume large Chinook), so changes in Chinook salmon size (for instance as shown by Ohlberger et al. (2018)) may affect the quality of this feature of critical habitat.

2.2.3.2.3 Passage

SRKWs require open waterways that are free from obstruction (e.g., physical, acoustic) to move within and migrate between important habitat areas throughout their range, communicate, find prey, and fulfill other life history requirements. In particular, vessels may present both physical and/or acoustic obstacles to whale passage, causing the whales to swim further and change direction more often, which can increase energy expenditure for whales and impact foraging

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[27] https://www.fisheries.noaa.gov/feature-story/coordinated-response-protected-southern-residents-sunken-ship-leaking-oil

behavior (review in NMFS (2010d), Ferrara et al. (2017), and see "Disturbance by Vessels and Sound" in the SRKW Status Section 2.2.3.1).

In summary, human activities managed under a variety of legal mandates have the potential to affect the habitat features essential to the conservation of SRKWs, including those that could increase water contamination and/or chemical exposure, decrease the quantity, quality, or availability of prey, or inhibit safe, unrestricted passage between important habitat areas to find prey and fulfill other life history requirements. Examples of these types of activities include (but are not limited to), in no particular order: (1) salmon fisheries and bycatch; (2) salmon hatcheries; (3) offshore aquaculture/mariculture; (4) alternative energy development; (5) oil spills and response; (6) military activities; (7) vessel traffic; (8) dredging and dredge material disposal; (9) oil and gas exploration and production; (10) mineral mining (including sand and gravel mining); (11) geologic surveys (including seismic surveys); and (12) activities occurring adjacent to or upstream of critical habitat that may affect essential features, labeled "upstream activities" (including activities contributing to point-source water pollution, power plant operations, liquefied natural gas terminals, desalinization plants) (see NMFS (2021a)).

2.2.3.3 Status of the Mexico DPS Humpback Whale

Humpback whales (*Megaptera novaeangliae*) are distinguished from other whales in the same family (*Balaenopteridae*) by much longer pectoral flippers (up to 5 m or about 1/3 total body length), a more robust body, fewer throat grooves (14 to 35), a pronounced dorsal fin, and their utilization of very long, complex, repetitive vocalizations (songs; Payne and McVay 1971) during courtship. They are generally dark on the dorsal side (back), but the flippers, sides and ventral surface of the body and flukes may have substantial natural white coloration plus acquired scars (white or black). Researchers distinguish individual humpback whales by the visually unique black and white patterns on the underside of the flukes, flukes shape, and trailing edge pattern as well as other individually variable features (Katona and Whitehead 1981).

Humpback whales were first listed as endangered under the precursor to the ESA in December 1970 (35 FR 18319). On September 8, 2016, NMFS revised the ESA listing for humpback whales to identify 14 DPSs, listing one as threatened, four as endangered, and nine others as not warranted for listing (81 FR 62260). Humpback whales from the threatened Mexico DPS, and Hawaii DPS, which was identified as not warranted for listing, could all occur in the action area where SEAK salmon fishing occurs.

We used information available in the most recent status review (Bettridge et al. 2015), most recent stock assessments (Muto et al. 2022; Young et al. 2023), NMFS species information (see websites below), a report on estimated abundance and migratory destinations for North Pacific humpback whales (Wade 2021), and recent Biological Opinions to summarize the status of the species, as follows.

Additional information on humpback whales can be found at:

- Humpback Whale Species Description
- Marine Mammal Stock Assessment Reports: Cetaceans-Large Whales
- Humpback Whale Critical Habitat
- Recovery plan

- Guidance on Occurrence of Humpback DPSs in Alaska

2.2.3.3.1 Diving and Social Behavior

Humpback whales are generally solitary animals that occasionally form fluid associations that can include paired or group feeding. Humpback whales feed on pelagic zooplankton and small schooling fish including capelin, herring, and sandlance. Like other large mysticetes (baleen whales), they take advantage of dense prey patches to engulf as much food as possible in a single mouthful. They also blow nets, or curtains, of bubbles around or below prey patches to concentrate the prey in one area, then lunge with open mouths through the middle. Dives appear to be closely correlated with the depths of prey patches, which vary from location to location. Typically, humpback whale groups are small (e.g., <10 individuals but can vary depending on social context and season), and associations between individuals do not last long, with the exception of the mother/calf pairs (Clapham and Mead 1999). Feeding group sizes and strategies appear to be dependent upon the prey characteristics and the feeding style preferences of individual whales.

Humpback whales are a favorite of whale watchers, as the species frequently performs aerial displays, including breaching, lobtailing, and flipper slapping, the purposes of which are not well understood.

2.2.3.3.2 Vocalization and Hearing

Humpback whale vocalization is much better understood than hearing. Different sounds are produced that correspond to different functions: feeding, breeding, and other social calls (Dunlop et al. 2008). Humpback whales produce a variety of vocalizations ranging from 20 hertz (Hz) to 10 kilohertz (kHz) (Winn et al. 1970; Tyack and Whitehead 1983; Payne and Payne 1985; Silber 1986; Thompson et al. 1986; Richardson et al. 1995; Au 2000; Frazer and Mercado III 2000; Erbe 2002; Au et al. 2006; Vu et al. 2012). Males sing complex sounds while in low-latitude breeding areas in a frequency range of 20 Hz to 4 kHz with estimated source levels from 144 to 174 dB (Winn et al. 1970; Richardson et al. 1995; Au 2000; Frazer and Mercado III 2000; Au et al. 2006). Other social sounds from 50 Hz to 10 kHz (most energy below 3 kHz) are also produced in breeding areas (Tyack and Whitehead 1983; Richardson et al. 1995). While in northern feeding areas, both sexes vocalize in grunts which can be very loud (175 to 192 dB re 1 μPa at 1 m) (Payne and Payne 1985; Thompson et al. 1986; Richardson et al. 1995; Au 2000; Erbe 2002). However, humpbacks tend to be less vocal overall in northern feeding areas than in southern breeding areas (Richardson et al. 1995).

2.2.3.3.3 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; during seasonal migrations they disperse widely in deep, pelagic waters and tend to avoid shallower coastal waters (Winn and Reichley 1985). Sexual maturity of humpback whales in the Northern Hemisphere occurs at approximately 5-11 years of age, and appears to vary both within and among populations

(Clapham 1992; Gabriele et al. 2007; Robbins 2007). Estimated mean calving rates are between 0.38 and 0.50 calves per mature female per year (Clapham and Mayo 1990; Straley et al. 1994; Steiger and Calambokidis 2000) and reproduction is annually variable (Robbins 2007). Annual adult mortality rates have been estimated to be 0.040 (Standard Error = 0.008) (Barlow and Clapham 1997) in the Gulf of Maine, and 0.037 (95% CI 0.022-0.056) (Mizroch et al. 2004) in the North Pacific/ Hawaiian Islands populations.

Humpback whales are present in SEAK in all months of the year and are expected to be found in the action area year-round. Most humpback whales that summer in SEAK 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/learn/nature/humpback-whale-fact-sheet.htm). Late fall and winter whale habitat in SEAK 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 1990). 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 SEAK occur in the spring (March-May), summer (June-August) and fall (September-November) and can be seen in Figure 37.

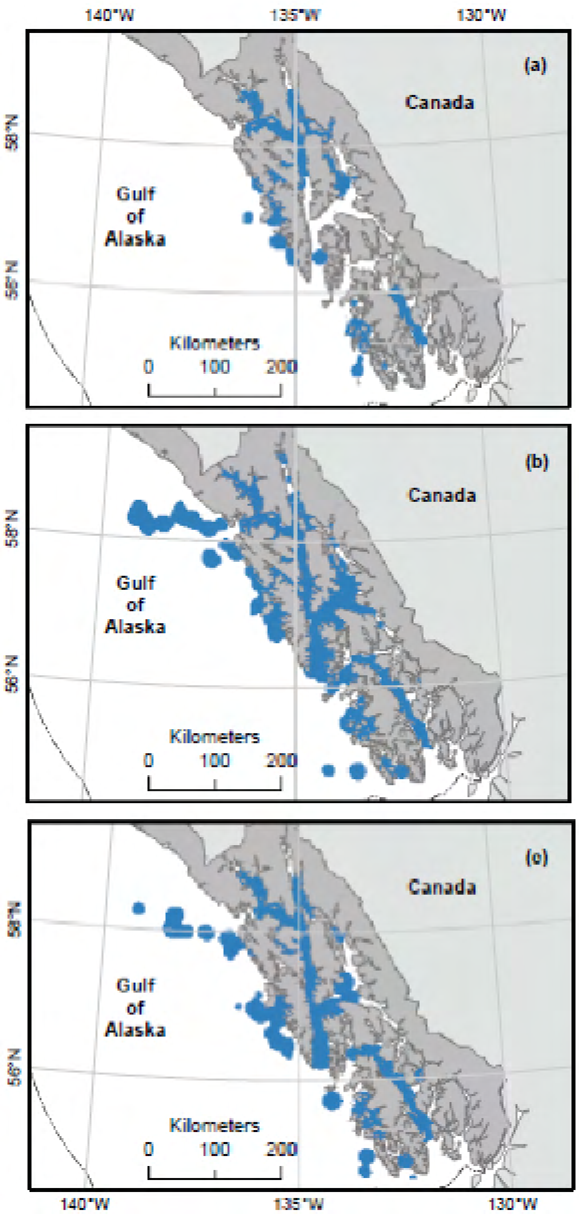


Figure 37. Seasonal humpback whale feeding BIAs in Southeast Alaska for (a) spring; (b) summer; and (c) fall (Ferguson et al. 2015).

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 1990). Whales from these two DPSs overlap on feeding grounds off Alaska, including SEAK, and are not easily distinguishable. Therefore, the listed Mexico DPS humpback whales may overlap with the SEAK salmon fisheries.

2.2.3.3.4 Abundance, Productivity and Trends

A large-scale photo-identification sampling study of humpback whales was conducted from 2004 to 2006 throughout the North Pacific (Calambokidis et al. 2008; Barlow et al. 2011). Known as the SPLASH (Structure of Populations, Levels of Abundance, and Status of Humpbacks) Project, the study was designed to sample all known North Pacific feeding and breeding populations and continues to underpin the majority of the population-level analyses for humpback whales in the North Pacific Ocean. Overall humpback whale abundance in the North Pacific based on the SPLASH Project was estimated at 21,808 individuals (CV = 0.04), confirming that this population of humpback whales has continued to increase and is now greater than some pre-whaling abundance estimates (Barlow et al. 2011). The 2015 humpback whale status review estimated a growth rate for the North Pacific population of 4.9% (Bettridge et al. 2015).

The most recent stock assessment report (SAR; Young et al. 2023) for humpback whales reflects redefined Marine Mammal Protection Act (MMPA) stocks that more closely align with the ESA humpback whale DPSs (Young et al. 2023). The Hawaii stock of humpback whales is consistent with the unlisted Hawaii DPS and the Mexico – North Pacific stock of humpback whales is consistent with a subset of the threatened Mexico DPS as shown in Table 32.

Table 32. DPS of origin for North Pacific humpback whale Demographically Independent Populations (DIPs), units, and stocks.

DPS	DIPs / units	Stocks
Central America	Central America - California (CA)-OR-WA DIP	Central America / Southern Mexico - CA-OR-WA stock
Mexico	Mexico - North (N) Pacific unit	Mexico - North Pacific stock
	Mainland Mexico - CA-OR-WA DIP	Mainland Mexico - CA-OR-WA stock
Hawai‘i	Hawai‘i - North Pacific unit	Hawai‘i stock
	Hawai‘i - Southeast Alaska / N British Columbia DIP	
Western North Pacific	Philippines / Okinawa - N Pacific unit	Western North Pacific stock
	Marianas / Ogasawara - N Pacific unit	

The overall abundances for each DPS have been estimated by Wade (2021) using a Multi-State mark-recapture model, where the Mexico DPS abundance is estimated at 2,913 (CV = 0.066) and the Hawaii DPS abundance is estimated at 11,540 (CV = 0.042). However, both DPSs distribute broadly on the feeding grounds. A relatively high density of humpback whales occurs throughout much of SEAK and northern British Columbia, particularly during the summer months, and the population is estimated by Wade (2021) at 5,890 (CV = 0.075). Of these whales, only a small fraction (2%) are from the Mexico DPS and the majority (98%) are from the unlisted Hawaii DPS. The probability of occurrence of each DPS in the whales’ summer feeding areas has been estimated from sighting data in Wade (2021) and is summarized in Table 33 below.

Table 33. Probability of encountering humpback whales from each DPS in the North Pacific Ocean (columns) in various feeding areas (rows). Adapted from Wade (2021) and consistent with the current version of the NMFS Alaska Region occurrence of ESA listed humpback whales off Alaska (NMFS 2021l).

Summer Feeding Areas	**North Pacific Distinct Population Segments**	
	Hawaii DPS (not listed)	Mexico DPS (threatened)
Kamchatka	9%	0%
Aleutian Islands, Bering, Chukchi, Beaufort	91%	7%
Gulf of Alaska	89%	11%
Southeast Alaska / Northern BC	98%	2%
Southern BC / WA	69%	25%
OR/CA	0%	58%

Although we do not have specific estimates of the current growth rate for the Mexico DPS, it is likely that the broader positive growth rate trends for humpback whales along the U.S. West Coast and in the North Pacific similarly reflect positive growth of this DPS. Wade (2021) estimated that 918 animals (CV=0.217; N_{min}=766 animals) from the Mexico - North Pacific stock may spend summers in SEAK. Population trends for Mexico DPS humpbacks are not known with confidence; however, the most recent SAR estimates a maximum growth rate of 6.6% (Young et al. 2023) for the Mexico - North Pacific stock, which is a subset of the Mexico DPS. The potential biological removal (PBR) allocation for U.S. waters, 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, is 127 whales per year for the Hawaii stock (Young et al. 2023). The minimum population estimate for the Mexico - North Pacific stock is considered unknown; and, therefore, PBR is undetermined for this stock. The total annual human-caused M/SI in U.S. waters is estimated to be 0.56 whales.

2.2.3.3.5 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), 2022 SAR (Young et al. 2023), global status review (Fleming and Jackson 2011), and the status review of humpback whales (Bettridge et al. 2015).

Recovery Goals

The 1991 Final Recovery Plan for the Humpback Whale includes the four following recovery goals (NMFS 1991):

- Maintain and enhance habitats used by humpback whales currently or historically
- Identify and reduce direct human-related injury and mortality

- Measure and monitor key population parameters
- Improve administration and coordination of recovery program for humpback whales

The 1991 Final Recovery Plan for the Humpback Whale includes a more complete description for down listing/delisting criteria for each of the four recovery goals.

NMFS is drafting a new recovery plan for the three ESA-listed DPSs that occur in U.S. waters (87 FR 35178, June 9, 2022) that will incorporate new information about humpback whale status and threats under the updated ESA designations.

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%, 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. Most observations of humpback whales under attack from killer whales reported vigorous defensive behavior and tight grouping when 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). However, 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 and saxitoxin have been detected in humpback whales and, in one study, domoic acid was found in 38% of humpback whales sampled and saxitoxin in 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 DPSs is available.

Anthropogenic Threats

Human activities are known to threaten humpback whales. Historically, whaling represented the greatest threat to every population of whales and was ultimately responsible for listing several species as endangered, but this threat has largely been curtailed. No whaling occurs within the range of Mexico DPS humpbacks. 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 all humpback whale DPSs in Alaska.

Fishery Interactions including Entanglements

Entanglement in fishing gear is a documented source of injury and mortality to cetaceans. This includes momentary contact with fishing gear (blow-through interactions), entanglement and drowning in fishing gear, and extended entanglements that may persist with animals for hours, weeks, or even years. Extended entanglements may result in reduced fitness, growth, annual survival, reproductive success, and/or survival of the affected individual. Entanglements may restrict an animal's ability to swim, avoid predators, or forage efficiently; cause physical injuries; or otherwise increase energy expenditures that reduce overall survival and fitness. Entanglement may result in only minor injury or may potentially significantly affect individual health, reproduction, or survival (Fleming and Jackson 2011). A photographic study of humpback whales in SEAK in 2003 and 2004 found at least 53% of individuals 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.

Several known interactions resulting in entanglements, mortality, or serious injury of the Mexico - North Pacific stock of humpback whales in SEAK are documented in the 2022 SAR (Young et al. 2023). The SEAK salmon drift gillnet fishery has a mean estimated annual mortality rate of 5.5 (CV = 1.0) humpback whales, with 0.13 (CV = 1.1) attributed to the Mexico – North Pacific stock/Mexico DPS from fishery observers and an additional 1.25 M/SI per year from stranding data observation and 0.03 of those attributed to the Mexico – North Pacific stock/Mexico DPS. The SEAK salmon drift gillnet fishery is listed as a Category I fishery under the Marine Mammal Species and Stocks Incidentally Killed or Injured in the 2024 MMPA List of Fisheries (89 FR 12257; February 16, 2024), due to interactions with unlisted harbor porpoise stocks. The Mexico - North Pacific stock of humpback whales are also listed as interacting with this fishery, as well as the Hawaii stock of humpback whales. Other sources of serious injury and mortality attribute a minimum mean annual mortality and serious injury rate from commercial fishing gear of 0.2 to the Mexico - North Pacific stock humpback whales in 2016-2020, from recreational pot fisheries of .01, from subsistence fisheries of .02, from unknown fisheries of .05, from marine debris of .05, and from other causes of .08 (Young et al. 2023). Within SEAK, information on interactions between the Mexico - North Pacific stock of humpback whales and fishing gear are detailed at length in Section 2.5.4 (Effects of the Action: Humpback Whales and Steller Sea Lions).

Subsistence Hunting

Whaling is generally no longer a threat to humpback whales in the North Pacific Ocean as commercial whaling is not active and subsistence hunters in Alaska are not authorized to take humpback whales from this stock. However, an intentional unauthorized take of a humpback whale by Alaska Natives in Toksook Bay in 2016 resulted in a mean annual mortality and serious injury rate of 0.2 whales between 2016 and 2020 (0.01 prorated to the Mexico-North Pacific stock (Young et al. 2023)).

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). Final 2022 SARs report a mean minimum annual morality and serious injury due to vessel strikes of 1.93 humpback whales/year, where 0.06 mortalities/year are attributed to the Mexico – North Pacific stock. For SEAK specifically the 2022 SAR reports an estimated annual mortality of 1.75 humpback whales/year in SEAK, where 0.04 mortalities/year are attributed to the Mexico – North Pacific stock.

Vessel noise disturbance is also a consideration for humpback whales in SEAK. As the vessel traffic and whale watching effort increases, whales are increasingly exposed to the underwater noise of vessels and a need to navigate around boats. In a 2019 study of whale watching vessels in Juneau, Alaska, humpback whales were evaluated from land-based platforms for behavioral responses to the presence and absence of whale watching vessels. They found that in the presence of boats, humpback whales in the study increased swimming speed, changed direction more often, and the inter-breath intervals decreased, and over more time around vessels, the respiration rate increased (Schuler et al. 2019). If and how these short-term responses to vessel disturbance translate into long term impacts is unknown.

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. 2004a). Available information does not suggest contaminant levels in humpback whales are having a significant impact on their persistence (Elfes et al. 2010).

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).

2.2.3.3.6 Critical Habitat

NMFS designated critical habitat for Mexico DPS humpback whales on April 21, 2021 (86 FR 21082, April 21, 2021). There is no SEAK salmon fishing in humpback whale critical habitat. The nearest designated critical habitat for Mexico DPS humpback whales to the SEAK salmon fisheries is hundreds of away - in the vicinity of Prince William Sound and the Strait of Juan de Fuca (Figure 38) (50 CFR 226.227). Thus, we anticipate no effect on humpback whale critical habitat.

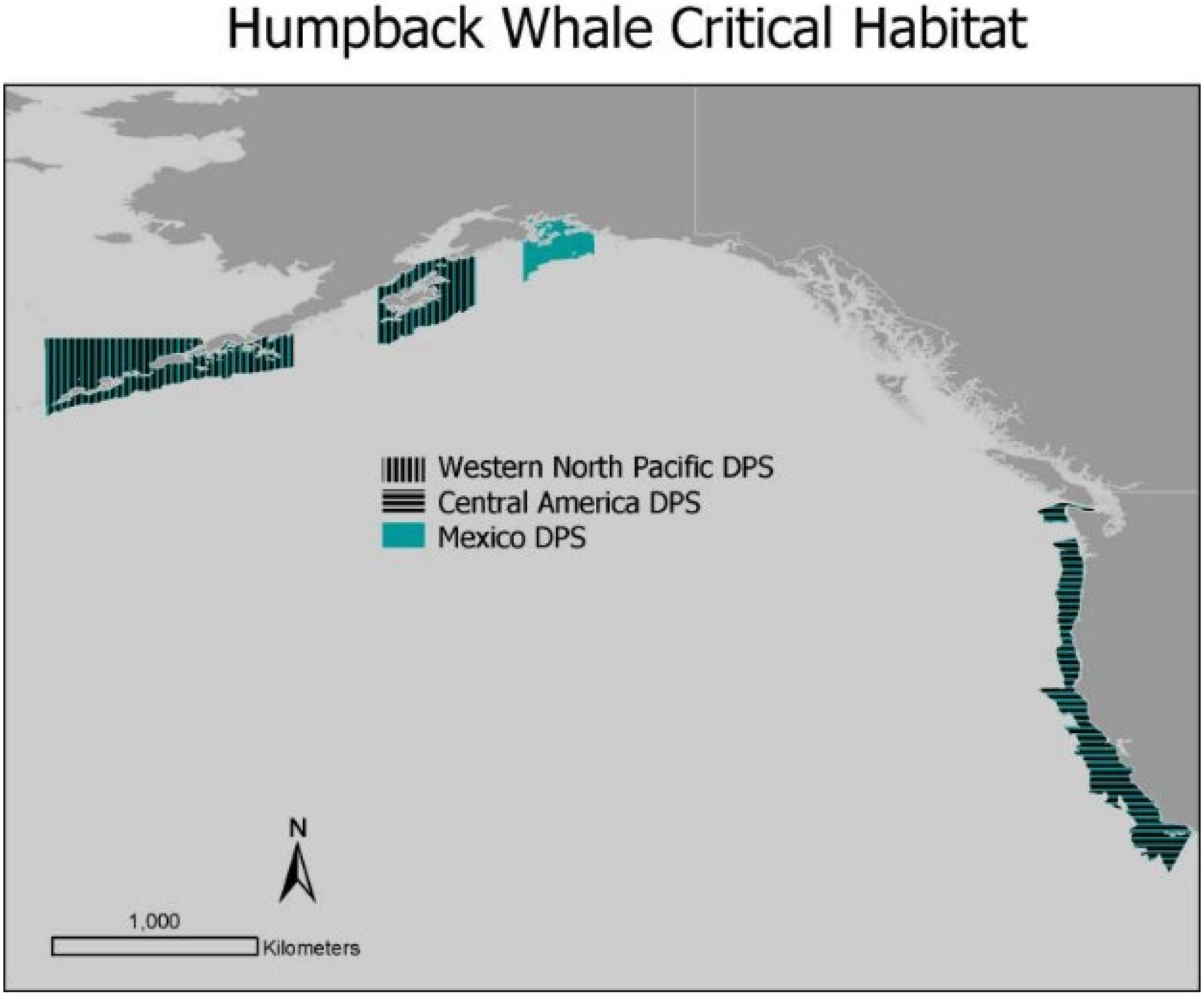


Figure 38. Humpback whale critical habitat.

2.2.3.4 Status of the Western DPS Steller Sea Lion

To summarize the status of the western DPS of Steller sea lions, we used peer-reviewed scientific literature, information available in the ESA-listing species status review, the most recent Alaska Marine Mammal Stock Assessment Reports (Young et al. 2023), species information from NMFS websites (see websites below), and the Western Distinct Population Segment Steller sea lion *Eumetopias jubatus* 5-Year Review. The 2022 and 2021 SARs did not revise the SAR for the western stock (DPS) of Steller sea lions, which was last updated in the 2020 SAR cycle, and did not revise the eastern stock (DPS) of Steller sea lions, which was last updated in the 2019 SAR cycle. However, both are carried forward into the more recent reports and can also be found in Young et al. (2023).

Additional information on Steller sea lions can be found at:

- Steller Sea Lion Species Description
- Marine Mammal Stock Assessment Reports: Pinnipeds-Otariids
- 2020 Western DPS Steller sea lion 5-year Review
- Steller Sea Lion Critical Habitat
- Recovery Plan

2.2.3.4.1 Population Structure, Status, and Trends

On November 26, 1990, NMFS published the final rule to list Steller sea lions as a threatened species under the ESA (effective December 4, 1990; 55 FR 49204). In 1997, NMFS reclassified Steller sea lions as two DPSs based on genetic studies and other information (62 FR 24345; May 5, 1997; Figure 39). At that time, the eastern DPS was listed as threatened, and the western DPS was listed as endangered. The western DPS is defined as Steller sea lions born west of 144° W. Long. (50 CFR 224.101), and the eastern DPS are Steller sea lions born east of 144° W. Long. On December 4, 2013, the eastern DPS was removed from the endangered species list (78 FR 66140; November 4, 2013).

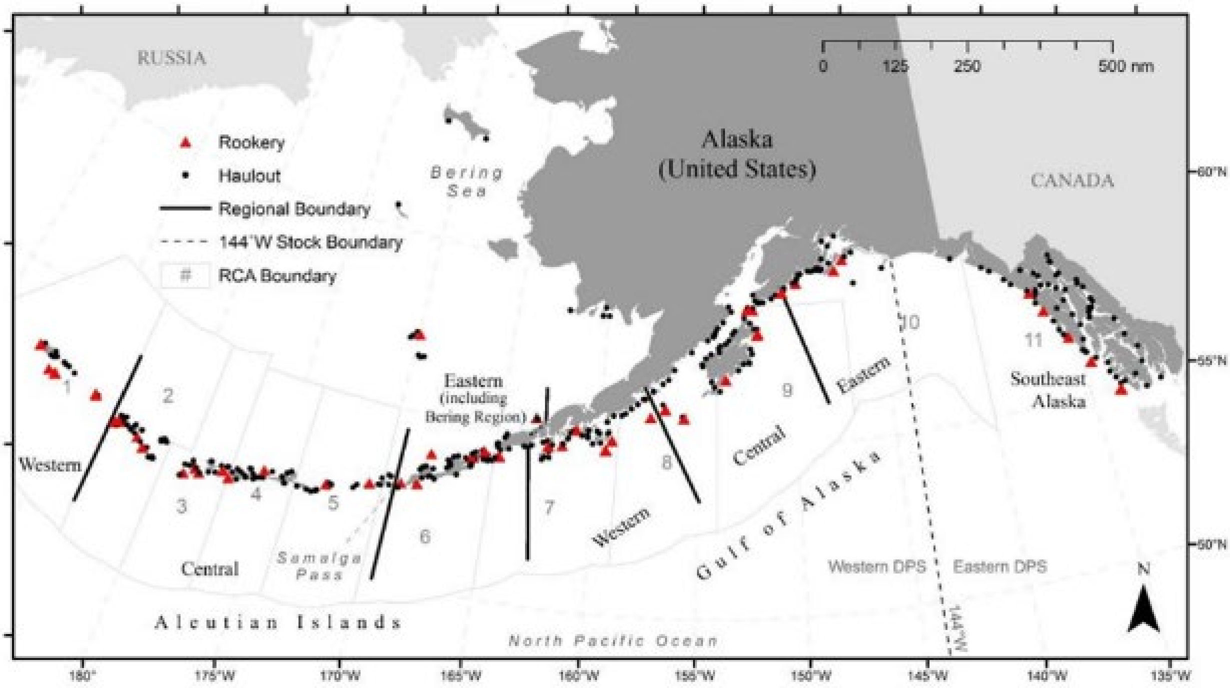


Figure 39. NMFS Steller sea lion survey regions, rookeries, haulouts, and line at 144 West (W) longitude depicting the separation of eastern and western DPSs (Fritz et al. 2016).

The western DPS Steller sea lion decreased from 220,000 to 265,000 animals in the late 1970s to less than 50,000 in 2000 (Loughlin et al. 1984; Loughlin and York 2000; Burkanov and Loughlin 2005). The sharp drop in abundance of the western DPS observed in the 1980s was caused largely by a steep decline in juvenile survival and a smaller decline in adult survival (York 1994; Holmes and York 2003). Survival increased in the 1990s as the population decline slowed, possibly as a result of the listing of Steller sea lions as threatened under the ESA in 1990 and a drop in mortality associated with incidental take in fisheries and legal and illegal shooting (Atkinson et al. 2008). By the 2000s, survival of both juveniles and adults in areas containing long-term monitoring plans had rebounded to rates similar to those observed in the mid-1970s prior to the decline (Holmes et al. 2007; Horning and Mellish 2012; Fritz et al. 2014; Maniscalco et al. 2014).

The most recent comprehensive aerial photographic and land-based surveys of western DPS Steller sea lions in Alaska were conducted during the 2021 (Southeast Alaska and Gulf of Alaska east of Shumagin Islands) and 2022 (Aleutian Islands west of Shumagin Islands) breeding seasons (Sweeney et al. 2023). The minimum population estimate for the U.S. portion of the range of western DPS Steller sea lions in 2022 was 49,837 (Young et al. 2023). The western DPS Steller sea lion non-pup and pup model-predicted counts were 37,333 (34,274-40,245) animals and 11,987 (95% credible interval of 11,291-12,703) animals, respectively. In Russia, the modeled count estimate in 2022 was 17,342 (95% credible interval of 13,944-21,354) for non-pups and 6,032 (95% credible interval of 5,555-6,541) for pups (Johnson 2018).

Data from 1978-2022 indicate that the western DPS Steller sea lion population was at its lowest levels in 2002. Between 2007 to 2022, western DPS non-pup and pup counts increased 1.05% and 0.50% per year, respectively (Sweeney et al. 2023). However, there was high variability among regions. Steller sea lions in the western Aleutian Islands region continued to decline, along with pups in the adjacent central Aleutian Islands region. East of Samalga Pass, Aleutian Islands, pup production slowed or plateaued in the early 2010s, with subsequent non-pup plateauing or declines starting in the late 2010s in all regions (Sweeney et al. 2023). The 2014-2016 North Pacific marine heatwave (PMH, i.e., "the blob"), one of the most severe heatwaves ever recorded, resulted in reduced survival of adult female Steller sea lions in the Gulf of Alaska and reduced survival of adult female and adult male Steller sea lions in Southeast Alaska (Hastings et al. 2023). It appears that adult females may have recovered from the effects of the PMH, based on recent data (Hastings et al. 2023).

2.2.3.4.2 Distribution

The western DPS of Steller sea lions includes animals born west of Cape Suckling, Alaska (144° W. Long.; 50 CFR 224.101). However, individuals move between rookeries and haul out sites regularly, even over long distances between eastern and western DPS locations (Jemison et al. 2013; Jemison et al. 2018; Hastings et al. 2020). Most adult Steller sea lions occupy rookeries during the summer pupping and breeding season and exhibit a high level of site fidelity (Raum-Suryan et al. 2002; Hastings et al. 2017). During the breeding season, some juveniles and non-breeding adults occur at or near the rookeries, but most are on haulouts (sites that provide regular retreat from the water on exposed rocky shoreline, gravel beaches, and wave-cut platforms or ice) (Rice 1998; Ban 2005; Call and Loughlin 2005). Steller sea lions disperse widely after the breeding season (late May to July), likely to access seasonally important prey resources. During fall and winter many sea lions disperse from rookeries and increase use of haulouts, particularly on terrestrial sites but also on sea ice in the Bering Sea (Calkins 1998).

2.2.3.4.3 Steller Sea Lion Occurrence in Action Area

Steller sea lions are composed of two genetically distinct DPSs, but western DPS Steller sea lions do occur in SEAK, which is east of Cape Suckling (144° W. Long.), and within the action area. Hastings et al. (2020) used mark-recapture models and 18 years of brand resighting data of over 3,500 Steller sea lions to estimate minimum proportions of Steller sea lions with western genetic material in regions within SEAK. Hastings et al. (2020) estimated that a minimum of 38% of Steller sea lions in the North Outer Coast-Glacier Bay and 13% of Steller sea lions in the Lynn Canal-Frederick Sound regions in Southeast Alaska have genetic makeup that is unique to the western DPS (Table 34, Figure 39).

Table 34. Proportions of Steller sea lion non-pups using regions in the population mixing zone (northern–central Southeast Alaska) by birth region, age-class, and maternal genetic lineage (mtW or mtE: western or eastern maternal haplotype). The proportion of western DPS Steller sea lions in each region should be calculated using the numbers highlighted in the second row from the bottom of the table. Birth regions were WSR (born in the Western Stock region, all with mtW), MZ (born in the new rookeries in the Mixing Zone of the Eastern Stock region: Graves Rocks and White Sisters, with mtW or mtE), or South (born in southern Southeast Alaska, Eastern Stock region: Forrester and Hazy rookeries, all with mtE). Regions of Southeast Alaska were: F, northern Outer Coast (OC); G, Glacier Bay; H, Lynn Canal; E, Frederick Sound; and D, central Outer Coast (Figure 1). mtW Total* = sum of WSR and MZ-mtW. Reproduced with permission from K. Hastings (Hastings et al. 2020).

Group	Region of Southeast Alaska				
	F	G	H	E	D
	North OC	Glacier Bay	Lynn Canal	Fred. Sound	Central OC
Juveniles (1-3 years old)					
South	0.298	0.208	0.282	0.522	0.461
MZ-*mtE*	0.326	0.449	0.421	0.302	0.523
MZ-*mtW*	0.258	0.272	0.288	0.166	0.004
WSR	0.118	0.071	0.009	0.010	0.012
mtW Total*	0.376	0.343	0.297	0.176	0.016
Animals 4+ years old					
South	0.203	0.207	0.510	0.765	0.665
MZ-*mtE*	0.411	0.396	0.375	0.170	0.290
MZ-*mtW*	0.314	0.322	0.098	0.053	0.014
WSR	0.072	0.075	0.017	0.012	0.031
mtW Total*	0.386	0.397	0.115	0.065	0.045
All nonpups (1+ years old)					
South	0.223	0.208	0.427	0.630	0.566

Group	Region of Southeast Alaska				
	F	G	H	E	D
	North OC	Glacier Bay	Lynn Canal	Fred. Sound	Central OC
MZ-*mtE*	0.393	0.420	0.392	0.243	0.403
MZ-*mtW*	0.302	0.299	0.167	0.115	0.009
WSR	0.082	0.073	0.014	0.012	0.022
mtW Total*	0.384	0.372	0.181	0.127	0.031

Information about Steller sea lion at-sea spatial use has been assessed primarily from satellite telemetry (Raum-Suryan et al. 2004; Fadely et al. 2005; Lander et al. 2009; Rehberg et al. 2009; Lander et al. 2020) but also from Platform of Opportunity (POP) data (Himes Boor and Small 2012). Along the outer coast of SEAK, Steller sea lions used most of the relatively narrow continental shelf between Hazy and Graves rookeries, but south of the Hazy to Forrester rookery complex use was closer to shore with less use along the shelf break (Figure 39). High-use areas were also scattered throughout the inside waters of this region and often adjacent to Steller sea lion haul-outs, likely to benefit from ephemeral concentrations of prey (Raum-Suryan et al. 2004; Sigler et al. 2004; Womble et al. 2005; Sigler et al. 2009; Womble et al. 2009).

Womble et al. (2005); (2009) studied the seasonal ecology of Steller sea lions in SEAK by relating the distribution of Steller sea lions to prey availability. Figure 40 depicts a likely seasonal foraging strategy for Steller sea lions in SEAK. Their 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 SEAK. Concentrated numbers of Steller sea lions in the action area are most likely to occur during seasonal prey aggregation. Herring, walleye pollock, salmon, and eulachon are among the species that congregate ephemerally. Similarly, the NMFS (2014b) Status Review of SEAK Pacific herring generalizes that sea lions forage on herring aggregations in winter, on spawning herring and eulachon in spring, and on various other species throughout the year. Kruse et al. (2000) reported that herring fishery managers use the presence of Steller sea lions on the spring spawning grounds as an indicator that spawning is imminent, even though herring have been in deeper adjacent waters for weeks prior to arrival of Steller sea lions.

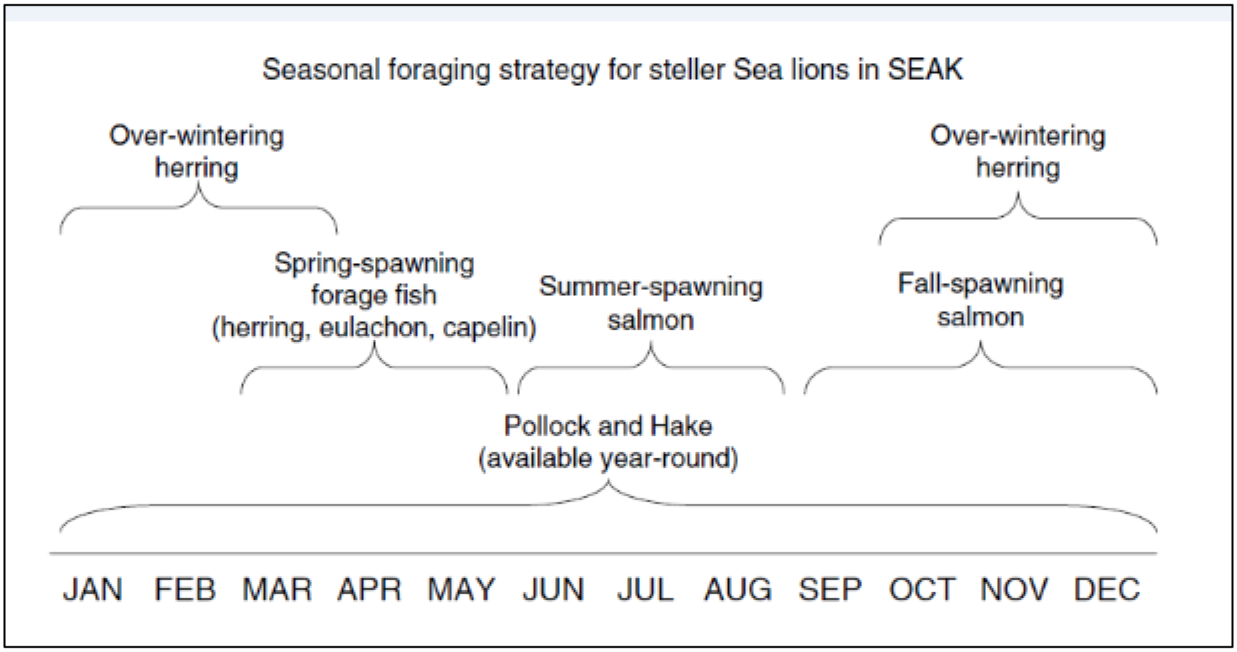


Figure 40. Seasonal foraging ecology of Steller Sea Lions. Reproduced with permission from (Womble et al. 2009).

NMFS expects that Steller sea lion presence in the action area will vary due to their spatial distribution during breeding versus non-breeding seasons. Steller sea lions are predatory and consume a wide range of prey, foraging and feeding primarily at night on over a hundred species of fish and cephalopods. Their diet varies in different parts of their range and at different times of the year, depending on the abundance and distribution of prey species (Gende and Sigler 2006; Womble and Sigler 2006; Womble et al. 2009). Steller sea lions prey on Pacific herring during winter, forage fish spawning aggregations during spring, and migrating Pacific salmon during summer and fall (Womble et al. 2009; Lander et al. 2020).

Reproduction and Growth

Adult male Steller sea lions arrive early on rookeries to establish breeding territories that they defend through the breeding season (Sandegren 1970; Calkins and Pitcher 1982). Males become sexually mature between three and eight years of age, but typically are not large enough to hold territory successfully until nine or ten years old (Thorsteinson and Lensink 1962; Pitcher and Calkins 1981). Females begin to arrive on rookeries in mid-May. Adult females typically give birth to their first pup between four to six years of age, usually giving birth to a single pup each year. However, they may not pup every year. Pupping occurs from about mid-May to mid-July and peaks in June. Females usually mate within two weeks after giving birth (Pitcher and Calkins 1981; Calkins and Pitcher 1982).

Feeding and Prey Selection

The amount of prey consumed and required by a Steller sea lion to maintain health and reproduce varies depending on sex, age, season, reproductive status, nutritional stress, and digestive efficiency (Rosen and Trites 1999; Rosen and Trites 2000; Winship and Trites 2003;

Rosen 2009). Diet varies regionally and seasonally (Sinclair and Zeppelin 2002; Sinclair et al. 2013), and as a result of dive ability, sex, and age (Raum-Suryan et al. 2004; Fadely et al. 2005; Rehberg and Burns 2008). Steller sea lions generally target fish and cephalopod species, including those that are densely schooled in spawning or migratory aggregations on the continental shelf or along oceanographic boundary zones (Sinclair and Zeppelin 2002; Sinclair et al. 2013).

2.2.3.4.4 Diving and Social Behavior

At-sea behavior of Steller sea lions varies greatly within and among individuals and is influenced by age, gender, time-of-day, weaning status (for juveniles), region, season, and lunar phase (e.g., Raum-Suryan et al. 2004; Pitcher et al. 2005; Rehberg and Burns 2008) as well as the distribution and abundance (including the aggregation and predictability) of primary prey (e.g., Sigler et al. 2004; Womble et al. 2005; Womble and Sigler 2006; Sigler et al. 2009; Womble et al. 2009). Most diving occurs during the night regardless of distribution (Rehberg et al. 2009; Waite et al. 2012; Lander et al. 2020). Foraging dives may be benthic or epipelagic, but their short foraging trips during the breeding season limit females to nearshore waters, although this varies with location (Lander et al. 2020).

2.2.3.4.5 Vocalization and Hearing

The ability to detect sound and communicate underwater is important for a variety of Steller sea lion life functions, including reproduction and predator avoidance. Steller sea lions have similar hearing thresholds in-air and underwater to other otariids. In-air hearing ranges from 0.250-30 kHz, with their best hearing sensitivity at 5-14.1 kHz (Mulsow and Reichmuth 2010). An underwater audiogram for Steller sea lions 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).

2.2.3.4.6 Threats

Brief descriptions of threats to Steller sea lions follow. More detailed information can be found in the Steller sea lion Recovery Plan (NMFS 2008k), the SARs (Young et al. 2023), and the Alaska Groundfish Biological Opinion (NMFS 2014c).

Fisheries Interactions

Although the Steller Sea Lion Recovery Plan (NMFS 2008k) ranked interactions with fishing gear and marine debris as a low threat to the recovery of the western DPS, Steller sea lions that interact or become entangled in fishing gear may be injured or die (Raum-Suryan et al. 2009; Freed et al. 2023). Based on data collected by Alaska Department of Fish and Game and NMFS, Young et al. (2023) reported Steller sea lions to be the most common species reported experiencing human-caused mortality and serious injury between 2017 and 2021 in Alaska. Young et al. (2023) Freed et al. (2023) summarize fisheries interactions of Steller sea lions as follows:

The most common cause of mortality and injury for the Eastern U.S. stock of Steller sea lions (eastern DPS) (n = 384, resulting in 333 M/SI from 2017-2021) was entanglement (i.e. entrapped in fishing gear; n = 222, resulting in 179 M/SI), followed by hooking in fishing gear (not necessarily entrapped; n = 113, resulting in 105 M/SI). Hookings of Eastern U.S. Steller sea lions primarily occurred during salmon fishing in which a line with gear was towed behind a vessel (n = 91, resulting in 89 M/SI). Depending on salmon species, location, and fishermen preference, different types of lures are used to attract fish including spinners, spoons, and flashers. Steller sea lions that have ingested gear are found with flashers hanging from the edge of their mouth connected to a monofilament line that is attached to a swallowed hook. Recreational fishermen, charter operators, and commercial trollers all tow lines with gear behind their vessel and all sometimes use flashers when fishing for salmon; Steller sea lions are known to interact with gear used by all three of these fishing groups.

Human-caused mortality and injury of the Western U.S. stock of Steller sea lions (western DPS) (n = 148, resulting in 146 M/SI from 2017-2021) was primarily caused by entanglement in fishing gear (n = 117, resulting in 115 M/SI), followed by entanglement in marine debris (n = 19, resulting in 19 M/SI), hooking in fishing gear (n = 5, resulting in 5 M/SI), shooting (n = 5, resulting in 5 M/SI), and injury related to MMPA authorized research (n = 2, resulting in 2 M/SI). Fishery interactions occurred most commonly in commercial trawl gear (n = 113, resulting in 111 M/SI). Interactions in the federal trawl fisheries typically resulted in mortality (the animal was already dead by the time it was observed); injuries are rare (Breiwick 2013).

Differences in the leading causes of M/SI for the Eastern U.S. and Western U.S. stocks of Steller sea lions are likely due to the geographical distribution of commercial and charter/recreational salmon hook and line fishing effort, which occurs more in Southeast Alaska than in any other part of the state. It is unknown whether differences in reported entanglement numbers for each stock are due to lower entanglement rates in the Western U.S. stock of Steller sea lions or the result of other factors, such as fewer people to notice entanglements in some of these areas, which result in fewer reports of entanglement.

NMFS, ADF&G, the Alaska Trollers Association, and others are actively working toward deterrent solutions to reduce interactions between Steller sea lions and salmon troll fisheries (K. Raum-Suryan, personal communication, May 2023). In addition, SEAK salmon fisheries could affect Steller sea lions through prey removal. However, Steller sea lions are generalist predators that eat a variety of fishes and cephalopods. Thus, we anticipate prey reductions from SEAK salmon fisheries will not be meaningful.

Vessel Disturbance

Vessel traffic, sea lion research, and tourism may disrupt sea lion feeding, breeding, or aspects of sea lion behavior. The Steller Sea Lion Recovery Plan (NMFS 2008k) ranked disturbance from these sources as a low threat to recovery. Disturbances from these sources are not likely affecting population dynamics in the western DPS.

Risk of Vessel Strike

NMFS Alaska Region Stranding Program has records of four confirmed reports of Steller sea lions being struck by vessels in SEAK between 2000 and 2024 (NMFS Alaska Region Stranding

Database, accessed September 9, 2024). Vessel strike is not considered a major threat to Steller sea lions.

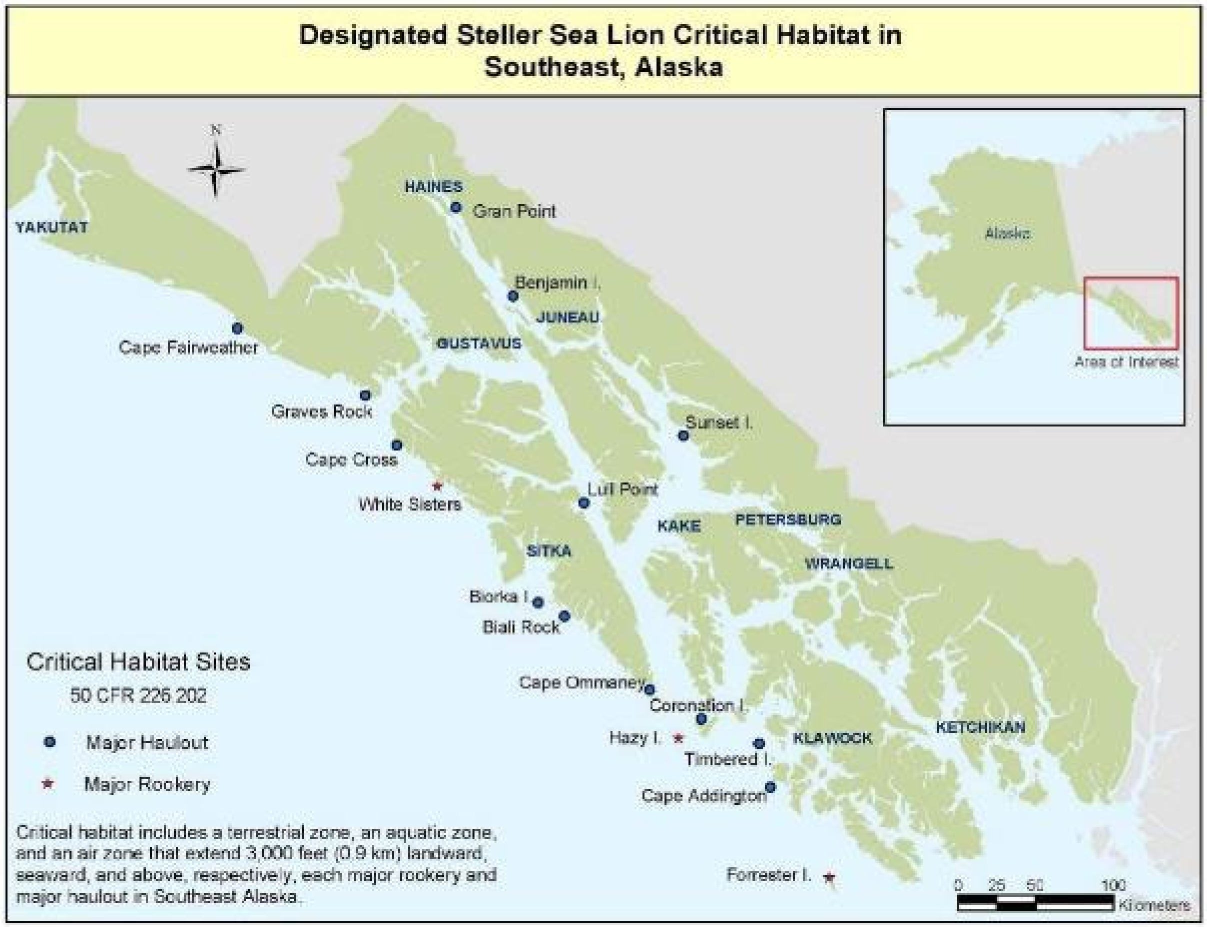
Recovery Goals

In the 2008 Recovery Plan, NMFS outlined a strategy to meet its goal of promoting the recovery of Steller sea lions and its ecosystem to a level that would warrant delisting (NMFS 2008k). Since the early 1990s when management actions reduced incidental takes from commercial fishing and illegal shooting of sea lions, recovery efforts have focused on implementing fishery management measures aimed at reducing the impact of commercial fishing on Steller sea lion prey (primarily through spatial and temporal measures to reduce impacts on prey availability and competition). While western DPS Steller sea lion non-pup and pup counts between 2007 and 2022 increased 1.05% and 0.50% per year, respectively (Sweeney et al. 2023), it is unclear if fisheries regulations implemented in the late 1990s contributed to this trend by limiting the catch of prey species or if the management changes and the positive population trend are simply coincidental (NMFS 2008k; Fritz et al. 2016; Young et al. 2023).

The highest priority goal set by NMFS is to continue to improve estimates of population abundance, trends, distribution, health, and essential habitat characteristics through monitoring and research and to identify key threats to the population. In addition to identifying individual threats, research needs to expand our understanding of how multiple interrelated threats, including climate change and marine heatwaves, combine to create long-term cumulative impacts on the western DPS. A second priority in the recovery plan is to maintain the current or similar fishery management measures (NMFS 2008k) until substantive evidence demonstrates that these measures can be reduced without limiting recovery.

2.2.3.4.7 Critical Habitat

On September 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, August 27, 1993). 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, each major rookery and haulout (50 CFR 226.202(a); Figure 41). 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.


Designated Steller Sea Lion Critical Habitat in Southeast, Alaska

Critical habitat includes a terrestrial zone, an aquatic zone, and an air zone that extend 3,000 feet (0.9 km) landward, seaward, and above, respectively, each major rookery and major haulout in Southeast Alaska.

Figure 41. Designated Steller sea lion critical habitat in SEAK.

2.2.4 Climate Change; Effects on Fish

The following section examines climate change effects on fish, with a focus on impacts to listed salmonid species analyzed in this Opinion (climate change effects on marine mammals are discussed above). One factor affecting the rangewide status of species, and aquatic habitat at large is climate change. The U.S. Global Change Research Program (USGCRP)[28], 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)[29], these effects pose the following impacts into the future:

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[28] http://www.globalchange.gov

[29] The Independent Scientific Advisory Board (ISAB) serves NMFS (NOAA Fisheries), Columbia River Indian Tribes, and Northwest Power and Conservation Council by providing independent scientific advice and

- 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, these effects are expected to occur 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. 2008b; Martins et al. 2012; Wainwright and Weitkamp 2013; Crozier et al. 2021). 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 on fish physiology
- temperature-induced changes to stream flow patterns
- alterations to freshwater, estuarine, and marine food webs
- changes in estuarine and ocean productivity

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. In an assessment of exposure to climate change, Crozier et al. (2019) found that steelhead vulnerability to climate change is high due to high exposure and sensitivity (Crozier et al. 2019; Ford 2022). However, how climate change will affect each stock or population of salmon varies widely depending on the

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recommendations regarding scientific issues that relate to the respective agencies' fish and wildlife programs. https://www.nwcouncil.org/fw/isab/

level or extent of change and the rate of change and the unique life history characteristics of different natural populations (Crozier et al. 2008a). 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% 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 increased to 73 degrees in July due to elevated temperatures associated with lower snowpack from the previous winter exacerbated by drought conditions due to increased occurrences of warm weather patterns.

2.2.4.1 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)). Higher ambient air temperatures will likely cause water temperatures to rise (ISAB 2007). In the northeast Pacific Ocean, sea surface temperatures from 2013-2020 were exceptionally high and coincided with widespread declines and low abundances for many west coast salmon and steelhead populations (SWFSC 2022). 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. As trends progress toward warmer oceans and streams, more extreme winter flood events, summer low flows, loss of snowpack in the mountains, and ocean acidification, salmon face increasing challenges (Ford 2022). 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 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. 2008a).

Salmonids require cold water for spawning and incubation. 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. 2008b; 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).

As climate change progresses and stream temperatures warm, thermal refugia will be essential to persistence of many salmonid populations. Thermal refugia are important for providing salmonids with patches of suitable habitat while allowing them to undertake migrations through or to make foraging forays into areas with greater than optimal temperatures. To avoid waters above summer maximum temperatures, juvenile rearing may be increasingly found only in the confluence of colder tributaries or other areas of cold water refugia (Mantua et al. 2009).

2.2.4.2 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. 2008a; 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. 2008a; 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).

2.2.4.3 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.

2.2.4.4 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). Overall, the marine heat wave from 2014 to 2016 had the most drastic impact on marine ecosystems in 2015, with lingering effects into 2016 and 2017. Conditions had somewhat returned to "normal" in 2018, but another marine heat wave in 2019 again set off a series of marine ecosystem changes across the North Pacific. One reason for lingering effects of ecosystem response is due to biological lags. These lags result from species impacts at larval or juvenile stages, which are typically most sensitive to extreme temperatures or changes in food supply. It is only once these species grow to adult size or recruit into fisheries that the impact of the heat wave is apparent (Ford 2022).

Exotic species benefit from these extreme conditions as they 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 from 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.

In marine habitat, scientists are not certain of all the factors impacting salmon and steelhead survival, but several ocean basin-scale and regional-scale events are linked with fluctuations in salmon and steelhead health and abundance, such as the Oceanic Niño Index (ONI), the Pacific Decadal Oscillation (PDO), and deep-water salinity and temperature (Ford 2022). The NWFSC's

Annual Salmon Forecast[30] provides annual summaries of these ocean indicators and additional indicators based on large-scale physical, regional-scale physical, and local-scale biological data that occur in the year of ocean entry for salmon smolts (Ford 2022). In general, years that are favorable for salmonid survival are characterized by physical conditions that include cold water along the U.S. West Coast before or after outmigration, no El Niño events at the equator, cold and salty water locally, and an early onset of upwelling. Climate change plays a part in salmon and steelhead mortality but more studies are needed.

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). This may result in changes to distribution and availability of salmon prey in the California region (Brady et al. 2017).

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 downwelling 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 (CO_2) 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).

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[30] https://www.fisheries.noaa.gov/west-coast/science-data/ocean-ecosystem-indicators-pacific-salmon-marine-survival-northern

A primarily positive or slightly negative pattern in the PDO was in place from 2014 through 2019, though since 2019 the pattern has been primarily negative[31]. The NWFSC's most recent 2022 summary of ocean ecosystem indicators[32] reported 2022 was a mix of good and bad ocean conditions for juvenile salmon in the Northern California Current. The PDO turned negative (cool phase) in January 2020 and has remained negative through 2022 with some of the lowest (coldest) values in the 25-year time series occurring in 2021 and 2022. The ONI also signaled cold ocean conditions. The ONI turned negative in May 2020 and has remained negative throughout 2022 with La Niña conditions (values less than or equal to -0.5 °C) for the last 15 consecutive three-month periods (August 2021 to October 2022). The National Weather Service Climate Prediction Center predicted ONI to remain negative throughout the winter and transition to ENSO-neutral conditions in February-April 2023. Despite the lackluster upwelling, the northern copepod biomass anomalies and copepod species richness showed signs of cool conditions in the spring and early summer. Still, the anomalies of northern copepods turned weakly negative by mid-summer, resulting in average biomass anomalies for the May–September period. Weakly positive temperature anomalies occurred in June 2022, following weak upwelling conditions. Strongly positive temperature anomalies followed in July through September. Cool and neutral temperature anomalies returned in September, and the remainder of fall was punctuated by strong positive anomalies. The existing regional climate cycles will interact with global climate changes in unknown and unpredictable ways[5].

2.2.4.5 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. (2008a); 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. 2008b; 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

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[31] https://www.ncei.noaa.gov/access/monitoring/pdo/

[32] https://www.fisheries.noaa.gov/west-coast/science-data/2022-summary-ocean-ecosystem-indicators

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 bio-ecological changes to fish or food webs in response to these physical/chemical changes is extremely limited, leading to considerable uncertainty.

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 in the south.

There are two proposed actions that relate to management of the salmon fisheries in SEAK – the first action (delegation) relates specifically to management in the EEZ and the second action (funding to the State to implement the 2019 PST Agreement) relates to management of salmon fisheries throughout SEAK. These SEAK fisheries occur in 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 salmon fisheries take listed Chinook salmon and have the potential to affect listed humpback whales and Steller sea lions where the fisheries occur, thus the area where the fisheries occur is included in the action area. In addition, the SEAK salmon fisheries catch Chinook salmon that would otherwise be available to the SRKW as they forage throughout their range. Chinook salmon stocks caught in the SEAK salmon fisheries 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 salmon fisheries, which for Chinook salmon stocks originating from the Columbia River have the farthest ranging migratory pattern that extends from SEAK to the northern California coast (see Figure 42 for reference).

The action area for this Opinion therefore includes fishing areas in SEAK and the marine areas from the Queen Charlotte Islands to the northern California coast, including coastal marine waters in Washington, Oregon, and California, including the marine waters of Puget Sound.

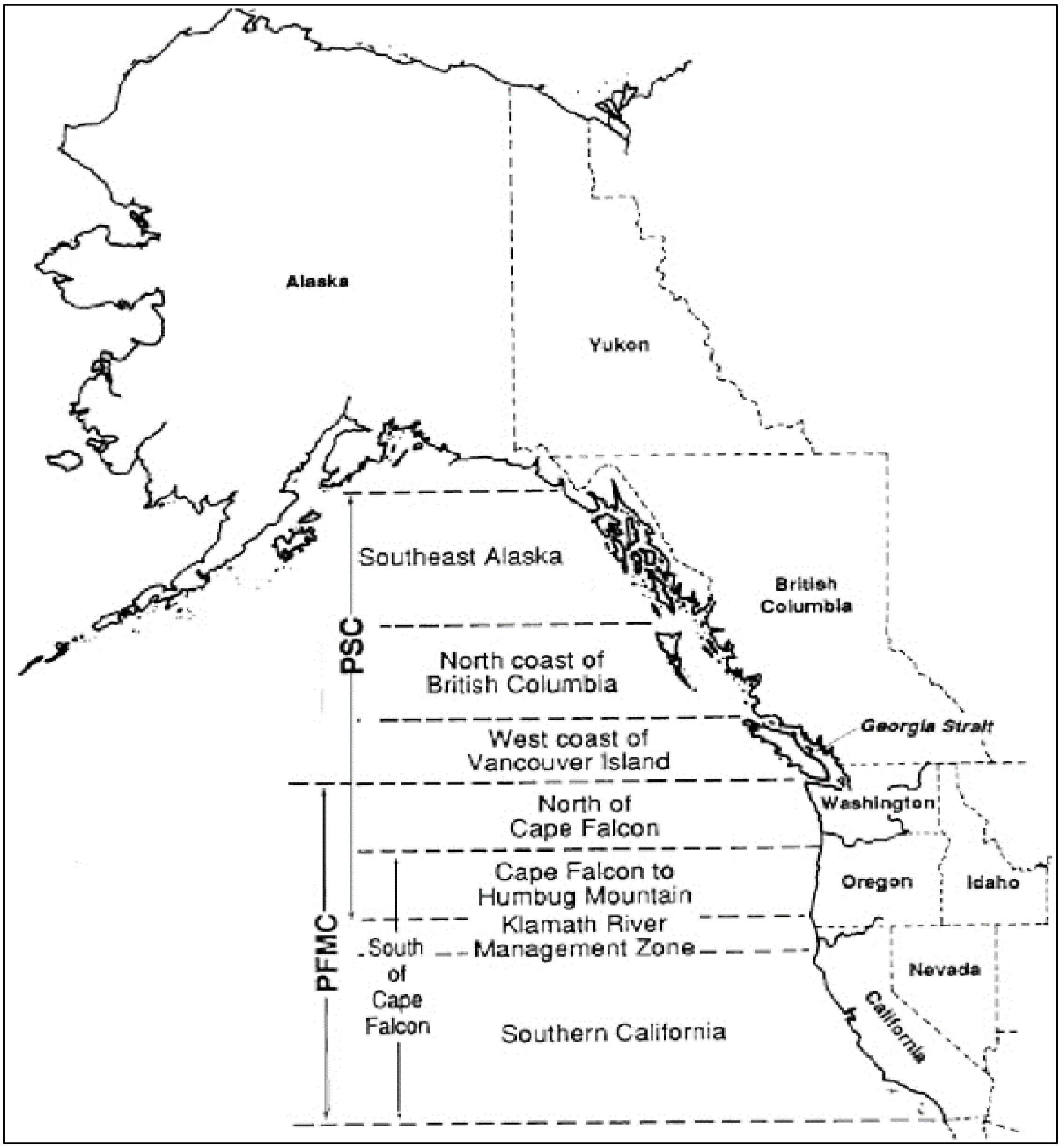

Figure 42. Areas managed subject to the authority of the PSC and the Pacific Fishery Management Council (PFMC) and various geographic subdivisions of each that are referenced throughout this Opinion. Note that Southeast Alaska is subject to the authority of the North Pacific Fishery Management Council (Also see Figure 2 above in Proposed Federal Action Section 1.3)

2.4 Environmental Baseline

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. 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 consultations, and the impact of State or private actions which are contemporaneous with the consultation in process. The impacts to listed species or designated critical habitat from federal agency activities or existing federal agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

The environmental baseline for the species affected by the proposed actions includes the effects of many activities that occur across the action area considered in this Opinion. In Section 2.2.4, we describe the on-going and anticipated temperature and marine effects of climate change on fish species, and in Section 2.2.3.1.4, we describe the impacts of climate change on SRKWs. Because the impacts of climate change are ongoing, the effects are reflected in the most recent biological viability assessment for Pacific Northwest salmon and steelhead (Ford 2022) and summarized in Section 2.2.4, Climate Change of this Opinion. Changes in climate and ocean conditions happen on several different time scales, as explained in Section 2.2.4, and have had a profound influence on distributions and abundances of marine and anadromous fishes. Evidence suggests that marine survival among salmonids fluctuates in response to 20- to 30-year cycles of climatic conditions and ocean productivity. Recalling the more detailed discussion about the likely effects of large-scale environmental variation on salmonids described in Section 2.2.4 across their entire range, effects in the environmental baseline that may occur from climate change on salmon in the marine ecosystem include warmer water temperatures, loss of coastal habitat due to sea level rise, ocean acidification, and changes in water quality and freshwater inputs (Mauger et al. 2015). In Section 2.2, we summarized the limiting factors for each of the Chinook salmon ESUs. Because the action area comprises solely marine waters, the discussion here encompasses known 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 salmon species in the action area first, and then to discuss the baseline for the affected marine mammal species.

2.4.1 Fisheries

In the Status of the Species section we provided an overview of the long-term trends in the fishery ERs of ESA-listed Chinook salmon and efforts made to address harvest as a limiting factor for each of the Chinook salmon ESUs. Recall that ERs used throughout this document are the proportion of the total return of adult salmon in a given year that die as a result of fishing activity including both the harvest (retained fish caught in the fishery) and any fish that die as a result of injury from encountering fishing gear. In this section, we provide more detail about the magnitude and distribution of harvest activities in recent years. In particular, we detail the magnitude of fishing-related mortality that occurred between 1999 and 2018 and how that mortality was distributed across marine area fisheries in the action area. The estimates of ERs are derived from post-season runs using the 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.

The harvest impacts on listed Chinook salmon ESUs from salmon fisheries are described in some detail in the discussion of the status of the species that considers harvest in the context of limiting factors (Section 2.2.1). U.S. fisheries that affect the action area have been consulted on previously and their effects are considered in the environmental baseline. These effects are reflected in annual escapements listed for each ESU in Section 2.2.1.

2.4.1.1 Southeast Alaska (SEAK) Salmon Fisheries

The effects of the future SEAK salmon fisheries are effects of the proposed actions and thus are discussed in Section 2.5, the Effects of the Action. In the environmental baseline, we describe the effects of past SEAK salmon fisheries. The SEAK salmon fisheries have caught a mix of Alaska origin, Canada origin, and Washington/Oregon/Idaho origin Chinook salmon. This includes fish from the four ESA-listed ESUs discussed in the Status of the Species section.

The effects of the past SEAK salmon fisheries include reducing the abundance of these fish. Over time, fishery impacts on Chinook salmon originating from the Pacific Northwest have been reduced as new PST Agreements have been negotiated. In our 1999 Opinion, NMFS considered the effects on listed species resulting from SEAK fisheries managed under the regime for the 1999 summer and 1999/2000 winter seasons. NMFS subsequently completed consultation on the full scope of the 1999 PST Agreement on November 18, 1999 (NMFS 1999a). Once the ESA and funding contingencies were satisfied, the 1999 PST 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 PST 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 PST Agreement (NMFS 2008a).

As discussed in the description of the proposed action, salmon fisheries in SEAK and some Canadian salmon fisheries are managed under an AABM regime, while other Canadian and all SUS west coast salmon fisheries are managed to achieve objectives for specific salmon stocks. For the SUS west coast salmon fisheries, objectives for specific stocks, including the four ESA listed ESUs addressed in this Opinion, are described in terms of total catch and/or total SUS fishery mortality limits, thus the effects of northern fisheries are incorporated into the objectives. In this subsection we describe quantitatively the past effects of each of the marine area salmon fisheries, including SEAK salmon fisheries, in the action area, to provide a picture of relative and combined impacts of these fisheries on the listed Chinook ESUs. This is followed by more detailed discussions of the salmon fisheries in the marine areas south of SEAK.

Additionally, while we recognize that the future effects of the salmon fisheries other than the SEAK salmon fisheries are technically part of the environmental baseline, to provide context for our analysis of the effects of the SEAK salmon fisheries and to most effectively present the combined effects of the salmon fisheries, we discuss those future fishery effects in the Section 2.5 of this Opinion (Effects of the Action). The environmental baseline describes the historic effects of the salmon fisheries, with a focus on the period 1999-2018, when previous PST Agreements were in effect.[33] This discussion provides context for the Effects discussion and describes the effects fisheries have had on the affected ESUs in the past.

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[33] While fisheries have occurred since 2018, these were managed under the 2019 PST Agreement and would thus have effects similar to those described in the Effects section. In addition, FRAM results are not available for 2 years following closure of any given year's salmon fisheries.

During the past two PST Agreements (the 1999 and 2009 Agreements, mentioned in Section 1.3) an all-gear allowable catch limit that counted towards PST obligations for the SEAK AABM salmon fishery has been determined in time for the opening of the SEAK early winter troll fishery[34]. This total allowable catch limit for treaty Chinook is allocated among troll, net, and sport fisheries through regulations established by the Alaska Board of Fisheries. Federal funding for management of the SEAK salmon fisheries has generally accompanied past PST Agreements, and been awarded to the State of Alaska, similar to the proposed action consulted on in this Opinion. As detailed in Section 1.3 (Proposed Action), the State develops and implements management plans for fisheries in state waters to allocate fish through state management plans. As with the commercial salmon troll fishery, the FMP governs sport fishing for salmon in the East Area with management delegated to the State of Alaska, and the State manages the commercial troll and sport fisheries without differentiating between the EEZ and State waters. After allocations to the net fisheries (drift and set gillnet and purse seine fisheries) are deducted from the all-gear allowable catch limit that is counted towards PST obligations, the remaining catch limit is allocated to troll (80%) and sport (20%) fisheries. Certain fisheries and fish are not allocated any portion of the Chinook salmon catch that counts towards PST obligations because they are either focused on production returning to Alaskan State hatchery facilities and rivers or are managed under provisions of other Chapters of the PST Agreement. In this section we will describe past salmon fisheries in SEAK, as those affect the current conditions and status of listed Chinook in the action area.

For the following subsections, recall the ER of each life history component (or stock) in a specific fishery is the percentage of the total mortality of the stock, in marine and freshwater, that occurred in the specific fishery identified. We further delineate the marine area exploitation as the ER of the stock of all of the fisheries occurring in marine waters (SEAK, Canadian, PFMC, Puget Sound, and Washington Coast) for a marine area harvest ER.

LCR Chinook Salmon ESU

The LCR Chinook Salmon ESU has three components including spring stocks, tule stocks, and far-north migrating bright stocks (See Status Section 2.2.1 for more detail). These components have different distributions and are subject to different rates of exploitation in the fisheries that affect them. For one of these LCR Chinook Salmon ESU components, the tule fall component, SUS salmon fisheries are managed to keep the total ER for all marine fisheries combined with Columbia River fisheries up to Bonneville Dam within certain limits. SEAK salmon fisheries are not managed to meet ERs for LCR Chinook salmon, but their impacts on tule stocks are considered in management of the SUS salmon fisheries, as described in more detail below.

Table 35. LCR Chinook Salmon ESU exploitation in marine area fisheries between 1999 and 2018.

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[34] Three terminal area fisheries are not allocated fish that count towards PST obligations in the Situk, Taku, and Stikine Rivers. All fisheries have been sampled for CWTs, which are processed and used to determine the proportion of catch comprised of Alaska hatchery fish.

LCR Chinook Salmon components	**SEAK Exploitation**	**Canadian Exploitation**	**PFMC Exploitation**	**Puget Sound Exploitation**	**WA Coast Bays**	**Marine Area Exploitation**[1]
	Average 1999 – 2018					
Spring	1.9%	5.9%	9.0%	0.1%	0.0%	16.9%
Tule fall	2.3%	16.1%	13.0%	0.2%	0.1%	31.8%
Bright (late-fall)	10.5%	22.6%	16.5%	0.0%	0.0%	49.6%

1. Freshwater Columbia River terminal fisheries are not included.

LCR spring Chinook salmon are not subject to specific exploitation impact limits for SUS marine area fisheries. NMFS concluded in its consultation for the PFMC salmon fisheries that management constraints for other stocks provide adequate protections (NMFS 2012f). ERs for LCR spring Chinook salmon in all marine area fisheries ranged between 10.9 and 23 % from 1999 to 2018, but were notably higher in 2002 and 2012 with the increases occurring mostly in southern west coast U.S. fisheries (Figure 43). Between 1999 and 2018 the ER on LCR spring Chinook salmon in marine area fisheries averaged 16.9% (Table 35). The ER in the SEAK fishery between 1999 and 2018 was 1.9% (Table 35), which accounted for an average of 11.5% of the marine area exploitation (Figure 44).

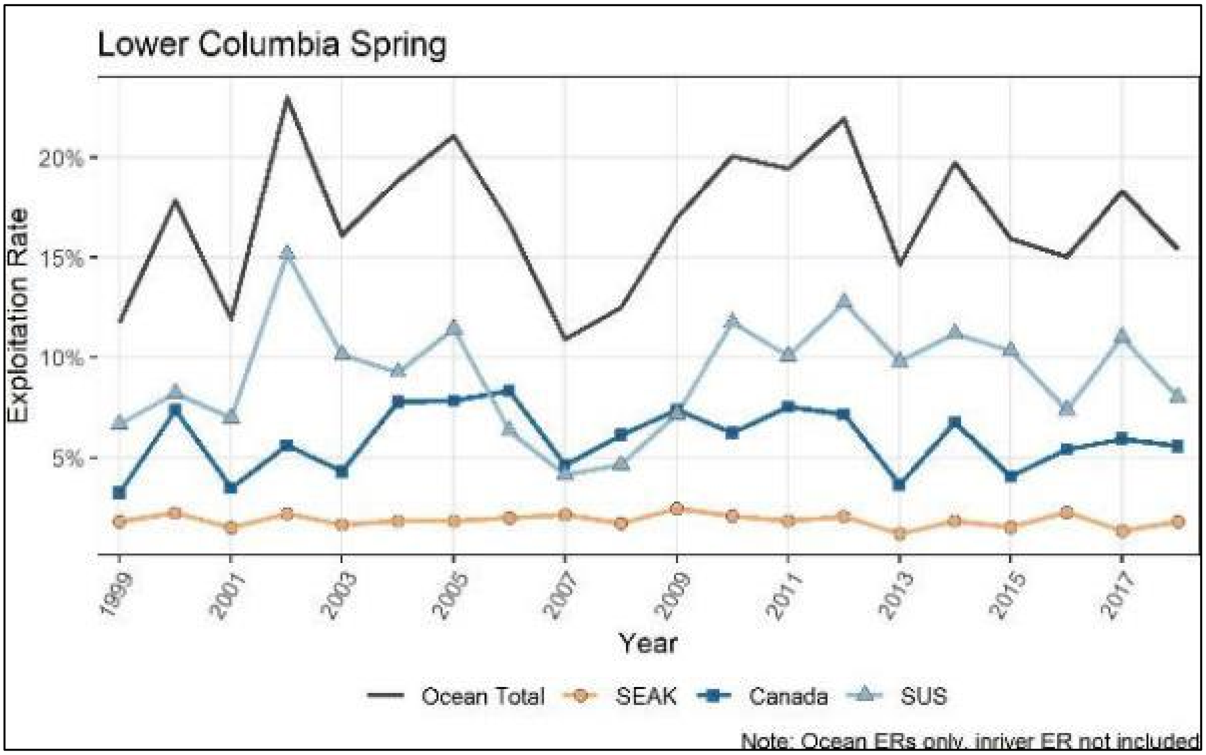

Figure 43. LCR spring Chinook salmon adult equivalent calendar year ocean ERs between 1999 and 2018 from FRAM model runs using actual post-season fishery catches and best available estimates of annual stock abundances.

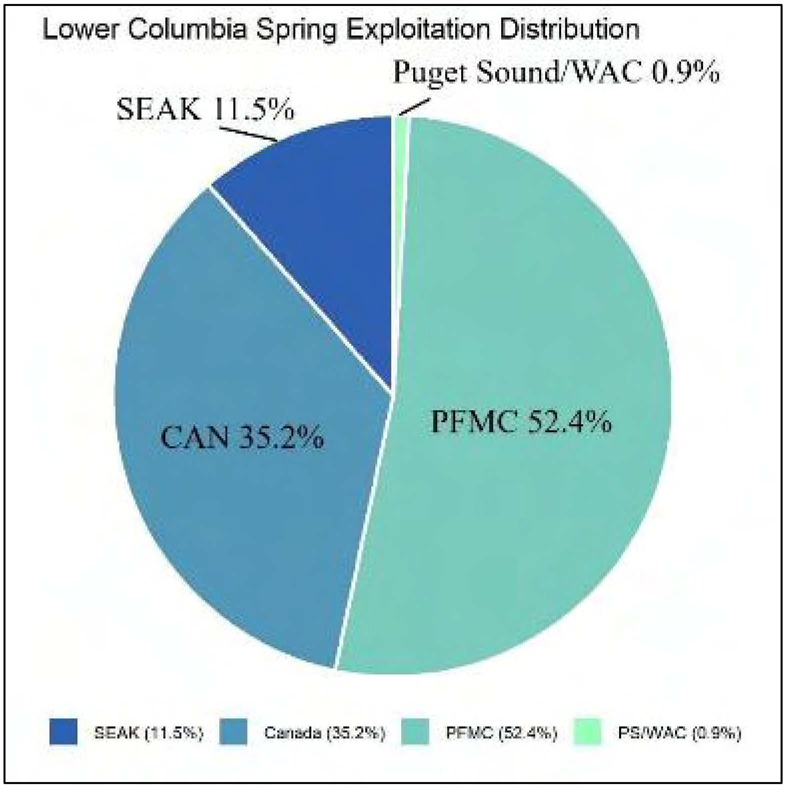

Figure 44. LCR spring Chinook salmon average exploitation distribution in marine area fisheries between 1999 and 2018.

SUS salmon fisheries have been managed subject to a total ER for the tule component of the LCR Chinook Salmon ESU (marine fisheries and mainstem Columbia River fisheries below Bonneville Dam), and the ER in the SEAK and Canadian salmon fisheries is accounted for in this total ER (NMFS 2012f). The ER limit for tule Chinook salmon has declined over the years as reflected in a series of consultations on SUS fisheries from 65% in 2001 to the current abundance-based management framework that allows the ER to vary from 30 to 41 % 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 very low (Table 35). LCR tule Chinook salmon are caught primarily in Canadian and SUS west coast salmon fisheries (Figure 45). Nonetheless, the current management framework for the PFMC fisheries requires that the impacts of all West Coast salmon fisheries, excluding those upstream of Bonneville Dam in freshwater areas, are accounted for in the total ER limit (NMFS 2012f). ERs in marine area fisheries have declined since 2005 (Figure 45). Between 1999 and 2018 the ER on LCR tule populations in marine area fisheries averaged 31.8% (Table 35). The ER in the SEAK fishery averaged 2.3% in this time period and accounted for 7.3% of the marine area exploitation of LCR tule Chinook salmon (Figure 46).

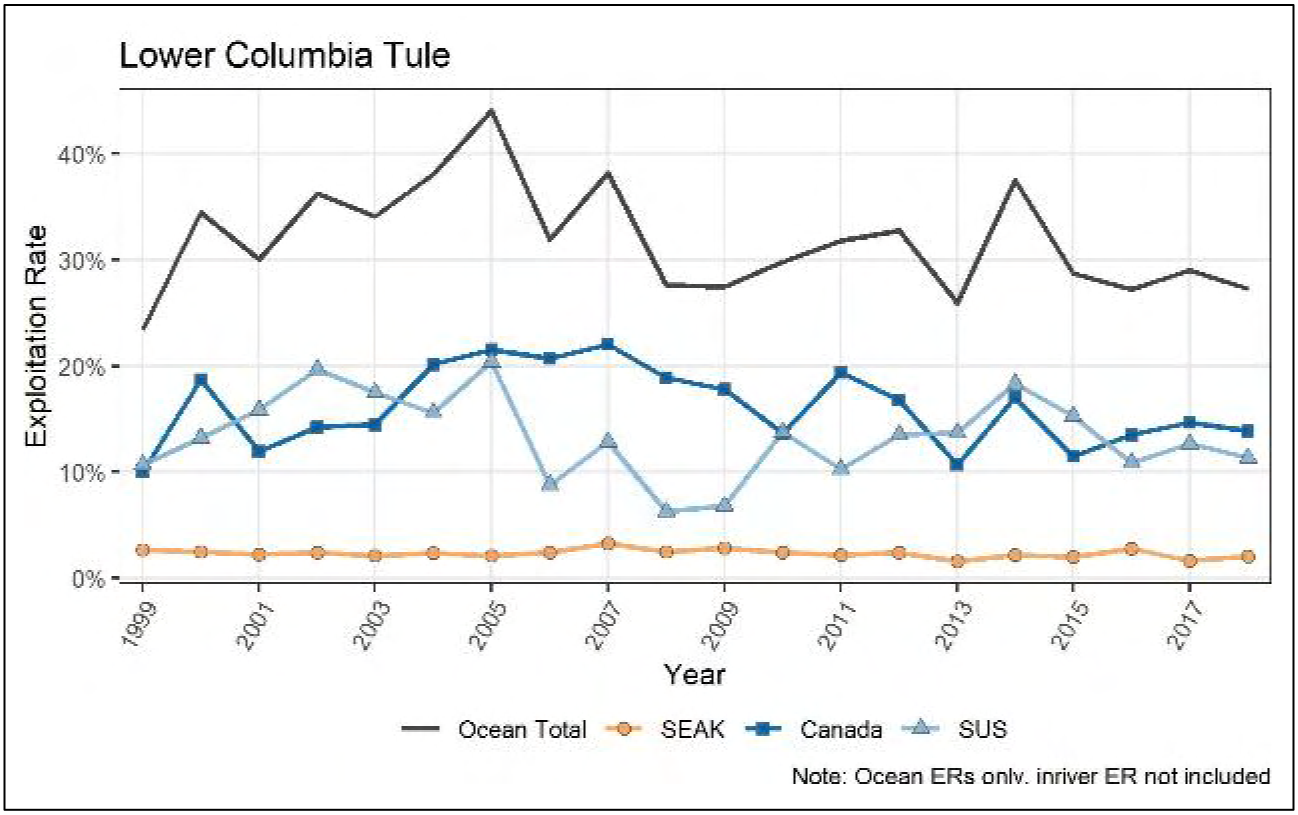

Figure 45. LCR tule Chinook salmon adult-equivalent calendar year ERs between 1999 and 2018 from FRAM model runs using actual post-season fishery catches and best available estimates of annual stock abundances.

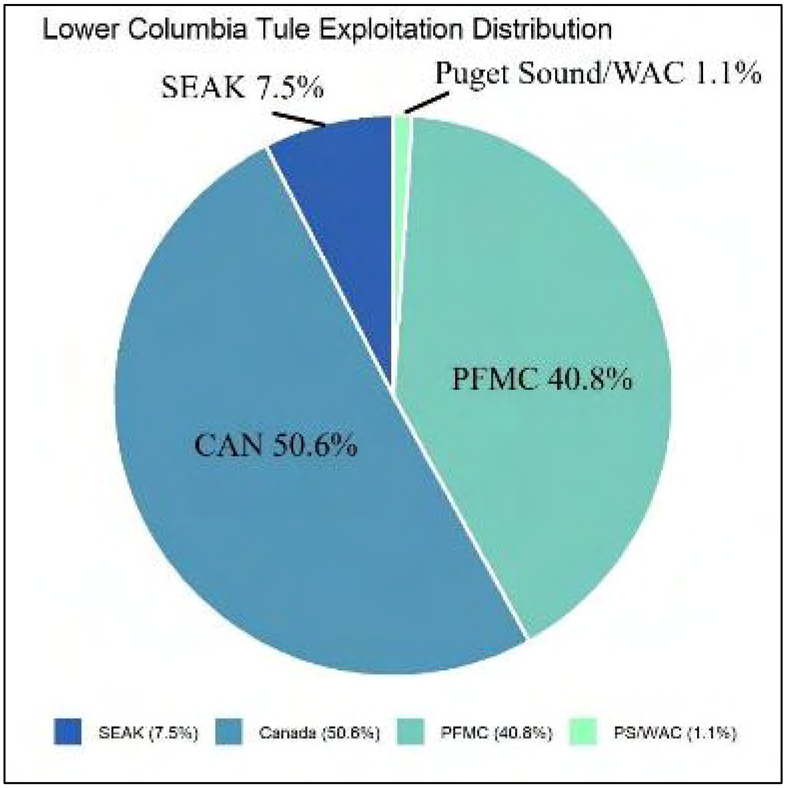

Figure 46. LCR tule fall Chinook salmon average exploitation distribution in marine area fisheries between 1999 and 2018.

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, there is not a specific ER limit for the bright component applied in any marine area fisheries. In its consultation for the PFMC fisheries, NMFS concluded the impact limit framework for LCR tule Chinook salmon along with an escapement goal specific to the North Fork Lewis River fall Chinook salmon population to be sufficient to limit fishery impacts to the ESU as a whole, so fishery managers do not apply a specific impact limit to the bright component (NMFS 2012f). 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 47). The ER on LCR bright populations, using the North Fork Lewis River fall Chinook salmon population as the indicator stock, averaged 49.6% in marine area fisheries and 10.5% in SEAK the fishery between 1999 and 2018 (Table 35). The SEAK fishery accounted for 21.1% of the overall marine area harvest (Figure 48).

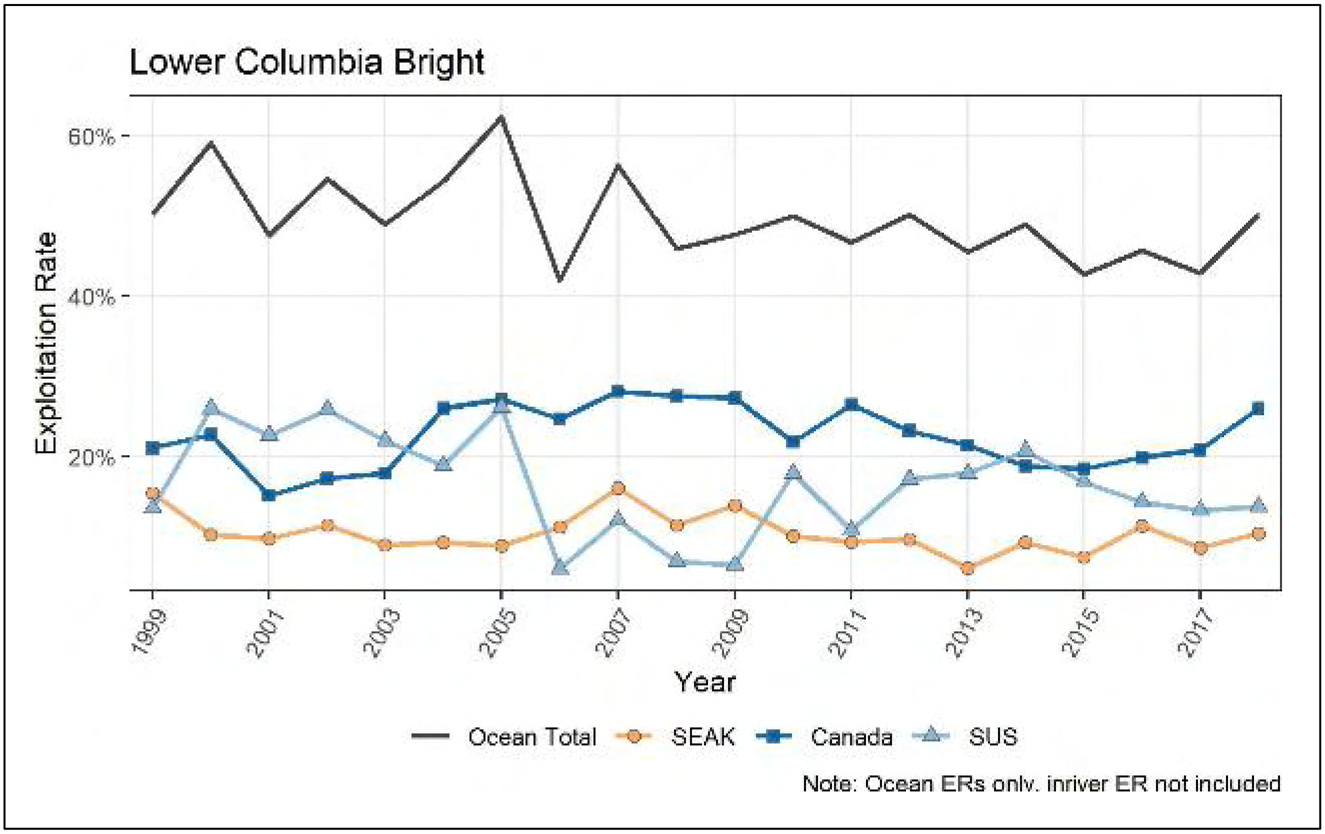

Figure 47. LCR bright Chinook salmon exploitation between 1999 and 2018 from FRAM model runs using actual post-season fishery catches and best available estimates of annual stock abundances.

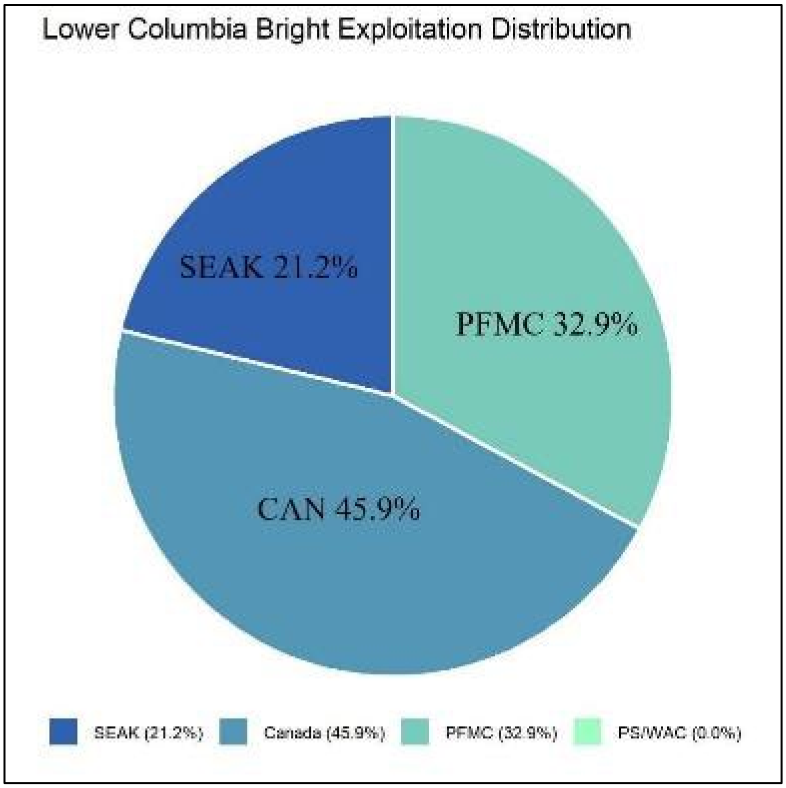

Figure 48. LCR bright fall Chinook salmon average exploitation distribution in marine area fisheries between 1999 and 2018.

Upper Willamette Spring Chinook Salmon ESU

UWR Chinook salmon are a far-north migrating stock. The ER on UWR Chinook salmon in marine area fisheries was generally low between 1999 and 2018 (Table 36). As discussed in the Status Section 2.2.2.2, most of the harvest-related conservation constraints for UWR Chinook salmon occur in freshwater fisheries, which are outside the action area. The limit in those fisheries is a maximum freshwater mortality rate for naturally produced Chinook salmon of 15%. Fishery managers do not apply a specific impact limit for UWR Chinook salmon in marine area fisheries. While the total marine area ER is generally low (Table 36), 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 southern west coast salmon fisheries, and are thus impacted less heavily in those fisheries. ER estimates in marine area fisheries have been relatively stable since 1999 (Figure 49). ERs on UWR Chinook salmon from 1999 to 2018 have averaged 8.3% in marine area fisheries and 3.8% in SEAK (Table 36). SEAK fisheries accounted for 45.4% of the marine area exploitation of UWR Chinook salmon between 1999 and 2018 (Figure 50).

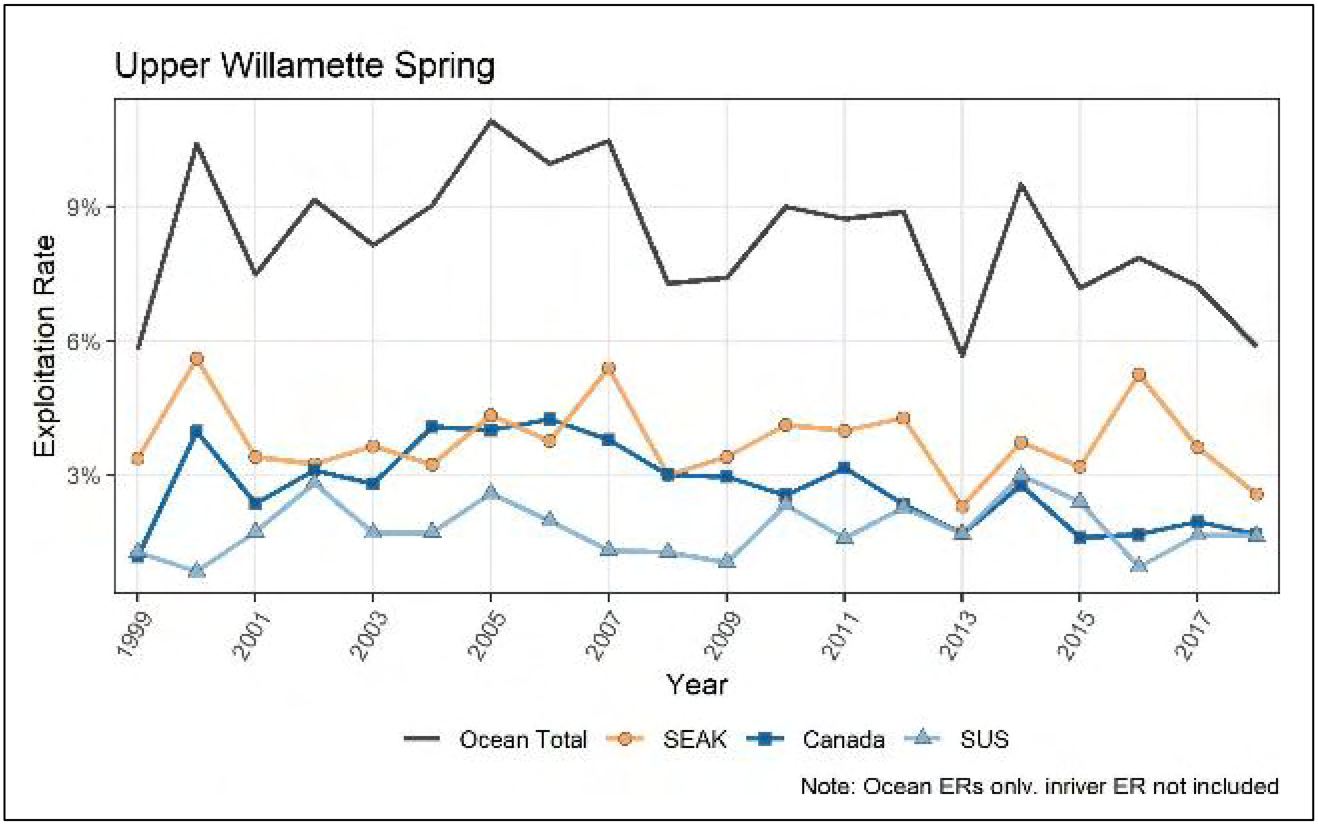

Figure 49. UWR Chinook Salmon adult equivalent calendar year exploitation between 1999 and 2018 from FRAM model runs using actual post-season fishery catches and best available estimates of annual stock abundances.

Table 36. UWR Chinook Salmon ESU exploitation in marine area fisheries between 1999 and 2018.

ESU	**SEAK Exploitation**	**Canadian Exploitation**	**PFMC Exploitation**	**Puget Sound Exploitation**	**Marine Area Exploitation**
	Average 1999 – 2018				
UWR Chinook Salmon	3.8%	2.7%	1.7%	0.1%	8.3%

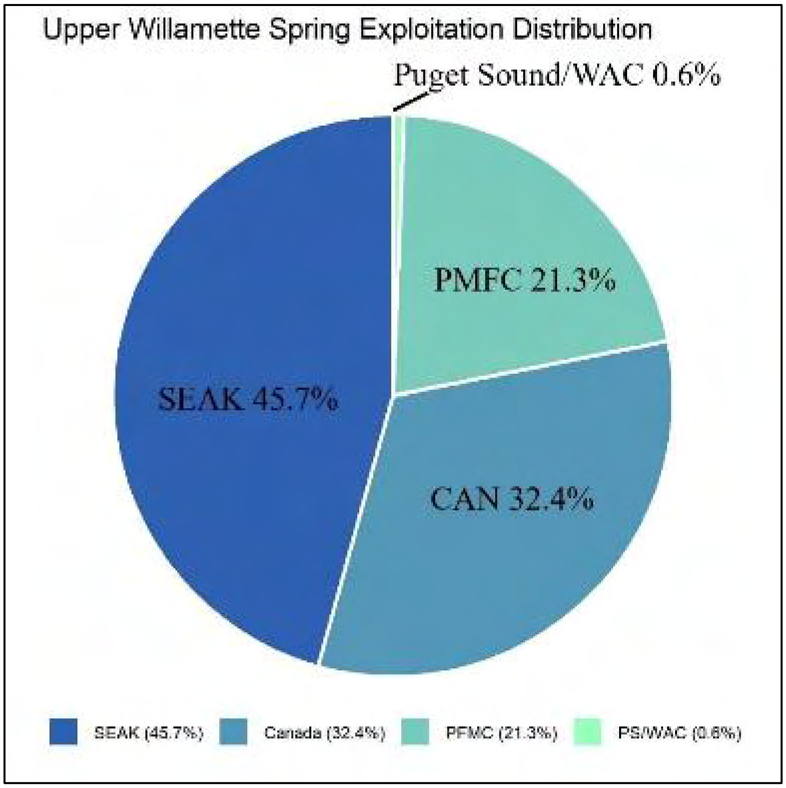

Figure 50. UWR Chinook Salmon ESU average exploitation distribution in marine area fisheries between 1999 and 2018.

Snake River Fall-run Chinook Salmon ESU

SRFC salmon have a broad marine area distribution that ranges from Oregon to SEAK. NMFS concluded in the 2008 Biological Opinion (NMFS 2008a) on the 2009 PST Agreement that an age-3 and age-4 adult equivalent total marine area ER for the SEAK, Canadian, and PFMC marine area fisheries combined of 30% less than the ER for the 1988 to 1993 base period is not likely to jeopardize this ESU. As mentioned in the Status Section 2.2.2.3, there is a separate standard used for managing freshwater fisheries. The 30% reduction standard is generally reported as a proportion (referred to as the Snake River fall-run Chinook index (SRFI)) of the base period ER. A 30% 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% standard. An index of 0.60 equates to a 40% reduction in ER relative to the base period average. This standard has been in use since the mid-1990s and is described in more detail in the Biological Opinion on the 1999 PST Agreement (NMFS 1999a). Although the index is considered each year against the proposed salmon fisheries during the PFMC preseason planning process, it has not constrained any marine fisheries in recent years.

Post season estimates of the SRFI index are shown in Figure 51 and compared to the 0.70 index indicating the index has averaged 0.61 since 1994 meaning that the marine area ER has been reduced by nearly 40% and that the 30% reduction has been achieved over the long-term.

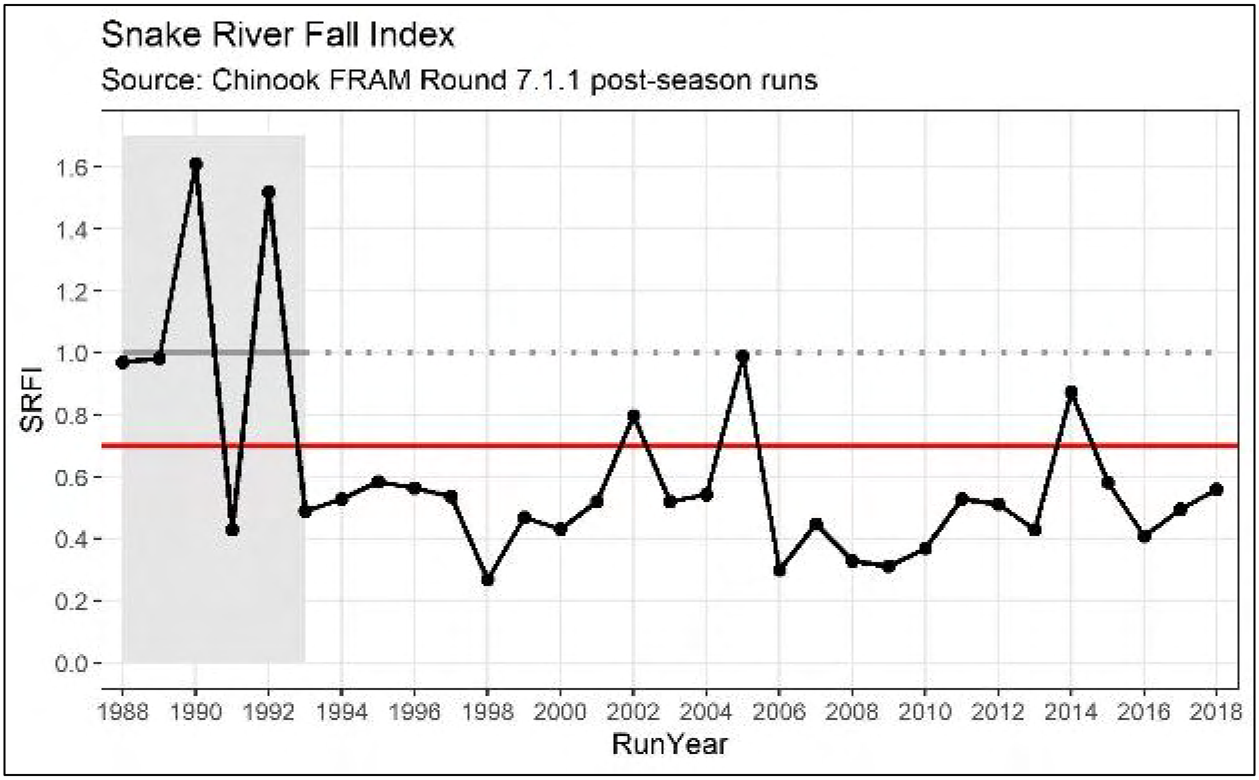

Figure 51. The SRFI. The horizontal lines show the 1988 to 1993 average (1.0) and a value of 0.70 which represents the 30% reduction in the base period average.

The SRFI approach was developed shortly after the SRFC salmon were listed and at a time when data related to harvest of SRFC salmon 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 estimate ERs more directly. The FRAM model is used here to report ERs in marine area fisheries; these have varied between roughly 30 and 50 % since 1999 with the greatest variability occurring in the SUS west coast salmon fisheries. ERs on SRFC salmon have averaged 30.4% in marine area fisheries (Figure 52). NMFS consulted on SUS west coast salmon marine fisheries using the SRFI approach and determined that was not likely to jeopardize the continued existence of SRFC Salmon ESU (NMFS 1996). The SRFC salmon ER in SEAK fisheries averaged 1.2% between 1999 and 2018 (Table 37) and accounted for 3.8% of marine area exploitation (Figure 53).

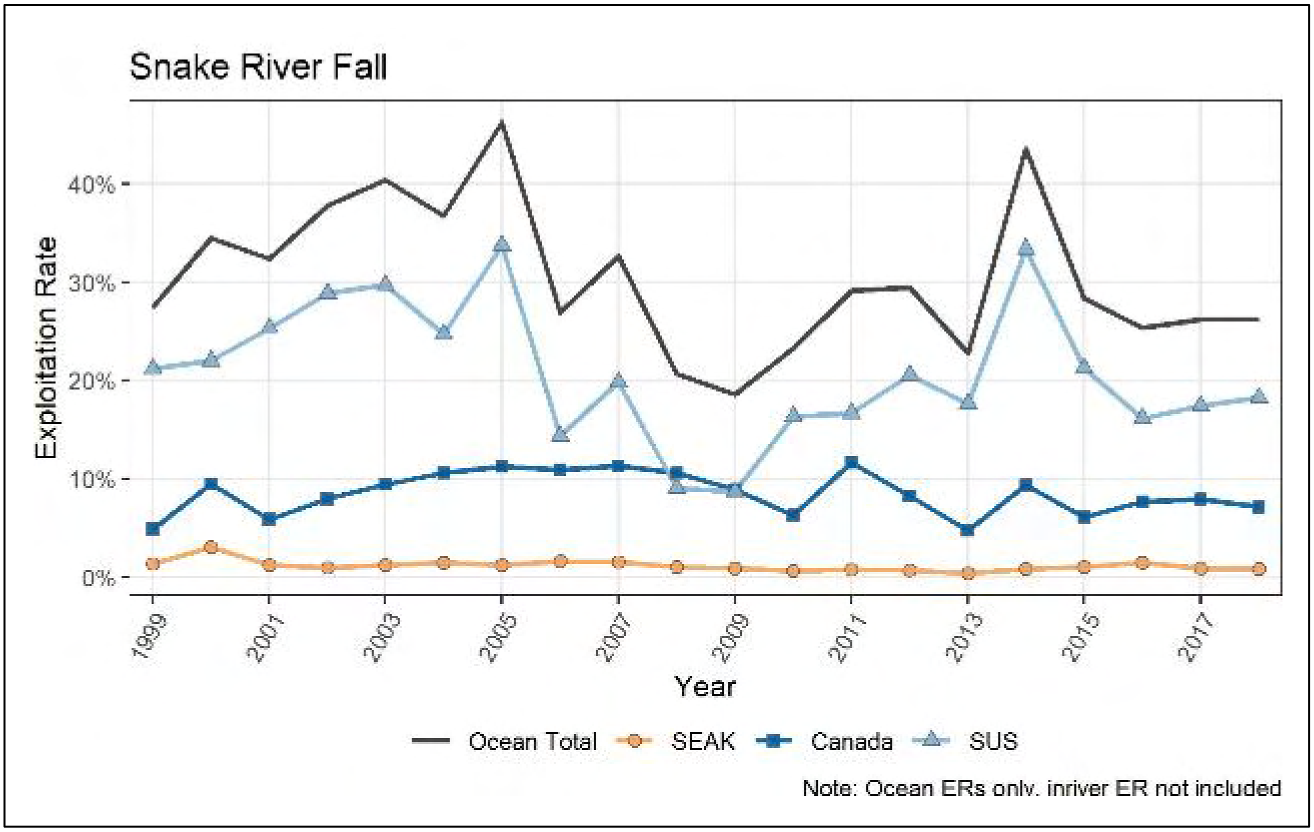

Figure 52. SRFC salmon adult-equivalent calendar year exploitation between 1999 and 2018 from FRAM model runs using actual post-season fishery catches and best available estimates of annual stock abundances.

Table 37. SRFC Salmon ESU exploitation in marine area fisheries between 1999 and 2018.

ESU	**SEAK Exploitation**	**Canadian Exploitation**	**PFMC Exploitation**	**Puget Sound Exploitation**	**Marine Area Exploitation**
	Average 1999 – 2018				
SRFC salmon	1.2%	8.5%	20.5%	0.3%	30.4%

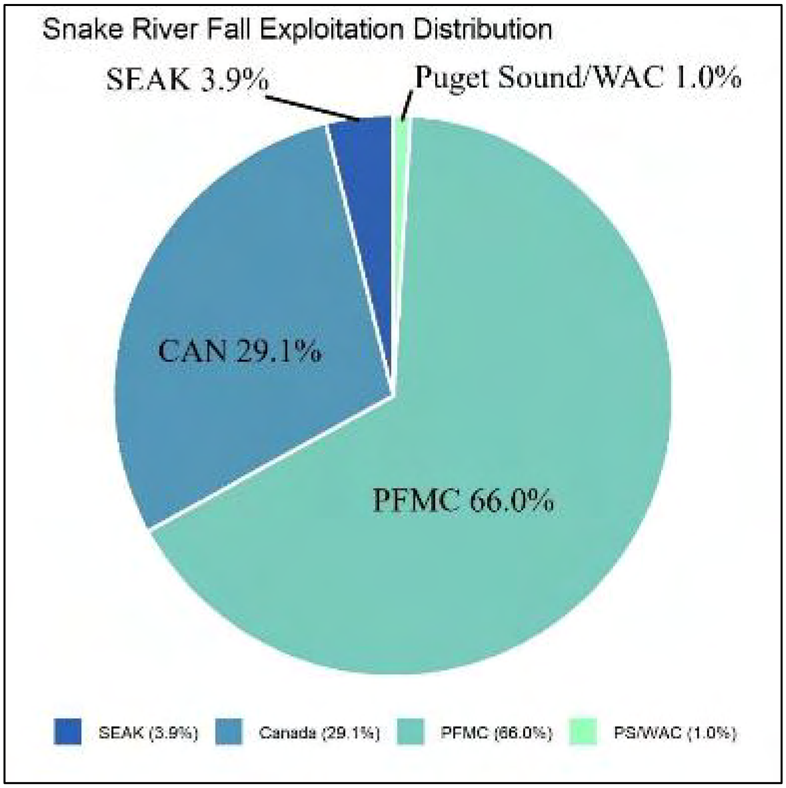

Figure 53. SRFC Salmon ESU average exploitation distribution in marine area fisheries between 1999 and 2018.

Puget Sound Chinook Salmon ESU

As discussed in Section 2.2.2.1 the Puget Sound Chinook Salmon ESU comprises 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. The Puget Sound Treaty Tribes and State of Washington manage Puget Sound salmon fisheries to stay within impact limits that have been developed on an annual basis. These limits are specific to each management unit (comprised of one or more populations) and vary considerably depending on the status of each unit. They are generally expressed as total ER or SUS west coast ER limits, thus they take into account some or all of the impacts of other marine fisheries. The management objectives used in Table 38 have generally been used in recent years and are described in the Biological Opinion on federal actions related to the proposed 2024 Puget Sound salmon fishing season (NMFS 2024c). The Puget Sound co-managers have submitted a new long-term RMP with conservation objectives they expect to use for management for the next decade, and these are similar to the objectives used to plan the 2024 fishing season

Table 38. Example Puget Sound Chinook salmon conservation objectives used to plan the 2024 fishing season (May 15, 2024 thru May 14, 2025)(from NMFS 2024c).

Management Unit/Population	Puget Sound Chinook Total, Southern US (SUS) and Pre-terminal SUS (PT SUS) Exploitation Rate Limits

	Upper Exploitation Rate Ceilings	Exploitation Rate Ceiling or Moderate Management Exploitation Rate Ceiling	Critical Exploitation Rate ceilings
Nooksack spring NF Nooksack SF Nooksack	-	-	10.9% SUS [1]
Skagit Summer/Fall Upper Skagit Lower Skagit Lower Sauk	-	52%	15% SUS
Skagit Spring Suiattle Upper Sauk Cascade	-	36%	10.7% SUS
Stillaguamish NF Stillaguamish SF Stillaguamish	13% SUS	9% SUS	9% SUS [2]
Snohomish[3] Skykomish Snoqualmie	10.3% SUS	9.3% SUS	8.3% SUS
Lake Washington Cedar River	14-15% PT SUS [4]	18% SUS	12% SUS
Green	14-15% PT SUS [4]	18% SUS	12% SUS
White River	-	22% SUS	15% SUS
Puyallup	14-15% PT SUS [4]	30% SUS	15% SUS
Nisqually	-	47%	Up to 50% reduction in SUS ER to meet LAT
Skokomish	-	50% [5]	12% PTSUS
Mid-Hood Canal	-	-	[6]
Dungeness	-	10% SUS	6% SUS
Elwha	-	10% SUS	6% SUS

[1] Nooksack SUS ER may increase above 10.9%, up-to 14.1%, in one of every five years.

[2] When the Stillaguamish terminal run size is forecasted to be below the LAT, the Co-managers will implement further guidelines, as described in the 2022 Puget Sound Chinook RMP, that could result in a SUS ER limit below 9%.

[3] Generally, SUS fisheries will be managed so that the total ER on the Snohomish MU would not exceed 20%. However, depending on the planned ER in northern fisheries, annual SUS fisheries may be planned up to the SUS ER limits described in this table, which may result in total ERs exceeding 20%.

[4] Pre-terminal SUS ER limits for the mid-Sound fall Chinook management units will be 14% when all three populations are forecasted to exceed their first level upper management threshold (UMT) spawning ground escapement estimates, based on terminal run size forecast (UMT 1: Lake WA=500; Green=4,500; Puyallup=1,538) and up to 15% when all three populations are forecasted to exceed their UMT 2 spawning ground escapement estimates, based on terminal run size forecast (Lake WA=500; Green=6,700; Puyallup=1,895).

[5] Up to 50 percent total ER when forecasted total escapement is higher than 1,650 to the natural spawning grounds and 2,000 to the hatchery. When forecasted total escapement is under the LAT, pre-terminal SUS rate will be limited to 12% and terminal fishery management actions will be taken to increase escapement.

[6] Puget Sound salmon fisheries impacts to the Mid-Hood Canal population shall be managed to have a negligible impact on the status of the population, from reductions in the number of spawning Chinook in the mid-Hood Canal streams. Based on recent assessments in NMFS' Puget Sound biological opinions (2018-2022), the

appropriately conservative level of impact is a spawner-reduction from Puget Sound fisheries of no more than four spawners.

The trends in total ERs for the Puget Sound management units vary considerably. Most have been relatively stable since 1999, but some show increasing trends over time (e.g., Skagit River summer/fall, Skokomish, Green, Puyallup) while others show decreasing trends (e.g., Nooksack, Stillaguamish, Elwha, Dungeness) (Figure 54 through Figure 56). The distribution of ERs among SEAK, Canadian, and southern west coast U.S. salmon fisheries also varies considerably (Figure 54 - Figure 56). The Nooksack and Stillaguamish populations are more vulnerable to harvest in Canada and have an ER that averages 23.3% and 20.5% respectively (Table 39). The ER on Strait of Juan de Fuca populations (Elwha and Dungeness) is relatively lower averaging 18.6% and 18.5% respectively. Canadian ERs on South Puget Sound populations range from 9.6% to 14.2%. For mid-Puget Sound populations, ERs range from 14.6% to 20.5%. With the exception of Skagit River summer/fall and Nooksack spring Chinook salmon populations, ERs in SEAK fisheries are less than 2% (Table 39). The proportion of the total exploitation that occurs in the SEAK fishery also varies by management unit, but ranges from 0.1% to 18.2% (Table 40).

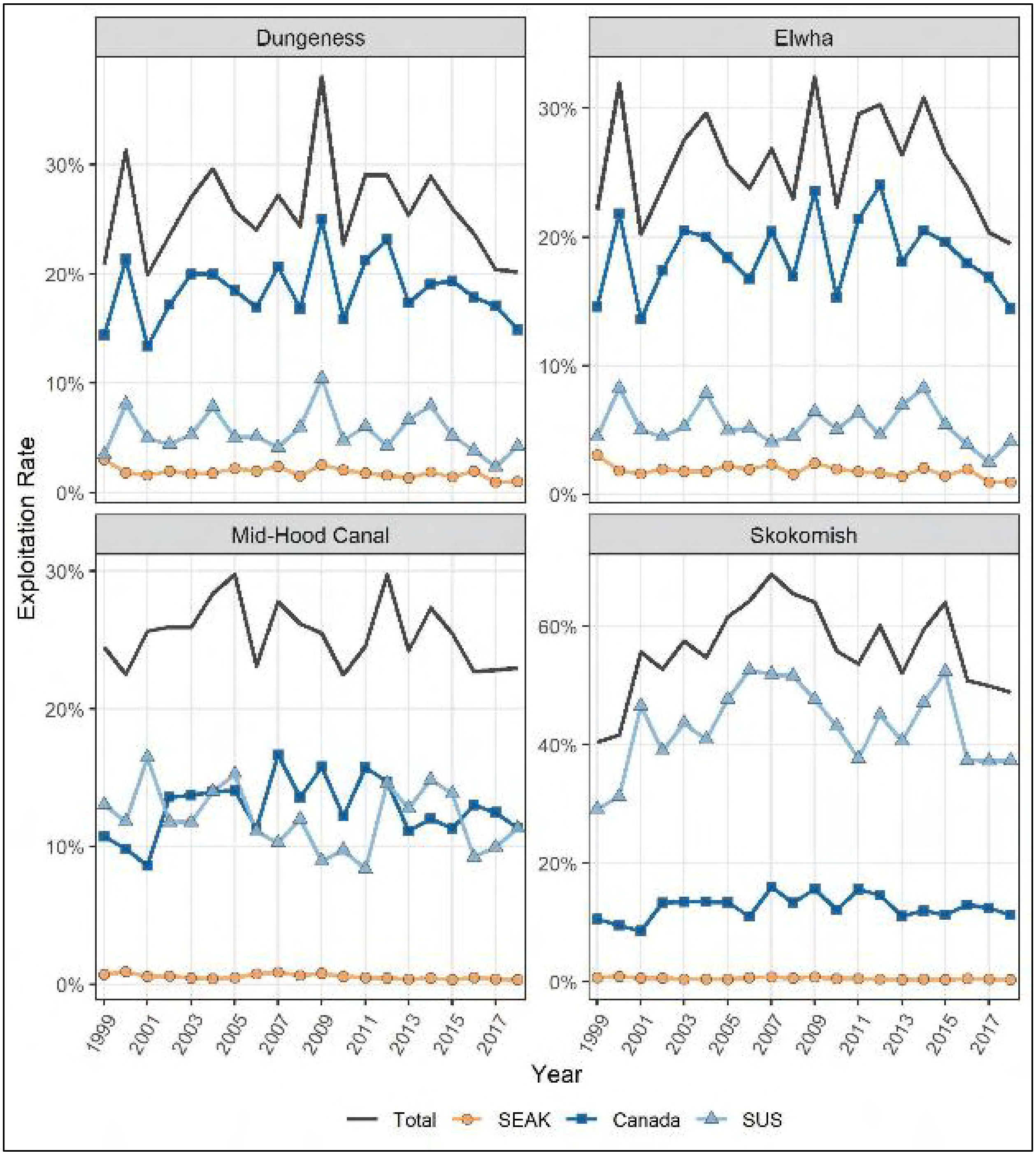

Figure 54. Total adult equivalent calendar year ERs on Strait of Juan de Fuca and Hood Canal Puget Sound Chinook salmon populations between 1999 and 2018 from FRAM model runs using actual post-season fishery catches and best available estimates of annual stock abundances. Between the 4 figures, note the different ER scales used on the x-axis.

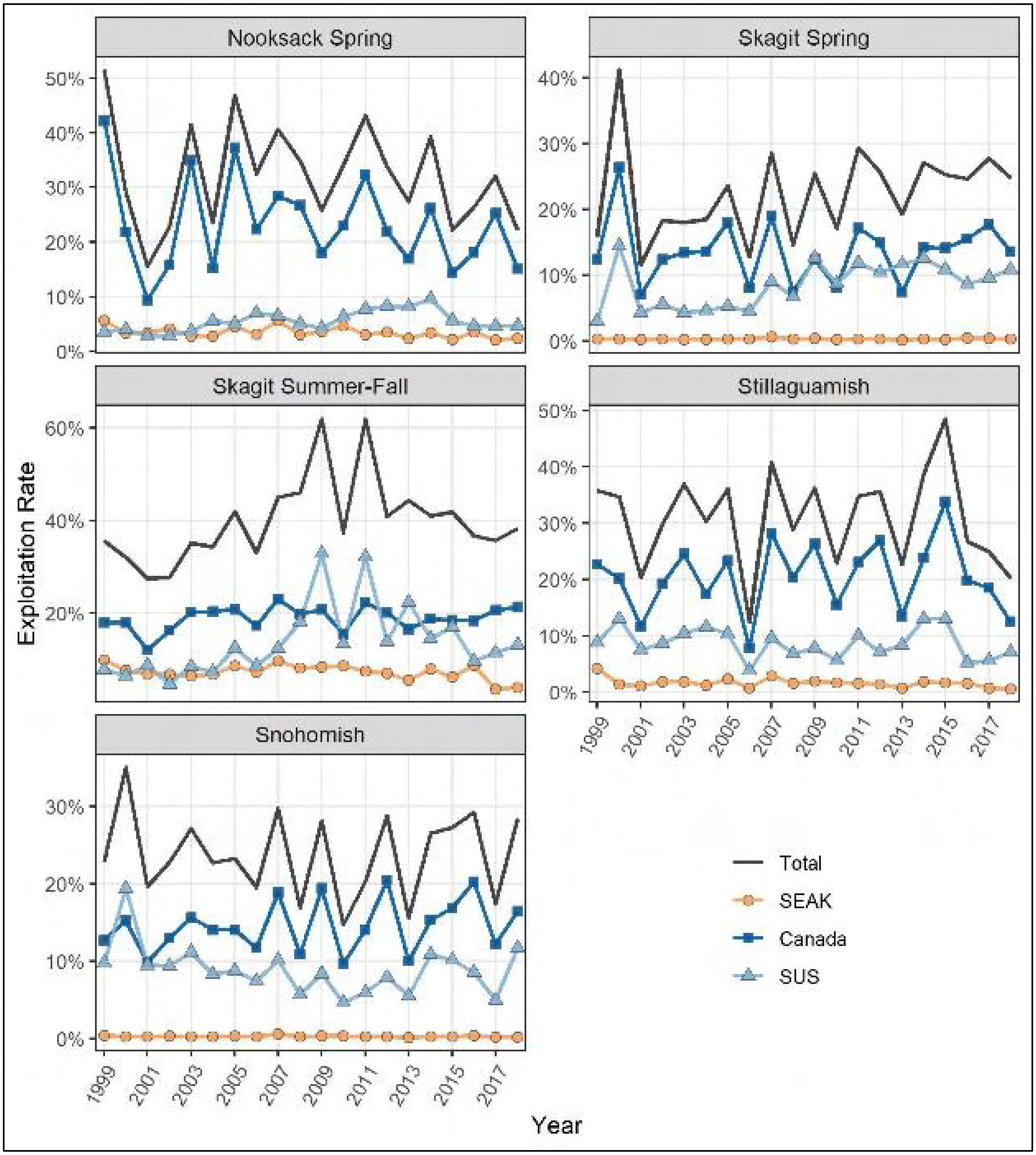

Figure 55. Total adult equivalent calendar year ERs on northern and central Puget Sound Chinook salmon populations between 1999 and 2018 from FRAM model runs using actual post-season fishery catches and best available estimates of annual stock abundances. Between the 5 figures, note the different ER scales used on the x-axis.

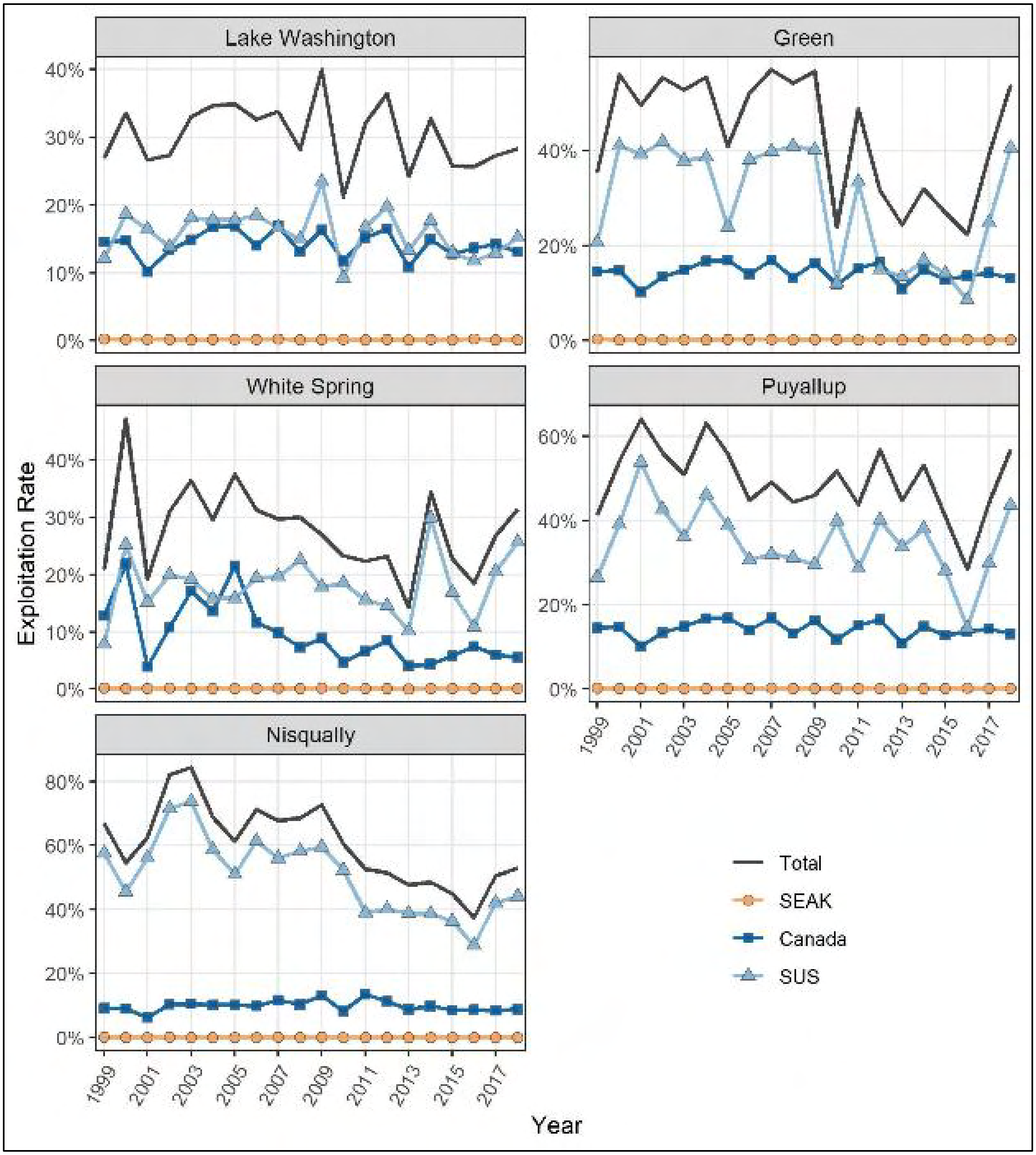

Figure 56. Total adult equivalent calendar year ERs on southern Puget Sound Chinook salmon populations between 1999 and 2018 from FRAM model runs using actual post-season fishery catches and best available estimates of annual stock abundances. Between the 5 figures, note the different ER scales used on the x-axis.

Table 39. Puget Sound Chinook salmon ERs between 1999 and 2018.

Stock	**SEAK Exploitation**	**Canadian Exploitation**	**PFMC Exploitation**	**Puget Sound Exploitation**	**Total Exploitation**
	Average 1999 – 2018				
Nooksack River (early)	3.5%	23.3%	2.3%	3.2%	32.3%
Skagit River (early)	0.3%	13.6%	0.9%	7.6%	22.5%
Skagit River (summer/fall)	7.3%	18.9%	1.1%	12.6%	39.9%
Stillaguamish River	1.7%	20.5%	1.9%	6.8%	30.9%
Snohomish River	0.3%	14.6%	1.7%	7.2%	23.8%
Lake Washington	0.2%	14.2%	4.9%	11.0%	30.3%
Duwamish-Green River	0.2%	14.2%	4.9%	24.1%	43.4%
Puyallup River	0.2%	14.2%	4.9%	30.3%	49.6%
Nisqually River	0.1%	9.8%	6.1%	44.4%	60.4%
White River (early)	0.1%	9.6%	1.3%	16.7%	27.9%
Skokomish River	0.5%	12.6%	6.1%	36.9%	56.1%
Mid-Hood Canal Rivers	0.5%	12.8%	6.2%	5.9%	25.4%
Dungeness River (early)	1.8%	18.5%	1.5%	4.0%	25.8%
Elwha River	1.8%	18.6%	1.5%	3.8%	25.8%

Table 40. The proportional distribution of harvest impacts of Puget Sound Chinook salmon distribution in marine areas and Puget Sound fisheries between 1999 and 2018.

Stock	**SEAK % of Exploitation**	**Canadian % of Exploitation**	**PFMC % of Exploitation**	**Puget Sound % of Exploitation**
	Average 1999 – 2018			
Nooksack River (early)	10.80%	72.20%	7.20%	9.90%
Skagit River (early)	1.50%	60.70%	4.00%	33.80%
Skagit River (summer/fall)	18.20%	47.30%	2.80%	31.60%
Stillaguamish River	5.50%	66.30%	6.30%	21.90%
Snohomish River	1.40%	61.10%	7.30%	30.20%
Lake Washington	0.50%	47.00%	16.20%	36.20%
Duwamish-Green River	0.40%	32.80%	11.30%	55.50%
Puyallup River	0.30%	28.70%	9.90%	61.00%
Nisqually River	0.10%	16.30%	10.10%	73.40%
White River (early)	0.50%	34.60%	4.80%	60.10%
Skokomish River	1.00%	22.40%	10.90%	65.80%
Mid-Hood Canal Rivers	2.10%	50.40%	24.40%	23.10%
Dungeness River (early)	7.10%	71.60%	5.90%	15.40%
Elwha River	7.10%	72.00%	5.90%	14.90%

2.4.1.2 Gulf of Alaska Groundfish Fisheries

Chinook salmon are caught incidentally in the Bering Sea/Aleutian Islands (BSAI) and Gulf of Alaska (GOA) groundfish fisheries. However, the BSAI fisheries occur outside the action area considered in this Biological Opinion and occur outside the known migratory path of the four ESA-listed species of Chinook salmon considered in this Opinion. We reviewed all sources of available data on stocks of Chinook salmon contributing to these incidental catches. The current biological opinion concluded that the only ESA listed salmon or steelhead species likely to be affected by the BSAI groundfish fishery are Upper Willamette River Chinook and Lower Columbia River Chinook (NMFS 2009b).

Groundfish fishing areas in the GOA are managed pursuant to the MSA through the NPFMC's GOA Groundfish FMP (for incidental bycatch monitoring see: https://www.fisheries.noaa.gov/alaska/bycatch/chinook-salmon-bycatch-management-alaska). GOA Groundfish FMP fishing areas 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. In biological opinions on this fishery, including the most recent Section 7 consultation in 2012, (NMFS 1999b; 2007a; 2012e; Stelle 2014) 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 2008 to 2022 the bycatch of Chinook salmon has averaged 20,548 and ranged from 8,396 to 54,559 (Kurland 2023). NMFS concluded that take of Snake River fall Chinook could be as high as 8-44 fish per year, but was unlikely to average more than five per year. Take of other Chinook ESUs including Puget Sound Chinook would be rare.

Estimates of the take of ESA listed Chinook salmon in the GOA groundfish fishery come from a review of code-wire tags that have been recovered in the fishery over the 20-year period of 1991 to 2010. Based on that review, NMFS estimated that the take of UWR Chinook salmon and LCR Chinook salmon averaged 5 and 12 fish per year, respectively out of a total bycatch that averaged 21,986[35].

2.4.1.3 Canadian Salmon fisheries

In these consultations and those on the SEAK fishery prior to the 1999 PST Agreement, NMFS generally tried to anticipate the effect of Canadian fisheries on the species status. Based on past PST Agreement performance NMFS has been able to rely on those to project Canadian fishing levels in its Biological Opinions. In order to describe fishery performance under past agreements and account for changing ocean conditions, we are using the 1999 to 2018 timeframe to characterize and present Canadian 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 PST Agreement from 2009

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[35] For annual estimates of Chinook salmon incidental catch see https://www.fisheries.noaa.gov/s3/2023-03/2022-chinook-incidental-catch-esa-annual-rpt.pdf

to 2018. Management provisions that applied to Canadian fisheries under those agreements are described in the respective Biological Opinions (NMFS 1999a; 2008a).

LCR Chinook Salmon ESU
The ER in Canadian salmon fisheries on LCR spring Chinook salmon populations averaged 5.9% between 1999 and 2018 (Table 35), but accounted for an average of 35.2% of the marine area exploitation (Figure 44). ERs on LCR tule populations averaged 16.1% in Canadian fisheries over the same time period (Table 35) and accounted for 50.6% of the ER of all marine area fisheries (Figure 46). For LCR bright populations, the 1999-2018 Canadian fisheries had ERs averaged 22.6% (Table 35) and accounted for 45.9% of the marine area exploitation (Figure 48).

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 salmon fisheries averaged 2.7% (Table 36) from 1999 to 2018, and this comprised 32.4% of the marine area exploitation of UWR Chinook salmon over this time frame (Figure 50).

Snake River Fall-run Chinook Salmon ESU
The ER on SRFC salmon in Canadian salmon fisheries averaged 8.5% between 1999 and 2018 (Table 37), comprising an average 29.1% of the marine area exploitation of SRFC salmon over this time period (Figure 53).

Puget Sound Chinook Salmon ESU
The ERs on Puget Sound Chinook salmon in Canadian salmon fisheries from 1999 to 2018 varied by stock ranging from 9.6% to 23.3% (Table 39). However, Canadian fisheries generally account for a larger proportion of the overall harvest than SEAK fisheries. Canadian fisheries ERs ranged from 16.3 to 47.0 % for south Puget Sound stocks, 22.4 to 72.0 % for Hood Canal and Strait of Juan de Fuca stocks, and 47.3 to 72.2 % for north and central Puget Sound stocks (Table 40).

2.4.1.4 Southern U.S. Fisheries

NMFS began conducting Section 7 consultations covering southern west coast U.S. salmon fisheries in 1992 as a consequence of the initial ESA listings of salmonids. These consultations have addressed the effects of fisheries off the coast of Washington, Oregon, and California managed by the PFMC, as well as fisheries in the Columbia River Basin and Puget Sound.

2.4.1.4.1 PFMC Salmon Fisheries

NMFS promulgates regulations for fisheries in the EEZ off the Pacific Coast of Washington, Oregon, and California pursuant to the MSA. The PFMC develops annual management measures consistent with 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 2024a). The 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 2024a). These standards are either based on reasonable and prudent alternatives described in jeopardy Biological Opinions on the fishery, or are management standards or frameworks recommended by the PFMC and approved by NMFS having been determined through an ESA section 7 consultation to be not likely to jeopardize the listed species in question. While the PST Agreements have served as ceilings for management of Chinook salmon fisheries in the EEZ off the West Coast, in practical terms PFMC salmon 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 considered the effects of PFMC salmon fisheries on ESA-listed species under its jurisdiction, including the four listed Chinook ESUs affected by the SEAK fisheries, in a number of Biological Opinions (NMFS 1996; 2001; 2004; 2012f). A more complete description of the consultation history for PFMC fisheries can be found in the recent Opinion that considered the effects of fishing to SRKW (NMFS 2021c).

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, PFMC salmon fisheries have been managed since 2012 using an abundance-based management framework on the tule component. The framework specifies a total ER that may vary from year-to-year between 30 and 41 % depending on a particular run size indicator. PFMC fisheries are managed such that when the PFMC salmon fishery impacts are added to the impacts of other marine area salmon fisheries and freshwater fisheries below Bonneville Dam, the total impacts are within the applicable total ER. NMFS consulted on the implementation of the PFMC fisheries using the abundance based management framework in 2012 and concluded that they would not jeopardize LCR Chinook salmon (NMFS 2012f).

Once the annual catch limits for the northern fisheries (Alaskan and Canadian) are set as described in Section 1.3, SUS fisheries in the PFMC areas and Columbia River are adjusted so as not to exceed the year specific total ER limit. In 2018, for example, the total ER limit for LCR tule Chinook salmon was 38%. At the end of the PFMC's preseason salmon planning process, the projected total ER from all salmon fisheries on LCR tules was 37.7% (PFMC 2018).

The ER on LCR spring Chinook salmon populations in PFMC fisheries averaged 9.0% exploitation from 1999 to 2018 (Table 35), accounting for 52.4% of the marine area exploitation (Figure 44).

The ER on LCR tule populations in PFMC fisheries has averaged 13.0% (Table 35) and accounted for 40.8% of the total marine exploitation on LCR tule Chinook salmon (Figure 46).

The ER on LCR bright populations averaged 16.5% in PFMC fisheries between 1999 and 2018 (Table 35) and accounted for 32.9% of the marine area exploitation (Figure 48).

Upper Willamette Spring Chinook Salmon ESU
UWR Chinook salmon are a far-north migrating stock. The marine area exploitation 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 salmon in PFMC fisheries is low, averaging 1.7% between 1999 and 2018 (Table 36) and accounting for 21.3% of the marine area exploitation (Figure 50).

Snake River Fall-run Chinook Salmon ESU
As discussed in Section 2.4.1.1, SRFC salmon are managed subject to an ER limit that applies to all marine area fisheries of a 30% reduction relative to the 1988 to 1993 base period. Because of their distribution and timing, more of the marine area impacts to SRFC salmon occur in PFMC fisheries. From 1999 to 2018, the ER on SRFC salmon in PFMC fisheries averaged 20.5% (Table 37) and accounted for 66.0% of the overall marine area harvest (Figure 53).

Puget Sound Chinook Salmon ESU
The framework for managing fisheries affecting Puget Sound Chinook salmon is described in Section 2.4.1.1. While the impacts of the PFMC salmon fisheries on Puget Sound Chinook salmon are generally relatively low, the PFMC salmon fisheries are planned in coordination with the Puget Sound salmon fisheries to ensure that the combined effects of those fisheries, when added to the effects of the northern fisheries, do not exceed the management objectives for each management unit.

The magnitude and distribution of harvest impacts to Puget Sound Chinook salmon varies by management unit. Between 1999 and 2018 ERs on Puget Sound populations in PFMC fisheries ranged from 0.9 to 6.2 % and, except for Mid-Hood Canal River populations (24.4%), accounted for 2.8 to 16.2 % of each stock’s total ER (Table 40).

2.4.1.4.2 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 2017e). 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 impacted in the fishery (SRFC salmon, LCR Chinook salmon, and UWR Chinook salmon) were very low (NMFS 2017e).

NMFS’ biological opinion issued in 2017 used information regarding the stock composition of the Chinook salmon bycatch based on samples taken from 2009 to 2014 from the at-sea and shore side sectors of the whiting fishery (NMFS 2017e). 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 both listed and unlisted ESUs contributed to bycatch, the major contributors to Chinook salmon bycatch in the at-sea sector were from ESUs not listed under the ESA. For the at-sea sector they contributed, on average, Klamath/Trinity Chinook salmon (28%) followed by south Oregon/north California (25%), Oregon Coast (10%), and northern British Columbia (11%) Chinook salmon (NMFS 2017e). Samples from Chinook salmon bycatch in the shore side whiting sector showed a contribution from Central Valley Chinook salmon (13%), and Oregon Coast showed a similar contribution and a very low contribution from British Columbia Chinook salmon (NMFS 2017e).

The remainder of stocks which included contributions from listed ESUs contributed 5% or less of the Chinook salmon bycatch in either fleet on average.

The low contribution rates to bycatch from the ESA-listed Chinook salmon ESUs (i.e., 5% or less) are consistent with qualitative characterizations of likely bycatch levels in analyses prior to NMFS' 2017 opinion (NMFS 2017e). These genetic sampling results provide more specific information regarding the stock composition of the Chinook salmon bycatch in the whiting fishery, and the results support the more qualitative expectations in the 2006 supplemental Opinion that impacts to ESA-listed ESUs are very low; i.e., less than 1% mortality per year for the most affected ESUs (NMFS 2017e).

Table 41. Bycatch of Chinook salmon in the Pacific Coast Groundfish Fisheries, 2008 to 2015 (NMFS 2017e).

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[36]	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[37]	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**

Salmon are also caught during commercial and recreational halibut fisheries occurring in the PFMC area. However, when salmon are caught in these fisheries when salmon fisheries are open these catches are accounted for under the Pacific Coast Salmon FMP management framework, therefore they are accounted for in the environmental baseline under the information reported above in the PFMC Salmon Fisheries section. When salmon fishing is closed, halibut fisheries may occasionally encounter salmon. Injuries and death from encounters with fishing gear and handling during times and areas where salmon fishing is otherwise closed are expected to result in the expected take of ESA-listed Puget Sound Chinook salmon, LCR Chinook salmon, and SRFC salmon of 4.3 fish (of each ESU) per year.

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[36] Includes only the Pacific whiting fishery. Tribal non-whiting fishery values were not available.

[37] Includes bycatch by vessels fishing under Exempted Fishing Permits (EFPs) not already included in a sector count. The added Chinook salmon bycatch by year under EFPs was 2002-22, 2003-51, 2004-3, 2014-1.

2.4.1.4.3 Puget Sound Salmon Fisheries

Puget Sound salmon fisheries catch LCR Chinook salmon, UWR Chinook salmon, and SRFC salmon on occasion, but the ERs in these fisheries on these ESUs are just fractions of 1% (Table 35, Table 36, and Table 37). The effects of Puget Sound fisheries on Puget Sound stocks are of course higher than the effects to other stocks. As described previously, Puget Sound salmon fisheries are managed to keep fishery impacts (total or SUS) within management unit-specific management objectives. Objectives used for the 2024-2025 season are described in Section 2.4.1.1. As described earlier, a new long-term RMP has been submitted to NMFS, and is currently under review. The management objectives in that RMP are similar to those used for 2024-2025.

Recent year ERs in Puget Sound fisheries ranged from 3.2 to 44.4 % since 1999 depending on stock (Table 39), and accounted for 9.9 to 73.40 % of each stock's total ER (Table 40). Not surprisingly, a higher proportion of the overall harvest impact on the Puget Sound Chinook Salmon ESU occurs in Puget Sound fisheries than in SEAK fisheries for stocks from the south and mid-Sound areas (Table 40).

2.4.1.4.4 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 2023b). Up to 18 Chinook (the average annual recreational fishery catch of Chinook salmon) are expected to be encountered on average per year in the halibut recreational fishery. However, of the total Chinook salmon that may be caught, only a small subset would involve take of ESA-listed Chinook salmon. NMFS concluded that the encounters were expected to result in the take of less than two ESA-listed Puget Sound Chinook salmon, less than one Lower Columbia River Chinook, and less than one Snake River fall Chinook salmon on average 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 salmon. In 2012 NMFS issued a Section 10 incidental take permit to the WDFW for listed species caught in these two fisheries, including Puget Sound Chinook salmon (NMFS 2012d). 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, NMFS authorized a subset of lethal take of up to 50 Chinook salmon annually. As of 2023 this Section 10 permit has not been renewed. WDFW has applied for a Section 10 permit allowing incidental take of 137 Chinook salmon annually in the coming years and it is currently being evaluated.

2.4.2 Hatchery production

Hatchery production of salmonids has occurred for over 100 years. Currently, there are hundreds of hatchery programs in Alaska, Oregon, Washington, and Idaho that produce juvenile salmon that migrate through the action area. While California hatcheries also produce salmon contributing to abundances in the Pacific Ocean, the migratory pattern of fish released from California hatcheries do not reach SEAK, nor do they contribute to a sizeable amount of the marine abundance along the coast of Washington State or inside Puget Sound. Many of the hatchery fish from Alaska, Oregon, Washington, and Idaho both contribute to fisheries and supplement abundance in the action area.

NMFS has completed Section 7 consultation on more than two hundred hatchery programs in numerous Biological Opinions (see Appendix C, Table C.1). A detailed description of the effects of these hatchery programs can be found within the site-specific Biological Opinions referenced in Appendix C, Table C.1. These effects are further described in (NMFS 2024e), which is incorporated here by reference. This Opinion includes, in the baseline, the effects of past and present hatchery operations and also includes the effects of future operations of hatchery programs for which NMFS has completed ESA section 7 consultation that remains valid. The effects of future operations of those hatchery consultations with expired ESA Section 7 consultation and those programs yet to undergo ESA Section 7 consultation are not included in the environmental baseline consistent with 50 CFR 402.02, but the effects of these programs on ESA-listed species will be considered under cumulative effects.

Hatcheries can provide benefits by reducing demographic risks and preserving genetic traits for populations at low abundance in degraded habitats. Population viability and reductions in threats are key measures for salmon and steelhead recovery (NMFS 2013f). Beside their role in conserving genetic resources, hatchery programs also are a tool that can be used to help improve viability (i.e., supplementation of natural population abundance through hatchery production). In general, these hatchery programs increase the number and spatial distribution of naturally spawning fish by increasing the natural production with returning hatchery adults. In addition, hatchery production can help to provide harvest opportunity to uphold the meaningful exercise of treaty rights for the Northwest tribes. Hatchery-origin fish may also pose risk through genetic, ecological, or harvest effects. For example, hatchery programs can affect ESA-listed salmon and steelhead through competition with natural-origin fish for spawning sites and food, outbreeding depression, and hatchery-influenced selection.

Because most hatchery programs are ongoing, the effects of each program are reflected in the most recent status of the species, which NMFS recently re-evaluated and was summarized in relevant ESU-specific sections of Section 2.2.1 of this Opinion. In addition, NMFS has completed Section 7 consultation on all of the hatchery programs included in Appendix C, Table C.1. and their effects are included in the environmental baseline. To ensure compliance with the ESA, NMFS has evaluated hatchery production in site-specific consultations that are informed by detailed Hatchery Genetic Management Plans (HGMPs) for each hatchery program in Table C.1. The effects of these programs are described in detail in each of the biological opinions referenced in Appendix C. Those analyses are incorporated by reference, and an overview of effects are summarized here.

Here we describe the analysis NMFS conducts to evaluate the effects of hatchery programs on ESA-listed fish and their critical habitat. For the programs NMFS has evaluated and concluded they are not likely to jeopardize listed fish or adversely modify their critical habitat, NMFS has determined these effects are sufficiently limited to avoid jeopardy or adverse modification, as described in the referenced opinions. Even when a hatchery program is terminated, the effects of that program on listed species can continue for a number of years depending on the species released. This is the case, generally, with the hatchery programs included in the baseline, and those effects and risks will be perpetuated by the ongoing operation of the programs. These risks include genetic risks, competition and predation on natural-origin fish, disease, and broodstock collection and facility effects. The direction of (beneficial to negative) and magnitude of these effects will depend on if programs use local fish[38] for hatchery broodstock, and increase from negligible to negative when programs do not use local fish for broodstock[39]. Hatchery programs can benefit population viability, but only if they use genetic resources that represent the ecological and genetic diversity of the target or affected natural population(s). When hatchery programs use genetic resources that do not represent the ecological and genetic diversity of the target or affected natural population(s), NMFS is particularly interested in how effective the program will be at isolating hatchery fish and at avoiding co-occurrence and effects that potentially disadvantage fish from natural populations. NMFS applies available scientific information, identifies the types of circumstances and conditions that are unique to individual hatchery programs, and then refines the range in effects for a specific hatchery program. Analysis of a hatchery program described in an HGMP for its effects on ESA-listed species and on designated critical habitat depends on six factors:

(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, the migration corridor, estuary, and ocean,
(4) research, monitoring, and evaluation that exists because of the hatchery program,
(5) the operation, maintenance, and construction of hatchery facilities that exist because of the hatchery program, and
(6) fisheries that exist because of the hatchery program, including terminal fisheries intended to reduce the escapement of hatchery-origin fish to spawning grounds.

The analysis assigns an effect for each factor from the following categories:

(1) positive or beneficial effect on population viability,
(2) negligible effect on population viability, and
(3) negative effect on population viability.

The effects of hatchery fish on ESU/DPS status will depend on which of the four VSP criteria are currently limiting the ESU/DPS and how the hatchery program affects each of the criteria

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[38] The term “local fish” is defined here as consistent with local natural population, meaning 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 37204, 37215, June 28, 2005).

[39] Exceptions include restoring extirpated populations and gene banks.

(NMFS 2005a). 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 abundance, productivity, spatial structure, and diversity, the role or importance of the affected natural population(s) in ESU recovery, the target viability for the affected natural population(s), and the environmental baseline including the factors currently limiting population viability. Hatchery actions designed to benefit salmon and steelhead viability sometimes produce only limited positive results. One potential reason for this is that other factors (i.e., limiting factors and threats) can offset or out-weigh the benefits from hatchery actions. Hatchery programs can serve an important conservation role when habitat conditions in freshwater depress juvenile survival or when access to spawning and rearing habitat is blocked. Under circumstances like these, and in the short-term, the demographic risks of extinction of such populations likely exceed genetic and ecological risks to natural-origin fish that would result from supplementing the natural population through hatchery actions. Benefits like this should be considered *transitory*, or short-term, and these benefits do not contribute to survival rate changes necessary to meet recovery plan abundance and productivity viability criteria. These hatchery programs help "to preserve remaining genetic diversity, and likely have prevented the loss of several populations" (NMFS 2005a; Ford et al. 2011b). However, until the factors limiting salmon and steelhead productivity are addressed, the full benefit (i.e., potential contributions to increased viability) of hatchery actions designed to benefit salmon and steelhead viability may not be realized. Therefore, fixing the factors limiting viability is the key to long-term viability. "The fitness of the naturally spawning population, its productivity, and the numbers of adult salmon returning to the watershed, ultimately must depend on the natural habitat, not on the output of the hatchery" (HSRG 2004). Salmon and steelhead populations that rely on hatchery production are not viable (McElhany et al. 2000; NMFS 2013f), and increased dependence on hatchery intervention results in decreasing benefits and increasing risks (ICBTRT 2007; NMFS 2014e).

Hatchery production from the Columbia River Basin and Puget Sound
Significant hatchery production that affects Chinook abundance in the action area occurs in the Columbia Basin and Puget Sound areas. NMFS has completed consultations for various production programs since the late 1990s as salmon and steelhead listing decisions were finalized. Over the course of this same period, there has been a concerted effort to ensure all programs that may affect ESA-listed species have undergone ESA compliance processes. A push to complete and update consultations for these hatchery programs occurred in the last several years, e.g., in Puget Sound, NMFS has completed site-specific section 7 consultations on 56 of 108 programs and in the Columbia River 140 of 160 programs (Appendix C). NMFS is actively evaluating additional programs under its 4(d) rule and through section 7 consultation. Essentially, at this time, NMFS has completed section 7 consultations on the majority of hatchery programs that contribute to ocean abundance of salmon that contribute to PST fisheries (see Appendix C, and NMFS 2024).

In the recent past, an average of 158 million juvenile Chinook salmon annually have been released from areas contributing to marine abundances affecting PST fisheries over the years of 2008 through 2023 (NMFS 2024a). The total number released from these areas varies substantially from year to year. For example, in the U.S. Salish Sea during this time period, annual releases of hatchery Chinook salmon ranged from 40.6 million in 2021 to a high of 52 million in 2023. In the Columbia River, annual Chinook hatchery releases ranged from 80.0

million in 2023 to 107.8 million in 2010. Approximately 62% of the Chinook releases occurred in the Columbia River; whereas 28% occurred in the U.S. portion of the Salish Sea. From a longer-term perspective, total release of hatchery Chinook salmon in that opinion's action area were typically more than 200 million fish prior to the mid-1990's (NMFS 2024a).

The history and evolution of hatcheries are important factors in analyzing their past and present effects. From their origin more than 100 years ago, hatchery programs have been tasked to compensate for factors that limit anadromous salmonid viability. The first hatcheries, beginning in the late 19th century, provided fish to supplement harvest levels, as human development and harvest impacted naturally produced salmon and steelhead populations. As development in freshwater systems continued (e.g., in the Columbia River Basin with dam construction between 1939 and 1975), hatcheries were used to mitigate for lost salmon and steelhead harvest attributable to reduced salmon and steelhead survival and habitat degradation. Since that time, most hatchery programs have been tasked to maintain fishable returns of adult salmon and steelhead, usually for cultural, social, recreational, or economic purposes, as the capacity of natural habitat to produce salmon and steelhead has been reduced.

A new role for hatcheries emerged during the 1980s and 1990s after naturally produced salmon and steelhead populations declined to unprecedented low levels. Because genetic resources that represent the ecological and genetic diversity of a species can reside in fish spawned in a hatchery, as well as in fish that spawn in the wild, hatcheries began to be used for conservation purposes (e.g., Snake River sockeye salmon). Such hatchery programs are designed to preserve the salmonid genetic resources until the factors limiting salmon and steelhead viability are addressed. In this role, hatchery programs reduce the risk of extinction (NMFS 2005a; Ford et al. 2011b). However, hatchery programs that conserve vital genetic resources are not without risk to the natural salmonid populations because the manner in which these programs are implemented can affect the genetic structure and evolutionary trajectory of the target population (i.e., natural population that the hatchery program aims to conserve) by reducing genetic and phenotypic variability and patterns of local adaptation (HSRG 2014; NMFS 2014d).

For hatchery programs that contribute to salmon abundance in the action area that originate from the Columbia River basin, NMFS directs federal funding to many of the hatchery programs that affect Lower River ESUs/DPSs through the Mitchell Act. NMFS first completed ESA consultation, along with RPAs, on the Mitchell Act program in 1999 (NMFS 1999c). Since that time, operators have carried out reforms including: improved monitoring of the status of salmon and steelhead populations; changes in the use of local broodstock; changes in production levels; use of weirs to selectively remove hatchery fish from the spawning grounds; and use of alternative release locations. These measures helped reduce adverse impact to ESA-listed species.

In 2017, NMFS completed an environmental impact statement (EIS) and biological opinion on its funding of the Mitchell Act program (NMFS 2017m). In connection with these analyses, several additional reform measures were implemented including the following:

- Changes in broodstock management to better align hatchery broodstocks with the diversity of the natural-origin populations that could be potentially affected by the hatchery programs.

- Reductions to the number of hatchery fish released from certain programs and the installation of six new seasonal weirs. These were aimed at reducing the abundance of hatchery-origin fish spawning naturally and concomitant genetic and ecological risks. Expected reduction in pHOS is described in NMFS (2018b), Tables 2-82, 2-83, and 2-84.

- Elimination of the release of Chambers Creek steelhead, a hatchery stock that did not originate from within the Columbia River basin, thereby reducing genetic risk to the ESA-listed Lower Columbia River steelhead DPS.

Recall, as mentioned in the Status of the Species section, specifically Section 2.2.2.1.2, actions described in the 2017 Mitchell Act Opinion sought to determine the efficacy of these reform actions over time. The Opinion described an unprecedented hatchery policy that aimed to futurize federally funded programs with monitoring to assess programs' success in terms of their intended harvest opportunities and their regional impacts on ESA-listed populations. As a result of some of the reforms not being fully implemented in the timeline NMFS anticipated, we have since reinitiated consultation on our funding action of Mitchell Act hatchery programs. We expect to have a new Opinion on funding Mitchell Act hatchery programs complete by 2025.

Since the listing of Upper Willamette River spring Chinook salmon and winter steelhead under the ESA, hatchery programs in the Willamette Basin that contribute to salmonid abundance within the action area have needed ESA consultation. The first section 7 consultation on the Willamette hatchery programs occurred with a Opinion issued in 2000 to the co-managers (NMFS 2000a). This opinion exempted take from the programs for three years. Subsequent section 7 consultation on the Willamette Project (all of the USACE dams and associated hatchery programs) was completed in 2008 with the issuance of a new Opinion to the co-managers (NMFS 2008h). One of the RPAs of this Opinion was to develop criteria and protocols for the spring Chinook salmon programs that incorporates natural-origin salmon into the hatchery broodstocks. That action was analyzed in a 2019 Opinion (NMFS 2019a). This 2019 Opinion also evaluated existing hatchery programs for summer steelhead and rainbow trout in the Upper Willamette River because new information on the effects of these hatchery programs to listed species become available subsequent to the issuance of the 2008 Opinion (NMFS 2008h).

In addition, NMFS completed a consultation on the Snake River fall-run Chinook salmon hatchery programs in 2012 (NMFS 2012b). In evaluating those programs, we concluded that the pHOS, coupled with the presumed proportion of natural-origin fish in the broodstocks (pNOB), led to a proportion of natural influence (PNI) that was considerably lower than the 67% that would be recommended for a population of high conservation concern. This posed a fitness risk through hatchery-influenced selection. In addition, the broodstock collection protocol—typically collected only at Lower Granite Dam—would limit conservation or development of subpopulation structure, posing a diversity risk.

While recognizing these risks, we also considered that although in theory the presence of so many hatchery-origin fish on the spawning grounds should cause fitness to decline, natural production in the population was increasing. Given that the hatchery program was also increasing in size, it was possible that the increase in natural production was caused by spawning of an increasing number of hatchery-origin fish, but it could not be ruled out that this was a supplementation response. Based on this, and the relatively short number of generations the population had been subjected to hatchery influence, NMFS concluded that issuing an ESA

Section 10 permit to continue operation of the programs through broodstock collection in 2017 (NMFS 2012b), without attempting to reduce hatchery influence, posed low risk to the survival or recovery of the population and thus the Snake River fall-run Chinook Salmon ESU. Because new information was limited and did not indicate any substantive changes, a similar conclusion was reached in a 2018 Opinion that assessed the effects of continuing the program through 2027 (NMFS 2018a).

In 2012, it was also clear that there were important information gaps that made it difficult to recommend actions to reduce genetic risk. A key part of the proposed action analyzed in the 2012 opinion was a supplemental research, monitoring, and evaluation (RM&E) program to produce more precise estimates of hatchery and natural composition, homing fidelity of hatchery fish, and area of origin of naturally produced fish. Results of these RM&E efforts were presented at a 2017 symposium (USFWS 2017). As a result of this RM&E program and based on the analysis in the 2018 Opinion (NMFS 2018a), release locations were moved to increase harvest opportunities and reduce impacts to mainstem spawning aggregates (NMFS 2018a). These changes were based on preliminary modeling (Cooney and Busack 2017) and were designed to align with Scenario C of the Snake River fall Chinook Recovery Plan (NMFS 2017q; 2018a).

This type of reduction of risks from and use of hatcheries as conservation tools did not just occur in the Columbia River Basin. Additionally, beginning in the 1990s, Washington 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 (SSDC 2007). The intent of hatchery reform is to reduce negative effects of artificial propagation on natural populations while retaining proven production and potential conservation benefits.

Across the Pacific Coast, hatchery programs are working to reduce adverse effects to wild fish by phasing out use of dissimilar broodstocks, such as out-of-basin or out-of-ESU stocks, and 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.

SRKW Prey increase program

Hatchery production has been and continues to be a significant component of the salmon prey base within the range of SRKW (Barnett-Johnson et al. 2007). Prey availability has been identified as a threat to SRKW recovery, and we expect hatchery programs that release species which contribute to SRKW diet to continue benefiting SRKW by contributing to their prey base, which is discussed in the SRKW sections of this Opinion.

In addition to the numerous hatchery programs for which increasing prey for SRKW is not a primary goal, in the last five years there have been initiatives to increase hatchery production with the specific purpose of supplementing the SRKW prey base. NMFS has allocated, through Congressionally approved spend plans, $5.6–7.3 million annually for FYs 2020–2023 to the federal prey increase program (intended to increase prey for SRKW to mitigate the effects of fisheries managed under the PST) out of $35.1–39.5 million Congressionally appropriated funds for 2019–2028 PST implementation (NMFS 2024a). 7.2 million Chinook salmon were released in 2022 funded by these appropriations (Table 42). Table 42 indicates that for 2020 and 2021 releases were lower than 2022 but increased in each subsequent year. For 2023, 2.9 million Chinook salmon have already been released (Table 42). We anticipate that funding for this program will continue, based on Congressional action to date at levels similar to or higher than those of recent years. NMFS will annually continue to only award funds to hatchery programs that meet NMFS' funding criteria as described and evaluated in its program-level 2024 EIS (NMFS 2024a) and biological opinion (NMFS 2024a). These specific criteria for selecting hatchery program operator proposals eligible to receive funding under the SRKW PIP are as follows:

1. Prey increase program -funded hatchery production should be for Chinook salmon stocks that are a high priority for SRKW (NOAA Fisheries and WDFW 2018; PFMC 2020).
2. Prey increase program -funded hatchery production should be distributed across an array of priority Chinook salmon stocks from different geographic areas and run timings (i.e., a diverse portfolio).
3. Prey increase program -funded hatchery production cannot jeopardize the survival and recovery of any ESA-listed species, including salmon or steelhead.
4. Prey increase program funding proposals should not include or require major capital upgrades to hatchery facilities.
5. All prey increase program funding proposals should have fisheries co-manager (i.e., state and tribal) agreement, as applicable.
6. Prey increase program -funded hatchery programs must be reviewed under the ESA and National Environmental Policy Act (NEPA), as applicable, before NMFS funding can be used. That is, a facility- and hatchery program-level (i.e., "site-specific") ESA and NEPA review must be completed.

These criteria ensure hatchery programs funded through the prey production program are consistent with hatchery reform.

NMFS (2024a) determined that implementing the SRKW PIP is not likely to appreciably reduce the likelihood of both survival and recovery of salmon or steelhead affected in PST fisheries. In that biological opinion, NMFS found aggregate effects of the SRKW PIP were likely to accrue from ecological interactions in the mainstem Columbia and Snake Rivers and in certain marine areas. In addition, NMFS evaluated whether the SRKW PIP has led to density dependent interactions affecting salmon growth and survival in the Pacific Ocean (NMFS 2024a). While we determined there are adverse effects likely occurring from the SRKW PIP, the general conclusion is that the influence of density dependent interactions on growth and survival is likely small in marine areas. The exact degree of risk to affected ESUs and DPSs will vary depending largely on the regional distribution of released hatchery fish, and on the relative composition in life history types (spring-, summer-, fall-run) and life history stages (subyearling, yearling) of hatchery Chinook salmon released as part of the SRKW PIP. NMFS will annually verify and document the regional distribution of released fish by modeling the total annual proposed release, to confirm effects analyzed within its 2024 SRKW PIP opinion (NMFS 2024e) remain valid and are consistent between this Opinion and the 2024 SRKW PIP opinion. Overall, the level of risk from the SRKW PIP to all potentially affected ESUs and DPSs NMFS determined was expected to be either negligible or low (NMFS 2024e).

In response to recommendations from the Washington State Southern Resident Orca Task Force (2018), the Washington State Legislature provided $12.5 million of funding “prioritized to increase prey abundance for southern resident orcas” (Engrossed Substitute House Bill 1109) for the 2021-2023 biennium (July 2021 through June 2023). This Washington State funding has resulted in approximately 11 million Chinook salmon released in 2022, 2023, and 2024 (Table 43). Because these fish have already been released, this production is included in the environmental baseline. Also included in the environmental baseline are the anticipated effects of state-funded production that has already undergone section 7 consultation

Not all of the hatchery programs that have been receiving state funds have been consulted on under the ESA; future state-funded production in these programs that have not been consulted on is considered in the Cumulative Effects section of this Opinion. Hatchery managers have submitted HGMPs to NMFS for the programs in Table 44, for consideration under NMFS’ 4(d) rule for threatened salmon. The effects of these programs on ESA listed salmon are expected to be generally the kinds of effects described above. We expect these programs to continue operate for the duration of the current State of Washington’s legislative biennium funding cycle, which currently ends in June of 2025. After that, there may be some changes arising from shifting demands on hatchery production due to changes from a variety of reasons, such as Washington State funding priorities shifting, or in conservation needs or harvest regime changes. Though we have not analyzed effects of these programs, and cannot therefore be certain what those effects are, it is reasonable to assume that those programs have many, most, or all of the same adverse effects as those described in for the programs listed in Table 44.

These federal and past state funding initiatives are currently increasing the prey base of Chinook salmon for SRKW (Table 44), as fish released from 2019 and 2020, depending on life history, began reaching adult age in the ocean in 2022. Fish funded by these programs and released to date will contribute to the prey base through 2029, as fish released through 2024 (Table 42 and Table 43) will take a few years to reach maturity in the ocean (within 3-5 years of release based on their type of release and life history; subyearling fall Chinook salmon, for instance, generally return to freshwater after four years of ocean residency (Groot and Margolis 1991)). As these fish exit the ocean after reaching maturity they may contribute to spawning and overall Chinook salmon abundance within the vicinity of their natal release. This will occur at varying intervals, given the various life histories and types of releases listed in Table 42 and Table 43, but as mentioned above, maturity will occur within 3-5 years post 2024.

Table 42. Number of fish released (release years 2020 through 2024) in millions, funded by federal SRKW prey increase funds in federal fiscal years 2020 through 2024 intended to increase SRKW prey base throughout areas where PST fisheries occur[1].

Chinook salmon hatchery program[2]	Program Operating Agency	Region	Life History	2020	2021	2022	2023	2024[3]	Available capacity	Site-specific ESA consultation
Issaquah Hatchery (SY)	WDFW	Puget Sound	Fall	-	-	0.707	1.000	1.000	1.000	NMFS (2021k)
Tulalip Bernie Gobin Hatchery (SY)	Tulalip Tribe	Puget Sound	Summer	-	-	0.958	1.809	1.100	2.000	NMFS (2021e)
Soos Creek Hatchery (SY)	WDFW	Puget Sound	Fall	-	2.003	2.078	2.137	2.100	2.000	NMFS (2019h)
East Bank and Marion Drain Hatcheries (Y)	Yakama Nation	Columbia River	Fall	-	-	0.020	0.110	-	0.500	NMFS (2013e)
Marion Drain Hatchery (SY)	Yakama Nation	Columbia River	Summer	-	0.280	-	-	0.089	0.500	NMFS (2013e)
Select-Area Fishery Enhancement (SAFE) (Y)	ODFW	Columbia River	Spring	-	1.345	1.507	1.431	1.392	1.500	NMFS (2021n)
Umatilla Hatchery (SY)	ODFW	Columbia River	Fall	-	-	0.128	-	0.140	0.130	NMFS (2011b)
Round Butte Hatchery (SY)	ODFW	Columbia River	Spring	-	0.167	-	-	-	n/a	NMFS (2017m)
Bonneville Hatchery (SY)	ODFW	Columbia River	Fall	-	0.344	0.250	0.235	0.256	0.250	NMFS (2017m)
Wells Hatchery (SY)	Douglas PUD/ WDFW	Columbia River	Summer	-	0.483	0.520	0.514	0.500	1.000	NMFS (2020c)
Little White/Willard NFH (SY)	USFWS	Columbia River	Fall	0.480	0.649	-	-	-	0.650	NMFS (2007c)
Little White/Willard NFH (Y)	USFWS	Columbia River	Spring	-	-	0.381	0.498	0.646	0.650	NMFS (2007c)

Chinook salmon hatchery program[2]	Program Operating Agency	Region	Life History	2020	2021	2022	2023	2024[3]	Available capacity	Site-specific ESA consultation
Dworshak NFH (Y)	Nez Perce Tribe	Columbia River	Spring	-	-	0.509	0.494	0.194	0.500	NMFS (2017n)
Spring Creek NFH (SY)	USFWS	Columbia River	Fall	-	0.689	0.066	-	1.769	2.000	NMFS (2007c)
Carson NFH (Y)	USFWS	Columbia River	Spring	-	-	-	0.074	0.061	0.100	NMFS (2007c)
TOTAL				**0.480**	**5.960**	**7.124**	**8.302**	**9.247**	**12.780**	**(NMFS 2024a)**

[1] Only the productions that have already been released at the time of this Opinion's signing are included in this table.
[2] Age of Chinook salmon at release (SY = subyearling; Y = yearling) .72
[3] Submitted goal for FY24

Table 43. Washington State funded production for 2019 through 2024 releases in millions for production increases for SRKW prey increase (excludes base production).

Chinook salmon hatchery program[2]	Program Operating Agency	Region	Life History	2019	2020	2021	2022	2023	2024	Max. annual goal
Lummi Bay Hatchery (SY)	Lummi Nation	Puget Sound	Spring	-	0.050	0.222	0.499	0.504	0.500	0.500
Skookum Creek (SY)	Lummi Nation	Puget Sound	Spring	-	0.870	0.795	-	0.762	1.000	1.000
University of WA (SY)	Muckleshoot Indian Tribes	Puget Sound	Fall	-	-	-	-	-	-	0.180
White River (SY)	Muckleshoot Indian Tribes	Puget Sound	Spring	-	-	0.168	0.238	0.273	0.200	0.200
Clarks Creek (SY)	Puyallup Tribe of Indians	Puget Sound	Fall	-	0.376	0.196	0.612	0.675	0.675	0.675

Chinook salmon hatchery program[2]	Program Operating Agency	Region	Life History	2019	2020	2021	2022	2023	2024	Max. annual goal
Puyallup (SY)	Puyallup Tribe of Indians	Puget Sound	Fall	-	-	-	-	-	-	1.000
Wilkeson Creek (SY)	Puyallup Tribe of Indians	Puget Sound	Fall	-	0.404	0.176	0.400	0.386	0.400	0.400
Squaxin/South Sound Net Pens, Fall (SY)	Squaxin	Puget Sound	Fall						0.200	0.200
Squaxin/South Sound Net Pens, Fall (Y)	Squaxin	Puget Sound	Fall						0.300	0.300
Hupp Springs (SY)	WDFW	Puget Sound	Spring	0.260	0.389	0.543	0.516	0.477	0.500	0.500
Kendall (SY)	WDFW	Puget Sound	Spring	0.704	0.449	0.382	0.636	0.533	0.500	0.500
Marblemount (SY)	WDFW	Puget Sound	Spring	-	0.246	0.160	0.128	0.204	0.100	0.100
Marblemount (Y)	WDFW	Puget Sound	Spring	0.087	0.405	0.415	-	0.499	0.500	0.500
Minter (SY)	WDFW	Puget Sound	Fall	0.763	0.321	0.333	0.291	0.419	0.400	0.400
Samish (SY)	WDFW	Puget Sound	Fall	1.089	1.218	-	0.906	1.043	1.000	1.000
Soos/Palmer (SY)	WDFW	Puget Sound	Fall	0.283	1.211	-	-	-	-	2.000
Wallace River (SY)	WDFW	Puget Sound	Summer	-	0.261	0.184	1.049	1.152	1.000	1.200
Wallace River (Y)	WDFW	Puget Sound	Summer	-	0.035	0.044	-	0.079	0.100	0.250
Whatcom Cr. (SY)	WDFW	Puget Sound	Fall	0.200	0.670	0.492	0.543	0.521	0.500	0.500

Chinook salmon hatchery program[2]	Program Operating Agency	Region	Life History	2019	2020	2021	2022	2023	2024	Max. annual goal
Wells Hatchery (SY)	Douglas PUD/ WDFW	Columbia River	Summer	-	0.541	0.483	0.520	0.514	0.500	1.000
Lewis River (SY)	WDFW	Columbia River	Spring	0.944	-	0.390	0.269	0.290	-	1.000
Klickitat Hatchery (SY)	Yakama Nation	Columbia River	Fall	-	1.000	-	0.575	0.155	1.000	1.000
Sol Duc/Bear Springs (SY)	Quileute Tribe	WA Coast	Summer	-	-	0.148	0.115	0.073	0.160	0.160
Sol Duc/Bear Springs (Y)	Quileute Tribe	WA Coast	Summer	-	0.070	0.071	0.080	0.020	0.075	0.075
Quinault Lake (SY)	Quinault Indian Nation	WA Coast	Fall	-	-	0.500	0.447	0.500	0.500	0.500
Forks Creek (SY)	WDFW	WA Coast	Fall	0.568	2.278	0.257	0.108	0.084	0.050	0.050
Naselle (SY)	WDFW	WA Coast	Fall	-	-	1.472	2.578	1.826	2.500	2.500
Sol Duc (SY)	WDFW	WA Coast	Summer	0.500	0.582	0.480	0.559	0.554	0.770	0.770
Sol Duc (Y)	WDFW	WA Coast	Summer	-	-	0.068	0.029	0.065	0.050	0.050
TOTAL				**5.398**	**11.376**	**7.979**	**11.098**	**11.608**	**13.930**	**18.510**

*Only the productions that have already been released at the time of this Opinion's signing are included in this table.

Table 44. Summary of federal and state funded 2019 through 2024 hatchery-origin Chinook salmon releases to increase SRKW prey.

Funding Source	**Releases Per Year (in millions)**					
	2019	2020	2021	2022	2023	2024*
PST (NMFS)	-	0.480	5.960	7.124	8.302	9.247
Washington State Legislature	5.398	11.856	7.979	11.098	11.608	13.480
TOTAL	**5.398**	**11.856**	**13.939**	**18.222**	**19.910**	**22.727**

*Only the productions that have already been released at the time of this Opinion's signing are included in this table.

Hatchery effects summary

Above we summarized the past and present effects on the four ESUs of ESA-listed Chinook addressed in this opinion from the salmon and steelhead produced from hatchery programs; and the anticipated effects of those programs that have completed ESA consultation. We described the effects of returning adult hatchery fish, including Chinook salmon not eaten by SRKW or other marine mammals or caught by the fisheries, and smolts competing with or preying upon outmigrating natural-origin fish by summarizing the effects evaluated in site specific consultations (Appendix C.1), which are incorporated by reference. We explain above the six factors we evaluate that may pose *positive*, *negligible*, or *negative* effects to population viability of naturally-produced salmon and steelhead from hatchery program operation. In each consultation on affected ESA-listed species, we assess the effects of the programs in the proposed action for each of the six factors, and then make an overall combined risk determination. Our overall determination is expressed as from low to high depending on the site-specific circumstances (e.g., the affected population(s)' contribution to the recovery plan delisting scenario, the six factor determinations, the status of the affected population(s), the status of the ESU, etc.). By virtue of completing consultation, the adverse effects of any program have been previously analyzed, and NMFS has completed consultations on many of the hatchery programs in the Columbia River basin and Puget Sound. In connection with these consultations, numerous modifications have been made over time to reduce the adverse impacts of hatchery programs to ESA listed salmon. Consultations on site-specific hatchery production increases have been completed on all of the programs receiving federal funds to increase SRKW prey (Table 42). Completed consultations are included in Table C.1.

NMFS has and will continue to work with hatchery operators and funders to ensure that all hatchery production, including increased hatchery production to support SRKWs, has been reviewed under the ESA (and NEPA as applicable) to ensure that it does not jeopardize the survival and recovery of any ESA-listed species or adversely modify critical habitat. For example, NMFS completed an ESA consultation (NMFS 2020d) for the release of hatchery fish into streams and rivers that flow into Puget Sound to identify potential impacts to SRKW and other non-salmonid listed species. This analysis looked at all of the potential hatchery production in the Puget Sound region. Separate analyses of the long-term effects of hatchery production on listed salmon and steelhead have been completed for hatchery programs in Table C.1. All of the completed analyses have determined that the hatchery programs will not jeopardize the continued existence of ESA-listed salmonids. NMFS has been working collaboratively with all state and tribal co-managers who rear and release hatchery fish, and other interested parties, to meet the goals related to increasing SRKW prey abundance while minimizing the risk to listed salmonid species. Recall that NMFS has adopted specific criteria for limiting which hatchery programs might receive annual funds as part of the federal PIP (NMFS 2024a), including criteria specifying any program receiving federal funds must have been determined to be not likely to jeopardize the survival and recovery of any ESA-listed species, including salmon or steelhead.

While we have reviewed the general past effects of hatcheries above, operation of these programs has resulted in effects ranging from beneficial to negative. These effects constitute factors that may increase risk to the recovery of the ESA-listed Chinook salmon ESUs, which result from the operation of hatcheries prior to this consultation, as well as the continued operation of hatcheries into the future for those hatchery programs that have already undergone a separate ESA Section 7 consultation. Completing the section 7 consultations at a site-specific level allowed NMFS to understand the comprehensive effects of the hatchery programs that are operating in the action area (e.g., the effects of broodstock collection, competition, predation, and water withdrawals, etc.). These effects are described in detail within each of the biological opinions referenced here in the environmental baseline (see Appendix C for the complete list), and those analyses are incorporated into our overview of effects summarized above. For the programs that have completed section 7 consultations, they are currently now aligned with their respective recovery plan, primarily by ensuring that the allowable level of genetic effects permits natural populations to improve in productivity, abundance, and diversity, which will allow them to adapt to both current and changing environments. While there are hatchery programs that have not yet been evaluated in section 7 consultations or under NMFS' 4(d) rule, we review the future effects of those programs in Section 2.6, Cumulative Effects.

2.4.3 Habitat

ESA listed salmon use nearshore areas and many of these are included in designated critical habitat for the ESUs. Nearshore areas including the Columbia River estuary and Puget Sound near shore areas are part of the action area, and are significantly affected by human activities. Beginning with Columbia River near shore areas, the estuary provides important habitat where juvenile LCR, UWR, and SRFC Chinook salmon feed and complete the process of acclimating to salt water while avoiding predators. Juveniles from these ESUs enter the estuary in two timing peaks each year. The first, likely made up of yearling migrants, passes Bonneville Dam during early to mid-May; the second (subyearlings) between late June and early July. Individuals of both life-history types generally spend less than a week in the estuary (McMichael et al. 2011). Subyearling Chinook salmon including small numbers of individuals from interior ESUs have been caught or detected in shallow water habitat along the margins of the estuary, including the channels that provide access to floodplain wetlands (Roegner and Teel 2014).

Estuarine floodplain habitats have undergone significant change in the last 100 years as a result of human development. Most of the marshes, wetlands, and floodplain channels that provided food and refuge have been diked off from the river and converted to agriculture and industrial and urban use. Corbett (2013) estimated losses of 70% for vegetated tidal wetlands and 55% for forested uplands between the late 1880s and 2010. Marcoe and Pilson (2017) conducted a spatial analysis of long-term land cover change for the estuary and its floodplain by comparing GIS representations of late 1800s maps with recent, high resolution land cover data from 2009. They calculated that 68–70% of the vegetated tidal wetlands, important habitats for juvenile salmonids, were lost over that 100-year plus period. Most of this loss was due to conversion of land for agriculture and urban development, but wetlands in the upper reaches of the estuary were converted to industrial and urban use (especially in the Portland/Vancouver area). Furthermore, water storage and release patterns from reservoirs upstream of the estuary have reduced peak spring and early summer flows. Kukulka and Jay (2003) estimated that diking combined with a more than 40% reduction in spring flows has reduced shallow water habitat area by 62% during the crucial spring period when juvenile salmon use of the estuary is highest. Taken individually, diking and alteration of the hydrograph (the flow of water at a specific point in a river or channel) reduced shallow water habitat area by 52% and 29%, respectively.

The estuary and plume (the low-salinity water mass that forms in the ocean when rivers or estuaries discharge into the ocean or a continental shelf) provide salmonids with a food-rich environment where they can complete the transition from freshwater to saltwater and from invertebrate to juvenile fish prey. Every anadromous fish that spawns in the Columbia River Basin undergoes a transformation at least twice in its lifetime—the first time while migrating out to sea during or soon after its first year of life and the second, 1 to 3 years later, when returning to spawn.

Use of the estuary and plume, and thus the impacts on salmonids because of changes to these areas, vary by species and major life history type. As discussed in Section 2.2.1, Status of Listed Species, anadromous salmonids have two major juvenile rearing strategies: ocean-type and stream-type (Fresh et al. 2005). Ocean type fish migrate to sea early in their first year of life after rearing for only a short period (or no time) in freshwater, but may feed and continue to grow in the estuary for weeks or months before ocean entry (Fresh et al. 2005). These fish make extensive use of shallow, vegetated floodplain habitats where the significant changes in flow and thus habitat access and quality described above have occurred. Conversely, stream-type fish rear in freshwater for a longer period, usually at least one year, before migrating to sea (Fresh et al. 2005). In terms of ESA-listed fish, LCR and UWR salmon produce stream-type juveniles. Fall-run populations of LCR and SRFC salmon are ocean-type fish. Spring-run populations of LCR Chinook salmon and UWR spring-run Chinook salmon are technically ocean-type fish but naturally represent a mixture of the two types. Ocean-type Chinook salmon in particular used the estuary as fry, fingerlings, subyearlings, and yearlings (Fresh et al. 2005); however, many previously common patterns are now considered rare.

Both ocean- and stream-type salmonids experience significant mortality in the estuary. However, because they spend different amounts of time in the estuary environments and use different habitats, they are subject to somewhat different combinations of threats and opportunities. For ocean-type juveniles, mortality is believed to be related most closely to lack of habitat, changes in food availability, and the presence of contaminants, including persistent, bio accumulative contaminants present in sediments in the shallow-water habitats where ocean-type juveniles rear Table 45. Stream-types are affected by these same factors, although presumably to a lesser degree because of their shorter residency times in the estuary. The influence of these factors on survival from Bonneville Dam to the ocean is summarized in the following sections.

Table 45. Relative importance to ocean- and stream-type salmonids of limiting factors in the Columbia River estuary, for factors rated as significant or higher in one of the two life-history types. Adapted from Table 3-1 of NMFS (2011c).

Factor	**Level of Impact[1]**	
	Ocean-type	**Stream-type**
Flow-related habitat changes	Major	Moderate
Sediment-related habitat changes	Significant	Moderate
Flow-related changes to access to off-channel habitat	Major	Moderate
Bank elevation changes	Major	Minor
Flow-related plume changes	Moderate	Major
Water temperature	Major	Moderate
Reduced macrodetrital inputs	Major	Moderate
Avian and pinniped predation	Minor	Major
Toxicants	Significant	Minor-Moderate

[1] Level of impact ratings: No likely effects, minor effects, moderate effects, significant effects, and major effects on populations.

Improvements and protections to estuary habitat include protecting riparian areas, restoring off-channel habitats, restoring and improving hydrology/access, reducing invasive plants, using dredged material beneficially, and acquiring land. Table 46 shows the summary of estuary habitat action metrics completed in the year 2015. From 2007-2016, 8,835 cumulative acres of estuary floodplain and 48.6 cumulative miles or estuary riparian area have been improved (ACOE 2017). One example of an improvement to estuary habitat is the restoration completed at LaCenter Wetlands by The Lower Columbia Estuary Partnership in which approximately 453 acres of floodplain habitat was reconnected to the East Fork Lewis River, off-channel habitat was restored, and non-native Reed Canary Grass was removed.

Table 46. Summary of Estuary Habitat Action Metrics, 2015 (ACOE 2017).

Action	**Acres**
Protect riparian areas (CRE 1.3)*	0
Restore off-channel habitat (CRE 9.4)	43
Restore full hydrology/access (CRE 10.1)	634
Improve hydrology/access (CRE 10.2)	256
Improve access (CRE 10.3)	0
Reduce invasive plants (CRE 15.3)	343
Use dredged materials beneficially (CRE 6.3)	0

Action	Acres
Land acquisition (CRE 9.3)	46
Total	**1,321**

* "CRE" refers to an action type described in NOAA Fisheries' "*Columbia River estuary ESA recovery plan module for salmon and steelhead*" (NMFS 2011c).

Many of the quantifiable Columbia River estuary and near shore habitat actions benefit LCR, UWR, and SRFC populations. Habitat restoration actions for salmonid habitat since the most recent FCRPS biological opinion (NMFS 2008i) are reflected in the improving status of these ESUs.

Moving into Puget Sound, 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 (SSDC 2007).

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 (SSDC 2007). 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 (Entrix 2005; SSDC 2007). 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 (SSDC 2007). 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.

Activities that NMFS has consulted on in the Puget Sound Region that affect salmon habitat include hydropower projects (Mud Mountain Dam (NMFS 2014f), Howard Hanson Dam, Operation, and Maintenance (NMFS 2019c)), the National Flood Insurance program (NMFS 2008f), marine construction (NMFS 2020b; 2021j; 2022i), and the Salish Sea Nearshore Programmatic (NMFS 2022h). In 2020, 2021, and 2022, NMFS issued Opinions for 39 (NMFS 2020b), 11 (NMFS 2021j), and 15 (NMFS 2022i) habitat-modifying projects in the nearshore marine areas of Puget Sound. The Opinions concluded that the proposed actions would jeopardize the continued existence of, and adversely modify critical habitat for, Puget Sound Chinook salmon and SRKWs. The expected improvements to Chinook salmon abundance resulting from implementation of the RPAs and conservation offsets as implemented under the Salish Sea Nearshore Programmatic Opinion (NMFS 2022h) for pending projects are expected to improve the habitat conditions for Puget Sound Chinook salmon.

The funding for U.S. domestic actions associated with the 2019 PST Agreement (Pacific Salmon Commission 2022) included funding for habitat restoration projects to improve habitat conditions for specified populations of Puget Sound Chinook salmon ($31.2 million[40] over 3 years; FY 2020-2022). In FY20, FY21, and FY22, $8.9 million, $8.8 million, and $8.8 million, respectively, was directed at habitat restoration projects within the northern boundary watersheds of Nooksack, Skagit, Stillaguamish, Snohomish, Dungeness, and Mid-Hood Canal, see Appendix F for a list of habitat projects funded by year. By improving habitat conditions for these populations, we anticipate Puget Sound Chinook salmon abundance will increase in the long term (see Appendix F for a list of projects by fiscal year). The projects funded through the initiative 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. Additional to the PST funding of habitat restoration projects in Puget Sound, funding to the BIA, through the Inflation Reduction Act, will also likely contribute to habitat restoration, climate resilience, and hatchery improvements.

2.4.4 Southern Resident Killer Whales

As described in Section 2.2.3.1 (Status of the Species) and assessed in the Final Recovery Plan (NMFS 2008b), the three major threats to SRKW include (1) quantity and quality of prey, (2) toxic chemicals that accumulate in top predators, and (3) impacts from sound and vessels. Other threats identified include oil spills, disease, inbreeding and the small population size, and other ecosystem-level effects (NMFS 2008b). It is likely that multiple threats act together to impact the whales, rather than any one threat being primarily responsible for the status of SRKWs. The 5-year review (NMFS 2021m) documents the latest progress made on understanding and addressing threats to SRKW. These threats affect the species' status throughout their geographic range, including the action area, as well as their critical habitat within the action area. As a result, most of the topics addressed in the Status of the Species and Critical Habitat Sections are also relevant to the environmental baseline and we refer to those descriptions or include only brief summaries in this section. NOAA's Species in the Spotlight Priority Action Plan[41] identifies high priority actions for SRKW 2021-2025 and ongoing progress towards implementation of recommendations from the WA state Governor's task force to address all major threats to SRKW can be found here: https://orca.wa.gov/.

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[40] $31.2 million is the sum total of Congressional appropriations for federal Fiscal Year (FY) 2020, 2021, and 2022; $10.4 million/year. This figure differs from the annual, direct projects funding level due to containing funds used for NMFS administrative costs.

[41] https://www.fisheries.noaa.gov/resource/document/species-spotlight-priority-actions-2021-2025-southern-resident-killer-whale

2.4.4.1 Prey Availability

Chinook salmon are the primary prey of SRKW throughout their geographic range, which includes the action area. The abundance, productivity, spatial structure, and diversity of Chinook salmon are affected by a number of natural and human actions, and these actions also affect prey availability for SRKWs. As discussed in the Status of the Species, the abundance of Chinook salmon now is significantly less than historic abundance due to a number of human activities. The most notable human activities that cause adverse effects on ESA-listed and non ESA-listed salmon include land use activities that result in habitat loss and degradation, hatchery practices, harvest, and hydropower systems. Details regarding baseline conditions of ESA-listed Chinook salmon in the action area are described above in Sections 2.4.1-2.4.3.

Here we provide a review of previous ESA Section 7(a)(2) consultations covering effects to SRKWs from activities whose effects in the action area were sufficiently large in terms of reducing available prey that they were found likely to adversely affect or jeopardize the continued existence of the whales. We also consider ESA Section 7(a)(2) consultations on hatchery actions that are contributing prey to the whales. We then qualitatively assess the remaining prey available to SRKWs in the action area.

2.4.4.1.1 Harvest Actions

Salmon fisheries that intercept fish that would otherwise pass through the action area and become available prey for SRKWs occur all along the Pacific Coast, from Alaska to California. In past harvest consultations, including Puget Sound salmon fisheries (NMFS 2010a; 2014a; 2015a; 2016g; 2017o; 2018g; 2019g; 2020f; 2021d; 2022a; 2023a; 2024c), PFMC-area salmon fisheries (NMFS 2008e; 2020e; 2021c), the Pacific Salmon Treaty 2009 Agreement (NMFS 2008a), and the *U.S. v. Oregon* Management Agreements (NMFS 2008c; 2018b), we characterized the short-term and long-term effects these salmon fisheries have on the SRKWs via prey reduction from fishery operations. 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. We first review individual fishery impacts and Biological Opinions, using evolving, best available methodologies, and then provide a comprehensive review of all fisheries to estimate baseline prey availability. The comprehensive fishery analysis uses updated methodology so that the assessments of multiple fisheries are comparable.

Salmon fisheries off Alaska, Canada, Washington, and Oregon are managed under the PST. The Treaty has annex agreements that provide detailed implementation provisions that are renegotiated periodically for multi-year periods ("PST Agreement"). The 2019-2028 PST Agreement currently in effect (Pacific Salmon Commission 2022) includes provisions limiting harvest impacts in all Chinook salmon fisheries and refining the management of coho, sockeye, chum, and pink salmon within its scope. This PST Agreement includes reductions in the allowable annual catch of Chinook salmon in the SEAK and Canadian West Coast of Vancouver Island and Northern British Columbia fisheries by up to 7.5 and 12.5 %, respectively, compared to the previous (2009-2018) PST Agreement. The level of reduction depends on the Chinook salmon abundance in a particular year. This comes on top of the reductions of 15 and 30 % for those same fisheries that occurred as a result of the 2009-2018 PST Agreement. These reductions should result in more salmon returning to the more southerly U.S. Pacific Coast portion of the EEZ than under prior PST Agreements. Therefore, under the new PST Agreement, the fisheries should have a smaller effect in terms of reducing SRKW prey than under the previous PST Agreement, which is seen in the analyses described below.

Salmon fisheries in the SUS are managed to meet specific objectives for ESA-listed and non-listed salmon ESUs and, as a result, can have impacts lower than what is allowed by the PST Agreement, particularly for Chinook salmon. Fisheries in the EEZ off the U.S. West Coast are managed by the PFMC (or the NPFMC off Alaska) and NMFS under the MSA. NMFS has issued Biological Opinions addressing the effects of these fisheries on all affected ESA-listed species including SRKWs, and fisheries are managed consistent with the proposed actions and ITSs in these Opinions.

In 2019 NMFS reinitiated consultation to consider effects of PFMC-area ocean salmon fisheries on SRKW given substantial new information, and the PFMC formed an Ad Hoc SRKW Workgroup (Workgroup) to reassess fishery effects on SRKWs and develop a long-term approach potentially including proposed conservation measure(s) or management tool(s) that limit PFMC salmon fishery impacts on Chinook salmon prey available for SRKWs as needed. The PFMC recommended Amendment 21 to address effects of PFMC-area ocean salmon fisheries on the Chinook salmon prey base of SRKWs, based on recommendations from the Workgroup. In 2021, NMFS consulted on the authorization of the West Coast ocean salmon fisheries through approval of the Pacific Salmon Fishery Management Plan including Amendment 21 and implementation of the Plan through regulations and concluded this action was not likely to jeopardize the continued existence of SRKW. NMFS ultimately approved the Amendment (86 FR 51017, September 14, 2021). The Amendment established a threshold representing a low pre-fishing Chinook salmon abundance in the NOF area (including the EEZ and state ocean waters), below which the PFMC and States will implement specific management measures (NMFS 2021c). The NOF abundance threshold is equal to the arithmetic mean of the seven lowest years of the estimated starting abundance (prior to fishing) from the FRAM (see PFMC (2020) for more details or (PFMC 2024a)), which also included years when SRKWs were in varied health. The threshold may be revised prior to the start of the fishing season using current data and updated methods if determined to be the best available science by the Salmon Technical Team (STT), Scientific and Statistical Committee (SSC), and the PFMC (PFMC 2024a). The threshold was updated in 2022 to incorporate new scientific information and is currently estimated[42] at 623,000 Chinook salmon.

Under the Amendment, each year, the preseason estimate of pre-fishing Chinook salmon abundance for the upcoming fishing year will be compared to the threshold. In years when the projected preseason abundance of Chinook salmon in the NOF area falls below the low

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[42] This threshold is the arithmetic mean of the seven lowest years of pre-fishing Chinook salmon abundance estimated to be present on October 1 in the area North of Cape Falcon (1994-1996, 1998-2000, and 2007), and are years where there was a general mix of SRKW status (i.e., consisting of a spectrum of risk), with two relatively good status years (1994 and 2007) and five years of fair or poor SRKW status. The low abundance threshold the PFMC developed for Amendment 21 also includes two periods when there were multiple and consecutive years of low Chinook salmon abundance (1995-1996, 1998-2000), given reproductive success is likely reliant on several years of optimal prey availability as female body condition and energy reserves potentially affect reproduction and/or result in reproductive failure at multiple stages. Should updates or changes occur to models that affect these historic estimates of abundance, the threshold should be recalculated using the same methodology.

abundance threshold, multiple management actions (e.g. quota adjustments and spatial/temporal closures) will be implemented through annual regulations within the NOF area, with the goal of limiting effects of the fishery on SRKWs. NMFS concluded in the Biological Opinion (NMFS 2021c) that the FMP including Amendment 21 is responsive to the abundance of Chinook salmon by requiring that fisheries be designed to meet FMP conservation objectives and addresses the needs of the whales by limiting prey removal from the fisheries in NOF areas during years with low Chinook salmon abundance. Amendment 21 also reduces the potential for competition between fisheries and SRKWs in times and areas where/when the fisheries and whales overlap, and when Chinook salmon abundance is low. Therefore, NMFS concluded that fisheries managed consistent with the proposed action were not likely to jeopardize the continued existence of the SRKW DPS or destroy or adversely modify its designated critical habitat (NMFS 2021c). In addition to limiting the reduction in prey availability on the coast, Amendment 21 may limit the reductions of prey by PFMC fisheries on Salish Sea prey in years with low salmon abundance, compared to the FMP without Amendment 21, but the extent of the impacts of the Amendment on inland prey availability specifically is unknown. In years when Chinook salmon abundance is above the threshold, we anticipate similar reductions in prey availability attributed to the PFMC fisheries as those observed in the 10-yr period considered in the Opinion (NMFS 2021c) into the foreseeable future.

Recent Biological Opinions considering the effects of Puget Sound salmon fisheries on SRKWs have considered percent reductions in Chinook salmon prey expected from the fisheries. In the most recent Biological Opinion on federal actions related to the salmon fisheries in Puget Sound (NMFS 2024c), NMFS estimated that the percent reductions of Chinook salmon from the tribal and state Puget Sound fisheries in 2011-2020 in inland waters of WA averaged 4.5%[43] annually, with the greatest reductions occurring in July-September. Percent reductions in overall abundance from the Puget Sound salmon fisheries of Chinook salmon in the Salish Sea in 2024-2025 were predicted to be similar to, but slightly less than, average reductions and were estimated to be 4.0% relative to the starting abundance. The pre-season estimate for abundance of age 3-5 Chinook salmon in the Salish Sea for 2024-2025 was approximately 1,181,819 fish—greater than the estimated abundance for the retrospective time period (2011-2020) post-season average of approximately 969,939 fish. Although some of the prey reduction due to the Puget Sound fisheries occurs in an area known for high SRKW use and is considered a foraging hot spot (an area where SRKWs are frequently detected or sighted such as the west side of San Juan Island), in recent years recreational fishery restrictions in the summer and winter, very limited commercial fishing, and limited tribal fishing, were expected to limit the impacts in this hot spot. Also, additional management measures were implemented to reduce impacts of vessel and noise disturbance.

Some directed fishery actions affecting salmon abundance may be mitigated by hatchery production. For example, the *U.S. v. Oregon* action was determined not likely to adversely affect SRKWs because hatchery production included as part of that action offset the in-river harvest reductions (i.e., reductions occur after Chinook salmon are no longer available as prey). Columbia River salmon stocks are currently managed in line with their recovery plans, the status of several stocks and ESUs have improved under the fishing regime, and hatchery programs are

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[43] The methodology to estimate this percent reduction differs from the PFMC SRKW Ad Hoc Workgroup report from 2021 and warrants caution in comparing impacts.

managed in ways to minimize effects to listed species (NMFS 2018b). Similarly, the federal Columbia River System (CRS) action was determined not likely to adversely affect SRKWs because part of the action included production of hatchery Chinook salmon that more than offset Chinook salmon mortality (NMFS 2008c; 2020g).

Finally, fisheries other than directed salmon fisheries may also catch Chinook salmon as bycatch, and this may include Chinook salmon that would otherwise pass through the action area. Specifically, the PFMC groundfish fisheries catch Chinook salmon as bycatch, and the most recent Biological Opinion found the PFMC groundfish fishery is likely to adversely affect, but not jeopardize, ESA-listed Chinook salmon (NMFS 2017e). Coastwide, while PFMC groundfish fisheries take an average of approximately 7,000 Chinook salmon per year, the fisheries are not likely to adversely affect SRKW, given a) the wide geographic expanse of the area and relatively low bycatch numbers and b) the relatively high number of young (under age 3) Chinook salmon taken, which are not the preferred prey of SRKW (NMFS 2022g). Recreational halibut fisheries in the Salish Sea have very limited bycatch mortality of Chinook salmon (less than 2 Chinook salmon on average each year), commercial and tribal halibut fisheries likely do not have incidental catch, and bottomfish and shrimp trawl fisheries have limited incidental take (lethal take of up to 50 Chinook salmon) (see Section 2.4.1, Environmental Baseline for Puget Sound Chinook and Steelhead in NMFS (2023a)).

The directed salmon harvest 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 or SRKWs. Additionally, Amendment 21 to the FMP for the ocean salmon fisheries addresses SRKW prey needs by limiting prey removal from the fisheries in NOF areas in low abundance years, and could limit reduction of Salish sea prey availability by PFMC fisheries in those years.

2.4.4.1.2 Hatchery Actions

As described in detail in the environmental baseline for Chinook salmon (Section 2.4.1-2.4.3), hatchery production of salmonids has occurred for over a hundred years. There are over 300 hatchery programs in Washington, Oregon, California, and Idaho that produce and release juvenile salmon that migrate through coastal and inland waters of the action area. Many of these fish contribute to both fisheries and the SRKW prey base in coastal and inland waters of the action area.

NMFS has completed Section 7(a)(2) consultations on more than two hundred hatchery programs (Doremus and Friedman 2021); refer to Appendix C, Table C.1). A detailed description of the effects of these hatchery programs can be found in the site-specific Biological Opinions referenced in Appendix C, Table C.1. Additionally, a description of the effects of hatchery production receiving federal funds to increase SRKW prey is included in the FEIS (NMFS 2024a) and the ESA consultation (NMFS 2024e) for the program, as well as the site-specific ESA and NEPA documents for the funded programs. These effects are further described in Appendix C of NMFS (2018b), which is incorporated here by reference. Currently, hatchery production is a significant component of the salmon prey base within the range of SRKWs (Barnett-Johnson et al. 2007; NMFS 2008d). Prey availability has been identified as a threat to SRKW recovery, and we expect the existing hatchery programs to continue benefiting SRKWs by contributing to their prey base.

As discussed in detail in the environmental baseline for Chinook salmon (Section 2.4.2) and in NMFS (2024e), funding through NMFS and the State of Washington has been used to increase regional hatchery production with the goal to enhance prey availability for SRKWs. One of the domestic actions associated with the 2019-2028 PST Agreement was to provide federal funding annually for increased hatchery production of SRKW prey. Thus far, the federal prey increase program has provided funds in FY20 ($5.6 million), FY21 ($7.3 million), FY22 ($6.3 million) (NMFS 2022f), and FY23 ($5.6 million). The federal prey increase program has resulted in the release of an additional 30.6 million Chinook salmon smolts from 2020-2023 when compared to releases prior to the 2019 PST Agreement (Rumsey 2021; NMFS 2022f) (Table 44), with adult (age 3+) Chinook salmon returning starting in 2022. We anticipate federal funding similar to the levels in 2023 to continue based on funding and implementation to date. These additional releases are contributing towards the goal of increasing adult Chinook salmon abundance by 4-5 % in coastal areas during the winter, and inland (Salish Sea) areas during the summer, which would overlap with SRKW occurrence. NMFS has and will continue to work with hatchery operators and funders to ensure that all hatchery production to support SRKWs receiving federal prey program funds has been thoroughly reviewed under the ESA (and NEPA as applicable) to ensure that it does not jeopardize the survival and recovery of any ESA-listed species or adversely modify critical habitat. All of the completed analyses to date have determined that the hatchery programs will not jeopardize listed salmonids, and most are not likely to adversely affect SRKW ((NMFS 2024e); also see Appendix C Table C.1).

Additionally, the Washington State Legislature provided approximately $13 million "prioritized to increase prey abundance for southern resident orcas" (Engrossed Substitute House Bill 1109) for the 2019-2021 biennium (July 2019 through June 2021), $12.5 million for the 2021-2023 biennium (July 2021 through June 2023), and $12.5 million for the 2023-2025 biennium (July 2023 through June 2025). These funds have resulted in an additional 60.9 million Chinook salmon smolts released through 2024, with adult Chinook salmon returning starting in 2021. See Table 44 for a summary of the total hatchery releases through 2024 funded by the PST Federal Appropriation and Washington State. We expect adult fish produced with this funding source to be available to SRKW as prey for three to five years following release, when these fish would return as 3-5 year olds. Many programs receiving Washington State funds have completed environmental reviews; however, as discussed above in Section 2.4.2, some have not. As described there, the effects of funding for production from programs with expired ESA Section 7 consultation and those programs yet to undergo ESA Section 7 consultation are not included in the environmental baseline consistent with 50 CFR 402.02, but the effects of these programs on ESA-listed species will be considered under cumulative effects to ensure that the adverse effects on listed fish are fully analyzed.

2.4.4.1.3 Habitat Actions

Habitat-altering activities such as agriculture, forestry, marine construction, levy maintenance, shoreline armoring, dredging, hydropower operations and new development continue to limit the ability of the habitat to produce and support salmon, and thus limit prey available to SRKWs in the action area. Many of these activities have a federal nexus and have undergone Section 7(a)(2) consultation. Those actions have nearly all met the standard of not jeopardizing the continued existence of the listed salmonids or adversely modifying their critical habitat (nor for SRKW), and when they did not meet that standard, NMFS identified RPAs. 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 Chinook salmon. In fact, listed 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 SRKWs were listed, federal agencies have consulted on impacts to the whales from actions affecting salmon by way of habitat modification.

Activities that NMFS has consulted on that affect salmon habitat, and therefore also likely limit prey available to SRKWs, are discussed in the Chinook salmon environmental baseline section (see Section 2.4.1-2.4.3).

In 2020, 2021, and 2022, NMFS issued Opinions for 39 (NMFS 2020b), 11 (NMFS 2021j), and 15 (NMFS 2022i) habitat-modifying projects in the nearshore marine areas of Puget Sound. The Opinions concluded that the proposed action would jeopardize the continued existence of, and adversely modify critical habitat for, Puget Sound Chinook salmon and SRKWs. The expected improvements to Chinook salmon abundance resulting from implementation of the RPAs and conservation offsets as implemented under the Salish Sea Nearshore Programmatic Opinion (NMFS 2022h) for pending projects are expected to improve the amount of prey available for SRKWs and avoid jeopardy and adverse modification for SRKWs and their critical habitat.

In 2021, NMFS consulted on the removal of four dams on the mainstem Klamath and associated activities such as infrastructure modifications, removal, and reservoir drawdown, that impact Chinook salmon habitat (NMFS 2019j). While temporary impacts to Chinook salmon are expected due to hatchery phase-out and short-term habitat degradation, long-term benefits to the SRKW prey base are expected due to increased natural-origin Chinook salmon production and survival.

The funding initiative for U.S. domestic actions associated with the 2019-2028 PST Agreement (Pacific Salmon Commission 2022) included funding for habitat restoration projects to improve habitat conditions for specified populations of Puget Sound Chinook salmon ($31.2 million[44] over 3 years; FY 2020-2022). In FY20, FY21, and FY22, $8.9 million, $8.8 million, and $8.8 million, respectively, was directed at habitat restoration projects within the northern boundary watersheds of Nooksack, Skagit, Stillaguamish, Snohomish, Dungeness, and Mid-Hood Canal. Projects were selected according to a list of preferred criteria, one of which included projects that supported high priority Chinook salmon populations for SRKW (see Appendix F for a list of funded projects). As a result of improving habitat conditions for these populations, we anticipate Puget Sound Chinook salmon abundance would increase and thereby benefit SRKWs in the long term.

2.4.4.1.4 Assessing Baseline Prey Availability

We assessed Chinook salmon abundance in the action area by referring to the FRAM-Shelton approach described in the PFMC SRKW Ad Hoc Workgroup Report (PFMC 2020), the Biological Opinion on PFMC-area fisheries (NMFS 2021c), and most recently in the 2024 Puget

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[44] $31.2 million is the sum total of Congressional appropriations for federal Fiscal Year (FY) 2020, 2021, and 2022; $10.4 million/year. This figure differs from the annual, direct projects funding level due to containing funds used for NMFS administrative costs.

Sound Chinook Salmon Fisheries Biological Opinion (NMFS 2024c). Here, we briefly describe the method the Workgroup developed to estimate the starting abundance of Chinook salmon prey available (age 3+) for fishery management years 1992-2020[45] within the action area (for more information see (PFMC 2020)) and Appendix D for a more detailed description of methods).

We assume that the range of Chinook salmon abundance experienced from 1992-2020 is likely representative of the range of abundances we expect to see in future years, and that Chinook salmon availability will continue to be variable as observed during this retrospective time period (1992-2020). These years encompass years of very low Chinook salmon abundance and years of relatively high abundance. Coastwide abundances of Chinook salmon are distributed among five spatial boxes selected to be most important for SRKW: Salish Sea, Southwest Coast of Vancouver Island (SWWCVI), the Washington Coast NOF, the Oregon Coast, and the California Coast (see PFMC (2020) for the full descriptions of all the areas and Appendix D Table D.1). The abundance estimates are specific to time periods from FRAM for an annual cycle: October to April, May to June, and July to September. While the FRAM-Shelton models provide estimates of abundance, we acknowledge that there are uncertainties and limitations to these methods (see detailed description in PFMC (2020) Section 5.6). Estimated pre-fishing Chinook salmon abundances aggregated by spatial box for each time step during the retrospective time period are provided in Figure 57 (see also Appendix B Table B.1). These estimates were derived using the post-season validation runs as described in Appendix D. These values represent starting abundances in October, prior to natural or fishery mortality estimates that occur in each subsequent time step. The Workgroup agreed to use starting abundances as the most appropriate initial abundance estimate for the purpose of estimating reductions in area-specific abundance attributable to fishery removals.

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[45] This retrospective time period was chosen because the analysis is anchored to data from FRAM model runs, and 1992-2020 is the time period for which validated FRAM model runs (version 7.1.1) were available at the time of this biological consultation. Fishing in 2019 and 2020 operated under the 2019 PST Agreement levels and are assessed separately in the Environmental Baseline. These years occur in the past, but align with the anticipated effects of the proposed actions considered in this consultation. The effects of fishing in 2021-2023 were unavailable at the time of this analysis.

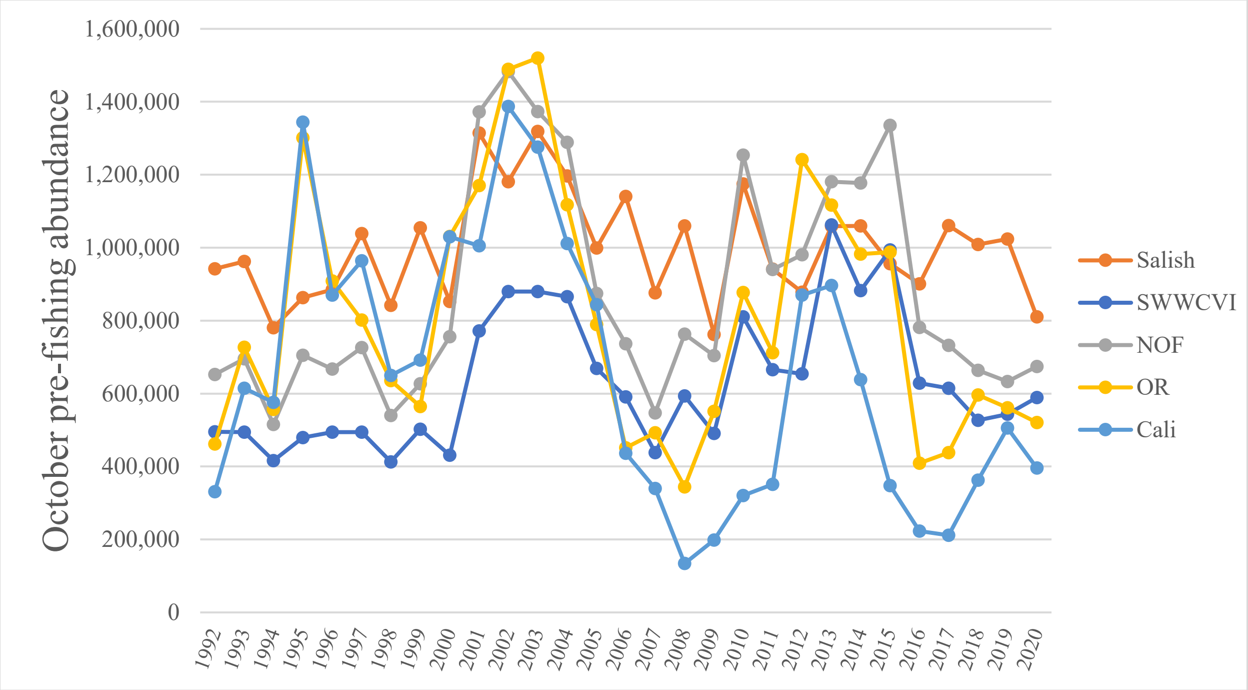
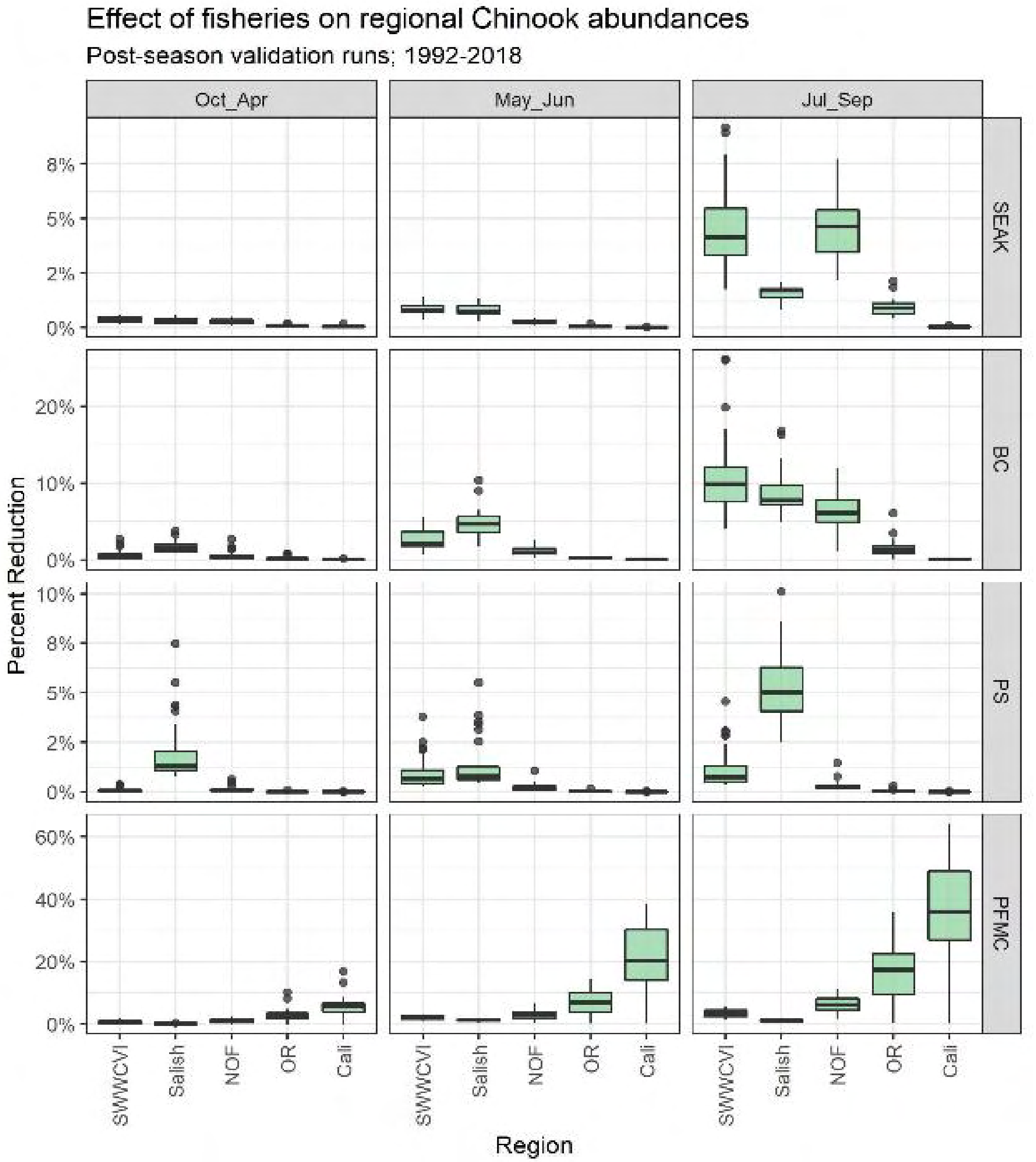


Figure 57. Post-season validation runs (FRAM 7.1.1) showing October pre-fishing Chinook salmon abundances by region in a retrospective analysis from 1992-2020. See Appendix D and PFMC (2020) for a description of the spatial regions.

Using the updated FRAM-Shelton models, and additional modifications as used in the 2022-2024 Puget Sound Salmon Fisheries consultations (NMFS 2022a; 2023a; 2024c), we conducted a retrospective analysis to evaluate how all PST fisheries have historically affected the prey available to SRKWs. This analysis involved comparing a series of "no fishing" scenarios to the FRAM validation runs, described 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 spatial areas across the SRKW range. "Prey reduction" is defined as the percent of prey that would have been available to SRKW in the specified areas of their range had the fishery not occurred. As such, other sources of mortality (natural, fishing) have been factored into the model, and the resulting percentages of prey reduction represent fish that are expected to overlap with, and be available to, SRKW. Results in this section and in the Effects Section on SRKW are presented as a series of box-and-whisker plots, which display a box representing the first quartile, median, and third quartile as the lower bound, midline, and upper bound of the box, respectively, the whiskers representing the minimum and maximum values, and the dots representing outliers which are values beyond 1.5*IQR (interquartile range, or distance between the first and third quartiles). 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. However, for the July-September time step, most of the reductions displayed actually occurred during those months, given that more fisheries operate during that season. Figure 58 summarizes the average percent reductions by fishery, time step, and region for the retrospective time period (FRAM validation runs) of 1992-2018 (see also Appendix B Table B.2).



Note: box-and-whisker plots display a box representing the first quartile, median, and third quartile as the lower bound, midline, and upper bound of the box, respectively, the whiskers representing the minimum and maximum values, and the dots representing outliers which are values beyond 1.5*IQR (interquartile range, or distance between the first and third quartiles).

Figure 58. Post-season validation runs (FRAM 7.1.1) showing historical percent prey reductions (Chinook salmon ages 3+) by fishery (rows), time step (columns), and region (x-axis) in a retrospective analysis of 1992-2018. Note the different scales on the y-axes. See Appendix B Table B.2 for the annual percent reductions. See Appendix D and PFMC (2020) for a description of the spatial regions.

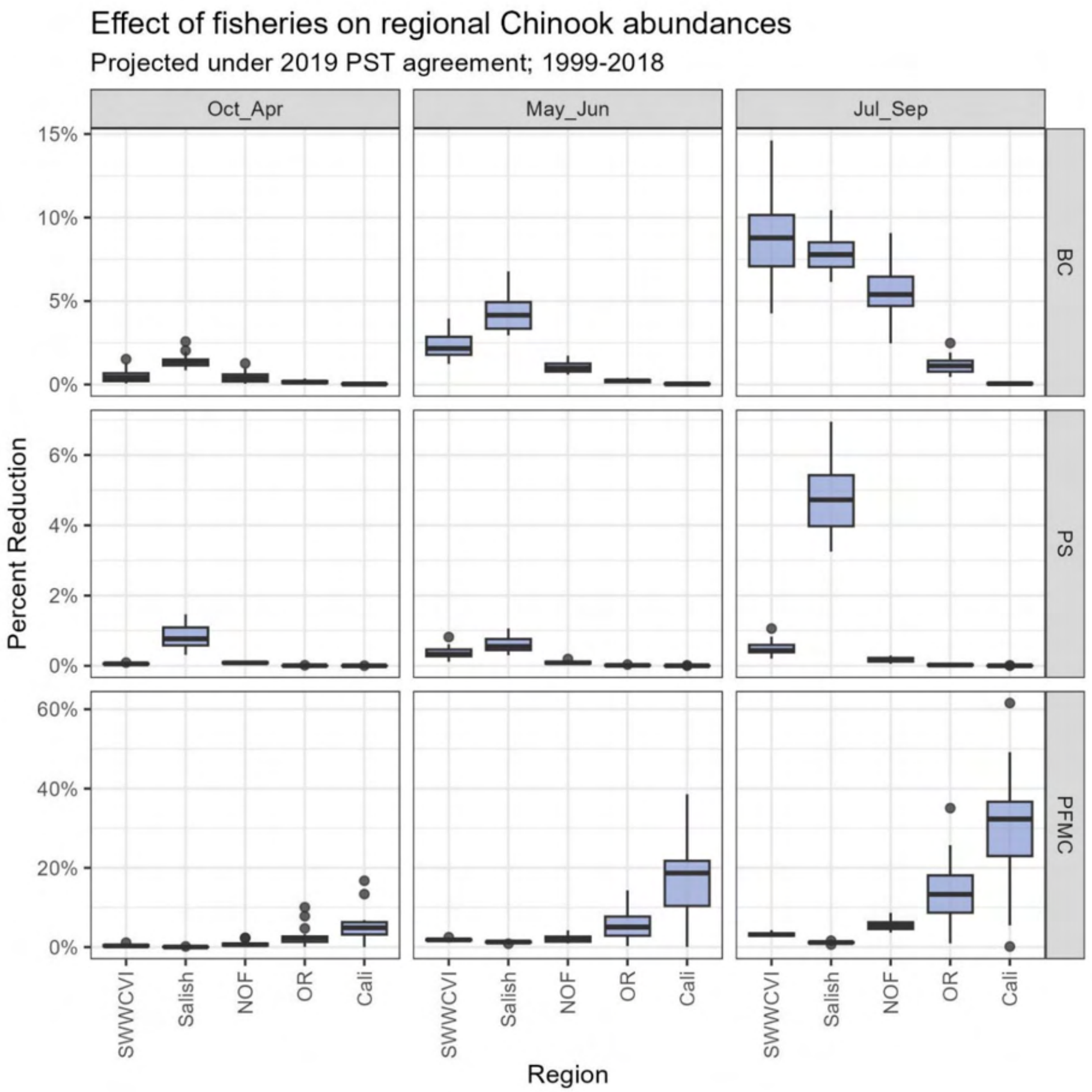
In general, the largest reductions in prey availability from the Canadian and U.S. fisheries occurred in coastal and inland waters from July-September; reductions were relatively smaller from October-April (Figure 58; Appendix B Table B.2). The largest overall reductions occurred in the PFMC fisheries off the coast of California (average 36%) and Oregon (average 16%) from July-September. The largest impacts from the Puget Sound fisheries occurred in inland waters from July-September (average 5.3%); however, Canadian fisheries removed a larger proportion of prey from Puget Sound during that time step (average 8.8%). The largest impacts from the SEAK fisheries occurred in the SWWCVI (average 4.7%) and NOF (average 4.6%) regions from July-September and to a lesser degree in the Salish Sea from May-September.

While prey removals from all areas in the SRKW range are of interest, we focus our attention on fishery impacts during times and places that are most likely to be important for SRKW foraging. Specifically, the Salish Sea and SWWCVI (which includes Swiftsure Bank) are important foraging areas during the May-June and July-September time steps. The NOF region is an important area during the October-April time step, though in recent years is becoming more important in the summer months (see Section 2.2.3.1, Status of the Species for a summary of SRKW seasonal ranging patterns). The large reductions in Oregon and California during July-September do not overlap with occurrence of SRKW (see Table 2 in NMFS (2021m)).

The above reductions represent the time period before the implementation of the current PST Agreement (2019-2028). Under the 2019 PST Agreement, all PST fisheries are expected to have reduced impacts on SRKW prey availability as compared to previous PST Agreements. As such, we assessed a "2019 Likely (SEAK 2009)" scenario (Scenario 3 in Section 2.5.1 and Appendix A) to evaluate how baseline fisheries (i.e., all fisheries subject to the PST except for SEAK fisheries that are part of the proposed action) would be expected to impact prey availability for SRKWs moving forward under the 2019 PST Agreement fishing levels, using the time period of 1999-2018 for Chinook salmon abundances. In general, this scenario represents what we can reasonably expect to occur under both the 2019 PST Agreement and other likely domestic constraints but without the proposed actions of delegation of management of federal fisheries to the State and funding to the State to implement the PST. SEAK fisheries are modeled to operate under previous agreement levels ("SEAK 2009"). For BC fisheries, in absence of details on further Canadian constraints, fisheries were modeled using catch limits as set by the 2019 PST Agreement, then applying an adjustment based on past performance of the fisheries (for AABM fisheries) or modeled using recent rates (for ISBM fisheries) to account for the likely expected future reductions.

In coastal waters, under the 2019 Likely (SEAK 2009) scenario, based on a range of abundances from the retrospective analysis for 1999-2018, Canadian fisheries are projected to reduce prey availability the most during July-September, primarily in the SWWCVI (average 8.8%) and NOF (average 5.7%) regions (Figure 59; Appendix B Table B.3). The PFMC fisheries would be expected to reduce prey available to the whales substantially in coastal waters during July-September (averages of 5.6% in NOF, 13.8% off the Oregon coast, and 29.6% off the California coast) (Figure 59; Appendix B Table B.3). The estimates for PFMC reductions incorporate the potential restrictions in Amendment 21 had the Amendment been in place during the retrospective time period; based on estimated abundances, those restrictions would have been triggered in one year only, 2007. Puget Sound fisheries would reduce prey in all coastal spatial boxes (NOF, OR, CA) by less than 1% in all time steps.

In the Salish Sea (inland waters), under the 2019 Likely (SEAK 2009) scenario, Canadian fisheries are projected to reduce prey availability in July-September (average 8%), whereas in October-April they would reduce prey availability by 1.4% (Figure 59; Appendix B Table B.3). In May-June, Canadian fisheries are projected to have a greater impact on prey reductions in the Salish Sea (4.3%) than the Puget Sound fisheries or PFMC fisheries do. PFMC fisheries are not expected to reduce the prey availability in the Salish Sea in October-April, but may minimally reduce prey available by an average of 1.3% in May-June, and 1.2% in July-September. Puget Sound fisheries are expected to have the greatest impact to prey availability in the Salish Sea during July-September when the whales most often occur there (reducing prey by an average of 4.8%). As noted above, when modeling out the 2019 PST Agreement and expected domestic constraints, projected reductions by PST fisheries are lower, on average, than observed reductions in the past.



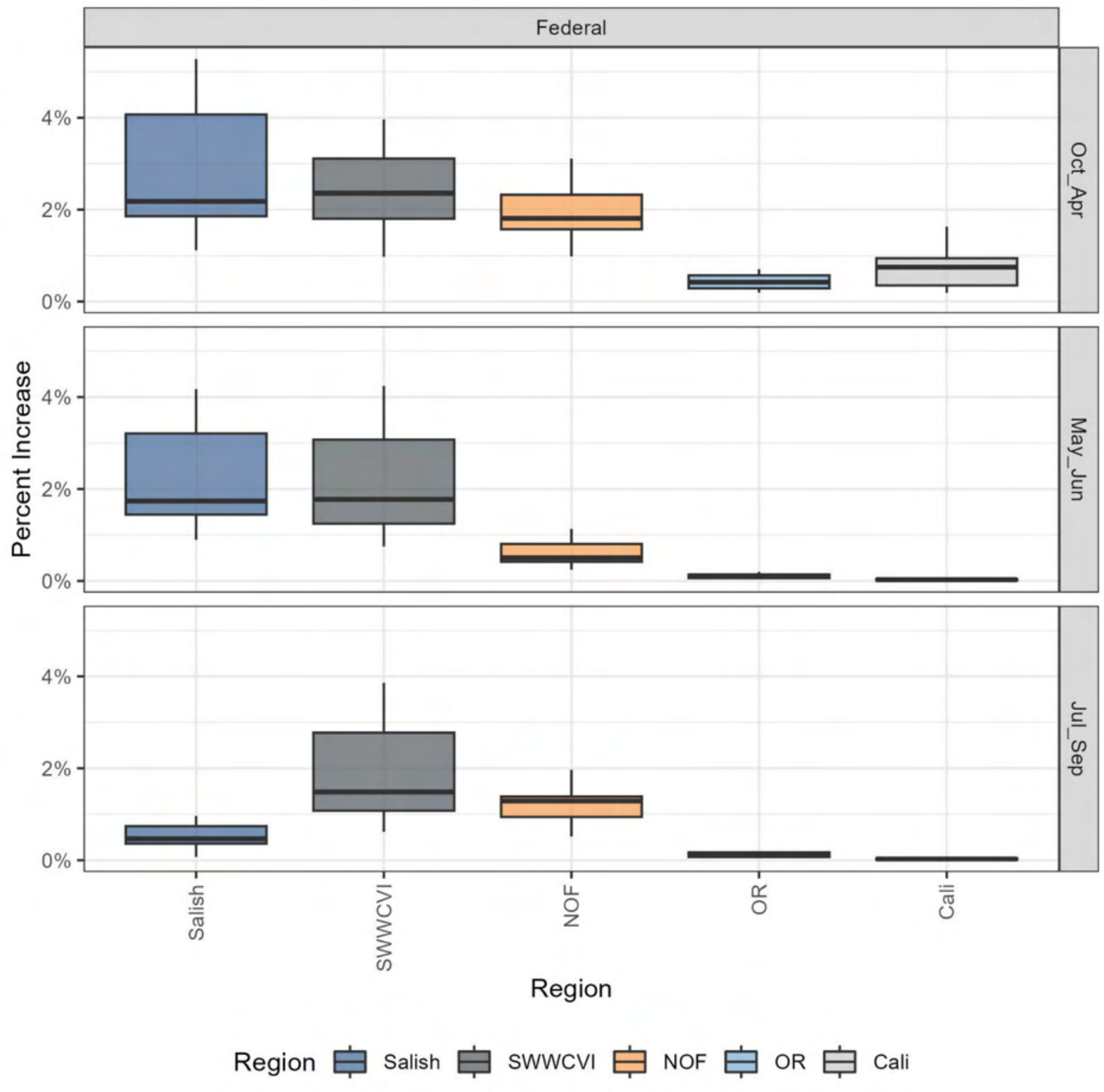
Note: box-and-whisker plots display a box representing the first quartile, median, and third quartile as the lower bound, midline, and upper bound of the box, respectively, the whiskers representing the minimum and maximum values, and the dots representing outliers which are values beyond 1.5*IQR (interquartile range, or distance between the first and third quartiles).

Figure 59. Projected percent prey reductions (Chinook salmon ages 3+) by baseline PST fisheries (i.e., those not part of the proposed action) (rows), time step (columns), and region (x-axis) expected to occur under the 2019 PST Agreement and other likely domestic constraints in a retrospective analysis of 1999-2018 (and SEAK operating under the 2009 Agreement). Note the different scales on the y-axes for each fishery. See Appendix B Table B.3 for the annual percent reductions. See Appendix D and PFMC (2020) for a description of the spatial regions.

Validated model runs of two years of implementation under the 2019 PST Agreement have now become available (FRAM 7.1.1). In 2019, SEAK salmon fisheries reduced SRKW prey abundance by 3.5% in SWWCVI, 1% in the Salish Sea, and 3.7% in NOF. In 2020, SEAK salmon fisheries reduced SRKW prey abundance by 3.4% in SWWCVI, 1.4% in the Salish Sea, and 5% in NOF.

Prey removals by fisheries have been partially mitigated by hatchery production in recent years. As described above, since 2020, NMFS has been awarding grants to hatchery operators to fund Chinook salmon production for the purpose of increasing prey availability for SRKW ("prey increase program") (NMFS 2024e; 2024a). This program has resulted in juvenile Chinook salmon released in 2020-2024 (see Table 44 for hatchery release numbers to date). The associated benefits to the SRKW prey base are expected to occur 3-5 years following implementation of each year of production; namely, from 2022 for the following several years as those fish that have been released to date age into the SRKW prey base (age 3+). We expect that the program will continue to be funded and implemented, with a new cohort maturing into the SRKW prey base each year. If the program is discontinued or modified, this may constitute a modification to how effects on Chinook salmon and SRKW are considered in this and other opinions and reinitiation of consultations that include in the environmental baseline the prey increase program would therefore need to be considered. For this analysis, we estimate Chinook salmon abundance increases in the action area by modeling hatchery production that has already been funded and released as part of the prey increase program (2020-2024). For a description of the methods used to estimate annual regional prey abundance increases as a result of the PST-funded hatchery program, please see Appendix D and NMFS (2024a). The annual projected benefit to the SRKW prey base is presented below based on a representative year of releases (2023) from federal funding, and this benefit is included in the analysis and expected to continue to occur through at least 2028, and thereafter, as fish released will continue to mature and return to be available for SRKW 3-5 years after implementation of production.

Based on the representative hatchery production that has been released as a result of the federal prey increase program, SRKW prey is expected to increase in various regions across their range (as compared to the post-season validation runs; see Figure 60), and at varying times throughout the year, for the next few years. As shown in Figure 60, using 2023 release numbers, during the October-April time step, SRKW prey is expected to increase by approximately 2%, on average, in the SWWCVI and NOF regions (also see Table 47). During the May-June time step, SRKW prey is expected to increase by approximately 2% on average, in the SWWCVI region, and in the July-September time step, prey is expected to increase by 2% in the SWWCVI region and 0.5% in the Salish Sea, on average (also see Table 47). These seasons and locations are expected to have the most overlap with SRKW. The ranges of increases presented in Figure 60 and Table 47 are estimates based on the production that has occurred in 2023, but depend on the level of Chinook salmon observed in that year. For example, variable ocean conditions are a major driver of ocean salmon abundances which can vary widely from year to year (see Figure 57). As such, percent prey increases due to the hatchery program may be smaller in years where ocean abundance is high (i.e., marine survival is high for salmon across all stocks).



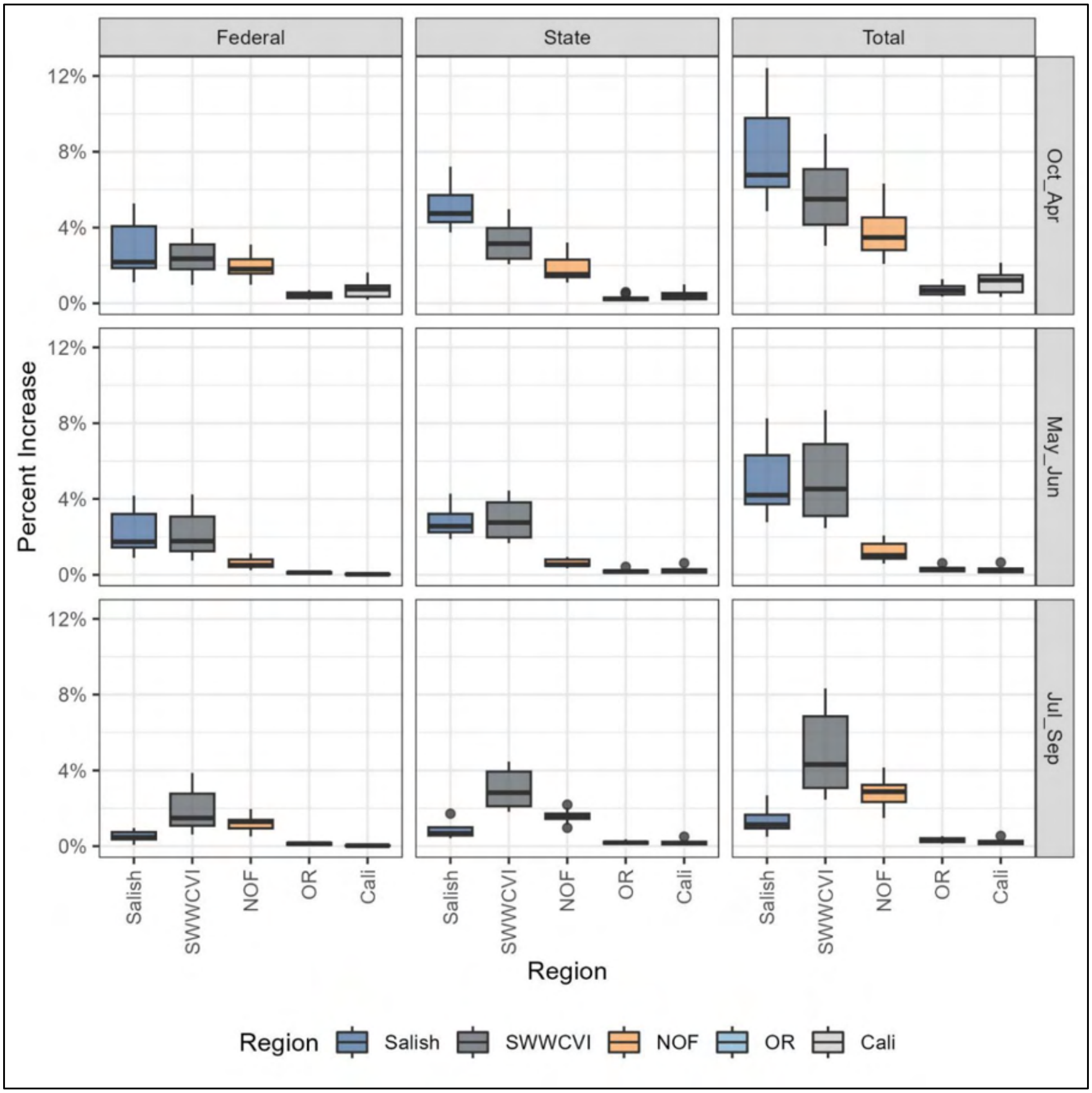
Note: box-and-whisker plots display a box representing the first quartile, median, and third quartile as the lower bound, midline, and upper bound of the box, respectively, the whiskers representing the minimum and maximum values, and the dots representing outliers which are values beyond 1.5*IQR (interquartile range, or distance between the first and third quartiles).

Figure 60. Expected annual impact of the U.S. federal prey increase funding (based on number of fish released in 2023) as represented by the expected percent increase of the SRKW prey base (age 3+ Chinook salmon) by spatial region (x-axis) and time step (rows) based on a range of abundances from the retrospective time period of 2009-2018. See Appendix D for methods and a description of the spatial regions.

In addition to the U.S. federal appropriations, the hatchery production for SRKW that has occurred to date funded by Washington State is expected to result in increases to the prey base as well (Table 44). With hatchery releases across the two programs spanning 2019-2024, the SRKW should experience a proportional increase to their prey base for the next several years (through at least 2028) based on the level of production already funded and released.

Using the same methods as described above and in NMFS (2024a) (also see Appendix D), we modeled out Chinook salmon releases for the SRKW hatchery initiative more comprehensively (including hatchery production for SRKW as funded by Washington State and the PST appropriation together). We used the same representative year (2023) to estimate the effects in terms of annual Chinook salmon abundance increases due to the combined state and federal funding across a range of recent abundances from 2009-2018 (see NMFS (2024a) and Appendix D for more details). See Table 47 for a summary of the results. Across the two programs, on average, at 2023 combined state and federal funding and production levels, we would expect SRKW prey to increase annually by 5.7% in the SWWCVI region, and 3.8% in NOF during the October-April time step. In the May-June time step, we would expect SRKW prey to increase annually, on average, by approximately 5% in the SWWCVI region. In the July-September time step, we would expect SRKW prey to increase annually, on average, by 4.9% in the SWWCVI region and 1.3% in the Salish Sea. These seasons and locations are expected to have the most overlap with SRKW. As described previously and under Cumulative Effects, there is a potential for negative impacts from some Washington State hatchery programs that do not have completed environmental analyses, and the extent of the effects that may increase risk to the recovery of the ESA-listed Chinook salmon ESUs have not yet been fully analyzed.

In summary, the additional funded hatchery production for SRKW as released in 2019-2024 is expected to have a measurable impact on SRKW prey availability through at least 2028. We expect that the increase in SRKW prey will be most beneficial during the winter (October-April time step) in coastal areas (NOF) and during the summer (July-September) in the Salish Sea and SWWCVI, as SRKWs are expected to occupy those areas during those seasons. However, we take into consideration the prey increases in all areas and seasons, as SRKW ranging appears to have shifted in recent years (NMFS 2021m; Ettinger et al. 2022). For example, prey increases due to hatchery production in the winter/spring months in the Salish Sea may benefit SRKW even though they historically have spent less time there during those seasons.



Note: box-and-whisker plots display a box representing the first quartile, median, and third quartile as the lower bound, midline, and upper bound of the box, respectively, the whiskers representing the minimum and maximum values, and the dots representing outliers which are values beyond 1.5*IQR (interquartile range, or distance between the first and third quartiles).

Figure 61. Expected annual impact of the U.S. federal, Washington State, and total (federal + state) prey increase funding including programs in baseline (ESA consultation completed) and in cumulative effects (ESA consultation pending), based on number of fish released in 2023, as represented by the expected percent increase of the SRKW prey base (age 3+ Chinook salmon) by spatial region (x-axis), time step (rows), and funding source (columns) based on a range of abundances from the retrospective time period of 2009-2018. See Appendix D for methods and a description of the spatial regions.

Table 47. Expected annual impact of the U.S. federal and Washington State prey increase funding including programs in baseline (ESA consultation completed) and in cumulative effects (ESA consultation pending), based on number of fish released in 2023, as represented by the average expected percent increase of the SRKW prey base (age 3+ Chinook salmon) by spatial region, time step, and funding source based on a range of abundances from the retrospective time period of 2009-2018. See Appendix D for methods and a description of the spatial regions.

Region	Time Step	Federal	WA State	Total
Salish	Oct_Apr	2.86%	5.13%	7.98%
Salish	May_Jun	2.26%	2.79%	5.04%
Salish	Jul_Sep	0.52%	0.81%	1.32%
SWWCVI	Oct_Apr	2.42%	3.30%	5.72%
SWWCVI	May_Jun	2.16%	2.90%	5.06%
SWWCVI	Jul_Sep	1.90%	3.00%	4.90%
NOF	Oct_Apr	1.92%	1.83%	3.75%
NOF	May_Jun	0.61%	0.61%	1.22%
NOF	Jul_Sep	1.23%	1.58%	2.81%
OR	Oct_Apr	0.44%	0.29%	0.73%
OR	May_Jun	0.11%	0.19%	0.30%
OR	Jul_Sep	0.12%	0.19%	0.32%
Cali	Oct_Apr	0.72%	0.44%	1.16%
Cali	May_Jun	0.03%	0.23%	0.26%
Cali	Jul_Sep	0.03%	0.19%	0.22%

2.4.4.1.5 Metabolic Needs

We are able to estimate the prey energy requirements for all members of the SRKW population each day, and estimate the prey energy requirements for the entire year, for specific seasons, and/or for geographic areas (inland waters and coastal waters; methodologies described in previous Biological Opinions; e.g., NMFS (2019g)). The daily prey energy requirements (DPERs) for individual females and males range from 41,376 to 269,458 kcal/day and 41,376 to 217,775 kcal/day, respectively, depending on size and age (Noren 2011). The DPERs can be converted to the number of fish required each year if the caloric densities of the fish (kcal/fish) consumed are known. However, caloric density of fish can vary because of multiple factors including differences in species, age and/or size, percent lipid content, geographic region, and season. Noren (2011) estimated that the daily consumption rate of a population with 82 individuals over the age of 1 year that consumes solely Chinook salmon would consume 289,131–347,000 fish/year by assuming the caloric density of Chinook salmon was 16,386 kcal/fish (i.e., the average value for adults from Fraser River). Williams et al. (2011) modeled annual SRKW prey requirements and found that the whole population requires approximately 211,000 to 364,100 Chinook salmon per year. Based on dietary/energy needs and 2015 SRKW abundances, Chasco et al. (2017a) also modeled SRKW prey requirements and found that in Salish Sea and U.S. West Coast coastal waters,[46] the population requires approximately 393,109,

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[46] These estimates do not include prey requirements off British Columbia, Canada.

adult (age 1+) Chinook salmon annually on average across model simulations, including 217,755 in the Salish Sea (discussed in more detail below). These estimates can vary based on several underlying assumptions including the size of the whale population and the caloric density of the salmon, but they provide a general indication of how many Chinook salmon need to be available and consumed to meet the biological needs of the whales.

As described in Section 2.2.3.1, many diet studies have informed our understanding of the SRKW diet, their preference for Chinook salmon, and a priority prey ranking of Chinook salmon stocks that are important to the population. While these studies have not assessed whether the fish consumed come from wild or hatchery populations, all available evidence suggests that SRKWs consume both wild and hatchery Chinook salmon given the high proportion of hatchery-origin fish in the priority stocks that were identified. Additionally, there is no evidence that SKRW can distinguish between wild and hatchery origin Chinook salmon. We have estimated that a minimum of 50-77% of the preferred Chinook salmon prey are made up of hatchery fish (NMFS 2024e), and as such it is extremely likely that hatchery fish are a main component of the SRKW diet.

Due to the lack of available information on the whales' foraging efficiency, it is extremely difficult to precisely estimate how much Chinook salmon or what density of salmon needs to be available to the whales for their survival and successful reproduction. Given the highly mobile nature of these animals, their large ranges with variable seasonal overlap, and the many sources of mortality for salmon, the whales likely need many more fish available throughout their habitat than what is required metabolically to meet their energetic needs.

In previous Opinions (e.g., NMFS (2019g)), we estimated the food energy of prey available to the whales relative to the estimated metabolic needs of the whales – a ratio that is referred to as a "forage ratio." The resulting forage ratios from past estimates indicate how much prey is available relative to the whales' needs by the magnitude of the value. For example, a forage ratio of 5.0 indicates that prey availability is 5 times the energy needs of the whales. We have not given much weight to these forage ratios when considering current prey availability because we do not have a known target value that would be adequate to meet SRKW metabolic needs. However, we consider previously estimated ratios 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. Relatively low foraging ratios were estimated in the summer months (July-September) in inland waters of WA. Specifically, we estimated previously (in NMFS (2019g)) that forage ratios in inland waters ranged from 17.57 to 29.77 in October-April, 16.39 to 30.87 in May-June, and 8.28 to 16.89 in July-September from 1992-2016 (assuming a SRKW population size of 75 individuals, using maximum DPER, and using Chinook salmon abundance derived from the FRAM validation scenario based on post season information that approximates what actually occurred; see NMFS (2019g) for further details). In coastal waters off Washington, Oregon, and California, forage ratios ranged from 10.84 to 33.41 in October-April, from 29.24 to 88.15 in May-June, and from 42.67 to 154.79 in July-September (NMFS 2021c). The abundance estimates in Figure 57 (and Appendix B Table B.1) are the number of adult Chinook salmon available to SRKWs at the beginning of each time step, prior to natural and fishery mortality and in that time step. Therefore, these are considered maximum estimates of prey available. Similar to other fishery models, the model the Workgroup used to develop the abundance estimates assumed constant adult mortality throughout the year and from one year to the next; however, natural mortality of salmonids likely varies across years, due in part to variable ocean conditions and their multiple predators. Hilborn et al. (2012) noted that natural mortality rates of Chinook salmon are likely substantially higher than the previous analyses suggest. Salmonids are prey for pelagic fishes, birds, and marine mammals (including SRKWs).

Specifically, marine mammal consumption of Chinook salmon in coastal waters has likely increased over the last 40 years as certain marine mammal populations have increased. Chasco et al. (2017a) used a spatial, temporal bioenergetics model to estimate Chinook salmon consumption by four marine mammals - harbor seals, California sea lions, Steller sea lions, and fish-eating killer whales - within eight regions of the Northeast Pacific, including areas off the U.S. West Coast. This model represents a scenario where the predation is an additive effect and there is an adequate supply of salmon available to predators (i.e., there is almost never a deficit of salmon relative predator demands), which may not reflect true prey availability to predators. Chasco et al. (2017a) determined that the number of individual salmon, including smolts, consumed annually by marine mammals in the entire Northeast Pacific (including inland waters of Salish Sea) has increased from 5 million to 31.5 million individual salmon from 1975-2015 (including juveniles). This includes an increase from 1.5 million to over 3.9 million adult salmon consumed in the Northeast Pacific on average across model parameter uncertainty. Consumption of all salmon ages by pinnipeds annually in the Puget Sound has increased from 68 metric tons to 625 metric tons from 1970 to 2015 (Chasco et al. 2017a). There is uncertainty around these specific values, but the modeled increase in predation on salmon from 1975-2015 does not change with variation in model parameters. With this increase, based on dietary/energy needs and 2015 marine mammal abundances, Chasco et al. (2017a) calculated that when species occur in inland waters of the Salish Sea, SRKWs would annually consume approximately 190,215 adult salmon (age 2+), harbor seals would annually consume approximately 346,327 salmon age 2+, and California sea lions and Steller sea lions combined would annually consume approximately 60 adult salmon (sea lions mainly consume smolts). Again, these values represent a model scenario where there is a consistent abundance of salmon for consumption and are only based on the energetic demands and diet preferences of marine mammals, not necessarily true prey availability or consumption. These estimates provide a general indication of how many Chinook salmon need to be consumed to meet the biological needs of these marine mammals.

Recent work by Couture et al. (2022) estimated that annual SRKW consumption of Chinook salmon ranged from 166,000 to 216,300 fish between 1979-2020 across the Salish Sea and West Coast of Vancouver Island (WCVI) from April-October each year. While SRKWs were not estimated to be prey limited in most years, Couture et al.'s work suggested that SRKW experienced an energetic deficit (in those months in those locations only) in six of the last 40 years, three of which were the most recent in the time series (2018-2020). The authors estimated various parameters that were factored into the novel model they used, including prey species diet proportion as a function of abundance, search efficiency, and prey handling time, which influence prey requirements and may partially explain our different results. Additionally, we note that, compared to our work presented in this Opinion, Couture et al. (2022) used alternative models for estimating SRKW Chinook salmon prey abundance and only modeled prey consumption in two regions (Salish Sea and off WCVI) in part of the year (April to October). The work by Couture et al. (2022) presents an important first step in parameterizing previously unknown variables (such as search efficiency), but further work is needed to refine and validate these metrics.

In summary, though abundance of Chinook salmon available at the beginning of a year (pre-fishing and natural mortality) is substantially greater than the required amount of salmon needed by SRKWs (depending on the model used – see Couture et al. (2022)), there is likely competition between SRKWs and other predators, and natural mortality of Chinook salmon may be high, further reducing Chinook salmon availability to SRKWs. Although some of these predators are likely consuming smolts, prey availability to SRKWs in the action area would be reduced in subsequent years based on dietary needs of other marine mammals as well as other predators (e.g. pelagic fish, sharks, and birds). In addition, the available information suggests coastwide prey availability is substantially lower in the winter than summer in coastal waters and opposite in inland waters.

2.4.4.2 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 populations. Mongillo et al. (2016) reported data for salmon populations along the west coast of North America, from Alaska to California, and found marine distribution was a large factor affecting persistent pollutant accumulation. They found higher concentrations of persistent pollutants in Chinook salmon populations that feed in close proximity to land-based sources of contaminants. There is some information available for contaminant levels of Chinook salmon in inland waters (i.e., Krahn et al. 2007; O'Neill and West 2009; Veldhoen et al. 2010; Mongillo et al. 2016). Some of the highest levels of certain pollutants were observed in Chinook salmon from Puget Sound and the Harrison River (a tributary to the Fraser River in British Columbia, Canada) (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 Canada 1999; Weitkamp 2010). However, populations of Chinook salmon that originated from the developed Fraser River and had a more northern distribution in the coastal waters of British Columbia and Alaska (DFO Canada 1999) had much lower concentrations of certain contaminants than salmon populations with more southern distributions like those from the Salish Sea and SUS West Coast (Mongillo et al. 2016). A recent study found higher levels of 4-nonylphenol, a contaminant of emerging concern derived from industrial products and sewage, in SRKWs compared to Bigg’s killer whales which could be related to their greater association with an estuarine food-chain (Lee et al. 2022).

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 SRKW 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 salmon originating from California have been measured to have higher concentrations of DDTs (O’Neill et al. 2006; Mongillo et al. 2016). Therefore, SRKW prey is highly contaminated, causing contamination in the whales themselves. Build-up of pollutants can lead to adverse health effects in mammals (see Toxic

Chemical Section in Section 2.2.3.1.3). Nutritional stress, potentially due to periods of low prey availability or in combination with other factors, could cause SRKW to metabolize blubber, which can redistribute pollutants to other tissues and may cause toxicity. Pollutants are also released during gestation and lactation which can impact calves (Noren et al. 2024).

Marine construction actions have implications for prey and water quality. For example, a recent Section 7(a)(2) consultation on removal and replacement of two breakwaters near Port Townsend, WA at Point Hudson was determined to likely adversely affect, but not jeopardize, SRKW and their critical habitat, though the project may have positive impacts on prey quality (NMFS 2022b). As part of removal, creosote treated piles will be replaced with steel piles, leading to net positive conservation credits determined by the Puget Sound Nearshore Habitat Conservation Calculator (see above, this section under Habitat Actions) and a possible slight improvement in prey quality by reducing PAHs. However, SRKW could be injured or disturbed by noise and sound pressure from the action as underwater sound from pile driving could exceed both behavioral and injury thresholds, causing whales to avoid the area, potentially temporarily reducing foraging, resting, and migrating. Criteria for monitoring are in place to stop-work on sightings of killer whales to ensure SRKW do not experience full intensity and duration of pile driving. Effects to salmon prey are not expected to be a source of harm for SRKW and the project is not expected to further reduce forage for SRKW.

Size and age structure of Chinook salmon has substantially changed across the Northeast Pacific Ocean (Ohlberger et al. 2018). Since the late 1970s, 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 shown declines in the 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). The authors suggest the reasons for this shift may be largely due to direct effects from size-selective removal by marine mammals and fisheries, followed by evolutionary changes toward these smaller sizes and early maturation (Ohlberger et al. 2019). Smaller fish have a lower total energy value than larger ones (O'Neill et al. 2014). Therefore, SRKWs need to consume more fish salmon in order to meet their caloric needs as a result of a decrease in average size of older Chinook salmon.

2.4.4.3 Vessel Activities and Sound

Commercial shipping, cruise ships, and military, recreational, and fishing vessels occur in the inland and coastal range of SRKWs. Additional whale watching, ferry operations, and recreational and fishing vessel traffic occur in their inland range. The overall density of traffic is lower in coastal waters compared to inland waters of the Salish Sea. Several studies in inland waters of Washington State and British Columbia have linked vessel interactions with short-term behavioral changes in NRKW and SRKW (see review in Ferrara et al. (2017)), whereas there have been no studies that have examined interactions of vessels and SRKWs with behavioral changes in coastal waters. These studies that occurred in inland waters concluded that vessel traffic 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 are rare, but remain a potential source of serious injury and mortality, although the true effect of vessel collisions on mortality is unknown.

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 (NRC 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 or reduces 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 inland waters of the SRKW range (Bassett et al. 2012; McKenna et al. 2013; Houghton et al. 2015; Veirs et al. 2016; SMRU Consulting 2021). 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 that 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, over the past few decades the contribution of shipping to ambient noise has increased by as much as 12 decibels (dB) (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). A recent study by SMRU Consulting (2021) characterized boat noise off the west side of San Juan Island and showed more boat noise during the day vs. at night and more on weekends (vs. midweek) and more on holiday weekends compared to post-holiday weekends. Echosounders used for navigation, commercial, and recreational fishing that use an 83 kHz signal, as well as those with a 200 kHz signal in deeper water, have emissions that extend outside of 400 meters (vessel approach distance used in Canada), which can create noise additions of 30 dB above ambient levels (Burnham et al. 2022). In a study that measured ambient sound in a natural setting, SRKWs increased their call amplitude in a 1:1 dB ratio with louder background noise, which corresponded to increased vessel counts (Holt et al. 2009). It should be noted that vessel speed also strongly predicts the whales' received sound levels from propeller and engine sound (Holt et al. 2017).

In 2017, the Vancouver Fraser Port Authority conducted a voluntary slow-down trial through Haro Strait (Burnham et al. 2021). They determined that a speed limit of 11 knots would achieve positive noise reduction results without compromising navigational safety through the Strait. Hydrophones were deployed at sites adjacent to the northbound and southbound shipping lanes to measure noise levels through the trial period from August to October. During that period, 61% of piloted vessels, including bulk carriers, tugs, passenger vessels, container ships, and tankers, participated in the trial by slowing to 11 knots through the Strait. When compared to the pre-trial control period, the acoustic intensity of ambient noise in important SRKW foraging habitat off the west coast of San Juan Island was reduced by as much as 44% (corresponding to a 2.5 dB reduction in median sound pressure level) when vessels slowed down through Haro Strait (Joy et al. 2019). Similarly, Burnham et al. (2021) describe the impacts of trials done in summer 2020 including slow down zones (speed limit of 11 or 14.5 knots depending on the type of vessel), as well as Interim whale Sanctuary Zones, and shifting tug and barge lanes away from SRKW foraging areas (comparing all to a control period prior to the trials). In 2020, there was more than 80% compliance with slow downs, leading to a median reduction in speed of 0.2-3.5 knots and reduced lower frequency sounds as well as reduced sound in SRKW-pertinent ranges. Shifting tug/barge lanes also had high participation and reduced sound levels in these ranges. However, there was low compliance with Interim Sanctuary Zones. The results of these trials show that vessel speed can be an effective target for the management of vessel impacts.

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 SRKWs 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 2013 to 2017 an average of 12 to 17 boats; (Seely 2016)). The average number of vessels with the whales decreased since 2014 likely due to decreased viewing effort on SRKWs by commercial whale watching vessels, with an average of 7-10 vessels with the whales at any given time in each year from 2018-2022 (Frayne 2023). In 2022, the maximum number of total vessels observed in a ½ mile radius of the whales was 27 (Frayne 2023). Fishing vessels are also found in close proximity to the whales and vessels that were actively fishing were responsible for 3% of the incidents inconsistent with the Be Whale Wise Guidelines and federal regulations in 2022 (Frayne 2023). In 2022, 81% of all incidents (inconsistent with Be Whale Wise guidelines and non-compliant with federal regulations, see Frayne (2023)) of vessel activities were committed by private recreational vessels, 7% U.S. commercial vessels, 4% Canadian commercial vessels, 1% commercial aircraft, 1% commercial fishing vessels, <1% maritime cargo/ferries, <1% enforcement, <1% private aircraft, and <1% by research vessels (Frayne 2023). Most incidents in violation of guidelines were violating the 7 knot (kt) speed limit within ½ mile of whales, followed by within 400 yards in the path of the whales. 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).

It is currently unclear if SRKWs experience noise loud enough to have more than a short-term behavioral response. As discussed in the Status of the Species (Section 2.2.3.1), reduced time spent feeding and the resulting potential reduction in prey consumption is likely the most important pathway of effects due to vessels (Ferrara et al. 2017; Holt et al. 2021b; Holt et al. 2021a). Although the impacts of short-term behavioral changes, including ephemeral feeding disruptions, on population dynamics are unknown, it is likely that because SRKWs are exposed to vessels during the majority of daylight hours they are in inland waters, and that the whales in general spend less time foraging in the presence of vessels, there may be biologically relevant effects at the individual or population-level (Ferrara et al. 2017). The extent of vessel impacts in coastal waters of SRKW critical habitat has not been studied and the density of vessels, particularly those targeting and following the whales for whale watching, is much less than inland waters.

We regularly consult on actions that increase vessel presence in Puget Sound, but none have reached a jeopardy conclusion from vessel presence. A recent Opinion on dock rehabilitation near Seattle by the U.S. Army Corps of Engineers was determined to be likely to adversely affect SRKWs but not likely to jeopardize the survival and recovery of the species (NMFS 2021g) due to increased vessel activity associated with the project.

Anthropogenic (human-generated) sound in the action area is generated by other sources beside vessels, including construction activities, and military operations. For example, Kuehne et al. (2020) reported measurements of underwater noise associated with military aircraft using a hydrophone deployed near a runway off Naval Air Station (NAS) Whidbey Island, WA. The average of the underwater received levels detected was 134 ± 3dB re 1 micropascal (μPa). The frequency of the sound from these overflights ranged from 20 Hz to 30 kHz, with a peak between 200 Hz and 1 kHz. However, these peak levels are well below the best hearing sensitivity of the whales reported by Branstetter et al. (2017) to be between 20 and 60 kHz. 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), that may impact ability to access prey.

In-water construction activities are permitted by the U.S. Army Corps of Engineers 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 Section 7 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. For example, see above in the section on Prey Quality in reference to NMFS 2022 consultation on replacement of breakwaters and pile driving. Similarly, as another example, the recent consultation on 11 habitat-modifying projects in Puget Sound (NMFS 2021j) stated, “criteria for monitoring and stop-work on sighting of SRKW is intended to ensure that SRKW will not experience duration or intensity of pile driving, either impact or vibratory, that would result in disturbance or harm to any individual of this species.” 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.

2.4.4.4 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, although not all incidents may be reported. Two killer whales have been recorded entangled in Dungeness crab commercial trap fishery gear off California (a transient in 2015 and unknown ecotype in 2016) (NMFS 2016r). In 2018, DFO disentangled a transient killer whale entangled in commercial prawn gear near Salt Spring Island, British Columbia (NMFS strandings data, unpubl.). In 2013, a NRKW stranded in British Columbia and a fish hook was observed in its colon, but had no evidence of perforation or mucosal ulceration (Raverty et al. 2020). In 1977, a SRKW (L8) drowned in a net and recreational fishing lures and lines were found in the stomach upon necropsy. 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 or injury. For example, one killer whale (unknown ecotype) was reported interacting with a salmon gillnet in British Columbia in 1994, but did not get entangled (Guenther et al. 1995). More recently, J39, a young male SRKW in J pod, was observed with a salmon flasher hooked in his mouth during the summer of 2015 around the San Juan Islands, which subsequently fell out with no signs of injury or infection.

All incidental mortality and injury of marine mammals in fishing gear must be reported in accordance with the MMPA (16 U.S.C. 1387(e)). 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, and must be reported.[47] No entanglements, injuries or mortalities of SRKW have been reported in recent years.

2.4.4.5 Oil Spills

As described in the Status of the Species (Section 2.2.3.1), SRKWs are vulnerable to the risks imposed by an oil spill. There is some level of risk from serious spills in the action area 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). The total volume of oil spills was less in 2017-2019 than in 2015-2017 but still higher than previous years (WDOE 2019). In 2014, NOAA responded to 16 actual and potential oil spills in Washington and Oregon. 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 six known pathways: contact, adhesion, inhalation, dermal contact, direct ingestion, and ingestion through contaminated prey (Jarvela-Rosenberger et al. 2017), all of which could have adverse health effects to killer whales (see discussion in Section 2.2.3.1). In addition, oil spills have the potential to adversely impact habitat and prey populations, and, therefore, if they occur they may reduce prey availability for SRKWs.

In August 2022, a commercial fishing vessel sank off the west side of San Juan Island (in the action area) and an oil sheen was seen (see: https://www.fisheries.noaa.gov/feature-story/coordinated-response-protected-southern-residents-sunken-ship-leaking-oil). Existing oil spill response plans were implemented and emergency ESA consultations were completed to minimize the impacts of response activities, including removing the vessel. The Wildlife Branch of the Incident Command monitored marine mammal sightings and activated a Killer Whale Deterrence Team to prevent exposure to the spill. SRKW were not seen directly in the sheen.

In 2021, NMFS consulted on the reauthorization of the North Wing pier at the British Petroleum (BP) Cherry Point refinery (NMFS 2021b). This Opinion concluded that the action was likely to adversely affect but not likely to jeopardize the survival and recovery of SRKW or adversely

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[47] See reporting requirements and procedures at 50 CFR 229.6 and https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-authorization-program#reporting-a-death-or-injury-of-a-marine-mammal-during-commercial-fishing-operations.

modify their critical habitat. The action does result in an incremental increase in risk of large oil spills. However, the oil spills most likely to occur would be substantially smaller in magnitude than the size likely to be catastrophic to SRKW according to Lacy et al. (2017). Ongoing smaller spills are likely to continue but these are not expected to occur at a frequency or magnitude that would indirectly or directly expose SRKW to acute toxicity or significantly affect toxin accumulation through prey.

2.4.4.6 Scientific Research

Most of the scientific research conducted on SRKW occurs in inland and coastal waters of Washington State. 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 occur in inland waters, with a small portion in the coastal range of SRKWs. 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, such as restricting the number of research vessels within 200 yards of a SRKW at any given time. The cumulative effects of research activities were considered in a batched Biological Opinion for four research permits in 2012 (NMFS 2012d). The cumulative effects were also considered in the Biological Opinion on the renewal of the research permits (NMFS 2018d). The Biological Opinion concluded the cumulative impacts of the scientific research projects were likely to adversely affect but were not likely to jeopardize the continued existence of SRKWs.

2.4.4.7 Climate Change

As described in the Status of the Species, changing ocean conditions driven by climate change may influence ocean survival and distribution of Chinook salmon and other Pacific salmon further affecting the prey available to SRKWs. The effects of climate change described in the Status Section would be expected to occur in the action area. Extensive climate change caused by the continuing buildup of human-produced atmospheric carbon dioxide and other greenhouse gases is predicted to have major environmental impacts in the action area during the 21st century and beyond. Warming trends in water and air temperatures are ongoing and are projected to disrupt the region’s annual cycles of rain and snow, alter prevailing patterns of winds and ocean currents, and result in higher sea levels (Glick 2005; Snover et al. 2005). These changes, together with increased acidification of ocean waters, would likely have profound effects on marine productivity and food webs, including populations of salmon.

2.4.5 Mexico DPS Humpback Whales

A number of human activities have contributed to the current status of populations of the Mexico DPS humpback whale in SEAK. The factors that have likely had the greatest impact are discussed in the sections below. For more information on all factors affecting Mexico DPS humpback whales considered in this Opinion, please refer to the following documents:

- "Alaska Marine Mammal Stock Assessments, 2022" (Young et al. 2023)
    - 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: https://repository.library.noaa.gov/view/noaa/4883

Fisheries

Worldwide, fisheries interactions have an impact on many marine mammal species. Humpback whales can become entangled in active fishing gear or in derelict fishing gear that has been lost, abandoned, or discarded (Baulch and Perry 2014). There is also concern that mortality from entanglement may be underreported, as many marine mammals that die from entanglement sink rather than strand ashore. Entanglement increases their energy expenditures as well as makes marine mammals more vulnerable to additional dangers, such as predation and ship strikes, by restricting agility and swimming speed.

Other potential impacts could occur as a result of SEAK salmon fisheries, such as vessel collisions with marine mammals or impacts related to noise, pollution, or marine debris generated by fishing vessels. It is also conceivable that 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 herring, pollock, and cod. Further, if humpback whales were to avoid fishing activity for any reason, fishing effort could indirectly impact humpback whales by increasing their energetic expenditure in search of food or by creating temporary exclusion from important foraging resources.

Harvest

Commercial whaling in the 19th and 20th centuries removed tens of thousands of whales from the North Pacific Ocean. As discussed in Section 2.2.3.4 of this Opinion, commercial harvest was the primary factor for ESA-listing of humpback whales. While there is no current commercial harvest of Mexico DPS humpback whales, this historical exploitation has impacted populations and distributions of humpback whales, 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. Since then, 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, Alaska (AK) in May (DeMarban and Demer 2016). There have been no reports of illegal harvest of humpback whales since 2016.

Natural and Anthropogenic Noise

Mexico DPS humpback whales in waters off SEAK 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 include: vessels (e.g. shipping, cruise ships. transportation, research); construction activities (e.g. drilling, dredging, pile-driving); sonars; aircraft; and military exercises). 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 or specific effects to the Mexico DPS. 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 waters in SEAK where Mexico DPS humpback whales are found. Many of the consultations have exempted the take (by harassment) of humpback whales from sounds produced during pile driving, drilling, and vessel operations.

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).

Through the ESA Section 7 consultation process NMFS analyzes the expected take and impacts on Mexico DPS humpback whales from construction activities and summarizes their findings in Letters of Concurrence and Biological opinions that are summarized in NOAA’s Environmental Consultation Organizer[48], which is publicly available.

Pollutants and Discharges

Previous development and discharges in portions of SEAK 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 2013c).

The Clean Water Act (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.

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[48] https://www.fisheries.noaa.gov/resource/tool-app/environmental-consultation-organizer-eco

The EPA issued a NPDES vessel general permit that authorizes several types of discharges incidental to the normal operation of vessels, such as gray water, black water, coolant, bilge water, ballast, and deck wash (EPA 2013). In 2018, the President signed into law the Vessel Incidental Discharge Act (VIDA). VIDA requires EPA to develop new national standards of performance for commercial vessel incidental discharges and the USCG to develop corresponding implementing regulations. Interim requirements apply until EPA publishes future standards and the USCG publishes corresponding implementing regulations under VIDA.

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 SEAK 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 2016-2020 of 0.04 Mexico - North Pacific stock humpback whales in SEAK, based on reports to the NMFS Alaska Region stranding network (Young et al. 2023).

Most of the vessel collisions in Alaska were reported in SEAK, but it is unknown whether the difference in ship strike rates between SEAK and other areas is due to differences in reporting, amount of vessel traffic, densities of whales, or other factors (Young et al. 2023).

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 boating and viewing practices. More information is available at www.whalesense.org.

Since 2011, cruise lines, marine pilots, NMFS, and the NPS biologists have worked together to produce seasonal weekly whale sightings maps to improve situational awareness for cruise ships and state ferries in SEAK. 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.

Humpback whales are exposed to research activities documenting their distribution and movements throughout their ranges. There were 24 active research permits authorizing takes of humpback whales in Alaskan waters in 2022 (NMFS 2023b). Activities associated with these permits could occur in SEAK, 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

Most of these research activities require a close vessel approach. The permits also include incidental harassment takes to cover activities such as tagging, where the research vessel may come within 91 m (100 yards) 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.

Climate Change

There is widespread consensus within the scientific community that atmospheric temperatures on earth are increasing. Recent studies and observations have shown changes in distribution (Brower et al. 2018), reproductive rates (Cartwright et al. 2019), body condition (Neilson and Gabriele 2020), and migratory patterns (van Weelden et al. 2021) of humpback whales, likely in response to climate change. The indirect effects of climate change on Mexico DPS humpback whales over time would likely include changes in the distribution of ocean temperatures suitable for many stages of their life history, the distribution and abundance of prey, and the distribution and abundance of competitors or predators.

2.4.6 Western DPS Steller Sea Lion

A number of human activities have contributed to the current status of populations of western DPS Steller Sea Lions in SEAK. 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 this Opinion, please refer to the following documents:

- "Alaska Marine Mammal Stock Assessments, 2022" (Young et al. 2023)
  - 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 DPS and western DPS (*Eumetopias jubatus*)" (NMFS 2008k)
  - Available online at www.fisheries.noaa.gov/resource/document/recovery-plan-steller-sea-lion-revision-eastern-and-western-distinct-population
- NMFS (2020a) western DPS Segment Steller sea lion (*Eumetopias jubatus*) 5-Year Review: Summary and Evaluation
  - Available online at https://media.fisheries.noaa.gov/dam-migration/steller-sea-lion-5year-review-0220.pd

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 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 salmon, pollock, herring, and Pacific cod in the eastern portion of their range (NMFS 2008k). In some regions fishery management measures appear to have reduced this potential competition (e.g., no trawl zones and gear restrictions on various fisheries in SEAK), and in others the very broad distribution of prey and seasonal fisheries that differs from that of sea lions may minimize competition as well.

As described in the Status Section above (2.2.3.5), Steller sea lions in SEAK are known to interact with fishing gear and marine debris. Because eastern and western DPS animals overlap in SEAK, 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 SEAK and northern British Columbia. From 2014-2018, there were 254 cases of mortality and serious injury reported for the western DPS (rangewide): 37.4 in U.S. commercial fisheries, 0.4 in unknown fisheries (commercial, recreational, or subsistence), 3.6 in marine debris, 3.6 due to other causes (arrow strike, entangled in hatchery net, illegal shooting, research), and 209 in subsistence harvest. These animals mostly interacted with observed trawl (20.5), longline (1.9), and gillnet (15) fisheries, typically resulting in death (Young et al. 2023).

Harvest and Illegal Shooting

As described in the Status Section (2.2.3.4), Steller sea lions are hunted for subsistence purposes across Alaska, including in SEAK. From the 5-year period from 2004 to 2008 (more recent data are not available), the annual statewide (excluding St. Paul Island) annual 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 estimated annual subsistence harvest of 209 individuals (Young et al. 2023). In addition, the Alaska Native Harbor Seal Commission and ADF&G 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 (Young et al. 2023). Illegal shooting of sea lions may occur to an unknown extent in SEAK. The Steller Sea Lion Recovery Plan (NMFS 2008k) ranked illegal shooting as a low threat to the recovery of the western DPS. 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. NMFS has recently documented instances of the shooting of 24 sea lions, including numerous sea lions killed in the Copper River Delta during commercial salmon fishing, resulting in two convictions to date for harassing and killing Steller sea lions with shotguns and obstructing the government's investigation into criminal activities (Wright and Savage 2016; 2017; DOJ 2018; Wright and Savage 2021).

Natural and Anthropogenic Noise

Steller sea lions in waters throughout SEAK 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 include: vessels (e.g. shipping, transportation, research); construction activities (e.g. drilling, dredging, pile-driving); sonars; aircraft; and military exercises. 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 SEAK waters. Many of the consultations have exempted the incidental take (by harassment) of marine mammals from sounds produced during pile driving, drilling, and vessel operations.

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).

Through the ESA Section 7 consultation process NMFS analyzes the expected take and impacts on western DPS Steller sea lions from construction activities and summarizes their findings in

Letters of Concurrence and Biological Opinions that are summarized in NOAA's Environmental Consultation Organizer[49], which is publicly available.

Pollutants and Discharges

Previous development and discharges in portions of SEAK 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 2013c).

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 gray water, black water, coolant, bilge water, ballast, and deck wash (EPA 2013). In 2018, the President signed into law the Vessel Incidental Discharge Act (VIDA). VIDA requires EPA to develop new national standards of performance for commercial vessel incidental discharges and the USCG to develop corresponding implementing regulations. Interim requirements apply until EPA publishes future standards and the USCG publishes corresponding implementing regulations under VIDA.

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

NMFS Alaska Region Stranding Program has records of four confirmed reports of Steller sea lions being struck by vessels in SEAK from 2000-2024 (NMFS Alaska Region Stranding Database, accessed September 9, 2024). 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 (2008k)).

NMFS's guidelines for approaching marine mammals are intended to dissuade vessels from approaching within 100 yards of haulouts and rookeries.

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. There

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[49] https://www.fisheries.noaa.gov/resource/tool-app/environmental-consultation-organizer-eco

were 24 active research permits authorizing takes of Steller sea lions in Alaskan waters in 2022 (NMFS 2023b). 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 from scientific research activities is not expected to rise to the level where injury or mortality is expected to occur.

2.5 Effects of the Action

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action but that are not part of the action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.02).

2.5.1 Retrospective Analysis

We describe the effects on listed salmonids of the proposed actions – 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 PST Agreement in SEAK. The proposed actions relate specifically to the effects of SEAK salmon fisheries. To analyze the effects of the SEAK fisheries under the 2019 PST Agreement on listed Chinook salmon, 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 2019 PST Agreement from the other fisheries managed under the Agreement. Note that while technically the effects of other fisheries are not part of the effects of the action – the 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 as implemented under the 2019 PST Agreement 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 2019 PST Agreement on ESA-listed species that are the subject of this Opinion.

The effect of the fisheries subject to the 2019 PST 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 off the west coast and in Puget Sound and is described in more detail below. The Pacific Salmon Commission uses the PST Chinook Model and results of the CTC Exploitation Rate Analysis (ERA) to evaluate fishing mortality, establish the catch ceiling for the SEAK AAMB fishery and assess compliance with the 2019 PST Agreement on Alaskan, Canadian and southern U.S. Chinook stocks impacted by fisheries managed under the PST. These analytical tools and the rationale for choosing the FRAM to conduct the retrospective analysis are discussed in more detail below.

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[50]. 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 or stock aggregates and their marked and unmarked subcomponents in FRAM, representing production from southern British Columbia to California. FRAM contains 73 preterminal and terminal fisheries from SEAK, Canada, Puget Sound, and off the coasts of Washington, Oregon and California. The model is equipped with the ability to process all fisheries as either non-selective, mark-selective,[51] 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 remainder for each age 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 exploitation rate analysis (ERA) using CWT recoveries in each year to assess impacts on tag groups representing individual stocks or stock aggregates. This analysis forms the basis of the 2009-2015 CYER base period used for evaluating performance of ISBM fisheries in the 2019 PST Agreement. A strength of the ERA is that it produces annual post-season estimates of stock-specific ERs using empirical CWT recoveries that occurred during the year being estimated. This differs from the FRAM, which, as described above, uses a reference base period. For southern U.S. stocks, ERA-based post-season

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[50] https://framverse.github.io/fram_doc/index.html

[51] In mark-selective fisheries, retention of fish marked to distinguish them as hatchery fish, generally with clipped adipose fins (fins are typically clipped in hatcheries), is permitted while fish with intact adipose fins must be released. In non-selective fisheries, retention of all fish is permitted.

ER estimates are available two years after the fishery occurs, whereas FRAM-based post-season ER estimates are typically available between two and three years after the fishery occurs. The ERA was not used for analyses in this Opinion, however, because it is not structured in a way that allows for manipulation of inputs to compare of differing fishing scenarios. The CTC also employs the PSC Chinook Model, with the primary purpose of establishing annual AIs and corresponding annual catch limits for the three AABM fisheries. While this model is considerably different from 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. An improved version of the PSC Chinook Model was implemented beginning in 2020, and contains updated stock and fishery stratifications that include 40 stocks and 48 fisheries, compared to the 30 stocks and 25 fisheries in the previous version of the model. Currently neither the CWT-based ER analysis nor the PSC Chinook Model are equipped to account for the differential effects of mark-selective fisheries, which have been employed for recreational Chinook salmon fisheries in Puget Sound since 2003, thus neither are being used in this analysis.

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 Salmon ESU. It contains 19 separate Puget Sound stocks that are each separated into marked (adipose clipped) and unmarked (adipose intact) components to accommodate the wide-spread use of mark selective fisheries. 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 Salmon ESU. In contrast, the Puget Sound stock structure is slightly more aggregated in the CTC's ERA and the PSC Chinook Model, which contain 14 and 8 Puget Sound stocks, respectively, and cannot provide ER estimates for all 14 management units. However, it should be noted, based on the results presented below, that only a few Puget Sound Chinook stocks with more northerly distributions are affected by the SEAK AABM Chinook fishery and exploitation rates for all Puget Sound stocks except for Nooksack spring and Skagit summer/fall Chinook are less than 5%. Depending on the stock, Puget Sound Chinook salmon are also exposed to a substantial level of mark-selective fishing pressure which the CWT-based ERA and PSC Chinook Model are not currently equipped to properly account for at this time[52]. 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 PST 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. The degree to which ER estimates are aligned between the various models varies by stock. For some stocks there will be a strong correlation, but for others the estimates may differ, sometimes significantly. It is important to note that no single model can be considered to be superior in all cases. 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

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[52] Algorithms will be incorporated into the CWT-based ER analysis and PSC Chinook Model by fall 2024 that will account for mark-selective fisheries.

apparent particularly in a complex consultation like this one that considers such a broad range of species from several geographic domains. Methods have evolved 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.

The Retrospective Analysis

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 PST Agreement on fisheries, and the resulting effects on ERs and escapements of ESA-listed species and other stocks of concern. The recent past performance of fisheries (1999 through 2018) is the result of a biological range of salmon abundances experienced over the past 20 years. We expect this range encompasses both possible high and low salmon abundances possible to occur during the term of this Opinion. Actual outcomes 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 2018) because they provide a known set of prior circumstances regarding stock abundance and actual fishery effects. 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 PST Agreement given an informed assessment of how fisheries are likely to be managed in the future, i.e., with domestic constraints for southern west coast U.S. fisheries in addition to those prescribed in the 2019 PST Agreement; 3) the previous scenario but with SEAK fisheries set to levels of the 2009 PST Agreement, to isolate the effects of the proposed action; and 4) how the fishery provisions in the 2019 PST Agreement would perform if there was an unexpected and broad scale decline of 40% in the abundance of Chinook salmon. The 40% abundance decline scenario is unlikely to occur during the term of the 2019 PST Agreement but is included to cover the situation of a prolonged and broad scale downturn in productivity and abundance that could occur as a consequence of long-term cycles in ocean conditions or global climate change. This scenario (the 40% abundance decline) is beyond what we have observed in the data to date.

Before describing the scenarios used in the retrospective analysis in more detail, it is important to highlight several points. Although the bilateral PST Agreement sets limits on the fisheries, domestic conservation considerations often result in fisheries that are reduced below the levels allowed by the PST Agreement. The 2019 PST 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 PST Agreement are the result of a complex bilateral negotiation whereby 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 PST 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, allocative considerations and year-specific circumstances. This understanding is specifically acknowledged in paragraph 5(c) of the Chinook chapter (Chapter 3) of the 2019 PST 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 PST Agreement. As an example, from 1999 to 2002 Canadian AABM fisheries were reduced greatly relative to what was allowed under the 1999 PST Agreement because of domestic concerns particularly for the WCVI Chinook stock. More recently at the end of the retrospective period, Canada managed the NCBC AABM fishery at levels well below that required by the 2009 PST Agreement. Southern U.S. fisheries in Puget Sound and along the coast have also often been 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 or below PST catch limits. In 2018, SEAK fisheries were voluntarily and deliberately managed to a harvest limit that was 10% 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 PST 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 in the retrospective analysis.

Additionally, the operation of hatchery programs within the action area was modified over the period between 1999-2018 for various reasons, ranging from budgetary constraints to conservation concerns in either the U.S. or Canada. The abundance levels of Chinook salmon experienced during this time period encompasses periods of higher levels of production, above the hatchery production levels described in the environmental baseline in Table 42 and Table 43, therefore the evaluation of how the tiered structure of the current fishery regime would perform retrospectively evaluates performance across a range of abundance encompassing these additional levels. However, Chinook salmon abundance in a given year is influenced by a number of factors in addition to prior levels of hatchery production; these include marine survival changing, or higher productivity from improved habitat. Thus, lower levels of hatchery production do not necessarily result in lower Chinook salmon abundance in a given year. Our scenarios account for varying levels of salmon abundance, and thus account for variation in future abundance levels.

For this analysis, the following four scenarios were run in FRAM using a retrospective analysis of the 1999-2018 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 2018 based on post season information. These runs are also used in other management forums such as the Pacific Fishery Management Council and North of Falcon 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 2018 and from this point forward are referred to as Scenario 1. See for example Figure 43 and Table 35. This scenario includes years managed under two different PST Agreements: 1999-2008 and 2009-2018.

Scenario 2: 2019 Likely

- *FRAM runs representing what we can reasonably expect to occur under both the 2019 PST 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 PST Agreement. Next, each run was assessed for their specific management objective to ensure that it also complied with likely domestic management objectives, for example, abundance-based total ER limits for LCR tule Chinook salmon and the low abundance threshold in the North of Falcon area for SRKW prey. For the other Chinook salmon ESUs (e.g., UWR and SRFC 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 in this scenario to account for the likely implementation of the 2019 PST 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 PST 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 each AABM fishery). For example, if a fishery on average caught only 80% 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 PST Agreement are evaluated relative to 2009-2015 CYER averages, with reductions in allowable ERs from that average varying by stock. For some stocks there are PSC-agreed management objectives (i.e., escapement goals) and for these stocks the CYER limits only apply in years when the escapement goal is not achieved (see Attachment I in Annex IV Chapter 3 of the 2019 PST Agreement for details). To best reflect this in the modeling scenario, we modeled the ISBM fisheries using 2009-2015 average effort rates (fishery scalars) from the FRAM validation runs in Scenario 1, as these rates should represent the average fishing scenario that resulted in the 2009 – 2015 average CYER for each stock. For many stocks, either the PST Agreement requires no reduction from the 2009-2015 CYER average, or they have other PST Agreement management objectives that are likely to be met, meaning CYER limits would not apply. For other stocks, however, reductions to the 2009-2015 CYER average are required. For example, there is no identified management objective for the Nicola stock, thus both U.S. and Canadian ISBM fisheries will annually be held to a limit of 95% of the 2009 – 2015 average CYER. To address these obligations that vary by stock, the following assumptions and small adjustments to the average fishing rates 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 occur in terminal areas.
- To meet U.S. ISBM obligations on Canadian stocks (95% of 2009-2015 CYER average when management objectives are not met for Cowichan, Nicola, and Harrison), a 5% 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, and recreational fisheries in Marine Areas 5 (western Strait of Juan de Fuca) and 7 (San Juan Islands).
- To meet Canadian ISBM obligations on U.S. stocks (87.5% of 2009-2015 CYER average), a 12.5% 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.

The models were run with AABM and ISBM fishery inputs as described above, then assessed individually for compliance with ISBM CYER limits for Puget Sound Chinook salmon stocks. Further reductions were made on a case by case basis to ensure that U.S. ISBM fishery impacts on Puget Sound Chinook salmon stocks were within ISBM CYER limits.

Once the AABM and ISBM fisheries were updated to reflect the provisions of the 2019 PST Agreement, additional fishery modifications were often necessary to ensure fisheries meet anticipated domestic management objectives. These modifications were made on a case-by-case basis to: (1) as necessary, reduce non-tribal North of Cape Falcon ocean fisheries and in-river fisheries so that the total ER on LCR tule Chinook salmon (a primary constraining stock in SUS west coast ocean salmon fisheries) is below the annual abundance-based ER limit, while maintaining the historical 60/40 sharing of LCR tule impacts between the ocean and the river, then (2) as necessary, modify non-tribal North of Cape Falcon ocean fisheries to comply with the management measures listed in Section 6.6.8 of Amendment 21 of the Pacific Coast Salmon Fishery Management Plan, should the October 1 estimate of Chinook salmon abundance in the North of Cape Falcon area fall below the defined threshold.

Scenario 3: 2019 Likely (SEAK 2009)

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

This scenario is intended to isolate the effects of the proposed action when compared with 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 PST Agreement. The same assumptions and adjustments (including for management error) were applied in this scenario as they were in the 2019 Likely Scenario (Scenario 2).

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% in the abundance of Chinook salmon.*

In this model scenario the starting cohort sizes for all stocks and ages were reduced by 40%. 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% 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, in the Proposed Action, 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, Chapter 3 of the 2019 PST Agreement. 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 salmon non-retention inputs generally used to estimate impacts in fisheries where unmarked Chinook salmon are required to be released 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% prior to running this model scenario.

Similar to Scenario 2, once these models were run with the reduced abundances and AABM fishery catch limits, we assessed each year individually and made additional reductions for southern U.S. fisheries as necessary to ensure compliance with (1) southern U.S. ISBM CYER limits, (2) LCR tule Chinook salmon abundance-based total ER limits, and (3) management measures required when estimates of Chinook salmon abundance in the north of Cape Falcon area fall below the defined SRKW prey abundance threshold. The assumptions and adjustments (including for management error) were applied in this scenario as they were in the 2019 Likely Scenario (Scenario 2).

The 40% abundance decline scenario is best compared to the 2019 Likely Scenario to provide a perspective on how the fishery provisions in the 2019 PST 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 scenario 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 PST Agreement. If the abundance of Chinook salmon did in fact decline by 40%, catches in ISBM fisheries would likely be reduced further, beyond the rates used in these model runs to address stock specific conservation concerns.

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%.

Modeling Outcomes

For each of the ESA-listed natural Chinook salmon stocks, ERs were graphed for the four scenarios covering the 1999-2018 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). 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 SRFC, Upper Willamette River Chinook salmon, or the Lower Columbia River Chinook salmon 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 SRFC are expressed in terms of the ERs rather than as SRFIs or escapements to provide consistency with the assessment and reporting of effects on other stocks. As explained in more detail below and in the environmental baseline, marine area fisheries have been managed subject to a standard limit referred to as the SRFI since 1996.

2.5.2 Chinook Salmon

2.5.2.1 Lower Columbia River Chinook Salmon

To assess the effects of the proposed actions using the retrospective analysis we compare the ERs from the 2019 Likely Scenario (Scenario 2) to each of the other scenarios for each of the Chinook ESUs, beginning with LCR Chinook. For LCR Chinook, we first compare the observed ERs in marine fisheries from those in the FRAM Validation runs (Scenario 1) with the 2019 Likely Scenario (Scenario 2) for each component of the ESU (Table 61, Figure 63, and Figure 64). For LCR spring Chinook salmon the absolute change in the average ER is -1.4% in marine area fisheries and -0.3% in the SEAK fishery, but these represent relative changes of -8.4% and -14.9%, respectively (Table 48).[53] For LCR tule Chinook salmon the absolute change in the average ER is -3.5% in marine area fisheries and -0.3% in the SEAK fishery, and these represent relative changes of -11.1% and -12.9 %, respectively (Table 48). And for LCR bright Chinook salmon the absolute change in the average ER is -4.3% in marine area fisheries and -1.0% in the SEAK fishery, and these represent relative changes of -8.6% and -9.9%, respectively (Table 48).

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[53] Absolute change is the actual change in the ER between the two scenarios being compared. [ER_{C} = Scenario 1 ER – Scenario 2 ER] . Relative change is the proportional difference between the two estimates of ER relative to the scenario being compared. ER_{R} = [Scenario 1 ER - Scenario 2 ER)/Scenario 1 ER].

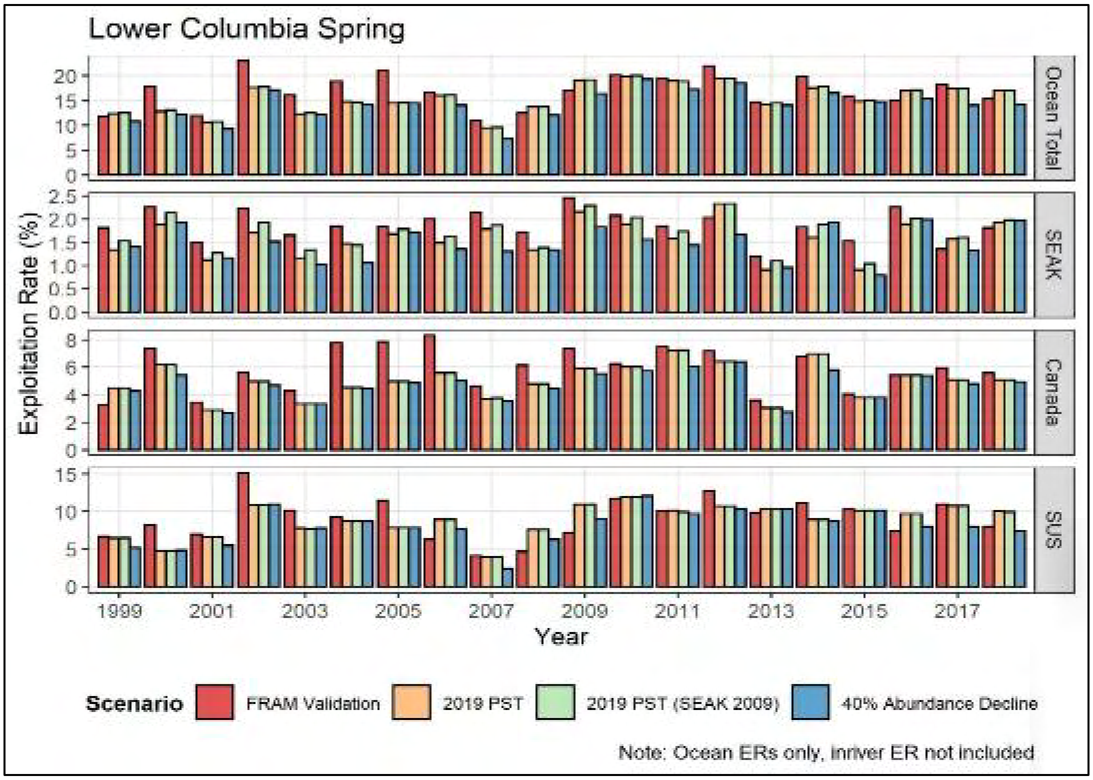

Figure 62. Comparison of ERs on LCR Spring Chinook salmon between Scenarios 1 through 4 in the retrospective analysis.

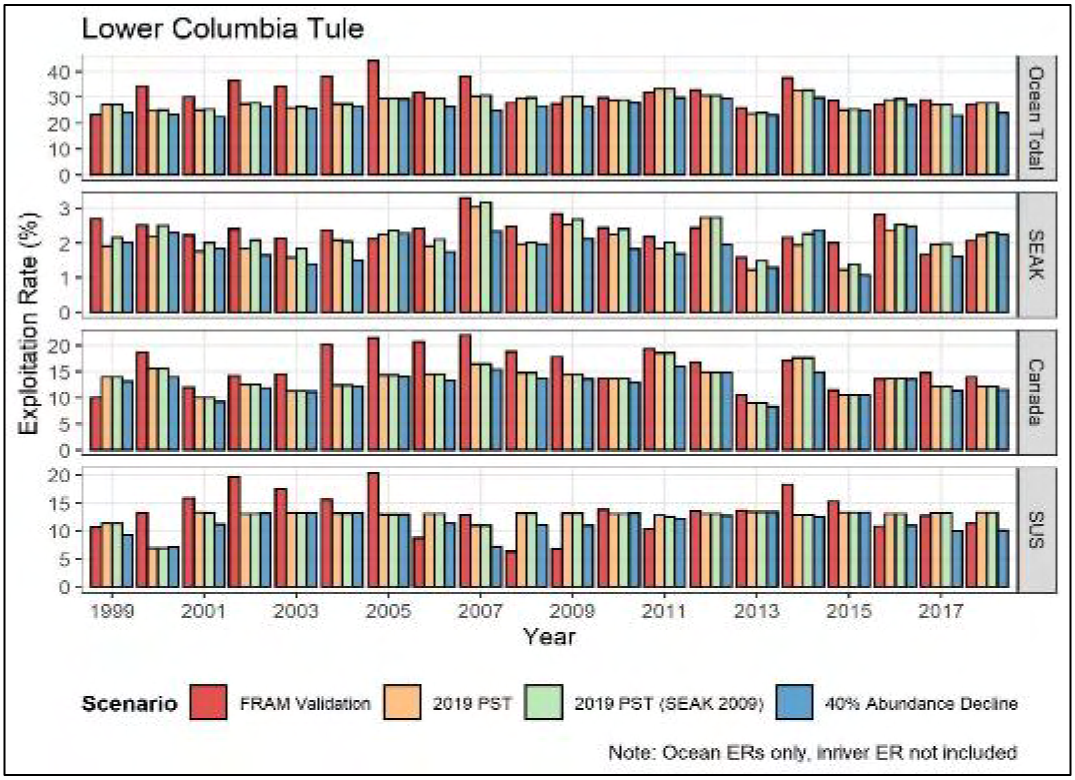

Figure 63. Comparison of ERs on LCR tule Chinook salmon between Scenarios 1 through 4 in the retrospective analysis.

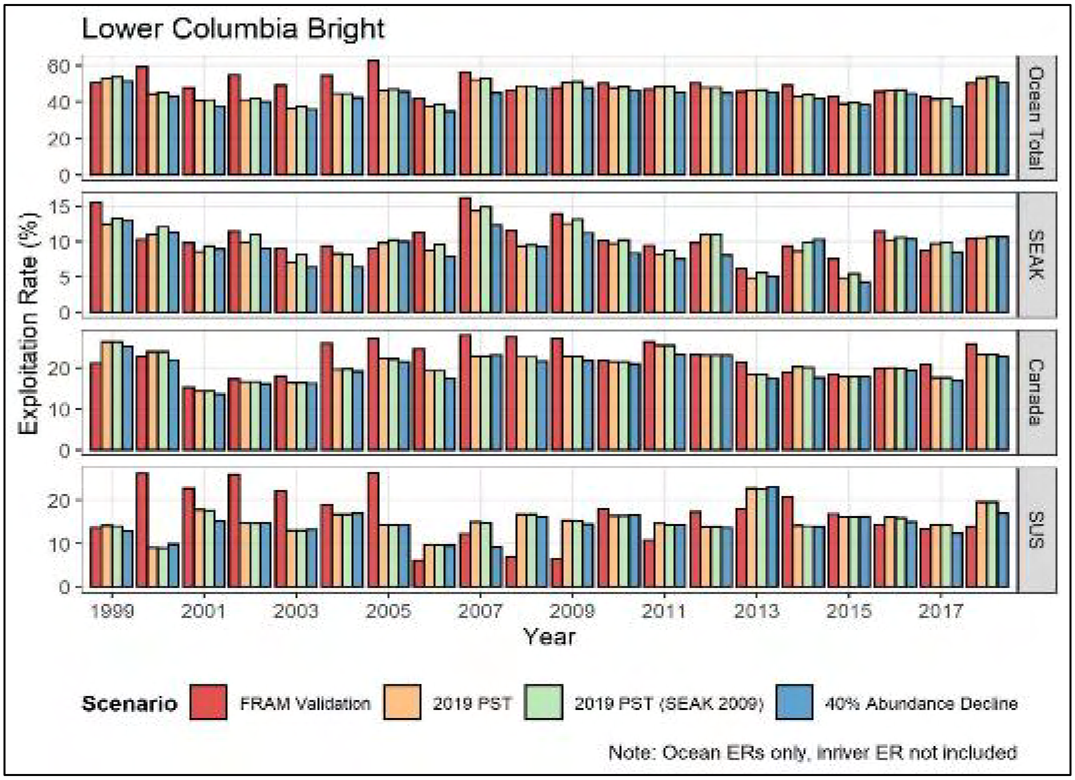

Figure 64. Comparison of ERs on LCR bright Chinook salmon between Scenarios 1 through 4 in the retrospective analysis.

Table 48. ER changes between Scenario 1 and Scenario 2 in the retrospective analysis on LCR Chinook salmon. Abs= absolute and Rel=relative.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
LCR Chinook – Spring component	Scenario 1	1.9%	5.9%	9.0%	0.1%	16.9%
	Scenario 2	1.6%	5.0%	8.7%	0.2%	15.5%
	Abs ER Change	-0.3%	-0.9%	-0.3%	0.0%	-1.4%
	Rel ER Change	-14.9%	-15.2%	-3.0%	10.4%	-8.4%
LCR Chinook – Tule component	Scenario 1	2.3%	16.1%	13.0%	0.3%	31.8%
	Scenario 2	2.0%	13.6%	12.2%	0.4%	28.3%
	Abs ER Change	-0.3%	-2.5%	-0.8%	0.0%	-3.5%
	Rel ER Change	-12.9%	-15.4%	-6.1%	11.7%	-11.1%
LCR Chinook – Bright component	Scenario 1	10.5%	22.6%	16.5%	0.0%	49.6%
	Scenario 2	9.5%	20.8%	15.1%	0.0%	45.4%
	Abs ER Change	-1.0%	-1.8%	-1.4%	0.0%	-4.3%
	Rel ER Change	-9.9%	-8.1%	-8.3%	NA	-8.6%

Scenarios 2 and 3 provide a more direct comparison of how ERs are expected to change as a result of the proposed reduction in the SEAK fishery from the 2009 PST Agreement (Scenario 3) to the 2019 PST Agreement (Scenario 2). Under the 2019 PST Agreement recall that in most years the SEAK fishery will be reduced by 7.5% relative to the 2009 PST 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% on LCR spring Chinook salmon, -0.2% on LCR tule Chinook salmon, and -0.6% on LCR bright Chinook salmon. The proposed change will result in the average ER relative change in the SEAK fishery of -7.4%, -7.5%, and -5.8%, respectively, consistent with the expected outcome from implementation of the PST (Table 49).

Table 49. ER changes between Scenario 3 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 3	1.7%	5.0%	8.7%	0.2%	15.6%
	Scenario 2	1.6%	5.0%	8.7%	0.2%	15.5%
	Abs ER Change	-0.1%	0.0%	0.0%	0.0%	-0.1%
	Rel ER Change	-7.4%	0.0%	0.2%	0.1%	-0.7%
LCR Chinook – Tule component	Scenario 3	2.2%	13.6%	12.2%	0.4%	28.4%
	Scenario 2	2.0%	13.6%	12.2%	0.4%	28.3%
	Abs ER Change	-0.2%	0.0%	0.0%	0.0%	-0.2%
	Rel ER Change	-7.5%	-0.1%	0.1%	0.1%	-0.6%
LCR Chinook – Bright component	Scenario 3	10.0%	20.8%	15.1%	0.0%	45.9%
	Scenario 2	9.5%	20.8%	15.1%	0.0%	45.4%
	Abs ER Change	-0.6%	0.0%	0.1%	0.0%	-0.5%
	Rel ER Change	-5.8%	0.2%	0.4%	NA	-1.1%

A comparison of Scenarios 2 and 4 examine how the fisheries will respond to a 40% reduction in coast wide abundance (Scenario 4). Fisheries managed to account for the 40% lower abundance (Scenario 4) will result in an absolute reduction in the average ER in the SEAK fishery of -0.1% on LCR spring Chinook salmon, -0.2% on LCR tule Chinook salmon, and -0.5% on LCR bright Chinook salmon, compared to Scenario 2. Fisheries managed to account for the 40% lower abundance will result in the average ER relative change in the SEAK fishery of -7.9%, -7.7%, and -5.7% compared to Scenario 2, respectively (Table 50).

Table 50. 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%	5.0%	8.7%	0.2%	15.5%

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Chinook – Spring component	Scenario 4	1.5%	4.7%	7.9%	0.2%	14.2%
	Abs ER Change	-0.1%	-0.3%	-0.8%	0.0%	-1.3%
	Rel ER Change	-7.9%	-6.6%	-9.4%	1.8%	-8.2%
LCR Chinook – Tule component	Scenario 2	2.0%	13.6%	12.2%	0.4%	28.3%
	Scenario 4	1.9%	12.7%	11.1%	0.4%	26.1%
	Abs ER Change	-0.2%	-0.9%	-1.2%	0.0%	-2.2%
	Rel ER Change	-7.7%	-6.3%	-9.6%	1.9%	-7.7%
LCR Chinook – Bright component	Scenario 2	9.5%	20.8%	15.1%	0.0%	45.4%
	Scenario 4	8.9%	19.9%	14.4%	0.0%	43.2%
	Abs ER Change	-0.5%	-0.9%	-0.8%	0.0%	-2.2%
	Rel ER Change	-5.7%	-4.3%	-5.1%	NA	-4.8%

2.5.2.2 Upper Willamette Chinook Salmon

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 65). The absolute change in the average ER is -1.2% in marine area fisheries and -0.6% in the SEAK fishery, but these represent relative changes of -14.2% and -15.9%, respectively (Table 51).

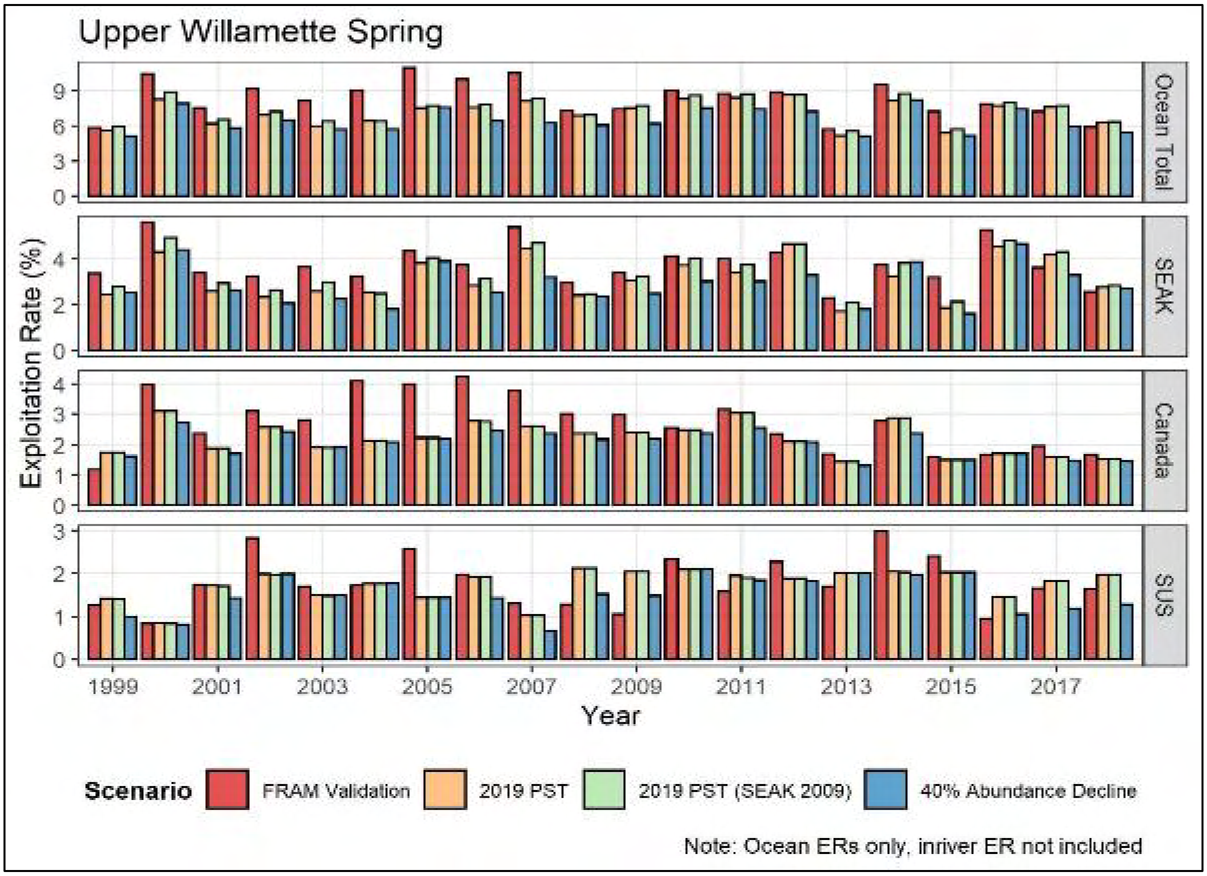

Figure 65. Comparison of ERs on UWR Spring Chinook salmon between Scenarios 1 through 4 in the retrospective analysis.

Table 51. ER changes between Scenario 1 and Scenario 2 in the retrospective analysis on UWR Chinook salmon.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
UWR Chinook Salmon	Scenario 1	3.8%	2.7%	1.7%	0.1%	8.3%
	Scenario 2	3.2%	2.2%	1.7%	0.0%	7.1%
	Abs ER Change	-0.6%	-0.5%	0.0%	0.0%	-1.2%
	Rel ER Change	-15.9%	-20.0%	-1.1%	-30.7%	-14.2%

Scenarios 2 and 3 provide a more direct comparison of how ERs are expected to change as a result of the proposed reduction in the SEAK fishery from the 2009 PST Agreement (Scenario 3) to the 2019 PST 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% and a relative change of -7.7% (Table 52), representing changes in the marine area exploitation of -0.3% and -3.5% respectively.

Table 52. 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	3.4%	2.2%	1.7%	0.0%	7.4%
	Scenario 2	3.2%	2.2%	1.7%	0.0%	7.1%
	Abs ER Change	-0.3%	0.0%	0.0%	0.0%	-0.3%
	Rel ER Change	-7.7%	0.1%	0.3%	0.1%	-3.5%

A comparison of Scenarios 2 and 4 examine how the fisheries will respond to a 40% reduction in coast wide abundance (Scenario 4). The absolute change in the average ER is -0.7% in marine area fisheries and -0.3% in the SEAK fishery, but these represent relative changes of -9.9% and -9.5%, respectively (Table 53).

Table 53. 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	3.2%	2.2%	1.7%	0.0%	7.1%
	Scenario 4	2.9%	2.0%	1.5%	0.0%	6.4%
	Abs ER Change	-0.3%	-0.2%	-0.2%	0.0%	-0.7%
	Rel ER Change	-9.5%	-7.6%	-13.7%	0.7%	-9.9%

2.5.2.3 Snake River Fall-Run Chinook Salmon

The retrospective analysis is used to compare the observed ERs from the FRAM Validation runs (Scenario 1) and the Likely Scenario 2 for SRFC (Figure 66). The absolute change in the average ER is -3.4% in marine area fisheries and -0.2% in the SEAK fishery, but these represent relative changes of -11.3% and -16.3%, respectively (Table 54).

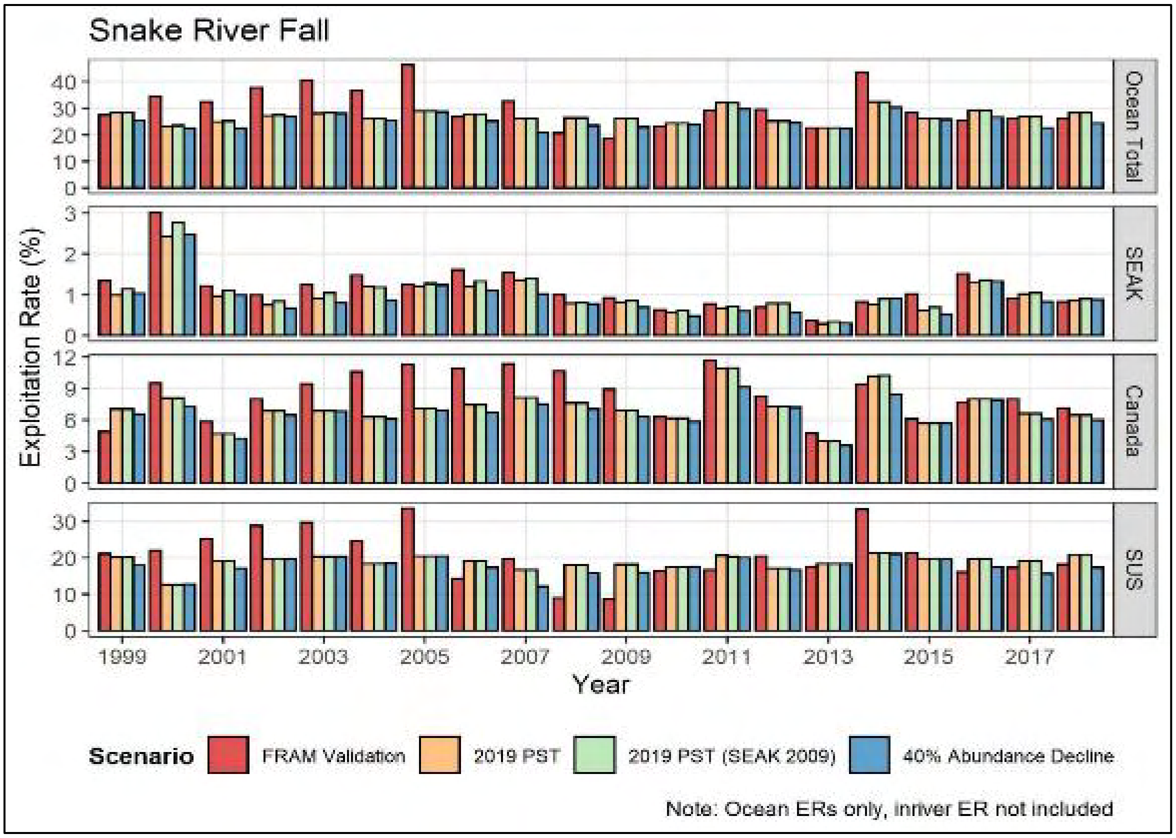

Figure 66. Comparison of ERs on SRFC between Scenarios 1 through 4 in the retrospective analysis.

Table 54. ER changes between Scenario 1 and Scenario 2 in the retrospective analysis on SRFC.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Snake River fall-run Chinook salmon	Scenario 1	1.2%	8.5%	20.5%	0.3%	30.4%
	Scenario 2	1.0%	7.1%	18.6%	0.3%	27.0%
	Abs ER Change	-0.2%	-1.4%	-1.9%	0.0%	-3.4%
	Rel ER Change	-16.3%	-16.7%	-9.0%	8.3%	-11.3%

Scenarios 2 and 3 provide a more direct comparison of how ERs are expected to change as a result of the proposed reduction in the SEAK fishery from the 2009 PST Agreement (Scenario 3) to the 2019 PST Agreement (Scenario 2). The proposed change will result in an absolute reduction in the average ER in the SEAK fishery of -0.1% and a relative change of -7.8% (Table 55), amounting to a change in the marine area ER of -0.1% and -0.3%, respectively.

Table 55. ER changes between Scenario 3 and Scenario 2 in the retrospective analysis on SRFC.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Snake River fall-run Chinook salmon	Scenario 3	1.0%	7.1%	18.6%	0.3%	27.1%
	Scenario 2	1.0%	7.1%	18.6%	0.3%	27.0%
	Abs ER Change	-0.1%	0.0%	0.0%	0.0%	-0.1%
	Rel ER Change	-7.8%	-0.1%	0.1%	0.0%	-0.3%

A comparison of Scenarios 2 and 4 examine how the fisheries will respond to a 40% reduction in coast wide abundance (Scenario 4). The absolute change in the average ER is -1.9% in marine area fisheries and -0.1% in the SEAK fishery, but these represent relative changes of -7.0% and -7.3%, respectively (Table 56).

Table 56. ER changes between Scenario 2 and Scenario 4 in the retrospective analysis on SRFC.

ESU	Comparison	SEAK Exploitation	Canadian Exploitation	PFMC Exploitation	Puget Sound Exploitation	Marine Area Exploitation
Snake River fall-run Chinook salmon	Scenario 2	1.0%	7.1%	18.6%	0.3%	27.0%
	Scenario 4	0.9%	6.6%	17.3%	0.3%	25.1%
	Abs ER Change	-0.1%	-0.5%	-1.3%	0.0%	-1.9%
	Rel ER Change	-7.3%	-7.3%	-7.0%	1.2%	-7.0%

2.5.2.4 Puget Sound Chinook Salmon

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

2.5.2.4.1 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 67 for Elwha River Chinook salmon. The absolute change in the average ER is -2.1% in all fisheries and -0.3% in the SEAK fishery, but these represent relative changes of -8.1% and -15.3%, respectively (Table 57).

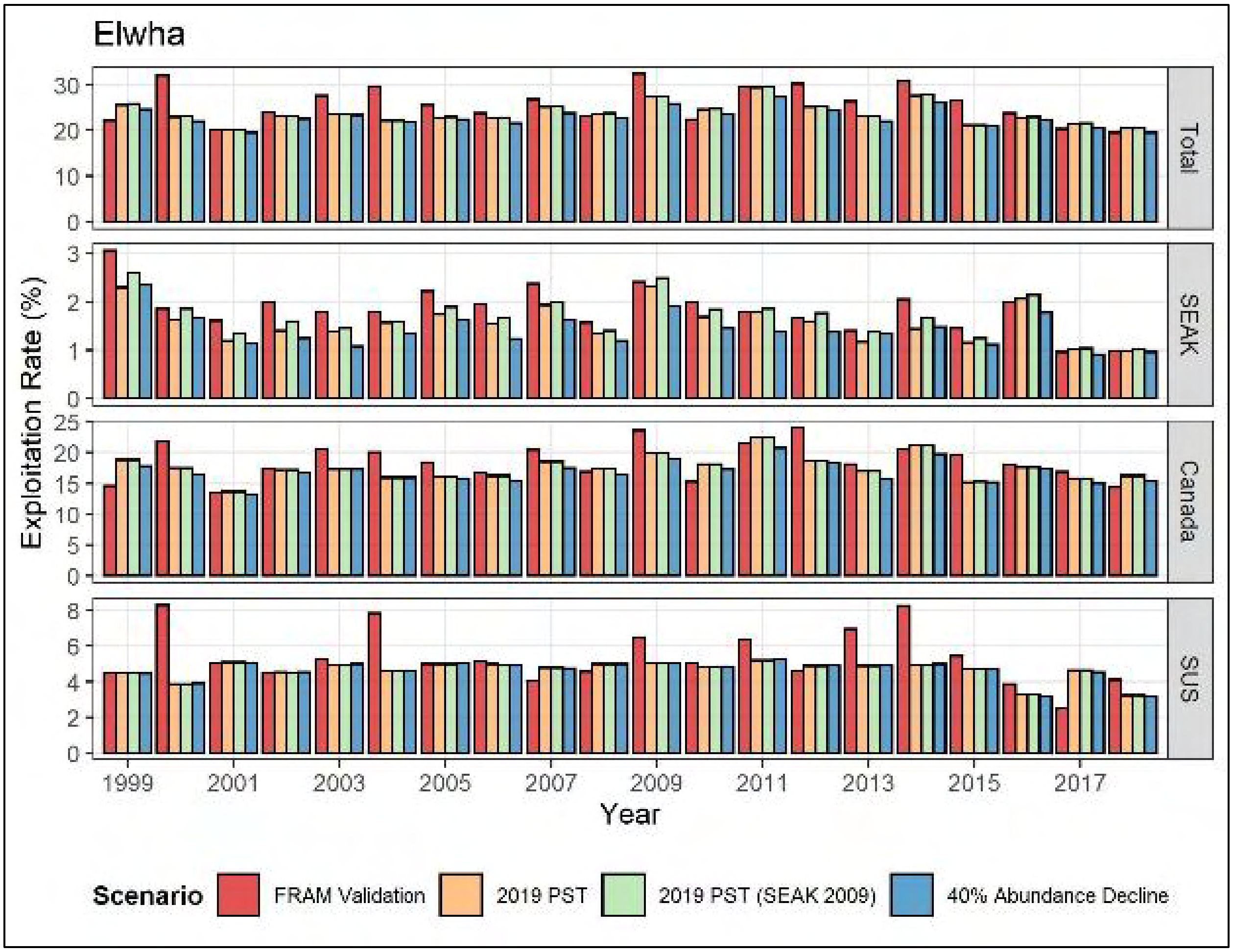

Figure 67. Comparison of ERs on Elwha River Chinook salmon between Scenarios 1 through 4 in the retrospective analysis.

Table 57. 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	Total Exploitation
Puget Sound Chinook Salmon – Elwha R	Scenario 1	1.8%	18.6%	1.5%	3.8%	25.8%
	Scenario 2	1.6%	17.5%	1.6%	3.0%	23.7%
	Abs ER Change	-0.3%	-1.1%	0.1%	-0.8%	-2.1%
	Rel ER Change	-15.3%	-5.7%	6.4%	-21.9%	-8.1%

Scenarios 2 and 3 provide a more direct comparison of how ERs are expected to change as a result of the proposed reduction in the SEAK fishery from the 2009 PST Agreement (Scenario 3) to the 2019 PST Agreement (Scenario 2). The proposed change will result in an absolute reduction in the average ER in the SEAK fishery of -0.1% and a relative change of -7.6% (Table 58), amounting to a change in total exploitation of -0.1% and -0.5%, respectively.

Table 58. 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	Total Exploitation
Puget Sound Chinook Salmon – Elwha R	Scenario 3	1.7%	17.5%	1.6%	3.0%	23.9%
	Scenario 2	1.6%	17.5%	1.6%	3.0%	23.7%
	Abs ER Change	-0.1%	0.0%	0.0%	0.0%	-0.1%
	Rel ER Change	-7.6%	0.0%	0.1%	0.1%	-0.5%

A comparison of Scenarios 2 and 4 examine how the fisheries will respond to a 40% reduction in coast wide abundance (Scenario 4). The absolute change in the average total ER is -0.9%, and -0.2% in the SEAK fishery, but these represent relative changes of -3.7% and -9.7%, respectively (Table 59).

Table 59. 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	Total Exploitation
Puget Sound Chinook Salmon – Elwha R	Scenario 2	1.6%	17.5%	1.6%	3.0%	23.7%
	Scenario 4	1.4%	16.8%	1.6%	3.0%	22.9%
	Abs ER Change	-0.2%	-0.7%	0.0%	0.0%	-0.9%
	Rel ER Change	-9.7%	-4.2%	-1.7%	0.8%	-3.7%

Results of the FRAM Validation analysis for the Dungeness population are quite similar to those of the Elwha and are shown in Figure 68 and Table 60 through Table 62. Comparing the observed ERs from the FRAM Validation runs (Scenario 1) with the 2019 Likely Scenario 2 the absolute change in the average total ER is -1.7%, and -0.3% in the SEAK fishery, but these represent relative changes of -6.8% and -15.5%, respectively (Table 60).

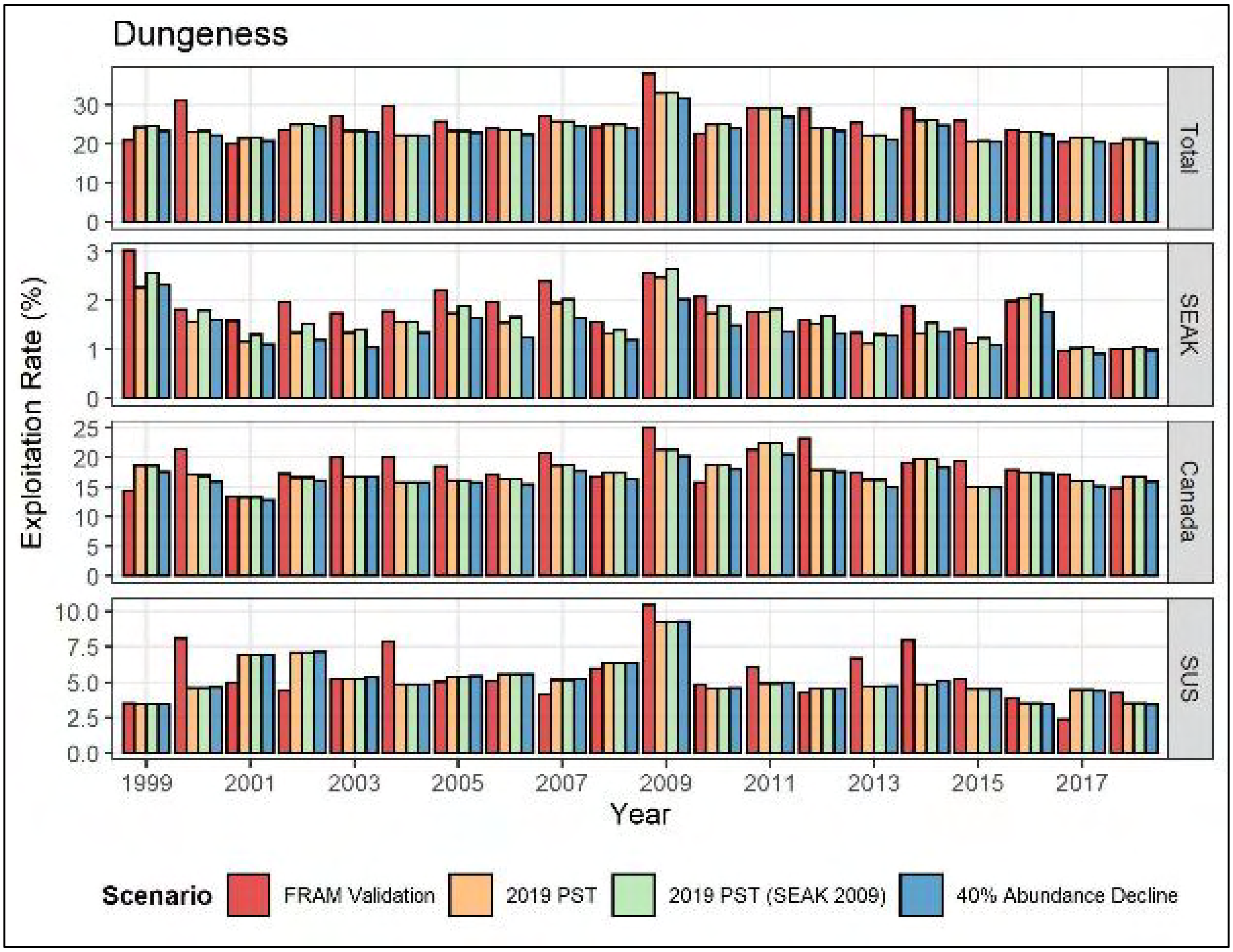

Figure 68. Comparison of ERs on Dungeness River Chinook salmon between Scenarios 1 through 4 in the retrospective analysis.

Table 60. 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	Total Exploitation
Puget Sound Chinook Salmon – Dungeness R	Scenario 1	1.8%	18.5%	1.5%	4.0%	25.8%
	Scenario 2	1.5%	17.4%	1.6%	3.5%	24.1%
	Abs ER Change	-0.3%	-1.1%	0.1%	-0.5%	-1.7%
	Rel ER Change	-15.5%	-6.0%	6.7%	-11.3%	-6.8%

Scenarios 2 and 3 provide a more direct comparison of how ERs are expected to change as a result of the proposed reduction in the SEAK fishery from the 2009 PST Agreement (Scenario 3) to the 2019 PST Agreement (Scenario 2). The proposed change will result in an absolute reduction in the average SEAK fishery ER of -0.1% and a relative change of -7.5% (Table 61), amounting to a change in total exploitation of -0.1% and -0.5%, respectively.

Table 61. 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	Total Exploitation
Puget Sound Chinook Salmon – Dungeness R	Scenario 3	1.7%	17.4%	1.6%	3.5%	24.2%
	Scenario 2	1.5%	17.4%	1.6%	3.5%	24.1%
	Abs ER Change	-0.1%	0.0%	0.0%	0.0%	-0.1%
	Rel ER Change	-7.5%	0.0%	0.1%	0.1%	-0.5%

A comparison of Scenarios 2 and 4 examine how the fisheries will respond to a 40% reduction in coast wide abundance (Scenario 4). The absolute change in the average total ER is -0.9%, and -0.2% in the SEAK fishery, but these represent relative changes of -3.5% and -9.8%, respectively (Table 62).

Table 62. 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	Total Exploitation
Puget Sound Chinook Salmon – Dungeness R	Scenario 2	1.5%	17.4%	1.6%	3.5%	24.1%
	Scenario 4	1.4%	16.7%	1.6%	3.6%	23.2%
	Abs ER Change	-0.2%	-0.7%	0.0%	0.1%	-0.9%
	Rel ER Change	-9.8%	-4.2%	-1.7%	1.5%	-3.5%

Figure 69 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 20 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.

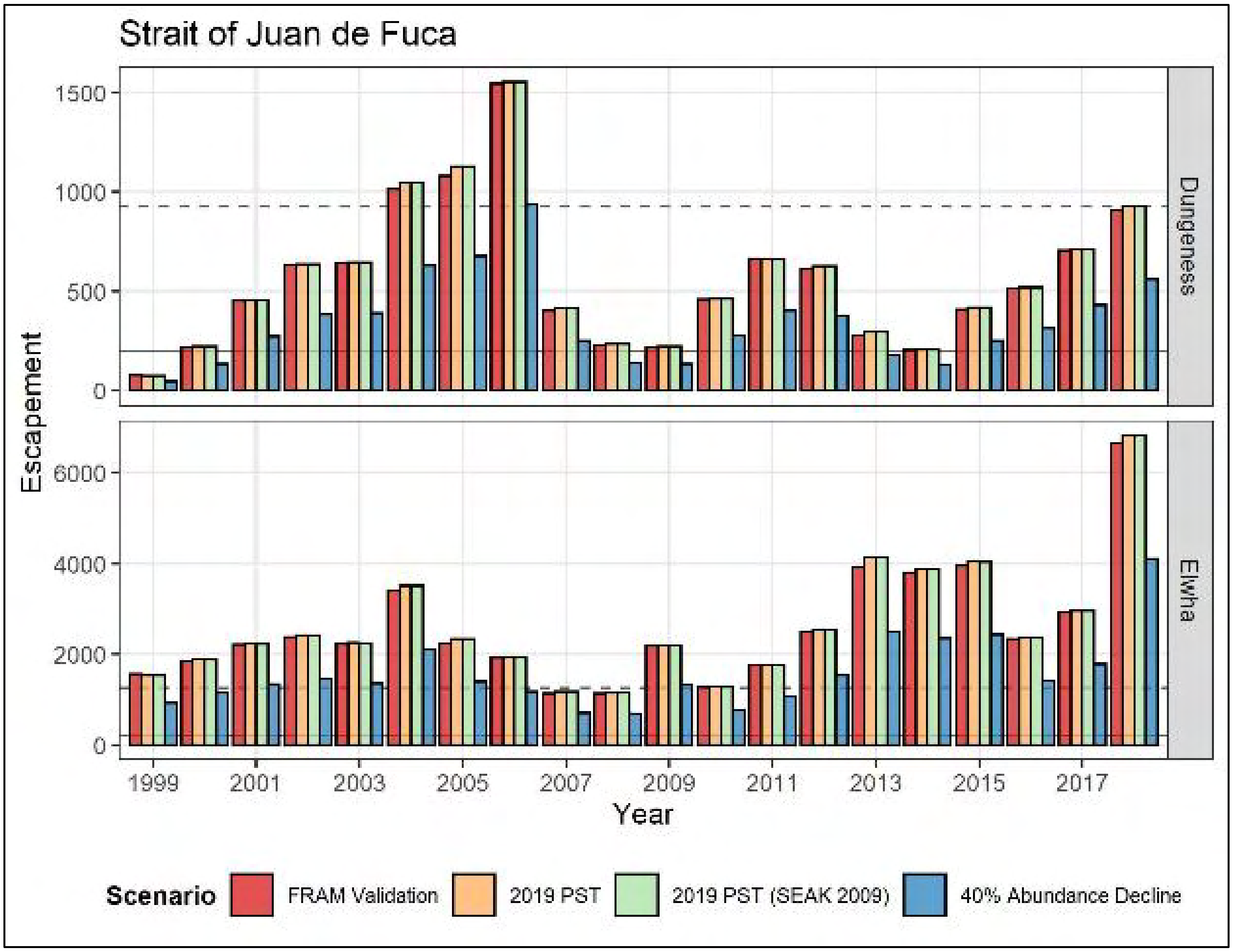

Figure 69. Escapement of Strait of Juan de Fuca populations based on retrospective analysis scenarios. (Dashed line represents UET, solid line represents CET, see Table 29 for population specific values).

2.5.2.4.2 Hood Canal

Comparing the observed ERs from the FRAM Validation runs (Scenario 1) with the Likely Scenario 2 are captured in Figure 70 for Mid-Hood Canal Chinook salmon. The absolute change in the average total ER is -2.1%, and -0.1% in the SEAK fishery, but these represent relative changes of -8.5% and -15.9%, respectively (Table 63).

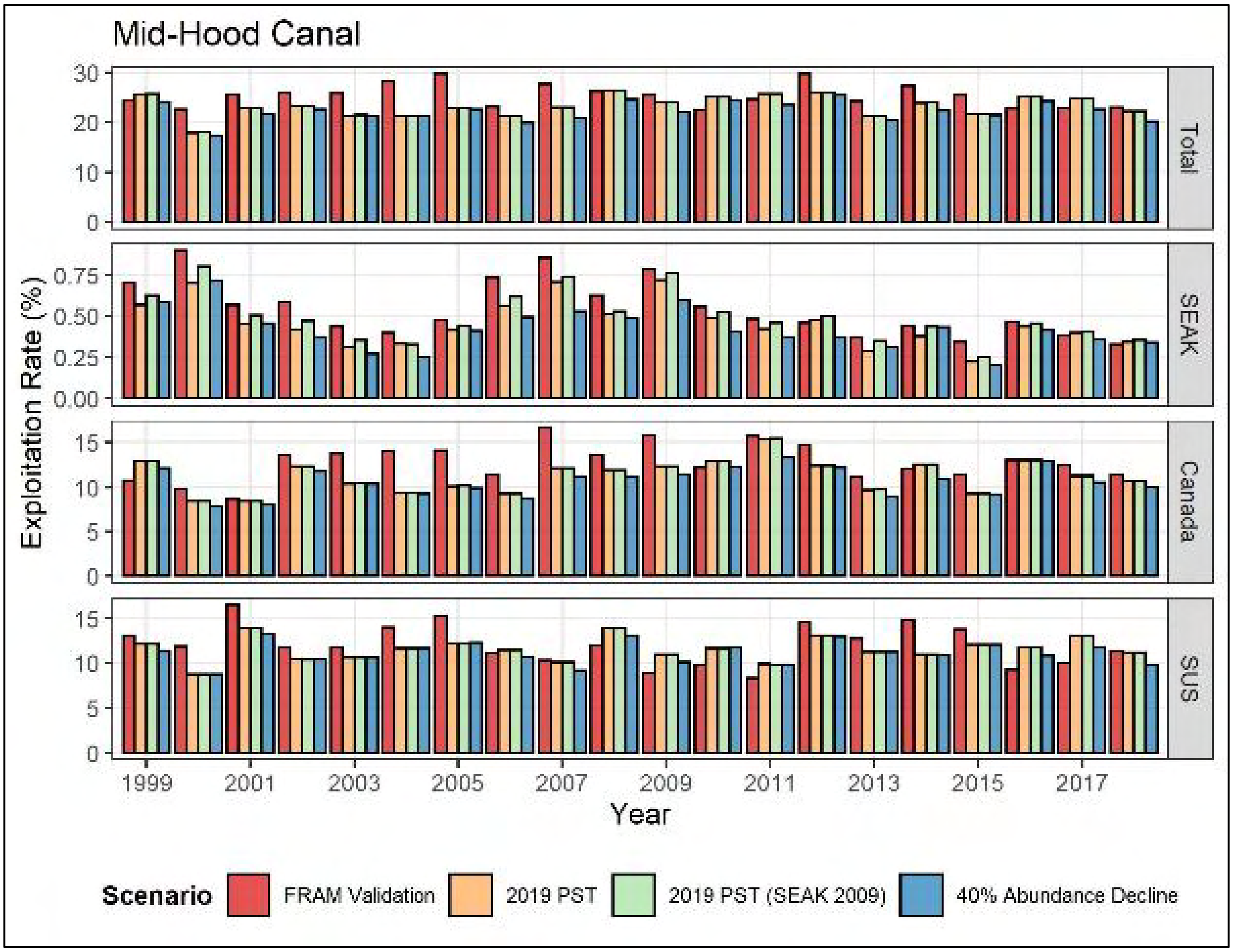

Figure 70. Comparison of ERs on Mid-Hood Canal Chinook salmon between Scenarios 1 through 4 in the retrospective analysis.

Table 63. 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	Total Exploitation
Puget Sound Chinook Salmon – Mid-Hood Canal	Scenario 1	0.5%	12.8%	6.2%	5.9%	25.4%
	Scenario 2	0.5%	11.2%	6.5%	5.1%	23.2%
	Abs ER Change	-0.1%	-1.6%	0.3%	-0.8%	-2.1%
	Rel ER Change	-15.9%	-12.1%	4.7%	-13.7%	-8.5%

Scenarios 2 and 3 provide a more direct comparison of how ERs are expected to change as a result of the proposed reduction in the SEAK fishery from the 2009 PST Agreement (Scenario 3) to the 2019 PST Agreement (Scenario 2). The proposed change will result in an absolute change in both the average total ER and SEAK ER of 0%, and a relative change in the total ER of -0.2%, and -7.6% in the SEAK fishery (Table 64).

Table 64. 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	Total Exploitation
Puget Sound Chinook Salmon – Mid-Hood Canal	Scenario 3	0.5%	11.2%	6.5%	5.1%	23.3%
	Scenario 2	0.5%	11.2%	6.5%	5.1%	23.2%
	Abs ER Change	0.0%	0.0%	0.0%	0.0%	0.0%
	Rel ER Change	-7.6%	-0.1%	0.1%	0.0%	-0.2%

A comparison of Scenarios 2 and 4 examine how the fisheries will respond to a 40% reduction in coast wide abundance (Scenario 4). The absolute change in the average total ER is -1.1%, and 0% in the SEAK fishery, but these represent relative changes of -4.8% and -8.5%, respectively (Table 65).

Table 65. 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	Total Exploitation
Puget Sound Chinook Salmon – Mid-Hood Canal	Scenario 2	0.5%	11.2%	6.5%	5.1%	23.2%
	Scenario 4	0.4%	10.6%	6.0%	5.1%	22.1%
	Abs ER Change	0.0%	-0.6%	-0.5%	0.0%	-1.1%
	Rel ER Change	-8.5%	-5.7%	-7.4%	0.8%	-4.8%

Comparing the observed ERs from the FRAM Validation runs (Scenario 1) with the Likely Scenario 2 are captured in Figure 71 for Skokomish River Chinook salmon. The absolute change in the average total ER is -1.7%, and -0.1% in the SEAK fishery, but these represent relative changes of -3.0% and -14.9%, respectively (Table 66).

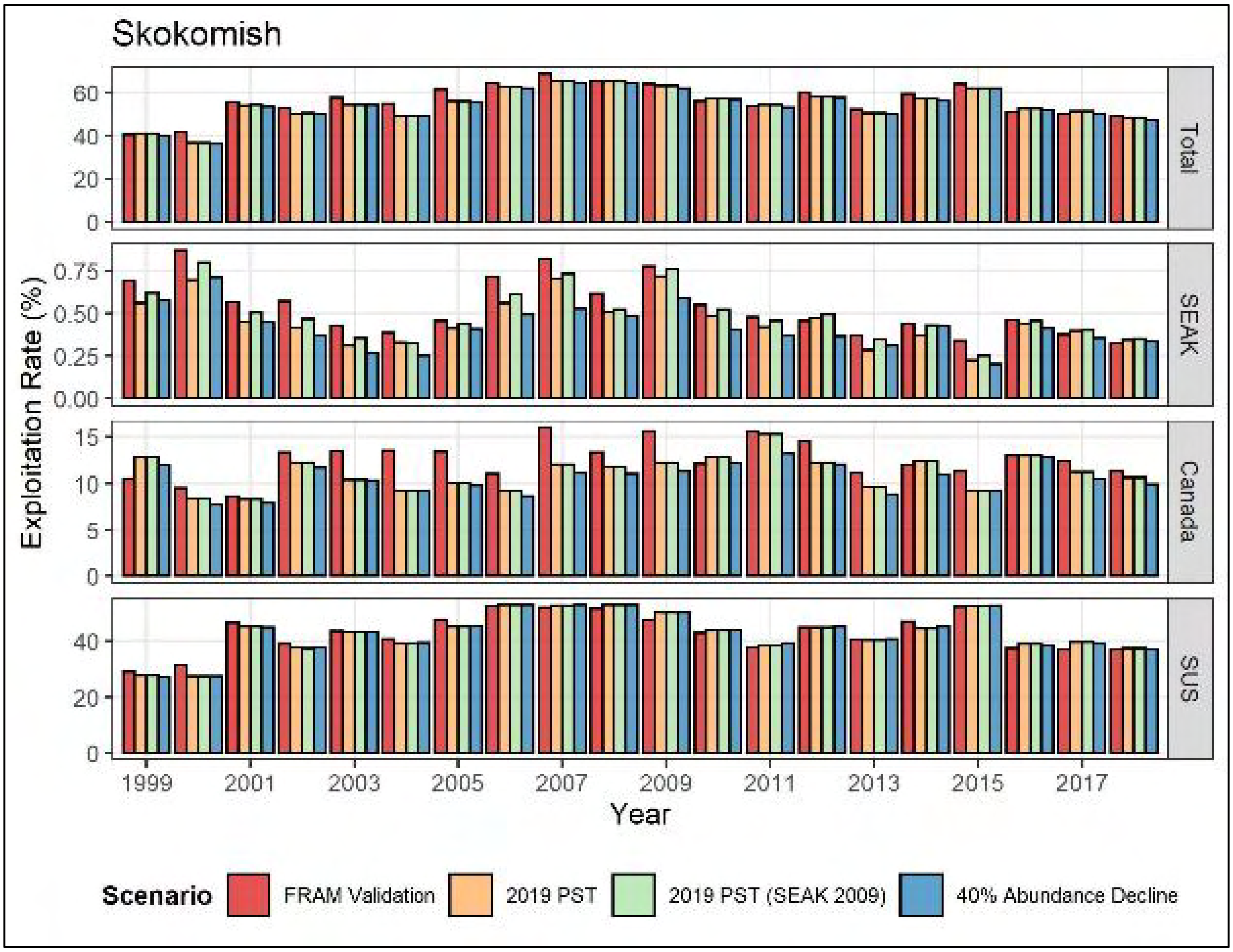

Figure 71. Comparison of ERs on Skokomish River Chinook salmon between Scenarios 1 through 4 in the retrospective analysis.

Table 66. 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	Total Exploitation
Puget Sound Chinook Salmon – Skokomish R	Scenario 1	0.5%	12.6%	6.1%	36.9%	56.1%
	Scenario 2	0.5%	11.1%	6.4%	36.4%	54.4%
	Abs ER Change	-0.1%	-1.4%	0.4%	-0.5%	-1.7%
	Rel ER Change	-14.9%	-11.2%	5.8%	-1.4%	-3.0%

Scenarios 2 and 3 provide a more direct comparison of how ERs are expected to change as a result of the proposed reduction in the SEAK fishery from the 2009 PST Agreement (Scenario 3) to the 2019 PST Agreement (Scenario 2). The proposed change will result in an absolute change in the average ER of 0% and a relative change in the SEAK fishery ER of -7.6% (Table 67), amounting to a change in average total ER of 0% and relative change of -0.1%, respectively.

Table 67. 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**	**Total Exploitation**
Puget Sound Chinook Salmon – Skokomish R	Scenario 3	0.5%	11.2%	6.4%	36.3%	54.4%
	Scenario 2	0.5%	11.1%	6.4%	36.4%	54.4%
	Abs ER Change	0.0%	0.0%	0.0%	0.0%	0.0%
	Rel ER Change	-7.6%	-0.1%	0.1%	0.0%	-0.1%

A comparison of Scenarios 2 and 4 examine how the fisheries will respond to a 40% reduction in coast wide abundance (Scenario 4). The absolute change in the average total ER is -0.6%, and 0% in the SEAK fishery, but these represent relative changes of -1.1% and -8.6%, respectively (Table 68).

Table 68. 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**	**Total Exploitation**
Puget Sound Chinook Salmon – Skokomish R	Scenario 2	0.5%	11.1%	6.4%	36.4%	54.4%
	Scenario 4	0.4%	10.5%	6.0%	36.9%	53.8%
	Abs ER Change	0.0%	-0.6%	-0.5%	0.5%	-0.6%
	Rel ER Change	-8.6%	-5.7%	-7.4%	1.5%	-1.1%

Figure 72 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 the majority of all scenarios. The Skokomish population exceeds the CET only once, and the Mid-Hood Canal population does in six years for all scenarios.

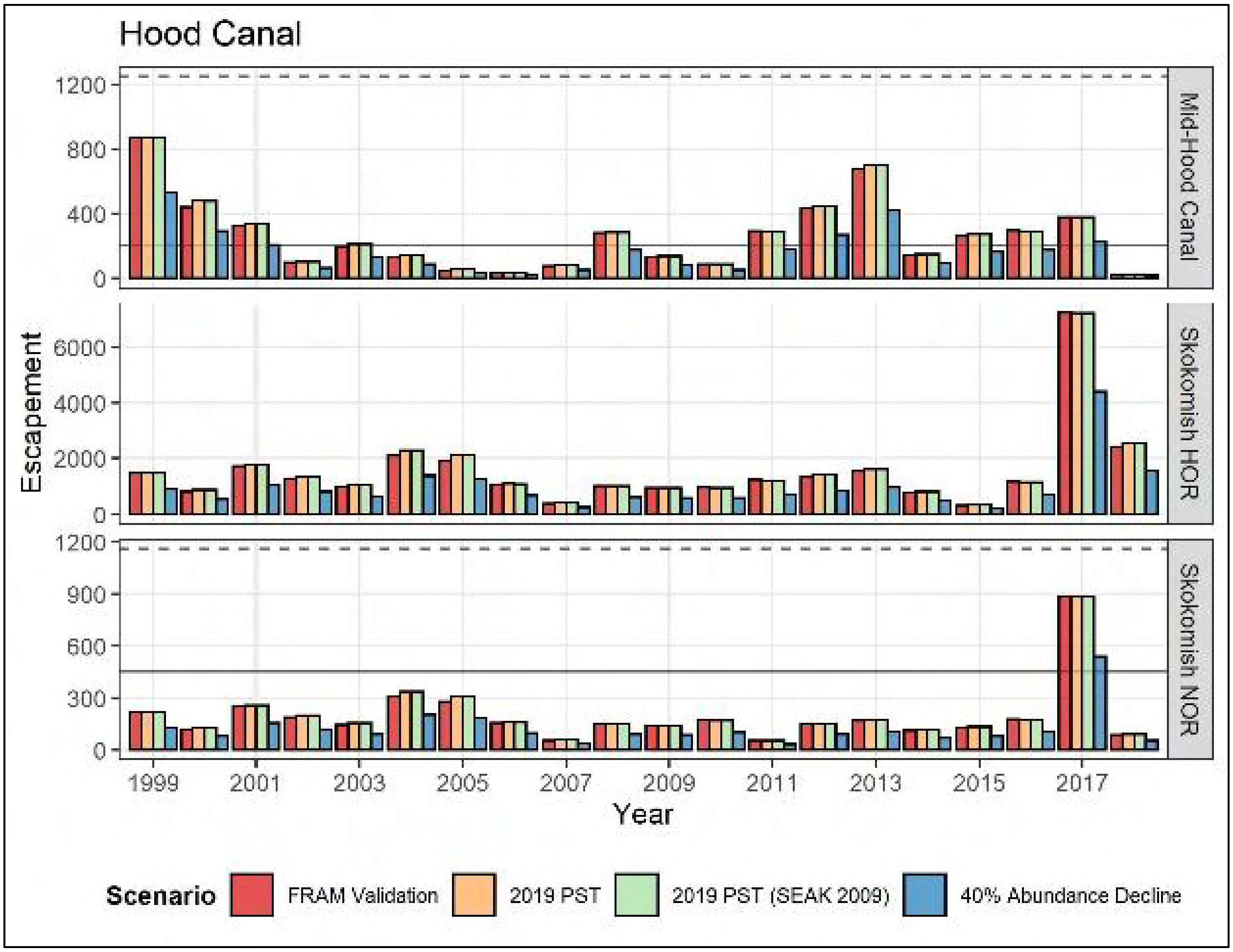

Figure 72. Escapement of Hood Canal populations based on retrospective analysis scenarios. (Dashed line represents UET, solid line represents CET, see Table 29 for population specific values).

2.5.2.4.3 Strait of Georgia

Comparing the observed ERs from the FRAM Validation runs (Scenario 1) with the Likely Scenario 2 are captured in Figure 73 for Nooksack River Chinook salmon. The absolute change in the average ER is -3.4% in fisheries and -0.5% in the SEAK fishery, but these represent relative changes of -10.4% and -15.7%, respectively (Table 69).

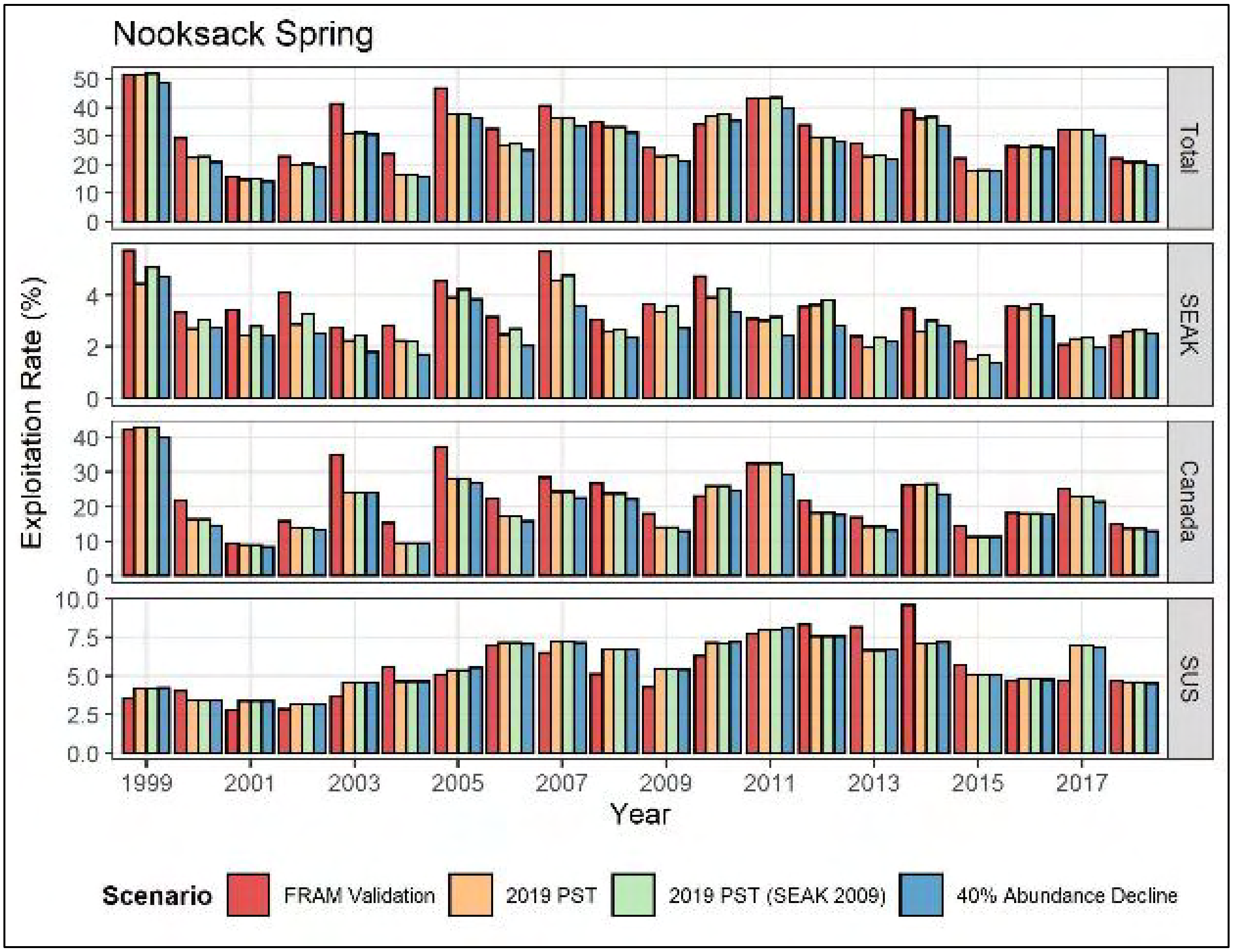

Figure 73. Comparison of ERs on Nooksack River Chinook salmon between Scenarios 1 through 4 in the retrospective analysis.

Table 69. 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	Total Exploitation
Puget Sound Chinook Salmon – Nooksack R	Scenario 1	3.5%	23.3%	2.3%	3.2%	32.3%
	Scenario 2	2.9%	20.3%	2.6%	3.0%	28.9%
	Abs ER Change	-0.5%	-3.0%	0.3%	-0.2%	-3.4%
	Rel ER Change	-15.7%	-12.7%	13.9%	-5.5%	-10.4%

Scenarios 2 and 3 provide a more direct comparison of how ERs are expected to change as a result of the proposed reduction in the SEAK fishery from the 2009 PST Agreement (Scenario 3) to the 2019 PST Agreement (Scenario 2). The proposed change will result in an absolute reduction in the average SEAK fishery ER of -0.2% and a relative change in the SEAK fishery ER of -7.8% (Table 70), amounting to a change in total exploitation of -0.3% and -0.9%, respectively.

Table 70. 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	Total Exploitation
Puget Sound Chinook Salmon – Nooksack R	Scenario 3	3.2%	20.3%	2.6%	3.0%	29.2%
	Scenario 2	2.9%	20.3%	2.6%	3.0%	28.9%
	Abs ER Change	-0.2%	0.0%	0.0%	0.0%	-0.3%
	Rel ER Change	-7.8%	-0.1%	0.1%	0.0%	-0.9%

A comparison of Scenarios 2 and 4 examine how the fisheries will respond to a 40% reduction in coast wide abundance (Scenario 4). The absolute change in the average total ER is -1.5% in fisheries and -0.3% in the SEAK fishery, but these represent relative changes of -5.1% and -9.6%, respectively (Table 71).

Table 71. 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	Total Exploitation
Puget Sound Chinook Salmon – Nooksack R	Scenario 2	2.9%	20.3%	2.6%	3.0%	28.9%
	Scenario 4	2.6%	19.1%	2.6%	3.0%	27.4%
	Abs ER Change	-0.3%	-1.2%	0.0%	0.0%	-1.5%
	Rel ER Change	-9.6%	-5.9%	-0.8%	0.8%	-5.1%

Figure 74 captures the changes in expected escapements for the Strait of Georgia populations across each scenario. Collectively, the Nooksack River aggregate exceeds the UET in six years, under Scenario 2 and Scenario 3, but are generally below the CET otherwise. The North Fork Nooksack River population exceeded the CET in the majority of the years, but the South Fork Nooksack River population is generally below its CET for all scenarios until more recently starting in 2016.

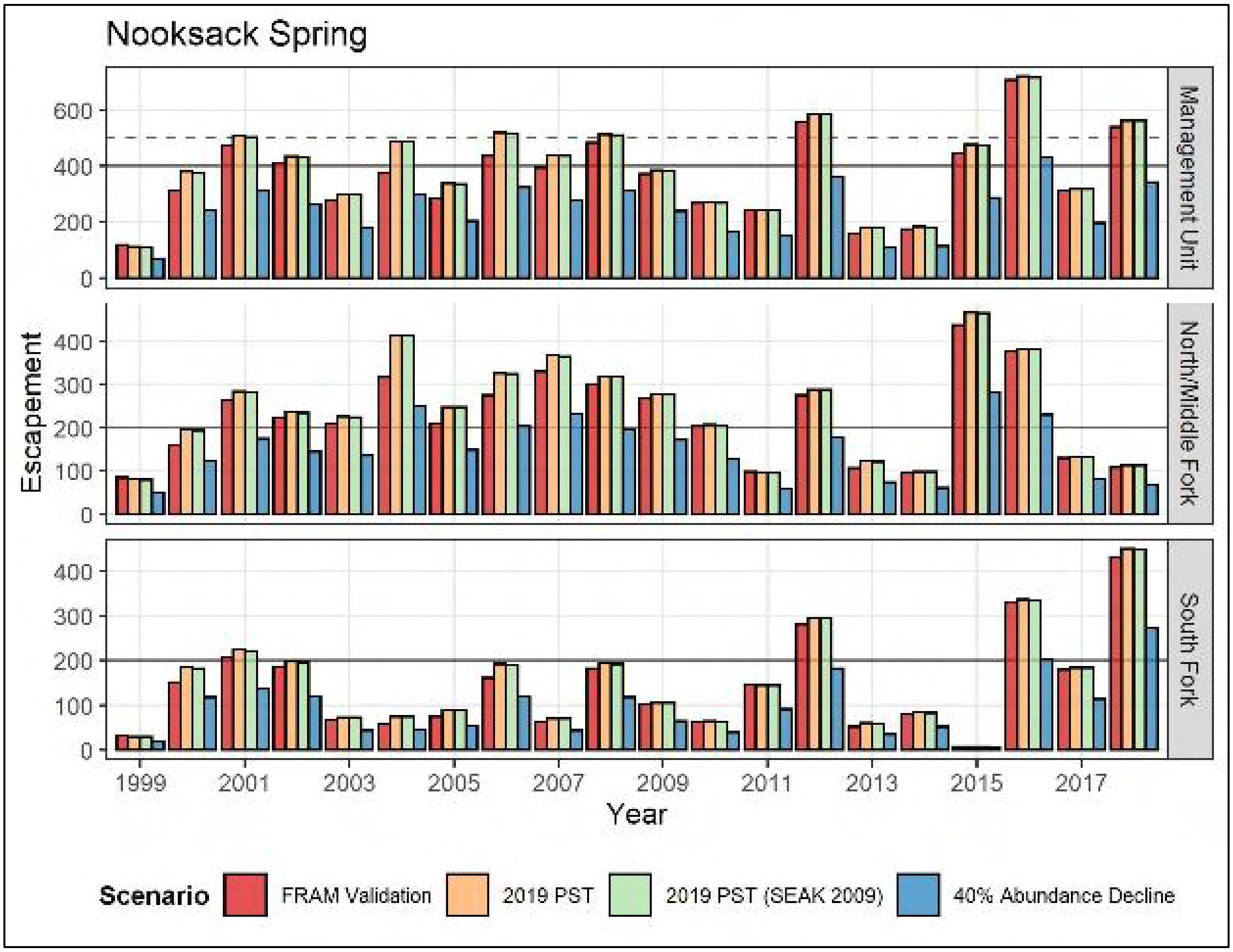

Figure 74. Escapement of Strait of Georgia populations based on retrospective analysis scenarios (dashed line represents UET, solid line represents CET, see Table 29 for this specific management unit).

2.5.2.4.4 Whidbey Basin

Comparing the observed ERs from the FRAM Validation runs (Scenario 1) with the Likely Scenario 2 are captured in Figure 75 for Skagit River spring Chinook salmon. The absolute change in the average total ER is -2.4%, and 0% in the SEAK fishery, and these represent relative changes of -10.5% and -11.9%, respectively (Table 72).

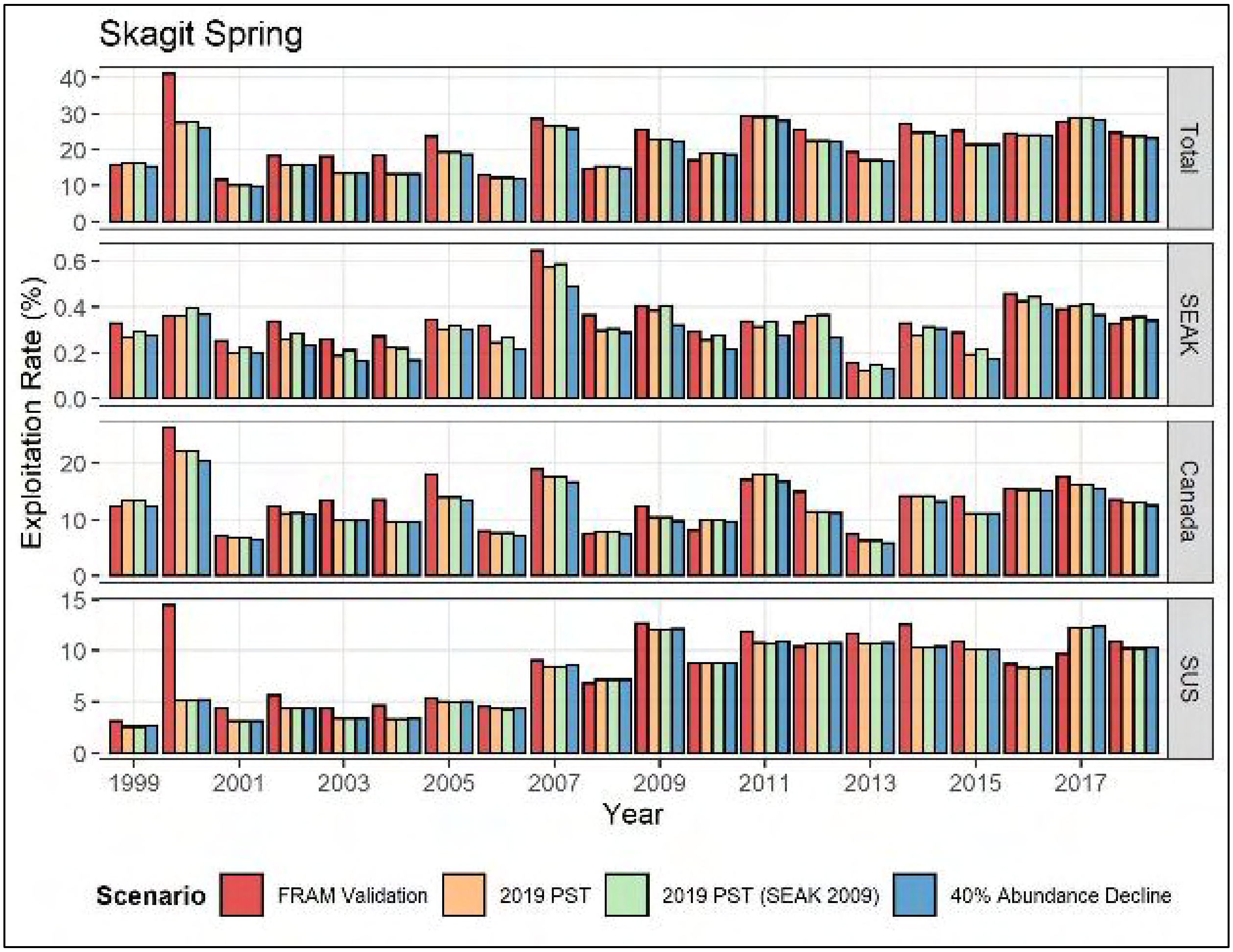

Figure 75. Comparison of ERs on Skagit River spring Chinook salmon between Scenarios 1 through 4 in the retrospective analysis.

Table 72. 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	Total Exploitation
Puget Sound Chinook Salmon – Skagit R spring	Scenario 1	0.3%	13.6%	0.9%	7.6%	22.5%
	Scenario 2	0.3%	12.3%	1.0%	6.5%	20.1%
	Abs ER Change	0.0%	-1.4%	0.1%	-1.1%	-2.4%
	Rel ER Change	-11.9%	-9.9%	13.4%	-14.2%	-10.5%

Scenarios 2 and 3 provide a more direct comparison of how the ER is expected to change as a result of the proposed reduction in the SEAK fishery from the 2009 PST Agreement (Scenario 3) to the 2019 PST Agreement (Scenario 2). The proposed change will result in an absolute change in the average SEAK fishery ER of 0% and a relative change in the SEAK fishery ER of -6.0% (Table 73), amounting to an absolute change in total exploitation of 0% and a relative change in total average ER of -0.1%.

Table 73. 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	Total Exploitation
Puget Sound Chinook Salmon – Skagit R spring	Scenario 3	0.3%	12.3%	1.0%	6.5%	20.1%
	Scenario 2	0.3%	12.3%	1.0%	6.5%	20.1%
	Abs ER Change	0.0%	0.0%	0.0%	0.0%	0.0%
	Rel ER Change	-6.0%	-0.1%	0.0%	0.1%	-0.1%

A comparison of Scenarios 2 and 4 examine how the fisheries will respond to a 40% reduction in coast wide abundance (Scenario 4). The absolute change in the average total ER is -0.5%, and 0% in the SEAK fishery, but these represent relative changes of -2.5% and -8.1%, respectively (Table 74).

Table 74. 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	Total Exploitation
Puget Sound Chinook Salmon – Skagit R spring	Scenario 2	0.3%	12.3%	1.0%	6.5%	20.1%
	Scenario 4	0.3%	11.8%	1.0%	6.6%	19.6%
	Abs ER Change	0.0%	-0.5%	0.0%	0.0%	-0.5%
	Rel ER Change	-8.1%	-4.2%	0.1%	0.8%	-2.5%

Figure 76 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 twelve years, for all scenarios except Scenario 4, and generally exceeds the CET across all years. There were only three instances where a Skagit River spring Chinook salmon population failed to exceed the CET under all four Scenarios in a given year: once for Suiattle and twice for Upper Cascade.

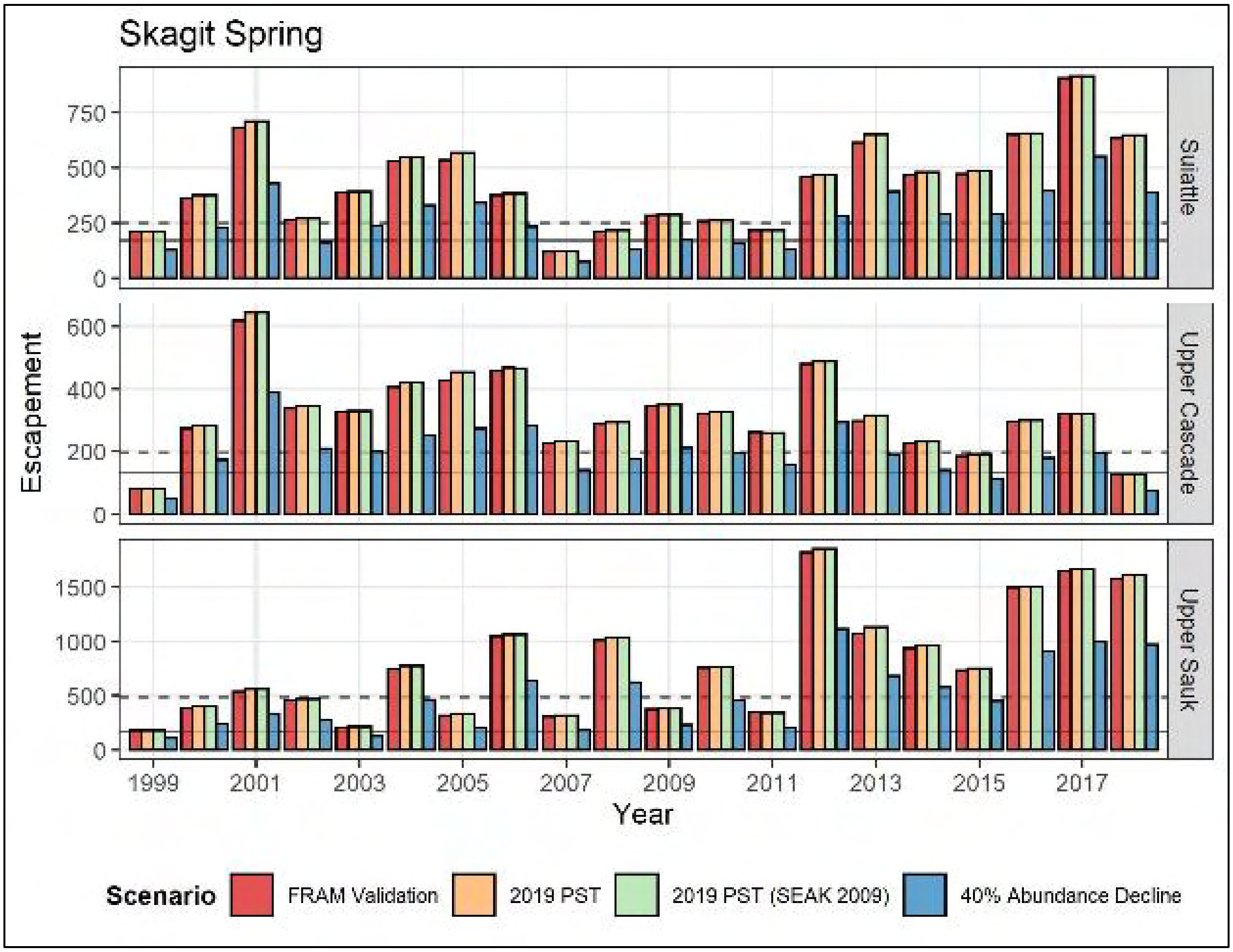

Figure 76. Escapement of Skagit River spring Chinook salmon populations based on retrospective analysis scenarios (dashed line represents UET, solid line represents CET, see Table 29 for population specific values).

Comparing the observed ERs from the FRAM Validation runs (Scenario 1) with the Likely Scenario 2 are captured in Figure 77 for Skagit River summer/fall Chinook salmon. The absolute change in the average total ER is -2.9%, and -1.2% in the SEAK fishery, and these represent relative changes of -7.3% and -16.5%, respectively (Table 75).

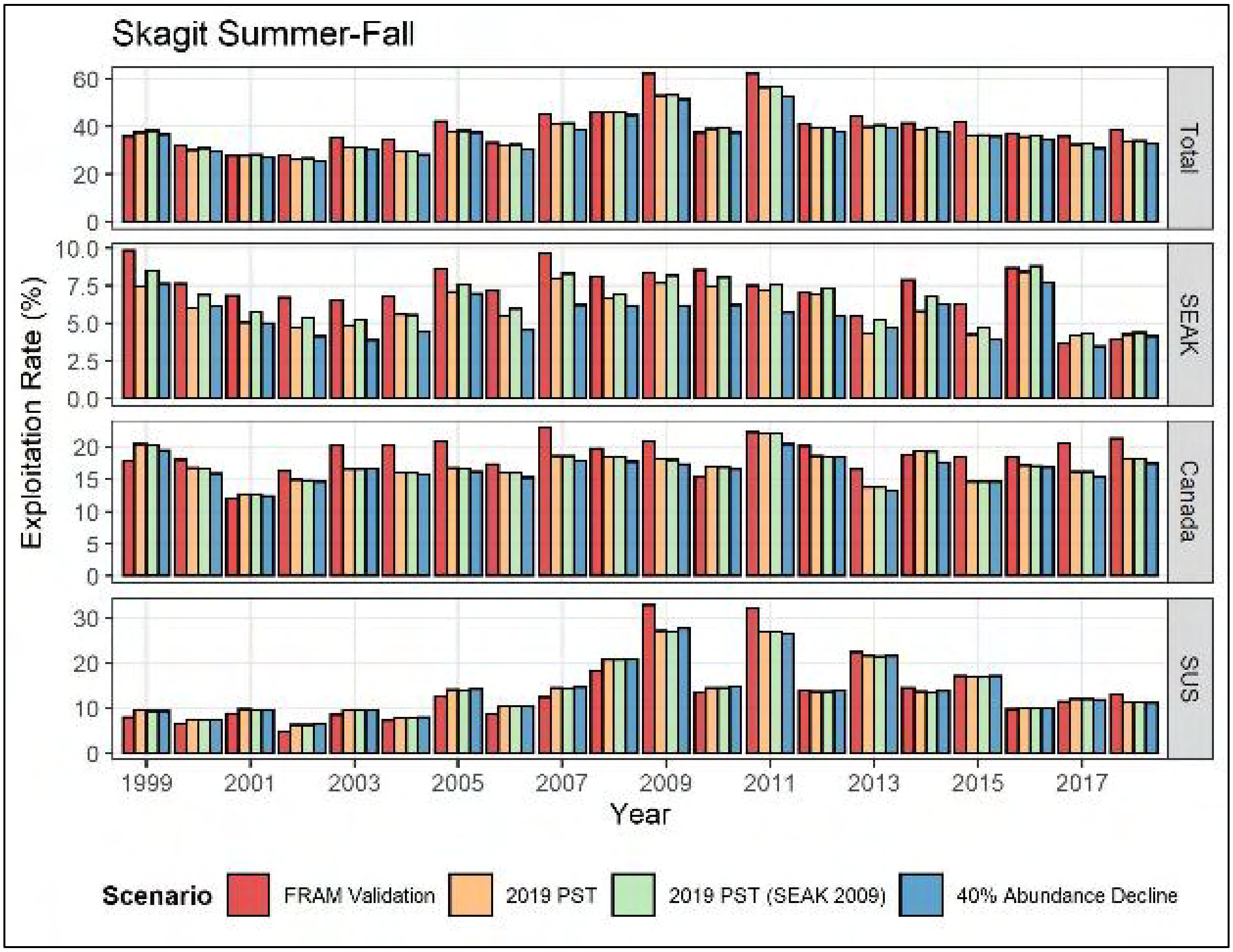

Figure 77. Comparison of ERs on Skagit River summer/fall Chinook salmon between Scenarios 1 through 4 in the retrospective analysis.

Table 75. 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	Total Exploitation
Puget Sound Chinook Salmon – Skagit R summ/fall	Scenario 1	7.3%	18.9%	1.1%	12.6%	39.9%
	Scenario 2	6.1%	17.1%	1.2%	12.6%	37.0%
	Abs ER Change	-1.2%	-1.8%	0.1%	0.0%	-2.9%
	Rel ER Change	-16.5%	-9.6%	8.3%	-0.1%	-7.3%

Scenarios 2 and 3 provide a more direct comparison of how the ER is expect to change as a result of the proposed reduction in the SEAK fishery from the 2009 PST Agreement (Scenario 3) to the 2019 PST Agreement (Scenario 2). The proposed change will result in an absolute reduction in the average SEAK ER of -0.5% and a relative change in the SEAK fishery ER of -7.8% (Table 76), amounting to an absolute change in total exploitation of -0.4% and a relative change in total exploitation of -1.1%.

Table 76. 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	Total Exploitation
Puget Sound Chinook Salmon – Skagit R summ/fall	Scenario 3	6.6%	17.0%	1.2%	12.6%	37.4%
	Scenario 2	6.1%	17.1%	1.2%	12.6%	37.0%
	Abs ER Change	-0.5%	0.0%	0.0%	0.1%	-0.4%
	Rel ER Change	-7.8%	0.2%	0.3%	0.5%	-1.1%

A comparison of Scenarios 2 and 4 examine how the fisheries will respond to a 40% reduction in coast wide abundance (Scenario 4). The absolute change in the average total ER is -1.2%, and -0.6% in the SEAK fishery, but these represent relative changes of -3.3% and -10.2%, respectively (Table 77).

Table 77. 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	Total Exploitation
Puget Sound Chinook Salmon – Skagit R summ/fall	Scenario 2	6.1%	17.1%	1.2%	12.6%	37.0%
	Scenario 4	5.4%	16.5%	1.1%	12.8%	35.8%
	Abs ER Change	-0.6%	-0.6%	-0.1%	0.1%	-1.2%
	Rel ER Change	-10.2%	-3.7%	-8.0%	1.1%	-3.3%

Figure 78 captures the changes in expected escapements for the Skagit River summer/fall Chinook salmon populations across each scenario. Both the Lower Sauk and Upper Skagit populations exceed the UET in the majority of scenarios, except Scenario 4. The Lower Skagit population exceeds the UET in nine years for Scenarios 1, 2 and 3, but generally falls between the UET and CET. There are no instances for any of the three populations where all four scenarios fail to exceed the CET in a given year. (Figure 78).

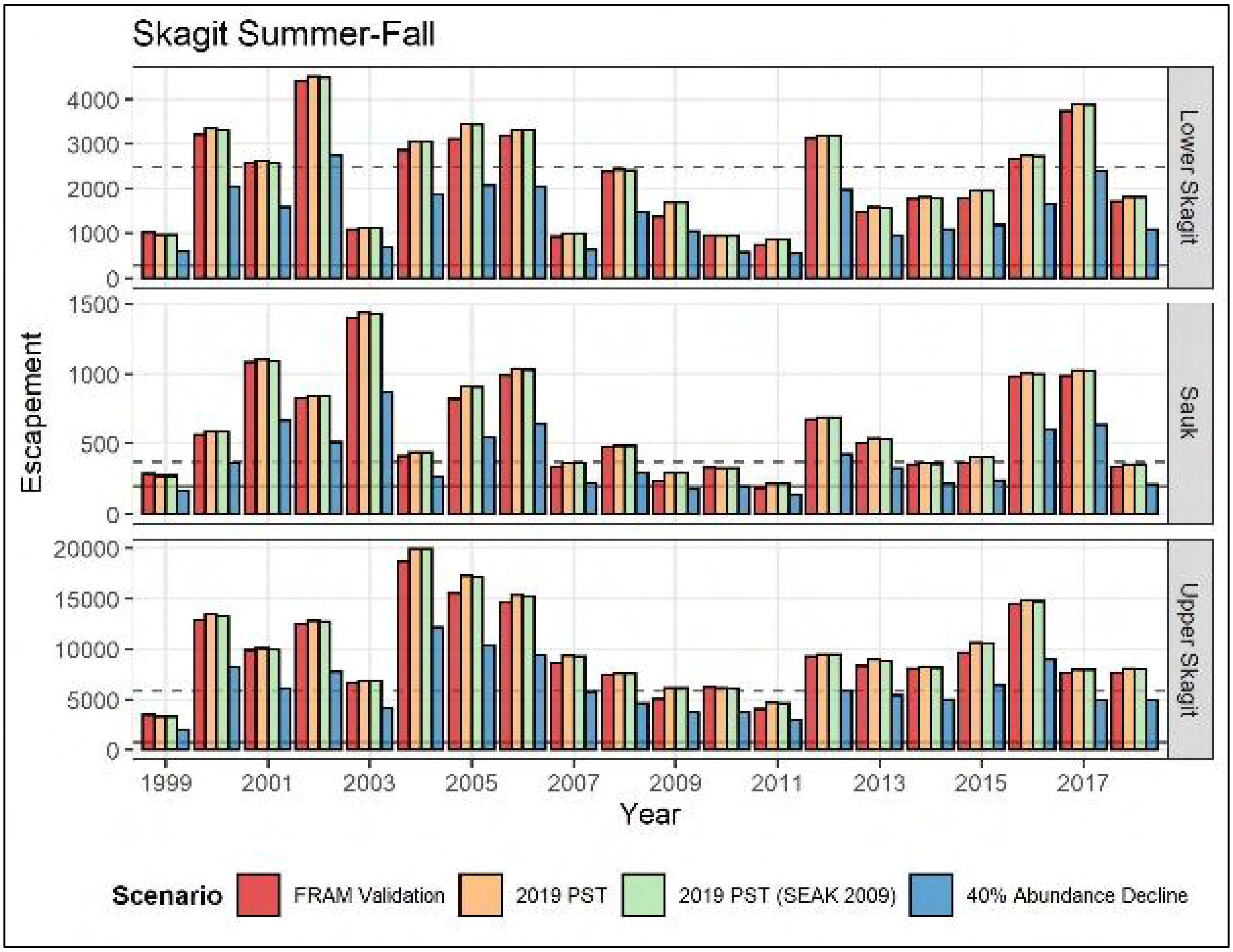

Figure 78. Escapement of Skagit River summer/fall Chinook salmon populations based on retrospective analysis scenarios (dashed line represents UET, solid line represents CET, see Table 29 for population specific values).

Comparing the observed ERs from the FRAM Validation runs (Scenario 1) with the Likely Scenario 2 are captured in Figure 79 for Stillaguamish River Chinook salmon. The absolute change in the average total ER is -1.2%, and is -0.3% in the SEAK fishery, but these represent relative changes of -4.0% and -17.5%, respectively (Table 78).

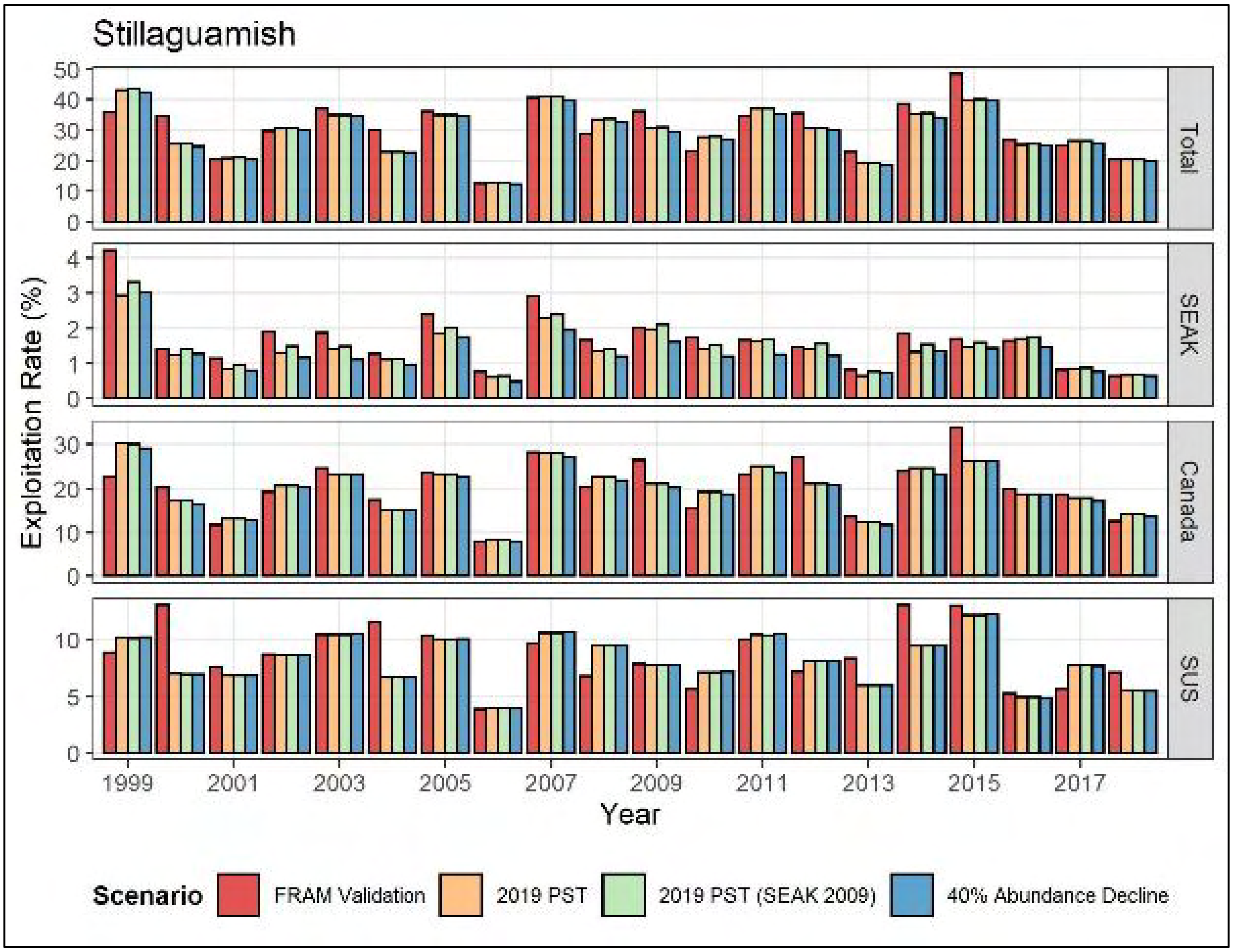

Figure 79. Comparison of ERs on Stillaguamish River Chinook salmon between Scenarios 1 through 4 in the retrospective analysis.

Table 78. 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	Total Exploitation
Puget Sound Chinook Salmon – Stillaguamish R	Scenario 1	1.7%	20.5%	1.9%	6.8%	30.9%
	Scenario 2	1.4%	20.1%	2.1%	6.1%	29.7%
	Abs ER Change	-0.3%	-0.4%	0.2%	-0.7%	-1.2%
	Rel ER Change	-17.5%	-2.0%	9.5%	-10.7%	-4.0%

Scenarios 2 and 3 provide a more direct comparison of how the ER is expected to change as a result of the proposed reduction in the SEAK fishery from the 2009 PST Agreement (Scenario 3) to the 2019 PST Agreement (Scenario 2). The proposed change will result in an absolute reduction in the average total ER of -0.1% and a relative change in the SEAK fishery ER of -7.6% (Table 79), amounting to a change in total exploitation of -0.1% and -0.3%, respectively.

Table 79. 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	Total Exploitation
Puget Sound Chinook Salmon – Stillaguamish R	Scenario 3	1.5%	20.1%	2.1%	6.0%	29.8%
	Scenario 2	1.4%	20.1%	2.1%	6.1%	29.7%
	Abs ER Change	-0.1%	0.0%	0.0%	0.0%	-0.1%
	Rel ER Change	-7.6%	0.0%	0.1%	0.1%	-0.3%

A comparison of Scenarios 2 and 4 examine how the fisheries will respond to a 40% reduction in coast wide abundance (Scenario 4). The absolute change in the average total ER is -0.7%, and -0.1% in the SEAK fishery ER, but these represent relative changes of -2.4% and -9.5%, respectively (Table 80).

Table 80. 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	Total Exploitation
Puget Sound Chinook Salmon – Stillaguamish R	Scenario 2	1.4%	20.1%	2.1%	6.1%	29.7%
	Scenario 4	1.3%	19.5%	2.1%	6.1%	28.9%
	Abs ER Change	-0.1%	-0.6%	0.0%	0.0%	-0.7%
	Rel ER Change	-9.5%	-3.0%	-1.0%	0.5%	-2.4%

Figure 80 captures the changes in expected escapements for the Stillaguamish River Chinook salmon populations across each scenario. The escapement exceeds the UET in fifteen years for each scenario except Scenario 4. Failure to exceed the CET occurs in Scenarios 1-3 in four years and in 11 years under Scenario 4.

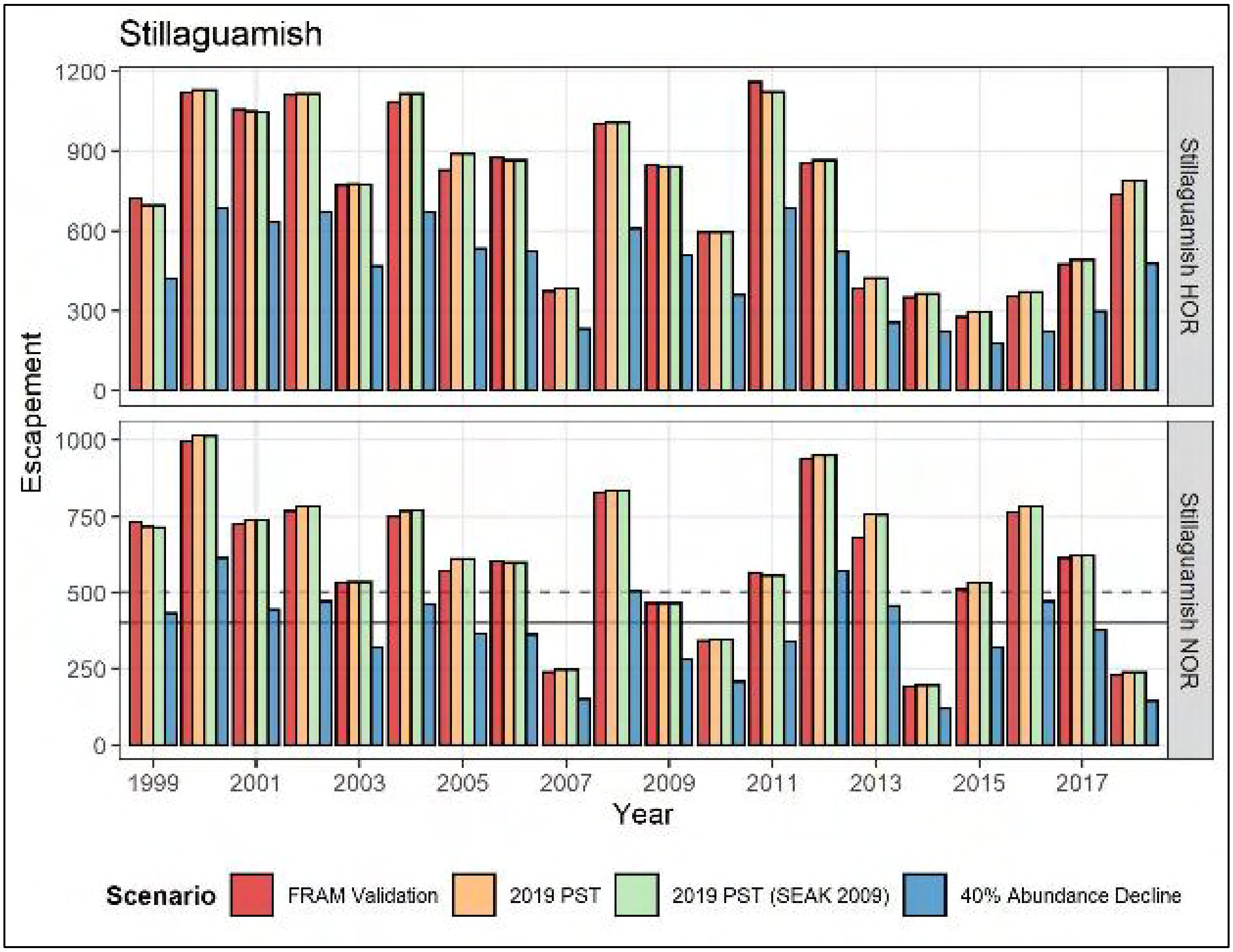

Figure 80. Escapement of Stillaguamish River Chinook salmon populations based on retrospective analysis scenarios (dashed line represents UET, solid line represents CET, see Table 29 for population specific values).

Comparing the observed ERs from the FRAM Validation runs (Scenario 1) with the Likely Scenario 2 are captured in Figure 81 for Snohomish River Chinook salmon. The absolute change in the average total ER is -2.0%, and -0.1% in the SEAK fishery, but these represent relative changes of -8.5% and -15.6%, respectively (Table 81).

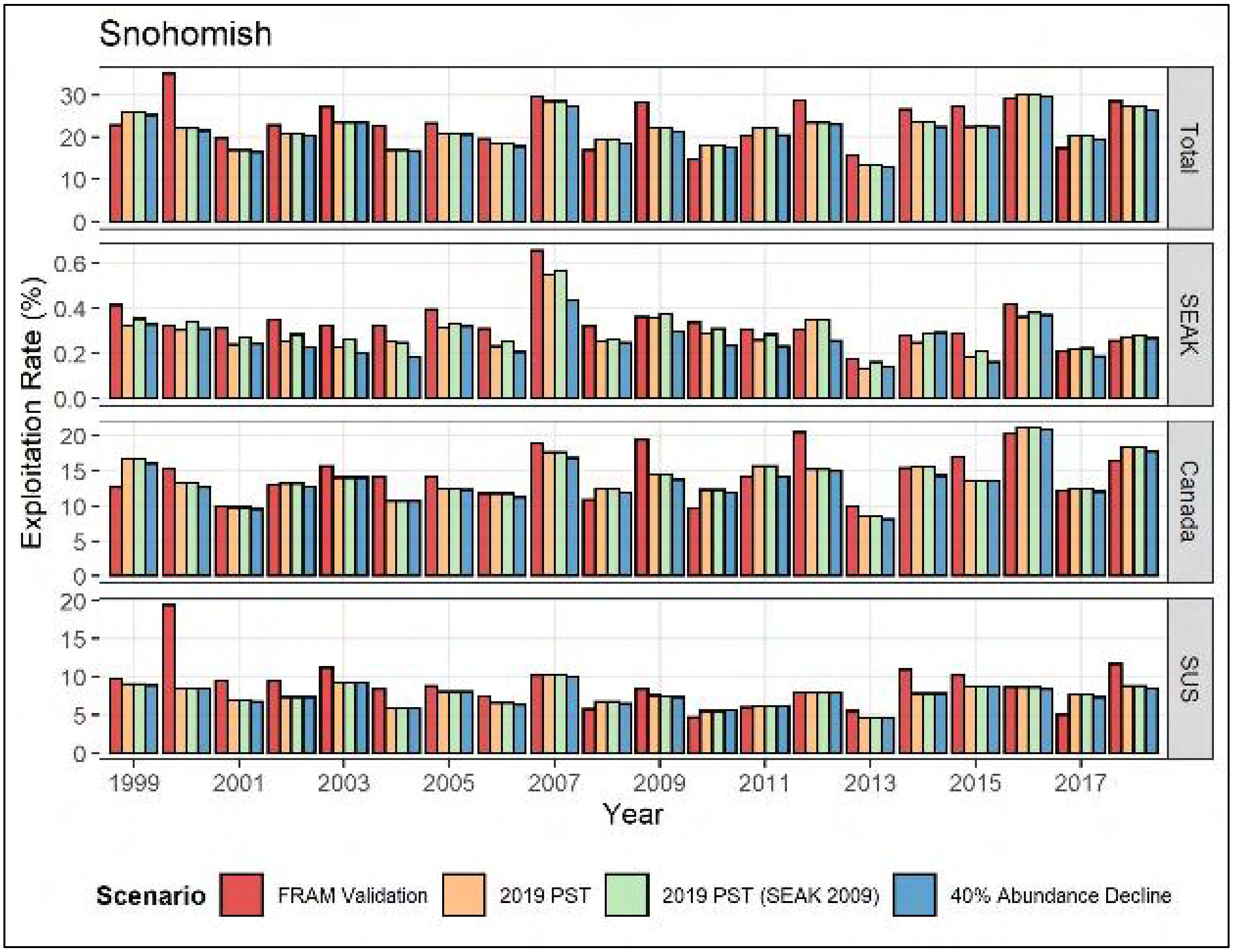

Figure 81. Comparison of ERs on Snohomish River Chinook salmon between Scenarios 1 through 4 in the retrospective analysis.

Table 81. 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	Total Exploitation
Puget Sound Chinook Salmon – Snohomish R	Scenario 1	0.3%	14.6%	1.7%	7.2%	23.8%
	Scenario 2	0.3%	13.9%	1.9%	5.7%	21.8%
	Abs ER Change	-0.1%	-0.6%	0.2%	-1.5%	-2.0%
	Rel ER Change	-15.6%	-4.1%	10.6%	-21.5%	-8.5%

Scenarios 2 and 3 provide a more direct comparison of how ERs are expected to change as a result of the proposed reduction in the SEAK fishery from the 2009 PST Agreement (Scenario 3) to the 2019 PST Agreement (Scenario 2). The proposed change will result in an absolute change in the average total ER of 0% and a relative change of -6.8% in the SEAK fishery (Table 82), amounting to a change in total exploitation of 0% and -0.1%, respectively.

Table 82. 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	Total Exploitation
Puget Sound Chinook Salmon – Snohomish R	Scenario 3	0.3%	14.0%	1.9%	5.7%	21.8%
	Scenario 2	0.3%	13.9%	1.9%	5.7%	21.8%
	Abs ER Change	0.0%	0.0%	0.0%	0.0%	0.0%
	Rel ER Change	-6.8%	0.0%	0.1%	0.0%	-0.1%

A comparison of Scenarios 2 and 4 examine how the fisheries will respond to a 40% reduction in coast wide abundance (Scenario 4). The absolute change in the average total ER is -0.6%, and 0% in the SEAK fishery, but these represent relative changes of -2.8% and -8.6%, respectively (Table 83).

Table 83. 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	Total Exploitation
Puget Sound Chinook Salmon – Snohomish R	Scenario 2	0.3%	13.9%	1.9%	5.7%	21.8%
	Scenario 4	0.3%	13.5%	1.8%	5.7%	21.2%
	Abs ER Change	0.0%	-0.5%	-0.1%	0.0%	-0.6%
	Rel ER Change	-8.6%	-3.4%	-6.1%	0.0%	-2.8%

Figure 82 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.

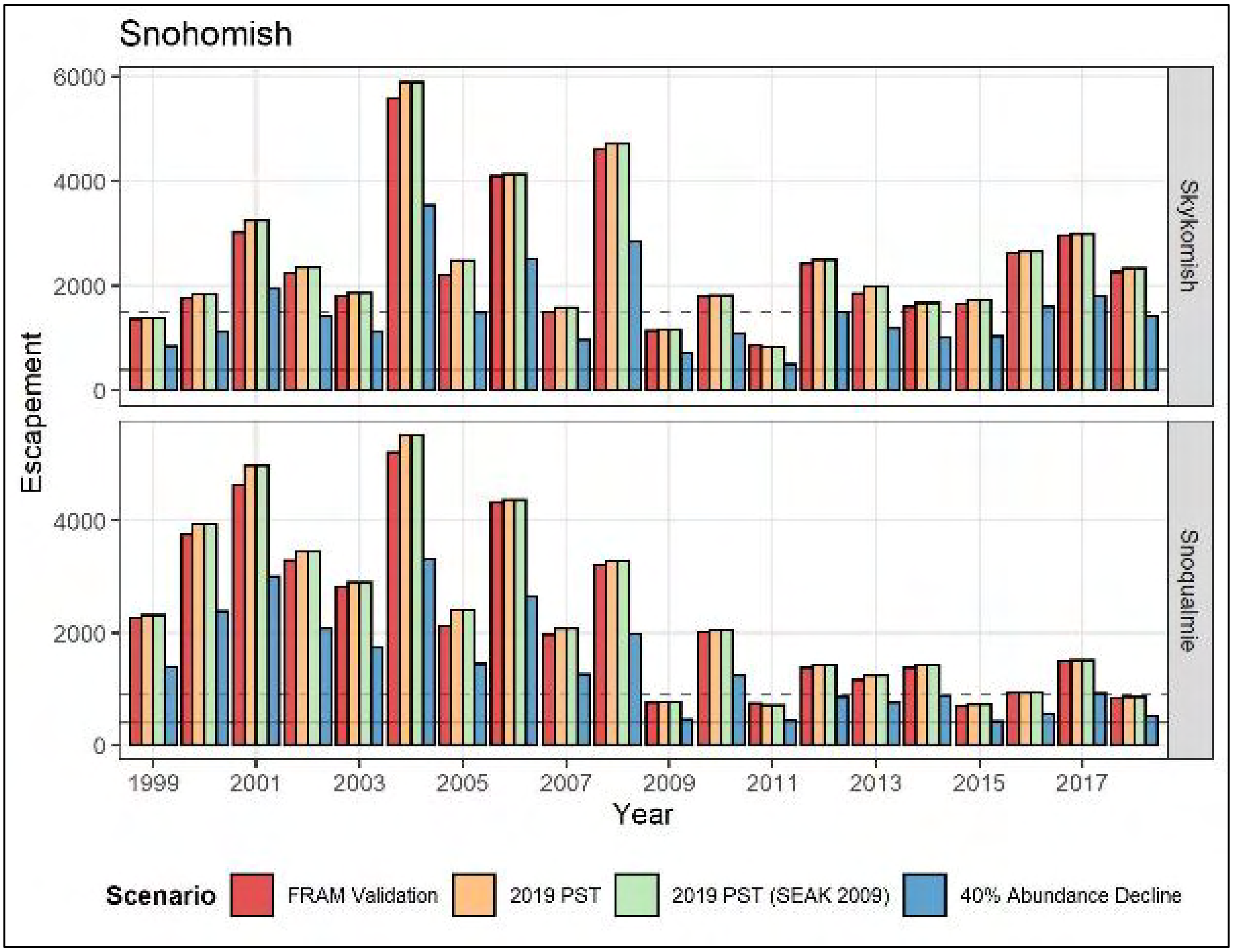

Figure 82. Escapement of Snohomish River Chinook salmon populations based on retrospective analysis scenarios (dashed line represents UET, solid line represents CET, see Table 29 for population specific values).

2.5.2.4.5 Central/South Puget Sound

Comparing the observed ERs from the FRAM Validation runs (Scenario 1) with the Likely Scenario 2 are captured in Figure 83 for Lake Washington Chinook salmon (Cedar River and North Lake Washington/Sammamish River populations). The absolute change in the average total ER is -2.8%, and is 0% in the SEAK fishery, and these represent relative changes of -9.2% and -16.2%, respectively (Table 84).

Figure 83. Comparison of ERs on Lake Washington Chinook salmon between Scenarios 1 through 4 in the retrospective analysis.

Table 84. 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	Total Exploitation
Puget Sound Chinook Salmon – Lake Washington	Scenario 1	0.2%	14.2%	4.9%	11.0%	30.3%
	Scenario 2	0.1%	12.4%	5.2%	9.8%	27.5%
	Abs ER Change	0.0%	-1.8%	0.3%	-1.2%	-2.8%
	Rel ER Change	-16.2%	-12.9%	5.3%	-10.8%	-9.2%

Scenarios 2 and 3 provide a more direct comparison of how the ER is expected to change as a result of the proposed reduction in the SEAK fishery from the 2009 PST Agreement (Scenario 3) to the 2019 PST Agreement (Scenario 2). The proposed change will result in an absolute reduction in the average total ER of 0%, and a relative change in the SEAK fishery ER of -7.9% (Table 85), amounting to a change in total exploitation of 0% and -0.1%, respectively.

Table 85. 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	Total Exploitation
Puget Sound Chinook Salmon – Lake Washington	Scenario 3	0.1%	12.4%	5.2%	9.8%	27.5%
	Scenario 2	0.1%	12.4%	5.2%	9.8%	27.5%
	Abs ER Change	0.0%	0.0%	0.0%	0.0%	0.0%
	Rel ER Change	-7.9%	-0.1%	0.1%	0.0%	-0.1%

A comparison of Scenarios 2 and 4 examine how the fisheries will respond to a 40% reduction in coast wide abundance (Scenario 4). The absolute change in the average total ER is -1.0%, and 0% in the SEAK fishery, but these represent relative changes of -3.8% and -9.5%, respectively (Table 86).

Table 86. 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	Total Exploitation
Puget Sound Chinook Salmon – Lake Washington	Scenario 2	0.1%	12.4%	5.2%	9.8%	27.5%
	Scenario 4	0.1%	11.7%	4.8%	9.8%	26.5%
	Abs ER Change	0.0%	-0.7%	-0.4%	0.1%	-1.0%
	Rel ER Change	-9.5%	-5.6%	-7.4%	0.6%	-3.8%

Figure 84 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, except for Scenario 4. The Sammamish River natural-origin population exceeds the UET in only one year, falling below the UET for each scenario in all other years. The Cedar River natural-origin population only falls below the UET for two or more years for Scenarios 1-3, and more often under Scenario 4, but the Sammamish River natural-origin population fails to exceed the CET under any scenario in the majority of years.

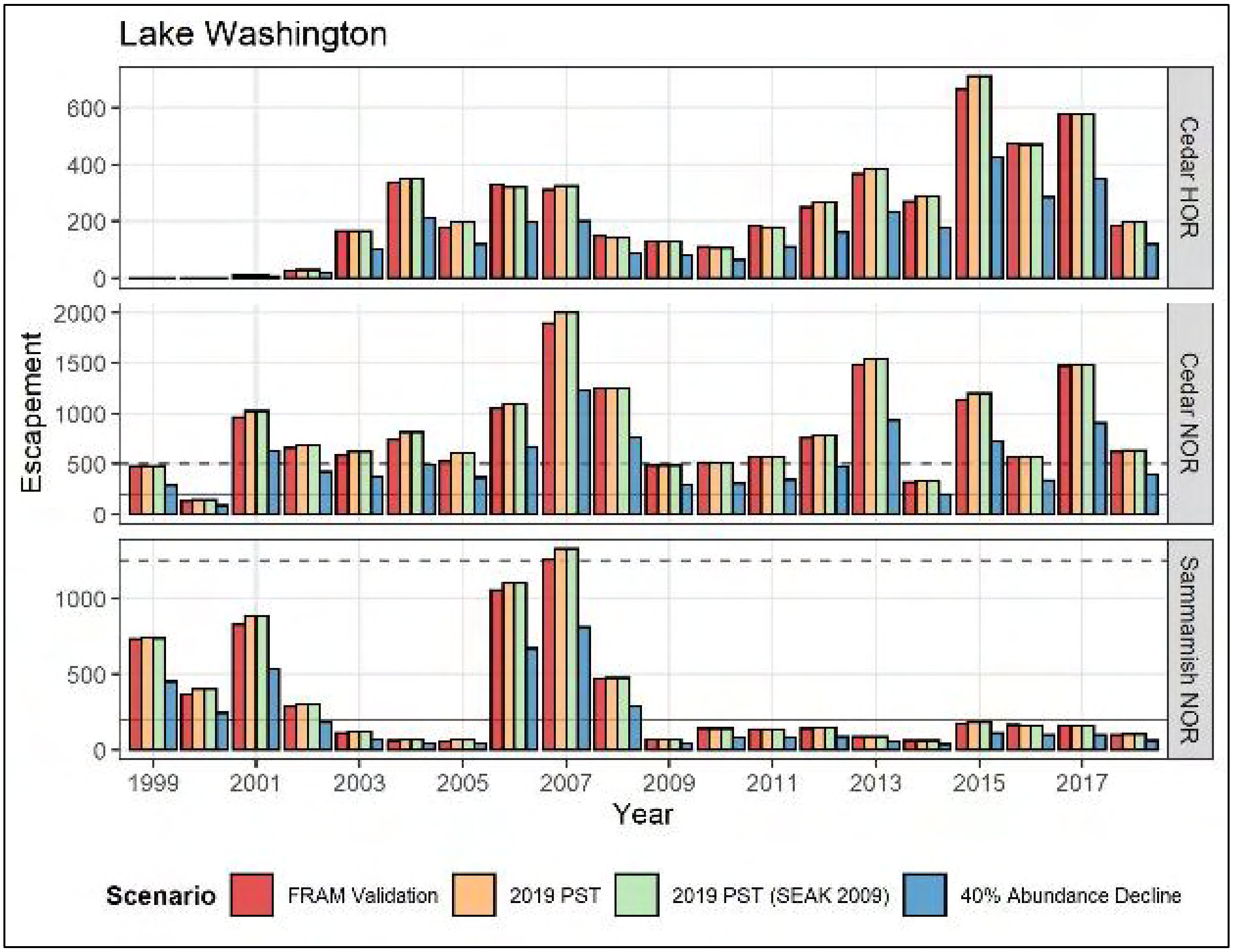

Figure 84. Escapement of Lake Washington Chinook salmon populations based on retrospective analysis scenarios (Dashed line represents UET, solid line represents CET, see Table 29 for population specific values).

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 total ER is -4.2%, and 0% in the SEAK fishery, but these represent relative changes of -9.8% and -16.2%, respectively (Table 87).

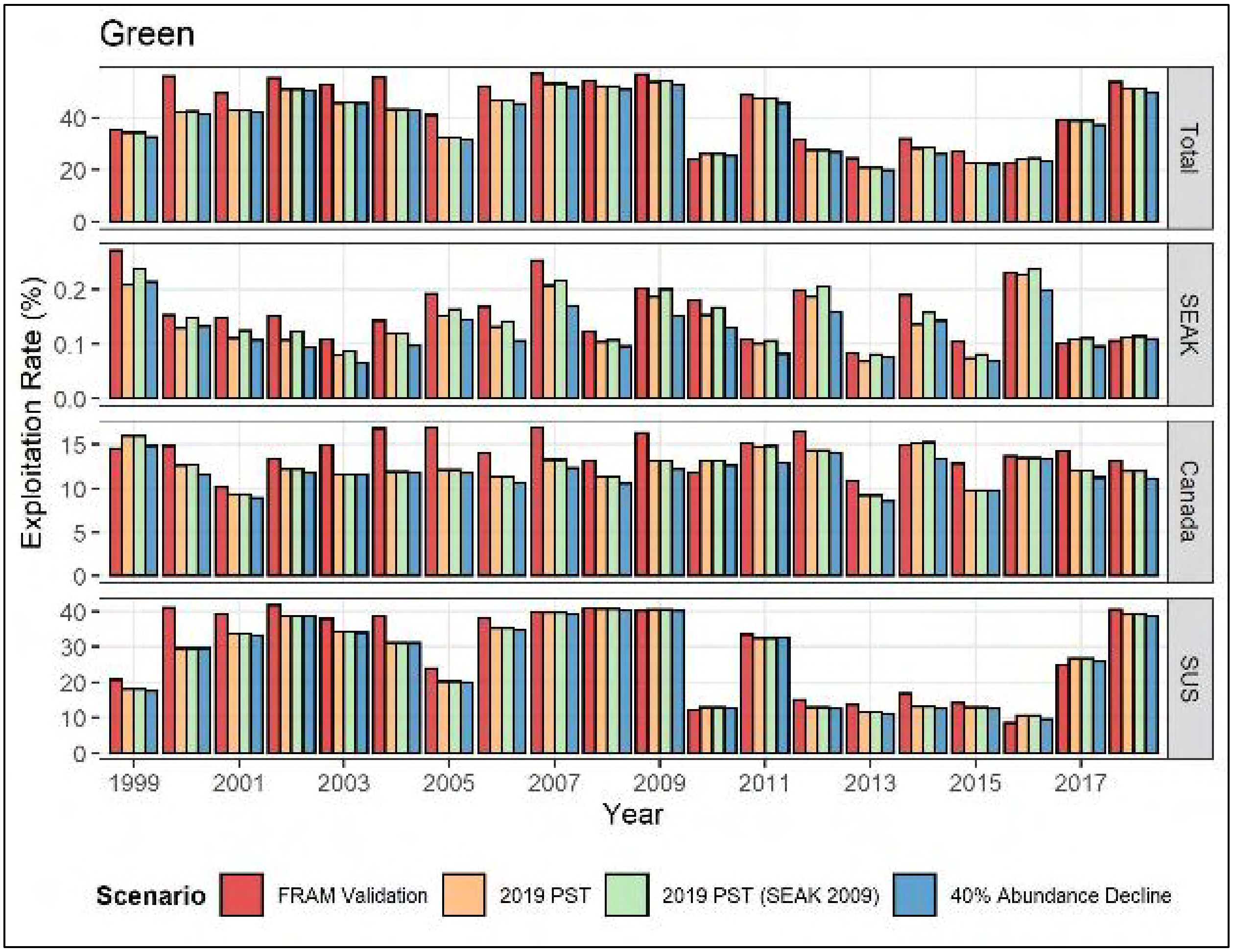

Figure 85. Comparison of ERs on Green River Chinook salmon between Scenarios 1 through 4 in the retrospective analysis.

Table 87. 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	Total Exploitation
Puget Sound Chinook Salmon – Green R	Scenario 1	0.2%	14.2%	4.9%	24.1%	43.4%
	Scenario 2	0.1%	12.4%	5.2%	21.5%	39.2%
	Abs ER Change	0.0%	-1.8%	0.3%	-2.6%	-4.2%
	Rel ER Change	-16.2%	-12.9%	5.3%	-10.9%	-9.8%

Scenarios 2 and 3 provide a more direct comparison of how the ER is expected to change as a result of the proposed reduction in the SEAK fishery from the 2009 PST Agreement (Scenario 3) to the 2019 PST Agreement (Scenario 2). The proposed change will result in an absolute reduction in the average total ER of 0%, and a relative change of -7.9% in the SEAK fishery (Table 88), amounting to a change in total exploitation of 0% and 0%, respectively.

Table 88. 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	Total Exploitation
Puget Sound Chinook Salmon – Green R	Scenario 3	0.1%	12.4%	5.2%	21.5%	39.2%
	Scenario 2	0.1%	12.4%	5.2%	21.5%	39.2%
	Abs ER Change	0.0%	0.0%	0.0%	0.0%	0.0%
	Rel ER Change	-7.9%	-0.1%	0.1%	0.0%	0.0%

A comparison of Scenarios 2 and 4 examine how the fisheries will respond to a 40% reduction in coast wide abundance (Scenario 4). The absolute change in the average total ER is -1.1%, and 0% in the SEAK fishery, but these represent relative changes of -2.7% and -9.5%, respectively (Table 89).

Table 89. 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	Total Exploitation
Puget Sound Chinook Salmon – Green R	Scenario 2	0.1%	12.4%	5.2%	21.5%	39.2%
	Scenario 4	0.1%	11.7%	4.8%	21.5%	38.1%
	Abs ER Change	0.0%	-0.7%	-0.4%	0.0%	-1.1%
	Rel ER Change	-9.5%	-5.6%	-7.4%	0.1%	-2.7%

Figure 86 captures the changes in expected escapements for the Green River Chinook salmon populations across each scenario. The natural-origin population generally exceeded the CET and in five years had escapements that exceeded the UET for scenarios 1 through 3. There were three years where all four scenarios failed to exceed the CET.

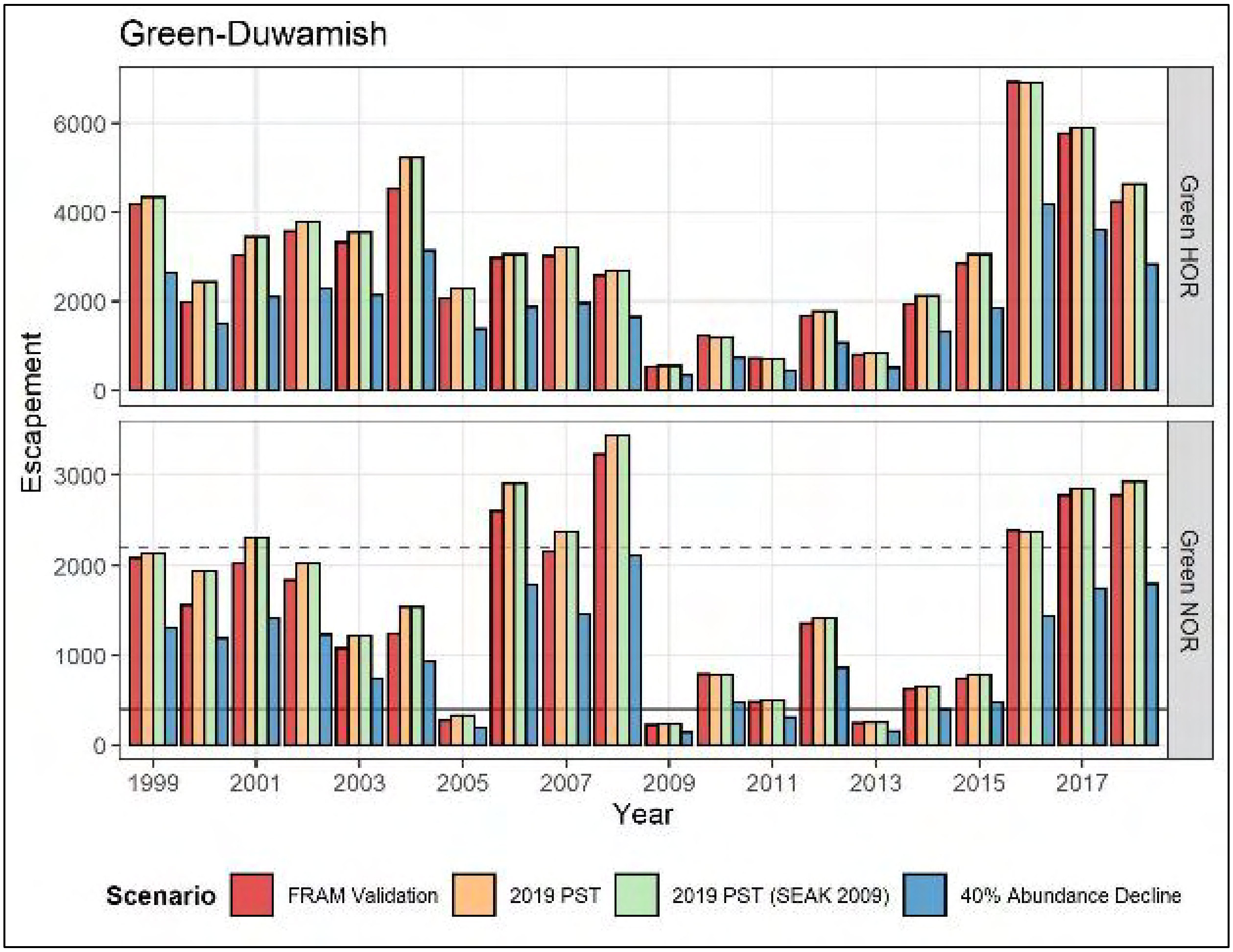

Figure 86. Escapement of Green River Chinook salmon populations based on retrospective analysis scenarios (dashed line represents UET, solid line represents CET, see Table 29 for population specific values).

Comparing the observed ERs from the FRAM Validation runs (Scenario 1) with the Likely Scenario 2 are captured in Figure 87 for White River Chinook salmon. The absolute change in the average total ER is -5.0%, and 0% in the SEAK fishery, but these represent relative changes of -17.9% and -7.5%, respectively (Table 90).

Figure 87. Comparison of ERs on White River Chinook salmon between Scenarios 1 through 4 in the retrospective analysis.

Table 90. 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	Total Exploitation
Puget Sound Chinook Salmon – White R	Scenario 1	0.1%	9.6%	1.3%	16.7%	27.9%
	Scenario 2	0.1%	7.6%	1.4%	13.7%	22.9%
	Abs ER Change	0.0%	-2.0%	0.1%	-3.0%	-5.0%
	Rel ER Change	-7.5%	-20.6%	5.3%	-18.2%	-17.9%

Scenarios 2 and 3 provide a more direct comparison of how the ER is expected to change as a result of the proposed reduction in the SEAK fishery from the 2009 PST Agreement (Scenario 3) to the 2019 PST Agreement (Scenario 2). The proposed change will result in an absolute reduction in the average total ER of 0%, and a relative change in the SEAK fishery of -5.2% (Table 91), amounting to a change in total exploitation of 0% and -0.1%, respectively.

Table 91. 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	Total Exploitation
Puget Sound Chinook Salmon – White R	Scenario 3	0.1%	7.7%	1.4%	13.7%	22.9%
	Scenario 2	0.1%	7.6%	1.4%	13.7%	22.9%
	Abs ER Change	0.0%	0.0%	0.0%	0.0%	0.0%
	Rel ER Change	-5.2%	-0.1%	0.1%	0.0%	-0.1%

A comparison of Scenarios 2 and 4 examine how the fisheries will respond to a 40% reduction in coast wide abundance (Scenario 4). The absolute change in the average total ER is -0.6%, and 0% in the SEAK fishery ER, but these represent relative changes of -2.5% and -6.1%, respectively (Table 92).

Table 92. 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	Total Exploitation
Puget Sound Chinook Salmon – White R	Scenario 2	0.1%	7.6%	1.4%	13.7%	22.9%
	Scenario 4	0.1%	7.1%	1.3%	13.7%	22.3%
	Abs ER Change	0.0%	-0.5%	-0.1%	0.1%	-0.6%
	Rel ER Change	-6.1%	-7.0%	-5.6%	0.4%	-2.5%

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 total ER is -1.6%, and 0% in the SEAK fishery ER, but these represent relative changes of -3.2% and -16.2%, respectively (Table 93).

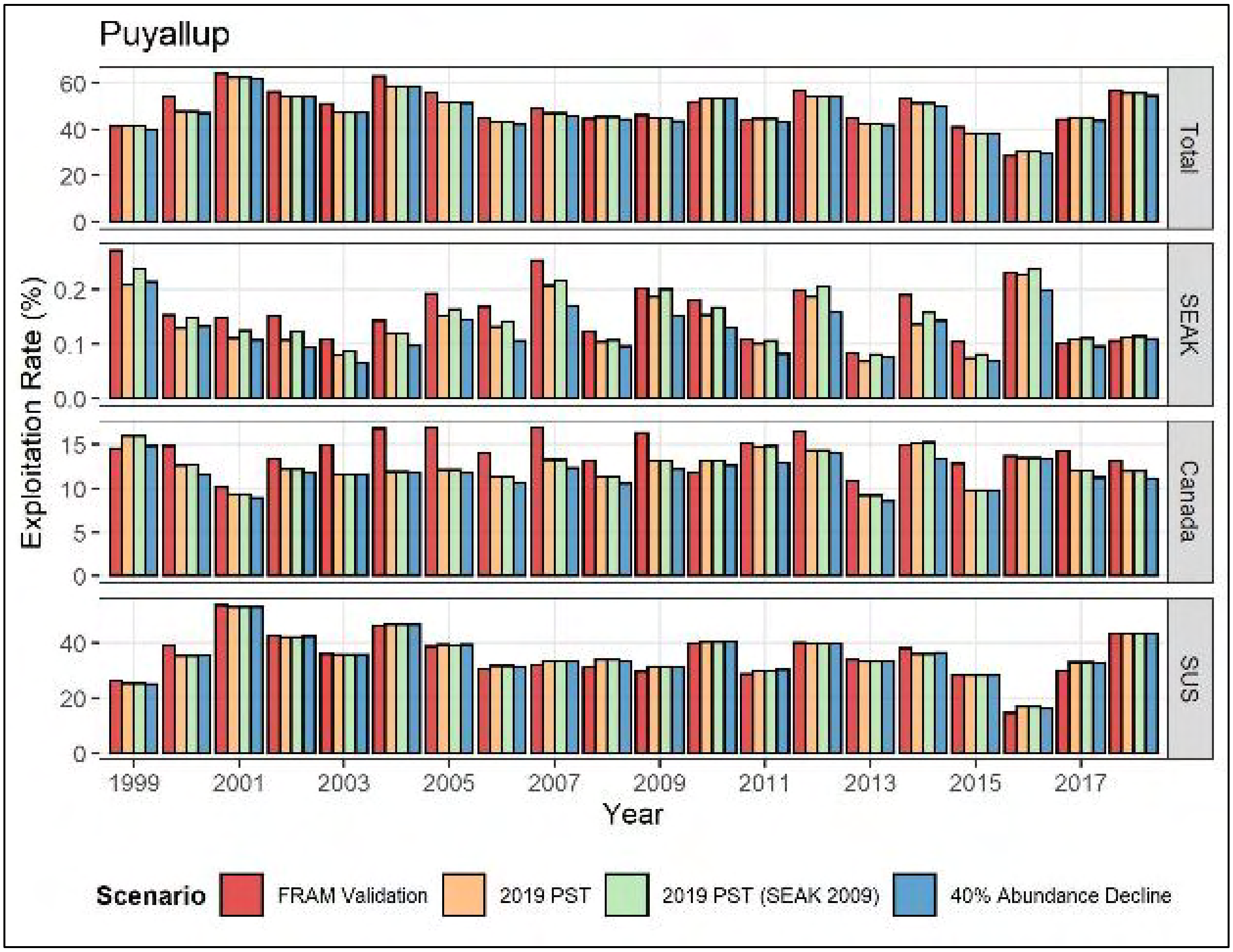

Figure 88. Comparison of ERs on Puyallup River Chinook salmon between Scenarios 1 through 4 in the retrospective analysis.

Table 93. 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	Total Exploitation
Puget Sound Chinook Salmon – Puyallup R	Scenario 1	0.2%	14.2%	4.9%	30.3%	49.6%
	Scenario 2	0.1%	12.4%	5.2%	30.3%	48.0%
	Abs ER Change	0.0%	-1.8%	0.3%	0.0%	-1.6%
	Rel ER Change	-16.2%	-12.9%	5.3%	0.1%	-3.2%

Scenarios 2 and 3 provide a more direct comparison of how ERs are expected to change as a result of the proposed reduction in the SEAK fishery from the 2009 PST Agreement (Scenario 3) to the 2019 PST Agreement (Scenario 2). The proposed change will result in an absolute reduction in the average total ER of 0%, and a relative change in the SEAK fishery ER of -7.9% (Table 94), amounting to a change in total exploitation of 0% and 0%, respectively.

Table 94. 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	Total Exploitation
Puget Sound Chinook Salmon – Puyallup R	Scenario 3	0.1%	12.4%	5.2%	30.3%	48.0%
	Scenario 2	0.1%	12.4%	5.2%	30.3%	48.0%
	Abs ER Change	0.0%	0.0%	0.0%	0.0%	0.0%
	Rel ER Change	-7.9%	-0.1%	0.1%	0.0%	0.0%

A comparison of Scenarios 2 and 4 examine how the fisheries will respond to a 40% reduction in coast wide abundance (Scenario 4). The absolute change in the average total ER is -0.7%, and 0% in the SEAK fishery ER, but these represent relative changes of -1.6% and -9.5%, respectively (Table 95).

Table 95. 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	Total Exploitation
Puget Sound Chinook Salmon – Puyallup R	Scenario 2	0.1%	12.4%	5.2%	30.3%	48.0%
	Scenario 4	0.1%	11.7%	4.8%	30.6%	47.3%
	Abs ER Change	0.0%	-0.7%	-0.4%	0.3%	-0.7%
	Rel ER Change	-9.5%	-5.6%	-7.4%	1.1%	-1.6%

Figure 89 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 seven separate years, and exceeds the CET in all cases except for Scenario 4 in one year. The White River population generally exceeds the UET. There were only five years where all four scenarios were below the UET, including one where all four scenarios were below the CET.

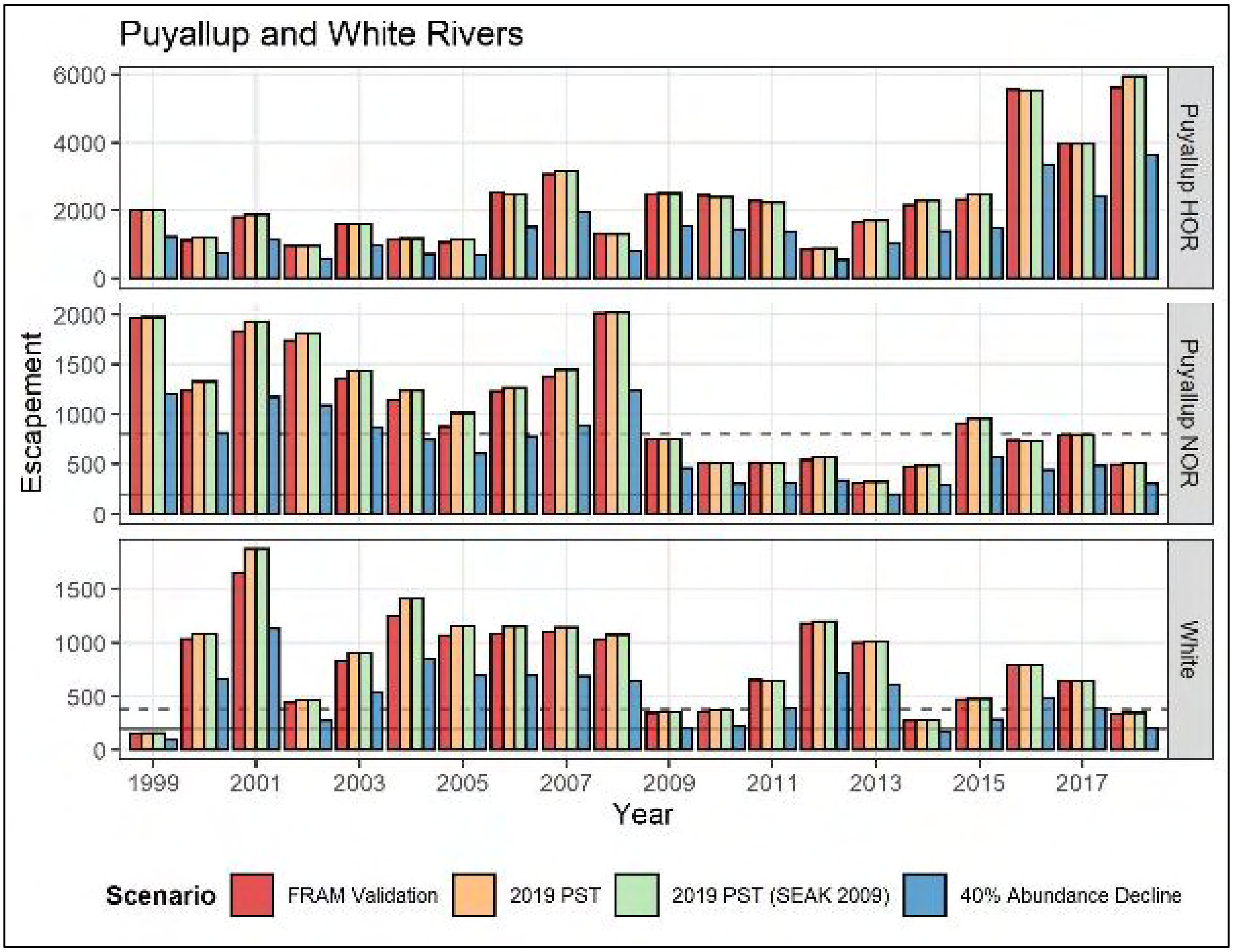

Figure 89. Escapement of Puyallup and White River Chinook salmon populations based on retrospective analysis scenarios (dashed line represents UET, solid line represents CET, see Table 29 for population specific values).

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 total ER is -1.3%, and 0% in the SEAK fishery ER, but these represent relative changes of -2.2% and -13.6%, respectively (Table 96).

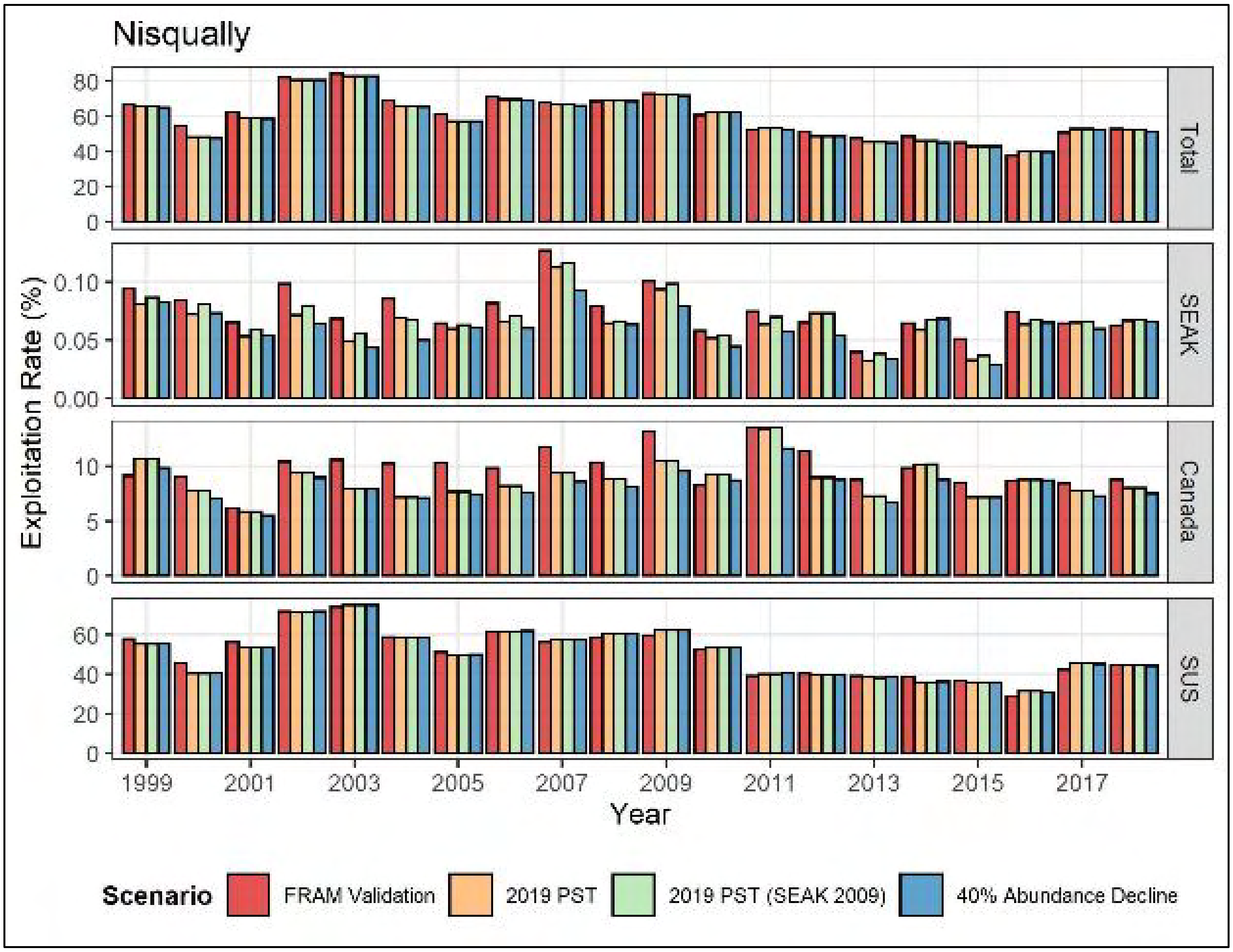

Figure 90. Comparison of ERs on Nisqually River Chinook salmon between Scenarios 1 through 4 in the retrospective analysis.

Table 96. 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	Total Exploitation
Puget Sound Chinook Salmon – Nisqually R	Scenario 1	0.1%	9.8%	6.1%	44.4%	60.4%
	Scenario 2	0.1%	8.7%	6.5%	43.8%	59.1%
	Abs ER Change	0.0%	-1.1%	0.4%	-0.5%	-1.3%
	Rel ER Change	-13.6%	-11.6%	6.0%	-1.2%	-2.2%

Scenarios 2 and 3 provide a more direct comparison of how ERs are expected to change as a result of the proposed reduction in the SEAK fishery from the 2009 PST Agreement (Scenario 3) to the 2019 PST Agreement (Scenario 2). The proposed change will result in an absolute reduction in the average total ER of 0%, and a relative change in the SEAK fishery of -6.1% (Table 97), amounting to a change in total exploitation of 0% and 0%, respectively.

Table 97. 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	Total Exploitation
Puget Sound Chinook Salmon – Nisqually R	Scenario 3	0.1%	8.7%	6.5%	43.8%	59.1%
	Scenario 2	0.1%	8.7%	6.5%	43.8%	59.1%
	Abs ER Change	0.0%	0.0%	0.0%	0.0%	0.0%
	Rel ER Change	-6.1%	-0.1%	0.0%	0.0%	0.0%

A comparison of Scenarios 2 and 4 examine how the fisheries will respond to a 40% reduction in coast wide abundance (Scenario 4). The absolute change in the average total ER is -0.5%, and 0% in the SEAK fishery, but these represent relative changes of -0.8% and -7.5%, respectively (Table 98).

Table 98. 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	Total Exploitation
Puget Sound Chinook Salmon – Nisqually R	Scenario 2	0.1%	8.7%	6.5%	43.8%	59.1%
	Scenario 4	0.1%	8.2%	6.2%	44.2%	58.6%
	Abs ER Change	0.0%	-0.5%	-0.3%	0.4%	-0.5%
	Rel ER Change	-7.5%	-6.3%	-4.9%	0.9%	-0.8%

Figure 91 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 except 2017, however since 2010 all scenarios exceed the CET each year.

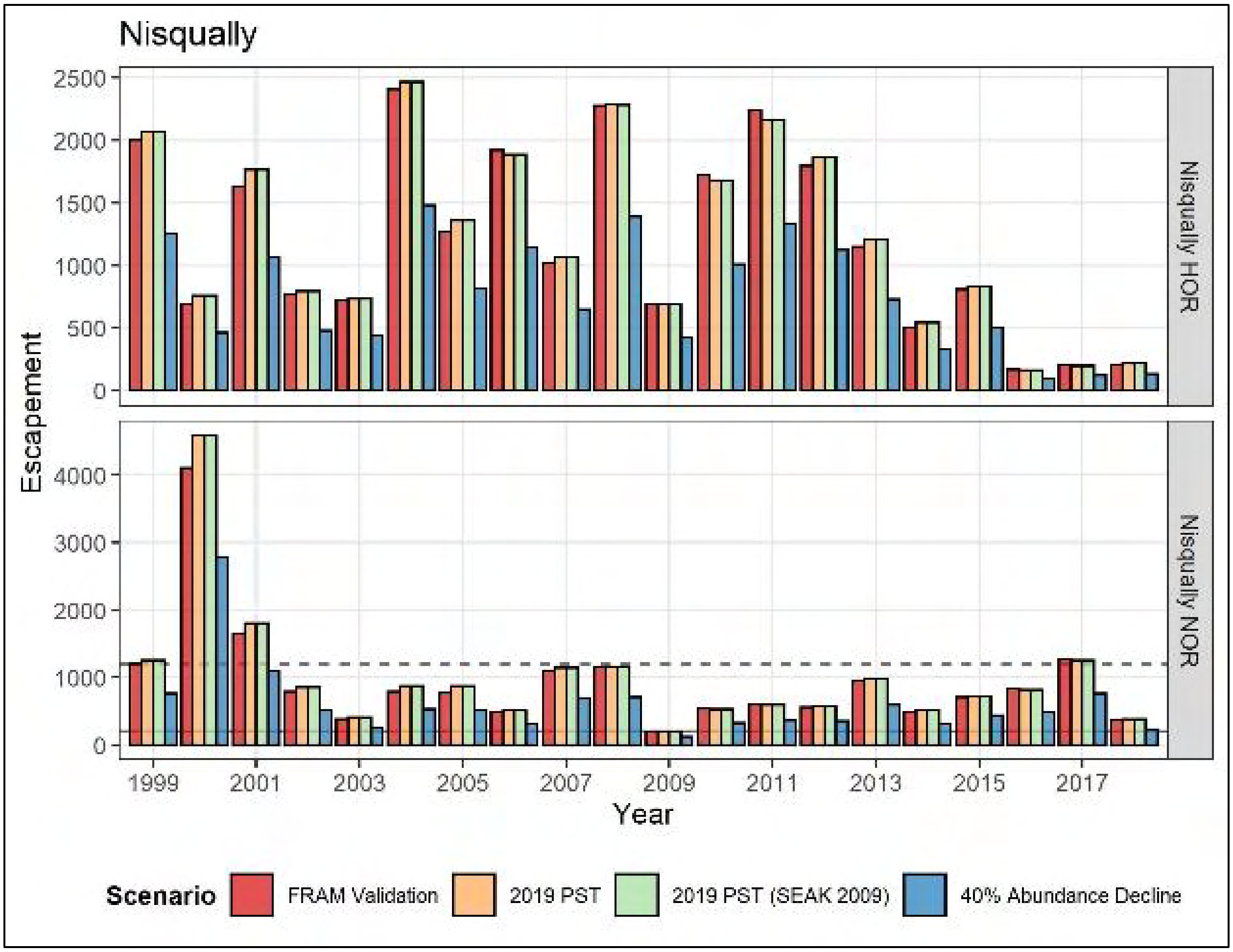

Figure 91. Escapement of Nisqually River Chinook salmon populations based on retrospective analysis scenarios (dashed line represents UET, solid line represents CET, see Table 29 for population specific values).

2.5.2.5 Chinook salmon ESU effects summary

The provisions of the PST Agreement related to the SEAK fishery in particular and fisheries in general will be responsive to changes in abundance. Different harvest rate tiers allow increased levels of catch as abundance increases and decreased catch as abundance decreases (see Appendix C in Chapter 3 of the 2019 PST Agreement). For each Chinook salmon ESU affected, ERs reported in this section are shown to be reduced in response to a significant decline in overall abundance, primarily due to reductions in ERs in AABM fisheries as the AIs for those fisheries decline. In turn, this results in a proportional reduction in catch that is similar to but slightly greater than the corresponding reduction in abundance. There are also domestic management constraints that require reductions to fishery impacts in southern U.S. ISBM fisheries as abundances decline for individual ESUs, for example, the abundance based management of LCR tule Chinook.

The effects for AABM reductions are consistent across the affected salmon ESUs because the 2019 PST Agreement requires a total reduction in the AABM fisheries' allowable rates of harvest from the 2009 PST Agreement, as described in the Proposed Action. These required reductions in harvest affect salmon ESUs and stocks relative to their migration routes, meaning those that more commonly migrate far north into the range of the SEAK salmon fisheries see larger effects, such as UWR Chinook salmon, versus those that do not, such as Puget Sound Chinook salmon, but all of them experience reductions in harvest to some extent, as designed by the strategy of curtailing harvest across the 2019 Agreement. Additionally, the driving factor of abundance as the limitation is also apparent, given the general patterns observed across the various fisheries depicted in Figures 41 through 70 are similar, as indicated by the lows and highs occurring similarly across the various areas.

LCR Chinook salmon
The retrospective analysis yielded different results for the different life-history components of the LCR Chinook salmon ESU.

For LCR spring Chinook salmon:

The retrospective analysis indicates that harvest of LCR spring Chinook salmon in the action area was very low under prior Agreements and is reduced further as intended under the current Agreement. The ER in the SEAK fishery averaged 1.9% in Scenario 1 and 1.6% in Scenario 2 (Table 48) indicating a reduction in ERs under the current Agreement compared to the previous Agreements. The proportion of marine area fishery impacts that occur in SEAK is moderate (11.5%) (Figure 44).

The ER in the SEAK fishery averaged 1.6% in Scenario 2 and 1.5% in Scenario 4 Table 50. Exploitation rates in the marine area fisheries in the action area would be reduced from 15.5% under Scenario 2 to 14.2% in Scenario 4 Table 50. The relative change in ER in the SEAK and marine area fisheries are -7.9% and -8.2%, respectively. Thus, management of the SEAK fisheries under the obligation of the 2019 PST Agreement is responsive to declines in abundance and very low fishery impacts would occur under a low abundance scenario.

For LCR tule Chinook salmon:
The ER on LCR tule Chinook salmon in the SEAK fishery averaged 2.3% in Scenario 1 and 2.0% in Scenario 2 (Table 48), indicating that harvest of LCR tule Chinook salmon in the action area is low, and reduced as intended by the 2019 PST Agreement.

The ER on LCR tule Chinook salmon in the SEAK fishery averaged 2.0% in Scenario 2 and 1.9% in Scenario 4 (Table 50), indicating an appropriate response to a significant reduction in abundance.

For LCR bright Chinook salmon:
The SEAK fisheries accounts for 21.2% of the marine fishery impacts on LCR bright Chinook salmon (Figure 48). The ER in the SEAK fishery averaged 10.5% in Scenario 1 and 9.5% in Scenario 2 (Table 48). Exploitation rates in the marine area fisheries in the action area also would be reduced from 49.6% under Scenario 1 to 45.4% in Scenario 2 (Table 48). The analysis indicates that harvest of LCR bright Chinook salmon in the action area would be reduced as intended by the 2019 PST Agreement.

The ER in the SEAK fishery averaged 9.5% in Scenario 2 and 8.9% in Scenario 4 (Table 50). Exploitation rates in the marine area fisheries in the action area also would be reduced from 45.4% under Scenario 2 to 43.2% in Scenario 4 (Table 50). The fisheries are thus responsive to a major decrease in abundance.

UWR Chinook salmon

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 (45.7%) (Figure 50). The ER in the SEAK fishery averaged 3.8% in Scenario 1 and 3.2% in Scenario 2 (Table 51), indicating the intended decrease in ER under the 2019 Agreement, maintaining a low ER.

The ER in the SEAK fishery averaged 3.2% in Scenario 2 and 2.9% in Scenario 4 (Table 53). Exploitation rates in the marine area fisheries in the action area also would be reduced from 7.1% under Scenario 2 to 6.4% in Scenario 4 (Table 53). The relative change in ER in the SEAK and marine area fisheries are -9.5% and -9.9%, respectively. Thus, the fisheries would be expected to respond to a significant decrease in abundance.

SRFC salmon

SRFC salmon are present in the SEAK fishery, but a relatively small proportion (3.9%) of the marine area fishery impacts occur in the SEAK fishery (Figure 53). The ER in the SEAK fishery averaged 1.2% in Scenario 1 and 1.0% in Scenario 2 (Table 54), indicating that harvest of SRFC salmon in the action area would be reduced as intended by the 2019 PST Agreement, maintaining an especially low ER.

The ER in the SEAK fishery averaged 1.0% in Scenario 2 and 0.9% in Scenario 4 (Table 56). Exploitation rates in the marine area fisheries in the action area also would be reduced from 27.0% under Scenario 2 to 25.1% in Scenario 4 (Table 56). This indicates the fisheries are responsive to a significant decrease in abundance.

Puget Sound Chinook salmon

Populations of Puget Sound Chinook salmon most significantly impacted by the SEAK salmon fisheries are the Stillaguamish, Dungeness, Elwha, Nooksack, and Skagit summer/fall populations. Results of our analysis for Dungeness, Elwha, Nooksack, and Skagit summer/fall were quite similar to Stillaguamish. The effects to the other most significantly impacted by the SEAK salmon fisheries, besides the Stillaguamish population, are as follows under Scenario 2 (the 2019 Likely): the Dungeness population in SEAK salmon fisheries has an ER of 1.5% that contributes to a total ER of 24.1% (Table 60); the Elwha population in SEAK salmon fisheries has an ER of 1.6% that contributes to a total ER of 23.7% (Table 57); the Nooksack population in SEAK salmon fisheries has an ER of 2.9% that contributes to a total ER of 28.9% (Table 69); and the Skagit summer/fall populations in SEAK salmon fisheries has an ER of 6.1% that contributes to a total ER of 37.0% (Table 75). Using the Stillaguamish Chinook salmon population to discern how comparisons between scenarios would similarly account for fishery impacts, fish from this population that are caught in the SEAK fishery account for 5.5% of the fishery impacts (Table 40). For Stillaguamish Chinook salmon, the ER in the SEAK fishery averaged 1.7% in Scenario 1 and 1.4% in Scenario 2 (Table 80). The retrospective analysis indicates that total ERs would be reduced from 30.9% under Scenario 1 to 29.7% in Scenario 2

(Table 80). The analysis indicates that harvest of Stillaguamish Chinook salmon in the action area would be reduced as intended by the 2019 PST Agreement. Comparison of ERs between the ER in the SEAK fishery for Stillaguamish Chinook salmon averaged 1.4% in Scenario 2 and 1.3% in Scenario 4 (Table 78). Total exploitation rates also would be reduced from 29.7% under Scenario 2 to 28.9% in Scenario 4 (Table 78). The relative change in ER in the SEAK and marine area fisheries are -9.5% and -2.4%, respectively.

2.5.3 Southern Resident Killer Whales

We examined the effects of the proposed actions: 1) the delegation of management authority in the EEZ to the State of Alaska, and 2) funding to the State of Alaska to implement the 2019 PST Agreement in Southeast Alaska (SEAK). The proposed actions relate specifically to the effects of SEAK salmon fisheries, so our analysis focuses on impacts of the fisheries on SRKW throughout their range. Because the SEAK salmon fisheries occur outside the SRKW range, there is no potential for direct interaction between whales and fishing vessels/gear (i.e., there is no overlap in time and space). Thus, the effects considered from the proposed actions include indirect effects from changes to prey availability. 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 salmon fisheries under the 2019 PST Agreement.

Similar to past biological opinions where we assessed the effects of fisheries (e.g., NMFS (2021c); NMFS (2024c)) and the 2009 PST Agreement (NMFS 2008a), our analysis on SEAK fisheries focuses on effects to Chinook salmon availability and not other prey species because the best available information indicates that SRKWs strongly prefer Chinook salmon (as described in the Status of the Species) and they are the most limiting prey species. The total abundance of other salmon and potential prey species within the range of SRKWs is orders of magnitude larger than the total abundance of Chinook salmon. This analysis considers whether effects of Chinook salmon prey reduction may impact the fitness of individual whales as the preferred and primary prey throughout all months of the year.

To date, the available data and analyses have not supported an analytical approach that statistically quantifies effects of changes in Chinook salmon abundance to killer whale survival and recovery (i.e., mortality and reproduction). In the absence of a predictive analytical tool to evaluate this relationship, we consider all of the information we have by identifying a variety of metrics or indicators with varying degrees of confidence (or weight) in order to assess the impacts of the proposed action. We term this a weight-of-evidence approach, which is a non-statistical approach to assess, review, and integrate all of the results and their associated degree of confidence to form a meaningful conclusion. First, we briefly discuss and summarize what is known about the relationship between SRKWs and their primary prey, Chinook salmon, and methods used to explore these relationships, and why we do not rely more extensively on correlations in our analysis of impacts of fisheries on prey availability and instead rely on a weight-of-evidence approach. This has been discussed more thoroughly in previous recent opinions (NMFS 2021c; 2022a; 2023a; 2024c) and is summarized here. We then discuss our evaluation of the potential indirect effects of changes in prey availability due to SEAK salmon fisheries under the 2019 PST Agreement. The analysis also 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.

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. We analyzed the effects of prey reduction in two steps. First, we estimated the reduction in prey available to the whales from the SEAK salmon 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 SEAK salmon fisheries compare to past fisheries reductions, 2) considering the amount of Chinook salmon prey available compared to the current SRKW population's Chinook salmon needs; and 3) evaluating effects of the SEAK salmon fisheries with respect to priority prey stocks.

2.5.3.1 Relationship between Chinook salmon abundance and SRKW demographics

Several studies in the past have found correlations between Chinook salmon abundance indices and SRKW demographic rates (e.g. fecundity and mortality) (Ford et al. 2005; Ford et al. 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 SRKW fecundity or survival). However, the assumption that these correlations represent causation was previously criticized by a panel of experts (Hilborn et al. 2012). The panel cautioned against overreliance on correlative studies. Population viability assessments (PVAs) from Lacy et al. (2017) and Murray et al. (2021) attempted to quantify and compare the three primary threats affecting the whales (e.g. prey availability, vessel noise and disturbance, and high levels of contaminants). In Lacy et al. (2017), over the range of scenarios tested, the effects of prey abundance on fecundity and survival had the largest impact on the population growth rate of all threats (vessels, contaminants, and prey availability). Furthermore, they suggested in order for the population to reach the recovery target of 2.3% growth rate, the acoustic disturbance would need to be reduced in half and the Chinook salmon abundance would need to be increased by 15% (Lacy et al. 2017). However, we note that the Lacy model is based on outdated correlations of coastwide Chinook abundance and survival or fecundity of SRKW. These strong correlations used by Lacy et al. (2017) do not hold up using contemporary demographic data (see also Nelson et al. (2024), and as such we cannot rely on the results from the model as best available science. We rely on more recent analyses, such as the PFMC Workgroup efforts described below (PFMC 2020). The updated population viability analysis in Murray et al. (2021) showed that no single threat alone could replicate observed SRKW past demographic trajectories (and see NMFS (2021c) for more on caveats and assumptions with these models). More recently, Williams et al. (2024) published a new PVA on SRKW extinction risk with respect to varying prey abundance, noise disturbance, contaminants, and other factors. The value of a PVA lies more in understanding the drivers of population change rather than the absolute value of a variable and its effect on the population. As such, this paper supports previous work that identifies several key threats to the SRKW population listed above and models their effects on population growth rate. However, the degree to which each of these threats alone affects the SRKW population is heavily dependent on their parameterization (i.e., the quantitative relationship between the variables and SRKW demographic outcomes based on empirical evidence). To that point, we note that Williams et al. (2024) do not provide any measures of uncertainty, nor assess the sensitivity of the model to parameter selection. While the general results support a positive effect of increasing Chinook salmon abundance on the SRKW population trajectory, there are limitations in interpreting specific prey abundance values and the associated extinction risk due to the reasons described above. Further, recent genomics work establishing the high level of inbreeding and the impact of inbreeding depression (Kardos et al. 2023) was not included in the inbreeding parameters of the Williams et al. (2024) PVA.

Another study found a significant inverse relationship between the observed demographic patterns in the SRKW population with the biennial pattern in abundance of pink salmon (Ruggerone et al. 2019). The authors provide no clear mechanistic explanation for this relationship but offer up a couple of hypotheses including that in high abundant pink salmon years (odd years), SRKW foraging efficiency declines thereby reducing the whales' nutritional status and affecting the survival in the subsequent year. In a subsequent paper, Ruggerone et al. (2023) compiled evidence from multiple past papers and data to show potential top-down effects by extensive pink salmon abundance in odd years that alter food web dynamics across the Pacific, including the NE Pacific and U.S. west coast. In those years, Chinook salmon abundance could be reduced due to higher competition for prey and may impact SRKW access to Chinook. During the latter part of the time series (1984–1997) considered in Ruggerone et al. (2023), pink salmon presence (even-numbered years) was associated with lower Chinook salmon growth during early marine residence, delayed maturity, and lower survival (SAR) in Salish Sea Chinook salmon stocks. This suggested that pink salmon were mediating ecosystem food-web dynamics and triggering negative density-dependent interactions in hatchery Chinook salmon during their first ocean year. However, during the early part of the time series (1972–1983), Chinook salmon survival was greater during years of pink salmon presence, suggesting predator buffering effects. The authors provide evidence of an El Niño-based "regime shift" that occurred around 1982–1983, whereby abundances of many predators shifted in Puget Sound, altering the influence of pink salmon within the ecosystem generally, and on hatchery Chinook salmon specifically. The Salish Sea hatchery populations included in the study were, with only one exception, Green River-derivative. Thus, the findings may not be broadly applicable to other Salish Sea natural- or hatchery-origin populations. Though it is difficult to find quantitatively statistically significant relationships between prey abundance and SRKW demographics, nutritional stress as a chronic condition can lead to reduced body size and condition of individuals (e.g., Trites and Donnelly (2003) and whales in poor body condition have a higher likelihood of mortality, while accounting for age and sex (Stewart et al. 2021).

There are several challenges to quantitatively characterizing the relationship between SRKWs and Chinook salmon and the impacts of reduced prey availability on SRKW behavior and health. Attempts to compare the relative importance of any specific Chinook salmon stock or stock groups using the strength of statistical relationships have not produced clear distinctions as to which stocks are most influential to SRKW demographics, and most Chinook salmon abundance indices are highly correlated with each other. Different Chinook salmon populations are likely more important in different years. Large aggregations of modeled Chinook salmon stocks that reflect abundance on a more coastwide scale have previously appeared to be equally or better correlated with SRKW vital rates than smaller aggregations of Chinook salmon stocks, or specific stocks such as Chinook salmon originating from the Fraser River that have been positively identified in diet samples as key sources of prey for SRKWs during certain times of the year in specific areas (see Hilborn et al. 2012; Ward et al. 2013). For example, low coastwide Chinook salmon abundance in the late 1990s corresponded to an approximate 20% decline in the SRKW population, constrained body growth, and low social cohesion as described in the Status of the Species. So, though it is difficult to identify a low abundance that is predicted to cause adverse effects to SRKWs, there is evidence SRKWs and other killer whale populations that are also known to consume Chinook salmon may have experienced adverse effects from low Chinook prey availability in the late 1990s likely due to common factors affecting changes in the populations (NMFS 2008b; Towers et al. 2015).

The PFMC's Workgroup attempted to quantify the relationship between Chinook salmon abundance and SRKW demographics and predict effects of reduction in prey by fisheries on SRKW (PFMC 2020). Here, we briefly describe their results applicable to our discussion of the relationship between Chinook abundance and SRKW status, but more detailed information is provided in (PFMC 2020) and (NMFS 2021m). Similar to past efforts, the Workgroup found predicting the relationship between SRKWs and Chinook salmon abundance to be challenging. The relationships between modeled Chinook salmon abundance and SRKW demographics examined by the Workgroup in this most recent analysis appear weaker than those from prior analyses. For example, although the average coastwide Chinook salmon abundance in this last decade is higher than the average over the entire time series (1992-2016), the SRKW population has experienced a decline in their population. One of the Workgroup's fitted regressions, however, met the criterion of statistical significance ($p \leq 0.05$) (winter Chinook abundance NOF and SRKW survival with a one-year time lag, $p = 0.0494$) and several regressions were near statistical significance in times and areas with likely whale presence. The Workgroup also attempted to predict the effects of the reduction in Chinook abundance due to PFMC ocean salmon fisheries on SRKW performance metrics, and results suggested that any effects of the fisheries on SRKW demographics were relatively small. In general, in any given year, the model-estimated changes in fecundity and survival were small when scenarios with the PFMC-driven reductions in Chinook abundance in the NOF area were compared to scenarios without the reductions (≤ 0.2% change in both mean estimates in survival and fecundity, see Table 5.5a in PFMC (2020), and see NMFS (2021c) and next paragraph for caveats). The Workgroup concluded that SRKWs are likely impacted by reductions in prey availability in the NOF area to some unknown degree, and there is potential for overlap with salmon fisheries in this area every year, but overall, the PFMC salmon fishery impacts on NOF abundance are small relative to both annual variation in abundance and the total abundance in a given year (PFMC 2020). Multiple limitations and key uncertainties for these analyses are highlighted by the Workgroup in their report (PFMC 2020).

A recent study delved into the relationship between demographic rates of SRKW and the abundance of Chinook salmon, employing integrative population modeling (IPM) to separately analyze the effects on reproduction and survival (Nelson et al. 2024). Using an annual time step, a sex- and age-stage model was employed to retroactively estimate SRKW population dynamics from 1940 to 2020. The modeling approach separately addressed SRKW fecundity and survival, treating fecundity as a stage-structured process and survival as an age-structured process. The models also incorporated either a 1-year lag or no lag for salmon abundance. The best model combined SRKW and NRKW populations, assuming a single carrying capacity value and a 1-year lag for the salmon covariate in the fecundity submodel. Generally, the data supported models featuring a 1-year lag for the salmon covariate in the fecundity submodel and no lag for the salmon covariate in the survival submodel. Nelson et al. evaluated 16 models and found that in eight of them, there was a 95% probability of a positive correlation between salmon abundance and survival, with all 16 models indicating at least a 50% likelihood of such a correlation. Conversely, models showed less support for fecundity being correlated with salmon abundance. Only 7 of the 16 models demonstrated a probability of a positive correlation between fecundity and salmon abundance of at least 50%. These findings suggest a potential linkage between SRKW abundance and NRKW abundance, hinting at potential resource competition between the two populations.

One key factor confounding our ability to quantitatively describe the relationship between SRKW demographic performance and the effects of the fisheries on Chinook salmon abundance, is the likely very low statistical power to detect a significant relationship because of the limits of the relevant data. Statistical power is the probability of detecting a significant effect (defined here in the common sense of $p \leq 0.05$ for a two-sided test), for different assumed values of the true effect. For models such as regression analyses that have been used to quantify relationships between SRKW demographic parameters (such as fecundity, survival) and changes in Chinook salmon abundance, existing data may be too limited to produce enough statistical power to detect a statistically significant relationship, even if a biologically significant difference exists. In most years, SRKWs experience fewer than five births or deaths; these already small sample sizes are exacerbated by the small (and declining) population, as well as the life history of the species (i.e., long lived individuals but low number of offspring per reproductive female), and the confounding effects on Chinook salmon abundance. Based on simulations and power analysis (Ward and Satterthwaite 2020) and described in (NMFS 2021c), results indicate that the SRKW demographic data alone would not be expected to help provide anything more than weak evidence for or against a significant change related to prey abundance (or any other perturbation). In NMFS (2021c), we concluded that analyses that are attempting to detect a significant change ($p \leq 0.05$) in SRKW demographic rates given a change in prey abundance (from management change or other source), may be unlikely to detect a significant effect even if a biologically significant effect is present. The PFMC's Scientific and Statistical Committee (SSC) reviewed the Workgroup's risk assessment methods and "agrees that further analyses are unlikely to yield more informative results, as the regressions, generalized linear models, and cluster analyses had similar results to each other and to previous analyses. Given the large amount of data usually required to detect small differences in survival of long-lived species, further work is unlikely to resolve these relationships."[54]

More recent research has found SRKW body condition can be collected for multiple individuals over multiple years (Fearnbach et al. 2018) and may be assessed against the salmon abundance. Stewart et al. (2021) used 473 measurements of body condition from 99 SRKWs from seven years between 2008-2019 to assess relationships between Chinook salmon abundance (from various runs) and SRKW body condition transition (changes from one body condition state to another) through Bayesian model selection. For J pod, the model that included Fraser River Chinook abundance was the best model for predicting a change in SRKW body condition compared to models with other Chinook or no Chinook covariates (though Salish Sea Chinook abundance was similarly a good predictor possibly because Fraser River runs make up a large proportion of Salish Sea abundance). They found there was a higher probability of a decline in body condition in J pod when Fraser River abundance was low. When Fraser River Chinook abundance dropped below 347,000 fish there was only a 37% median probability of increasing or stable SRKW body condition, compared to >86% median probability when Chinook abundance was above 750,000 fish. For L pod, the best fit model showed a relationship with the probability

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[54] https://www.pcouncil.org/documents/2019/11/agenda-item-e-4-a-supplemental-ssc-report-1.pdf/

of a change in body condition and Puget Sound Chinook, but this relationship was weaker (including large confidence intervals) than the relationship between J pod and Fraser River Chinook. All other models between L pod condition and salmon abundance indicators showed unintuitive relationships (higher probability of a decline in body condition with higher salmon abundance). Still, the model showed that if Puget Sound Chinook abundance is over 399,000 fish, the median probability of stable or increasing body condition for L pod was 0.82-0.89. This probability decreased to 0.32 at a Puget Sound Chinook abundance of just 235,000 fish. For K pod, the best model did not include any covariates of salmon abundance. We note that these Chinook abundance values were derived using older versions of FRAM and are not comparable to abundance estimates presented in the environmental baseline for SRKW (see Appendix B Table B.1). Model results also suggested that whales in poorest body condition have a higher probability of mortality. Additional efforts to relate body condition to demographic rates, including reproduction, are ongoing.

Effects of reductions in Chinook salmon abundance are likely a more significant risk to SRKWs at relatively low levels of Chinook abundance and this likely also depends on the status of SRKWs at the time. Past efforts have recognized the likely greater risk to SRKW in low Chinook abundance years (PFMC 2020). Populations with healthy individuals may be less affected by changes to prey abundance than populations with less healthy individuals (i.e., there may be a spectrum of risk based on the status of the whale population). Fisheries impacts on prey availability are expected to reduce prey availability at all abundance levels, but removals present more risk to SRKWs at lower salmon abundance levels and when the whales have a poor status. Because SRKWs are already stressed due to the cumulative effects of multiple stressors, and the stressors can interact additively or synergistically, any additional stress such as reduced Chinook salmon abundance likely has a greater physiological effect than it would for a healthy population, which may have negative implications for SRKW vital rates and population viability (e.g., National Academy of Sciences (2017)). At some low Chinook abundance level, the prey available to the whales may not be sufficient to allow for successful or efficient foraging, leading to adverse effects (such as reduced body condition and growth and/or poor reproductive success). This could affect SRKW survival and fecundity. For example, food scarcity could cause whales to draw on fat stores, mobilizing the relatively high levels of contaminants stored in their fat and potentially affecting reproduction and immune function (Mongillo et al. 2016). Increasing time spent searching for prey during periods of reduced prey availability may decrease the time spent socializing; potentially reducing reproductive opportunities. Also, low abundance across multiple years may have even greater effect because SRKWs likely require more food consumption during certain life stages, female body condition and energy reserves potentially affect reproduction and/or result in reproductive failure at multiple stages of reproduction (e.g. failure to ovulate, conceive, carry pregnancies to term, or successfully nurse calves), and effects of prey availability on reproduction could be combined across consecutive years. Good fitness and body condition coupled with stable group cohesion and reproductive opportunities are important for reproductive success. We note that current photogrammetry work by Fearnbach and Durban (2023) for body conditions for 2022 show that 20% of J pod is in the poorest body condition state (out of five body condition categories); K and L pods have 6% and 13% of individuals in the poorest body condition for 2022, respectively. Further, J pod has the lowest proportion of individuals above normal body condition (below 60%, vs. ~60% and ~80% for L and K pods, respectively).

Furthermore, on top of difficulties in identifying a robust quantitative model that identifies a low abundance threshold that is predicted to cause adverse effects to SRKWs, there are also difficulties in estimating the total amount of Chinook salmon needed by SRKWs to meet their metabolic needs. Though there are estimates of the metabolic needs of the population of SRKWs that we cite throughout this Opinion (such as Noren (2011); Williams et al. (2011); Chasco et al. (2017a); see the Environmental Baseline, Section 2.4.4), these estimates can vary based on several underlying assumptions including the size of the whale population and the caloric density of the salmon. Also, as noted in the Environmental Baseline, given the lack of available information on the whales' foraging efficiency, it is difficult to evaluate how much Chinook salmon or what density of salmon needs to be available to the whales in order for their survival and successful reproduction. The whales and prey are both highly mobile and have large ranges with variable overlap seasonally. It is also currently uncertain how other factors in their environment, such as vessel presence, further impacts their foraging efficiency and therefore the amount of prey needed throughout their habitat. New analysis by Holt et al. (2021a) found that the probability of prey capture for SRKWs increased as prey abundance increased (both Chinook and coho), highlighting that the more prey available may allow for higher likelihood of meeting caloric needs. Though there are general estimates of how many Chinook salmon need to be consumed to meet the biological needs of the whales, we do not have estimates of the total amount of salmon needed in their environment or what density is needed for the SRKW population to be able to consume an adequate amount of salmon. Therefore, we consider values of metabolic, caloric needs in our analysis of effects but we are unable to quantify how this reduction by fisheries affects foraging efficiency of the whales. Consequently, we are limited in our interpretation of these values and apply a low weight to analysis on energetic requirements of the whales and calorie availability of prey when assessing the effects of the action.

Although there is currently no robust quantitative model for a low Chinook abundance threshold, the PFMC recently adopted an amendment to the PFMC salmon FMP that includes an identified low abundance threshold for Chinook salmon abundance in coastal salmon fisheries north of Cape Falcon, Oregon (Amendment 21 to the FMP, NMFS (2021c), and see the Environmental Baseline, Section 2.4.7) recognizing likely greater risk to SRKW in low abundance years. The threshold was based on one statistically significant relationship between SRKW viability parameters and Chinook salmon abundance in the NOF management area. Amendment 21 to the FMP is designed to minimize the effects of PFMC fisheries on prey availability and address the concerns for disproportionately high percent prey reductions in years of particularly low Chinook salmon abundance in times and areas when/where the fisheries and whales overlap and potential for localized depletion by fisheries in SRKW foraging locations (i.e., non-homogenous reduction across a spatial area). The threshold used is based on years included in the Workgroup's analysis when Chinook salmon abundance was relatively low and there was a general mix of SRKW status (i.e., consisting of a spectrum of risk), with two relatively good status years (1994 and 2007) and five years of fair or poor SRKW status, as well as including two periods when there were multiple and consecutive years of low Chinook salmon abundance (1995-1996, 1998-2000). If prey availability is low on the coast (particularly below the threshold), and abundance is low or depletion occurs in foraging hot spots, SRKWs may increase searching efforts in other areas within their geographic range, including in the Salish Sea (though management actions associated with Amendment 21 may help reduce depletion in foraging hot spots).

In summary, given the multiple caveats in interpreting the results discussed above, we apply a relatively low weight to regression analyses in general (including those discussed above) and continue to rely on a more qualitative weight-of-evidence approach. Again, to date, the available data and analyses have not supported an analytical approach that statistically quantifies effects of changes in Chinook salmon abundance to killer whale demographic rates (i.e., survival and reproduction). For body condition, connections to Chinook salmon abundance were not identified for all pods. We also apply low weight to estimates of ratios of prey abundance to metabolic needs for reasons outlined above. Therefore, we use a weight-of-evidence approach to consider all of the available information, identifying a variety of metrics or indicators with varying degrees of confidence, in order to assess the indirect impacts of the proposed action on SRKWs through possible changes in prey availability. Though statistically significant relationships continue to be difficult to identify, the recent adoption of PFMC-area fisheries management based on low abundance thresholds recognize the higher risk to SRKW demographic rates in low Chinook salmon abundance years.

2.5.3.1.1 Short-Term (Annual) Effects

The SEAK salmon 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 removed by the fisheries managed under the 2019 PST Agreement. As described in Section 1.3, provisions of the 2019 PST Agreement result in reductions in catch by SEAK salmon fisheries relative to those allowed under the 2009 PST Agreement. In the SEAK salmon fisheries, in most years, catch is reduced by 7.5% relative to what was allowed in the 2009 PST Agreement, but at higher abundance levels catch reductions are either 3.25 or 1.5%. Because of these reductions to harvest, we anticipate reduced effects to prey availability under the 2019 PST Agreement compared to the previous regime.

In order to evaluate how prey reductions from SEAK salmon fisheries affect SRKWs, we used the same methods as described in Appendix D and used in the environmental baseline for SRKW. The expected prey reduction due to SEAK salmon fisheries was evaluated by season (FRAM time steps of October-April, May-June, and July-September) and five spatial areas considered to be most important for SRKW (SWWCVI, Salish Sea, NOF, Oregon, and California (PFMC (2020) and Appendix D). In general, coastal waters during the winter and inland waters (Salish Sea) during the summer/fall are of the most importance to SRKW, although we assess prey reductions in all times (winter, spring, and summer/fall) and all 5 spatial areas, including the total annual reduction. As in the environmental baseline for SRKW, reductions presented for July-September are cumulative for the whole year (and reductions presented for May-June are cumulative of October-April and May-June). However, most of the fisheries reductions displayed for July-September actually occur during those months. The resulting percent reductions across all time steps represent the amount of prey that would have been available to SRKW at that time (factoring natural mortality and mortality due to other fisheries from the previous time step) if the SEAK salmon fisheries did not occur.

Short-term effects of the SEAK salmon fisheries under the 2019 PST Agreement on prey availability were evaluated by: 1) the expected percent reduction in Chinook salmon available to SRKW as a result of SEAK salmon fisheries (percent reduction), 2) assessment of the current metabolic needs of the SRKW population relative to the remaining prey base after fisheries removals, and 3) qualitative assessment of Chinook salmon stocks taken by SEAK salmon fisheries. Our analysis is limited to the seasons described above and updated information on average number of days when the whales are in inland waters compared to coastal waters, as finer scale temporal and spatial stratification for SRKW occurrence and Chinook salmon stocks is not currently available.

We evaluated the effects of the SEAK salmon fisheries by comparing the "2019 Likely" scenario (Scenario 2) described in Section 2.5.1 (and Appendix A) with the "SEAK fisheries off" scenario described in Appendix D, which included estimated fishing levels under the 2019 PST Agreement in Canadian fisheries and U.S. fisheries (including PFMC and Puget Sound salmon fisheries, as modified by more stringent domestic constraints) but without the SEAK salmon fisheries. Comparing these two scenarios allows us to isolate the reductions in prey availability due to the SEAK salmon fisheries.

Under the 2019 PST 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 actions at 2019 Likely fishing levels, which incorporates more stringent constraints than are required by the 2019 PST 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 several years, fishery constraints currently in place are unlikely to be relaxed during the remainder of the current 2019 PST Agreement.

Percent Prey Reductions

Fisheries in SEAK do not directly overlap with the range of the SRKW, but they do catch Chinook salmon that would have been available to the whales in their coastal or inland range during migration or prior to entering natal streams. The reduced prey availability attributed to the SEAK salmon fisheries is measured as the expected percent reduction from the "2019 Likely" scenario (Scenario 2 in Section 2.5.2) of the total Chinook salmon prey available to them in different seasons and locations. The analysis uses past levels of Chinook salmon abundance to project the range of future abundances and estimate the percent reductions we expect to see under the 2019 PST Agreement. This analysis uses the same FRAM-Shelton methods as used in the environmental baseline (Section 2.4.4) and described in Appendix D[55]. The results of that analysis are presented in Figure 92 below (see also Appendix E, Table E.1). 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. As such, the "annual" reduction is represented by the July-September

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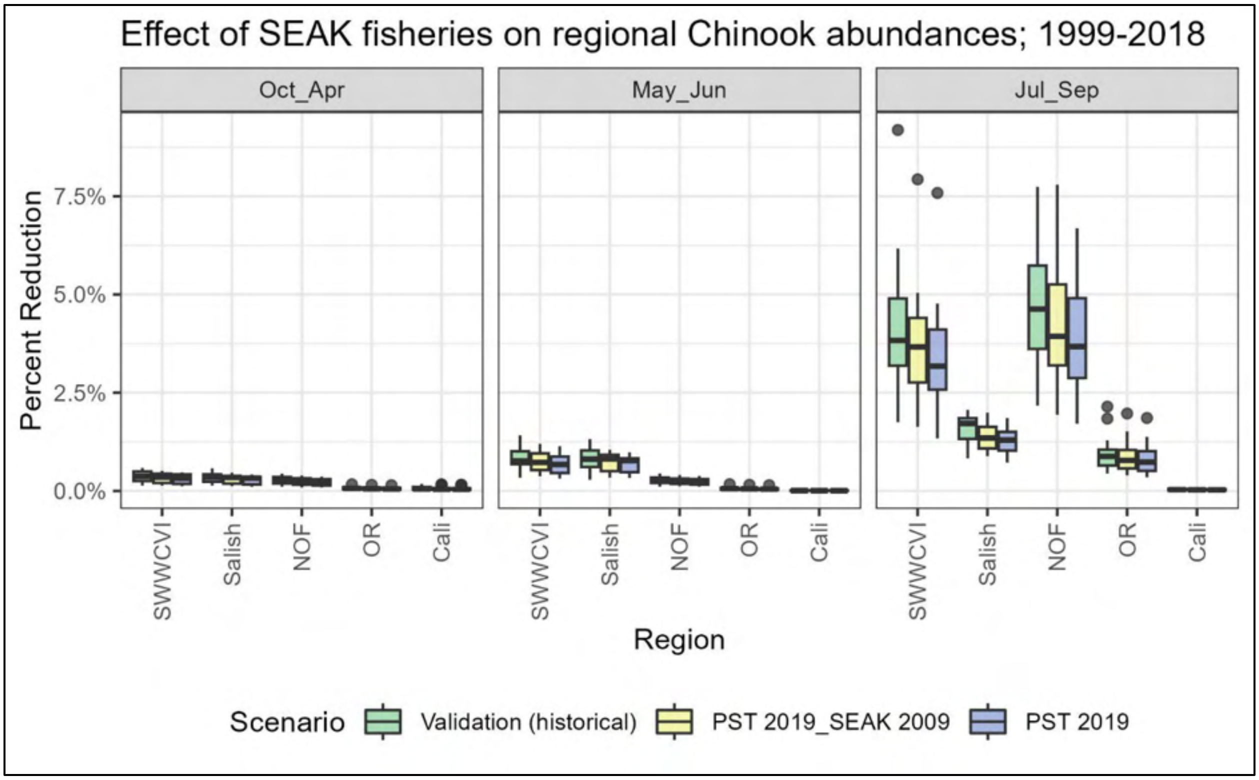
[55] We note that methods used here have been updated as compared to those used in the 2019 Opinion on the delegation of management authority to SEAK (NMFS 2019e), including the FRAM-Shelton model, which includes the 'coastal' area refined further in four spatial boxes (see Appendix D). As such the results presented here are not comparable to those in the 2019 Opinion. The methods used here align with the recent PFMC Workgroup (PFMC 2020), and other recent fisheries Opinions (NMFS 2021c; 2024b).

time step, although most reductions displayed in that time step actually occur during those months.



Note: box-and-whisker plots display a box representing the first quartile, median, and third quartile as the lower bound, midline, and upper bound of the box, respectively, the whiskers representing the minimum and maximum values, and the dots representing outliers which are values beyond 1.5*IQR (interquartile range, or distance between the first and third quartiles).

Figure 92. Projected percent prey reductions (Chinook salmon ages 3+) by SEAK salmon fisheries under three scenarios by time step (columns) and region (x-axis). "Validation (historical)" (green) represents historical SEAK salmon fisheries reductions from 1999-2018 (i.e., validation runs in Section 2.4.4; see Appendix B Table B2). "PST 2019_SEAK 2009" (yellow) represents expected prey reductions by SEAK salmon fisheries under the previous 2009 PST Agreement, with all other fisheries operating under the current 2019 PST Agreement levels (Scenario 3) (Appendix E Table E1a). "PST 2019" (purple) represents expected prey reductions due to SEAK salmon fisheries under the current 2019 PST Agreement levels (Scenario 2) (Appendix E Table E1b). Midline of the boxplots represents the median. See PFMC (2020) for a description of the spatial regions.

On average, under the 2019 PST Agreement, SEAK salmon fisheries are expected to reduce SRKW prey abundance annually by 3.5% in SWWCVI, 1.3% in the Salish Sea, and 4% in NOF. This translates to an annual average of 22,500, 13,000, and 37,000 fish in each area, respectively (Appendix E Table E.2). Annual average prey reductions in Oregon and California[56] are expected to be much lower (0.8% and 0.03%, respectively) and are not expected to be meaningful to the SRKW prey base in those areas. There is one outlier in the retrospective analysis for the SWWCVI region, 2007, where SEAK salmon fisheries under the 2019 PST

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[56] Prey reductions in California due to SEAK fisheries comprise Oregon stocks only. California stocks are not expected to be affected by SEAK salmon fisheries, due to a lack of California stocks in SEAK catch data (JCTC 2022) and the unlikelihood that California stocks that migrated to SEAK and escaped the fishery would also migrate back to California as an adult.

Agreement would be expected to reduce prey abundance by 7.6% (Figure 92), or just over 33,000 fish. This impact is exacerbated by 2007 having the second lowest year of abundance in that region in the time series (Appendix B Table B.1). Otherwise, all prey reductions in that region are expected to be below 5% based on the range of Chinook salmon abundances seen in 1999-2018. All prey reductions in the Salish Sea and NOF due to SEAK salmon fisheries are expected to be below 2% and 7%, respectively, for the range of abundances seen in 1999-2018. Note that fishing in 2019 and 2020 (see Section 2.4.4.1.4) were within the range projected above.

While overall annual prey reductions in the regions described above are relatively low due to SEAK salmon fisheries, there are times and areas of interest that are important for SRKW foraging. As described in the Status of the Species (Section 2.2.3.1), SRKW are primarily found in the Salish Sea (and SWWCVI) during the summer-fall months, and in coastal waters (primarily NOF) during the winter months. As such, we assess prey reductions due to SEAK salmon fisheries during those times and locations. During the winter and spring seasons (FRAM time steps October-April and May-June), reductions due to SEAK salmon fisheries (2019 Likely scenario) are very small, averaging less than one half of 1% across all spatial regions (Figure 92; Appendix E Table E.1). During the summer-fall months (FRAM time step July-September), reductions due to SEAK salmon fisheries (2019 Likely scenario) are higher than winter or spring in all areas, but particularly in the Salish Sea and SWWCVI (values described above) (Figure 92; Appendix E Table E.1), when SRKW are expected to be in those areas. Given that SRKW have been arriving in the Salish Sea later in the year compared to historical patterns (NMFS 2021m; Ettinger et al. 2022), indicating that they are spending more time in coastal waters (and likely nearby in the SWWCVI and NOF regions), summer-fall reductions in coastal areas are also of interest. Reductions due to SEAK salmon fisheries are highest in NOF (an area of high use by SRKW) during the summer-fall, averaging 4% but reaching as high as 7% in some years (Figure 92; Appendix E Table E.1). If this pattern continues, SRKWs may be more affected by the relatively greater percent reduction in NOF during the July-September FRAM time step than they were in previous years.

As described earlier, higher reductions in relatively low abundance years may be of concern to the SRKW population, which may be prey deficient in certain years (Couture et al. 2022) and presents with varied numbers of skinny individuals with reduced body condition each year (Fearnbach and Durban 2023). In the retrospective analysis for SEAK salmon fisheries, low salmon abundance years in the NOF region include 1999, 2000, and 2007 (as established by the PFMC Workgroup which, in part, inform the threshold set forth in Amendment 21 to the PFMC salmon FMP; see Environmental Baseline, Section 2.4.4 for further details). However, the low abundance years which informed the threshold included some years which were relatively good status years for SRKW, including 2007 (PFMC 2020; NMFS 2021i). If salmon abundance in the future is similar to 1999 and 2000, prey reductions in NOF due to SEAK salmon fisheries are expected to be lower than the average of 4% (3.54% and 2.92%, respectively) (Appendix E Table E.1). Prey reduction due to SEAK salmon fisheries in a year with salmon abundance at 2007 levels is expected to be 5.83% in NOF, which is higher than the average expected reduction in NOF (4%), and if realized may contribute to reduced prey availability in a year with potential nutritional stress. As described above, 2007 was also an outlying high prey reduction year in SWWCVI.

If prey reductions due to SEAK salmon fisheries occurred non-homogenously throughout a region, it may result in localized depletions, which could present another high risk scenario to the SRKW population if those localized density effects a) overlapped with known foraging hot spots, and/or b) occurred in times/areas where SRKWs are expected to occur. However, given that SEAK salmon fisheries occur far away in time and space, we are unable to determine how or if prey reductions would vary within each of the five geographic regions assessed, or cause finer-scale density effects.

In general, the model predicts that percent reductions from the SEAK salmon fisheries in NOF may not necessarily be smaller during low Chinook salmon abundance years. This pattern likely reflects the fishery management measures designed to limit catch of Chinook salmon in SEAK. This indicates the AI calculation to set the Chinook salmon catch limit in AABM fisheries may not annually correspond to the total Chinook salmon abundance calculated in the NOF area that is important to SRKWs. However, we note that if the NOF abundance in the future was similar to 2007 levels, it would be below the 2023 threshold (623,000) which would trigger additional protections for SRKW under Amendment 21 to the Pacific Coast Salmon Fishery Management Plan, which is intended to minimize the effects of the PFMC salmon fishery on prey availability to SRKW.

Energetic Requirements

It is helpful to consider the magnitude of prey reductions and prey abundance in the context of each season along with the energetic needs of the whales. To consider the prey reduction from SEAK salmon fisheries in context of the energetic needs of the whales, in previous opinions we have estimated the post-fishing Chinook salmon food energy available (in kilocalories (kcal)) compared to the current population's metabolic needs, and we take that approach here as well.

We estimated the range of post-fishing abundances we are likely to see over with all fisheries operating under the 2019 PST Agreement levels and other likely domestic constraints (Figure 93). These abundance values represent expected Chinook salmon (age 3+) after both fishing and natural mortality, including SRKW predation. Annual variation in Chinook salmon abundance is a greater contributor to prey availability than fisheries alone, and the following analysis helps put in context the extent to which fisheries reduce available kilocalories.

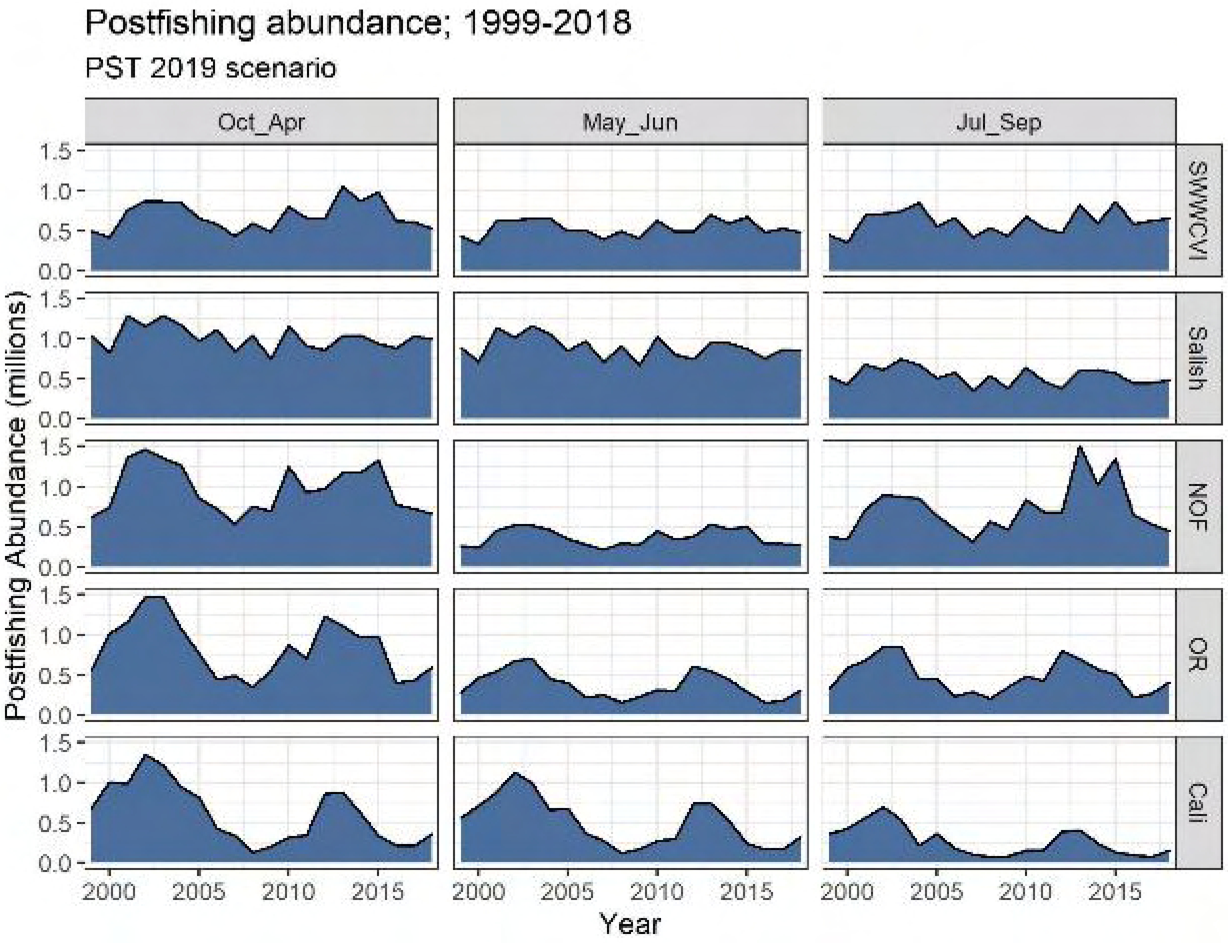

Figure 93. Expected post-fishing prey abundance (Chinook salmon age 3+) by time step (columns) and region (rows) under the 2019 PST Agreement and other likely domestic constraints in a retrospective analysis from 1999-2018. See PFMC (2020) for a description of the spatial regions.

We calculated the daily prey energy requirements (DPER) for the current population of SRKWs based on methods outlined in (NMFS 2019g) derived from body mass equations in Noren (2011) for age- and sex-specific energy needs, including an upper (maximum) and lower (minimum) bound on the estimates. Prey energy requirement calculations do not include increased energetic cost of body growth for juveniles or increased energy cost from lactation for females, as these are currently unknown. We combined the sex- and age-specific DPER with the population census data to estimate DPER for all members of the SRKW population, based on the population size and demographic make-up as of January 2024 (74 whales age 1+ years, see https://www.orcanetwork.org/births-and-deaths) (considering calves born in 2023 as age 1 in 2024). We multiplied the DPER 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), using the average of the maximum likely occurrence of the number of days in inland waters from 2017-2021 (see Figure 25 in the Status of the Species, Section 2.2.3.1). We subtracted out the number of days inland to derive the coastal occurrence days as any days not sighted in inland waters are assumed to mean the SRKW are in coastal waters. Coastal occurrence here means any of the coastal spatial regions from PFMC (2020)—SWWCVI, NOF, Oregon, and California—and any other locations not included. We do not have enough data to determine the number of days SRKWs occur in each of the coastal spatial regions described by PFMC (2020). Next, we summed the DPER across pods by time periods and multiplied by the percent of Chinook salmon in the diet for each time period (55% for October-April; 97% for May-June; 71% for July-September) using diet proportions as described in NMFS (2019g)), and then summed across time periods for a yearly need. These estimates are presented in Table 99. With this approach, we are assuming that the SRKW's Chinook salmon needs in the recent past are representative of what they need in the future (i.e., this method 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.).

Table 99. Minimum and maximum seasonal energy prey requirements from Chinook salmon for the SRKW population as of January 2024 (74 individuals) using the maximum number of days in inland waters of Washington State for the recent past (2017-2022) for the three FRAM time steps. For a full description of methods please see NMFS (2019g).

Time Step	Chinook salmon prey needs (kcal)			
	Minimum		Maximum	
	Inland	**Coastal**	**Inland**	**Coastal**
October-April	255,494,954	1,166,745,988	306,839,983	1,402,387,314
May-June	84,905,253	636,827,136	102,015,008	765,351,880
July-September	250,743,330	546,004,340	301,283,335	656,235,765
Annual Total	591,143,537	2,349,577,463	710,138,327	2,823,974,960

Based on our analysis, the overall yearly energetic needs of SRKW from Chinook salmon ranges from 591 million kcal while in inland waters to 2.8 billion kcal while in coastal waters. The highest Chinook salmon kcal requirement occurs in coastal waters during the October-April timeframe, which reflects both the larger number of days in that season, and a greater amount of time spent in coastal waters. We note that Puget Sound salmon fishery co-managers also calculate caloric needs for SRKWs using slightly different methods but with similar findings in Puget Sound (NMFS 2023a; Parker 2023).

Annual post-fishing Chinook salmon abundance estimates (Figure 93) were converted to kcal based on the estimated lipid content of specific stocks by size and age (data from O'Neill et al. (2014)), using the methods as described in the 2019 Puget Sound salmon fisheries consultation (NMFS 2019g). Averaging across the time series, based on this analysis, there are approximately 5.5 billion kcals of Chinook salmon estimated to be available in the Salish Sea following all fisheries at 2019 PST Agreement levels and other likely domestic constraints, which is 7.7 to 9.3 times greater than the total annual metabolic needs for SRKW in inland waters. This would increase to 5.7 billion kcals of Chinook salmon available in the Salish Sea if SEAK salmon fisheries were not to occur, leaving 8 to 9.6 times greater Chinook salmon than annual inland metabolic needs for SRKW. Additionally, there are approximately 20.7 billion kcals of Chinook salmon estimated to be available following fisheries in coastal waters (SWWCVI to California), which is 7.3 to 8.8 times greater than the total annual metabolic needs for SRKW. This would increase to 21.5 billion kcals of Chinook salmon available in coastal waters if SEAK salmon fisheries were not to occur, leaving 7.6 to 9.1 times greater Chinook salmon than annual coastal metabolic needs for SRKW. Therefore, although the proposed SEAK salmon fishing would reduce the amount of prey available, with the SEAK fisheries operating at 2019 PST Agreement levels we expect there will be more Chinook salmon kcals available than what is required metabolically by the whales, following recent trends of occurrence and Chinook salmon diet composition. However, we are unable to quantify how the reduction resulting from the SEAK fisheries affects foraging efficiency of SRKWs. As described above, larger reductions in low abundance years[57] would result in proportionally fewer kilocalories available to the whales, and may present added concern.

Priority Chinook Salmon Prey Stocks

As described in the Status of the Species (Section 2.2.3.1), NMFS and WDFW identified Chinook salmon stocks that are thought to be most important to SRKWs.[58] The factors that led to the priority ranking include 1) observed to be in the diet, 2) consumed during winter (vulnerable) months, and 3) degree of spatial and temporal overlap with the stock. Some of these priority stocks are caught in the SEAK salmon fisheries. The stocks contributing the most to the SEAK salmon fisheries catch include the Columbia Upriver Brights, WCVI hatchery, North Oregon coast, Northern BC, Fraser summer, and Mid Columbia River Brights, and Columbia River summer (contributing to over 75% of the fishery catch; Table 100). The Northern BC, WCVI hatchery, and North Oregon coast stocks are not currently considered in the top of the priority prey list for SRKWs (NOAA Fisheries and WDFW 2018); however, the Columbia Upriver Bright stock ranks as number three on the priority list. Fraser summer, Mid Columbia River Brights, and Columbia River summer rank 9, 4, and 8, respectively, on the SRKW priority prey list.

Between 1985 and 2020, an average of 18.9% of the SEAK salmon fisheries' catch was the Columbia Upriver Brights stock (JCTC 2022). On average, 11.87% of the stock's total return was caught in the SEAK salmon fisheries[59] (JCTC 2022). 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 not feasible that SRKWs would have encountered and consumed all the Columbia Upriver Brights that would be made available in the absence of the proposed actions.

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[57] In 2023 and 2024, the projected abundances of Chinook salmon in the NOF region was 889,900 and 815,900 fish, respectively, which are above the low abundance threshold set by Amendment 21 to the PFMC ocean salmon FMP, which is currently 623,000 (PFMC 2023b; 2024b).

[58] https://media.fisheries.noaa.gov/dam-migration/srkw_priority_chinook_stocks_conceptual_model_report___list_22june2018.pdf

[59] The most recent 3-year geometric mean spawning escapement for the Columbia Upriver Brights stock is 88,859 with a minimum stock size threshold (MSST) of 19,182 (PFMC 2023). 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 (2023b)).

Table 100. Fishery and stock catch from SEAK AABM troll net and sport (JCTC (2022), Appendix B1). Note that SEAK catch includes both ESA-listed and non-listed Chinook salmon stocks.[60]

Fishery:	**Southeast Alaska AABM Troll Net and Sport**				
	2021	**Average (1985-2020)**			
Model Stock	**% of Fishery Catch**	**% of Fishery Catch**	**% of Stock Catch**	**% of Stock Total Return**	**Associated Escapement Indicator Stocks***
Upriver Brights	18.79%	18.90%	21.50%	11.87%	Upriver Brights
WCVI Hatchery	21.86%	15.71%	28.56%	13.39%	NA
North Oregon Coast	6.86%	9.40%	21.92%	11.89%	Nehalem Siletz Siuslaw
Northern BC	1.69%	7.42%	67.30%	13.18%	Skeena
Fraser Summer Ocean-type 0.3	15.24%	7.34%	31.74%	12.15%	Lower Shuswap
WA Coastal Wild	5.30%	5.77%	33.67%	15.70%	Grays Harbor Fall Queets Fall Quilayute Fall Hoh Fall
Mid Columbia River Brights	6.39%	5.42%	19.31%	11.10%	Not Represented
Taku and Stikine	1.23%	4.39%	53.03%	9.91%	Taku Stikine
Southern SE AK	2.58%	3.91%	96.69%	32.13%	Unuk
WA Coastal Hatchery	4.13%	3.51%	32.65%	13.57%	NA
Columbia River Summer	4.76%	3.24%	18.21%	9.83%	Mid-Columbia Summers
Northern SE AK	1.08%	2.70%	99.63%	45.98%	Chilkat
Yakutat Forelands	0.00%	2.21%	0.00%	34.60%	Situk
WCVI Natural	3.55%	2.22%	30.64%	16.19%	NWVI Natural Aggregate SWVI Natural Aggregate
Mid-Oregon Coast	1.11%	2.00%	10.64%	5.48%	South Umpqua Coquille
Upper Georgia Strait	0.91%	1.16%	40.91%	13.48%	East Vancouver Island North Phillips
Willamette River Spring	0.71%	0.95%	6.35%	2.68%	NA
Fall Cowlitz Hatchery	0.71%	0.85%	3.12%	1.62%	NA
Central BC	0.24%	0.62%	28.81%	6.89%	Atnarko
Lewis River Wild	0.84%	0.59%	16.05%	5.62%	Lewis
Middle Georgia Strait	0.75%	0.41%	9.71%	3.10%	NA
Harrison Fall	0.29%	0.32%	1.83%	0.53%	Harrison
Puget Sound Fingerling	0.24%	0.19%	0.38%	0.21%	NA
Fraser Summer Stream-type 1.3	0.10%	0.16%	3.29%	1.05%	Chilko
Skagit Wild	0.14%	0.11%	3.79%	1.32%	Skagit Summer/Fall
Spring Cowlitz Hatchery	0.05%	0.08%	1.58%	0.82%	NA
Alsek	0.10%	0.08%	46.37%	2.74%	Alsek

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[60] Some of the stocks presented in Table 102 are part of listed ESUs, and the terminology in the table may differ as compared to that used in Section 2.5.2, Chinook Salmon Effects, above.

Fishery:	**Southeast Alaska AABM Troll Net and Sport**				
	2021	**Average (1985-2020)**			
Model Stock	**% of Fishery Catch**	**% of Fishery Catch**	**% of Stock Catch**	**% of Stock Total Return**	**Associated Escapement Indicator Stocks***
Lower Georgia Strait	0.10%	0.11%	3.03%	1.25%	Cowichan
Lyons Ferry	0.11%	0.07%	1.93%	1.18%	Not Represented
Nooksack Fall	0.05%	0.06%	0.30%	0.20%	Not Represented
Puget Sound Natural Fall	0.02%	0.02%	0.33%	0.18%	NA
Chilliwack Fall Hatchery	0.03%	0.02%	0.19%	0.07%	NA
Nooksack Spring	0.03%	0.02%	4.87%	1.65%	Nooksack Spring
Puget Sound Yearlings	0.00%	0.01%	0.25%	0.16%	NA
Fraser Spring 1.2	0.00%	0.01%	0.45%	0.14%	Nicola
Pundledge Summers	0.01%	0.01%	5.83%	1.72%	NA
Snohomish Wild	0.00%	0.01%	1.03%	0.23%	Snohomish
Stillaguamish Wild	0.00%	0.00%	1.02%	0.39%	Stillaguamish
Fraser Spring 1.3	0.00%	0.00%	0.00%	0.00%	Chilcotin
Lower Bonneville Hatchery	0.00%	0.00%	0.00%	0.00%	NA
Spring Creek Hatchery	0.00%	0.00%	0.00%	0.00%	NA

*NA = a hatchery stock; Not Represented = a wild stock without an escapement indicator.

There are also priority Chinook stocks that are not large contributors to the SEAK salmon fishery catch, but a relatively moderate proportion of these stocks' total return are taken by the SEAK salmon fisheries. These include upper Georgia Strait (13.48% of the total return are caught in the SEAK salmon fisheries) and Washington Coast (15.7% of the total wild run return are caught in the SEAK salmon fisheries, and 13.75% of the hatchery return are caught in SEAK salmon fisheries) (Table 100). The Puget Sound Chinook salmon stocks are ranked high on the priority list, but make up a small proportion of the fishery catch and the SEAK catch is a low proportion of the total run size (Table 100). While the priority prey list serves as a guide to understand which impacted stocks may most impact SRKW, we emphasize that a diverse portfolio of Chinook salmon is important for SRKW to accommodate their diet year-round – including varied stocks, geographic locations, and run seasons.

In summary, the SEAK salmon fisheries catch will be reduced by up to 7.5% relative to what was allowed under the 2009 PST Agreement. The 7.5% reduction is for the entire fishery, and as the salmon analysis (Section 2.5.2) indicates, the effects of this reduction are not equal across all stocks of Chinook salmon, given that their different life histories and migratory patterns expose them to different rates of harvest in the SEAK salmon fisheries. Although the SEAK salmon fisheries could result in up to a nearly 8% reduction in the prey available to the whales in the SWWCVI region (e.g. in 2007), this occurrence is an outlier would likely occur rarely (average reduction is 3.5%) and during a time period (July-September) when the whales are more often observed in inland waters. However, recent trends in SRKW occurrence suggest July-September in coastal areas may be of greater importance than in the past. In addition, prey reductions in NOF have occasionally reached 6-7%. The maximum prey reductions in the Salish Sea could be up to 2% during the summer months. Larger increases in prey reduction in coastal and inland waters would have the biggest impact in low abundance years. Although the proposed fishing would reduce the amount of prey available, we expect there will be more Chinook salmon kcals available than what is required metabolically by the whales, following recent trends of SRKW occurrence and Chinook salmon diet composition. Lastly, some of the Chinook salmon caught in SEAK are from priority runs for SRKWs. However, with the exception of the Columbia River Brights that have a relatively large run size, the largest stocks contributing to the SEAK salmon fisheries catch are currently not considered at the top of the priority prey list for SRKWs (NOAA Fisheries and WDFW 2018).

2.5.3.1.2 Long-Term Effects

In considering long-term effects of the proposed action on the SRKW prey base, we rely, in part, on the long-term effects to salmon, specifically Chinook salmon. Final recovery plans have been adopted for all ESA-listed 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 other relevant information 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 in this Opinion, NMFS reviewed the status, environmental baseline, effects of the proposed actions, and cumulative effects for each listed Chinook salmon ESU. As described in Sections 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 abundance in the ocean by comparing a 40% 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 PST Agreement will respond to reduced abundance in terms of effect on exploitation rates and resulting escapements. Although unlikely to occur, that scenario assessed how the 2019 PST Agreement would respond to a precipitous drop in abundance due to any number of reasons, including if a prolonged and broad scale downturn 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 Sections 2.5.2.5). However, the responsiveness of the regime (e.g. reduced exploitation rates) does not necessarily 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. 7.6% in SWWCVI).

Although the effects from the SEAK salmon fisheries include reducing prey available to SRKWs, the likelihood that higher percent reductions from the SEAK salmon fisheries (e.g. 7.6% in SWWCVI) coupled with multiple consecutive low abundance years will occur is low, based on recent trends.[61] The overall annual prey reduction anticipated in all areas is anticipated to be on the order of 5% or less (Figure 92).

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[61] The forecasted Chinook salmon abundances in the NOF region for 2023 and 2024 are above the low abundance threshold (PFMC 2023b; 2024b), and for the Puget Sound region the forecasted Chinook salmon starting abundances for the 2023-2024 and 2024-2025 seasons are higher than the recent 10-year averages of post-season estimates (NMFS 2023a and 2024c).

2.5.3.2 Effects to Southern Resident Killer Whale Critical Habitat

In addition to the indirect effects to the species discussed above, the proposed actions affect critical habitat designated for SRKWs. Based on the natural history of SRKWs and their habitat needs, we identified three physical or biological features essential for the conservation of SRKWs: (1) Water quality to support growth and development, (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 (50 C.F.R. 226.206). This analysis considers effects to these features.

We do not expect the proposed action to impact water quality or passage because there is no overlap of the fisheries and SRKW critical habitat. The proposed action has the potential to affect the quantity and availability of prey in critical habitat. As described previously, the focus on Chinook salmon provides a conservative estimate of the potential effects of the action on the prey feature of critical habitat because the total abundance of all salmon and other potential prey species within the critical habitat is orders of magnitude larger than the total abundance of Chinook salmon.

We would not expect any impacts from the proposed action on prey quality with respect to levels of harmful contaminants. However, as described in the environmental baseline for SRKWs (Section 2.4.4), size and age structure in Chinook salmon has substantially changed across the Northeast Pacific Ocean since the 1970s. Across most of the region, adult Chinook salmon (ocean ages 4 and 5) are becoming smaller, the size of age 2 fish are generally increasing, and most of the Chinook salmon populations from Oregon to Alaska have shown declines in the proportions of age 4- and 5-year olds and an increase in the proportion of 2-year olds (mean age in populations has declined over time) (Ohlberger et al. 2018). Strength of trends varied by region (see the environmental baseline). The declining trend in the proportion of older ages in Washington stocks was observed but was slightly weaker than that in Alaska. (Ohlberger et al. 2019) found that reasons for this shift may be largely due to direct effects from size-selective removal by resident killer whales and fisheries. Through simulation modeling, Ohlberger et al. (2019) found evidence that harvest, in comparison to resident killer whale predation, had a "weaker effect" on the observed changes in Chinook salmon mean body size, and that in the simulations, harvesting alone could not explain changes in size (without predation also) in the past 50 years. The simulations suggested that harvest impacts on size were likely stronger in the earlier period of the simulation and less so in more recent periods as harvest rates have declined while resident killer whale predation has increased, and that size composition may have at least partly recovered with the decline in harvest over the last decades if predation pressure had not increased. Therefore, we would not expect the current level of harvest to appreciably decrease Chinook salmon size (i.e., quality) thereby reducing the conservation value of the prey feature.

However, as described above, we do expect adverse effects of the proposed SEAK salmon fishing by reducing prey quantity and availability in critical habitat resulting from the harvest of adult salmon. The extent of reductions in adult Chinook salmon in the action area due to SEAK salmon fisheries is described in detail in the Effects analysis for SRKWs above. The reductions of age 3+ Chinook salmon in designated critical habitat from the SEAK salmon fisheries are expected to range from < 0.1% – 7.6%, depending on the region, 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. It is difficult to assess how reductions in prey abundance may vary throughout critical habitat (including the five regions assessed above), and specifically how or whether localized depletions or density effects could occur due to SEAK salmon fisheries within the spatial regions assessed within designated critical habitat.

As described above, we also estimated the Chinook salmon food energy available to the whales and compared available kilocalories to needs and evaluated the reduction due to SEAK salmon fisheries. We anticipate that the retrospective analysis of post-fishing prey availability is representative of what is happening under the 2019 PST Agreement. While overall Chinook salmon prey availability is larger than needed to meet the current SRKW population's metabolic needs, we are unable to quantify how reduction due to SEAK salmon fisheries affects the foraging efficiency of the whales. When prey is scarce, SRKWs 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.

Finally, although a majority of the SEAK salmon fisheries catch is from stocks that originate from and return to SRKW critical habitat (see Table 102), the stocks making up the largest component of that catch are not identified to be priority stocks for SRKW prey. Only one, Columbia Upriver Brights, rank high on the SRKW priority prey list (NOAA Fisheries and WDFW 2018). However, any stocks that may overlap in time and space with SRKW are deemed important prey.

2.5.4 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 the primary 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 component 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 an expected interaction for Steller sea lions. Not all entanglements or interactions will cause M/SI, and the M/SI outcomes of entanglements or interactions will now always be known. Therefore, we will analyze the interaction (entanglement) rate and estimate the portion of that interaction that is likely to be M/SI.

Other potential impacts could occur as a result of the fishery, such as vessel collisions with marine mammals, impacts related to any pollution or marine debris generated by fishing vessels, or disturbance from 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.

At this time, the available information does not suggest that any of these additional other potential impacts 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. And, while competition with fisheries for prey is considered a threat in the recovery of the western DPS of Steller sea lions, salmon is not the target species driving this concern (NMFS 2008k). Because ship strikes of Steller sea lions are very rare and none have been identified or attributed to salmon fishing vessels or activity, we consider the risk of vessel collision to be discountable (Young et al. 2023). While there are records of vessel strikes of humpback whales in SEAK, none of these encounters have been identified with or attributed to salmon fishing vessels or activity in the SAR (Young et al. 2023). Disturbance, marine debris, and pollution from fishing vessels is not well understood and we do not have data on these potential stressors. Without evidence to support analyses of how these factors may affect ESA-listed species as a result of the proposed action or evidence to suggest they are actually impacting ESA-listed species, NMFS assumes these factors are insignificant and/or discountable. As a result, the effects analysis will concentrate on the impact of interactions between ESA-listed species and fishing gear used in the SEAK salmon fisheries. For this Effects of the Action analysis, we summarize the available information that indicates humpback whales and Steller sea lions are subject 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 DPS Steller sea lions, respectively) and their anticipated response to these interactions.

2.5.4.1 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) that occur incidental to each fishery for marine mammal stocks[62] 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 between marine mammals and commercial fisheries (frequent, occasional, and remote likelihood of an interaction or no known interactions, respectively) that result in M/SI of marine mammals. In order to categorize fisheries, NMFS often relies upon data provided by 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 self-reporting where fishermen report mortalities and injuries directly to NMFS. The Marine Mammal Authorization Program provides a framework for self-reporting and informs fishermen of their obligation to self-report mortality and injury with marine mammals incidental to fishing in order to comply with Section 118 of the MMPA (16 U.S.C. 1387). While the self-reporting requirement exists for all fisheries regardless of LOF Category, fishermen in Category I and II fisheries are required to enroll in the Marine Mammal Authorization Program and carry documentation (annual certificates) onboard that outline their obligations to report and provide guidance on how to report these to NMFS. Fishermen are

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[62] Stocks as defined under the MMPA. These may not necessarily coincide with ESA-listed populations of marine mammals (e.g.,the Mexico-North Pacific stock of humpback whales is a subset of the ESA-listed Mexico DPS of humpback whales).

automatically enrolled through their certificates and the documentation is mailed to permit holders. Still, the level of compliance with the statutory and regulatory requirement to self-report through the Marine Mammal Authorization Program is unknown and NMFS considers these data in marine mammal management, but acknowledges that they are likely incomplete and should be considered minimum estimates.

The 2024 LOF classifies two SEAK fisheries as either Category I or II fisheries. The AK Yakutat salmon set gillnet (generally referred to as commercial SEAK set gillnet herein) is classified as a Category II fishery signifying that occasional interactions that result in M/SI of marine mammal stocks occur: However, that classification is driven by M/SI of unlisted harbor porpoise stocks, and the Mexico - North Pacific stock of humpback whales are the only ESA-listed stock that is listed as an interacting stock that may be incidentally killed or injured by this fishery. The AK Southeast salmon drift gillnet (generally referred to as commercial SEAK drift gillnet herein) is classified as a Category I fishery signifying that frequent interactions that result in M/SI of marine mammal stocks occur:[63] However, that classification is driven by unlisted harbor porpoise stock, and the Mexico - North Pacific stock of humpback whales are the only ESA-listed stock that is listed as an interacting stock that may be incidentally killed or injured by this fishery. That said, in addition, the unlisted eastern DPS Steller sea lion population is included as a marine mammal stock that may be incidentally killed or injured by this fishery due to a historic record (previous to the data window for this analysis described below), and this may have included a fraction of western DPS Steller sea lions that occur in SEAK and overlap with eastern DPS Steller sea lions.

All of the other SEAK salmon fisheries are classified as Category III fisheries, signifying remote levels of interactions that result in M/SI of marine mammal stocks occur or no known interactions occur, including: AK Southeast salmon purse seine; AK salmon troll (includes commercial SEAK troll fishing); and AK/WA/OR/CA commercial passenger fishing vessel fishery (includes salmon charter fishing).

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, AMMOP observers were deployed in the SEAK set gillnet fishery. In 2008, there was a Steller sea lion interaction documented by an AMMOP observer (offwatch and not actively observing) in this fishery (Manly 2009). During this period, where 6.3% of the total fishing effort was monitored by AMMOP observers, no other marine mammal interactions were observed in the fishery. In 2012 and 2013, AMMOP 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 ADF&G Districts 106, 107, and 108; see Figure 94). During this period, approximately 6.5% of total fishing effort in these districts was monitored by AMMOP 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 (marine mammal SARs: Young et al. 2023). 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). Bycatch includes

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[63] https://www.fisheries.noaa.gov/national/marine-mammal-protection/list-fisheries-summary-tables

momentary contact with fishing gear (blow-through interactions), entanglement and drowning in fishing gear, and extended entanglements that may persist with animals for hours, weeks, or even years. Extended entanglements may result in reduced fitness, growth, annual survival, reproductive success, and/or survival of the affected individual. In addition, data were collected by AMMOP observers in this fishery on the number of "blow-throughs", where sizable portions of netting were found to be damaged when nets were retrieved. While the source of the damaged gear of most blow-throughs was unknown, it is understood from analyzing the size of the hole in the net that these were primarily a result of humpback whales swimming through the net and to a lesser extent attributed to other smaller marine mammals (Manly 2015). Most blow-throughs are thought to be a temporary contact with fishing gear, where the whale swims through the gillnet without getting wrapped by the float line, the lead line, or the gillnet and are generally able to push through the netting cleanly without becoming entangled, though the potential exists for animals to acquire netting and retain some amount of gear during a blow-through. Therefore, blow-throughs are considered interactions in this analysis. There were 3 humpback whale blow-throughs that were observed in each year (2012 and 2013); all 6 events occurred in District 106. Extrapolating 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.

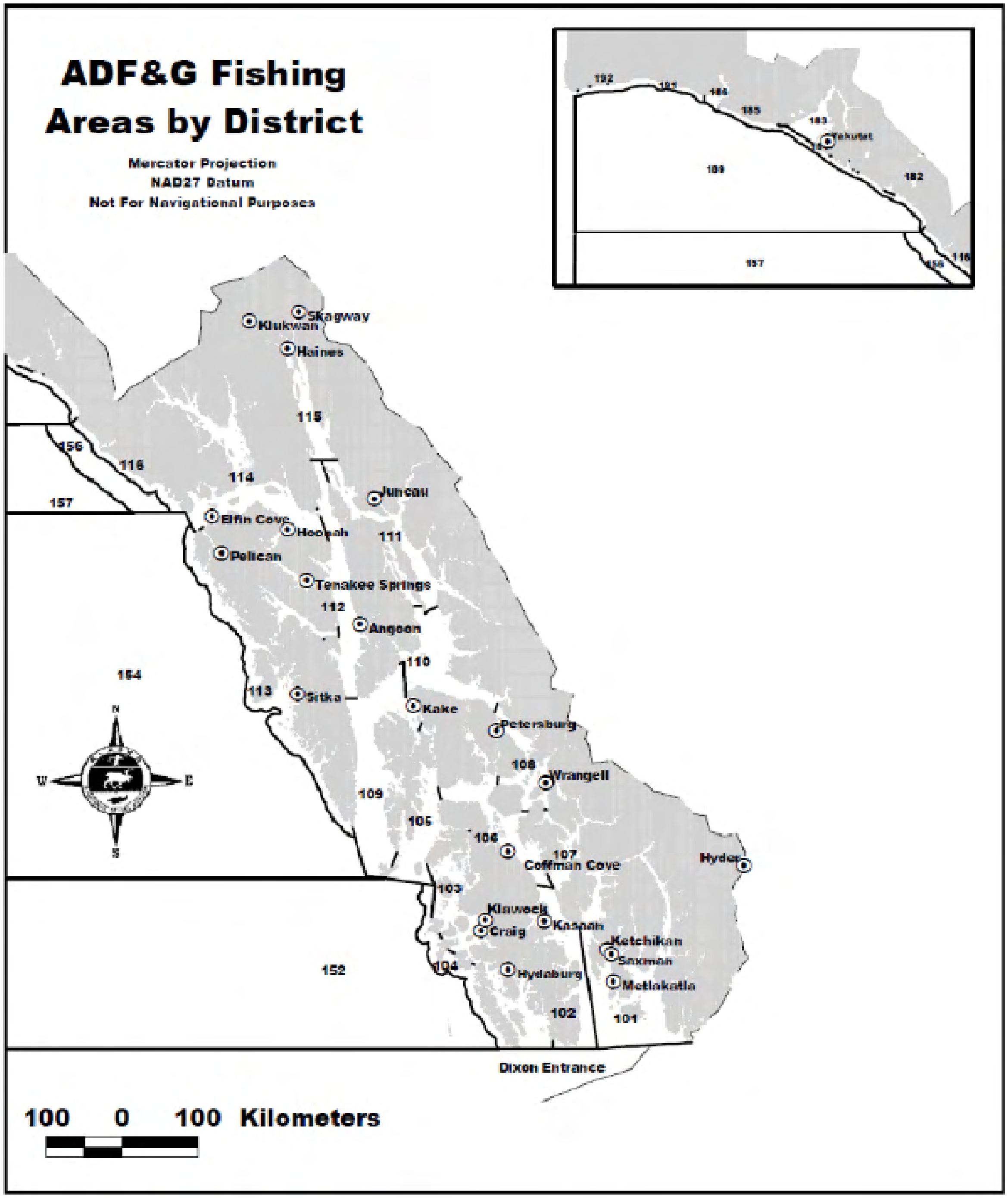

Figure 94. Map of ADF&G salmon fishing districts.

As mentioned above, due to 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 Marine Mammal Authorization Program (fishermen self-reports as required by the MMPA) to evaluate the relative impact of interactions of 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 (Young et al. 2023) and the Human-caused mortality and injury of NMFS-managed Alaska Marine Mammal Stocks (M/SI report) published annually (Freed et al. 2023). These data are collected opportunistically and typically are not extrapolated within the SARs into more comprehensive estimates of total strandings or human interactions that may have occurred as there is no standardized effort from which an extrapolation can be based, thus 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 reports and draft reports and evaluate the portion of these interactions likely to be interactions with ESA-listed species.

Given the limitations of observer coverage and stranding program coverage and the uncertainty in self-reporting levels, NMFS acknowledges that estimates are minimum estimates. Therefore, we attempt to account for uncertainty wherever possible. This is accomplished by extrapolating observer estimates to unobserved portions of the fishing effort and by including estimates of interactions and M/SI from unknown fishing gear where salmon fishing cannot be ruled out as the potential source: these estimates are presented as "reasonably certain" to occur.

The methods for summarizing and, where relevant, extrapolating these data and estimates are substantially modified from the previous 2019 Biological Opinion. We have several more years of marine mammal fisheries interaction records, data analyzed in more recent SARs, and a revised stock structure for humpback whales under the MMPA, along with additional information on the rate of occurrences of humpback whales and Steller sea lions in SEAK since the previous 2019 Biological Opinion. Thus, we made modifications to incorporate this best available data into the analysis in this Opinion and also made changes that substantially improved clarity and readability in this analysis.

2.5.4.2 Summary of Humpback Whale Interactions with SEAK Fisheries

SEAK is a mixing zone for humpback whales from the Hawai'i stock (Hawai'i DPS) and Mexico-North Pacific Stock (a portion of the Mexico DPS); however, because it is not possible to differentiate the stock or DPS of humpback whales reported, each interaction is reported in both SARs from the mixing zone. The most recent SAR for the Mexico - North Pacific humpback whale is the 2022 SAR (88 FR 54592, August 11, 2023) and uses data from 2016-2020, and represents that subset of the DPS equivalent. The reporting window in the most recent annual M/SI report (Freed et al. 2023) is the 5-year window (2017-2021). M/SI report data are finalized prior to their addition into the SAR, therefore, there is a lag in these data windows in the SAR. Additional data are considered and incorporated, as deemed necessary.

With respect to fisheries and/or fishing gear that are confirmed to be or may be associated with SEAK salmon fisheries, the 2022 SARs describes the following information and totals for average annual M/SI for all humpback whale (presented below as combined data with both Hawaii stock/DPS and Mexico - North Pacific stock/Mexico DPS together and are allocated by DPS later in the analysis):

- Estimate of 5.5 (CV=1.0) mean annual mortalities per year in Districts 106, 107, and 108 in SEAK drift gillnet gear.
- Estimate of 1.40 mean annual mortalities per year due to entanglement in SEAK gillnet gear reported to the Alaska Marine Mammal Stranding Program (not included in the Districts 106, 107, and 108 observations).
- Minimum estimated total of 0.35 mean annual mortalities per year in unidentified SEAK fishing gear (gear that could potentially be salmon gear).

We note that the SARs only provide accounting of estimates of mean annual mortality based on interactions where M/SI was determined, and not the total number of interactions. In order to further understand the possible extent of interactions between humpback whales and SEAK salmon fisheries (i.e., to include interactions that may not necessarily lead to M/SI but may otherwise constitute take under the ESA), we reviewed all reports of interactions and human caused strandings of Mexico - North Pacific stock of humpback whales from 2017-2021 that are documented and evaluated for M/SI in Freed et al. (2023) and summarized them as follows:

- 15 incidents (3 per year) of humpback whale interactions with fishing gear in SEAK reported to NMFS that may involve salmon fishing gear.
- Of the 15 total interactions, where 10 incidents were identified as SEAK drift gillnet gear: 8 of those were accounted for in the SARs in the mean annual mortality estimates for SEAK drift gillnet (not all are = 1 M/SI) and 2 of these incidences were ultimately deemed to be non-serious injuries (NSI; interactions with no M/SI but that are also take).
- 1 incident (0.2 per year) involving SEAK purse seine gear that resulted in mortality.

The only incident reported with unidentified SEAK fishing gear (that could potentially have been salmon fishing gear) had M/SI attributed to it (so is reported above in the SARs) and there are no additional reports to reference.

2.5.4.3 Summary of Steller sea lion Interactions with SEAK Fisheries

The most recent SARs for the Western stock of Steller sea lions (2020 SAR, using data from 2014-2018 and found in Young et al. (2023)) 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 stock/DPS delineation line at Cape Suckling (144º W) the SARs generally attribute Steller sea lion interactions that are documented east of the line at Cape Suckling to the Eastern stock SAR. However, as described previously and as described in the guidance memo issued by the NMFS Alaska Regional Office (NMFS 2020k) there is mixing of western DPS Steller sea lions and eastern DPS Steller sea lions east of Cape Suckling. The area of mixing includes the SEAK waters north of Sumner Strait, which is located in SEAK in the vicinity of Kupreanof and Kuiu Islands, near Petersburg. As a result, we examined the available information relating interactions with the Eastern stock of Steller sea lions to help inform general Steller sea lion interactions with SEAK salmon fisheries.

The most recent SARs for the Eastern stock of Steller sea lions (2019 SAR, using data from 2013-2017 and found in Young et al. (2023)) provides a summary accounting of human caused mortality and serious injuries that is used in this analysis. Thus this 5-year window (2013-2017) is the primary window for Steller sea lion analysis, and it has been supplemented with data from

Freed et al. (2023; 2017-2021 data) and other additional data where necessary. 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:

- There were 165 incidents of hooked and/or entanglement interactions (33 per year) with SEAK commercial and recreational troll fisheries reported to NMFS from 2013-2017.
    - Of these, at least 158 (31.6 per year) were identified as salmon fishing gear and the remaining are gear for unknown or unspecified target species, but that could be salmon fishing gear.
- The 2020 SAR notes that (typically) it is not discernible whether salmon troll gear interactions documented involved recreational or commercial components of the fishery. Thus, we summarize these together in this Biological Opinion.

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 but may otherwise constitute take under the ESA, we reviewed all reports of interactions and human caused strandings and self-reports of the Eastern stock of Steller sea lions from 2017-2021 that are evaluated for M/SI in Freed et al. (2023). Note that this report has a different temporal window from the current 2019 SAR (2013-2017 versus the annual M/SI report 2017-2021). In summary, Freed et al. (2023) describes:

- A total of 70 incidents (14 per year) of interactions reported to NMFS from 2017-2021 between Steller sea lions and fishing gear in SEAK that may involve salmon fishing gear.
    - Of the 70 interactions, 68 interactions were from salmon troll gear. Of these, 4 were hooked in the mouth and classified as non-serious injury (NSI; interactions with no M/SI but that are also take). The remaining 64 interactions (12.8 per year) are reports of Steller sea lions with flashers hanging from their mouths. In these cases, the salmon troll hook is generally swallowed and the entanglement is likely fatal. Consequently, these are recorded as a full M/SI (= 1/each).
    - 1 of the 68 flasher/hook entanglements was initially deemed serious injuries, but that animal was anesthetized and disentangled and thought to have a much higher chance of survival after the intervention.
    - Of the 70 interactions, 2 were from unidentified SEAK fishing gear (gear that could potentially be salmon fishing gear - monofilament, hooks, etc.). Of these, both interactions were assigned 1 M/SI each, resulting in 0.4 M/SI per year.
- No incidents involving SEAK gillnet fisheries or the SEAK purse seine fishery were documented.

2.5.4.4 Exposure of ESA-listed Marine Mammals

As described earlier in the Status of the Species and in the Effects Analysis sections above, humpback whales from both the listed Mexico DPS and the unlisted Hawaii DPS mix in SEAK. The 2022 SARs for humpback whales in the U.S. Pacific revised the stock structure for humpback whales (Young et al. 2023). The Central North Pacific stock is now broken out into separate stocks, including the Mexico - North Pacific and Hawaii stocks. Note that the newly designated Mexico - North Pacific stock is a subset of the ESA-listed Mexico DPS and the newly designated Hawai'i stock is equivalent to the unlisted Hawai'i DPS (see humpback whale Status of the Species). The 2022 SARs employ the NOAA 'Occurrence of Endangered Species Act (ESA) Listed Humpback Whales off Alaska' guidance document to partition takes documented in the Central North Pacific stock to Mexico - North Pacific stock and Hawai'i stock for SEAK data (NMFS 2021l). We use the same rationale and NOAA guidance in the following exposure analysis, assigning 2% of the total SEAK humpback whales estimates to the ESA-listed DPS (Mexico DPS).

Also described earlier in the Status of the Species and in this Effects section above, mixing of the western DPS Steller sea lions with eastern DPS Steller sea lions occurs in SEAK. We use the NOAA 'Occurrence of Western and Eastern Distinct Population Segment Steller Sea Lions East of 144° W. Longitude' guidance document (NMFS 2020k). We use the rationale from the NOAA guidance following Hastings et al. (2020) in the following exposure analysis and apply these to the non-pup abundance estimates (Sweeney et al. 2023) to distill an overall western DPS occurrence rate for all Steller sea lions throughout SEAK. Non-pup numbers are used because a pup in SEAK is assumed to be from the eastern DPS since the western DPS is defined as Steller sea lions born west of 144° W. Long. (50 C.F.R. 224.101). An overall occurrence estimate for SEAK is necessary for a few key reasons. Listed western DPS and unlisted eastern DPS Steller sea lions are both present in SEAK and thus any potential interaction could be from either DPS. Also, we do not have spatial data to estimate whether the number of interactions, if any, that could occur in the specific regions for which we have an estimate of the proportion of western DPS in that region. Moreover, interactions and M/SI data are derived from surveys of Steller sea lion haulout and Steller sea lions can and do swim large distances with entanglements and so we cannot assume that the area in which animals have been reported with entanglements is the source area for the interaction. Using the approach of applying regional occurrence proportions to regional estimates, we conclude that 3% of the overall abundance of non-pup Steller sea lions throughout SEAK are from the western DPS and we assign 3% of the total SEAK Steller sea lion interaction and M/SI estimates to the ESA-listed contingent in this analysis (western DPS; Table 101).

Table 101. The Steller sea lion mixing zones (Hastings et al. 2020) applied to the modeled non-pup counts for each area to calculate western DPS and eastern DPS Steller sea lions by area and totaled to generate overall western DPS occurrence for SEAK (Sweeney et al. 2023).

Hastings et al. (2020)			**Modeled Non-Pup Count**	**Western Stock Non-Pup Count**
SEAK Areas	**Mixing Zone**	**proportion western DPS**		
Central Outer Coast	D	0.022	3,131	69
Frederick Sound	E	0.012	1,850	22
North Outer Coast	F	0.082	3,826	314

Hastings et al. (2020)			**Modeled Non-Pup Count**	**Western Stock Non-Pup Count**
SEAK Areas	**Mixing Zone**	**proportion western DPS**		
Glacier Bay	G	0.073	1,423	104
Lynn Canal	H	0.014	578	8
Remaining SEAK	I, B, C	-	6,298	0
TOTAL			17,106	517
Overall % wester DPS Steller sea lions in SEAK (Total Western Stock Non-Pup Count / Total Modeled Non-Pup Count)			517 / 17,106 = 3%	

2.5.4.5 Response

Information on the anticipated response (i.e., M/SI rates which are calculated from the proportion of total interactions that lead to M/SI so we can apply this to cases where outcomes are unknown) 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 (Freed et al. 2023). For humpback whales, the anticipated M/SI rates for interactions that may involve SEAK salmon fisheries based on the most recent data described above and evaluated by Freed et al. (2023) is as follows:

- SEAK salmon drift gillnet: 8 M/SI assigned / 10 total interaction recorded = 80% M/SI rate.
- SEAK salmon purse seine: 1 M/SI assigned / 1 total interaction recorded = 100% M/SI rate.
- Unknown fishing gear (not gillnet, though it could be from other salmon fishery gear types): 1.75 M/SI assigned / 2 total interaction recorded = 88% M/SI rate.

For Steller sea lions, the anticipated M/SI rates for interactions that may involve SEAK salmon fisheries based on the analyzed data described above and evaluated by Freed et al. (2023) is as follows:

- SEAK salmon troll and hook and line records (that include both commercial and recreational): 64 M/SI assigned / 68 total interactions recorded = 94% M/SI rate.
- SEAK unknown fishing gear (could be troll fishing gear, but not confirmed): 2 M/SI assigned / 2 total interactions recorded = 100% M/SI rate.

2.5.4.6 Extent of ESA-listed Marine Mammal Interactions Expected

In the following sections, we describe the available information and analysis of expected 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, we specifically outline the minimum levels of interactions and M/SI expected, as well as those that are reasonably certain to occur for ESA-listed populations of humpback whales and Steller sea lions in each SEAK salmon fisheries.

Humpbacks and SEAK Drift, Set, and Subsistence Gillnet Fisheries

With respect to data on humpback whale interactions with the SEAK gillnet fisheries (drift, set, and subsistence) from 2016-2020 as described above in Section 2.5.4.2 (Summary of Humpback Whale Interactions with SEAK Fisheries), a total of 10 entanglements attributed to SEAK gillnet gear have been reported to NMFS (9 commercial and 1 subsistence), or an average of 2 entanglements of humpback whales per year. There was also 1 entanglement of a humpback whale with unknown gear identified as a buoy, but with no other description. Without more information, we cannot rule that out as being related to drift gillnet. NMFS Alaska Marine Mammal Health and Stranding Response Program confirmed that gillnet entangled whales have been reported throughout Southeast Alaska (S. Wright, NMFS, Pers. Comm. May 3, 2023).

As mentioned previously, it has also been estimated that 5.5 (CV=1) humpback whales are entangled annually in Districts 106, 107, and 108, collectively. There are several other Districts in SEAK that have salmon gillnet effort that were not observed. ADF&G provided an estimate of the salmon gillnet effort in Districts 106, 107, and 108 relative to the overall SEAK fishery and the observed portion of the fishery constitutes roughly one-third of all effort. While we do not have estimates specific to these unobserved areas, we also do not have reason to believe that drift gillnet effort in the observed districts are more or less susceptible to interactions with humpback whales. To account for the additional substantive effort of the unobserved portions of the fishery, we extrapolated the estimates from Manly (2015) by multiplying them by 3 to provide an approximation of these estimates SEAK-wide. Thus, from the 5.5 M/SI estimated from observer coverage in a portion of the fishery, we estimate 16.5 M/SI incidents per year for humpback whales for all of SEAK.

In addition, data from AMMOP estimated 46.5 blow-throughs per year for these same districts. In the absence of additional data, we expect that these interactions are accounted for in the entanglement estimates, which include subsequent observation of humpback whales with gear attached that have been reported through the Alaska Marine Mammal Stranding Program to characterize those entanglements. Acknowledging we do not understand if these districts are more or less susceptible to blow-through interactions with humpback whales than other districts, we also extrapolate these estimates to the unobserved portion of the fishery by multiplying them by 3 to provide an approximation of these estimates SEAK-wide. Thus, from the estimated 46.5 blow-through interactions estimated from observer coverage in a portion of the fishery, we estimate 140 blow-through interactions per year SEAK-wide.

Thus, we assume that 16.5 entanglements and 140 blow-throughs could occur across SEAK annually. Based on information provided in the Status of the Species, we assume that about 2%

of these humpback whale interactions with SEAK drift gillnet gear occur with Mexico DPS individuals.

A summary of the analysis of the extent of Mexico DPS humpback whale interactions and estimated M/SI with SEAK drift gillnet fishery (including subsistence gillnet fishing) is provided below:

Summary of humpback whales - SEAK Drift, Set, and Subsistence Gillnet Fisheries:

<u>Minimum</u>

- All Interactions:
  5.5 entanglements per year + 46.5 blow-throughs per year (both estimated from observer data (Manly 2015)) + 2 NSI interactions per year (strandings from Freed et al. (2023)) = 48.5 total interactions per year * 0.02 (% of Mexico DPS in SEAK)
  = 0.97 Mexico DPS interactions per year
- M/SI Only:
  6.9 M/SI per year (from SARs (Young et al. 2023)) * 0.02 (% of Mexico DPS in SEAK)
  = 0.14 Mexico DPS M/SI per year

<u>Reasonably certain</u>

- All Interactions:
  140 blow-throughs + 16.5 entanglements per year (extrapolations of Manly (2015) interactions to entire fishery presented above) = 156.5 * 0.02 (% of Mexico DPS in SEAK)
  = 3.13 Mexico DPS interactions per year
  Note: the 2.0 NSI strandings are not added because the extrapolated numbers account for unobserved interactions and thus these kinds of opportunistic data are already accounted for.
- M/SI Only:
  16.5 interactions/entanglements per year * 0.80 M/SI rate (derived above in Section 2.5.4.5 Response) = 13.2 M/SI * 0.02 (% of Mexico DPS in SEAK)
  = 0.26 Mexico DPS M/SI per year

Sea Lions and SEAK Drift, Set, and Subsistence Gillnet Fisheries

With respect to data on Steller sea lion interactions with the SEAK drift gillnet fishery described above in Section 2.5.4.3 (Summary of Steller Sea Lion Interactions with SEAK Fisheries), there were no Steller sea lions observed taken during observer coverage of this fishery in Districts 106, 107, and 108, nor are there any reports in Freed et al. (2023). Although there are no SEAK reports of this in the SAR, we acknowledge that Steller sea lions have been entangled by gillnet in other areas and that the risk is not zero. Thus, we assume that there could be rare events of interactions with Steller sea lions and this fishery.

A summary of the analysis of the extent of western DPS Steller sea lion interactions and estimated M/SI with the SEAK drift gillnet fishery is provided below:

Summary of Steller sea lion - SEAK Drift, Set, and Subsistence Gillnet Fisheries:

Minimum

- All Interactions: 0 (Freed et al. 2023)
- M/SI Only: 0

Reasonably certain

- All Interactions: >0 risk (undefined)
- M/SI Only: potential >0 risk (undefined)

Humpbacks and SEAK Purse Seine Fishery

With respect to data on humpback whale interactions with the SEAK purse seine fishery as described above in Section 2.5.4.2, one entanglement of a humpback whale with SEAK purse seine gear has been reported to NMFS and is included in the M/SI report. NMFS Alaska Marine Mammal Health and Stranding Response Program data include two entanglements of humpback whales with unknown gear identified as nets and/or involving heavy-gauged line, but it is unknown if either of these involve SEAK purse seine gear, though given the gear descriptions, it is unlikely that either originated as purse seine and thus are not included in our estimates. 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 for drift gillnet gear (Manly 2015). The 1 incident from the M/SI report (0.2 per year) documented from stranding data (Freed et al. 2023) involving SEAK purse seine gear that resulted in mortality. Thus, we can assume that there are a small number of occasional interactions with humpback whales and this fishery, with a small fraction (2%) of those occurring with Mexico DPS humpback whales.

Summary of humpback whales - SEAK Purse Seine Fishery:

Minimum

- All Interactions:
  0.2 per year (Freed et al. 2023) * 0.02 (% of Mexico DPS in SEAK)
  = 0.004 Mexico DPS humpback whale entanglements per year
- M/SI Only:
  0.2 M/SI per year (Freed et al. 2023) * 0.02 (% of Mexico DPS in SEAK)
  = 0.004 Mexico DPS M/SI per year

Reasonably certain

- All Interactions: small number of occasional (undefined); same as minimum total
- M/SI Only: small number of occasional (undefined); same as minimum total

Sea Lions and SEAK Purse Seine Fishery

With respect to data on Steller sea lion interactions with the SEAK purse seine fishery as described above in Section 2.5.4.3, there have been no entanglements of Steller sea lions in SEAK purse seine gear reported to NMFS. Although there are no SEAK reports of this in the SAR, we acknowledge that Steller sea lions have been entangled by purse seine gear in other areas and that the risk is not zero. Thus, we assume that there could be rare events of interactions with Steller sea lions and this fishery. A summary of the analysis of the extent of western DPS Steller sea lion interactions and estimated M/SI with the SEAK purse seine fishery is provided below:

Summary of Steller sea lion - SEAK Purse Seine Fishery:

Minimum

- All Interactions: 0 (Freed et al. 2023)
- M/SI Only: 0

Reasonably certain

- All Interactions: >0 risk (undefined)
- M/SI Only: potential >0 risk (undefined)

Humpbacks and SEAK Commercial and Recreational Troll Fisheries

With respect to data on humpback whale interactions with the SEAK troll fisheries as described above in Section 2.5.4.2, there have been no interactions reported to NMFS. 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 (2%) of those occurring with Mexico DPS humpback whales. Although there are no SEAK reports of this in the SAR, we acknowledge that humpback whales have been entangled by the commercial and/or recreational troll gear in other areas and that the risk is not zero. Thus, we assume that there could be rare events of interactions with humpback whales and these fisheries. A summary of the analysis of the extent of Mexico DPS humpback whale interactions and estimated M/SI with the SEAK troll fishery is provided below:

Summary of humpback whales - SEAK Troll Fisheries:

Minimum

- All Interactions: 0 (Freed et al. 2023)
- M/SI Only: 0

Reasonably certain

- All Interactions: >0 risk (undefined)
- M/SI Only: potential >0 risk (undefined)

Sea Lions and SEAK Commercial and Recreational Troll Fisheries

With respect to data on Steller sea lion interactions with the SEAK troll fishery as described above in Section 2.5.4.3, there have been 165 interactions (average of 33 per year) reported to NMFS that are likely SEAK troll gear (commercial and recreational total) reported from 2013-2017 (from SARs (Young et al. 2023)) and 70 interactions (14 per year) from 2017-2021 (Freed et al. 2023). Given these are minimum estimates, we used the higher values from (Young et al. 2023) preferentially in the analysis though still relied on Freed et al. (2023) for non-serious injury interactions where no M/SI was assigned. Although more specific data on the locations of these entangled Steller sea lions were not available in the reports, the Alaska Marine Mammal Stranding Program confirmed that Steller sea lion strandings are reported throughout SEAK (Mandy Keogh, NMFS, personal communication, May 3, 2023). In most of these incidents, it has not been determined whether this gear originates from the commercial or recreational troll fishery. There has not been any observer coverage of troll fisheries to generate any local or regional estimates of Steller sea lion interactions. However, there are annual ADF&G surveys of rookeries and haulouts in SEAK that document the flasher entanglements that are indicative of hook ingestions, and this effort provides an index of minimum interactions that is useful in this analysis.

A summary of the analysis of the extent of western DPS Steller sea lion interactions and estimated M/SI with the SEAK troll fishery is provided below:

Summary of Steller sea lion - SEAK Troll Fisheries:

<u>Minimum</u>

- All Interactions:
  33 per year (SARs (Young et al. 2023))*0.03 (% of western DPS in SEAK)
  = **0.99 western DPS interactions per year**

- M/SI Only:
  33 per year (All interactions resulted in M/SI from SARs (Young et al. 2023)) * 0.03 (% of western DPS in SEAK)
  = **0.99 western DPS Steller sea lion M/SI per year**

<u>Reasonably certain</u>

- All Interactions:
  33.8 per year includes unknown fishing gear that could be salmon troll (33 from the SARs (Young et al. 2023) plus 0.8 per year non-serious injury from salmon troll (2 NSI interactions reported in the 5-year window of Freed et al. 2023)) * 0.03 (% of western DPS in SEAK)
  = **1.0 western DPS interactions per year**

- M/SI Only:
  33 per year (SARs (Young et al. 2023)) * 0.03 (% of western DPS in SEAK)
  = **0.99 western DPS Steller sea lion M/SI per year**

2.5.4.7 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 observer and stranding records, and additional evaluations that can be made about what is reasonably certain to occur given relevant information at hand and incorporating the best available data. In summarizing the effects analysis, we outline the minimum levels of bycatch and M/SI expected, as well as levels that are reasonably certain will occur, for ESA-listed DPSs of humpback whales and Steller sea lions in each SEAK salmon fishery. We note there are not data available regarding the relative age or 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 DPSs. A summary of the interactions and M/SI estimates from the analysis above are compiled in Table 102.

Table 102. Summary of annual interactions and M/SI estimates for humpback whales (a) and Steller sea lions (b) by SEAK salmon fishing gear type with proportion expected to be from the ESA-listed DPS indicated in parentheses. Estimates are broken out by minimum estimates and those that are considered reasonably certain, which required assumptions and extrapolation.

(a) Humpback whales					
SEAK Fishery		Minimum		Reasonably Certain	
		All Humpback whales	Mexico DPS only	All Humpback whales	Mexico DPS only
Gillnet Fisheries	All Interactions	48.5	0.97	156.5	3.13
	M/SI only	6.9	0.14	13.2	0.26
Purse Seine Fishery	All Interactions	0.2	0.004	0.2	0.004
	M/SI only	0.2	0.004	0.2	0.004
Troll Fisheries	All Interactions	0	0	*Rare event possible	
	M/SI only	0	0	*Rare event possible	
Humpback whale Totals	**All Interactions**	**48.7**	**0.97**	**156.7**	**3.13**
	M/SI only	**7.1**	**0.14**	**13.4**	**0.26**

(a) Humpback whales

SEAK Fishery		Minimum		Reasonably Certain	
		All Humpback whales	Mexico DPS only	All Humpback whales	Mexico DPS only
Gillnet Fisheries	All Interactions	48.5	0.97	156.5	3.13
	M/SI only	6.9	0.14	13.2	0.26
Purse Seine Fishery	All Interactions	0.2	0.004	0.2	0.004
	M/SI only	0.2	0.004	0.2	0.004
Troll Fisheries	All Interactions	0	0	*Rare event possible	
	M/SI only	0	0	*Rare event possible	
Humpback whale Totals	**All Interactions**	**48.7**	**0.97**	**156.7**	**3.13**
	M/SI only	**7.1**	**0.14**	**13.4**	**0.26**

(b) Steller sea lions

SEAK Fishery		Minimum		Reasonably Certain	
		All Steller sea lions	wDPS only	All Steller sea lions	wDPS only
Gillnet Fisheries	All Interactions	0	0	*Rare event possible	
	M/SI only	0	0	*Rare event possible	
Purse Seine Fishery	All Interactions	0	0	*Rare event possible	
	M/SI only	0	0	*Rare event possible	
Troll Fisheries	All Interactions	33	0.99	33.8	1.0

	M/SI only	33	0.99	33	0.99
Steller sea lion Totals	**All Interactions**	**33**	**0.99**	**33.8**	**1.0**
	M/SI only	**33**	**0.99**	**33**	**0.99**

In conclusion, we expect up to 4 Mexico DPS Humpback whales to interact with the SEAK salmon fisheries per year (of which, 1 take being M/SI over a 3-year period) and 1 western DPS Steller sea lion to interact with the SEAK salmon fisheries each year (of which, 1 take being M/SI). Note, the final numbers are rounded up to whole numbers/animals.

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. 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 above, including in Section 2.2.4, Climate Change, Effects on Fish, and Section 2.2.3.1.4, Climate Change and Other Ecosystem Effects on SRKW.

Some types of human activities that contribute to cumulative effects e.g., private activities that are primarily associated with other commercial and sport fisheries, construction, dredging and dredge material disposal, vessel traffic and sound, alternative energy development, offshore aquaculture/mariculture, and marine pollution are expected to have adverse impacts on salmon and marine mammals, including SRKWs, western DPS Steller sea lion, and Mexico DPS humpback whale. Many of these activities have occurred in the recent past and had an effect on the environmental baseline. These can be considered reasonably certain to occur in the future because they occurred frequently in the recent past, especially if authorizations or permits have not yet expired. Tribal, state, and local government actions will likely be in the form of legislation, shoreline growth management, administrative rules, or policy initiatives and fishing permits. 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, novel fishing gear or methods, resource extraction, or 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. Although these factors are ongoing to some extent and likely to continue in the future, past occurrence is not a guarantee of continuing level of activity. That will depend on whether there are economic, administrative, and legal impediments (or in the case of contaminants, safeguards). Although state, tribal, and local governments have often developed plans and initiatives to benefit marine species, including

ESA-listed salmon and listed marine mammals, they must be applied and sustained in a comprehensive way before NMFS can consider them “reasonably certain to occur” in our analysis of cumulative effects. Therefore, it is difficult to assess the cumulative impacts and the relative importance of effects in addition to those already identified, given these effects may occur at somewhat higher or lower levels than those described in the environmental baseline.

Salmon

The future effects of salmon hatchery programs that are funded and/or operated by non-federal entities and that have not undergone ESA consultation are included in Cumulative Effects. It is likely that the type and extent of salmon hatchery programs and the numbers of fish released in the action area will change over time. Although adverse effects to ESA-listed salmon from these programs will continue, as described in Section 2.4.2 (environmental baseline), changes to the programs are likely to reduce effects such as competition and predation on natural-origin salmon and steelhead compared to current levels, especially for those species that are listed under the ESA. This is because the programs that adversely affect ESA listed species must undergo review under the ESA to ensure that listed species are not jeopardized and that “take” under the ESA from salmon and steelhead hatchery programs is minimized or avoided, in order for NMFS to exempt take resulting from the programs from the take prohibition. Although adverse effects on natural-origin salmon will likely not be completely eliminated, effects would be expected to decrease from current levels over time to the extent that hatchery programs are evaluated by NMFS under the ESA.

Specifically, we expect reductions in effects on listed salmon are likely to occur through changes to the following, similar to changes that have been made to programs which NMFS has already reviewed under the ESA:

- Hatchery monitoring information and best available science,
- Times and locations of fish releases to reduce risks of competition and predation,
- Management of overlap in hatchery- and natural-origin spawners to meet gene flow objectives,
- Decreased use of isolated hatchery programs,
- Increased use of integrated hatchery programs for conservation purposes,
- Incorporation of new research results and improved best management practices for hatchery operations,
- Creation of wild fish only areas,
- Changes in the species propagated and released into streams and rivers and in hatchery production levels,
- Termination of programs,
- Increased use of marking of hatchery-origin fish,
- More accurate estimates of natural-origin salmon and steelhead abundance for abundance-based fishery management approaches.

Activities occurring in the Puget Sound area were considered in the discussion of cumulative effects in the Biological Opinion on the Puget Sound Harvest RMP (NMFS et al. 2011) 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 2008g, Washington State Department of Transportation Preservation, Improvement, and

Maintenance Activities ; 2013d), the National Flood Insurance Program (NMFS 2008f), 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 et al. 2011; NMFS 2023a). Additionally, as discussed in the above-cited biological 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.

The federally approved Shared Strategy for Puget Sound recovery plan for Puget Sound Chinook Salmon (SSDC 2007), 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. Government and private actions may include changes in shoreline and water uses, including ownership and intensity, which could affect listed species or their habitat. All neutral and negative effects from activities currently taking place are considered within the environmental baseline of this Opinion and are expected to continue to occur.

Overall, we anticipate that projects to restore and protect habitat, restore access and recolonize the former range of salmon, and improve fish survival throughout their ranges will result in a beneficial effect on salmon compared to the current conditions. We also expect that future harvest and development activities will continue to have adverse effects on listed species in the action area; however, we anticipate these activities will be mindful of ESA-listed species and will perhaps be less harmful than would have otherwise occurred in the absence of the current body of scientific work that has been established for anadromous fish. In general, we think the level of adverse effects will be lower than those in the recent past, and much lower than those in the more distant past. NMFS anticipates that available scientific information will continue to grow and tribal, public, and private support for salmon recovery will remain high. This will continue to fuel state and local habitat restoration and protection actions as well as hatchery, harvest, and other reforms that are likely to result in improvements in fish survival.

Marine Mammals

NMFS, in coordination with its multiple partners, has implemented targeted management actions identified in the SRKW recovery plan (NMFS 2008b) and informed by research. Transboundary efforts between the U.S. and Canada have occurred to address all the threats identified in the recovery plan. Be Whale Wise is a partnership of governmental agencies, non-profits and other stakeholders that implement and educate the public about best vessel practices in the Salish Sea to protect marine resources, including SRKWs. There is currently a voluntary ¼ mile “No-Go” Whale Protection Zone along the west side of San Juan Island from Mitchell Bay to Eagle Point (and ½ mile around Lime Kiln Lighthouse) as part of the San Juan County Marine Resources Committee Marine Stewardship Area; these are key summer foraging areas for the whales. San Juan County expanded this area to include a ¼ mile no vessel zone to Cattle Point starting in

2018 and WDFW has been increasing education and outreach regarding this area, including with the fishing community.

On March 14, 2018, WA Governor's Executive Order 18-02 was signed which ordered state agencies to take immediate actions to benefit SRKWs and established a Task Force to identify, prioritize, and support the implementation of a longer-term action plan for SRKW recovery. The Task Force provided recommendations in a final Year 1 report in November 2018[64] that addressed the three main threats to SRKW, including many actions specific to salmon recovery. State legislation was put into place to protect salmon habitat (House Bill 1579), address harmful contaminants (Senate Bill 5135) and reduce the risk of oil spills (House Bill 1578). In addition, a new state law was signed in 2019 increasing vessel viewing distances from 200 to 300 yards to the side of the whales and limiting vessel speed within ½ nautical mile of the whales to seven knots over ground. This state law (Senate Bill 5577) also established a commercial whale watching license program and charged WDFW with administering the licensing program and developing rules for commercial whale watching by January 2021 for inland Washington waters (see RCW 77.65.615 and RCW 77.65.620). On December 18th, 2020, new commercial whale watching rules were adopted that took effect in 2021. These rules specify that commercial whale watching occur at distances of <0.5 nautical mile from July-September during two 2-hr time periods in the day for no greater than three vessels at once, makes the no-go zone on the west side of San Juan island mandatory for commercial whale watching, and establishes training, reporting, monitoring, and license procedures.[65] There is also an exclusion from approaching a group with a calf under one year old or an otherwise vulnerable, e.g., pregnant or malnourished, individual. Senate Bill 5918 amends RCW 79A.60.630 to require the state's boating safety education program to include information about the Be Whale Wise guidelines, as well as all regulatory measures related to whale watching, which is expected to decrease the effects of vessel activities to whales in state waters. WDFW submitted a report to the State Legislature in November 2022 about the effectiveness of state regulations for SRKW, including general vessel regulations and those associated with the commercial whale watching license program. That report summarized relevant information and results from public survey and focus group engagement. The analysis of all input resulted in WDFW recommending an expansion of the buffer distance for all vessels to 1000 yards from SRKWs. That recommendation became Senate Bill 5371, and was signed by Governor Jay Inslee in May 2023, to go into effect in 2025 (see RCW 77.15.740).

On November 8, 2019, the Task Force released its Year 2 report[66] that assessed progress made on implementing Year 1 recommendations, identified outstanding needs and emerging threats, and developed new recommendations. Some of the progress included increased hatchery production to increase prey availability for SRKW. Washington State funding and hatchery releases for the 2019-2021, 2021-2023, and 2023-2025 biennia are discussed in the Environmental Baseline, Section 2.4.4.1. Additional releases by Washington State may benefit SRKWs, however, some programs receiving this state funding do not have completed

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[64] Report available at https://www.orca.wa.gov/wp-content/uploads/TaskForceReport-2018.pdf

[65] https://wdfw.wa.gov/species-habitats/at-risk/species-recovery/orca/rule-making

[66] Report available at https://www.orca.wa.gov/wp-content/uploads/TaskForceFinalReport-2019.pdf

consultations under the ESA and may have negative impacts on ESA-listed Chinook salmon. As described above, the negative effects of these programs would be expected to decrease from current levels due to modifications made as part of the ESA review and approval process. In addition, over 19.2 million additional chum salmon and over 15.3 million additional coho salmon were produced and released with these funds from 2019-2023.

The State of Washington passed House Bill 1579 that addresses habitat protection of shorelines and waterways (Chapter 290, Laws of 2019 (2SHB 1579)), and funding was included for salmon habitat restoration programs and to increase technical assistance and enforcement of state water quality, water quantity, and habitat protection laws. Other actions included measures to increase survival through the hydropower system on the lower Snake and Lower Columbia rivers, legislation to decrease impacts of predatory fish on salmon (Chapter 290, Laws of 2019 (2SHB 1579)), funding to the Washington State Department of Transportation to complete fish barrier corrections, and funding to implement a lower Snake River dams stakeholder engagement process. These measures will not improve prey availability in the near term, but are designed to improve conditions in the long term.

Since 2019, Canada has implemented annual conservation actions geared towards SRKWs including area-based fishery closures, interim sanctuary zones, and both voluntary initiatives and mandatory vessel regulations as part of interim orders to protect the whales. Interim measures were enacted for 2024,[67] and were designed to reduce vessel- and prey-related threats for SRKWs when in the Salish Sea.

There are several state- and industry-led efforts underway to reduce impacts from commercial vessel activities. For example, the Port of Vancouver ECHO program has implemented voluntary vessel slowdown areas in the Salish Sea that reduce sound and could reduce severity in the event of a vessel strike. In the U.S., Quiet Sound is a program designed to study and reduce the impacts of acoustic and physical disturbance from large commercial vessels on SRKWs. For more information on Quiet Sound, please visit https://maritimeblue.org/quiet-sound/. In 2022, Quiet Sound launched a voluntary commercial slowdown trial[68] in north Puget Sound and Admiralty Inlet. While the trial was intended to reduce impacts from commercial shipping to SRKW, it may also result in decreased acoustic and physical impacts to humpback whales. Approximately 70% of ships transiting the area during that time participated in the slowdown (Quiet Sound 2023). In 2023, Quiet Sound launched the second voluntary commercial slowdown on October 12, when SRKW were first observed in the slowdown area for the season. The slowdown remained in effect until January 12, 2024.[69]

Additional activities that may occur in the coastal waters off Washington, Oregon, and California will likely consist of state or foreign government actions related to ocean use policy and management of public resources, such as fishing or energy development projects. Changes in ocean use policies as a result of non-federal government action are highly uncertain and may be subject to sudden changes as political and financial situations develop. Examples of actions that

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[67] https://www.pac.dfo-mpo.gc.ca/fm-gp/mammals-mammiferes/whales-baleines/srkw-measures-mesures-ers-eng.html

[68] https://quietsound.org/trial-slowdown

[69] https://quietsound.org/admiralty-inlet-slowdown

may occur include development of aquaculture projects, changes to state fisheries which may alter fishing patterns, installation of aquaculture, hydrokinetic or wind energy projects near areas where SRKWs are known to occur, designation or modification of marine protected areas that include habitat or resources that are known to affect marine mammals in general, and coastal development which may alter patterns of shipping or boating traffic. Examples of actions that may occur in the Salish Sea include increased boat traffic, increased pollution, and increased pressure on salmonids through habitat alterations due to this highly urbanized area. However, none of these potential state, local, or private actions, can be anticipated with any reasonable certainty in the action area at this time, and most of those described as examples would likely involve federal involvement of some type given the federal government's role in regulating activity in the ocean across numerous agencies and activities. Any action authorized, funded, or carried out by a federal agency would be subject to ESA section consultation.

All of the activities described in the environmental baseline sections of this Opinion that affect the western DPS Steller sea lion and Mexico DPS humpback whale are expected to continue into the foreseeable future. Commercial harvest of humpback whales is no longer a threat. Vessel traffic, coastal development (and its associated noise and habitat disturbance), climate change, pollution, and tourism may increase as the global population increases. Subsistence harvest and illegal shooting of Steller sea lions are likely to continue at low levels. Fisheries are managed to optimal sustainable yields and are not expected to increase in magnitude. However, derelict gear continues to accumulate in SEAK waters and without a dedicated and sustained collection and removal program, increasing amounts of derelict gear may increase the risk of entanglement of Steller sea lions and humpback whales over time. Scientific research in SEAK is not likely to increase appreciably.

Tourism is increasing in SEAK and the majority of tourists to SEAK arrive by cruise ships. After a two-year hiatus in tourism due to the Covid-19 pandemic in 2020 and 2021, and fewer than average visitors in 2022, tourism in Alaska in 2023 exceeded pre-pandemic levels with more than 1.6 million visitors arriving by cruise ship, and the majority of those cruise ships coming to SEAK ports (Weibold 2023). Increasing numbers of vessels, visitors, and the length of the cruise ship season will likely increase the demand for marine-based tourism, thereby increasing the effects of these activities on Steller sea lions and humpback whales. Effects of increased cruise ship tourism will likely result in increases in disturbance, displacement, pollution, noise, and vessel interactions. NMFS continues to implement programs such as Whale SENSE (a stewardship, education, and recognition program for commercial whale watch operators) and other wildlife viewing campaigns to promote responsible wildlife viewing practices.

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in assessing the risk that the proposed actions pose to species and critical habitat. In this section, we 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 action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of critical habitat as a whole for the conservation of the species.

As discussed in more detail in Section 1.3, the proposed actions considered in this opinion are 1) the delegation of management authority over salmon fisheries in the EEZ in SEAK to the State of Alaska, and 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 PST Agreement.

2.7.1 Lower Columbia River Chinook Salmon

The LCR Chinook Salmon 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. Eighteen hatchery-origin programs are also included as part of the listed ESU (Table 8). 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 they are therefore subject to very different patterns of harvest (Table 10). As a consequence, we analyze the effect of the proposed actions on the ESU by considering the effect of the SEAK fisheries 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 9. Recovery efforts for populations in both MPGs depend on reintroduction programs and other population specific recovery actions.

Spring Chinook salmon populations in the Cowlitz basin (Upper Cowlitz, Cispus, and Tilton), Lewis, and Kalama rivers on the Washington side of the Columbia River in the Cascade MPG are managed to meet hatchery escapement objectives in SUS west coast salmon fisheries. 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 to ensure access to and from the upper basin through the full life cycle is meeting recovery criteria. 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 in years when escapement objectives were not anticipated to be met management actions were taken with in-river fisheries 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 11), 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 limiting factor.

LCR spring Chinook salmon are caught in fisheries from Alaska to Oregon and in mainstem and tributary fisheries in the lower Columbia River. The harvest of LCR spring Chinook salmon has declined significantly from the highs observed in the 1980s (Figure 6). Reductions occurred in both ocean and in-river 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, specifically the SEAK salmon fisheries operating under the 2019 PST Agreement. Results of the retrospective analysis are described in Section 2.5.1.1. 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 PST Agreement. Exploitation rates on LCR spring Chinook in the marine area fisheries in the action area would be reduced from 16.9% under Scenario 1 to 15.5% in Scenario 2 (Table 48). The proportion of the total marine area fishery ER attributable to the SEAK fishery for the LCR spring component averaged 1.9% of the marine exploitation in Scenario 1 and 1.6% in Scenario 2 (Table 48). 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 moderate (11.5%) (Figure 44). The retrospective analysis indicates that harvest of LCR spring Chinook salmon in the SEAK fisheries under the 2019 PST Agreement is very low and lower than past PST Agreements (Scenario 1). The ER in the SEAK fishery averaged 1.6% in Scenario 2 and 1.5% in Scenario 4, in which we assume a 40% reduction in Chinook abundance for purposes of setting the SEAK catch levels (Table 50). Exploitation rates in the marine area fisheries in the action area would be reduced from 15.5% under Scenario 2 to 14.2% in Scenario 4 (Table 50). The relative change in ER in the SEAK and marine area fisheries are -7.9% and -8.2%, respectively. Thus, management of the SEAK fisheries under the 2019 PST Agreement is responsive to declines in abundance and very low SEAK salmon fishery impacts to the LCR spring component 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 9). Overall, there has been little change in the status of Chinook salmon populations in the LCR ESU since the prior status review (NMFS 2016m; 2022j). Increases in abundance were noted in about 39% of the fall-run populations (Table LCR Status 4) but hatchery contribution remains high for multiple populations (Table 12). Relative to baseline VSP levels identified in the recovery plan (NMFS 2013f) 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 2022j). 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 15). For many populations the high proportions of hatchery-origin spawners affect the VSP scores and otherwise compromise the status of the populations.

LCR tule Chinook salmon are caught in fisheries from Alaska to Oregon and in mainstem and tributary fisheries in the lower Columbia River. The harvest of LCR tule Chinook salmon has declined significantly from the highs observed in the 1980s and even further than the lows observed in the late 1990s (Figure 6). Reductions occurred in both ocean and in-river fisheries as a consequence of conservation actions taken to protect LCR tule Chinook salmon and other fall Chinook salmon stocks returning to the Columbia River and elsewhere.

The retrospective analysis was used to characterize the effects of the proposed actions, specifically the SEAK fisheries managed under the 2019 PST Agreement. The ER on LCR tule Chinook salmon in the SEAK fishery averaged 2.3% in Scenario 1 (prior PST Agreements) and 2.0% in Scenario 2 (2019 PST Agreement) (Table 48). Exploitation rates in the marine area fisheries in the action area would be reduced from 31.8% under Scenario 1 to 28.3% in Scenario 2 (Table 48). The ER for LCR tule Chinook salmon the SEAK fishery accounts for 7.5% of the marine area fishery impacts on this component (Figure 46).

The ER on LCR tule Chinook salmon in the SEAK fishery averaged 2.0% in Scenario 2 and 1.9% in Scenario 4, where abundance levels are assumed to be 40% below average for the retrospective period (Table 50). Exploitation rates on LCR tules in the marine area fisheries in the action area would be reduced from 28.3% under Scenario 2 to 26.1% in Scenario 4 (Table 50). The relative change in ER for LCR tules in the SEAK and marine area fisheries are -7.7% and -7.7%, respectively, which indicates that under low abundance conditions SEAK salmon fisheries exhibit a moderate curtailment of exploitation.

As compared to the spring and bright populations in the ESU, there is an additional point that is relevant to NMFS's 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 framework. The framework specifies a total ER that may vary from year-to-year between 30 and 41% depending on a particular run size indicator. The ER limit considers the impacts all marine area salmon fisheries and in-river fisheries below Bonneville Dam, and is used to manage SUS fisheries. NMFS reviewed the proposed management framework in 2012 and concluded that it would not jeopardize LCR Chinook salmon (NMFS 2012f).

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 on provisions of the PST Agreement (described in Section 1.3). Once those are set, SUS west coast salmon fisheries in the PFMC areas and Columbia River are adjusted so the combined effects of the AABM and other salmon fisheries do not to exceed the year-specific total ER limit. The necessary coordination among jurisdictions occurs during the annual PSC and PFMC preseason processes. In 2018, for example, the total ER limit for LCR tule Chinook salmon was 38%. At the end of the preseason planning process, the projected total ER from all salmon fisheries on LCR tules was 37.7% (PFMC 2018).

The retrospective analysis confirms that ERs of LCR tule Chinook salmon in the SEAK fishery would be reduced under the 2019 PST Agreement. Whether those reductions accrue to increased escapement would depend on how the SUS west coast salmon fisheries are managed. As the majority of the harvest mortality occurs in southern fisheries (Figure 46), there is sufficient opportunity to reduce harvest as needed to meet the annual ER limit. Our analysis shows that under the 2019 PST Agreement, the effects of SEAK fisheries on the tule component of the ESU would continue to be relatively low, allowing for SUS west coast salmon fisheries to continue to be managed consistent with the abundance-based ER framework that has already been determined not to jeopardize the LCR Chinook Salmon ESU (NMFS 2012f).

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 9). 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 9). The spawning escapement of Lewis River brights has averaged 8,725 natural-origin fish over the last ten years and generally exceeded its escapement objective of 5,700 fish by a wide margin since 1990 (Table 11). Escapements to the Sandy are no longer directly monitored, but compared to an abundance target for delisting of 3,747 fish appear to be at low risk, based on the combined tule and bright ODFW single Sandy River fall-run data series, which increased during the recent review period (five-year geomean = 2,074 fish, a 76% increase from the previous status review) (Ford 2022).

LCR bright Chinook salmon are far north migrating and are caught in fisheries from Alaska to Oregon and in mainstem and tributary fisheries in the lower Columbia River. Because they have a more northerly migration pattern, they are subject to more harvest in the SEAK and northern Canadian fisheries than the other LCR Chinook components. 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 in the late 1980s (Figure 6).

The retrospective analysis was used to characterize the effects of the proposed actions, specifically the management of the SEAK fisheries consistent with the 2019 PST Agreement. The ER for the LCR bright component in the SEAK fishery averaged 10.5% in Scenario 1 (prior PST Agreements) and 9.5% in Scenario 2 (2019 PST Agreement) (Table 48). ERs in the marine area fisheries in the action area are reduced from 49.6% under Scenario 1 to 45.4% in Scenario 2 (Table 48). ERs for LCR bright Chinook salmon in the SEAK fishery account for 21.2% of the marine area fishery impacts (Figure 48). The analysis indicates that harvest of LCR bright Chinook salmon in the SEAK fisheries under the 2019 PST Agreement is very low, and lower than under past PST Agreements.

The ER in the SEAK fishery averaged 9.5% in Scenario 2 and 8.9% in Scenario 4, which assumes a 40% reduction in abundance (Table 50). Exploitation rates in the marine area fisheries in the action area would be reduced from 45.4% under Scenario 2 to 43.2% in Scenario 4, while the SEAK fisheries show a similar pattern exhibiting a reduction from 9.5% to 8.9% (Table 50). The relative change in ER in the SEAK and marine area fisheries are -5.7% and -4.8%, respectively.

Summary

In summary, based on the status review (NMFS 2022j), we conclude that there has been relatively little net change in the VSP score for the LCR Chinook ESU since the last review, and reaffirmed that the status of this ESU remains threatened. As discussed in Section 2.2.2.1, 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 on LCR Chinook salmon are uncertain, but it is reasonable to expect that the effects will be negative. As indicated in the recovery plan (NMFS 2013f) 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 the environmental baseline, we detail our completion of more than a hundred Section 7 consultations on hatchery programs in numerous Biological Opinions (Report to Congress, 2023; see Appendix C, Table C.1). A detailed description of the effects of these hatchery programs can be found within the site-specific Biological Opinions referenced in Appendix C, Table C.1. These effects are further described in Appendix C of NMFS (2018b), which, as discussed in the environmental baseline, is incorporated by reference. All of the completed analyses have concluded that the hatchery programs will not jeopardize listed salmonids, and our analysis takes account of the effects on ESA-listed species and their critical habitat, particularly in this case LCR Chinook salmon, that may be affected by the returning increased Chinook salmon produced from these programs that escape contributing to the prey base (i.e., those not eaten by SRKW) or caught by the fisheries discussed in this Opinion. The abundance levels of Chinook salmon experienced during the 1999-2018 retrospective period encompasses periods of higher levels of hatchery production than are currently occurring as specified in the environmental baseline (Table 42 and Table 43) therefore the evaluation of how the tiered structure of the current fishery regime would perform retrospectively evaluates performance across a range of abundance encompassing the levels expected in the marine environment in the coming years.

In the environmental baseline we also acknowledge the effects from past harvest, from a variety of fisheries in the Action Area that intercept LCR Chinook salmon, and anticipate these activities be managed in a way that accounts for impacts to ESA-listed species. This is based on completed ESA reviews of both salmon and non-salmon fisheries, as indicated in the environmental baseline. The analysis in biological opinions on these fisheries concludes that effects from these harvest activities are expected to be less harmful than under prior harvest regimes, and we expect these reduced effects to continue into the future.

NMFS (2024e) determined that production funded by NMFS in order to mitigate effects of SRKW prey removals by salmon fisheries subject to the 2019 PST Agreement, added to current levels of hatchery production, is not likely to appreciably reduce the likelihood of the survival and recovery of salmon or steelhead affected by PST fisheries. In that opinion, NMFS evaluated the effects of the prey increase funding program, including whether it has led to density dependent interactions affecting salmon growth and survival in the Pacific Ocean (NMFS 2024e). While NMFS (2024e) acknowledged adverse effects to listed fish in natal watersheds as described in site-specific opinions, and found aggregate effects of the SRKW PIP were likely to accrue from ecological interactions in the mainstem Columbia and Snake Rivers and in certain marine areas, the exact degree of risk to affected ESA-listed salmonids will vary. For the aggregate effects this depend largely on the regional distribution of released hatchery fish, and on the relative composition in life history types (spring-, summer-, fall-run) and life history stages (subyearling, yearling) of hatchery Chinook salmon released as part of the SRKW PIP. Overall, the level of risk to all potentially affected ESUs and DPSs NMFS determined was expected to be either negligible or low, and NMFS determined the PIP would not jeopardize any affected ESA-listed species (NMFS 2024e). 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 PST Agreement would be responsive to a significant reduction in abundance (e.g., 40%), and specifically that SEAK fisheries would be reduced in this scenario.

Cumulative effects are future state and private activities that are reasonably certain to occur in the action area (see Section 2.6). NMFS anticipates that future human development activities will continue to have adverse effects on listed species in the Action Area. On the other hand, NMFS also expects that available scientific information will continue to grow at a fast pace and tribal, public, and private support for salmon recovery will remain high and this will fuel the upward trend in habitat restoration and protection actions as well as hatchery, harvest, and hydropower reforms that are likely to result in improvements in fish survival. After review of the available information, NMFS did not identify any qualifying activities in marine areas where LCR Chinook salmon occur that are likely to influence LCR Chinook salmon in a way that further informs NMFS's assessment of the proposed actions.

A determination regarding the effects of the proposed actions related to the SEAK fishery to the LCR Chinook Salmon ESU requires comment on each of the life history types. Freshwater salmon fisheries occur outside the action area and were therefore considered as part of the overall assessment of the species status. For the spring Chinook salmon 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 with in-river fisheries 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 very low (1.9% ER) under the past PST Chinook salmon management regimes and are reduced further as a consequence of reductions occurring under the 2019 PST Agreement (1.6% ER).

For LCR tule populations, SUS west coast salmon fisheries are managed according to the framework described above which requires those fisheries to be managed to ensure that total fishery ERs do not exceed a year-specific framework objective. Impacts to the tule populations in the SEAK fishery have been relatively very low (2.3% ER) and are reduced further under the 2019 PST Agreement (2.0% ER), but in any case, SUS west coast salmon 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%), but, as with the other components of the ESU, have been reduced as a consequence of reductions in the SEAK fishery under the 2019 PST Agreement (9.5%). The resulting level of expected impacts from the SEAK fishery is low and unlikely to alter the achievement of escapements for the populations that already exhibit viable status.

In short, escapement goals and other management objectives were generally met for the various life history components of the LCR Chinook Salmon ESU during the term of the 2009 PST Agreement. Under the 2019 PST Agreement, SEAK fishery impacts to the ESU were reduced further thus increasing the likelihood that management objectives will continue to be met, which has consistently been the case since implementation began (PFMC 2023a). 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 changes in overall abundance, even a significant change in abundance. Thus, we expect that the proposed action will not prevent the LCR Chinook Salmon 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, the environmental baseline within the action area, the effects of the proposed actions, and cumulative effects, it is NMFS's 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.

2.7.2 Upper Willamette Chinook Salmon

There are seven demographically independent populations in the ESU (Table 16), four of which are considered "core" populations including the Clackamas, North Santiam, McKenzie, and Middle Fork (MF) Willamette. In order to meet the biological criteria for delisting, the NMFS recommended four out of the seven populations achieve viable status (ODFW and NMFS 2011).

According to the most recent status review (Ford 2022) 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 slightly decreased since the previous five-year status review (NMFS 2016h) and still range only in the high hundreds of fish (Table 18). The proportion of natural-origin spawners has improved or remained stable in the North Santiam, Clackamas, and McKenzie river basins depending on the population. 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 population. This population has seen a decrease in its five-year geo-mean of natural spawners (Table 18). Conversely, the Clackamas and McKenzie rivers have previously been viewed as natural population strongholds, and both individual populations are experiencing small increases in abundance in recent years (Table 18) (Ford 2022).

The status of UWR Chinook salmon populations is characterized relative to persistence (which combines the abundance and productivity criteria), spatial structure, diversity, and 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 (Ford 2022).

UWR Chinook salmon is a far north migrating stock that is harvested in ocean fisheries (primarily in Canada and Alaska), and in lower mainstem Columbia River fisheries, fisheries in the mainstem Willamette River, and other tributary fisheries in the Willamette Basin. The effects of freshwater fisheries are described in the Status Section. Marine area fisheries in the SUS west coast also impact UWR Chinook salmon but to a lesser degree, along with Canadian fisheries as mentioned above. 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. ODFW proposed a FMEP to limit the harvest rate on natural-origin fish in all freshwater fisheries to no more than 15%. As discussed in the Status section, NMFS concluded that the FMEP for freshwater fisheries affecting UWR spring Chinook limiting the harvest rate on natural-origin fish to no more than 15% was not likely to jeopardize the UWR Chinook ESU (NMFS 2001). In fact, 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% (ODFW 2017).

The ER on UWR Chinook salmon in marine area fisheries between 1999 and 2018 were relatively stable and averaged 8.3% (Figure 9 and Table 36), but this also represents a significant decrease in harvest in marine area fisheries compared to those that occurred historically. Exploitation rates in marine area fisheries in the 1980s averaged on the order of 20% (Figure 9).

The recovery plan for UWR Chinook salmon (ODFW and NMFS 2011) reviewed the limiting factors and threats and describes strategies for addressing each of them (Chapter 5 in ODFW and NMFS (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% (Figure 9). From 1996 to 2006 the total ER for all fisheries averaged 21%. Since 2006 the total ER has generally been below 20% (Figure 9), and fishing plans have been adopted that limit harvest rates in freshwater fisheries (e.g., the Fishery Management Plan for the Willamette River sets the maximum freshwater mortality rate for naturally produced Chinook salmon at 15% (ODFW and WDFW 2020)). As a consequence, and particularly because of the management reforms in freshwater fisheries, the recovery plan concluded that harvest was neither a primary nor secondary limiting factor and that other limiting factors are the key bottlenecks currently impeding the recovery of UWR Chinook salmon populations (ODFW and NMFS 2011).

The retrospective analysis was used to characterize the effects of the proposed actions. The ER in the SEAK fishery averaged 3.8% in Scenario 1 (estimates of actual ERs from 1999 to 2018) and 3.2% in Scenario 2 (estimates of ERs likely to occur in 1999 to 2019 if managed under the 2019 PST Agreement) (Table 51). Exploitation rates in the marine area fisheries in the action area would be reduced from 8.3% under Scenario 1 to 7.1% in Scenario 2 (Table 51). Comparison of ERs between Scenario 2 and Scenario 3 (SEAK fisheries managed under 2009 Agreement, other marine fisheries managed under 2019 Agreement) showed a similar pattern with smaller differences in the ERs between the scenarios. 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 (45.7%) (Figure 50). The analysis indicates that harvest of UWR Chinook salmon in the action area are reduced under the 2019 Agreement compared to the 2009 Agreement.

The ER in the SEAK fishery averaged 3.2% in Scenario 2 and 2.9% in Scenario 4 (assuming abundance reduced by 40%) (Table 53). Exploitation rates in the marine area fisheries in the action area would be reduced from 7.1% under Scenario 2 to 6.4% in Scenario 4 (Table 53). The relative change in ER in the SEAK and marine area fisheries are -9.5% and -9.9%, respectively. This analysis indicates that ERs would be reduced in response to a significant decline in overall abundance, primarily due to reductions in ERs in AABM fisheries (including the SEAK fisheries) as the Abundance Indices declines. This would also result in a proportional reduction in catch that is similar to but slightly greater than the corresponding reduction in abundance. This is a result of the "broken-stick" structure of the relationship between catch and abundance for the AABM fisheries, where there are different harvest rate tiers that allow increased levels of catch as abundance increases (see Appendix C in Chapter 3 of the 2019 PST Agreement). This indicates that provisions of the PST 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%.

As discussed in 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 on UWR Chinook salmon are uncertain, but it is reasonable to expect that the effects will be negative. As indicated in the recovery plan (ODFW and NMFS 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 PST Agreement would be responsive to a significant reduction in abundance (40%).

In the environmental baseline, we detail our completion of more than a hundred Section 7 consultations on hatchery programs in numerous Biological Opinions (Report to Congress, 2023; see Appendix A, Table A.1). A detailed description of the effects of these hatchery programs can be found within the site-specific Biological Opinions referenced in Appendix C, Table C.1. These effects are further described in Appendix C of NMFS (2018b), which, as discussed in the environmental baseline, is incorporated by reference. All of the completed analyses have determined that the hatchery programs will not jeopardize listed salmonids. Our analyses take account of the effects on ESA-listed species and their critical habitat, particularly in this case UWR Chinook salmon, that may be affected by hatchery production, including by increased returns of Chinook salmon produced from these programs that escape contributing to the prey base (i.e., those not eaten by SRKW) or caught by the fisheries analyzed in this Opinion. The abundance levels of Chinook salmon experienced during the 1999-2018 fishing year time period encompasses periods of higher levels of hatchery production, above the hatchery production levels specified in the environmental baseline in Table 42 and Table 43, therefore the evaluation of how the tiered structure of the current fishery regime would perform retrospectively evaluates performance across a range of abundance encompassing these additional levels in the marine environment in the coming years.

In the environmental baseline we also acknowledge the effects from past harvest, from a variety of fisheries in the Action Area that intercept UWR Chinook salmon, and anticipate these activities be managed in a way that accounts for impacts to ESA-listed species. This is based on completed ESA reviews of both salmon and non-salmon fisheries, as indicated in the environmental baseline. The analysis in biological opinions on these fisheries concludes that effects from these harvest activities are expected to be less harmful than under prior harvest regimes, and we expect these reduced effects to continue into the future.

NMFS (2024e) determined that production funded by NMFS to mitigate effects of SRKW prey removals by salmon fisheries subject to the 2019 PST Agreement, added to current levels of hatchery production, is not likely to appreciably reduce the likelihood of the survival and recovery of salmon or steelhead affected by PST fisheries. In that opinion, NMFS evaluated the effects of the prey increase funding program, including whether it has led to density dependent interactions affecting salmon growth and survival in the Pacific Ocean (NMFS 2024e). While NMFS (2024e) acknowledged adverse effects to listed fish in natal watersheds as described in site-specific opinions, and found aggregate effects of the SRKW PIP were likely to accrue from ecological interactions in the mainstem Columbia and Snake Rivers and in certain marine areas, the exact degree of risk to affected ESA-listed salmonids will vary. For the aggregate effects this will depend largely on the regional distribution of released hatchery fish, and on the relative composition in life history types (spring-, summer-, fall-run) and life history stages (subyearling, yearling) of hatchery Chinook salmon released as part of the SRKW PIP. Overall, the level of risk to all potentially affected ESUs and DPSs NMFS determined was expected to be either negligible or low, and NMFS determined the PIP would not jeopardize any affected ESA-listed species (NMFS 2024e).

Cumulative effects are future state and private activities that are reasonably certain to occur in the action area (see Section 2.6). NMFS anticipates that future human development activities will continue to have adverse effects on listed species in the Action Area. On the other hand, NMFS also expects that available scientific information will continue to grow at a fast pace and tribal, public, and private support for salmon recovery will remain high and this will fuel the upward trend in habitat restoration and protection actions as well as hatchery, harvest, and hydropower reforms that are likely to result in improvements in fish survival. 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 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 salmon 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% of the marine area harvest of the ESU occurs in the

SEAK fishery due to the ESU's far north migratory path, the absolute level of harvest in the SEAK fishery that is the subject of the two proposed actions has been very low (3.8%) and is reduced further as a consequence of the 2019 PST Agreement (3.2%). 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 reduction in abundance.

Although there is uncertainty about the magnitude and timing of the effects of climate change, we expect that the direction of these effects from 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 reduction in abundance.

After reviewing and analyzing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed actions, and cumulative effects, it is NMFS's 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.

2.7.3 Snake River Fall-Run Chinook Salmon

Historically there were two populations within the SRFC 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 since listing although it has declined in the most recent five years of reported data. The return of total adult spawners averaged 37,812 fish from 2010 to 2014 and 22,141 fish from 2015 to 2019 (Table 24). While the total number of fish spawning decreased during the more recent time period, the proportion of fish on the spawning grounds that were natural-origin fish increased slightly from 31% (11,722 fish) from 2010 to 2014 to 33% (7,307 fish) between 2015 and 2019 (Table 23). This compares to a minimum escapement threshold of natural-origin spawners of 4,200. To assure that all sources of mortality are accounted for, the Interior Columbia Technical Review Team (ICTRT) recommended that productivities used in interior Columbia River viability assessments be expressed in terms of returns to the spawning grounds. SRFC salmon have been above the ICTRT defined minimum abundance threshold since 2001 (Ford 2022) although productivity, as seen in broodyear returns-per-spawner, has been below replacement (1:1) in recent years. The overall risk rating for abundance and productivity was designated low (Table 25).

The risk rating for spatial structure and diversity is moderate (Table 25). 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 SRFC 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 25), 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 (Ford 2022).

There are many factors that affect the abundance, productivity, spatial structure, and diversity of the SRFC 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. 2011b). Ocean conditions have also affected the status of this ESU. Ocean conditions affecting the survival of SRFC salmon were generally poor during the early part of the last 20 years (NMFS 2017q). More recent conditions have also generally followed this pattern, except for ocean indicators in 2021 showing a more positive condition for fish entering the ocean in that year[70]. Harvest as a limiting factor has been addressed through reductions that have occurred in both ocean and in river fisheries.

SRFC salmon have a broad ocean distribution and are caught in ocean fisheries from Alaska to Oregon. 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. In river fisheries are currently managed subject to an abundance based harvest rate limit that ranges from 21.5% to 45% (NMFS 2018b). Freshwater harvest rates have averaged 31.8% since 2009 when the current management framework was first implemented (Figure 12).

SUS marine area fisheries have been managed since the mid-1990's to achieve a 30% reduction relative to the 1988 to 1993 base period. The 30% reduction standard is reported as a proportion (referred to as the SRFI; see Environmental Baseline, Section 2.4.1.1.3 for more detail). A 30% reduction in the average base period ER equates to an index value of 0.70. Post season estimates of the index averaged 0.61 since 1994 indicating that ocean ERs have been reduced over the long term by nearly 40% (Table 49).

The retrospective analysis informs our analysis of the effects of the proposed actions. The ER in the SEAK fishery averaged 1.2% in Scenario 1 (prior PST Agreements) and 1.0% in Scenario 2 (2019 PST Agreement) (Table 54). ERs in all the in the marine area fisheries in the action area would be reduced from 30.4% under Scenario 1 to 27.0% in Scenario 2 Table 54. SRFC salmon are present in the SEAK fishery, but a relatively small proportion (3.9%) of the marine area fishery impacts occur in the SEAK fishery (Figure 53). The analysis indicates that harvest of SRFC salmon in the action area would be reduced under the 2019 PST Agreement compared to the prior Agreements.

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[70] Link to overview of ocean indicators over time: https://www.fisheries.noaa.gov/west-coast/science-data/ocean-conditions-indicators-trends

As discussed in Section 2.2.2.3, the status of SRFC 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 on SRFC salmon are uncertain, but it is reasonable to expect that the effects will be negative. As indicated in the recovery plan (NMFS 2017q) and elsewhere, it is essential that we make continued progress on all fronts to address factors that are limiting the status of SRFC 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 PST Agreement would be responsive to a significant reduction in abundance (e.g., 40%), a reduction that is beyond what we can reasonably expect to see over the immediate future.

A comparison of the results from Scenarios 2 and 4 is designed to assess how the PST 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 1.0% in Scenario 2 and 0.9% in Scenario 4 (Table 56). ERs in the marine area fisheries in the action area would be reduced from 27.0% under Scenario 2 to 25.1% in Scenario 4 (Table 56). The relative change in ER in the SEAK and marine area fisheries are -7.3% and -7.0%, respectively, which indicates that SEAK salmon fisheries exhibit a moderate curtailment of exploitation under Scenario 4.

The analysis indicates that ERs 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 similar to but slightly greater than the corresponding reduction in abundance. This is a result of the “broken-stick” structure of the relationship between catch and abundance for the AABM fisheries, where there are different harvest rate tiers that allow increased levels of catch as abundance increases (see Appendix C in Chapter 3 of the 2019 PST Agreement). 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%.

In the environmental baseline, we detail our completion of more than a hundred Section 7 consultations on hatchery programs in numerous Biological Opinions (Report to Congress, 2023; see Appendix C, Table C.1). A detailed description of the effects of these hatchery programs can be found within the site-specific Biological Opinions referenced in Appendix A, Table A.1. These effects are further described in Appendix C of NMFS (2018b), which, as discussed in the environmental baseline, is incorporated by reference. All of the completed analyses have determined that the hatchery programs will not jeopardize listed salmonids, and our analyses take account of the effects on ESA-listed species and their critical habitat, particularly in this case SRFC salmon, that may be affected by the returning increased Chinook salmon produced from these programs that escape contributing to the prey base (i.e., those not eaten by SRKW) or caught by the fisheries analyzed in this Opinion. The abundance levels of Chinook salmon experienced during 1999-2018 retrospective period encompasses periods of higher levels of hatchery production than are currently occurring as specified in the Environmental Baseline (Table 42 and Table 43) therefore the evaluation of how the tiered structure of the current fishery regime would perform retrospectively evaluates performance across a range of abundance encompassing the levels expected in the marine environment in the coming years.

In the environmental baseline we also acknowledge the effects from past harvest, from a variety of fisheries in the Action Area that intercept SRFC salmon, and anticipate these activities be managed in a way that accounts for impacts to ESA-listed species. This is based on completed ESA reviews of both salmon and non-salmon fisheries, as indicated in the environmental baseline. The analysis in biological opinions on these fisheries concludes that effects from these harvest activities are expected to be less harmful than under prior harvest regimes, and we expect these reduced effects to continue into the future.

NMFS (2024e) determined that production funded by NMFS intended to mitigate effects of prey removals by salmon fisheries subject to the 2019 PST Agreement, added to current levels of hatchery production, is not likely to appreciably reduce the likelihood of the survival and recovery of salmon or steelhead affected by PST fisheries. In that opinion, NMFS evaluated the effects of the prey increase funding program, including whether it has led to density dependent interactions affecting salmon growth and survival in the Pacific Ocean (NMFS 2024e). While NMFS (2024e) found aggregate effects of the SRKW PIP were likely to accrue from ecological interactions in the mainstem Columbia and Snake Rivers and in certain marine areas, the exact degree of risk to affected ESA-listed salmonids will vary. It will depend largely on the regional distribution of released hatchery fish, and on the relative composition in life history types (spring-, summer-, fall-run) and life history stages (subyearling, yearling) of hatchery Chinook salmon released as part of the SRKW PIP. Overall, the level of risk to all potentially affected ESUs and DPSs NMFS determined was expected to be either negligible or low, and NMFS determined the PIP would not jeopardize any affected ESA-listed species (NMFS 2024e).

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 SRFC salmon is such that they are not likely to be affected significantly by activities in Puget Sound. NMFS anticipates that future human development activities will continue to have adverse effects on listed species in the Action Area. On the other hand, NMFS also expects that available scientific information will continue to grow at a fast pace and tribal, public, and private support for salmon recovery will remain high and this will fuel the upward trend in habitat restoration and protection actions as well as hatchery, harvest, and hydropower reforms that are likely to result in improvements in fish survival. After review of the available information, NMFS did not identify any qualifying activities in marine areas that are likely to influence SRFC salmon in a way that further informs NMFS' assessment of the proposed actions.

As indicated above, the status of SRFC salmon has improved markedly since the time of listing. 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 two proposed actions has been very low (1.2%) and would be reduced further as a consequence of the 2019 PST Agreement. The resulting ER is 1.0% (Table 54) for the 2019 PST Agreement, and 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 SRFC salmon 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 reduction in abundance.

After reviewing and analyzing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed actions, and cumulative effects, it is NMFS's biological opinion that the proposed actions are not likely to appreciably reduce the likelihood of both survival and recovery of the SRFC Salmon ESU.

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 26). The populations are aggregated into 14 management units (Table 29) 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 (Table 29). 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 of the two proposed actions 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 1.7% to 7.3% (Table 39). 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 5.5% to 18.2% (Table 40). ERs on the nine other management units in the SEAK fishery are quite low ranging from 0.1 to 0.5% (Table 39). Not only are these levels of exploitation minor, but the proportion of marine area harvest that occurs on this second grouping of Puget Sound management units in the SEAK fishery are also very low, ranging from 0.1% to 2.1% (Table 40).

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 2008a). Total ERs on the Dungeness and Elwha Chinook salmon populations in the Strait of Juan de Fuca region averaged 53% from 1987 to 1997 and 28% 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% from 1992 to 1994, have since decreased to an average of 14% between 2009 and 2016 (Figure 16). Exploitation rates on the Nooksack populations from the Georgia Basin declined from an average of 30% from 1983 to 1997 to 21% thereafter (Figure 17). Between 1992 and 1999 total ERs for Stillaguamish Chinook salmon and Skagit River summer/fall stocks averaged 41% and 45% respectively, compared to rates of 31% and 44% thereafter (Figure 17). 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 Nooksack and Stillaguamish populations are most vulnerable to harvest in Canada and have an ER that averages 23.3% and 20.5% respectively (Table 39). The ER on Strait of Juan de Fuca populations (Elwha and Dungeness) is relatively lower averaging 18.6% and 18.5% respectively. Canadian ERs on South Puget Sound populations range from 9.6% to 14.2%. For mid-Puget Sound populations, ERs range from 14.6% to 20.5%. With the exception of Skagit River summer/fall and Nooksack spring Chinook salmon populations, ERs in SEAK fisheries are less than 2% (Table 39). The proportion of the total exploitation that occurs in the SEAK fishery also varies by management unit, but ranges from 0.1% to 18.2% (Table 40).

In this Opinion we have used the retrospective analysis to help characterize the effects of the SEAK fishery on the various salmon ESUs. Results of the retrospective analysis are described in Section 2.5.1.1. Scenario 1 provides estimates of the ERs that occurred between 1999 and 2018. 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 PST Agreement.

Populations of Puget Sound Chinook salmon most significantly impacted by the SEAK salmon fisheries are the Stillaguamish, Dungeness, Elwha, Nooksack, and Skagit summer/fall populations. These populations were determined because each has a high importance to the adopted recovery delisting scenario, coupled with currently having a low status. Results of our analysis for Dungeness, Elwha, Nooksack, and Skagit summer/fall were quite similar to Stillaguamish. The effects to the other most significantly impacted by the SEAK salmon fisheries, besides the Stillaguamish population, are as follows under Scenario 2 (the 2019 Likely): the ER on the Dungeness population in SEAK salmon fisheries is 1.5% that contributes to a total ER of 24.1% (Table 60); the ER on the Elwha population in SEAK salmon fisheries is 1.6% that contributes to a total ER of 23.7% (Table 57); the ER on the Nooksack population in SEAK salmon fisheries is 2.9% that contributes to a total ER of 28.9% (Table 69); and the ER on the Skagit summer/fall populations in SEAK salmon fisheries is 6.1% that contributes to a total ER of 37.0% (Table 75). Using the Stillaguamish Chinook salmon population to discern how comparisons between scenarios would similarily account for fishery impacts, fish from this population that are caught in the SEAK fishery accounts for 5.5% of the total marine fishery impacts (Table 40). For Stillaguamish Chinook salmon, the ER in the SEAK fishery averaged 1.7% in Scenario 1 and 1.4% in Scenario 2 (Table 78). The retrospective analysis indicates that total ERs for Stillaguamish Chinook salmon is reduced from 30.9% under Scenario 1 to 29.7% in Scenario 2 (Table 78). The analysis indicates that harvest of Stillaguamish Chinook salmon in the action area would be reduced as intended by the 2019 PST Agreement, which follows the pattern we observe for the other populations.

The 40% 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 PST 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 salmon averaged 1.4% in Scenario 2 and 1.3% in Scenario 4 (Table 80). Total exploitation rates would be reduced from 29.7% under Scenario 2 to 28.9% in Scenario 4 (Table 80). The relative change in ER in the SEAK and action fisheries are -9.5% and -2.4%, respectively.

The preceding discussion briefly summarizes the results of the retrospective analysis for Stillaguamish Chinook salmon. Results for the Dungeness, Elwha, Nooksack and Skagit summer/fall Chinook salmon are substantively similar to the results for the Stillaguamish in terms of the relative and absolute changes in exploitation rates when comparing scenarios. 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.

The effects of hatchery programs that may be ongoing and future effects of federal actions that have undergone consultation and result in hatchery production are captured in the environmental baseline section of this Biological Opinion. In the environmental baseline, we describe our completion of more than a hundred Section 7 consultations on hatchery programs in numerous Biological Opinions (Report to Congress, 2023; see Appendix A, Table A.1). A detailed description of the effects of these hatchery programs can be found within the site-specific Biological Opinions referenced in Appendix C, Table C.1. These effects are further described in Appendix C of NMFS (2018b), which, as discussed in the environmental baseline, is incorporated by reference. All of the completed analyses have determined that the hatchery programs will not jeopardize listed salmonids, and our analyses take account the effects on ESA-listed species and their critical habitat, particularly in this case Puget Sound Chinook salmon, that may be affected by the returning increased Chinook salmon produced from these programs that escape contributing to the prey base (i.e., those not eaten by SRKW) or caught by the fisheries analyzed in this Opinion. The abundance levels of Chinook salmon experienced during 1999-2018 retrospective period encompasses periods of higher levels of hatchery production, above the hatchery production levels specified in the environmental baseline (Table 42 and Table 43); therefore the evaluation of how the tiered structure of the current fishery regime would perform retrospectively evaluates performance across a range of abundance encompassing the levels expected in the marine environment in the coming years.

There are ongoing conservation hatchery programs for the Dungeness, Stillaguamish, and Nooksack management units. The release of fish from these three programs will continue to supplement the number and spatial distribution of naturally spawning fish with hatchery adult returns for these important populations.

Some hatchery programs in Puget Sound are not yet covered by approvals under NMFS' 4(d) rule for listed salmonids or by biological opinions. NMFS is continuing to work with hatchery managers to ensure all hatchery programs are managed consistent with the ESA, however, until that time, it is impossible to fully describe the effects of these programs. We assume they result in some level of adverse effects to ESA-listed salmonids, as generally described in prior sections of this opinion.

Numerous activities have degraded salmon habitat in Puget Sound as described in the environmental baseline section. Habitat restoration and protection activities are on-going throughout the Sound including habitat restoration funding designed to address limiting habitat conditions for the Stillaguamish, Dungeness, Nooksack, and Mid Hood Canal populations. Funding of projects in these watersheds was aimed at making progress toward recovery by improving abundance and productivity; some of these projects were funded and completed since 2019 (Section 2.4.3).

In the environmental baseline we also acknowledge the effects from past harvest (Section 2.4.1), from a variety of fisheries in the Action Area that intercept Puget Sound Chinook salmon, and anticipate these activities be managed in a way that accounts for impacts to ESA-listed species. This is based on completed ESA reviews of both salmon and non-salmon fisheries, as indicated in the environmental baseline. The analysis in biological opinions on these fisheries concludes that effects from these harvest activities are expected to be less harmful than under prior harvest regimes, and we expect these reduced effects to continue into the future.

As discussed in Section 2.2.2.4, 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 PST Agreement would be responsive to a significant reduction in abundance (e.g., 40%).

NMFS (2024e) determined that production funded by NMFS intended to mitigate effects of prey removals by salmon fisheries subject to the 2019 PST Agreement, added to current levels of hatchery production, is not likely to appreciably reduce the likelihood of the survival and recovery of salmon or steelhead affected by PST fisheries. In that opinion, NMFS evaluated the effects of the prey increase funding program, including whether it has led to density dependent interactions affecting salmon growth and survival in the Pacific Ocean (NMFS 2024e). While NMFS (2024e) found aggregate effects of the SRKW PIP were likely to accrue from ecological interactions in certain marine areas, the exact degree of risk to affected ESA-listed salmonids will vary. It will depend largely on the regional distribution of released hatchery fish, and on the relative composition in life history types (spring-, summer-, fall-run) and life history stages (subyearling, yearling) of hatchery Chinook salmon released as part of the SRKW PIP. Overall, taking into account the site-specific evaluations of effects and the aggregate effects described above, the level of risk to all potentially affected ESUs and DPSs NMFS determined was expected to be either negligible or low, and NMFS determined the PIP would not jeopardize any affected ESA-listed species (NMFS 2024e).

Cumulative effects are future state and private activities that are reasonably certain to occur in the action area (see Section 2.6). Although marine areas in Puget Sound are part of the action area, after review of the available information, NMFS anticipates that future human development activities will continue to have adverse effects on listed species in the Action Area. On the other hand, NMFS also expects that available scientific information will continue to grow at a fast pace and tribal, public, and private support for salmon recovery will remain high and this will fuel the upward trend in habitat restoration and protection actions as well as hatchery, harvest, and hydropower reforms that are likely to result in improvements in fish survival. NMFS did not identify any qualifying activities or effects in marine areas that are likely to influence Puget Sound Chinook salmon in a way that further informs NMFS's assessment of the proposed actions.

In summary, the most recent review of the status of Puget Sound Chinook salmon gave mixed results (Ford 2022). Some populations showed signs of improvement, while others declined, but overall the Puget Sound Chinook Salmon ESU remains threatened. In this context we consider in this Opinion the effects of the SEAK fishery that are the subject of the two proposed actions. Exploitation rates in the SEAK fishery for nine of the 14 management units in Puget Sound are extremely low, ranging between 0.1% and 0.5%. Exploitation rates for the other five management units range from 1.8% (Dungeness and Elwha) to 7.3% (Skagit River summer/fall). Exploitation rates for the Stillaguamish and Nooksack have averaged 1.7% and 3.5%, respectively (Table 39). The ER 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). As described in the Effects section (2.5.2.4), exploitation rates for all of the management units have been reduced from rates under the 2009 Agreement, though modestly, as a consequence of changes to the SEAK fishery under the 2019 PST Agreement.

Given the relatively low effects of the SEAK fisheries to most populations of Puget Sound Chinook salmon, the somewhat higher effects on Skagit Chinook in light of that population's relatively robust status, the SEAK fisheries' responsiveness to changes in abundance, and the expected benefits from already funded and completed habitat projects and the operation of conservation hatchery programs to support populations with very low abundance, 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.

After reviewing and analyzing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed actions, and cumulative effects, it is NMFS's 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.

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 action are likely to jeopardize the continued existence of SRKWs or adversely modify or destroy their designated critical habitat. The proposed action is set within a backdrop of the current condition of SRKWs, their main prey Chinook salmon, and their critical habitat in the action area and other past and present federal, state, or private actions and other human activities in the action area that impact SRKWs, their Chinook salmon prey, and their designated critical habitat.

Current Status of SRKWs and Critical Habitat

The SRKW DPS, composed of J, K, and L pods, was listed as endangered under the ESA on February 16, 2006 (70 FR 69903, November 18, 2005). The limiting factors affecting the recovery of this population include reduced prey availability and quality, high levels of contaminants from pollution, and disturbances from vessels and sound (NMFS 2008b). Oil spills and disease as well as the small population size and inbreeding are also risk factors. It is likely that multiple threats are acting together to impact SRKWs.

In the early 1970s following live-captures for aquaria display, the SRKW population was at its lowest known abundance (68 whales). The highest recorded abundance since the 1970s was 98 whales in 1995, though the population declined to 81 whales by 2001. At present, the SRKW population has declined to near historically low levels (Figure 20). At the time of the 2023 census, the Center for Whale Research reported 75 whales in the population (CWR 2023), with one adult male presumed dead since the census, bringing the population to 74 individuals.

The NWFSC continues to evaluate changes in demographic rates (fecundity and survival), and has recently updated previous population viability analyses (Krahn et al. 2004b; Hilborn et al. 2012; Ward et al. 2013). Population projections using different estimates of fecundity and survival show a downward trend over the next 25 years. The declining trend is, in part, due to the changing age and sex structure of the population, and is also related to the relatively low fecundity rate observed over the period from 2017 to 2021 (see Figure 23 and NMFS (2021m)). Though fecundity rates are declining, average SRKW survival rates estimated by the NWFSC have been slowly increasing since the late 1990s. The population trajectories reflect the endangered status of the SRKWs and variable periods of decline experienced over the long and short term and are based on a limited data set for the small population. The population viability analysis does not link population growth or decline to any specific threat, but reflects the combined impacts of all of the threats in the past. As a long-lived and slow to reproduce species that has shown capacity to grow in the past, SRKW response to actions to limit threats will take time and it will be difficult to link specific actions to potential improvements in the population trajectory in the future.

The demographic and physiological status of the whales is important because SRKWs are already stressed due to the cumulative effects of multiple stressors, and the stressors can interact additively or synergistically. Any additional stress can likely have a greater physiological effect than it would for a healthy population, which may have negative implications for SRKW vital rates and population viability (e.g., National Academy of Sciences (2017)). We have identified that periods of low Chinook salmon abundance are higher risk conditions for SRKW when effects are more likely to impact the health of the whales. Based on data collected in 2022 by Fearnbach and Durban (2023), 20% of J pod, 13% of L pod, and 6% of K pod are in the lowest body condition category (poor body condition). Pod-specific body condition has been tied to

Chinook salmon abundance in certain regions (Stewart et al. 2021), suggesting prey availability may play a role.

SRKWs occur throughout the coastal waters off Washington, Oregon, northern California, and Vancouver Island and are known to travel as far south as central California and as far north as Southeast Alaska (one sighting in 2007) (Figure 24). During the spring, summer, and fall months, SRKWs have typically spent a substantial amount of time in the Salish Sea (i.e., inland waters), with strong site fidelity shown to the region as a whole and high occurrence in the San Juan Island area (particularly the west coast of San Juan Island in summer). Although seasonal movements are somewhat predictable, there can be large inter-annual variability in arrival time and days present in the Salish Sea from spring through fall, with late arrivals and fewer days present in inland waters in recent years (NMFS 2021m; Ettinger et al. 2022). There is also variability in occurrence across the three pods with J pod more consistently encountered in inland waters year-round (NMFS (2021m); Figure 25), while K and L pods tend to spend more time in coastal waters of the action area.

Land- and vessel-based opportunistic sightings, survey-based visual sightings, satellite tracking, and passive acoustic recordings have supported a new understanding of the SRKW coastal geographic range. Satellite tagging results indicate J pod has high use areas in the Salish Sea during winter months, whereas K and L pods occur almost exclusively in coastal waters, primarily off Washington, with hotspot areas in the NOF area off Grays Harbor and the Columbia River. Acoustic detections occurred off the Washington coast in all months of the year, with peak detections per month in both March and April, indicating that SRKWs may be present in the NOF coastal waters at nearly any time of year, more often than previously believed (Hanson et al. 2017). They also occur in coastal waters off Oregon, and California during December to mid-May with only occasional visits into the Salish Sea. Similarly, passive acoustic recorders have corroborated the results from the satellite tagging efforts and detected SRKWs along the coast, particularly off the Washington coast (although acoustic effort was higher off Washington). This information informed an expansion of SRKW critical habitat to include coastal areas important for feeding and passage (NMFS 2021a).

Critical habitat includes both inland and coastal waters. In Washington State, approximately 2,560 square miles of inland waters are designated 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. In 2021, NMFS published a final rule to revise SRKW critical habitat (86 FR 41668; August 2, 2021), which maintains the previously designated critical habitat in inland waters of Washington and expands it to include six additional coastal critical habitat areas off the coast of Washington, Oregon, and California (nearly 16,000 additional sq. miles). Based on the natural history of SRKWs and their habitat needs, three physical or biological features essential to conservation were identified in designating critical habitat: (1) Water quality to support growth and development, (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 (50 C.F.R. 226.206). The proposed actions for this opinion have the potential to affect prey quantity and availability, and the analysis of effects to SRKWs considers pathways of effects that also apply to the prey feature of critical habitat.

Over a decade of prey scale and tissue sampling, and SRKW fecal sampling, gives us high confidence that the SRKW diet consists of a high percentage of Chinook salmon, especially in the spring and summer months. NMFS and WDFW released a priority stock report identifying the Chinook salmon stocks believed to be of most importance to the health of the SRKW population along the West Coast, with Puget Sound, Columbia River, Strait of Georgia, and Fraser stocks ranking high on the list (NOAA Fisheries and WDFW 2018).

Environmental Baseline in the Action Area

A number of baseline natural conditions and human actions affect the abundance, productivity, spatial structure, and diversity of Chinook salmon and these actions also affect prey availability for SRKWs. Natural occurrences that affect Chinook salmon can include changes in climate and ocean conditions (e.g. the Pacific Decadal Oscillation and the El Nino/Southern Oscillation). Human activities that can cause adverse effects on salmon include land use activities that result in habitat loss and degradation, hatchery practices, harvest, and hydropower systems. The potential impacts of climate and oceanographic change on whales and other marine mammals from natural occurrences and human actions will likely involve effects on habitat availability and food availability. For example, changing ocean conditions driven by climate change may influence ocean survival and distribution of Chinook and other Pacific salmon further affecting the prey available to SRKWs (for predicted distribution shifts see Shelton et al. (2021)). Prey availability may also be affected by the increased competition from other predators including other resident killer whales and pinnipeds (Chasco et al. 2017a; Chasco et al. 2017b) as well as pelagic fish, sharks, and birds.

Chinook salmon harvest by a number of fisheries occurs in inland and coastal waters of the action area. As discussed in the environmental baseline, the primary fisheries within the action area include PFMC coastal salmon fisheries, Puget Sound state- and tribe-co-managed salmon fisheries, British Columbia salmon fisheries, and the actions related to SEAK salmon fisheries (that are the subject of this Opinion), all of which are managed under the PST. The 2019 PST Agreement includes provisions limiting harvest impacts in all Chinook salmon fisheries within its scope. Reductions in fisheries compared to previous PST Agreements will result in larger proportions of annual salmon abundance in SRKW critical habitat. Additional domestic constraints on salmon fisheries further limit harvest rates. For example, Amendment 21 to the salmon fishery management plan for PFMC fisheries may further limit the reductions in prey availability by those fisheries in years with low salmon abundance (below the threshold established in Amendment 21) when additional fishery management measures will be implemented. In addition, other fisheries (including Canadian fisheries) within the action area may catch Chinook salmon as bycatch such as the PFMC groundfish fisheries or fisheries directed at other target salmon species.

One of the domestic actions associated with the 2019-2028 PST Agreement was to provide federal funding annually for increased hatchery production of SRKW prey. The PST federal appropriation has resulted in the release of an additional 30.6 million Chinook salmon smolts from 2020-2024, when compared to releases prior to the 2019 PST Agreement (Rumsey 2021; NMFS 2022f) (Table 44). These additional releases are contributing towards the goal of increasing adult Chinook salmon abundance in coastal areas during the winter, and inland (Salish Sea) areas during the summer starting in 2022 and will continue into the future 3-5 years after implementation of each year of funding and production. Based on the availability of funding and the implementation of the program to date, we expect that the program will continue to be funded and implemented at least through the remainder of the 2019 PST Agreement, with a new cohort maturing into the SRKW prey base each year. The annual projected benefit to the SRKW prey base is presented below based on a representative year of releases (2023), and this benefit is included in the analysis and expected to occur with continued funding through at least 2028, and possibly after, and benefits thereafter as fish released will continue to mature and return to be available for SRKW 3-5 years after implementation of production. If the program is discontinued or modified, this may constitute a modification to how effects on Chinook salmon and SRKW are considered in this and other opinions and reinitiation of consultations that include in the environmental baseline the prey increase program would therefore need to be considered.

Currently, based on the hatchery production that has been released through 2024 (using 2023 as a representative year) using PST funds, SRKW prey is expected to increase in various regions across their range, and at varying times throughout the year (Figure 60). Most notably, Chinook salmon prey is expected to increase annually, on average, by 2% in the northern coastal areas (SWWCVI and NOF) during the winter months, over 2% in the SWWCVI region during the spring, and by 0.5% in the Salish Sea and 2% in the SWWCVI region during July-September. We expect that this additional hatchery production for SRKW will not only provide a meaningful amount of added prey to the environment and potentially more foraging opportunities, and contribute to mitigating the effects of all PST salmon fisheries, but it also may provide a buffer in low abundance years, and/or in years where fisheries reductions may be relatively high.

As described in the environmental baseline, the Washington State Legislature has funded hatchery production for SRKW in their 2019-2021, 2021-2023, and 2023-2025 biennia, providing 60.9 million additional Chinook salmon releases from 2019-2024 (Table 44). As described below, the Chinook produced using this funding are indistinguishable to SRKW as prey from the federally funded production, thus the state funding is likely increasing the available prey to the whales. For this analysis, we have the highest confidence in the benefits of the Washington State-funded production that has completed all environmental compliance analyses and assured that these programs are not likely to jeopardize ESA-listed Chinook salmon populations. For those that have not undergone an ESA analysis, we have not relied on those fish to mitigate for the effects of the fishery.

Habitat actions are also expected to support increased availability of Chinook salmon to the whales in coastal and inland waters. As part of the 2019 PST Agreement, approximately $31.2 million over three years (2020-2022), and additional funds in 2023, was directed at habitat restoration projects for Puget Sound Chinook salmon within the northern boundary watersheds of Nooksack, Skagit, Stillaguamish, Snohomish, Dungeness, and Mid-Hood Canal (see Appendix F for a list of funded projects). Although we are not able to quantify the exact benefit to the SRKW prey base of these projects, by improving habitat conditions for these populations, we anticipate Puget Sound Chinook salmon abundance would increase and thereby benefit SRKWs in the long term.

In addition to actions affecting the quantity and availability of SRKW prey in the environmental baseline, others may affect the quality of prey. Many studies have documented elevated concentrations of contaminants in preferred Chinook salmon prey, and actions such as marine construction activities or oil spills may further introduce contaminants, affecting prey and water quality. SRKWs also face physical and acoustic impacts by vessels, and entanglement risk by fisheries. These impacts are considered in the final conclusion of this Opinion.

Effects of SEAK Salmon Fisheries on SRKWs and Critical Habitat

The SEAK salmon fisheries are expected to indirectly affect SRKWs and their critical habitat through reduction of their primary prey, Chinook salmon. There is no direct overlap of the fisheries and SRKWs in time and space, so we do not anticipate any vessel or gear impacts. While there are several challenges to quantitatively characterize the relationship between Chinook salmon abundance and SRKW health and status, available science supports a relationship, and intuitively, at some low Chinook salmon abundance level, the prey available to the whales may not be sufficient to allow for successful foraging, leading to adverse effects (such as reduced body condition and growth and/or poor reproductive success).

Percent Prey Reductions

Based on the biological information described in the status and environmental baseline sections, our effects analysis focused on the expected reduction in Chinook salmon prey available to SRKWs as a result of the proposed SEAK fisheries under the 2019 PST Agreement in the short and long term. As described throughout the SRKW analysis, "percent prey reductions" resulting from SEAK salmon fisheries describe the estimated reduction in prey availability expected from each region within the SRKW range, after subtracting natural and other fishery (BC, PFMC, PS) mortality. To put those reductions in context, we 1) assessed how the proposed SEAK fisheries compared to past fisheries, 2) considered the amount (in kilocalories) of Chinook salmon prey available (with and without SEAK salmon fisheries) compared to the current population's Chinook salmon energetic requirements, and 3) qualitatively evaluated stock-specific catch of SEAK fisheries with respect to priority prey stocks for SRKW. Even though the percent reductions contemplated would affect prey abundance in SRKW range directly, it is unlikely that SRKWs would consume every single fish that would make it back to SRKW habitat absent the action, given the spatial and temporal variability of SRKWs and migrating salmon within those five regions. However, it is likely that SRKWs would detect or respond to reduced prey abundance or density in their range of the action area, but uncertain how they would do so.

Under the 2019 PST Agreement, the SEAK fisheries catch of Chinook salmon is reduced in most years by 7.5% relative to what was allowed in the 2009 PST Agreement. In the WCVI fishery, in most years, catch of Chinook salmon is reduced by 12.5% relative to what was allowed in the 2009 PST Agreement. Because of these reductions to Chinook salmon harvest, we anticipate reduced effects to prey availability under the 2019 PST Agreement than under the previous regime (i.e., we expect more prey to be available).

Annually, the SEAK fisheries are expected to reduce the abundance of Chinook salmon prey by up to 2% in the Salish Sea, up to 6.7% in NOF, and up to 7.6% in SWWCVI, with average reductions in prey abundance of 1.3% in the Salish Sea, 4% in NOF, and 3.5% in SWWCVI. The higher reductions on the coast would occur during a time when the whales were historically observed less often in coastal waters, although recent trends indicate that coastal waters may be more important during the spring and summer moving forward. The highest percent reduction (7.6%) only occurred in one year in one region for the range of abundances evaluated in the retrospective analysis and we would expect reductions to be lower for most years in the future in this region (all other years were below a 5% reduction). However, the higher reduction occurred in a low abundance year in NOF, which is a year of concern for SRKW. Percent reductions would have greater impacts to SRKW in years of low Chinook salmon abundance. During October through April in coastal waters when the whales are more often present, the SEAK fisheries would reduce prey availability by less than 1% across all coastal regions. Expected prey reductions in Oregon and California by SEAK fisheries are very small (less than 1%), have limited overlap with SRKW, and are not considered to be meaningful to the SRKW prey base in those areas.

The reductions described above are lower than the impacts of SEAK fisheries in the past. For example, in the validation runs (historical percent reductions), the SEAK fisheries reduced prey availability in SWWCVI by up to 9.2% in July through September (compared to up to 7.6% under the 2019 PST Agreement) and in inland waters (Salish Sea) in July through September by up to 2.1% (compared to up to 2% under the 2019 PST Agreement) (Appendix B Table B.2). 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, given the spatial and temporal variation of SRKWs and migrating salmon within the five regions assessed. Additionally, the reduction in prey applies to broad areas with varying seasonal overlap with the whales. It is difficult to assess how reductions in prey abundance may vary within the five geographic regions assessed, such as localized depletions or density effects, as the SEAK fisheries occur farther away in space and time.

Energetic requirements

We also estimated the Chinook salmon food energy available to SRKWs in the five spatial regions of their range following the fisheries, and compared that to the current population's metabolic needs in kilocalories. We include this information to understand the magnitude and potential impact of the proposed action on SRKWs. Overall, there is estimated to be 5.5 billion kcals of Chinook salmon available in the Salish Sea following all PST fisheries at 2019 PST Agreement levels and other likely domestic constraints, which is 7.7 to 9.3 times greater than the total annual metabolic needs for SRKW in inland waters. This would increase to 5.7 billion kcals of Chinook salmon available in the Salish Sea if SEAK fisheries were not to occur, leaving 8 to 9.6 times greater Chinook salmon than annual inland metabolic needs for SRKW. In coastal waters (SWWCVI to California), there are approximately 20.7 billion kcals of Chinook salmon estimated to be available following fisheries, which is 7.3 to 8.8 times greater than the total annual metabolic needs for SRKW. This would increase to 21.5 billion kcals if SEAK fisheries were not to occur, leaving 7.6 to 9.1 times greater Chinook salmon than annual coastal metabolic needs for SRKW. Although the proposed fishing would reduce the amount of prey available, we expect there will be more Chinook salmon kcals available than what is required metabolically by the whales, following recent trends of occurrence and Chinook salmon diet composition. However, we are limited in our interpretation of these values and are unable to quantify how this reduction affects the foraging efficiency of SRKWs; therefore, we have low confidence in this metric. As described above, larger reductions in low abundance years would result in proportionally fewer kilocalories available to the whales, and may present added concern.

Priority Chinook Salmon Prey Stocks

Lastly, we compared the Chinook salmon stocks caught in the SEAK fisheries with the priority stocks identified. With the exception of the Columbia Upriver Brights, the largest stocks contributing to the SEAK fisheries catch are currently not considered at the top of the priority prey list for SRKWs, but several are moderately important (NOAA Fisheries and WDFW 2018). SEAK fisheries took nearly 12% of the Columbia Upriver Brights total return. Highly-ranked stocks on the priority list (e.g. Puget Sound Chinook salmon and lower Columbia River fall stocks) make up a small proportion of the SEAK fishery catch and the catch is a low proportion of the total run size of those stocks.

Long-Term Effects

In addition to the reductions in prey, we also considered potential long-term impacts on Chinook salmon. This Opinion concludes that the actions will not jeopardize the listed salmon that the whales depend on over the long term. Although unlikely to occur, in evaluating a potential 40% reduction in overall salmon abundance, the analysis on fishery impacts for salmon indicates that the management regime would compensate for reduced abundance as intended by further fishery constraints. However, the percent prey reductions from the SEAK fisheries do not always change in proportion to the overall reduction in abundance of Chinook salmon. As described above, in years when the abundance of Chinook salmon was relatively low (e.g. 2007), fisheries had larger percentage impacts to prey availability (7.6%) than in higher abundance years. However, we do not expect disproportionate prey reductions to occur regularly, and rely on the Chinook salmon conclusion of this Opinion that the actions will not jeopardize the listed salmon that the whales depend on over the long term.

Critical Habitat

Critical habitat includes water quality, prey, and passage as features that are essential to the conservation of SRKWs. We do not expect the SEAK fisheries to impact water quality or passage, however, we do expect the fisheries to affect the availability of prey, as described above. The annual reductions of age 3-5 Chinook salmon in designated critical habitat from the SEAK fisheries are expected to be up to 2% in the Salish Sea, up to 7.6% in SWWCVI, up to 6.7% in NOF, up to 1.9% in Oregon, and less than 0.1% in California, with the greatest reductions expected to occur in July – September. This impact to critical habitat may cause SRKWs to spend more time foraging than when prey is plentiful and increase the risk of poor body condition and nutritional stress. However, as mentioned previously, the federally-funded hatchery production for SRKW prey is expected to benefit the SRKW prey feature with continued funding through at least 2028 and benefits thereafter as fish released will continue to mature and return to be available for SRKW 3-5 years after implementation of production. We also consider Washington State funded hatchery production for SRKW prey that has ESA coverage, and expect this will also contribute to the SRKW prey for programs that have completed their environmental compliance. Additionally, the benefits of ongoing habitat protection and restoration actions are expected to mitigate some of the prey loss from all PST fisheries in the longer term, including SEAK harvest, however the timing and extent of those benefits is uncertain.

Cumulative Effects

Washington State has implemented several actions that are expected to benefit SRKW in the coming years. The Task Force set up by Governor Inslee in 2018 provided recommendations to address the main threats to SRKWs. In the years since, several Washington State House and Senate bills have been put forward addressing salmon recovery, harmful contaminants and oil spills, and vessel impacts. Most recently, Governor Inslee signed Senate Bill 5371 into law, which expands the buffer distance for all vessels around SRKW to 1000 yards, and will go into effect in 2025.

Additionally, the Washington State Legislature has provided additional funds (approx. $12.5 million) for Chinook salmon hatchery production to augment the SRKW prey base for the 2023-2025 biennium (July 2023 through June 2025), with one year left of implementation[71] at the time of signing this Opinion. However, we acknowledge the benefits of potential future State production may be tempered by the potential for uncertain negative impacts to ESA-listed Chinook salmon from production by hatchery programs that have not yet undergone ESA section 7 consultation and have not relied on those to mitigate for the effects of the fishery.

Since 2019, Canada has implemented annual conservation actions geared towards SRKWs including area-based fishery closures, interim sanctuary zones, and both voluntary initiatives and mandatory vessel regulations as part of interim orders to protect the whales. Interim measures have been released for 2024, and were designed to reduce vessel- and prey-related threats for SRKWs when in the Salish Sea.

Industry-led collaborative efforts are underway to reduce impacts from commercial vessel activities. The Port of Vancouver ECHO program and the U.S.-based Quiet Sound program are taking actions to understand the benefits and impacts of commercial vessel slowdowns in the Salish Sea, which are expected to benefit SRKWs.

Summary Conclusion

We have evaluated the best available information on the status of the species, the environmental baseline, the effects of the action, and cumulative effects. 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 analyzed in this Opinion add a measurable adverse effect in addition to the existing conditions. The proposed SEAK fisheries could result in up to 7.6% annual reduction in the prey available to the whales in the SWWCVI region, but this would likely occur rarely (most years the percent reduction is anticipated to be lower than 5% in that region). For NOF, although reductions in available prey have surpassed 6% in some years, the percent reduction is anticipated to be 4% in most years. Most of the reduction in SWWCVI and NOF will occur during July through September, which is a time period when the whales were historically observed more often in inland waters, although in recent years they have been in the coastal range more during this time. Additionally, the reductions calculated are 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.,

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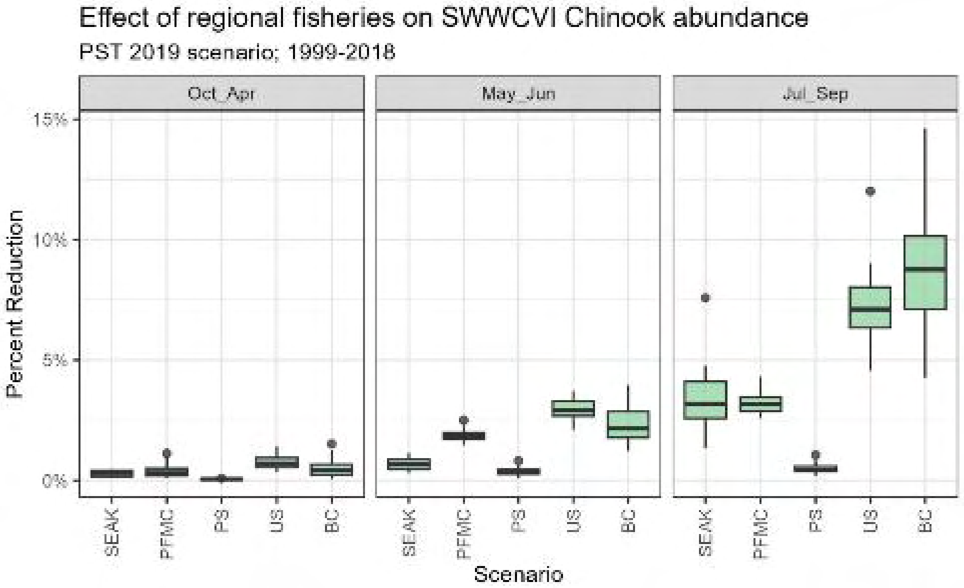
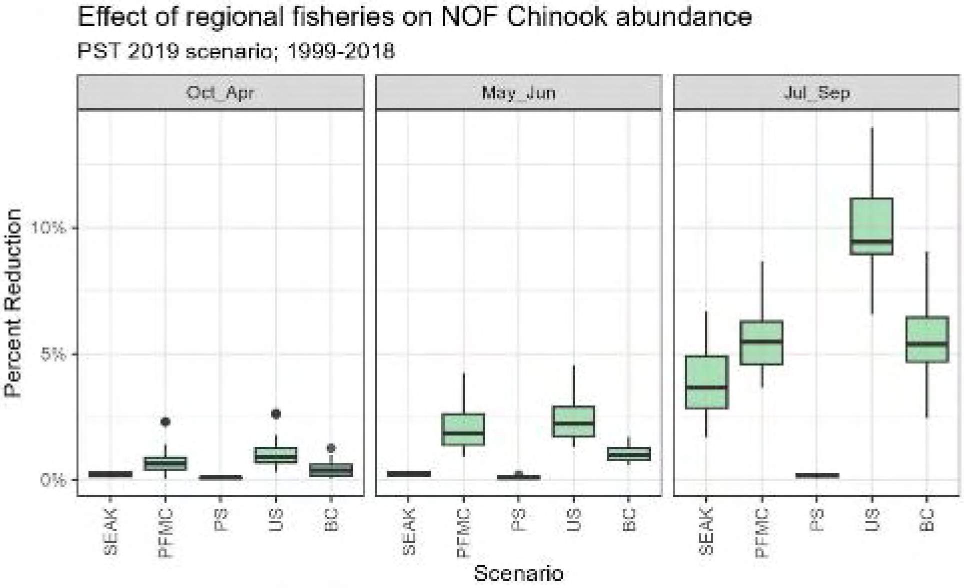
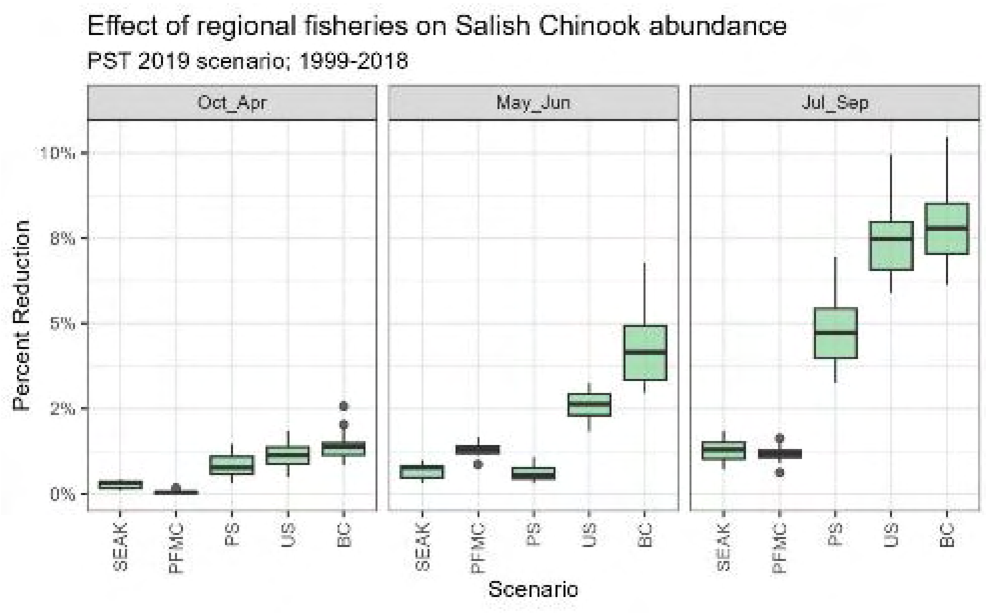
[71] Spring Chinook salmon yearling are reared for more than one year after they have been produced, so two springs after the spawning event is when they would be released. Therefore, fish spawned in 2024, produced/reared with 2023-2025 biennium funds would be released in the in the spring 2026.

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, which did occur in 2007. With the exception of the Columbia River Brights that have relatively large run sizes, the whales' highest priority stocks are not a high proportion of the SEAK fisheries catch, and there should be at least 7 times the population's caloric needs available following fisheries.

When combining the baseline PST fisheries with the proposed actions, SEAK fisheries, we can assess the total impact to SRKW due to prey reduction by PST fisheries. Figure 95 presents a summary of percent reductions by all PST fisheries by season and region for SWWCVI, NOF and Salish, showing that SEAK fisheries are a relatively low contributor to the overall prey reductions by PST fisheries in certain times and areas. For example, prey reductions in Oregon and California are negligible (Section 2.5.3.1.1), and prey reductions in Puget Sound year-round are quite low (Figure 95).


Effect of regional fisheries on SWWCVI Chinook abundance
PST 2019 scenario; 1999-2018
Oct_Apr
May_Jun
Jul_Sep
Percent Reduction
15%
10%
5%
0%
SEAK
PFMC
PS
US
BC
Scenario


Effect of regional fisheries on NOF Chinook abundance
PST 2019 scenario; 1999-2018
Oct_Apr
May_Jun
Jul_Sep
Percent Reduction
10%
5%
0%
SEAK
PFMC
PS
US
BC
Scenario



Note: box-and-whisker plots display a box representing the first quartile, median, and third quartile as the lower bound, midline, and upper bound of the box, respectively, the whiskers representing the minimum and maximum values, and the dots representing outliers which are values beyond 1.5*IQR (interquartile range, or distance between the first and third quartiles).

Figure 95. Projected percent prey reductions (Chinook salmon ages 3+) by all PST fisheries (x-axis) and time step (columns) expected to occur under the 2019 PST Agreement and other likely domestic constraints using a range of salmon abundances from a retrospective analysis of 1999-2018. US includes SEAK, PFMC, and PS combined. Each plot represents SRKW prey reduction in each region as described in Appendix D. While reductions are cumulative across the three timesteps, most of the reduction displayed in the July-September timestep occurs during those months. Note the different scales on the y-axes for each region. See Appendix D and PFMC (2020) for a description of the spatial regions.

While we have quantified reductions by each of the fisheries under the 2019 PST Agreement and other domestic constraints using consistent methods, we note that the fisheries all have different levels of overlap with the SRKWs and catch different proportions of Chinook salmon stocks. The SEAK fisheries have similar reductions to those resulting from PFMC fisheries in important areas like NOF and SWWCVI, but the SEAK fisheries do not directly overlap with the SRKWs. While Puget Sound fisheries have the lowest reductions in NOF and SWWCVI, they have the highest reduction in an area with the most concentrated overlap between those fisheries and a known foraging area for SRKW in the summer as well as catch of the highest priority prey. In summary, the reductions from all U.S. fisheries in SWWCVI, NOF, and the Salish Sea are generally below 10%, but may reach or surpass 15% in some areas. SEAK reductions are expected to generally be small (below 5% and even lower in the Salish Sea) and there is no direct overlap of the fishery and SRKWs. But, it is worth noting that these are average reductions and some years may have higher reductions that could pose a higher risk to SRKW depending on Chinook salmon abundance available that year.

Several actions are in place that will at least partially mitigate the reductions in prey available to the SRKW from the SEAK fisheries. There have been 30.6 million Chinook salmon released as part of the federal funding initiative to improve the SRKW prey base and partially mitigate all PST fisheries. At this level of production, we would expect to see an annual average increase in prey abundance by approximately 2% in the northern coastal regions (SWWCVI and NOF) in October-April. In May-June, we expect to see an annual average increase by 2% in SWWCVI, and in July-September we expect to see an annual average increase by 2% in the SWWCVI and region, and 0.5% in the Salish Sea. This level of production has occurred for the last three years, and the corresponding increase in prey abundance started in 2022 and will continue for the next several years as the Chinook salmon that have already been released age into the prey base (age 3+). We expect that the program will continue to be funded and implemented, with a new cohort maturing into the SRKW prey base each year. This prey benefit is included in the analysis and expected to occur for the duration with funding expected to occur at least through 2028, and benefits expected thereafter as fish released through 2028 will continue to mature and return to be available for SRKW 3-5 years after implementation and production.

Hatchery production funded by Washington State for SRKW prey has resulted in approximately 60.9 million Chinook salmon smolts produced from 2019 through 2024 (Table 44). However, we acknowledge the benefits of some State production may be tempered by the potential for some uncertain impacts to ESA-listed Chinook salmon by hatchery programs that have not yet undergone ESA section 7 consultation, as the potential negative impacts to salmon have not yet been analyzed and have not relied on these fish in our analysis here.

SRKWs are heavily reliant on the availability of Chinook salmon in their environment as the primary preferred prey throughout all seasons of the year (Section 2.2.3.1). Given this strong connection, the proposed fisheries have the potential to adversely affect SRKWs ability to successfully forage and acquire enough food to meet their metabolic needs, which could affect survival and recovery of the population. However, the reduction in prey availability from PST harvest, both Canadian and all U.S. salmon fisheries, including the SEAK fisheries, will be partially mitigated by increased hatchery production in their designated critical habitat (Section 2.4.4.1.4), which will reduce impacts from the fisheries during times of low prey availability for the whales (which present added concern to the health and survival of SRKW; see Section 2.5.3.1.1). The PST-funded habitat projects and ongoing habitat protection and restoration recovery actions are anticipated to increase salmon abundance over the long-term. Protective measures for PFMC fisheries for SRKW will also limit fishery impacts during times of low abundance.

Further, additional protective measures in U.S. and Canadian waters are being implemented to reduce impacts from fisheries and vessels in key foraging areas. Some of these actions have been in place for several years and others have been initiated in 2023 and are expected to continue. 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 due, in part, to reduced prey. The reductions in harvest levels in SEAK salmon fisheries and other salmon fisheries under the 2019 PST Agreement in addition to hatchery, habitat, 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, 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 SRKWs or appreciably diminish the value of critical habitat as a whole for the conservation of the SRKWs. As summarized above, SEAK fisheries have adverse effects on SRKWs by reducing their primary prey, Chinook salmon, but SEAK fisheries are a relatively low contributor to the overall prey reductions by PST fisheries in certain times and areas. Reductions attributable to SEAK fisheries are expected to be relatively small in times and areas that whales are expected to be foraging, hatchery programs mitigate some of the prey loss, and other measures such as vessel regulations and habitat restoration help to improve access to prey. With seasonal shifts in SRKW distribution, coastal areas during the summer or fall may be more important to the whales in future years. Higher prey reductions during these seasons in coastal areas, like NOF, as compared to the Salish Sea, do present a concern. However, given the greater overall prey availability in the larger coastal areas, the impacts would be more distributed throughout space. There is also a small risk of relatively higher prey reductions in low abundance years that we considered, though it has only happened once in the 10-year period we assessed. Not only will the prey increase program provide some protection as a buffer during low abundance years, Amendment 21 (see Section 2.4.4.1.1) would likely be implemented in years of low abundance in NOF, providing additional protections for SRKW in coastal waters. In addition, the proposed 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, any relevant mitigation, and other recovery actions, in improving conditions for listed Chinook salmon and SRKWs compared to past years.

2.7.6 Mexico DPS Humpback Whale

As discussed in more detail in the *Status of Species, Environmental Baseline*, and *Effects of the Action* sections, Mexico DPS humpback whales in SEAK are affected by a number of stressors including natural threats, climate change, anthropogenic noise, pollution, research activities, noise from military exercises, vessel strikes, tourism, and fisheries interactions. Of these stressors, fisheries interactions, primarily entanglements in gillnets, are reasonably certain to occur as a result of the proposed action.

Wade (2021) estimated that 918 animals (CV=0.217; N_{min}=766 animals) from the Mexico - North Pacific stock may spend summers in SEAK. Population trends for Mexico DPS humpbacks are not known with confidence; however, the most recent SAR estimates a maximum growth rate of 6.6% (Young et al. 2023) for the Mexico - North Pacific stock, which is a subset of the Mexico DPS. The 2022 SARs, which incorporate new MMPA stocks for humpback whales, represent the best scientific information available for this analysis. Because the data used to derive the population estimates are more than eight years old, they cannot be used to calculate a PBR level. PBR will remain undetermined for this stock until more recent data become available.

We predict that a maximum of four individuals from the Mexico DPS are reasonably certain to interact annually with the SEAK salmon fisheries (rounded value from Table 102). This includes momentary contact with fishing gear (blow-through interactions), entanglement and drowning in fishing gear, and extended entanglements that may persist with animals for hours, weeks, or even years. Extended entanglements may result in reduced fitness, growth, annual survival, reproductive success, and/or survival of the affected individual. Entanglements may restrict an animal's ability to swim, avoid predators, or foraging efficiently; cause physical injuries; or otherwise increase energy expenditures that reduce overall survival and fitness. Of these interactions, we expect 0.26 interactions per year to result in M/SI across all SEAK salmon fisheries. In other words, we estimate that one animal from the Mexico DPS is reasonably certain to experience M/SI every three years as a result of interactions with the SEAK salmon fisheries. NMFS has proposed guidelines (85 FR 53763, August 31, 2020) for safely deterring marine mammals that may reduce rates of fishery interactions with humpback whales. The method for estimating the number of animals affected by fishery interactions was described in the *Effects of the Action* section.

Although fisheries interactions from the proposed action may affect individual humpback whales, we do not expect these interactions to have population-level effects. The SEAK salmon fisheries would continue to be prosecuted subject to the 2019 PST Agreement; therefore, we do not expect an increase in the rate of fishery interactions with humpback whales as a result of the actions. The current increasing population trend for humpback whales in SEAK indicates that the current level of ongoing interaction with salmon fisheries is not preventing population growth.

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, and cumulative effects, it is NMFS's biological opinion that the proposed action is not likely to appreciably reduce the likelihood of both survival and recovery of the Mexico DPS humpback whale.

2.7.7 Western DPS Steller Sea Lion

As discussed in more detail in the *Status of Species, Environmental Baseline*, and *Effects of the Action* sections, western DPS Steller sea lions in SEAK are affected by a number of stressors including climate change, anthropogenic noise, pollution, harvest, research activities, noise from military exercises, vessel strikes, illegal shooting, and fisheries interactions. Of these stressors, fisheries interactions, primarily entanglements by hook ingestion in the salmon troll fishery, are likely to result from the proposed actions. Although some critical habitat is present in the action area, it is not likely to be adversely affected by the action (see Section 2.12.6).

The western DPS Steller sea lion population is estimated at 49,837 animals in the most recent SAR (Young et al. 2023). Of the Steller sea lions present in the action area, 3% are estimated to be from the listed western DPS (see the *Effects of the Action* section for details on how this proportion was derived).

We predict that a maximum of one individual Steller sea lion from the western DPS is reasonably certain to interact annually with the salmon fisheries under the proposed actions (Table 102). We expect this one interaction per year to result in M/SI. The method for estimating the number of animals affected by fishery interactions was described in the *Effects of the Action* section.

M/SI related to entanglement and hook ingestion may reduce fitness, growth, reproductive success, and may cause death of the affected individual. Entanglements may restrict an animal's ability to swim, avoid predators, or foraging efficiently; cause physical injuries; or otherwise increase energy expenditures that reduce overall fitness. NMFS has proposed guidelines (85 FR 53763, August 31, 2020) and is testing methods (e.g., targeted acoustic startle technology, Götz and Janik (2016)) for safely deterring marine mammals away from troll fishing gear and other in-water gear that may reduce Steller sea lion interaction rates.

Although entanglements and hook ingestions may affect individual Steller sea lions, we do not expect these interactions to have population-level effects on the western DPS of this species. The current population trend for Steller sea lions in SEAK indicates that this type and level of interaction with salmon fisheries is not hindering population growth. Factors such as climate-induced changes in prey distribution and reduced winter prey abundance appear to have a greater influence on population dynamics of western DPS Steller sea lions than entanglements in SEAK fisheries (NMFS 2020a; Maniscalco 2023). Overall, non-pups and pups in the western DPS increased 1.05% and 0.50% per year, respectively, between 2007 and 2022; however, there is high variability in population trends among subregions (Sweeney et al. 2023). Western DPS population abundance indices in Alaska show increasing trends in all subregions except the two westernmost subregions (western and central Aleutian Islands). Because the commercial salmon troll fishery does not occur west of 144 degrees W. Longitude (an area where the population is increasing), it is extremely unlikely that the fishery is contributing to the observed declines in those two subregions. Western DPS Steller sea lions that occur east of 144 degrees W. Longitude and in the SEAK salmon fishing area are increasing.

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, and cumulative effects, it is NMFS's biological opinion that the proposed action is not likely to appreciably reduce the likelihood of both survival and recovery of the western DPS 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, the effects of other activities caused by the proposed action, and the 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, SRFC 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 designated critical habitat for SRKW.

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 an act that actually kills or injures fish or wildlife, such as a 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). "Harass" is further defined by guidance as to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering." "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.

The ESA does not prohibit the take of threatened species unless special regulations have been promulgated, pursuant to ESA section 4(d), to promote the conservation of the species. Federal regulations promulgated pursuant to section 4(d) of the ESA extend the section 9 prohibitions to the take of Mexico DPS humpback whales (50 C.F.R. § 223.213), and LCR Chinook, UWR Chinook, SRFC, and Puget Sound Chinook salmon (50 C.F.R. § 223.203).

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 of the PST Agreement. As indicated in the description of the proposed actions, 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 subject to NMFS' delegation of management to the State of Alaska and regulations issued by the ADF&G conforming with the MSA, Salmon FMP, and the PST Agreement. The State of Alaska manages and monitors the salmon fisheries in SEAK with assistance through federal grants to implement the PST. The expected take in the SEAK salmon fisheries in both federal and state waters is therefore described in the following incidental take statement for the ESA-listed species adversely affected by 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 four ESA-listed ESUs (LCR Chinook, UWR Chinook, SRFC, and Puget Sound Chinook salmon) 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 consistent with the 2019 PST Agreement. It is not possible to count actual numbers of fish from each ESA-listed Chinook ESU directly taken in the fishery, as natural-origin fish from these ESUs are not distinguishable from fish from non-ESA-listed Chinook ESUs or from unmarked hatchery

Chinook salmon simultaneously encountered in the fishery. Therefore, we have identified two surrogates for the extent of take for the four listed ESUs.

First, 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 Chinook catch and total mortality for each fishery (see Section 1.3, Proposed Federal Action). Second, estimates of the stock composition of the catch are developed annually, using indicator stocks that represent the four listed ESUs and their stratas and life histories. These estimates are informative as to the proportion of the catch and total mortality relevant to each listed ESU. As explained in Section 1.3, Proposed Federal Action, fisheries are managed for limits on Chinook catch and total mortality based on preseason and inseason abundance estimates, and the catch is sampled to determine stock composition of hatchery fish. These sampling efforts provide postseason estimates of total Chinook salmon catch, total mortality, and stock composition which can be used as surrogates for the incidental take of ESA-listed Chinook salmon because they can be monitored directly and readily assessed for compliance, and the information can be used by NMFS to determine the magnitude of take of the four ESA-listed Chinook ESU affected, as explained further below.

Total catch and mortality levels

Chapter 3 of the PST Agreement requires management responses when Chinook salmon total catch and/or total mortality in SEAK AABM fisheries exceeds their limits (2019 PST Agreement, Chapter 3, paragraphs 4, 6, 7(b)). The responses are specific to the circumstances but share a common goal, i.e., to result in fisheries that do not exceed the PST catch limits or to reduce the difference between preseason fishery planning and performance as evaluated postseason. For example, if the actual Chinook catch in the SEAK AABM fishery exceeds the preseason catch limit (overage) then the overage shall be paid back in the fishing year after the overage occurs (paragraph 6(h)(i)) creating a substantial disincentive to exceed the catch limit. The provisions of Chapter 3 reasonably guard against our surrogate take indicator exceeding the level we have analyzed in our biological opinion by incorporating overage responses.

In our Effects analysis, we assume that total catch and mortality levels will either be within the level set annually through the PST process and consistent with the limits described in Chapter 3, or, in the case of an exceedance, that responses will be implemented as described in Chapter 3. Total catch and mortality levels are directly related to the amount of take NMFS has analyzed and expects in our Opinion of each of the listed Chinook ESUs, because that take is generally proportional to the overall catch or mortality of Chinook in the SEAK AABM fishery as evaluated in the Retrospective Analysis. Therefore, as one of our take surrogates, if the Chinook salmon total catch or total mortality limits described in Chapter 3 are exceeded and responses are not implemented as described in Chapter 3 of the 2019 PST Agreement in a given year when necessary, this would exceed the extent of take analyzed in the Opinion for the four threatened ESUs affected by the fishery.

Indicator stock exploitation rates

However, since the AABM framework is not stock-specific, there is potential for any one of the ESA-listed Chinook salmon ESUs to unintentionally experience ERs outside the range of our analysis, even if the total catch or total mortality limits described in Chapter 3 are not exceeded. This could occur if a particular listed ESU or stock was caught in proportions that exceeded the historical contributions of that ESU or stock to SEAK salmon fisheries observed in our analysis. The data necessary to determine if take exceeds our expectations for a listed ESU independently will be available annually through the CTC ERA. Recall from Section 2.5.1., the PSC CTC conducts an annual ERA using CWT recoveries in each year to assess impacts on CWT groups representing individual stocks or stock aggregates. NMFS will use this analysis for evaluating performance in the 2019 PST Agreement. A strength of the ERA is that it produces annual post-season estimates of stock-specific ERs using empirical CWT recoveries that occurred during the year being estimated. Similar to our first surrogate, the amount of take associated with each ESU independently, and each stock within an ESU, is still directly related to total catch and fishery mortality in that specific year for that stock specifically.

We are using stock-specific results from the CTC ERA analysis rather than the FRAM to establish take surrogates for the four ESUs considered in this opinion for several reasons: (1) CTC ERA-derived post-season estimates of ER are based on empirical CWT recoveries that occurred during the year for which the ER is being estimated; (2) the CTC ERA-derived post-season estimates ER are available in a more timely manner than those derived using the FRAM, often more than one year sooner; (3) use of the CTC ERA provides continuity and consistency with the information used to assess compliance with the 2019 PST Agreement including provisions for management of the SEAK AABM Chinook fishery, as results of the ERA are required as inputs to the annual calibration of the PSC Chinook Model; (4) the CTC ERA estimates ERs for the same time period as the retrospective FRAM analysis for indicator stocks that are representative of the four Chinook ESUs; (5) the FRAM and CTC ERA generally show similar patterns in exploitation rates over the 1999-2018 period used in the analysis. Therefore, we use the stock-specific results from the CTC ERA analysis, rather than the FRAM, to establish the independent take surrogates for the four Chinook salmon ESUs considered in this opinion.

Chapter 3 of the PST Agreement includes the specific indicator stocks for which the CTC assesses fishing related mortality by fishery and year and that information can be used to assess the performance of the fisheries relative to the catch and mortality limits in Chapter 3. Populations or life-history components in the four listed ESUs that are significantly affected by the proposed actions are represented by corresponding PSC indicator stocks. Our definition of populations or ESU life-history components that are significantly affected by the Proposed Action are those that currently experience greater than 10% of their total marine area fishery ER in the SEAK AABM fishery. The ERs provided in the annual CTC ERA analysis for those indicator stocks that are significantly affected by the proposed actions provides the information NMFS can use to assess fishing mortality relative to the ESU-specific ERs during the time frame of the Retrospective Analysis to determine if the extent of take resulting from the proposed actions is consistent with our analysis in this opinion.

Our analysis indicates take varies across the various life-history components and populations of the affected Chinook salmon ESUs. Therefore, individual Chinook salmon ESU take surrogates are based on the CTC ERA postseason ER in the SEAK AABM fishery during the retrospective analysis period (1999-2018) for representative PSC indicator stocks for each of the ESUs. The indicator stocks listed below represent the significantly affected populations or ESU life-history components in the SEAK AABM fishery based on the results of the retrospective analysis, as defined above. The Upper Willamette and Snake River fall Chinook ESUs each contain only one life history and the Snake River fall Chinook ESU is comprised of a single population. The LCR and Puget Sound populations comprise multiple life histories and ESUs. The following take surrogates account for those factors.

The ESU-specific take surrogates for the Upper Willamette, Snake River Fall Chinook and Puget Sound Chinook ESU are the highest observed single year postseason ERs in the SEAK AABM fishery during the analysis period (1999-2018), calculated using the CTC ERA, for each of the following PSC indicator stocks:

- Willamette spring (WSH) in the Upper Willamette Chinook ESU;
- Lyons Ferry in the Snake River fall Chinook ESU;
- Nooksack spring fingerling (NSF) and Skagit summer fingerling (SSF) indicator stocks in the Puget Sound Chinook ESU.

Because the post-season estimates in both the CTC ERA and FRAM validation are updated periodically, we do not provide numeric take surrogates here but focus on the data source and method, e.g., CTC ERA derived estimates. As the CTC ERA is run on an annual basis, there can occasionally be changes to the historical ERs, for example if there have been corrections or updates to historical CWT recovery data. Therefore, as future CTC ERA runs are completed, values could change slightly, but the criteria NMFS would use in determining if the extent of take resulting from the proposed actions is consistent with our analysis and would remain the same (i.e., the highest observed single year postseason ERs in the SEAK AABM fishery during the analysis period (1999-2018)).

For the LCR Chinook ESU, we use dual take surrogates - specifically the escapement goals for the bright and spring components of the LCR Chinook ESU:

- The Lewis River wild stock (LRW) is the PSC indicator stock for the Lower Columbia River bright component of the ESU. The escapement goal used for management purposes for the North Fork Lewis River population is 5,700 salmon. Annual escapements averaged 13,100 salmon between 2012 and 2023 and, with few exceptions, have met or exceeded the goal since at least 1980. Take would be exceeded should the ER for the LWR stock exceed the CTC ERA-calculated highest single year observed postseason ER value during the analysis period (1999-2018) and the escapement goal was not met in that year.
- The spring component of the LCR Chinook ESU does not currently have a PSC indicator stock. Therefore, the best available information for this component of the ESU for impacts in the SEAK AABM Chinook fishery is the results of the FRAM validation data series in the retrospective analysis. The historic spawning habitat for the spring-run Chinook salmon populations in Washington is now largely inaccessible to salmon due to impassable dams. The principle management objective for these

populations is to meet hatchery escapement goals for Cowlitz and Lewis river spring Chinook salmon. The Cowlitz Salmon Hatchery has met its escapement objective of 1,337 salmon in 10 out of the last 12 years, with the last five years experiencing two shortfalls. The Lewis River Salmon Hatchery has met its escapement objective of 1,380 salmon in 7 out of the last 12 years, with only one shortfall over the last five years. Take would be exceeded should the FRAM-based ER in SEAK fisheries for the LCR spring component exceed the FRAM calculated highest single year observed postseason ER value during the analysis period (1999-2018) in the FRAM validation scenario in the retrospective analysis and the hatchery escapement goals were not met in that year.

2.9.1.2 Southern Resident Killer Whales

The harvest of salmon that may occur under the proposed action 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. We cannot directly monitor the extent of take because the available data currently do not quantify the 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 salmon fisheries as quantitative regression analyses have limitations (see Section 2.5.3.1). Therefore, we identify here two surrogates for the extent of take for SRKW. Both surrogates measure the amount of fish removed by the SEAK salmon fisheries because the amount of fish removed by the fisheries relates to the effects on SRKWs, that is, the harm that results from the reduction in prey availability. Both surrogates can be monitored directly and readily assessed for compliance.

First, NMFS is using the expected level of Chinook salmon catch in SEAK fisheries, which we can quantify and monitor, as a surrogate for incidental take of SRKW. This extent of take for SRKW is therefore the same as the extent of expected catch of Chinook salmon that 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. If the Chinook salmon total catch or total mortality limits described in Chapter 3 are exceeded and responses are not implemented as described in Chapter 3 of the 2019 PST Agreement in a given year when necessary, this would exceed the extent of take analyzed in the Opinion.

Second, NMFS will also monitor the percent reduction of Chinook salmon prey attributed to the SEAK salmon fisheries as a surrogate for incidental take of SRKWs. This “prey reduction” value, as analyzed in the Effects section, includes only the amount of Chinook salmon catch expected to overlap in time and space with SRKW (i.e., available prey after natural and fisheries mortality). We can quantify and monitor this value, and it directly relates to the extent of effects on prey availability. The extent of take NMFS expects for SRKWs in future years is expected to vary but be within the range of prey reductions analyzed that would have occurred during the most recent decade (2009 to 2018) had the 2019 PST Agreement been in effect. Therefore, NMFS will use percent reductions in Chinook salmon abundance attributable to the SEAK salmon fisheries as another measure of expected take in addition to the surrogate described above. Over the most recent decade of Chinook salmon abundances, percent reductions due to SEAK salmon fisheries are estimated to range from 0.01-6.7% in coastal areas (depending on spatial region), and 0.7-1.9% in inland waters. If the percent reduction in abundance in any one year exceeds the maximum of the range of percent reduction in abundance estimated for that region from 2009 to 2018, this will constitute an exceedance of take.

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 actions. ESA-listed species interactions with SEAK salmon fisheries considered as take in the biological opinion include entanglement and blow-throughs[72] in a net or other component 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, also occur and are considered interactions. These hooking and entanglement interactions are all considered take, however they may not lead to M/SI in all cases. We conclude that the amount of take that is reasonably certain to occur in the SEAK fisheries and exempted in this ITS is up to 4 Mexico DPS humpback whale interactions on average each year, where 0.26 interactions per year are expected to cause M/SI (1 M/SI every 3 years). We also expect 1 Western DPS Steller sea lion M/SI interaction on average each year that is expected to result in 1 M/SI on average each year[73].

While we are able to describe an amount of take that we expect to occur, based on stranding data, self-reports, and observer data that contributes to monitoring of ESA listed humpback and Steller sea lion interactions in the SEAK salmon fisheries, we acknowledge that these data are limited. 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 we are generally not able to identify their DPS of origin. In the absence of precise DPS identification for each take, we employ the best available science to allocate those takes relative to the proportion of occurrence of listed versus non-listed humpback whales and Steller sea lions in SEAK. Furthermore, we note that the recovery of these DPSs continues despite past rates of take that are essentially identical to what we expect to occur in the future.

Based on the historical record of the opportunistic reports described in the Effect Analysis above, Table 103 summarizes the expected number of interactions with SEAK salmon fishery gear of each species and the portion expected to be ESA-listed. The portion of takes expected to be ESA-listed is based on the best available information on the percent of listed species found in SEAK (detailed in Section 2.5.4). We would consider the extent of take to be exceeded if the

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[72] See a description of a blow-through in Section 2.5.4.1 Marine Mammals Interactions in SEAK Salmon Fisheries.

[73] 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, except for the M/SI takes of ESA-listed humpback whales, which are expected to be less than 1 each year. For these M/SI takes of ESA-listed humpback whales, we estimate one take every three years is reasonably certain to occur.

number of interactions summarized in the annual Human-caused mortality and injury of NMFS-managed marine mammal stocks or summarized in SARs for the stocks exceed the take numbers from Table 103. Take is calculated based on interactions and not allocated differently based on severity or if the interaction leads to M/SI; however, the portion of take that is expected to lead to M/SI is provided for context.

Table 103. The amount of annual take of humpback whales and Steller sea lions that is reasonably likely to occur from incidental interactions with SEAK salmon fishing (values are rounded up).

Species	Take	# of Takes by Species	# of Takes From ESA-Listed Portion of Species
Humpback whale	Interaction	157	4
	M/SI	14	0.26 (1 every 3 years)
Steller sea lion	Interaction	34	1
	M/SI	33	1

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 action, 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" refer to those actions NMFS considers necessary or appropriate to minimize the impact of the incidental take on the species (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 the SEAK salmon fisheries considered in this Biological Opinion:

1. NMFS will ensure management objectives established preseason for the SEAK salmon fisheries is consistent with the terms of the 2019 PST Agreement.
2. NMFS will ensure inseason management actions taken during the course of the State of Alaska's (interchangeable with "ADF&G") implementation of the fisheries will be consistent with the 2019 PST Agreement.
3. NMFS will ensure catch limits and other measures used to manage fisheries will be monitored adequately to ensure compliance with management objectives.
4. NMFS will ensure the fisheries will be sampled for stock composition and other

biological information.

5. NMFS will work to improve monitoring of fishery interactions with ESA-listed marine mammals.
6. NMFS will monitor and review, annually, the estimated percent reductions of SRKW Chinook salmon prey by SEAK salmon fisheries using the best available measures.

2.9.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the federal action agency must comply (or must ensure that any applicant complies) with the following terms and conditions. The NMFS or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the actions and impacts 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 actions would likely lapse.

These terms and conditions constitute no more than a minor change to the proposed actions because they are consistent with the basic design of the proposed actions.

1. The following terms and conditions implement reasonable and prudent measure 1:

   1a. NMFS, specifically the West Coast Region, in cooperation with ADF&G shall ensure that management objectives established by ADF&G preseason for the SEAK fisheries are consistent with all applicable provisions of Annex IV of the PST.
   1b. NMFS, specifically the West Coast Region, in cooperation with ADF&G shall annually provide the point of contact (listed in number 7 below) with a final ERA estimate, to evaluate whether the extent of incidental take expected to occur is exceeded as described in Section 2.9.1.1 of the ITS prior to the next season.

2. The following terms and conditions implement reasonable and prudent measure 2:

   2a. NMFS, specifically the West Coast Region, in cooperation with ADF&G shall ensure that all in-season management actions taken by ADF&G during the course of the SEAK fisheries are consistent with all applicable provisions of Annex IV of the PST.

3. The following terms and conditions implement reasonable and prudent measures 3:

   3a. NMFS, specifically the West Coast Region, in cooperation with ADF&G shall ensure that all limits described in the proposed action considered in this Opinion were adhered to in all SEAK salmon fisheries through postseason monitoring reports, including any necessary responses required per the 2019 PST Agreement, by the date specified below in Term and Condition 7.
   3b. NMFS, specifically the West Coast Region, in cooperation with ADF&G 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 PST Agreement were adhered to by ADF&G while conducting all SEAK fisheries through postseason monitoring reports by the date specified below in Term and Condition 7.

3c. NMFS, specifically West Coast Region, in cooperation with ADF&G shall assess annually individual Chinook salmon ESU take surrogates, which are based on the CTC ERA postseason ER in the SEAK AABM fishery during the retrospective analysis period (1999-2018), for representative PSC indicator stocks for each of the ESUs, to determine whether the extent of take exempted for listed salmon was exceeded.

4. The following terms and conditions implement reasonable and prudent measure 4:

4a. NMFS, specifically the West Coast Region, in cooperation with ADF&G shall monitor the catch for stock composition and other biological information at levels of monitoring and sampling effort that are comparable to those used in recent years and needed to manage and evaluate the fisheries consistent with the 2019 PST Agreement, Chapter 3.

5. The following terms and conditions implement reasonable and prudent measure 5:

5a. NMFS, specifically the Alaska Region, will collaborate with ADF&G to encourage fishermen to fulfill their reporting obligations under section 118 of the MMPA by self-reporting incidental mortality and injury of marine mammals during the course of fishing.

5b. NMFS, specifically the Alaska Fisheries Science Center, will continue to work with ADF&G to evaluate the feasibility of observing State fisheries through the Alaska Marine Mammal Observer Program to generate more reliable estimates of fishery interactions with marine mammals. NMFS will use the MMPA List of Fisheries categorization and known data gaps to identify which fisheries to prioritize.

5c. NMFS, specifically the Alaska Region, will encourage ADF&G to continue Steller sea lion haul out surveys in SEAK in order to document a minimum number of Steller sea lions interactions with fishing gear.

6. The following terms and conditions implement reasonable and prudent measure 6:

6a. NMFS, specifically the West Coast Region, will estimate, using the best available science, annual fishery abundance reductions of age 3+ Chinook salmon by SEAK salmon fisheries. Post-season estimates will be calculated when post-season data and new model runs become available. The annual estimated reduction in Chinook salmon attributable to the SEAK salmon fisheries represents the difference between end of year abundances absent fishing and end of year abundances after SEAK fisheries occur (e.g., total mortalities resulting from fisheries across the entire management year). This shall be done using the methodology developed by the PFMC's Ad Hoc Workgroup for the stratifications defined by the PFMC SRKW Ad Hoc Workgroup: NOF, Oregon coast, California coast, Salish Sea, and SWWCVI. Percent reductions for each region will be calculated from the annual estimated reduction attributable to fishing mortality relative to the starting (pre-fishing) abundance at the beginning of the model run (Oct 1).

6b. NMFS, specifically the West Coast Region, will compare the annual estimated percent Chinook salmon age 3+ reductions (based on validated post-season runs) in the five spatial regions due to SEAK salmon fisheries (as in 6a) to the range of percent reductions during the most recent decade (2009 to 2018), described in Appendix E Table E1b, which represent the reductions that would have been expected in those years had the 2019 PST Agreement been in effect. NMFS WCR will consider the percent reductions to be within the range of effects analyzed and consistent with the ITS if percent reductions do not exceed the high end of the ranges per region. These values will be reported to the NMFS point of contact, specified in Term and Condition 7, as soon as possible following the completion of each new post-season model run.

7. NMFS, in cooperation with ADF&G, will ensure reports and notifications required by the Biological Opinion and this incidental take statement are annually electronically available for review by August 1 with 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
1009 College St., SE, Suite 210, Lacey, WA 98503

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 work with researchers, states and tribal fishery managers on tools to evaluate effectiveness of harvest management and other potential mitigation measures (habitat restoration and hatchery production and operations) to contribute to the prey base of SRKWs. To that end, NMFS should work on tools to better understand fisheries impacts SRKWs, including an evaluation of the ability to predict post-season percent reductions due to SEAK salmon fisheries from pre-season model runs.

2. NMFS should continue to develop a methodology or metrics to help assess performance of Chinook salmon hatchery programs to increase prey availability for SRKW, and should also continue to evaluate the relationship between prey abundance, high risk conditions, and SRKW population demographics and health.

3. In cooperation with ADF&G and other knowledgeable entities, NMFS should 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, NMFS should 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 should 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 the salmon troll fishery and the sport salmon fishery in the SEAK EEZ to the State of Alaska and 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 as currently described by the provisions of each Chapter and Annex of the PST Agreement, which define the specific limits of catch and total mortality limits for SEAK salmon fisheries..

Under 50 CFR 402.16(a): "Reinitiation of consultation is required and shall be requested by the federal agency, where discretionary federal involvement or control over the action has been retained or is authorized by law and: (1) If the amount or extent of taking specified in the incidental take statement is exceeded; (2) If new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the Biological Opinion or written concurrence; or (4) If a new species is listed or critical habitat designated that may be affected by the identified 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 5. 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.

2.12.1 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 2018b). The effects of PFMC fisheries on these ESUs were reviewed in Biological Opinions in 1996 (NMFS 1996) and 2001 (NMFS 2001). NMFS (2001) concluded that the expected take from the PFMC ocean and Fraser Panel salmon fisheries of Upper Columbia River Spring-run Chinook salmon is at most an occasional event. NMFS (2001) found it would be impossible to measure or detect potential effects of the proposed actions on Upper Columbia River Spring-run 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. The ability to detect these ESUs in areas further north, i.e., SEAK, is similar.

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 Genetic Stock Identification (GSI) studies suggest that mature Snake River spring Chinook salmon 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, and in the SEAK fisheries close to 80% of the all-gear allowable catch limit is allocated to the troll fleet, which harvests the majority of that allocation in July through September. 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% 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 2001), which are still relevant, concluded that fish from these ESUs are rarely, if ever, caught in ocean fisheries (U.S. or Canadian) and are not likely to be affected adversely by fisheries managed under the NPFMC's FMP. Although these Opinions focused on the PFMC 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 2018b). Given that these in-depth analyses showed that fish from these ESUs are rarely, if ever, caught in any ocean fisheries, and no information has come forward that changes these findings, we continue to conclude it is highly unlikely that either the Upper Columbia River spring-run or Snake River spring/summer Chinook salmon ESUs are caught in SEAK fisheries, thus the effects of those fisheries on these ESUs 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 2008a). These stocks reside primarily off California and the SUS west coast and are even more rarely caught in northern fisheries (Canadian, and then even further north in SEAK) than the Columbia River origin fish discussed above (NMFS 2008a). 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) and NMFS (2001)). The catch of any ESA-listed California Coastal, Central Valley spring-run, and Sacramento winter-run Chinook salmon in SEAK fisheries is highly unlikely and thus discountable due to their respective ocean migration patterns.

2.12.1.1 Chinook Salmon Critical Habitat

LCR Chinook Salmon, UWR Chinook Salmon, and SRFC salmon
As a consequence of the proposed actions some salmon from either the LCR Chinook, UWR, or SRFC salmon ESUs may die and may not return to freshwater areas as they would have if not for the proposed actions. In determining the effects on any of their respective designated critical habitats, we considered the consequence of an unknown number of salmon not returning to freshwater areas and how this would affect the PBFs of critical habitat. We determined that it is not possible to meaningfully measure, detect, or evaluate any potential changes in the value of PBFs. Additionally, the location of any impact would be unknown and speculative, and any impacts would be so broad and diffuse that they would not meaningfully relate to the species under consultation. Therefore, the effects of harvest activities from the proposed action on critical habitat PBFs are discountable. The fisheries in SEAK do not overlap in time or space with designated critical habitat for these ESUs. The proposed actions therefore are not likely to adversely affect these ESUs’ critical habitat.

Puget Sound Chinook Salmon
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.

Recall that in this Section (2.5.2.4) we describe the effects on Puget Sound Chinook salmon 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 PST Agreement in SEAK. Because fishing that occurs as a result of the proposed actions occurs in SEAK, similar to ESUs from the Columbia River we cannot detect any measurable disturbance to critical habitat that would occur from these activities for this ESU and therefore the proposed action is not likely to adversely affect critical habitat for this ESU.

2.12.2 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 1999a; 2015c), these ESUs 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.

2.12.3 Chum Salmon

There are two ESA-listed chum salmon ESUs that may range into northern waters: Columbia River chum salmon 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 2008a), and determined that no take in the SEAK fishery was expected. Hood Canal summer-run chum salmon are rarely caught in ocean fisheries (NMFS 2008a). Furthermore, Hood Canal summer-run chum salmon return timing (HCCC (Hood Canal Coordinating Council) 2005) 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 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 salmon harvest in northern or PFMC fisheries (NMFS 2008a). Based on the considerations summarized here the likely impact of capture on either ESA-listed chum salmon ESU in SEAK fisheries is discountable.

2.12.4 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 salmon. 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 salmon do migrate northward in the ocean, but mainly remain close to Vancouver Island (Tucker et al. 2015) and do not travel as far north as SEAK. 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 2017q). Sockeye salmon are also rarely if ever caught in PFMC area fisheries, suggesting that the migratory research is still current on ocean distribution of Snake River sockeye unlikely ever being exposed to ocean salmon fisheries (NMFS 2018b). All these considerations suggest that it is unlikely that Snake River sockeye salmon are encountered in the SEAK fisheries, and the current lack of data would make it impossible to measure or detect potential effects of the proposed actions on these ESUs.

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 salmon exist (Haggerty et al. 2009). Commercial net and troll fisheries extending from Dixon Entrance in SEAK 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 salmon through harvest areas (NMFS 2009d). The evaluation of these ocean fisheries in the Lake Ozette sockeye salmon limiting factors analysis concluded that there are no directed commercial sockeye salmon fisheries in the marine environment when and where the Ozette sockeye salmon population is present during the ocean rearing and migration period (NMFS 2009d). 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 2009d). 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.

2.12.5 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 2001; 2018g). 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 2001; UCSRB 2007; NMFS 2009c; ODFW and NMFS 2011; NPFMC 2012; NMFS 2013f; 2014h; 2016o; 2016i; 2016j; 2016k; 2016q; 2017q; 2018g). These rare events of catching a steelhead in these fisheries make it impossible to measure or detect potential effects of the proposed actions on the listed DPSs, as the data are not available to determine if they were from hatchery stocks, healthy natural-origin stocks, or listed DPS stocks. Given the rarity of the event, it is more likely the steelhead caught in ocean fisheries come from the more abundant hatchery stocks or healthy natural-origin stocks, as they would make up more of the ocean abundance. 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 2001). Our expectation is that steelhead ocean migrations do not extend far north and these rare events in the SEAK fisheries are more likely from encountering locally migrating steelhead stocks, meaning they are native to the rivers that originate in Canada that enter the Pacific Ocean off the coast of SEAK. Additionally, 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 2018b). 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 5.

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.

2.12.6 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 macrocephalus*), or Steller sea lion 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. 2018). 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 offshore waters of the Gulf of Alaska (outside the action area) 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. 2011b; Wade et al. 2011a; 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 (Braham and Rice 1984; Scarff 1986; Clapham et al. 2004). 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.

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 SEAK (east of 144° W. longitude) includes a terrestrial zone, an aquatic zone, and an air zone that extend 3,000 feet above each major rookery and haulout (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. The only meaningful way that SEAK fisheries could affect critical habitat is through prey removal. 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 (Figure 41).

Effects

Below we have analyzed effects for all of the species listed above, as well as for designated critical habitat for Steller sea lions. 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. 2018). Additionally, the majority of entanglements of large whales on the U.S. West Coast are associated with fixed pot/trap gear, gear that is not used in the SEAK salmon fisheries (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 recent 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 Steller sea lion 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 Western North Pacific 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. 2018). 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 SEAK is rare, we consider the risk of vessel collision to be discountable. As described in Section 2.2.3.5., 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. Under the MSA, this consultation is intended to promote the conservation of EFH as necessary to support sustainable fisheries and the managed species’ contribution to a healthy ecosystem. For the purposes of the MSA, EFH means “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity”, and includes the associated physical, chemical, and biological properties that are used by fish (50 CFR 600.10). 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 may result from actions occurring within EFH or outside of it and may include direct, indirect, site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) of the MSA also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. Such recommendations may include measures to avoid, minimize, mitigate, or otherwise offset the adverse effects of the action on EFH (50 CFR 600.905(b))].

The existing information and EFH consultation is incorporated in this section. The analysis is based, in part, on the EFH assessment provided by NMFS and descriptions of EFH for North Pacific Scallop (NPFMC 2024b), North Pacific groundfish (NPFMC 2020), North Pacific salmon (NPFMC 2024a), Pacific coast groundfish (PFMC 2023e), coastal pelagic species (CPS) (PFMC 2023d), Pacific coast salmon (PFMC 2024a), and highly migratory species (HMS) (PFMC 2023c) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

The proposed project occurs within EFH for various federally managed fish species within the North Pacific Scallop (NPFMC 2024b), North Pacific groundfish (NPFMC 2020), North Pacific salmon (NPFMC 2024a), Pacific coast groundfish (PFMC 2023e), CPS (PFMC 2023d), Pacific coast salmon (PFMC 2024a), and HMS (PFMC 2023c) fishery management plans.

The action area is described in detail above in Section 2.3, and species managed by the NPFMC, PFMC and by state and tribal co-managers in Puget Sound are discussed here as a result of possible effects from the proposed action.

Pursuant to the MSA, the Councils have designated EFH for weathervan scallops (NPFMC 2024b), over 30 species of groundfish (NPFMC 2020), all salmon known to exist in the North Pacific Ocean (NPFMC 2024a), six coastal pelagic species (PFMC 2023d), over 90 species of groundfish (PFMC 2023e), 11 highly migratory species (PFMC 2023c), and three species of federally-managed Pacific salmon: Chinook salmon (*O. tshawytscha*), coho salmon (*O. kisutch*), and Puget Sound pink salmon (*O. gorbuscha*) (PFMC 2024a). The PFMC does not manage the fisheries for chum salmon (*O. keta*), and neither Council manages fisheries for steelhead (*O. mykiss*). Therefore, EFH has not been designated for these species.

3.2 Adverse Effects on Essential Fish Habitat

NMFS determined the proposed action would adversely affect EFH as follows: 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.

Prey species can be considered a component of EFH (NMFS 2010e). However, the action considered in this opinion is promulgation of fisheries targeting adult salmon, which are not considered prey for any of the remaining species managed under the other FMPs. Furthermore, the salmon fisheries considered in this opinion have not documented interception of prey species for the adult species managed under the other FMPs either.

When gear associated with commercial or recreational fishing breaks free, is abandoned, or becomes otherwise lost in the aquatic environment, it becomes derelict gear. In commercial fisheries, gillnets, long lines, purse seines, and boating material are occasionally lost to the aquatic environment. The gear used in the proposed actions are gillnets, purse seines, and hook and line gear. Derelict fishing gear, as with other types of marine debris, can directly affect salmon habitat and can directly affect managed species via "ghost fishing." Ghost fishing is included here as an impact to EFH because the presence of marine debris affects the physical, chemical, or biological properties of EFH. For example, once plastics enter the water column, they contribute to the properties of the water. If debris is ingested by fish, it would likely cause harm to the individual. Another example is in the case of a lost net in a river. Once lost, the net becomes not only a potential barrier to fish passage, but also a more immediate entanglement threat to the individual.

Derelict gear can adversely affect salmon EFH directly by such means as physical harm to eelgrass beds or other estuarine benthic habitats; harm to coral and sponge habitats or rocky reefs in the marine environment; and by simply occupying space that would otherwise be available to salmon. Derelict gear also causes direct harm to salmon (and potentially prey species) by entanglement. Once derelict gear becomes a part of the aquatic environment, it affects the utility of the habitat in terms of passive use and passage to adjacent habitats. More specifically, if a derelict net is in the path of a migrating fish, that net can entangle and kill the individual fish. Fisheries managed under the proposed actions address the third type of possible EFH impact, the removal of salmon carcasses, by continuing to manage for maximum sustainable spawner escapement and implementation of management measures to prevent overfishing. The use of proper spawner escapement levels ensures fisheries are returning a consistent level of marine-derived nutrients back to freshwater areas.

Fishing vessel operation will occur in SEAK as a result of the proposed actions. Vessels can adversely affect EFH by affecting physical or chemical mechanisms. Physical effects can include physical contact with spawning gravel and redds (freshwater streams) and propeller wash in eelgrass beds (estuaries). However, the bounds of the action area are outside the bounds of freshwater EFH. Vessels operate in these marine waters as a result of implementing fisheries governed by any of the four FMPs, and for other non-fishing related activities. All of these operations provide potential for physical damage to any bottom habitat.

Most of the harvest related activities in SEAK occur from boats or along river banks, with most of the fishing activity in the marine and nearshore areas. The gear fishermen use include hook-and-line, drift gillnets, and purse seines. The types of salmon fishing gear that are used in SEAK salmon fisheries in general actively avoid contact with the substrate because of the resultant interference with fishing and potential loss of gear. Possible fishery-related impacts on riparian vegetation and habitat would occur primarily through bank fishing, movement of boats and gear to the water, and other stream side usages. The proposed fisheries include actions that would minimize these impacts if they did occur, such as area closures. Also, these effects would occur to some degree through implementation of fisheries or activities other than the salmon fisheries (i.e., recreational boating and marine species fisheries). Therefore, the proposed fisheries would have a negligible additional impact on the physical environment. The use of the gear in the fisheries promulgated through the action in Section 1.3 of this Opinion does not contribute to a decline in the values of estuarine and near shore substrate or deeper water, offshore habitats through gear effects. As adult salmon are not known prey species to the other species in the remaining FMPs, prey removal is also not considered to have a discernable impact on EFH. Additionally, the bounds of the action area are outside the bounds of freshwater EFH, therefore redd or juvenile fish disturbance will not result from the action in this opinion. Fishing vessel operation as a result of the action may result in physical damage to marine EFH. Generally fishing effort has fluctuated in recent years, and both commercial and recreational fishing vessels fish for Chinook and coho salmon and the effort solely attributable to the action considered in this opinion is unknown. However, based on the gear type used and the total fishing effort, the effect on essential habitat features of the affected species from the action discussed in this biological opinion will be minimal, certainly not enough to contribute to a decline in the values of the habitat.

Therefore, it is NMFS opinion that each current Councils' actions address EFH protection, and no discernible adverse effects on EFH for species managed under the the North Pacific Scallop (NPFMC 2024b), North Pacific groundfish (NPFMC 2020), North Pacific salmon (NPFMC 2024a), Coastal Pelagic Species Fishery Management Plan (PFMC 2023d), the Pacific Coast Groundfish Management Plan (PFMC 2023e), the Fishery Management Plan for U.S. West Coast Fisheries for Highly Migratory Species (PFMC 2023c), and the Pacific Coast Salmon Plan (PFMC 2024a) will result from the proposed action considered in this Biological Opinion.

3.3 Essential Fish Habitat Conservation Recommendations

NMFS determined that the following conservation recommendations are necessary to avoid, minimize, mitigate, or otherwise offset the impact of the proposed action on EFH.

The RPMs 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 RPMs 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.

3.4 Supplemental Consultation

The NMFS must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations [50 CFR 600.920(l)].

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The DQA specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the Opinion addresses these DQA components, documents compliance with the DQA, and certifies that this Opinion has undergone pre-dissemination review.

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 Opnion are the NMFS. 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 within 2 weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adhere 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 part 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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6. APPENDICES

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% Abundance Decline

Section 1: Summary of Model Scenario Inputs

Table A.1: Abundance indices and management error adjustments used to derive annual catch limits for each of the three aggregate abundance-based management fisheries: Southeast Alaska (SEAK), Northern British Columbia (NBC), and West Coast Vancouver Island (WCVI).

	Preseason Abundance Indices			Management Error Adjustment		
Year	SEAK	NBC	WCVI	SEAK	NBC	WCVI
1999	1.15	1.12	0.60	1.00	0.75	1.00
2000	1.14	1.00	0.54	1.00	0.76	1.00
2001	1.14	1.02	0.66	1.00	0.57	0.88
2002	1.74	1.45	0.95	0.94	0.61	1.00
2003	1.79	1.48	0.85	1.00	0.98	0.98
2004	1.88	1.67	0.90	0.97	0.88	0.79
2005	2.05	1.69	0.88	1.00	0.89	0.82
2006	1.69	1.53	0.75	1.00	0.91	0.85
2007	1.60	1.35	0.67	1.00	0.82	0.99
2008	1.07	0.96	0.76	0.97	0.92	1.00
2009	1.33	1.10	0.72	1.00	0.78	0.97
2010	1.35	1.17	0.96	1.00	0.80	1.00
2011	1.69	1.38	1.15	0.93	0.77	1.00
2012	1.52	1.32	0.89	0.98	0.89	0.91
2013	1.20	1.10	0.77	1.00	0.71	0.98
2014	2.57	1.99	1.20	1.00	0.75	1.00
2015	1.45	1.23	0.85	0.93	0.97	1.00
2016	2.06	1.70	0.89	0.91	0.70	1.00
2017	1.27	1.15	0.77	1.00	0.72	0.97
2018	1.07	1.01	0.59	0.99	0.86	1.00

Table A.2: Annual catch limits 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	140,323	109,753	78,600	163,800	109,753	78,600	86,300	65,656	40,400
2000	140,323	98,257	70,800	161,400	98,257	70,800	85,600	58,954	35,900
2001	140,323	76,132	76,178	161,400	76,132	76,178	85,600	45,530	39,542
2002	249,482	117,808	135,400	283,560	117,808	135,400	131,320	69,144	74,700
2003	266,585	192,334	109,152	311,200	192,334	109,152	140,323	112,902	65,452
2004	325,436	214,573	92,884	317,199	214,573	92,884	136,535	114,509	55,778
2005	334,465	219,509	94,605	353,900	219,509	94,605	205,165	116,876	56,944
2006	266,585	202,382	83,868	294,800	202,382	83,868	140,323	108,445	43,086
2007	266,585	146,778	86,922	280,000	146,778	86,922	111,833	86,830	44,451
2008	135,792	114,813	99,600	139,834	114,813	99,600	78,675	69,366	51,700
2009	205,165	110,983	91,891	218,800	110,983	91,891	97,300	66,590	47,066
2010	205,165	121,935	136,800	221,800	121,935	136,800	98,500	72,953	76,000
2011	247,314	140,332	192,100	273,489	140,332	192,100	130,179	83,015	90,400
2012	261,253	154,826	106,414	261,464	154,826	106,414	109,596	91,593	63,337
2013	140,323	101,154	98,711	176,000	101,154	98,711	89,300	60,692	50,578
2014	372,921	217,465	200,400	439,400	217,465	200,400	266,585	115,886	94,300
2015	190,620	155,673	111,802	220,199	155,673	111,802	97,278	93,365	67,041
2016	303,220	174,669	116,600	322,381	174,669	116,600	185,999	93,392	69,400
2017	205,165	107,384	98,056	209,700	107,384	98,056	93,600	64,430	50,243
2018	138,279	113,423	77,300	142,395	113,423	77,300	80,116	68,503	39,300

Section 2: Summary of Stock Specific Exploitation Rates

Table A.3: 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	11.7%	12.3%	12.5%	10.9%	1.8%	1.3%	1.5%	1.4%	3.2%	4.5%	4.5%	4.3%	6.7%	6.5%	6.5%	5.2%
2000	17.8%	12.8%	13.1%	12.2%	2.3%	1.9%	2.1%	1.9%	7.4%	6.2%	6.2%	5.4%	8.2%	4.8%	4.8%	4.9%
2001	11.9%	10.6%	10.8%	9.3%	1.5%	1.1%	1.3%	1.2%	3.5%	2.9%	2.9%	2.7%	7.0%	6.6%	6.6%	5.5%
2002	23.0%	17.6%	17.8%	17.2%	2.2%	1.7%	1.9%	1.5%	5.6%	5.0%	5.0%	4.7%	15.1%	10.9%	10.9%	11.0%
2003	16.1%	12.3%	12.4%	12.1%	1.7%	1.2%	1.3%	1.0%	4.3%	3.4%	3.4%	3.3%	10.1%	7.8%	7.7%	7.8%
2004	18.8%	14.7%	14.7%	14.2%	1.8%	1.5%	1.4%	1.1%	7.8%	4.5%	4.5%	4.4%	9.2%	8.7%	8.7%	8.8%
2005	21.1%	14.5%	14.6%	14.4%	1.8%	1.7%	1.8%	1.7%	7.8%	4.9%	4.9%	4.8%	11.4%	7.8%	7.8%	7.8%
2006	16.7%	16.0%	16.1%	14.1%	2.0%	1.5%	1.6%	1.4%	8.3%	5.6%	5.6%	5.1%	6.3%	8.9%	8.9%	7.7%
2007	10.9%	9.5%	9.6%	7.3%	2.2%	1.8%	1.9%	1.3%	4.6%	3.7%	3.7%	3.5%	4.1%	4.0%	4.0%	2.4%
2008	12.5%	13.7%	13.8%	12.1%	1.7%	1.3%	1.4%	1.3%	6.1%	4.8%	4.8%	4.5%	4.7%	7.6%	7.6%	6.3%
2009	17.0%	19.1%	19.2%	16.4%	2.5%	2.2%	2.3%	1.8%	7.4%	5.9%	5.9%	5.5%	7.2%	11.0%	11.0%	9.1%
2010	20.1%	19.9%	20.0%	19.3%	2.1%	1.9%	2.0%	1.6%	6.2%	6.0%	6.0%	5.7%	11.8%	11.9%	11.9%	12.0%
2011	19.5%	18.9%	18.9%	17.2%	1.8%	1.6%	1.7%	1.4%	7.5%	7.2%	7.2%	6.1%	10.1%	10.1%	9.9%	9.7%
2012	21.9%	19.5%	19.5%	18.4%	2.0%	2.3%	2.3%	1.7%	7.2%	6.4%	6.4%	6.4%	12.7%	10.7%	10.7%	10.4%
2013	14.6%	14.3%	14.4%	14.1%	1.2%	0.9%	1.1%	1.0%	3.6%	3.1%	3.1%	2.8%	9.8%	10.3%	10.3%	10.3%
2014	19.8%	17.6%	17.8%	16.4%	1.8%	1.6%	1.9%	1.9%	6.8%	7.0%	7.0%	5.8%	11.2%	9.0%	8.9%	8.7%
2015	15.9%	14.9%	15.0%	14.8%	1.5%	0.9%	1.0%	0.8%	4.1%	3.8%	3.8%	3.8%	10.3%	10.2%	10.2%	10.2%
2016	15.0%	17.0%	17.1%	15.4%	2.3%	1.9%	2.0%	2.0%	5.4%	5.4%	5.4%	5.4%	7.4%	9.7%	9.7%	8.0%
2017	18.3%	17.4%	17.5%	14.1%	1.4%	1.6%	1.6%	1.3%	5.9%	5.1%	5.1%	4.8%	11.0%	10.8%	10.8%	8.0%
2018	15.4%	17.0%	17.1%	14.3%	1.8%	1.9%	2.0%	2.0%	5.6%	5.1%	5.1%	4.9%	8.0%	10.0%	10.0%	7.4%

	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**
'99-18 Avg	**16.9%**	**15.5%**	**15.6%**	**14.2%**	**1.9%**	**1.6%**	**1.7%**	**1.5%**	**5.9%**	**5.0%**	**5.0%**	**4.7%**	**9.1%**	**8.9%**	**8.8%**	**8.0%**

Table A.4: 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%	27.1%	27.4%	24.4%	2.7%	1.9%	2.2%	2.0%	10.0%	13.9%	13.9%	13.1%	10.7%	11.3%	11.3%	9.3%
2000	34.4%	24.7%	25.0%	23.3%	2.5%	2.2%	2.5%	2.3%	18.7%	15.6%	15.6%	13.9%	13.2%	6.9%	6.9%	7.1%
2001	30.1%	25.1%	25.3%	22.4%	2.2%	1.8%	2.0%	1.8%	11.9%	10.0%	10.0%	9.3%	15.9%	13.3%	13.3%	11.3%
2002	36.3%	27.4%	27.7%	26.6%	2.4%	1.8%	2.1%	1.6%	14.2%	12.5%	12.5%	11.9%	19.7%	13.1%	13.1%	13.1%
2003	34.1%	26.0%	26.2%	25.8%	2.1%	1.6%	1.8%	1.4%	14.5%	11.2%	11.2%	11.2%	17.5%	13.2%	13.2%	13.2%
2004	38.1%	27.6%	27.5%	26.8%	2.4%	2.1%	2.0%	1.5%	20.1%	12.3%	12.3%	12.1%	15.6%	13.2%	13.2%	13.2%
2005	44.0%	29.5%	29.6%	29.3%	2.1%	2.2%	2.4%	2.3%	21.5%	14.3%	14.3%	14.0%	20.4%	13.0%	13.0%	13.0%
2006	31.9%	29.4%	29.6%	26.3%	2.4%	1.9%	2.1%	1.7%	20.7%	14.5%	14.5%	13.2%	8.8%	13.0%	13.0%	11.3%
2007	38.2%	30.4%	30.6%	24.9%	3.3%	3.0%	3.2%	2.3%	22.0%	16.4%	16.5%	15.4%	12.9%	11.0%	11.0%	7.2%
2008	27.6%	29.8%	29.8%	26.7%	2.5%	2.0%	2.0%	2.0%	18.9%	14.7%	14.7%	13.7%	6.3%	13.1%	13.1%	11.0%
2009	27.5%	30.1%	30.3%	26.5%	2.8%	2.5%	2.7%	2.1%	17.8%	14.5%	14.5%	13.5%	6.8%	13.1%	13.1%	10.9%
2010	29.8%	28.9%	29.0%	27.9%	2.4%	2.2%	2.4%	1.8%	13.6%	13.6%	13.6%	12.9%	13.8%	13.1%	13.1%	13.2%
2011	31.8%	33.2%	33.2%	29.9%	2.2%	1.8%	2.0%	1.7%	19.4%	18.5%	18.6%	16.0%	10.3%	12.8%	12.6%	12.2%
2012	32.8%	30.7%	30.7%	29.4%	2.4%	2.7%	2.7%	2.0%	16.8%	14.9%	14.9%	14.8%	13.5%	13.1%	13.1%	12.7%
2013	25.9%	23.7%	24.0%	23.1%	1.6%	1.2%	1.5%	1.3%	10.7%	9.1%	9.1%	8.3%	13.7%	13.4%	13.4%	13.5%
2014	37.5%	32.5%	32.8%	29.8%	2.2%	1.9%	2.3%	2.4%	17.0%	17.7%	17.7%	14.9%	18.3%	12.9%	12.9%	12.6%
2015	28.7%	25.1%	25.2%	24.9%	2.0%	1.2%	1.4%	1.1%	11.5%	10.5%	10.5%	10.5%	15.3%	13.3%	13.3%	13.3%
2016	27.2%	29.1%	29.2%	26.9%	2.8%	2.4%	2.5%	2.5%	13.5%	13.6%	13.6%	13.5%	10.9%	13.1%	13.0%	10.9%
2017	29.0%	27.3%	27.3%	23.0%	1.7%	1.9%	2.0%	1.6%	14.7%	12.1%	12.1%	11.3%	12.7%	13.2%	13.2%	10.0%
2018	27.3%	27.7%	27.8%	23.9%	2.1%	2.2%	2.3%	2.2%	13.9%	12.1%	12.1%	11.5%	11.4%	13.3%	13.3%	10.1%
'99-18 Avg	**31.8%**	**28.3%**	**28.4%**	**26.1%**	**2.3%**	**2.0%**	**2.2%**	**1.9%**	**16.1%**	**13.6%**	**13.6%**	**12.7%**	**13.4%**	**12.6%**	**12.6%**	**11.5%**

Table A.5: 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	50.2%	52.9%	53.6%	51.2%	15.5%	12.4%	13.2%	12.9%	21.1%	26.4%	26.4%	25.3%	13.6%	14.0%	13.9%	12.9%
2000	59.1%	44.1%	44.9%	43.1%	10.3%	11.0%	12.0%	11.3%	22.8%	24.1%	24.0%	22.0%	26.0%	9.0%	8.9%	9.9%
2001	47.7%	40.6%	41.3%	37.8%	9.8%	8.5%	9.3%	8.9%	15.2%	14.3%	14.3%	13.7%	22.7%	17.7%	17.6%	15.1%
2002	54.7%	41.2%	42.1%	39.9%	11.4%	9.9%	10.9%	9.1%	17.3%	16.7%	16.6%	16.1%	25.9%	14.6%	14.6%	14.8%
2003	49.0%	36.5%	37.4%	35.7%	9.0%	7.1%	8.1%	6.3%	18.0%	16.4%	16.3%	16.3%	22.0%	13.0%	13.0%	13.1%
2004	54.3%	44.6%	44.5%	42.4%	9.4%	8.3%	8.1%	6.4%	26.1%	19.7%	19.7%	19.1%	18.9%	16.6%	16.6%	16.8%
2005	62.3%	46.2%	46.6%	45.7%	8.9%	9.8%	10.2%	10.0%	27.2%	22.3%	22.2%	21.5%	26.2%	14.2%	14.2%	14.3%
2006	42.0%	37.6%	38.4%	34.7%	11.2%	8.7%	9.5%	7.8%	24.7%	19.3%	19.2%	17.4%	6.0%	9.7%	9.6%	9.5%
2007	56.4%	52.2%	52.6%	44.7%	16.1%	14.3%	14.8%	12.3%	28.1%	23.0%	23.0%	23.2%	12.1%	14.9%	14.8%	9.2%
2008	45.9%	48.6%	48.8%	47.0%	11.5%	9.3%	9.5%	9.3%	27.5%	22.7%	22.7%	21.7%	6.9%	16.7%	16.6%	16.0%
2009	47.7%	50.7%	51.1%	47.5%	13.9%	12.5%	13.1%	11.1%	27.3%	22.9%	22.8%	21.9%	6.5%	15.2%	15.2%	14.5%
2010	50.0%	47.6%	48.0%	45.9%	10.2%	9.7%	10.2%	8.3%	21.9%	21.6%	21.5%	21.0%	18.0%	16.3%	16.3%	16.6%
2011	46.8%	48.2%	48.5%	45.0%	9.4%	8.1%	8.7%	7.5%	26.5%	25.6%	25.6%	23.3%	10.8%	14.5%	14.2%	14.2%
2012	50.2%	47.9%	47.9%	44.9%	9.7%	10.9%	10.9%	8.1%	23.3%	23.2%	23.2%	23.2%	17.2%	13.8%	13.8%	13.6%
2013	45.6%	46.0%	46.6%	45.3%	6.1%	4.8%	5.6%	5.1%	21.5%	18.5%	18.5%	17.4%	18.0%	22.6%	22.5%	22.9%
2014	49.0%	43.0%	44.0%	41.7%	9.4%	8.6%	9.9%	10.3%	18.9%	20.2%	20.1%	17.6%	20.8%	14.1%	14.0%	13.8%
2015	42.8%	38.9%	39.4%	38.4%	7.5%	4.8%	5.4%	4.3%	18.5%	17.9%	17.9%	17.9%	16.8%	16.1%	16.0%	16.1%
2016	45.7%	45.9%	46.4%	44.6%	11.4%	10.0%	10.5%	10.3%	19.9%	20.0%	20.0%	19.4%	14.4%	15.9%	15.9%	14.8%
2017	42.9%	41.5%	41.7%	37.8%	8.6%	9.7%	9.8%	8.4%	20.9%	17.7%	17.7%	17.1%	13.4%	14.2%	14.2%	12.3%
2018	50.2%	53.3%	53.4%	50.5%	10.4%	10.5%	10.7%	10.6%	26.0%	23.3%	23.3%	22.9%	13.8%	19.5%	19.5%	16.9%
'99-18 Avg	**49.6%**	**45.4%**	**45.9%**	**43.2%**	**10.5%**	**9.5%**	**10.0%**	**8.9%**	**22.6%**	**20.8%**	**20.8%**	**19.9%**	**16.5%**	**15.1%**	**15.1%**	**14.4%**

Table A.6: 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	5.8%	5.6%	6.0%	5.1%	3.4%	2.4%	2.8%	2.5%	1.2%	1.7%	1.7%	1.6%	1.3%	1.4%	1.4%	1.0%
2000	10.4%	8.3%	8.9%	7.9%	5.6%	4.3%	4.9%	4.4%	4.0%	3.1%	3.1%	2.7%	0.8%	0.8%	0.8%	0.8%
2001	7.5%	6.2%	6.5%	5.8%	3.4%	2.6%	2.9%	2.6%	2.4%	1.9%	1.9%	1.7%	1.7%	1.7%	1.7%	1.4%
2002	9.2%	6.9%	7.2%	6.5%	3.2%	2.3%	2.6%	2.1%	3.1%	2.6%	2.6%	2.4%	2.8%	2.0%	2.0%	2.0%
2003	8.1%	6.0%	6.4%	5.7%	3.6%	2.6%	3.0%	2.3%	2.8%	1.9%	1.9%	1.9%	1.7%	1.5%	1.5%	1.5%
2004	9.0%	6.4%	6.4%	5.7%	3.2%	2.5%	2.5%	1.8%	4.1%	2.1%	2.1%	2.1%	1.7%	1.8%	1.8%	1.8%
2005	10.9%	7.5%	7.7%	7.5%	4.3%	3.8%	4.0%	3.9%	4.0%	2.2%	2.2%	2.2%	2.6%	1.4%	1.4%	1.4%
2006	10.0%	7.5%	7.8%	6.4%	3.8%	2.8%	3.1%	2.5%	4.2%	2.8%	2.8%	2.5%	2.0%	1.9%	1.9%	1.4%
2007	10.5%	8.1%	8.3%	6.2%	5.4%	4.5%	4.7%	3.2%	3.8%	2.6%	2.6%	2.4%	1.3%	1.0%	1.0%	0.7%
2008	7.3%	6.9%	6.9%	6.0%	3.0%	2.4%	2.5%	2.4%	3.0%	2.3%	2.3%	2.2%	1.3%	2.1%	2.1%	1.5%
2009	7.4%	7.5%	7.7%	6.2%	3.4%	3.1%	3.2%	2.5%	3.0%	2.4%	2.4%	2.2%	1.0%	2.0%	2.0%	1.5%
2010	9.0%	8.3%	8.6%	7.5%	4.1%	3.7%	4.0%	3.0%	2.5%	2.5%	2.5%	2.4%	2.3%	2.1%	2.1%	2.1%
2011	8.7%	8.4%	8.7%	7.4%	4.0%	3.4%	3.7%	3.0%	3.2%	3.0%	3.0%	2.6%	1.6%	1.9%	1.9%	1.8%
2012	8.9%	8.6%	8.6%	7.2%	4.3%	4.7%	4.7%	3.3%	2.3%	2.1%	2.1%	2.1%	2.3%	1.9%	1.9%	1.8%
2013	5.7%	5.2%	5.6%	5.1%	2.3%	1.7%	2.1%	1.8%	1.7%	1.4%	1.4%	1.3%	1.7%	2.0%	2.0%	2.0%
2014	9.5%	8.2%	8.7%	8.2%	3.7%	3.3%	3.8%	3.9%	2.8%	2.9%	2.9%	2.4%	3.0%	2.0%	2.0%	2.0%
2015	7.2%	5.4%	5.7%	5.1%	3.2%	1.9%	2.1%	1.6%	1.6%	1.5%	1.5%	1.5%	2.4%	2.0%	2.0%	2.0%
2016	7.9%	7.7%	8.0%	7.4%	5.3%	4.5%	4.8%	4.6%	1.7%	1.7%	1.7%	1.7%	0.9%	1.5%	1.4%	1.1%
2017	7.2%	7.6%	7.7%	5.9%	3.6%	4.2%	4.3%	3.3%	1.9%	1.6%	1.6%	1.5%	1.7%	1.8%	1.8%	1.2%
2018	5.9%	6.3%	6.3%	5.4%	2.6%	2.8%	2.8%	2.7%	1.7%	1.5%	1.5%	1.5%	1.6%	2.0%	2.0%	1.3%
'99-18 Avg	**8.3%**	**7.1%**	**7.4%**	**6.4%**	**3.8%**	**3.2%**	**3.4%**	**2.9%**	**2.7%**	**2.2%**	**2.2%**	**2.0%**	**1.8%**	**1.8%**	**1.7%**	**1.5%**

Table A.7: 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	27.4%	28.2%	28.4%	25.5%	1.3%	1.0%	1.1%	1.0%	4.9%	7.0%	7.0%	6.5%	21.2%	20.2%	20.2%	17.9%
2000	34.5%	23.2%	23.5%	22.5%	3.0%	2.4%	2.8%	2.5%	9.5%	8.1%	8.1%	7.2%	22.0%	12.7%	12.7%	12.9%
2001	32.4%	25.0%	25.1%	22.4%	1.2%	1.0%	1.1%	1.0%	5.9%	4.7%	4.7%	4.3%	25.3%	19.4%	19.4%	17.2%
2002	37.8%	27.2%	27.3%	26.8%	1.0%	0.7%	0.8%	0.7%	8.0%	6.8%	6.8%	6.4%	28.8%	19.7%	19.7%	19.7%
2003	40.4%	28.1%	28.3%	28.0%	1.2%	0.9%	1.0%	0.8%	9.4%	6.8%	6.9%	6.8%	29.7%	20.4%	20.4%	20.4%
2004	36.8%	26.0%	25.9%	25.5%	1.5%	1.2%	1.2%	0.9%	10.6%	6.3%	6.3%	6.1%	24.7%	18.5%	18.5%	18.5%
2005	46.3%	28.9%	28.9%	28.7%	1.2%	1.2%	1.3%	1.2%	11.3%	7.1%	7.1%	6.9%	33.8%	20.6%	20.6%	20.6%
2006	26.9%	27.8%	27.9%	25.1%	1.6%	1.2%	1.3%	1.1%	10.9%	7.4%	7.4%	6.7%	14.4%	19.2%	19.1%	17.3%
2007	32.6%	26.2%	26.2%	20.7%	1.5%	1.3%	1.4%	1.0%	11.3%	8.1%	8.1%	7.5%	19.8%	16.7%	16.7%	12.2%
2008	20.6%	26.4%	26.5%	23.6%	1.0%	0.8%	0.8%	0.8%	10.6%	7.6%	7.6%	7.0%	9.0%	18.1%	18.1%	15.8%
2009	18.5%	26.0%	26.1%	22.9%	0.9%	0.8%	0.8%	0.7%	8.9%	6.9%	6.9%	6.3%	8.7%	18.3%	18.3%	15.9%
2010	23.3%	24.3%	24.3%	23.9%	0.6%	0.6%	0.6%	0.5%	6.3%	6.2%	6.2%	5.8%	16.4%	17.6%	17.6%	17.6%
2011	29.1%	32.2%	32.0%	29.7%	0.8%	0.7%	0.7%	0.6%	11.7%	10.9%	10.9%	9.1%	16.7%	20.6%	20.4%	20.0%
2012	29.5%	25.2%	25.2%	24.4%	0.7%	0.8%	0.8%	0.6%	8.3%	7.3%	7.3%	7.2%	20.5%	17.2%	17.2%	16.7%
2013	22.7%	22.7%	22.7%	22.3%	0.4%	0.3%	0.3%	0.3%	4.7%	4.0%	4.0%	3.6%	17.6%	18.4%	18.4%	18.4%
2014	43.6%	32.4%	32.5%	30.4%	0.8%	0.8%	0.9%	0.9%	9.4%	10.2%	10.2%	8.4%	33.4%	21.4%	21.4%	21.1%
2015	28.3%	25.9%	26.0%	25.8%	1.0%	0.6%	0.7%	0.5%	6.1%	5.7%	5.7%	5.7%	21.2%	19.6%	19.6%	19.6%
2016	25.3%	29.0%	29.1%	26.7%	1.5%	1.3%	1.4%	1.3%	7.7%	8.0%	8.0%	7.9%	16.2%	19.8%	19.8%	17.5%
2017	26.2%	26.8%	26.8%	22.6%	0.9%	1.0%	1.0%	0.8%	7.9%	6.6%	6.6%	6.1%	17.4%	19.2%	19.2%	15.7%
2018	26.2%	28.3%	28.3%	24.3%	0.8%	0.9%	0.9%	0.9%	7.1%	6.4%	6.4%	6.0%	18.2%	21.0%	21.0%	17.4%
'99-18 Avg	**30.4%**	**27.0%**	**27.1%**	**25.1%**	**1.2%**	**1.0%**	**1.0%**	**0.9%**	**8.5%**	**7.1%**	**7.1%**	**6.6%**	**20.8%**	**18.9%**	**18.9%**	**17.6%**

Table A.8: 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	51.5%	51.4%	51.9%	48.9%	5.7%	4.4%	5.1%	4.7%	42.2%	42.8%	42.7%	40.0%	3.5%	4.2%	4.2%	4.2%
2000	29.2%	22.4%	22.9%	20.8%	3.3%	2.7%	3.1%	2.7%	21.9%	16.3%	16.4%	14.7%	4.0%	3.4%	3.4%	3.4%
2001	15.6%	14.7%	15.0%	14.1%	3.4%	2.4%	2.8%	2.4%	9.4%	8.9%	8.9%	8.4%	2.8%	3.4%	3.4%	3.3%
2002	22.8%	19.8%	20.3%	19.0%	4.1%	2.9%	3.3%	2.5%	15.9%	13.8%	13.9%	13.3%	2.8%	3.1%	3.1%	3.1%
2003	41.4%	30.8%	31.1%	30.4%	2.7%	2.2%	2.4%	1.8%	35.0%	24.1%	24.1%	24.1%	3.7%	4.6%	4.6%	4.6%
2004	23.6%	16.4%	16.4%	15.8%	2.8%	2.2%	2.2%	1.7%	15.2%	9.5%	9.5%	9.5%	5.6%	4.6%	4.6%	4.6%
2005	46.8%	37.5%	37.8%	36.2%	4.5%	3.9%	4.2%	3.8%	37.2%	28.2%	28.2%	26.9%	5.1%	5.4%	5.4%	5.5%
2006	32.5%	26.9%	27.1%	25.0%	3.2%	2.5%	2.7%	2.0%	22.4%	17.3%	17.3%	15.9%	7.0%	7.1%	7.1%	7.1%
2007	40.6%	36.2%	36.4%	33.4%	5.7%	4.5%	4.7%	3.6%	28.4%	24.4%	24.5%	22.6%	6.5%	7.2%	7.2%	7.1%
2008	34.9%	33.1%	33.2%	31.3%	3.0%	2.6%	2.7%	2.4%	26.7%	23.8%	23.8%	22.2%	5.1%	6.7%	6.7%	6.7%
2009	25.9%	22.8%	23.0%	21.0%	3.6%	3.3%	3.6%	2.7%	18.0%	14.0%	14.0%	12.9%	4.3%	5.4%	5.4%	5.4%
2010	34.1%	37.1%	37.5%	35.3%	4.7%	3.9%	4.3%	3.3%	23.0%	26.1%	26.1%	24.7%	6.3%	7.1%	7.1%	7.2%
2011	43.1%	43.2%	43.4%	39.7%	3.1%	3.0%	3.1%	2.4%	32.3%	32.3%	32.4%	29.1%	7.7%	8.0%	8.0%	8.1%
2012	33.7%	29.4%	29.5%	28.1%	3.5%	3.6%	3.8%	2.8%	21.9%	18.2%	18.2%	17.7%	8.3%	7.6%	7.5%	7.6%
2013	27.5%	22.8%	23.3%	21.9%	2.4%	2.0%	2.4%	2.2%	16.9%	14.2%	14.2%	13.1%	8.1%	6.6%	6.7%	6.7%
2014	39.2%	36.1%	36.6%	33.7%	3.5%	2.6%	3.0%	2.8%	26.2%	26.5%	26.5%	23.7%	9.6%	7.1%	7.1%	7.2%
2015	22.2%	17.9%	18.1%	17.7%	2.2%	1.5%	1.7%	1.4%	14.4%	11.3%	11.3%	11.3%	5.7%	5.1%	5.1%	5.1%
2016	26.3%	26.2%	26.4%	25.7%	3.6%	3.5%	3.6%	3.2%	18.1%	18.0%	18.0%	17.8%	4.7%	4.8%	4.8%	4.7%
2017	32.1%	32.2%	32.3%	30.2%	2.1%	2.3%	2.4%	2.0%	25.3%	22.9%	23.0%	21.5%	4.6%	7.0%	7.0%	6.8%
2018	22.2%	20.9%	20.9%	19.9%	2.4%	2.6%	2.6%	2.5%	15.1%	13.7%	13.7%	12.9%	4.7%	4.6%	4.6%	4.5%
'99-18 Avg	**32.3%**	**28.9%**	**29.2%**	**27.4%**	**3.5%**	**2.9%**	**3.2%**	**2.6%**	**23.3%**	**20.3%**	**20.3%**	**19.1%**	**5.5%**	**5.6%**	**5.6%**	**5.7%**

Table A.9: 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	15.8%	16.2%	16.3%	15.3%	0.3%	0.3%	0.3%	0.3%	12.4%	13.4%	13.4%	12.4%	3.1%	2.6%	2.6%	2.6%
2000	41.1%	27.6%	27.6%	26.0%	0.4%	0.4%	0.4%	0.4%	26.3%	22.1%	22.1%	20.4%	14.4%	5.1%	5.1%	5.2%
2001	11.6%	10.1%	10.1%	9.8%	0.3%	0.2%	0.2%	0.2%	7.1%	6.8%	6.8%	6.5%	4.3%	3.1%	3.1%	3.1%
2002	18.3%	15.7%	15.8%	15.6%	0.3%	0.3%	0.3%	0.2%	12.4%	11.1%	11.2%	11.0%	5.6%	4.3%	4.3%	4.4%
2003	18.0%	13.4%	13.4%	13.4%	0.3%	0.2%	0.2%	0.2%	13.5%	9.9%	9.9%	9.9%	4.3%	3.3%	3.3%	3.3%
2004	18.5%	13.2%	13.2%	13.1%	0.3%	0.2%	0.2%	0.2%	13.6%	9.7%	9.7%	9.6%	4.6%	3.3%	3.3%	3.3%
2005	23.6%	19.3%	19.3%	18.7%	0.3%	0.3%	0.3%	0.3%	18.0%	14.0%	14.0%	13.4%	5.3%	5.0%	5.0%	5.0%
2006	12.8%	12.2%	12.2%	11.8%	0.3%	0.2%	0.3%	0.2%	8.0%	7.6%	7.7%	7.2%	4.5%	4.3%	4.3%	4.3%
2007	28.6%	26.5%	26.6%	25.7%	0.6%	0.6%	0.6%	0.5%	18.9%	17.5%	17.5%	16.7%	9.0%	8.4%	8.4%	8.5%
2008	14.6%	15.2%	15.2%	14.8%	0.4%	0.3%	0.3%	0.3%	7.5%	7.8%	7.8%	7.4%	6.8%	7.1%	7.1%	7.2%
2009	25.4%	22.8%	22.8%	22.2%	0.4%	0.4%	0.4%	0.3%	12.4%	10.4%	10.4%	9.8%	12.6%	12.0%	12.0%	12.1%
2010	17.1%	18.9%	18.9%	18.5%	0.3%	0.3%	0.3%	0.2%	8.1%	9.9%	9.9%	9.5%	8.7%	8.7%	8.7%	8.8%
2011	29.3%	29.0%	29.1%	28.0%	0.3%	0.3%	0.3%	0.3%	17.2%	18.0%	18.0%	16.8%	11.8%	10.7%	10.7%	10.9%
2012	25.7%	22.4%	22.4%	22.2%	0.3%	0.4%	0.4%	0.3%	15.0%	11.4%	11.4%	11.2%	10.4%	10.7%	10.7%	10.8%
2013	19.3%	17.1%	17.1%	16.8%	0.2%	0.1%	0.1%	0.1%	7.5%	6.3%	6.3%	5.9%	11.7%	10.7%	10.7%	10.7%
2014	27.1%	24.7%	24.8%	23.9%	0.3%	0.3%	0.3%	0.3%	14.3%	14.2%	14.2%	13.3%	12.5%	10.3%	10.3%	10.4%
2015	25.2%	21.4%	21.4%	21.4%	0.3%	0.2%	0.2%	0.2%	14.1%	11.1%	11.1%	11.1%	10.9%	10.1%	10.1%	10.1%
2016	24.6%	24.0%	24.0%	23.8%	0.5%	0.4%	0.4%	0.4%	15.5%	15.3%	15.3%	15.1%	8.7%	8.3%	8.3%	8.3%
2017	27.7%	28.9%	28.9%	28.3%	0.4%	0.4%	0.4%	0.4%	17.7%	16.2%	16.3%	15.6%	9.6%	12.2%	12.2%	12.3%
2018	24.8%	23.7%	23.7%	23.2%	0.3%	0.3%	0.4%	0.3%	13.6%	13.1%	13.1%	12.5%	10.9%	10.2%	10.2%	10.3%
'99-18 Avg	**22.5%**	**20.1%**	**20.1%**	**19.6%**	**0.3%**	**0.3%**	**0.3%**	**0.3%**	**13.6%**	**12.3%**	**12.3%**	**11.8%**	**8.5%**	**7.5%**	**7.5%**	**7.6%**

Table A.10: 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	35.6%	37.2%	38.1%	36.4%	9.8%	7.4%	8.5%	7.6%	17.9%	20.5%	20.3%	19.4%	7.8%	9.4%	9.3%	9.3%
2000	32.1%	30.0%	30.8%	29.3%	7.6%	6.0%	6.9%	6.1%	18.0%	16.7%	16.6%	15.8%	6.5%	7.3%	7.3%	7.4%
2001	27.5%	27.4%	28.0%	27.0%	6.8%	5.0%	5.7%	5.0%	12.0%	12.8%	12.7%	12.4%	8.7%	9.7%	9.6%	9.5%
2002	27.7%	25.9%	26.5%	25.1%	6.7%	4.7%	5.4%	4.1%	16.3%	14.9%	14.9%	14.7%	4.7%	6.2%	6.2%	6.3%
2003	35.2%	30.9%	31.2%	30.1%	6.5%	4.8%	5.2%	3.9%	20.2%	16.5%	16.5%	16.6%	8.4%	9.5%	9.5%	9.6%
2004	34.4%	29.3%	29.3%	28.1%	6.8%	5.6%	5.6%	4.4%	20.3%	16.0%	16.0%	15.8%	7.2%	7.8%	7.8%	7.9%
2005	42.0%	37.7%	38.1%	37.2%	8.7%	7.1%	7.6%	7.0%	20.8%	16.7%	16.6%	16.1%	12.5%	14.0%	13.9%	14.1%
2006	33.1%	31.9%	32.3%	30.2%	7.2%	5.5%	6.0%	4.6%	17.3%	16.0%	16.0%	15.2%	8.6%	10.4%	10.4%	10.4%
2007	45.0%	40.9%	41.2%	38.7%	9.7%	7.9%	8.3%	6.2%	23.0%	18.6%	18.6%	17.9%	12.4%	14.4%	14.4%	14.6%
2008	46.0%	45.9%	46.0%	44.7%	8.1%	6.7%	6.9%	6.2%	19.7%	18.5%	18.5%	17.7%	18.2%	20.7%	20.6%	20.8%
2009	62.0%	52.8%	53.1%	51.1%	8.4%	7.7%	8.2%	6.2%	20.8%	18.0%	18.0%	17.3%	32.8%	27.1%	27.0%	27.7%
2010	37.4%	38.8%	39.2%	37.4%	8.6%	7.4%	8.1%	6.2%	15.4%	16.9%	16.8%	16.5%	13.4%	14.5%	14.4%	14.7%
2011	61.9%	56.2%	56.5%	52.5%	7.5%	7.2%	7.6%	5.7%	22.2%	22.0%	22.0%	20.4%	32.2%	27.0%	26.9%	26.4%
2012	41.0%	39.2%	39.4%	37.7%	7.0%	6.9%	7.3%	5.5%	20.1%	18.6%	18.5%	18.4%	13.8%	13.7%	13.6%	13.9%
2013	44.3%	39.7%	40.3%	39.5%	5.5%	4.3%	5.3%	4.7%	16.5%	13.8%	13.7%	13.2%	22.3%	21.5%	21.3%	21.6%
2014	41.1%	38.7%	39.5%	37.6%	7.9%	5.8%	6.8%	6.3%	18.7%	19.3%	19.3%	17.6%	14.5%	13.5%	13.4%	13.7%
2015	41.8%	35.9%	36.3%	35.6%	6.3%	4.2%	4.7%	3.9%	18.5%	14.7%	14.7%	14.7%	17.0%	16.9%	16.9%	17.0%
2016	36.7%	35.5%	35.8%	34.5%	8.7%	8.4%	8.8%	7.7%	18.3%	17.1%	17.0%	16.8%	9.6%	10.0%	10.0%	10.0%
2017	35.7%	32.3%	32.4%	30.7%	3.7%	4.2%	4.4%	3.5%	20.6%	16.1%	16.1%	15.4%	11.4%	12.0%	12.0%	11.8%
2018	38.3%	33.6%	33.7%	32.6%	3.9%	4.3%	4.4%	4.1%	21.3%	18.1%	18.1%	17.4%	13.1%	11.2%	11.2%	11.1%
'99-18 Avg	**39.9%**	**37.0%**	**37.4%**	**35.8%**	**7.3%**	**6.1%**	**6.6%**	**5.4%**	**18.9%**	**17.1%**	**17.0%**	**16.5%**	**13.8%**	**13.8%**	**13.8%**	**13.9%**

Table A.11: 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	35.8%	43.3%	43.6%	42.3%	4.2%	2.9%	3.3%	3.0%	22.8%	30.2%	30.1%	29.1%	8.8%	10.2%	10.2%	10.2%
2000	34.7%	25.5%	25.6%	24.7%	1.4%	1.2%	1.4%	1.3%	20.2%	17.2%	17.2%	16.4%	13.1%	7.0%	7.0%	7.0%
2001	20.4%	20.8%	20.9%	20.4%	1.1%	0.8%	0.9%	0.8%	11.7%	13.1%	13.1%	12.8%	7.6%	6.9%	6.9%	6.8%
2002	29.9%	30.7%	30.8%	30.2%	1.9%	1.3%	1.5%	1.2%	19.3%	20.8%	20.7%	20.4%	8.7%	8.6%	8.6%	8.7%
2003	36.9%	34.9%	35.0%	34.7%	1.9%	1.4%	1.5%	1.1%	24.6%	23.0%	23.0%	23.1%	10.5%	10.5%	10.5%	10.5%
2004	30.3%	22.8%	22.8%	22.6%	1.3%	1.1%	1.1%	1.0%	17.4%	15.0%	15.0%	15.0%	11.6%	6.7%	6.7%	6.7%
2005	36.1%	34.9%	35.0%	34.5%	2.4%	1.9%	2.0%	1.7%	23.4%	23.0%	23.0%	22.7%	10.4%	10.0%	10.0%	10.1%
2006	12.5%	12.8%	12.8%	12.2%	0.8%	0.6%	0.7%	0.5%	7.8%	8.2%	8.2%	7.8%	3.9%	3.9%	3.9%	3.9%
2007	40.8%	41.0%	41.1%	39.7%	2.9%	2.3%	2.4%	2.0%	28.2%	28.1%	28.1%	27.1%	9.7%	10.7%	10.7%	10.7%
2008	28.9%	33.6%	33.6%	32.7%	1.7%	1.3%	1.4%	1.2%	20.4%	22.7%	22.7%	21.9%	6.8%	9.5%	9.5%	9.5%
2009	36.3%	30.9%	31.0%	29.7%	2.0%	2.0%	2.1%	1.6%	26.4%	21.1%	21.1%	20.3%	7.9%	7.8%	7.8%	7.8%
2010	22.9%	27.8%	27.9%	27.0%	1.7%	1.4%	1.5%	1.2%	15.6%	19.3%	19.3%	18.6%	5.7%	7.1%	7.1%	7.2%
2011	34.8%	37.0%	37.1%	35.2%	1.7%	1.6%	1.7%	1.3%	23.1%	25.0%	25.0%	23.4%	10.0%	10.4%	10.4%	10.5%
2012	35.6%	30.7%	30.8%	30.2%	1.5%	1.4%	1.6%	1.2%	27.0%	21.2%	21.2%	20.9%	7.2%	8.1%	8.1%	8.1%
2013	22.7%	19.0%	19.1%	18.4%	0.8%	0.7%	0.8%	0.7%	13.6%	12.4%	12.4%	11.7%	8.4%	6.0%	6.0%	6.0%
2014	38.8%	35.3%	35.6%	34.0%	1.9%	1.3%	1.5%	1.3%	23.8%	24.5%	24.6%	23.2%	13.1%	9.5%	9.5%	9.5%
2015	48.5%	40.0%	40.0%	39.9%	1.7%	1.5%	1.6%	1.4%	33.8%	26.3%	26.3%	26.3%	13.0%	12.2%	12.2%	12.2%
2016	26.8%	25.4%	25.4%	24.9%	1.7%	1.7%	1.8%	1.5%	19.8%	18.8%	18.7%	18.6%	5.3%	4.9%	4.9%	4.9%
2017	25.0%	26.5%	26.5%	25.6%	0.8%	0.9%	0.9%	0.8%	18.6%	17.8%	17.8%	17.2%	5.6%	7.8%	7.8%	7.7%
2018	20.3%	20.3%	20.3%	19.7%	0.7%	0.7%	0.7%	0.6%	12.5%	14.1%	14.1%	13.5%	7.1%	5.5%	5.5%	5.5%
'99-18 Avg	**30.9%**	**29.7%**	**29.8%**	**28.9%**	**1.7%**	**1.4%**	**1.5%**	**1.3%**	**20.5%**	**20.1%**	**20.1%**	**19.5%**	**8.7%**	**8.2%**	**8.2%**	**8.2%**

Table A.12: 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	22.9%	26.0%	26.0%	25.2%	0.4%	0.3%	0.4%	0.3%	12.7%	16.6%	16.6%	16.0%	9.8%	9.0%	9.0%	8.8%
2000	35.0%	22.1%	22.1%	21.4%	0.3%	0.3%	0.3%	0.3%	15.3%	13.3%	13.3%	12.7%	19.4%	8.5%	8.5%	8.4%
2001	19.7%	16.9%	17.0%	16.5%	0.3%	0.2%	0.3%	0.2%	9.9%	9.8%	9.8%	9.5%	9.5%	6.9%	6.9%	6.7%
2002	22.8%	20.7%	20.8%	20.3%	0.4%	0.3%	0.3%	0.2%	13.0%	13.2%	13.2%	12.8%	9.4%	7.3%	7.3%	7.3%
2003	27.2%	23.4%	23.5%	23.4%	0.3%	0.2%	0.3%	0.2%	15.6%	14.0%	14.0%	14.0%	11.2%	9.2%	9.2%	9.2%
2004	22.7%	16.9%	16.9%	16.8%	0.3%	0.3%	0.2%	0.2%	14.1%	10.7%	10.7%	10.7%	8.3%	5.9%	5.9%	5.9%
2005	23.3%	20.8%	20.8%	20.7%	0.4%	0.3%	0.3%	0.3%	14.1%	12.4%	12.5%	12.3%	8.8%	8.0%	8.0%	8.1%
2006	19.5%	18.5%	18.6%	17.8%	0.3%	0.2%	0.3%	0.2%	11.7%	11.8%	11.8%	11.3%	7.5%	6.5%	6.5%	6.3%
2007	29.7%	28.4%	28.5%	27.3%	0.7%	0.5%	0.6%	0.4%	18.9%	17.6%	17.6%	16.8%	10.2%	10.2%	10.2%	10.1%
2008	17.0%	19.4%	19.4%	18.6%	0.3%	0.3%	0.3%	0.2%	10.9%	12.4%	12.4%	11.9%	5.8%	6.7%	6.7%	6.5%
2009	28.2%	22.3%	22.3%	21.3%	0.4%	0.4%	0.4%	0.3%	19.4%	14.4%	14.4%	13.8%	8.4%	7.5%	7.5%	7.3%
2010	14.7%	18.1%	18.1%	17.6%	0.3%	0.3%	0.3%	0.2%	9.7%	12.3%	12.3%	11.8%	4.6%	5.5%	5.5%	5.5%
2011	20.4%	22.0%	22.1%	20.5%	0.3%	0.3%	0.3%	0.2%	14.1%	15.6%	15.6%	14.1%	6.0%	6.2%	6.2%	6.2%
2012	28.8%	23.4%	23.4%	23.1%	0.3%	0.3%	0.3%	0.3%	20.5%	15.2%	15.2%	15.0%	8.0%	7.9%	7.9%	7.8%
2013	15.7%	13.3%	13.3%	12.9%	0.2%	0.1%	0.2%	0.1%	10.0%	8.6%	8.6%	8.1%	5.5%	4.6%	4.6%	4.6%
2014	26.6%	23.6%	23.6%	22.4%	0.3%	0.2%	0.3%	0.3%	15.4%	15.5%	15.5%	14.3%	10.9%	7.8%	7.8%	7.8%
2015	27.3%	22.5%	22.5%	22.4%	0.3%	0.2%	0.2%	0.2%	16.9%	13.5%	13.5%	13.5%	10.1%	8.7%	8.7%	8.7%
2016	29.3%	30.1%	30.1%	29.7%	0.4%	0.4%	0.4%	0.4%	20.3%	21.1%	21.2%	21.0%	8.6%	8.6%	8.6%	8.4%
2017	17.4%	20.3%	20.3%	19.5%	0.2%	0.2%	0.2%	0.2%	12.2%	12.5%	12.5%	12.0%	5.0%	7.6%	7.6%	7.3%
2018	28.4%	27.4%	27.4%	26.4%	0.3%	0.3%	0.3%	0.3%	16.5%	18.3%	18.3%	17.7%	11.7%	8.8%	8.8%	8.4%
'99-18 Avg	**23.8%**	**21.8%**	**21.8%**	**21.2%**	**0.3%**	**0.3%**	**0.3%**	**0.3%**	**14.6%**	**13.9%**	**14.0%**	**13.5%**	**8.9%**	**7.6%**	**7.6%**	**7.5%**

Table A.13: 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	27.0%	26.9%	26.9%	25.1%	0.3%	0.2%	0.2%	0.2%	14.5%	15.9%	16.0%	14.8%	12.2%	10.7%	10.7%	10.1%
2000	33.6%	23.6%	23.6%	22.4%	0.2%	0.1%	0.1%	0.1%	14.8%	12.6%	12.6%	11.5%	18.7%	10.8%	10.8%	10.8%
2001	26.7%	22.6%	22.6%	21.5%	0.1%	0.1%	0.1%	0.1%	10.2%	9.4%	9.4%	8.9%	16.4%	13.1%	13.1%	12.5%
2002	27.4%	23.9%	23.9%	23.4%	0.2%	0.1%	0.1%	0.1%	13.4%	12.1%	12.2%	11.7%	13.8%	11.6%	11.6%	11.6%
2003	33.1%	27.1%	27.2%	27.1%	0.1%	0.1%	0.1%	0.1%	14.9%	11.5%	11.5%	11.5%	18.1%	15.6%	15.6%	15.5%
2004	34.7%	25.8%	25.8%	25.7%	0.1%	0.1%	0.1%	0.1%	16.8%	11.8%	11.8%	11.8%	17.8%	13.8%	13.8%	13.8%
2005	34.9%	28.1%	28.2%	27.8%	0.2%	0.2%	0.2%	0.1%	16.9%	12.1%	12.1%	11.7%	17.8%	15.9%	15.9%	15.9%
2006	32.7%	30.0%	30.0%	28.6%	0.2%	0.1%	0.1%	0.1%	14.0%	11.4%	11.4%	10.6%	18.5%	18.5%	18.5%	17.9%
2007	33.8%	30.6%	30.6%	28.9%	0.3%	0.2%	0.2%	0.2%	16.9%	13.2%	13.2%	12.3%	16.6%	17.2%	17.2%	16.4%
2008	28.2%	29.3%	29.3%	27.8%	0.1%	0.1%	0.1%	0.1%	13.2%	11.4%	11.4%	10.6%	14.9%	17.8%	17.8%	17.1%
2009	39.9%	38.6%	38.7%	37.1%	0.2%	0.2%	0.2%	0.2%	16.3%	13.1%	13.2%	12.2%	23.4%	25.3%	25.3%	24.8%
2010	21.2%	24.1%	24.1%	23.4%	0.2%	0.2%	0.2%	0.1%	11.8%	13.2%	13.2%	12.6%	9.3%	10.7%	10.7%	10.7%
2011	32.1%	32.5%	32.5%	30.7%	0.1%	0.1%	0.1%	0.1%	15.2%	14.7%	14.8%	12.9%	16.8%	17.7%	17.6%	17.7%
2012	36.5%	33.0%	33.0%	32.6%	0.2%	0.2%	0.2%	0.2%	16.5%	14.3%	14.3%	14.0%	19.8%	18.5%	18.5%	18.4%
2013	24.2%	20.7%	20.7%	20.0%	0.1%	0.1%	0.1%	0.1%	10.9%	9.2%	9.2%	8.5%	13.3%	11.4%	11.4%	11.4%
2014	32.8%	29.8%	29.8%	27.9%	0.2%	0.1%	0.2%	0.1%	14.9%	15.2%	15.2%	13.4%	17.6%	14.5%	14.4%	14.4%
2015	25.8%	21.9%	21.9%	21.8%	0.1%	0.1%	0.1%	0.1%	12.8%	9.7%	9.7%	9.7%	13.0%	12.1%	12.1%	12.0%
2016	25.6%	27.6%	27.6%	26.8%	0.2%	0.2%	0.2%	0.2%	13.6%	13.5%	13.5%	13.4%	11.8%	13.9%	13.9%	13.2%
2017	27.3%	28.3%	28.3%	26.6%	0.1%	0.1%	0.1%	0.1%	14.2%	12.0%	12.0%	11.2%	12.9%	16.2%	16.2%	15.3%
2018	28.3%	26.1%	26.1%	24.4%	0.1%	0.1%	0.1%	0.1%	13.1%	11.9%	11.9%	11.2%	15.1%	14.1%	14.1%	13.1%
'99-18 Avg	**30.3%**	**27.5%**	**27.5%**	**26.5%**	**0.2%**	**0.1%**	**0.1%**	**0.1%**	**14.2%**	**12.4%**	**12.4%**	**11.7%**	**15.9%**	**15.0%**	**15.0%**	**14.6%**

Table A.14: 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	35.4%	34.2%	34.3%	32.5%	0.3%	0.2%	0.2%	0.2%	14.5%	15.9%	16.0%	14.8%	20.6%	18.1%	18.1%	17.5%
2000	56.0%	42.3%	42.4%	41.3%	0.2%	0.1%	0.1%	0.1%	14.8%	12.6%	12.6%	11.5%	41.1%	29.6%	29.6%	29.6%
2001	49.6%	43.0%	43.0%	42.1%	0.1%	0.1%	0.1%	0.1%	10.2%	9.4%	9.4%	8.9%	39.3%	33.5%	33.5%	33.1%
2002	55.4%	50.8%	50.8%	50.3%	0.2%	0.1%	0.1%	0.1%	13.4%	12.1%	12.2%	11.7%	41.8%	38.6%	38.5%	38.5%
2003	52.9%	45.7%	45.7%	45.5%	0.1%	0.1%	0.1%	0.1%	14.9%	11.5%	11.5%	11.5%	37.9%	34.1%	34.1%	33.9%
2004	55.5%	43.2%	43.2%	42.9%	0.1%	0.1%	0.1%	0.1%	16.8%	11.8%	11.8%	11.8%	38.6%	31.2%	31.2%	31.0%
2005	41.0%	32.3%	32.3%	31.7%	0.2%	0.2%	0.2%	0.1%	16.9%	12.1%	12.1%	11.7%	23.9%	20.1%	20.1%	19.9%
2006	52.2%	46.7%	46.7%	45.5%	0.2%	0.1%	0.1%	0.1%	14.0%	11.4%	11.4%	10.6%	38.0%	35.2%	35.2%	34.7%
2007	57.0%	53.1%	53.1%	51.7%	0.3%	0.2%	0.2%	0.2%	16.9%	13.2%	13.2%	12.3%	39.8%	39.7%	39.7%	39.2%
2008	54.2%	52.2%	52.2%	51.0%	0.1%	0.1%	0.1%	0.1%	13.2%	11.4%	11.4%	10.6%	40.9%	40.8%	40.7%	40.3%
2009	56.7%	53.9%	53.9%	52.5%	0.2%	0.2%	0.2%	0.2%	16.3%	13.1%	13.2%	12.2%	40.2%	40.6%	40.6%	40.2%
2010	23.9%	26.1%	26.1%	25.3%	0.2%	0.2%	0.2%	0.1%	11.8%	13.2%	13.2%	12.6%	11.9%	12.8%	12.8%	12.6%
2011	48.7%	47.2%	47.2%	45.5%	0.1%	0.1%	0.1%	0.1%	15.2%	14.7%	14.8%	12.9%	33.4%	32.4%	32.3%	32.6%
2012	31.6%	27.4%	27.4%	26.8%	0.2%	0.2%	0.2%	0.2%	16.5%	14.3%	14.3%	14.0%	15.0%	12.9%	12.9%	12.6%
2013	24.4%	20.7%	20.7%	19.7%	0.1%	0.1%	0.1%	0.1%	10.9%	9.2%	9.2%	8.5%	13.5%	11.4%	11.4%	11.1%
2014	32.0%	28.3%	28.3%	26.0%	0.2%	0.1%	0.2%	0.1%	14.9%	15.2%	15.2%	13.4%	16.8%	13.0%	13.0%	12.5%
2015	26.9%	22.6%	22.6%	22.2%	0.1%	0.1%	0.1%	0.1%	12.8%	9.7%	9.7%	9.7%	14.1%	12.8%	12.9%	12.4%
2016	22.4%	24.2%	24.2%	23.1%	0.2%	0.2%	0.2%	0.2%	13.6%	13.5%	13.5%	13.4%	8.5%	10.5%	10.5%	9.6%
2017	39.1%	38.8%	38.8%	37.2%	0.1%	0.1%	0.1%	0.1%	14.2%	12.0%	12.0%	11.2%	24.8%	26.7%	26.7%	25.9%
2018	53.8%	51.1%	51.1%	49.8%	0.1%	0.1%	0.1%	0.1%	13.1%	11.9%	11.9%	11.2%	40.6%	39.1%	39.1%	38.5%
'99-18 Avg	**43.4%**	**39.2%**	**39.2%**	**38.1%**	**0.2%**	**0.1%**	**0.1%**	**0.1%**	**14.2%**	**12.4%**	**12.4%**	**11.7%**	**29.0%**	**26.7%**	**26.6%**	**26.3%**

Table A.15: 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	41.3%	41.5%	41.5%	40.1%	0.3%	0.2%	0.2%	0.2%	14.5%	15.9%	16.0%	14.8%	26.5%	25.3%	25.3%	25.1%
2000	54.1%	48.0%	48.0%	47.2%	0.2%	0.1%	0.1%	0.1%	14.8%	12.6%	12.6%	11.5%	39.1%	35.2%	35.2%	35.5%
2001	64.2%	62.6%	62.6%	62.1%	0.1%	0.1%	0.1%	0.1%	10.2%	9.4%	9.4%	8.9%	53.9%	53.1%	53.1%	53.1%
2002	56.2%	54.4%	54.4%	54.1%	0.2%	0.1%	0.1%	0.1%	13.4%	12.1%	12.2%	11.7%	42.6%	42.2%	42.2%	42.4%
2003	51.1%	47.4%	47.4%	47.4%	0.1%	0.1%	0.1%	0.1%	14.9%	11.5%	11.5%	11.5%	36.1%	35.8%	35.8%	35.8%
2004	63.1%	58.7%	58.7%	58.7%	0.1%	0.1%	0.1%	0.1%	16.8%	11.8%	11.8%	11.8%	46.2%	46.8%	46.8%	46.8%
2005	55.9%	51.6%	51.6%	51.3%	0.2%	0.2%	0.2%	0.1%	16.9%	12.1%	12.1%	11.7%	38.9%	39.3%	39.3%	39.5%
2006	44.8%	43.3%	43.3%	42.2%	0.2%	0.1%	0.1%	0.1%	14.0%	11.4%	11.4%	10.6%	30.6%	31.8%	31.8%	31.5%
2007	49.2%	46.9%	46.9%	45.6%	0.3%	0.2%	0.2%	0.2%	16.9%	13.2%	13.2%	12.3%	32.0%	33.5%	33.5%	33.2%
2008	44.5%	45.3%	45.3%	44.2%	0.1%	0.1%	0.1%	0.1%	13.2%	11.4%	11.4%	10.6%	31.2%	33.9%	33.9%	33.5%
2009	46.1%	44.8%	44.8%	43.5%	0.2%	0.2%	0.2%	0.2%	16.3%	13.1%	13.2%	12.2%	29.6%	31.5%	31.4%	31.2%
2010	51.8%	53.6%	53.7%	53.3%	0.2%	0.2%	0.2%	0.1%	11.8%	13.2%	13.2%	12.6%	39.9%	40.3%	40.3%	40.6%
2011	43.9%	44.6%	44.6%	43.1%	0.1%	0.1%	0.1%	0.1%	15.2%	14.7%	14.8%	12.9%	28.7%	29.8%	29.7%	30.2%
2012	56.8%	54.3%	54.4%	54.1%	0.2%	0.2%	0.2%	0.2%	16.5%	14.3%	14.3%	14.0%	40.1%	39.9%	39.9%	39.9%
2013	44.8%	42.4%	42.4%	42.0%	0.1%	0.1%	0.1%	0.1%	10.9%	9.2%	9.2%	8.5%	33.8%	33.2%	33.2%	33.4%
2014	53.2%	51.3%	51.3%	50.0%	0.2%	0.1%	0.2%	0.1%	14.9%	15.2%	15.2%	13.4%	38.1%	36.0%	35.9%	36.5%
2015	41.1%	38.1%	38.1%	38.0%	0.1%	0.1%	0.1%	0.1%	12.8%	9.7%	9.7%	9.7%	28.2%	28.3%	28.3%	28.3%
2016	28.4%	30.4%	30.4%	29.7%	0.2%	0.2%	0.2%	0.2%	13.6%	13.5%	13.5%	13.4%	14.5%	16.7%	16.7%	16.1%
2017	44.2%	45.2%	45.2%	43.9%	0.1%	0.1%	0.1%	0.1%	14.2%	12.0%	12.0%	11.2%	29.9%	33.1%	33.1%	32.6%
2018	56.8%	55.6%	55.6%	54.6%	0.1%	0.1%	0.1%	0.1%	13.1%	11.9%	11.9%	11.2%	43.6%	43.6%	43.6%	43.3%
'99-18 Avg	**49.6%**	**48.0%**	**48.0%**	**47.3%**	**0.2%**	**0.1%**	**0.1%**	**0.1%**	**14.2%**	**12.4%**	**12.4%**	**11.7%**	**35.2%**	**35.5%**	**35.5%**	**35.4%**

Table A.16: 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	66.8%	65.7%	65.7%	65.1%	0.1%	0.1%	0.1%	0.1%	9.2%	10.6%	10.7%	9.8%	57.6%	55.0%	55.0%	55.3%
2000	54.7%	48.1%	48.1%	47.6%	0.1%	0.1%	0.1%	0.1%	9.0%	7.8%	7.8%	7.1%	45.6%	40.3%	40.3%	40.5%
2001	62.5%	59.1%	59.1%	58.6%	0.1%	0.1%	0.1%	0.1%	6.2%	5.9%	5.9%	5.5%	56.2%	53.1%	53.1%	53.1%
2002	82.0%	80.7%	80.7%	80.6%	0.1%	0.1%	0.1%	0.1%	10.4%	9.4%	9.4%	8.9%	71.5%	71.3%	71.3%	71.6%
2003	84.4%	82.9%	82.9%	82.8%	0.1%	0.0%	0.1%	0.0%	10.6%	8.0%	8.0%	8.0%	73.7%	74.8%	74.8%	74.8%
2004	69.0%	65.6%	65.6%	65.5%	0.1%	0.1%	0.1%	0.0%	10.2%	7.2%	7.2%	7.1%	58.7%	58.3%	58.3%	58.4%
2005	61.4%	57.2%	57.2%	57.0%	0.1%	0.1%	0.1%	0.1%	10.3%	7.7%	7.7%	7.4%	51.1%	49.4%	49.4%	49.5%
2006	71.3%	69.7%	69.7%	69.3%	0.1%	0.1%	0.1%	0.1%	9.8%	8.2%	8.2%	7.6%	61.3%	61.5%	61.5%	61.6%
2007	67.8%	66.7%	66.7%	66.1%	0.1%	0.1%	0.1%	0.1%	11.7%	9.3%	9.4%	8.6%	56.0%	57.2%	57.2%	57.3%
2008	68.6%	69.0%	69.0%	68.4%	0.1%	0.1%	0.1%	0.1%	10.3%	8.8%	8.8%	8.2%	58.2%	60.1%	60.1%	60.2%
2009	72.7%	72.5%	72.5%	71.9%	0.1%	0.1%	0.1%	0.1%	13.1%	10.4%	10.4%	9.5%	59.5%	61.9%	61.9%	62.2%
2010	60.6%	62.6%	62.7%	62.4%	0.1%	0.1%	0.1%	0.0%	8.3%	9.2%	9.2%	8.7%	52.3%	53.4%	53.4%	53.6%
2011	52.6%	53.4%	53.4%	52.1%	0.1%	0.1%	0.1%	0.1%	13.5%	13.4%	13.5%	11.6%	39.0%	39.9%	39.8%	40.5%
2012	51.5%	48.6%	48.6%	48.5%	0.1%	0.1%	0.1%	0.1%	11.4%	8.9%	8.9%	8.8%	40.1%	39.6%	39.6%	39.6%
2013	47.7%	45.5%	45.5%	45.1%	0.0%	0.0%	0.0%	0.0%	8.8%	7.3%	7.3%	6.7%	38.8%	38.1%	38.1%	38.3%
2014	48.5%	46.0%	46.1%	45.1%	0.1%	0.1%	0.1%	0.1%	9.8%	10.1%	10.1%	8.8%	38.6%	35.9%	35.9%	36.2%
2015	44.9%	42.9%	42.9%	42.9%	0.1%	0.0%	0.0%	0.0%	8.5%	7.2%	7.2%	7.2%	36.3%	35.7%	35.7%	35.6%
2016	37.5%	40.0%	40.0%	39.5%	0.1%	0.1%	0.1%	0.1%	8.7%	8.8%	8.8%	8.7%	28.7%	31.1%	31.1%	30.7%
2017	50.6%	53.0%	53.0%	52.2%	0.1%	0.1%	0.1%	0.1%	8.4%	7.8%	7.8%	7.3%	42.1%	45.1%	45.1%	44.9%
2018	53.0%	52.4%	52.4%	51.5%	0.1%	0.1%	0.1%	0.1%	8.8%	8.1%	8.1%	7.5%	44.1%	44.3%	44.3%	44.0%
'99-18 Avg	**60.4%**	**59.1%**	**59.1%**	**58.6%**	**0.1%**	**0.1%**	**0.1%**	**0.1%**	**9.8%**	**8.7%**	**8.7%**	**8.2%**	**50.5%**	**50.3%**	**50.3%**	**50.4%**

Table A.17: 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	20.9%	16.1%	16.1%	14.7%	0.2%	0.2%	0.2%	0.2%	12.8%	11.2%	11.3%	9.9%	7.8%	4.7%	4.7%	4.6%
2000	47.2%	28.4%	28.4%	26.4%	0.1%	0.1%	0.1%	0.1%	21.9%	20.7%	20.8%	18.5%	25.2%	7.5%	7.5%	7.7%
2001	19.3%	12.4%	12.4%	12.1%	0.1%	0.1%	0.1%	0.1%	3.9%	3.5%	3.5%	3.2%	15.2%	8.8%	8.8%	8.7%
2002	31.0%	22.0%	22.0%	21.9%	0.2%	0.2%	0.2%	0.1%	10.8%	8.4%	8.4%	8.3%	20.0%	13.5%	13.5%	13.5%
2003	36.5%	24.0%	24.0%	24.0%	0.1%	0.1%	0.1%	0.1%	17.1%	9.5%	9.5%	9.5%	19.2%	14.4%	14.4%	14.4%
2004	29.6%	19.8%	19.8%	19.8%	0.1%	0.1%	0.1%	0.1%	13.6%	7.2%	7.2%	7.2%	15.9%	12.5%	12.5%	12.5%
2005	37.6%	28.0%	28.0%	26.9%	0.1%	0.1%	0.1%	0.1%	21.6%	13.7%	13.8%	12.5%	15.9%	14.1%	14.1%	14.3%
2006	31.3%	24.9%	24.9%	23.9%	0.2%	0.1%	0.2%	0.1%	11.7%	8.3%	8.3%	7.4%	19.4%	16.5%	16.5%	16.4%
2007	29.8%	23.8%	23.8%	22.9%	0.3%	0.3%	0.3%	0.2%	9.8%	7.9%	7.9%	7.2%	19.7%	15.7%	15.7%	15.5%
2008	30.0%	28.3%	28.3%	27.7%	0.2%	0.1%	0.1%	0.1%	7.3%	6.4%	6.4%	5.8%	22.5%	21.8%	21.8%	21.7%
2009	27.0%	23.4%	23.4%	22.7%	0.2%	0.2%	0.2%	0.2%	8.9%	7.2%	7.3%	6.7%	17.9%	15.9%	15.9%	15.8%
2010	23.3%	23.5%	23.5%	23.1%	0.1%	0.1%	0.1%	0.1%	4.7%	5.1%	5.1%	4.7%	18.5%	18.3%	18.2%	18.3%
2011	22.4%	20.3%	20.3%	19.9%	0.1%	0.1%	0.1%	0.1%	6.6%	6.5%	6.5%	6.1%	15.6%	13.7%	13.7%	13.7%
2012	23.2%	22.2%	22.2%	21.8%	0.1%	0.1%	0.1%	0.1%	8.5%	7.4%	7.4%	7.1%	14.6%	14.7%	14.7%	14.7%
2013	14.3%	12.8%	12.8%	12.4%	0.1%	0.1%	0.1%	0.1%	4.0%	3.6%	3.6%	3.2%	10.2%	9.1%	9.1%	9.1%
2014	34.5%	31.4%	31.4%	31.1%	0.1%	0.1%	0.1%	0.1%	4.4%	4.4%	4.4%	4.0%	29.9%	26.9%	26.9%	26.9%
2015	22.8%	20.2%	20.2%	20.1%	0.1%	0.1%	0.1%	0.1%	5.8%	4.8%	4.8%	4.7%	16.9%	15.3%	15.3%	15.3%
2016	18.5%	18.5%	18.6%	18.2%	0.1%	0.1%	0.1%	0.1%	7.5%	7.1%	7.1%	6.9%	10.9%	11.3%	11.3%	11.1%
2017	26.8%	27.9%	27.9%	27.3%	0.2%	0.2%	0.2%	0.2%	6.0%	5.3%	5.3%	4.9%	20.6%	22.4%	22.4%	22.3%
2018	31.4%	29.9%	29.9%	29.4%	0.2%	0.2%	0.2%	0.2%	5.5%	4.8%	4.8%	4.4%	25.7%	25.0%	25.0%	24.8%
'99-18 Avg	**27.9%**	**22.9%**	**22.9%**	**22.3%**	**0.1%**	**0.1%**	**0.1%**	**0.1%**	**9.6%**	**7.6%**	**7.7%**	**7.1%**	**18.1%**	**15.1%**	**15.1%**	**15.1%**

Table A.18: 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	40.4%	41.0%	41.1%	39.8%	0.7%	0.6%	0.6%	0.6%	10.5%	12.8%	12.8%	12.0%	29.1%	27.7%	27.7%	27.2%
2000	41.6%	36.5%	36.6%	36.0%	0.9%	0.7%	0.8%	0.7%	9.5%	8.4%	8.4%	7.7%	31.3%	27.4%	27.4%	27.6%
2001	55.6%	54.0%	54.0%	53.3%	0.6%	0.4%	0.5%	0.5%	8.5%	8.3%	8.3%	7.9%	46.5%	45.2%	45.2%	45.0%
2002	52.8%	50.2%	50.2%	49.8%	0.6%	0.4%	0.5%	0.4%	13.3%	12.2%	12.3%	11.7%	38.9%	37.5%	37.5%	37.8%
2003	57.5%	54.2%	54.3%	54.2%	0.4%	0.3%	0.4%	0.3%	13.4%	10.4%	10.4%	10.4%	43.6%	43.5%	43.5%	43.6%
2004	54.7%	48.9%	48.9%	48.8%	0.4%	0.3%	0.3%	0.3%	13.5%	9.2%	9.2%	9.2%	40.8%	39.3%	39.3%	39.3%
2005	61.5%	55.8%	55.9%	55.7%	0.5%	0.4%	0.4%	0.4%	13.4%	10.1%	10.1%	9.8%	47.7%	45.4%	45.4%	45.5%
2006	64.2%	62.6%	62.7%	62.0%	0.7%	0.6%	0.6%	0.5%	11.0%	9.2%	9.2%	8.6%	52.6%	52.9%	52.8%	52.8%
2007	68.7%	65.5%	65.5%	64.5%	0.8%	0.7%	0.7%	0.5%	16.0%	12.0%	12.0%	11.0%	51.9%	52.7%	52.7%	53.0%
2008	65.5%	65.2%	65.2%	64.3%	0.6%	0.5%	0.5%	0.5%	13.3%	11.8%	11.8%	11.0%	51.6%	52.9%	52.9%	52.9%
2009	64.0%	63.1%	63.1%	62.1%	0.8%	0.7%	0.8%	0.6%	15.6%	12.2%	12.2%	11.3%	47.6%	50.1%	50.1%	50.3%
2010	55.7%	57.2%	57.2%	56.8%	0.5%	0.5%	0.5%	0.4%	12.1%	12.8%	12.8%	12.2%	43.1%	43.9%	43.9%	44.2%
2011	53.7%	54.3%	54.3%	52.9%	0.5%	0.4%	0.5%	0.4%	15.6%	15.3%	15.3%	13.2%	37.6%	38.6%	38.5%	39.3%
2012	60.0%	57.9%	57.9%	57.6%	0.5%	0.5%	0.5%	0.4%	14.5%	12.2%	12.2%	12.0%	45.0%	45.1%	45.1%	45.2%
2013	52.0%	50.3%	50.4%	49.9%	0.4%	0.3%	0.3%	0.3%	11.1%	9.6%	9.7%	8.9%	40.6%	40.4%	40.4%	40.7%
2014	59.4%	57.5%	57.5%	56.5%	0.4%	0.4%	0.4%	0.4%	11.9%	12.4%	12.4%	10.9%	47.1%	44.7%	44.6%	45.2%
2015	63.9%	61.9%	62.0%	62.1%	0.3%	0.2%	0.3%	0.2%	11.3%	9.2%	9.2%	9.2%	52.3%	52.4%	52.5%	52.7%
2016	50.8%	52.4%	52.4%	51.9%	0.5%	0.4%	0.5%	0.4%	12.9%	12.9%	13.0%	12.8%	37.4%	39.0%	39.0%	38.6%
2017	49.9%	51.2%	51.2%	50.0%	0.4%	0.4%	0.4%	0.4%	12.4%	11.2%	11.2%	10.5%	37.2%	39.6%	39.6%	39.2%
2018	48.8%	48.3%	48.3%	47.3%	0.3%	0.3%	0.3%	0.3%	11.3%	10.6%	10.6%	9.9%	37.3%	37.3%	37.4%	37.0%
'99-18 Avg	**56.1%**	**54.4%**	**54.4%**	**53.8%**	**0.5%**	**0.5%**	**0.5%**	**0.4%**	**12.6%**	**11.1%**	**11.2%**	**10.5%**	**43.0%**	**42.8%**	**42.8%**	**42.8%**

Table A.19: 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	24.4%	25.6%	25.7%	24.1%	0.7%	0.6%	0.6%	0.6%	10.7%	12.9%	13.0%	12.1%	13.0%	12.1%	12.1%	11.3%
2000	22.5%	17.9%	18.0%	17.2%	0.9%	0.7%	0.8%	0.7%	9.8%	8.4%	8.4%	7.8%	11.8%	8.8%	8.8%	8.7%
2001	25.6%	22.8%	22.9%	21.7%	0.6%	0.5%	0.5%	0.5%	8.6%	8.4%	8.4%	8.0%	16.5%	14.0%	13.9%	13.3%
2002	25.9%	23.2%	23.2%	22.5%	0.6%	0.4%	0.5%	0.4%	13.6%	12.3%	12.3%	11.7%	11.8%	10.4%	10.4%	10.4%
2003	25.9%	21.3%	21.4%	21.3%	0.4%	0.3%	0.4%	0.3%	13.7%	10.4%	10.4%	10.4%	11.7%	10.6%	10.6%	10.6%
2004	28.3%	21.3%	21.3%	21.2%	0.4%	0.3%	0.3%	0.3%	14.0%	9.3%	9.3%	9.3%	14.0%	11.6%	11.6%	11.6%
2005	29.8%	22.8%	22.8%	22.5%	0.5%	0.4%	0.4%	0.4%	14.0%	10.2%	10.2%	9.9%	15.2%	12.2%	12.2%	12.2%
2006	23.1%	21.3%	21.3%	19.9%	0.7%	0.6%	0.6%	0.5%	11.3%	9.3%	9.3%	8.7%	11.1%	11.4%	11.4%	10.7%
2007	27.8%	22.9%	23.0%	20.8%	0.9%	0.7%	0.7%	0.5%	16.6%	12.1%	12.1%	11.1%	10.3%	10.1%	10.1%	9.2%
2008	26.2%	26.3%	26.3%	24.6%	0.6%	0.5%	0.5%	0.5%	13.6%	11.9%	11.9%	11.1%	12.0%	13.9%	13.9%	13.0%
2009	25.5%	23.9%	24.0%	22.0%	0.8%	0.7%	0.8%	0.6%	15.8%	12.3%	12.3%	11.3%	8.9%	10.9%	10.9%	10.1%
2010	22.5%	25.0%	25.1%	24.3%	0.6%	0.5%	0.5%	0.4%	12.2%	12.9%	12.9%	12.3%	9.8%	11.6%	11.6%	11.7%
2011	24.6%	25.7%	25.7%	23.4%	0.5%	0.4%	0.5%	0.4%	15.7%	15.4%	15.4%	13.3%	8.4%	9.9%	9.8%	9.7%
2012	29.7%	26.0%	26.0%	25.5%	0.5%	0.5%	0.5%	0.4%	14.7%	12.4%	12.4%	12.1%	14.6%	13.1%	13.1%	13.0%
2013	24.2%	21.2%	21.3%	20.5%	0.4%	0.3%	0.3%	0.3%	11.1%	9.7%	9.7%	8.9%	12.8%	11.2%	11.2%	11.2%
2014	27.3%	23.8%	23.9%	22.3%	0.4%	0.4%	0.4%	0.4%	12.0%	12.5%	12.5%	11.0%	14.9%	10.9%	10.9%	10.8%
2015	25.5%	21.5%	21.5%	21.5%	0.3%	0.2%	0.3%	0.2%	11.3%	9.2%	9.3%	9.2%	13.8%	12.0%	12.0%	12.0%
2016	22.7%	25.2%	25.2%	24.1%	0.5%	0.4%	0.5%	0.4%	13.0%	13.0%	13.0%	12.9%	9.2%	11.7%	11.7%	10.8%
2017	22.8%	24.6%	24.7%	22.6%	0.4%	0.4%	0.4%	0.4%	12.5%	11.3%	11.3%	10.6%	10.0%	13.0%	13.0%	11.7%
2018	23.0%	22.2%	22.2%	20.2%	0.3%	0.3%	0.4%	0.3%	11.3%	10.7%	10.7%	10.1%	11.3%	11.1%	11.1%	9.8%
'99-18 Avg	**25.4%**	**23.2%**	**23.3%**	**22.1%**	**0.5%**	**0.5%**	**0.5%**	**0.4%**	**12.8%**	**11.2%**	**11.2%**	**10.6%**	**12.0%**	**11.5%**	**11.5%**	**11.1%**

Table A.20: 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	20.9%	24.3%	24.6%	23.3%	3.0%	2.3%	2.6%	2.3%	14.4%	18.6%	18.6%	17.6%	3.5%	3.5%	3.4%	3.4%
2000	31.3%	23.1%	23.3%	22.1%	1.8%	1.6%	1.8%	1.6%	21.3%	17.0%	16.9%	15.9%	8.1%	4.6%	4.6%	4.6%
2001	20.0%	21.3%	21.5%	20.8%	1.6%	1.2%	1.3%	1.1%	13.4%	13.3%	13.3%	12.8%	5.0%	6.9%	6.9%	6.9%
2002	23.6%	25.0%	25.1%	24.5%	2.0%	1.3%	1.5%	1.2%	17.2%	16.5%	16.5%	16.2%	4.4%	7.1%	7.1%	7.1%
2003	27.0%	23.3%	23.4%	23.2%	1.7%	1.3%	1.4%	1.0%	20.0%	16.7%	16.7%	16.8%	5.3%	5.2%	5.2%	5.3%
2004	29.6%	22.2%	22.2%	22.0%	1.8%	1.6%	1.6%	1.3%	20.0%	15.9%	15.9%	15.8%	7.8%	4.8%	4.8%	4.8%
2005	25.7%	23.3%	23.4%	22.9%	2.2%	1.7%	1.9%	1.6%	18.5%	16.2%	16.2%	15.8%	5.0%	5.4%	5.4%	5.4%
2006	24.0%	23.5%	23.6%	22.3%	2.0%	1.6%	1.7%	1.2%	17.0%	16.4%	16.4%	15.6%	5.1%	5.6%	5.6%	5.5%
2007	27.2%	25.7%	25.8%	24.4%	2.4%	1.9%	2.0%	1.6%	20.7%	18.6%	18.7%	17.6%	4.1%	5.1%	5.1%	5.2%
2008	24.4%	25.0%	25.0%	23.9%	1.6%	1.3%	1.4%	1.2%	16.8%	17.3%	17.3%	16.4%	6.0%	6.4%	6.4%	6.3%
2009	38.0%	33.0%	33.1%	31.5%	2.6%	2.5%	2.6%	2.0%	25.0%	21.3%	21.2%	20.2%	10.4%	9.2%	9.2%	9.3%
2010	22.7%	25.0%	25.2%	24.0%	2.1%	1.7%	1.9%	1.5%	15.8%	18.7%	18.7%	17.9%	4.8%	4.5%	4.5%	4.6%
2011	29.1%	29.0%	29.0%	26.9%	1.8%	1.8%	1.8%	1.4%	21.2%	22.3%	22.3%	20.5%	6.1%	4.9%	4.9%	5.0%
2012	29.0%	23.9%	24.1%	23.4%	1.6%	1.5%	1.7%	1.3%	23.1%	17.9%	17.8%	17.5%	4.3%	4.5%	4.5%	4.6%
2013	25.4%	22.1%	22.3%	21.1%	1.3%	1.1%	1.3%	1.3%	17.4%	16.3%	16.3%	15.1%	6.7%	4.7%	4.7%	4.7%
2014	28.9%	25.9%	26.1%	24.7%	1.9%	1.3%	1.6%	1.4%	19.1%	19.7%	19.7%	18.2%	7.9%	4.8%	4.8%	5.1%
2015	26.0%	20.7%	20.8%	20.6%	1.4%	1.1%	1.2%	1.1%	19.3%	15.0%	15.0%	15.0%	5.2%	4.5%	4.5%	4.5%
2016	23.7%	22.9%	23.0%	22.4%	2.0%	2.0%	2.1%	1.8%	17.9%	17.4%	17.4%	17.2%	3.9%	3.5%	3.5%	3.4%
2017	20.4%	21.5%	21.6%	20.5%	1.0%	1.0%	1.0%	0.9%	17.1%	16.1%	16.1%	15.2%	2.4%	4.4%	4.4%	4.4%
2018	20.2%	21.2%	21.2%	20.3%	1.0%	1.0%	1.0%	1.0%	14.9%	16.7%	16.7%	15.9%	4.2%	3.5%	3.5%	3.4%
'99-18 Avg	**25.8%**	**24.1%**	**24.2%**	**23.2%**	**1.8%**	**1.5%**	**1.7%**	**1.4%**	**18.5%**	**17.4%**	**17.4%**	**16.7%**	**5.5%**	**5.2%**	**5.2%**	**5.2%**

Table A.21: 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	22.1%	25.6%	25.9%	24.6%	3.1%	2.3%	2.6%	2.3%	14.6%	18.8%	18.8%	17.8%	4.5%	4.5%	4.5%	4.5%
2000	32.0%	23.0%	23.2%	22.0%	1.9%	1.6%	1.8%	1.7%	21.8%	17.5%	17.5%	16.5%	8.3%	3.9%	3.9%	3.9%
2001	20.2%	20.0%	20.1%	19.4%	1.6%	1.2%	1.3%	1.1%	13.6%	13.7%	13.7%	13.3%	5.0%	5.1%	5.1%	5.0%
2002	23.9%	23.1%	23.3%	22.6%	2.0%	1.4%	1.6%	1.2%	17.4%	17.2%	17.2%	16.8%	4.5%	4.5%	4.5%	4.5%
2003	27.6%	23.6%	23.7%	23.3%	1.8%	1.4%	1.4%	1.1%	20.5%	17.3%	17.3%	17.3%	5.3%	5.0%	5.0%	5.0%
2004	29.6%	22.1%	22.1%	21.9%	1.8%	1.6%	1.6%	1.3%	20.0%	15.9%	15.9%	15.9%	7.8%	4.6%	4.6%	4.6%
2005	25.6%	22.9%	23.0%	22.4%	2.2%	1.7%	1.9%	1.6%	18.4%	16.2%	16.2%	15.8%	5.0%	5.0%	5.0%	5.0%
2006	23.8%	22.7%	22.9%	21.6%	1.9%	1.5%	1.7%	1.2%	16.7%	16.2%	16.2%	15.5%	5.1%	5.0%	5.0%	4.9%
2007	26.9%	25.2%	25.2%	23.8%	2.4%	1.9%	2.0%	1.6%	20.4%	18.5%	18.5%	17.4%	4.1%	4.8%	4.8%	4.7%
2008	23.0%	23.7%	23.7%	22.6%	1.6%	1.3%	1.4%	1.2%	16.9%	17.3%	17.3%	16.5%	4.6%	5.0%	5.0%	5.0%
2009	32.5%	27.3%	27.5%	25.9%	2.4%	2.3%	2.5%	1.9%	23.6%	20.0%	19.9%	18.9%	6.5%	5.1%	5.0%	5.0%
2010	22.4%	24.6%	24.7%	23.6%	2.0%	1.7%	1.8%	1.5%	15.3%	18.1%	18.1%	17.3%	5.1%	4.8%	4.8%	4.9%
2011	29.6%	29.5%	29.5%	27.4%	1.8%	1.8%	1.9%	1.4%	21.4%	22.5%	22.5%	20.7%	6.3%	5.2%	5.2%	5.3%
2012	30.3%	25.1%	25.2%	24.5%	1.7%	1.6%	1.8%	1.4%	24.1%	18.6%	18.6%	18.2%	4.6%	4.9%	4.9%	4.9%
2013	26.4%	23.0%	23.2%	22.1%	1.4%	1.2%	1.4%	1.3%	18.1%	17.0%	17.0%	15.8%	6.9%	4.9%	4.9%	4.9%
2014	30.8%	27.6%	27.9%	26.1%	2.0%	1.4%	1.7%	1.5%	20.5%	21.3%	21.3%	19.7%	8.3%	4.9%	4.9%	5.0%
2015	26.5%	21.1%	21.2%	21.1%	1.4%	1.1%	1.2%	1.1%	19.6%	15.3%	15.3%	15.3%	5.4%	4.7%	4.7%	4.7%
2016	23.8%	22.9%	23.0%	22.3%	2.0%	2.1%	2.1%	1.8%	18.0%	17.6%	17.6%	17.3%	3.8%	3.2%	3.2%	3.2%
2017	20.3%	21.5%	21.5%	20.5%	1.0%	1.0%	1.0%	0.9%	16.9%	15.9%	15.9%	15.1%	2.5%	4.6%	4.6%	4.5%
2018	19.5%	20.4%	20.5%	19.5%	1.0%	1.0%	1.0%	1.0%	14.4%	16.2%	16.2%	15.4%	4.1%	3.2%	3.2%	3.1%
'99-18 Avg	**25.8%**	**23.7%**	**23.9%**	**22.9%**	**1.8%**	**1.6%**	**1.7%**	**1.4%**	**18.6%**	**17.5%**	**17.5%**	**16.8%**	**5.4%**	**4.6%**	**4.6%**	**4.6%**

Section 3: Summary of Puget Sound Chinook Escapements

Table A.22: Projected natural escapement by scenario for Dungeness and Elwha River Chinook.

	Dungeness				**Elwha**			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	75	74	74	45	1,554	1,530	1,529	925
2000	218	222	222	134	1,851	1,894	1,891	1,143
2001	453	455	454	273	2,207	2,232	2,229	1,343
2002	633	636	636	383	2,375	2,414	2,413	1,454
2003	640	646	645	388	2,224	2,247	2,244	1,349
2004	1,014	1,045	1,045	628	3,400	3,504	3,505	2,107
2005	1,081	1,128	1,128	676	2,231	2,331	2,330	1,399
2006	1,543	1,554	1,553	939	1,920	1,940	1,938	1,171
2007	403	413	413	251	1,137	1,168	1,167	708
2008	229	233	233	140	1,131	1,150	1,149	693
2009	220	222	222	134	2,176	2,196	2,195	1,330
2010	457	463	462	279	1,266	1,282	1,281	774
2011	665	661	661	403	1,771	1,761	1,760	1,072
2012	614	626	626	377	2,492	2,543	2,543	1,532
2013	278	294	293	177	3,913	4,132	4,127	2,490
2014	204	208	208	126	3,806	3,882	3,875	2,354
2015	407	417	417	250	3,948	4,045	4,042	2,429
2016	514	519	519	312	2,341	2,365	2,363	1,420
2017	705	712	712	431	2,925	2,955	2,954	1,788
2018	905	927	927	559	6,652	6,812	6,812	4,110
'99-'18 Avg	**563**	**573**	**573**	**345**	**2,566**	**2,619**	**2,617**	**1,580**

Table A.23: Projected natural escapement by scenario for Mid-Hood Canal and Skokomish River Chinook.

	Mid-Hood Canal				**Skokomish HOR**				**Skokomish NOR**			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	871	871	870	528	1,476	1,471	1,470	892	217	217	217	132
2000	438	479	478	291	811	882	881	536	119	131	130	79
2001	327	337	336	204	1,710	1,753	1,752	1,060	252	259	259	157
2002	95	100	100	61	1,292	1,357	1,356	820	190	201	201	121
2003	194	208	208	125	983	1,050	1,049	630	145	155	155	93
2004	129	141	141	84	2,100	2,276	2,275	1,367	309	337	337	202
2005	46	51	51	31	1,901	2,115	2,114	1,269	280	312	312	187
2006	30	31	31	19	1,059	1,094	1,093	666	156	162	161	98
2007	73	82	82	50	377	419	419	257	56	62	62	38
2008	277	283	283	172	1,007	1,018	1,018	619	148	151	151	92
2009	130	134	134	82	936	951	950	582	138	142	141	87
2010	84	84	84	50	979	956	956	577	173	171	171	103
2011	290	287	287	177	1,235	1,184	1,184	730	55	54	54	34
2012	432	446	446	268	1,356	1,408	1,408	847	149	154	154	93
2013	675	698	697	422	1,544	1,596	1,594	964	169	175	175	106
2014	142	147	147	90	763	820	821	502	112	115	115	71
2015	260	270	269	162	321	339	338	203	129	134	134	80
2016	293	286	286	173	1,178	1,156	1,155	698	179	176	176	106
2017	376	375	375	228	7,253	7,213	7,212	4,398	887	884	884	538
2018	21	21	21	13	2,405	2,557	2,553	1,556	89	91	91	55
'99-'18 Avg	**259**	**267**	**266**	**162**	**1,534**	**1,581**	**1,580**	**959**	**198**	**204**	**204**	**124**

Table A.24: Projected natural escapement by scenario for Nooksack River Spring Chinook.

	North/Middle Fork Nooksack Spring				**South Fork Nooksack Spring**			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	85	81	80	49	32	30	30	19
2000	160	195	193	124	152	185	183	118
2001	264	284	282	174	208	224	222	137
2002	223	236	234	144	187	198	197	121
2003	210	226	224	136	68	73	73	44
2004	318	413	413	251	58	75	75	46
2005	209	248	247	148	75	89	88	53
2006	275	326	325	204	162	192	191	120
2007	331	368	366	232	63	71	70	44
2008	301	319	319	195	182	193	192	118
2009	268	278	277	172	102	105	105	65
2010	204	206	205	127	64	65	64	40
2011	97	96	95	60	146	145	144	92
2012	275	289	289	178	280	294	294	182
2013	106	122	121	74	52	60	59	36
2014	94	98	97	61	80	84	83	52
2015	438	468	466	282	8	8	8	5
2016	377	383	382	230	331	337	335	202
2017	130	133	133	82	180	184	184	114
2018	108	112	112	68	432	450	449	273
'99-'18 Avg	**224**	**244**	**243**	**150**	**143**	**153**	**152**	**94**

Table A.25: 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	208	209	209	126	83	83	83	50	180	181	181	109
2000	360	375	375	227	273	284	284	172	388	404	404	245
2001	682	711	710	428	619	646	645	389	538	561	561	338
2002	263	270	269	162	337	346	346	208	456	468	468	281
2003	385	391	391	235	325	330	330	198	211	214	214	128
2004	528	547	547	328	405	420	420	252	746	774	774	464
2005	534	569	569	341	428	455	455	273	318	338	338	203
2006	375	383	383	231	458	468	467	283	1,043	1,064	1,064	643
2007	118	121	121	73	228	233	233	140	309	316	316	190
2008	209	214	214	129	287	293	293	177	1,010	1,035	1,034	623
2009	282	285	285	172	345	349	349	210	378	383	383	231
2010	259	261	261	157	322	325	325	195	756	763	763	458
2011	216	214	214	129	261	259	259	156	346	344	344	208
2012	458	466	466	280	481	489	489	294	1,818	1,851	1,851	1,112
2013	613	650	649	391	298	315	315	190	1,069	1,131	1,131	680
2014	465	479	479	289	225	232	232	140	933	961	961	580
2015	470	484	484	290	184	190	190	114	731	752	752	452
2016	651	657	657	394	296	299	299	179	1,494	1,507	1,507	904
2017	905	914	914	550	319	322	322	194	1,642	1,659	1,659	999
2018	633	647	647	389	124	127	127	76	1,573	1,608	1,608	968
'99-'18 Avg	**431**	**442**	**442**	**266**	**315**	**323**	**323**	**195**	**797**	**816**	**816**	**491**

Table A.26: 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	3,488	3,335	3,309	2,019	1,015	970	962	587	287	274	272	166
2000	12,862	13,473	13,304	8,225	3,205	3,357	3,315	2,049	566	593	585	362
2001	9,916	10,097	10,003	6,104	2,562	2,609	2,585	1,578	1,085	1,104	1,094	668
2002	12,497	12,816	12,727	7,772	4,402	4,514	4,483	2,737	823	844	838	512
2003	6,672	6,874	6,823	4,148	1,087	1,120	1,112	676	1,398	1,441	1,430	869
2004	18,647	19,937	19,966	12,210	2,857	3,054	3,059	1,870	412	441	441	270
2005	15,553	17,263	17,183	10,376	3,109	3,451	3,435	2,074	819	910	905	547
2006	14,644	15,338	15,228	9,427	3,178	3,329	3,305	2,046	992	1,039	1,032	639
2007	8,679	9,315	9,274	5,809	928	996	992	621	338	362	361	226
2008	7,495	7,601	7,587	4,622	2,384	2,418	2,413	1,470	478	484	484	295
2009	5,025	6,190	6,156	3,833	1,367	1,684	1,674	1,043	237	293	291	181
2010	6,217	6,143	6,099	3,768	952	940	934	577	333	329	327	202
2011	4,039	4,676	4,646	2,994	739	856	850	548	189	219	218	140
2012	9,306	9,470	9,470	5,861	3,126	3,182	3,181	1,969	678	690	690	427
2013	8,325	8,967	8,861	5,398	1,467	1,580	1,561	951	502	540	534	325
2014	8,084	8,273	8,167	4,997	1,759	1,800	1,777	1,087	354	362	358	219
2015	9,679	10,672	10,599	6,446	1,777	1,959	1,946	1,183	367	405	402	244
2016	14,476	14,847	14,771	8,940	2,669	2,737	2,723	1,648	981	1,006	1,001	606
2017	7,665	7,985	7,971	4,945	3,724	3,880	3,873	2,402	985	1,026	1,024	635
2018	7,655	8,070	8,059	4,897	1,711	1,804	1,802	1,095	336	355	354	215
'99-'18 Avg	**9,546**	**10,067**	**10,010**	**6,140**	**2,201**	**2,312**	**2,299**	**1,411**	**608**	**636**	**632**	**387**

Table A.27: Projected natural escapement by scenario for Stillaguamish River Chinook.

	Stillaguamish HOR				**Stillaguamish NOR**			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	722	696	696	421	732	717	715	432
2000	1,120	1,130	1,128	683	995	1,014	1,012	613
2001	1,055	1,048	1,047	631	727	739	738	445
2002	1,109	1,115	1,115	672	767	784	783	472
2003	771	776	774	466	531	535	535	321
2004	1,085	1,114	1,114	670	749	768	769	462
2005	828	889	889	533	571	612	611	367
2006	875	866	866	523	603	599	598	361
2007	373	381	381	231	239	247	247	150
2008	1,002	1,006	1,006	608	827	833	833	503
2009	846	841	841	509	464	465	464	282
2010	594	594	594	359	342	345	345	208
2011	1,160	1,122	1,121	685	566	556	555	339
2012	856	864	864	521	936	948	948	572
2013	383	423	422	255	681	757	756	456
2014	350	364	363	221	190	196	195	119
2015	275	294	294	177	511	533	533	320
2016	353	371	371	223	764	784	784	471
2017	473	490	490	297	613	622	622	377
2018	735	788	787	476	228	239	239	144
'99-'18 Avg	**748**	**759**	**758**	**458**	**602**	**615**	**614**	**371**

Table A.28: Projected natural escapement by scenario for Snohomish River Chinook.

	Skykomish				**Snoqualmie**			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	1,368	1,394	1,393	842	2,266	2,308	2,307	1,395
2000	1,756	1,838	1,838	1,111	3,757	3,934	3,932	2,377
2001	3,021	3,247	3,246	1,960	4,634	4,980	4,978	3,005
2002	2,239	2,351	2,351	1,418	3,289	3,455	3,453	2,083
2003	1,805	1,861	1,861	1,117	2,821	2,910	2,909	1,747
2004	5,584	5,897	5,897	3,541	5,215	5,507	5,508	3,307
2005	2,203	2,483	2,482	1,490	2,128	2,397	2,397	1,439
2006	4,096	4,137	4,136	2,503	4,331	4,375	4,374	2,646
2007	1,498	1,587	1,587	963	1,965	2,081	2,080	1,263
2008	4,616	4,708	4,708	2,843	3,210	3,275	3,275	1,978
2009	1,140	1,167	1,167	707	744	762	762	461
2010	1,784	1,816	1,815	1,095	2,024	2,060	2,060	1,242
2011	858	832	832	507	730	707	707	431
2012	2,422	2,490	2,490	1,497	1,376	1,414	1,414	850
2013	1,847	1,977	1,977	1,192	1,162	1,244	1,244	750
2014	1,595	1,666	1,666	1,012	1,372	1,434	1,433	871
2015	1,650	1,720	1,720	1,033	679	709	708	425
2016	2,622	2,647	2,647	1,591	924	933	933	561
2017	2,965	2,982	2,982	1,803	1,501	1,509	1,509	912
2018	2,262	2,340	2,339	1,412	824	852	852	514
'99-'18 Avg	**2,367**	**2,457**	**2,457**	**1,482**	**2,248**	**2,342**	**2,342**	**1,413**

Table A.29: 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	0	0	0	0	471	474	474	289	733	739	738	450
2000	0	0	0	0	133	145	145	88	370	403	403	246
2001	8	9	9	5	957	1,023	1,023	621	827	883	883	536
2002	26	27	27	16	656	687	687	415	288	302	302	182
2003	164	166	166	100	579	618	618	371	112	119	119	72
2004	336	351	351	211	735	808	808	485	62	68	68	41
2005	177	196	196	118	522	606	606	364	60	70	69	42
2006	329	321	321	196	1,044	1,089	1,089	664	1,055	1,100	1,100	671
2007	312	325	325	201	1,895	2,003	2,003	1,226	1,255	1,327	1,327	812
2008	147	141	141	88	1,244	1,249	1,249	763	474	476	476	291
2009	128	128	128	78	477	477	477	292	70	70	70	43
2010	109	106	106	64	509	504	503	304	142	140	140	85
2011	185	179	179	110	565	561	561	345	138	137	137	84
2012	249	266	266	160	752	781	781	470	143	149	149	90
2013	367	385	385	233	1,475	1,541	1,540	931	86	90	90	55
2014	270	289	289	177	319	330	330	202	63	65	65	40
2015	665	711	711	427	1,132	1,198	1,198	720	174	184	184	111
2016	474	471	471	285	565	561	560	339	165	163	163	99
2017	577	578	578	352	1,468	1,481	1,481	903	161	162	162	99
2018	184	195	195	119	614	632	631	385	102	105	105	64
'99-'18 Avg	**235**	**242**	**242**	**147**	**806**	**838**	**838**	**509**	**324**	**338**	**338**	**206**

Table A.30: Projected natural escapement by scenario for Green River Chinook.

	Green HOR				**Green NOR**			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	4,180	4,333	4,331	2,644	2,083	2,134	2,133	1,302
2000	1,970	2,440	2,439	1,490	1,556	1,936	1,935	1,184
2001	3,023	3,448	3,447	2,097	2,025	2,313	2,313	1,407
2002	3,577	3,793	3,792	2,296	1,838	2,025	2,024	1,227
2003	3,319	3,554	3,553	2,142	1,075	1,216	1,215	732
2004	4,512	5,217	5,218	3,142	1,243	1,536	1,536	925
2005	2,070	2,299	2,298	1,385	270	325	325	196
2006	2,974	3,058	3,057	1,874	2,605	2,912	2,911	1,784
2007	3,012	3,204	3,204	1,963	2,157	2,372	2,371	1,458
2008	2,575	2,681	2,681	1,644	3,234	3,441	3,441	2,110
2009	525	545	545	335	220	229	229	141
2010	1,226	1,203	1,203	728	787	784	784	475
2011	721	710	710	436	479	493	493	305
2012	1,681	1,772	1,772	1,069	1,352	1,416	1,416	855
2013	799	838	838	508	242	253	253	154
2014	1,947	2,125	2,125	1,308	620	646	646	398
2015	2,839	3,051	3,050	1,841	733	780	780	471
2016	6,926	6,901	6,900	4,184	2,389	2,375	2,374	1,439
2017	5,763	5,893	5,892	3,599	2,777	2,858	2,857	1,745
2018	4,230	4,628	4,627	2,829	2,781	2,931	2,931	1,793
'99-'18 Avg	**2,893**	**3,085**	**3,084**	**1,876**	**1,523**	**1,649**	**1,648**	**1,005**

Table A.31: Projected natural escapement by scenario for Puyallup River Chinook.

	Puyallup HOR				**Puyallup NOR**				**White Spring**			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	1,983	1,991	1,990	1,212	1,968	1,974	1,973	1,202	152	162	162	98
2000	1,108	1,190	1,190	726	1,233	1,325	1,325	808	1,033	1,089	1,089	660
2001	1,782	1,856	1,856	1,126	1,831	1,932	1,932	1,172	1,653	1,877	1,876	1,135
2002	943	940	940	568	1,733	1,802	1,802	1,088	437	463	462	278
2003	1,599	1,598	1,598	959	1,360	1,436	1,436	862	834	899	899	539
2004	1,138	1,157	1,157	695	1,140	1,234	1,234	741	1,248	1,414	1,414	849
2005	1,041	1,134	1,134	681	875	1,010	1,010	606	1,071	1,161	1,161	696
2006	2,530	2,461	2,460	1,503	1,228	1,265	1,265	772	1,084	1,152	1,152	698
2007	3,073	3,158	3,158	1,933	1,373	1,447	1,447	886	1,106	1,148	1,148	693
2008	1,308	1,291	1,291	788	2,014	2,021	2,021	1,233	1,028	1,074	1,074	647
2009	2,480	2,491	2,490	1,523	745	748	748	458	348	355	355	214
2010	2,436	2,375	2,375	1,433	518	512	512	309	361	369	369	222
2011	2,278	2,214	2,214	1,363	513	507	507	312	654	652	652	393
2012	829	868	868	522	541	563	563	339	1,182	1,199	1,199	720
2013	1,633	1,702	1,701	1,028	316	328	328	198	1,000	1,014	1,013	609
2014	2,131	2,269	2,268	1,389	469	483	483	295	276	284	284	172
2015	2,304	2,459	2,458	1,476	903	953	953	572	471	477	477	286
2016	5,568	5,520	5,519	3,337	738	730	729	441	794	798	798	479
2017	3,965	3,963	3,963	2,414	785	790	790	481	650	650	650	392
2018	5,626	5,949	5,948	3,622	494	507	507	309	338	345	345	207
'99-'18 Avg	**2,288**	**2,329**	**2,329**	**1,415**	**1,039**	**1,078**	**1,078**	**654**	**786**	**829**	**829**	**499**

Table A.32: Projected natural escapement by scenario for Nisqually River Chinook.

	Nisqually HOR				**Nisqually NOR**			
Year	**S1**	**S2**	**S3**	**S4**	**S1**	**S2**	**S3**	**S4**
1999	1,999	2,073	2,072	1,254	1,202	1,256	1,256	760
2000	692	759	759	462	4,100	4,582	4,581	2,787
2001	1,632	1,763	1,763	1,067	1,643	1,806	1,805	1,093
2002	766	794	794	479	789	854	853	515
2003	721	733	733	440	382	411	411	247
2004	2,407	2,468	2,468	1,482	792	876	876	526
2005	1,267	1,361	1,361	817	768	870	870	522
2006	1,922	1,888	1,887	1,145	493	515	515	313
2007	1,021	1,064	1,064	650	1,098	1,146	1,146	698
2008	2,274	2,284	2,283	1,387	1,152	1,161	1,161	707
2009	686	686	686	420	194	194	194	119
2010	1,724	1,678	1,678	1,011	542	531	531	320
2011	2,242	2,160	2,161	1,331	599	589	589	363
2012	1,797	1,865	1,865	1,122	554	577	577	347
2013	1,150	1,203	1,202	726	943	986	985	595
2014	502	540	540	330	491	510	510	311
2015	807	833	832	500	703	726	726	436
2016	168	163	163	98	832	817	817	493
2017	202	196	196	119	1,269	1,250	1,250	758
2018	207	218	218	133	373	380	380	231
'99-'18 Avg	**1,209**	**1,236**	**1,236**	**749**	**946**	**1,002**	**1,002**	**607**

APPENDIX B. MODELING RESULTS FOR SRKW ENVIRONMENTAL BASELINE

Table B.1. Post-season validation runs (FRAM 7.1.1) showing historical October pre-fishing Chinook salmon abundances by region in a retrospective analysis from 1992-2020. See Appendix D and PFMC (2020) for a description of the spatial regions.

Year	Region				
	SWWCVI	**Salish**	**NOF**	**OR**	**Cali**
1992	494,850	942,511	652,570	461,505	331,211
1993	494,585	962,580	694,962	726,617	614,654
1994	416,597	780,136	515,793	556,886	576,280
1995	479,499	863,217	704,852	1,301,233	1,343,781
1996	494,208	885,175	667,092	908,855	869,789
1997	494,644	1,039,093	726,362	801,451	963,725
1998	412,878	841,894	540,346	635,501	649,538
1999	501,909	1,054,270	626,975	564,584	692,145
2000	430,718	852,973	755,960	1,030,571	1,030,259
2001	771,771	1,314,062	1,372,350	1,170,271	1,005,699
2002	880,148	1,180,661	1,482,669	1,488,779	1,387,006
2003	879,460	1,318,493	1,373,535	1,520,145	1,275,724
2004	866,138	1,197,040	1,288,536	1,117,257	1,011,330
2005	668,957	999,356	874,622	789,442	843,790
2006	590,470	1,140,814	736,300	451,607	436,108
2007	438,487	876,223	547,222	492,807	339,898
2008	593,106	1,059,407	762,858	344,385	134,161
2009	490,486	762,396	704,193	551,623	198,153
2010	810,242	1,174,961	1,253,484	876,757	320,456
2011	665,107	941,321	940,670	711,864	351,394
2012	654,030	877,935	980,600	1,241,745	869,781
2013	1,062,118	1,059,295	1,181,022	1,116,532	896,463
2014	882,178	1,059,875	1,177,498	982,485	638,421
2015	994,244	955,923	1,335,017	987,391	347,879
2016	628,543	900,657	781,476	408,739	223,186
2017	614,695	1,060,960	731,845	438,495	211,895
2018	527,210	1,009,215	663,662	596,483	362,720
2019	543,690	1,024,051	633,225	561,412	505,310
2020	589,009	810,150	674,293	520,301	395,985

Table B.2. Post-season validation runs (FRAM 7.1.1) showing historical percent prey reductions (Chinook salmon ages 3+) by fishery, time step, and region in a retrospective analysis from 1992-2018. See Appendix D and PFMC (2020)(for a description of the spatial regions.

	US Fisheries														
	Oct-Apr					May-Jun					Jul-Sep				
	Region														
Year	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali
1992	1.36%	7.97%	1.88%	3.37%	8.10%	7.86%	8.07%	4.22%	7.39%	29.74%	19.47%	13.53%	13.48%	21.28%	64.24%
1993	1.65%	4.74%	2.44%	4.56%	8.83%	5.90%	5.46%	4.42%	9.49%	31.33%	15.55%	11.87%	13.22%	23.44%	53.75%
1994	1.18%	4.50%	2.00%	3.51%	6.55%	4.33%	3.63%	4.54%	11.29%	33.17%	13.42%	9.07%	12.70%	24.99%	57.77%
1995	1.13%	5.73%	2.23%	2.51%	5.56%	5.70%	4.99%	7.41%	11.94%	36.36%	12.95%	8.81%	14.90%	24.17%	57.78%
1996	1.32%	4.61%	2.56%	4.54%	8.27%	4.76%	4.89%	5.43%	12.16%	32.76%	9.98%	8.78%	12.79%	24.85%	48.75%
1997	1.30%	3.69%	2.17%	4.30%	7.01%	5.29%	4.79%	5.73%	13.85%	35.70%	12.97%	9.59%	14.84%	27.04%	56.96%
1998	1.35%	2.77%	1.77%	2.64%	5.23%	4.72%	3.32%	4.45%	9.07%	26.58%	12.52%	8.32%	12.75%	18.24%	44.40%
1999	0.54%	1.48%	0.93%	1.85%	3.14%	3.53%	2.54%	3.39%	8.68%	21.87%	8.75%	7.21%	10.54%	19.18%	37.65%
2000	1.06%	1.68%	1.26%	1.56%	3.26%	4.00%	2.66%	4.63%	10.74%	30.63%	8.72%	7.89%	10.12%	18.69%	39.35%
2001	0.95%	1.75%	1.06%	2.61%	4.86%	3.46%	2.65%	2.31%	5.14%	15.73%	6.66%	8.37%	8.31%	13.09%	28.15%
2002	0.96%	1.63%	1.17%	2.42%	4.65%	3.95%	2.95%	3.30%	6.48%	19.31%	8.82%	8.57%	12.37%	15.42%	32.90%
2003	2.37%	1.17%	2.07%	3.54%	6.37%	4.10%	2.62%	3.67%	7.61%	21.78%	9.53%	6.61%	15.32%	20.51%	35.62%
2004	2.17%	1.20%	2.93%	8.14%	13.45%	4.12%	2.89%	4.64%	14.49%	38.59%	10.94%	6.22%	16.19%	36.85%	61.60%
2005	1.78%	2.21%	2.55%	4.96%	6.86%	5.09%	4.18%	4.46%	9.60%	23.09%	11.66%	7.36%	18.28%	23.54%	42.91%
2006	1.58%	1.31%	2.81%	10.19%	16.80%	3.25%	2.57%	2.83%	10.55%	26.30%	9.87%	7.58%	12.47%	27.34%	49.22%
2007	1.02%	2.19%	1.40%	2.43%	6.56%	4.25%	3.37%	2.52%	5.19%	18.48%	13.61%	9.04%	12.46%	18.09%	36.40%
2008	0.31%	1.65%	0.49%	3.29%	5.65%	2.30%	2.22%	1.07%	2.77%	6.44%	5.56%	6.01%	6.05%	9.20%	7.33%
2009	0.36%	1.56%	0.25%	0.05%	0.06%	2.25%	2.79%	0.84%	0.18%	0.05%	7.00%	7.32%	7.43%	1.26%	0.19%
2010	0.48%	1.22%	0.44%	0.25%	1.03%	2.69%	2.72%	1.38%	0.78%	2.61%	5.63%	7.12%	7.42%	3.28%	5.56%
2011	0.68%	1.35%	0.59%	0.49%	1.39%	2.62%	2.64%	1.37%	1.43%	6.50%	7.88%	8.65%	9.06%	6.88%	14.87%
2012	0.61%	1.38%	0.77%	1.39%	2.44%	3.53%	3.32%	2.43%	3.78%	12.34%	8.35%	10.47%	10.10%	11.68%	23.60%
2013	0.48%	1.27%	0.86%	2.24%	3.77%	2.26%	2.86%	2.58%	6.89%	18.90%	5.03%	7.85%	10.94%	18.10%	33.90%
2014	1.03%	1.61%	1.24%	2.56%	5.49%	3.90%	3.49%	3.27%	5.92%	19.42%	8.82%	7.73%	17.86%	17.16%	36.04%

US Fisheries															
	Oct-Apr					May-Jun					Jul-Sep				
	Region														
Year	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali
2015	0.76%	1.80%	0.86%	1.28%	6.09%	3.15%	3.84%	2.28%	3.89%	20.23%	6.46%	7.63%	11.84%	9.15%	28.86%
2016	0.81%	1.75%	0.88%	2.51%	6.54%	2.86%	2.63%	1.72%	4.31%	17.42%	8.07%	6.01%	12.06%	12.26%	31.82%
2017	0.53%	1.85%	0.67%	1.19%	5.10%	2.50%	1.97%	1.41%	1.93%	10.69%	6.67%	6.37%	8.06%	6.45%	25.68%
2018	0.29%	1.49%	0.60%	2.29%	3.75%	2.43%	2.17%	1.51%	2.88%	9.50%	6.06%	6.86%	6.82%	9.29%	21.21%

BC Fisheries															
	Oct-Apr					May-Jun					Jul-Sep				
	Region														
Year	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali
1992	0.23%	3.71%	0.23%	0.13%	0.02%	2.22%	8.95%	0.88%	0.15%	0.02%	26.14%	16.78%	11.90%	6.01%	0.14%
1993	0.16%	3.24%	0.14%	0.05%	0.01%	2.07%	10.33%	0.72%	0.08%	0.01%	26.04%	16.36%	11.08%	2.67%	0.07%
1994	0.14%	2.47%	0.13%	0.05%	0.00%	1.78%	6.10%	0.70%	0.08%	0.01%	19.90%	11.88%	11.66%	3.43%	0.04%
1995	0.03%	1.55%	0.02%	0.00%	0.00%	0.85%	3.24%	0.25%	0.01%	0.00%	9.88%	7.77%	4.82%	0.78%	0.01%
1996	0.01%	1.45%	0.01%	0.00%	0.00%	0.73%	4.52%	0.22%	0.02%	0.00%	3.99%	7.12%	1.13%	0.09%	0.00%
1997	0.03%	1.01%	0.03%	0.00%	0.00%	0.85%	2.99%	0.27%	0.03%	0.00%	10.00%	7.15%	4.81%	0.85%	0.01%
1998	0.09%	0.85%	0.07%	0.02%	0.00%	0.94%	1.68%	0.33%	0.04%	0.00%	10.61%	5.18%	5.30%	0.96%	0.02%
1999	0.28%	0.90%	0.28%	0.12%	0.01%	1.14%	2.40%	0.48%	0.08%	0.01%	8.82%	4.94%	4.18%	0.80%	0.02%
2000	2.11%	2.87%	1.36%	0.31%	0.05%	3.82%	4.28%	1.12%	0.13%	0.02%	7.57%	6.09%	3.51%	0.37%	0.02%
2001	0.81%	1.41%	0.58%	0.23%	0.03%	1.96%	2.98%	0.70%	0.14%	0.02%	4.78%	5.38%	2.56%	0.47%	0.02%
2002	0.66%	1.46%	0.52%	0.15%	0.02%	3.66%	6.08%	1.56%	0.27%	0.03%	7.47%	7.71%	4.99%	0.78%	0.03%
2003	1.05%	1.18%	0.95%	0.27%	0.03%	3.83%	4.47%	1.86%	0.30%	0.03%	8.16%	6.37%	6.09%	0.87%	0.03%
2004	1.77%	2.00%	1.69%	0.71%	0.10%	3.63%	4.06%	1.79%	0.39%	0.04%	11.15%	8.24%	7.26%	1.57%	0.05%
2005	2.69%	2.84%	2.68%	0.77%	0.09%	4.64%	4.72%	2.55%	0.51%	0.05%	12.10%	9.05%	10.13%	1.75%	0.05%
2006	1.45%	1.60%	1.36%	0.63%	0.12%	3.66%	3.66%	1.66%	0.45%	0.05%	12.30%	7.43%	8.00%	2.28%	0.06%
2007	1.30%	2.23%	1.10%	0.33%	0.08%	5.56%	5.77%	2.08%	0.35%	0.06%	16.99%	8.54%	7.60%	1.32%	0.07%
2008	0.30%	0.79%	0.27%	0.18%	0.05%	2.03%	2.34%	0.91%	0.32%	0.08%	8.91%	6.28%	6.11%	1.81%	0.15%

BC Fisheries

	Oct-Apr					May-Jun					Jul-Sep				
Year	Region SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali
2009	0.57%	1.20%	0.49%	0.17%	0.06%	3.22%	5.12%	1.42%	0.31%	0.08%	11.16%	10.26%	7.04%	1.19%	0.11%
2010	0.22%	0.95%	0.19%	0.11%	0.05%	2.27%	3.31%	0.97%	0.23%	0.07%	6.28%	7.15%	4.57%	1.05%	0.09%
2011	0.35%	0.93%	0.31%	0.14%	0.03%	3.78%	5.46%	1.72%	0.40%	0.08%	11.96%	9.67%	7.30%	1.51%	0.09%
2012	0.35%	0.97%	0.30%	0.08%	0.02%	1.91%	3.78%	0.79%	0.11%	0.02%	8.22%	7.56%	5.26%	0.73%	0.03%
2013	0.17%	1.83%	0.17%	0.05%	0.01%	1.59%	4.66%	0.87%	0.17%	0.02%	5.08%	7.33%	5.09%	0.71%	0.03%
2014	0.40%	1.21%	0.38%	0.16%	0.02%	2.18%	4.87%	1.24%	0.29%	0.04%	7.35%	9.72%	8.86%	1.68%	0.07%
2015	0.14%	1.35%	0.13%	0.06%	0.02%	1.66%	6.49%	0.86%	0.23%	0.06%	6.38%	13.29%	5.74%	1.21%	0.09%
2016	0.23%	1.60%	0.22%	0.14%	0.04%	2.46%	5.38%	1.18%	0.41%	0.08%	9.71%	9.06%	8.18%	2.58%	0.13%
2017	0.19%	1.48%	0.17%	0.08%	0.03%	2.45%	5.23%	1.04%	0.28%	0.07%	12.07%	9.37%	6.77%	1.75%	0.14%
2018	0.06%	1.65%	0.05%	0.01%	0.00%	1.87%	6.40%	0.70%	0.10%	0.02%	12.41%	10.76%	5.26%	0.80%	0.05%

PFMC Fisheries

	Oct-Apr					May-Jun					Jul-Sep				
Year	Region SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali
1992	0.46%	0.04%	0.93%	3.10%	7.92%	2.73%	1.72%	2.85%	7.17%	29.72%	4.88%	1.28%	7.70%	19.77%	64.19%
1993	0.87%	0.09%	1.74%	4.46%	8.76%	2.61%	1.43%	3.66%	9.40%	31.31%	4.49%	1.17%	7.38%	22.49%	53.72%
1994	0.60%	0.07%	1.49%	3.41%	6.49%	1.44%	0.44%	3.83%	11.21%	33.15%	2.39%	0.26%	5.93%	23.71%	57.73%
1995	0.93%	0.11%	2.05%	2.49%	5.55%	2.47%	0.45%	6.73%	11.89%	36.35%	5.14%	0.60%	10.79%	23.72%	57.77%
1996	1.06%	0.12%	2.30%	4.52%	8.26%	1.94%	0.60%	4.70%	12.10%	32.75%	3.53%	0.54%	8.17%	24.27%	48.74%
1997	0.98%	0.09%	1.94%	4.26%	7.00%	2.55%	0.91%	5.04%	13.77%	35.69%	4.34%	0.84%	8.17%	26.06%	56.94%
1998	0.98%	0.08%	1.46%	2.58%	5.20%	2.51%	1.26%	3.90%	9.02%	26.57%	3.76%	1.02%	7.14%	17.41%	44.39%
1999	0.28%	0.03%	0.69%	1.79%	3.11%	2.05%	1.27%	2.97%	8.61%	21.87%	3.47%	1.10%	5.60%	18.19%	37.64%
2000	0.47%	0.05%	0.86%	1.49%	3.22%	2.29%	0.93%	4.23%	10.70%	30.62%	3.74%	0.62%	6.05%	18.23%	39.34%
2001	0.66%	0.07%	0.83%	2.56%	4.83%	2.20%	1.12%	2.01%	5.09%	15.73%	3.68%	1.07%	5.80%	12.62%	28.13%
2002	0.66%	0.09%	0.96%	2.38%	4.62%	2.95%	1.67%	3.04%	6.44%	19.31%	4.69%	1.59%	8.04%	14.65%	32.88%

PFMC Fisheries															
	Oct-Apr					May-Jun					Jul-Sep				
	Region														
Year	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali
2003	1.98%	0.17%	1.77%	3.47%	6.32%	3.17%	1.62%	3.40%	7.56%	21.78%	5.13%	1.81%	10.25%	19.80%	35.60%
2004	1.84%	0.22%	2.63%	8.07%	13.40%	3.09%	1.68%	4.35%	14.43%	38.58%	5.54%	1.85%	11.11%	35.86%	61.57%
2005	0.98%	0.11%	1.60%	4.86%	6.81%	3.05%	1.85%	3.78%	9.48%	23.08%	4.97%	1.74%	10.80%	22.32%	42.88%
2006	0.99%	0.11%	2.34%	10.08%	16.74%	1.58%	0.95%	2.29%	10.44%	26.29%	2.93%	0.97%	5.41%	25.62%	49.18%
2007	0.40%	0.04%	0.87%	2.32%	6.47%	1.85%	1.25%	1.88%	5.10%	18.47%	3.15%	0.88%	4.85%	16.79%	36.36%
2008	0.07%	0.01%	0.25%	3.23%	5.60%	0.84%	0.63%	0.64%	2.64%	6.41%	1.36%	0.60%	2.11%	8.17%	7.25%
2009	0.00%	0.00%	0.00%	0.00%	0.00%	0.72%	0.63%	0.39%	0.09%	0.02%	1.23%	0.49%	1.54%	0.37%	0.11%
2010	0.02%	0.00%	0.05%	0.15%	0.87%	1.65%	1.23%	1.06%	0.71%	2.58%	2.56%	1.30%	3.86%	2.55%	5.49%
2011	0.10%	0.01%	0.13%	0.38%	1.27%	1.32%	1.07%	0.97%	1.34%	6.49%	2.41%	1.08%	3.80%	5.88%	14.81%
2012	0.21%	0.04%	0.46%	1.34%	2.40%	2.42%	2.01%	2.14%	3.75%	12.34%	4.15%	1.60%	6.01%	11.14%	23.58%
2013	0.28%	0.05%	0.66%	2.21%	3.75%	1.52%	1.59%	2.29%	6.83%	18.89%	2.76%	1.27%	7.10%	17.61%	33.88%
2014	0.44%	0.06%	0.72%	2.47%	5.44%	2.61%	1.86%	2.75%	5.80%	19.40%	4.45%	1.82%	9.54%	15.91%	35.99%
2015	0.29%	0.05%	0.39%	1.19%	5.98%	1.96%	1.87%	1.82%	3.78%	20.20%	3.11%	1.70%	6.47%	8.22%	28.79%
2016	0.24%	0.03%	0.44%	2.34%	6.36%	1.23%	1.01%	1.15%	4.11%	17.38%	2.15%	0.87%	4.03%	10.10%	31.72%
2017	0.11%	0.01%	0.29%	1.08%	4.97%	1.03%	0.62%	0.96%	1.82%	10.66%	2.45%	0.91%	4.02%	5.53%	25.62%
2018	0.12%	0.02%	0.45%	2.26%	3.72%	1.40%	0.98%	1.23%	2.84%	9.49%	2.46%	0.83%	3.68%	8.82%	21.19%

Puget Sound Fisheries															
	Oct-Apr					May-Jun					Jul-Sep				
	Region														
Year	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali
1992	0.38%	7.49%	0.49%	0.09%	0.02%	3.80%	5.50%	1.06%	0.16%	0.02%	4.56%	10.10%	1.46%	0.29%	0.02%
1993	0.32%	4.31%	0.34%	0.02%	0.01%	2.23%	3.41%	0.53%	0.05%	0.02%	3.03%	8.63%	0.77%	0.10%	0.01%
1994	0.09%	4.07%	0.11%	0.01%	0.00%	1.89%	2.53%	0.45%	0.05%	0.02%	2.41%	6.73%	0.44%	0.07%	0.01%
1995	0.07%	5.51%	0.08%	0.00%	0.00%	2.50%	3.86%	0.50%	0.03%	0.01%	3.08%	6.62%	0.51%	0.04%	0.01%
1996	0.15%	4.37%	0.17%	0.01%	0.00%	2.12%	3.53%	0.49%	0.04%	0.00%	2.83%	6.58%	0.51%	0.05%	0.00%

	Puget Sound Fisheries														
	Oct-Apr					May-Jun					Jul-Sep				
	Region														
Year	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali
1997	0.05%	3.40%	0.05%	0.01%	0.00%	1.80%	3.13%	0.40%	0.03%	0.00%	2.81%	6.77%	0.46%	0.04%	0.00%
1998	0.02%	2.38%	0.02%	0.00%	0.00%	1.20%	1.26%	0.27%	0.02%	0.00%	1.53%	5.39%	0.21%	0.02%	0.00%
1999	0.02%	1.30%	0.03%	0.00%	0.00%	0.68%	0.73%	0.17%	0.02%	0.00%	0.78%	4.74%	0.14%	0.01%	0.00%
2000	0.01%	1.10%	0.01%	0.00%	0.00%	0.54%	0.61%	0.09%	0.01%	0.00%	0.64%	5.23%	0.07%	0.00%	0.00%
2001	0.06%	1.48%	0.07%	0.01%	0.00%	0.67%	0.85%	0.13%	0.02%	0.00%	0.72%	5.95%	0.15%	0.02%	0.00%
2002	0.04%	1.30%	0.05%	0.01%	0.00%	0.45%	0.64%	0.10%	0.01%	0.00%	0.50%	5.01%	0.12%	0.01%	0.00%
2003	0.02%	0.76%	0.02%	0.00%	0.00%	0.28%	0.42%	0.06%	0.01%	0.00%	0.37%	3.16%	0.09%	0.01%	0.00%
2004	0.03%	0.73%	0.06%	0.00%	0.00%	0.28%	0.51%	0.07%	0.01%	0.00%	0.36%	2.53%	0.11%	0.01%	0.00%
2005	0.35%	1.69%	0.61%	0.02%	0.00%	0.94%	1.26%	0.30%	0.04%	0.00%	1.00%	3.36%	0.33%	0.03%	0.00%
2006	0.11%	0.79%	0.12%	0.01%	0.00%	0.47%	0.54%	0.12%	0.02%	0.00%	0.59%	4.44%	0.12%	0.02%	0.00%
2007	0.11%	1.73%	0.09%	0.01%	0.00%	0.96%	1.05%	0.23%	0.02%	0.00%	1.10%	5.85%	0.22%	0.02%	0.00%
2008	0.07%	1.48%	0.12%	0.02%	0.00%	0.73%	0.89%	0.19%	0.05%	0.01%	0.80%	3.92%	0.27%	0.06%	0.01%
2009	0.03%	1.20%	0.04%	0.00%	0.00%	0.52%	1.05%	0.12%	0.02%	0.01%	0.74%	4.61%	0.26%	0.06%	0.01%
2010	0.05%	0.77%	0.10%	0.01%	0.00%	0.33%	0.53%	0.08%	0.01%	0.00%	0.41%	4.20%	0.19%	0.03%	0.01%
2011	0.07%	0.85%	0.11%	0.01%	0.00%	0.37%	0.55%	0.09%	0.01%	0.00%	0.57%	5.52%	0.19%	0.03%	0.00%
2012	0.04%	1.01%	0.06%	0.00%	0.00%	0.36%	0.57%	0.08%	0.01%	0.00%	0.44%	6.97%	0.18%	0.01%	0.00%
2013	0.04%	1.05%	0.07%	0.00%	0.00%	0.29%	0.71%	0.09%	0.01%	0.00%	0.39%	5.33%	0.29%	0.03%	0.00%
2014	0.09%	1.15%	0.21%	0.01%	0.00%	0.42%	0.69%	0.14%	0.02%	0.00%	0.51%	3.70%	0.30%	0.04%	0.00%
2015	0.07%	1.18%	0.18%	0.01%	0.00%	0.35%	0.61%	0.11%	0.02%	0.01%	0.41%	3.87%	0.28%	0.04%	0.01%
2016	0.02%	1.29%	0.02%	0.01%	0.00%	0.47%	0.62%	0.12%	0.02%	0.01%	0.50%	3.26%	0.16%	0.03%	0.01%
2017	0.05%	1.55%	0.08%	0.01%	0.01%	0.71%	0.79%	0.19%	0.03%	0.01%	0.79%	4.50%	0.19%	0.03%	0.01%
2018	0.03%	1.34%	0.05%	0.00%	0.00%	0.68%	0.88%	0.16%	0.02%	0.00%	0.81%	5.02%	0.23%	0.02%	0.00%

SEAK Fisheries															
	Oct-Apr					May-Jun					Jul-Sep				
	Region														
Year	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali
1992	0.51%	0.44%	0.47%	0.18%	0.16%	1.15%	0.68%	0.25%	0.05%	0.01%	8.95%	1.42%	2.95%	1.18%	0.03%
1993	0.46%	0.35%	0.37%	0.09%	0.07%	1.00%	0.55%	0.22%	0.03%	0.00%	7.12%	1.43%	3.84%	0.84%	0.02%
1994	0.49%	0.37%	0.40%	0.09%	0.05%	0.99%	0.64%	0.25%	0.04%	0.00%	7.97%	1.77%	5.36%	1.24%	0.02%
1995	0.13%	0.11%	0.10%	0.02%	0.01%	0.73%	0.67%	0.18%	0.01%	0.00%	4.12%	1.33%	2.82%	0.41%	0.01%
1996	0.11%	0.12%	0.09%	0.01%	0.01%	0.68%	0.74%	0.24%	0.02%	0.00%	2.98%	1.34%	3.18%	0.54%	0.01%
1997	0.28%	0.20%	0.18%	0.04%	0.01%	0.91%	0.72%	0.29%	0.04%	0.00%	5.41%	1.73%	5.67%	0.93%	0.01%
1998	0.35%	0.32%	0.29%	0.05%	0.03%	0.99%	0.76%	0.26%	0.03%	0.00%	7.01%	1.73%	4.91%	0.81%	0.01%
1999	0.24%	0.15%	0.21%	0.06%	0.03%	0.78%	0.53%	0.25%	0.05%	0.00%	4.47%	1.20%	4.75%	0.98%	0.02%
2000	0.59%	0.53%	0.40%	0.07%	0.04%	1.15%	1.10%	0.30%	0.03%	0.00%	4.14%	1.80%	3.78%	0.44%	0.01%
2001	0.24%	0.21%	0.16%	0.04%	0.03%	0.57%	0.67%	0.16%	0.03%	0.00%	2.14%	1.14%	2.17%	0.46%	0.01%
2002	0.26%	0.24%	0.16%	0.03%	0.02%	0.53%	0.62%	0.16%	0.03%	0.00%	3.51%	1.69%	3.97%	0.75%	0.02%
2003	0.37%	0.24%	0.28%	0.06%	0.05%	0.63%	0.57%	0.20%	0.04%	0.00%	4.01%	1.54%	4.62%	0.71%	0.02%
2004	0.30%	0.25%	0.24%	0.08%	0.05%	0.74%	0.69%	0.22%	0.05%	0.01%	5.02%	1.74%	4.72%	1.00%	0.02%
2005	0.46%	0.41%	0.35%	0.08%	0.05%	1.05%	1.02%	0.36%	0.07%	0.01%	5.55%	2.07%	6.79%	1.19%	0.02%
2006	0.49%	0.41%	0.37%	0.11%	0.06%	1.20%	1.07%	0.42%	0.11%	0.01%	6.17%	1.96%	6.67%	1.84%	0.04%
2007	0.52%	0.42%	0.44%	0.10%	0.10%	1.41%	1.05%	0.41%	0.07%	0.01%	9.19%	2.06%	7.13%	1.29%	0.04%
2008	0.17%	0.16%	0.11%	0.04%	0.05%	0.72%	0.68%	0.23%	0.08%	0.02%	3.32%	1.38%	3.57%	1.01%	0.07%
2009	0.32%	0.36%	0.20%	0.04%	0.06%	1.00%	1.10%	0.33%	0.07%	0.02%	4.86%	2.05%	5.43%	0.82%	0.07%
2010	0.41%	0.44%	0.29%	0.09%	0.16%	0.70%	0.95%	0.24%	0.05%	0.02%	2.52%	1.44%	3.20%	0.69%	0.06%
2011	0.51%	0.50%	0.36%	0.10%	0.11%	0.91%	1.01%	0.30%	0.07%	0.01%	4.58%	1.74%	4.64%	0.96%	0.05%
2012	0.37%	0.34%	0.25%	0.05%	0.04%	0.72%	0.71%	0.21%	0.03%	0.00%	3.53%	1.37%	3.63%	0.51%	0.02%
2013	0.17%	0.17%	0.13%	0.03%	0.02%	0.43%	0.54%	0.20%	0.05%	0.01%	1.75%	0.94%	3.34%	0.45%	0.01%
2014	0.51%	0.39%	0.30%	0.07%	0.04%	0.84%	0.91%	0.36%	0.10%	0.01%	3.65%	1.97%	7.69%	1.21%	0.05%
2015	0.41%	0.58%	0.28%	0.08%	0.11%	0.82%	1.32%	0.34%	0.09%	0.02%	2.81%	1.82%	4.88%	0.88%	0.07%
2016	0.55%	0.43%	0.42%	0.17%	0.18%	1.14%	0.99%	0.44%	0.17%	0.03%	5.35%	1.76%	7.74%	2.15%	0.10%
2017	0.37%	0.28%	0.30%	0.10%	0.13%	0.75%	0.56%	0.26%	0.08%	0.02%	3.36%	0.83%	3.73%	0.88%	0.05%

	SEAK Fisheries														
	Oct-Apr					May-Jun					Jul-Sep				
	Region														
Year	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali
2018	0.14%	0.14%	0.11%	0.02%	0.02%	0.34%	0.29%	0.11%	0.02%	0.00%	2.74%	0.87%	2.87%	0.46%	0.02%

Table B.3. Projected percent reductions of baseline PST fisheries (i.e., those not part of the proposed action) expected to occur under the 2019 PST Agreement and other likely domestic constraints. (SEAK fisheries under the previous 2009 PST Agreement in this model; Scenario 3).

	BC Fisheries Expected reductions under 2019 Agreement (SEAK 2009)														
	Oct-Apr					May-Jun					Jul-Sep				
	Region														
Year	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali
1999	0.50%	1.57%	0.51%	0.21%	0.02%	1.90%	3.04%	0.78%	0.13%	0.01%	11.72%	6.78%	5.53%	1.10%	0.02%
2000	1.52%	2.57%	0.97%	0.22%	0.04%	3.39%	4.96%	0.99%	0.12%	0.01%	8.13%	7.73%	4.16%	0.45%	0.02%
2001	0.60%	1.42%	0.43%	0.17%	0.03%	1.68%	3.30%	0.59%	0.12%	0.02%	4.55%	6.40%	2.46%	0.46%	0.02%
2002	0.54%	1.45%	0.43%	0.12%	0.02%	3.01%	5.18%	1.27%	0.22%	0.02%	6.47%	7.84%	4.13%	0.64%	0.02%
2003	0.64%	1.36%	0.58%	0.16%	0.02%	2.85%	5.05%	1.34%	0.22%	0.02%	7.78%	8.47%	5.40%	0.78%	0.03%
2004	0.77%	1.47%	0.74%	0.31%	0.05%	2.08%	3.99%	0.98%	0.21%	0.02%	9.13%	8.03%	5.38%	1.18%	0.03%
2005	1.27%	1.96%	1.26%	0.36%	0.04%	2.89%	4.63%	1.54%	0.31%	0.03%	9.72%	8.61%	7.77%	1.38%	0.03%
2006	0.84%	1.66%	0.79%	0.36%	0.07%	2.76%	4.26%	1.21%	0.32%	0.04%	11.08%	8.48%	6.67%	1.92%	0.05%
2007	0.80%	2.03%	0.67%	0.20%	0.05%	3.95%	5.44%	1.48%	0.25%	0.04%	14.61%	7.94%	6.38%	1.15%	0.06%
2008	0.21%	0.89%	0.19%	0.12%	0.04%	1.74%	2.94%	0.75%	0.26%	0.06%	8.43%	7.10%	5.33%	1.59%	0.13%
2009	0.44%	1.38%	0.38%	0.13%	0.04%	2.75%	4.93%	1.19%	0.26%	0.07%	9.99%	9.28%	6.18%	1.05%	0.10%
2010	0.21%	0.85%	0.18%	0.11%	0.04%	2.16%	4.04%	0.93%	0.22%	0.06%	6.30%	7.53%	4.38%	0.99%	0.08%
2011	0.33%	1.31%	0.29%	0.13%	0.03%	3.83%	6.77%	1.73%	0.40%	0.08%	12.35%	10.44%	7.34%	1.52%	0.09%
2012	0.28%	1.04%	0.23%	0.06%	0.01%	1.79%	3.36%	0.73%	0.10%	0.02%	7.75%	6.89%	5.20%	0.76%	0.03%
2013	0.14%	0.94%	0.14%	0.04%	0.01%	1.23%	3.12%	0.69%	0.14%	0.02%	4.26%	6.14%	4.43%	0.62%	0.02%

2014	0.41%	0.98%	0.39%	0.16%	0.02%	2.17%	4.05%	1.25%	0.30%	0.04%	7.28%	9.58%	9.07%	1.73%	0.07%
2015	0.14%	1.17%	0.13%	0.06%	0.02%	1.55%	4.76%	0.80%	0.21%	0.06%	5.68%	9.48%	5.38%	1.14%	0.08%
2016	0.26%	1.32%	0.25%	0.15%	0.04%	2.49%	4.26%	1.19%	0.41%	0.08%	9.24%	7.63%	7.89%	2.48%	0.13%
2017	0.16%	1.42%	0.14%	0.07%	0.02%	2.07%	3.57%	0.86%	0.23%	0.06%	9.68%	6.48%	5.42%	1.40%	0.11%
2018	0.06%	1.28%	0.04%	0.01%	0.00%	1.65%	3.30%	0.60%	0.09%	0.02%	10.63%	7.72%	4.79%	0.77%	0.05%

PFMC Fisheries Expected reductions under 2019 Agreement (SEAK 2009)															
	Oct-Apr					**May-Jun**					**Jul-Sep**				
Year	**Region** **SWWCVI**	**Salish**	**NOF**	**OR**	**Cali**	**SWWCVI**	**Salish**	**NOF**	**OR**	**Cali**	**SWWCVI**	**Salish**	**NOF**	**OR**	**Cali**
1999	0.29%	0.03%	0.70%	1.80%	3.11%	1.90%	1.11%	2.92%	8.60%	21.87%	3.44%	1.09%	5.56%	18.15%	37.64%
2000	0.60%	0.06%	0.91%	1.52%	3.22%	2.31%	0.86%	4.26%	10.70%	30.62%	3.51%	0.63%	5.55%	18.10%	39.33%
2001	0.40%	0.05%	0.73%	2.47%	4.82%	1.96%	1.17%	1.84%	5.03%	15.72%	3.36%	1.07%	4.63%	12.36%	28.13%
2002	0.47%	0.07%	0.88%	2.30%	4.62%	2.24%	1.43%	2.57%	6.34%	19.30%	3.66%	1.22%	5.95%	14.28%	32.87%
2003	0.70%	0.09%	1.25%	3.17%	6.28%	2.14%	1.27%	2.82%	7.41%	21.76%	3.61%	1.23%	6.63%	19.16%	35.59%
2004	1.13%	0.17%	2.32%	7.80%	13.38%	2.51%	1.40%	4.03%	14.33%	38.57%	4.30%	1.35%	8.66%	35.07%	61.56%
2005	0.62%	0.09%	1.42%	4.73%	6.80%	2.05%	1.27%	3.10%	9.31%	23.07%	3.57%	1.18%	7.49%	21.72%	42.87%
2006	0.94%	0.10%	2.32%	10.07%	16.74%	1.91%	1.28%	2.44%	10.47%	26.29%	3.35%	1.09%	5.97%	25.73%	49.18%
2007	0.41%	0.04%	0.88%	2.32%	6.47%	1.73%	1.19%	1.78%	5.08%	18.46%	3.12%	0.91%	4.64%	16.76%	36.36%
2008	0.14%	0.02%	0.29%	3.28%	5.61%	1.64%	1.18%	1.13%	2.85%	6.45%	2.58%	1.04%	4.21%	8.85%	7.29%
2009	0.10%	0.01%	0.05%	0.06%	0.01%	1.69%	1.38%	0.93%	0.25%	0.07%	2.77%	1.08%	3.67%	0.94%	0.15%
2010	0.13%	0.01%	0.09%	0.20%	0.88%	1.72%	1.46%	1.02%	0.70%	2.58%	2.81%	1.49%	3.94%	2.69%	5.49%
2011	0.11%	0.01%	0.13%	0.39%	1.27%	1.80%	1.56%	1.22%	1.40%	6.50%	2.93%	1.31%	4.43%	6.08%	14.82%
2012	0.26%	0.04%	0.49%	1.36%	2.40%	1.84%	1.39%	1.87%	3.71%	12.33%	3.29%	1.16%	5.39%	10.95%	23.58%
2013	0.20%	0.05%	0.61%	2.15%	3.75%	1.46%	1.39%	2.29%	6.83%	18.89%	2.67%	1.25%	7.29%	17.56%	33.89%
2014	0.32%	0.05%	0.66%	2.42%	5.44%	1.86%	1.31%	2.21%	5.65%	19.38%	3.18%	1.31%	6.86%	15.29%	35.97%
2015	0.37%	0.05%	0.43%	1.22%	5.99%	1.78%	1.66%	1.69%	3.74%	20.19%	2.90%	1.63%	6.17%	8.15%	28.78%
2016	0.31%	0.03%	0.47%	2.37%	6.37%	1.63%	1.28%	1.43%	4.23%	17.40%	2.81%	1.20%	5.13%	10.52%	31.74%
2017	0.26%	0.02%	0.37%	1.14%	4.98%	1.82%	1.35%	1.32%	1.93%	10.69%	3.00%	1.14%	4.63%	5.61%	25.63%

2018	0.18%	0.02%	0.48%	2.29%	3.73%	1.70%	1.18%	1.41%	2.88%	9.50%	2.89%	1.05%	4.40%	8.89%	21.19%

Puget Sound Fisheries
Expected reductions under 2019 Agreement (SEAK 2009)

	Oct-Apr					**May-Jun**					**Jul-Sep**				
	Region														
Year	**SWWCVI**	**Salish**	**NOF**	**OR**	**Cali**	**SWWCVI**	**Salish**	**NOF**	**OR**	**Cali**	**SWWCVI**	**Salish**	**NOF**	**OR**	**Cali**
1999	0.06%	0.35%	0.08%	0.00%	0.00%	0.23%	0.34%	0.06%	0.01%	0.00%	0.33%	4.36%	0.09%	0.02%	0.00%
2000	0.07%	0.39%	0.05%	0.00%	0.00%	0.25%	0.33%	0.04%	0.00%	0.00%	0.33%	5.34%	0.05%	0.01%	0.00%
2001	0.05%	0.52%	0.09%	0.00%	0.00%	0.28%	0.41%	0.06%	0.01%	0.00%	0.35%	5.56%	0.10%	0.02%	0.00%
2002	0.05%	0.74%	0.10%	0.00%	0.00%	0.30%	0.51%	0.07%	0.01%	0.00%	0.42%	5.31%	0.11%	0.01%	0.00%
2003	0.05%	0.63%	0.07%	0.00%	0.00%	0.28%	0.44%	0.07%	0.01%	0.00%	0.40%	3.48%	0.11%	0.02%	0.00%
2004	0.05%	0.79%	0.11%	0.00%	0.00%	0.33%	0.55%	0.08%	0.01%	0.00%	0.42%	3.29%	0.13%	0.02%	0.00%
2005	0.05%	0.77%	0.09%	0.00%	0.00%	0.33%	0.56%	0.09%	0.01%	0.00%	0.48%	3.93%	0.13%	0.02%	0.00%
2006	0.06%	0.88%	0.07%	0.01%	0.00%	0.48%	0.66%	0.12%	0.02%	0.00%	0.65%	5.18%	0.13%	0.02%	0.00%
2007	0.09%	1.47%	0.08%	0.00%	0.00%	0.82%	1.07%	0.19%	0.02%	0.00%	1.06%	6.27%	0.20%	0.02%	0.00%
2008	0.07%	0.87%	0.14%	0.02%	0.00%	0.46%	0.66%	0.13%	0.03%	0.01%	0.58%	4.60%	0.25%	0.06%	0.01%
2009	0.06%	1.16%	0.08%	0.01%	0.00%	0.51%	0.78%	0.12%	0.02%	0.00%	0.64%	4.85%	0.21%	0.03%	0.01%
2010	0.06%	0.77%	0.12%	0.01%	0.00%	0.34%	0.60%	0.09%	0.02%	0.00%	0.45%	4.41%	0.22%	0.04%	0.01%
2011	0.07%	1.30%	0.10%	0.01%	0.00%	0.52%	0.80%	0.13%	0.02%	0.00%	0.72%	5.69%	0.24%	0.04%	0.00%
2012	0.05%	1.07%	0.08%	0.00%	0.00%	0.41%	0.79%	0.09%	0.01%	0.00%	0.54%	6.95%	0.21%	0.02%	0.00%
2013	0.04%	1.17%	0.08%	0.00%	0.00%	0.33%	0.75%	0.10%	0.01%	0.00%	0.42%	5.38%	0.29%	0.03%	0.00%
2014	0.05%	0.72%	0.12%	0.01%	0.00%	0.26%	0.45%	0.08%	0.01%	0.00%	0.35%	3.25%	0.22%	0.03%	0.00%
2015	0.02%	0.31%	0.10%	0.00%	0.00%	0.11%	0.30%	0.04%	0.01%	0.00%	0.21%	3.64%	0.20%	0.04%	0.00%
2016	0.04%	0.60%	0.06%	0.00%	0.00%	0.25%	0.53%	0.07%	0.01%	0.00%	0.40%	4.16%	0.15%	0.04%	0.00%
2017	0.07%	1.31%	0.11%	0.01%	0.00%	0.62%	0.95%	0.17%	0.03%	0.01%	0.83%	5.61%	0.24%	0.04%	0.01%
2018	0.06%	0.48%	0.08%	0.00%	0.00%	0.28%	0.51%	0.07%	0.01%	0.00%	0.45%	3.99%	0.17%	0.02%	0.00%

APPENDIX C. HATCHERY PROGRAM ESA SECTION 7 CONSULTATIONS

Table C.1. Hatchery programs that have been addressed in previously completed ESA Section 7 consultations.

Biological Opinion	Programs Authorized in Opinion	Signature Date	Citation
USFWS Artificial Propagation Programs in the Lower Columbia and Middle Columbia River	Little White Salmon/Willard National Fish Hatchery Complex Coho	November 27, 2007	NMFS (2007c), NMFS (2016d)
	Little White Salmon/Willard National Fish Hatchery Complex spring Chinook		
	Little White Salmon/Willard National Fish Hatchery Complex URB fall Chinook		
	Carson National Fish Hatchery spring Chinook		
	Spring Creek National Fish Hatchery fall Chinook (tule)		
	Eagle Creek National Fish Hatchery coho		
	Eagle Creek National Fish Hatchery winter steelhead		
	Warm Springs National Fish Hatchery Warm Springs River spring Chinook		
Letter: Request for Concurrence with the Yakima Nation Fisheries’	Lake Cle Elum/ Yakima Basin Lakes	July 1, 2009	(Turner 2009)

Biological Opinion	Programs Authorized in Opinion	Signature Date	Citation
assessment of potential impacts			
Umatilla River Spring Chinook Salmon, Fall Chinook Salmon, and Coho Salmon Hatchery Programs	Umatilla spring Chinook	April 19, 2011	NMFS (2011b), NMFS (2016l)
	Umatilla fall Chinook		
	Umatilla coho		
Snake River Fall Chinook Salmon Hatchery Programs, ESA Section 10(a)(1)(A) permits, numbers 16607 and 16615	Lyons Ferry Hatchery Snake River fall Chinook	October 9, 2012	NMFS (2012b)
	Fall Chinook salmon Acclimation program		
	Idaho Power Company fall Chinook		
	Nez Perce Tribal Hatchery Snake River fall Chinook		
Entiat National Fish Hatchery Summer Chinook Salmon Hatchery Program	Entiat summer Chinook	April 18, 2013	NMFS (2013b)
Snake River Sockeye Salmon Hatchery Program	Snake River sockeye	September 28, 2013	NMFS (2013a)
Yakima River Spring Chinook Salmon,	Upper Yakima River spring Chinook/Cle Elum Supplementation and Research Facility (CESRF)	November 25, 2013	NMFS (2013e)

Biological Opinion	Programs Authorized in Opinion	Signature Date	Citation
Summer/Fall Chinook Salmon, and Coho Salmon Hatchery Programs	Yakima River summer and fall run Chinook production program		
	Yakima River coho Reintroduction program		
Sandy River Spring Chinook Salmon, Coho Salmon, Winter Steelhead, and Summer Steelhead Programs	Sandy River spring Chinook	August 7, 2014	NMFS (2014e)
	Sandy River coho		
	Sandy River winter steelhead		
	Sandy River summer steelhead		
Issuance of Section 10(a)(1)(A) Permit 18928 for the Chief Joseph Hatchery Okanogan Spring Chinook Salmon Program	Chief Joseph Hatchery Okanogan spring Chinook	October 27, 2014	NMFS (2014g)
Reinitiation of the Issuance of Three Section 10(a)(1)(A) Permits for the Upper Columbia River Chiwawa River, Nason Creek, and White River Spring Chinook Salmon Hatchery Programs	Chiwawa spring Chinook	May 29, 2015 (original signed July 3, 2013)	NMFS (2015b)
	Nason Creek spring Chinook		
Six Lower Snake River	Catherine Creek spring/summer Chinook	June 24, 2016	NMFS (2016a)

Biological Opinion	Programs Authorized in Opinion	Signature Date	Citation
Spring/Summer Chinook Salmon Hatchery Programs	Upper Grande Ronde spring/summer Chinook		
	Imnaha River spring/summer Chinook		
	Lookingglass Creek spring Chinook		
	Lostine spring/summer Chinook		
	Tucannon River Endemic spring Chinook		
Issuance of a Section 10(a)(1)(A) Permit 18583 for the Upper Columbia Wenatchee River Summer Steelhead Hatchery Program	Wenatchee summer steelhead	July 20, 2016	NMFS (2016v)
Issuance of Four Section 10(a)(1)(A) Permits for Spring Chinook Salmon Hatchery Programs in the Methow Subbasin	Methow Hatchery spring Chinook	October 13, 2016	NMFS (2016p)
	Winthrop National Fish Hatchery spring Chinook		
Mitchell Act Funded Hatchery Programs	Bonneville coho	January 15, 2017	NMFS (2017m)
	Bonneville fall Chinook (tule)		
	Big Creek Chinook (tule)		

Biological Opinion	Programs Authorized in Opinion	Signature Date	Citation
	Big Creek coho		
	Big Creek chum		
	Big Creek winter steelhead		
	Gnat Creek winter steelhead		
	Klaskanine winter steelhead		
	Klaskanine coho		
	Klaskanine fall Chinook (tule)		
	Clackamas summer steelhead		
	Clackamas winter steelhead		
	Clackamas spring Chinook		
	Grays River coho		
	N. F. Toutle fall Chinook (tule)		
	N. F. Toutle coho		
	Kalama fall Chinook (tule)		
	Kalama coho (type N)		
	Kalama summer steelhead		

Biological Opinion	Programs Authorized in Opinion	Signature Date	Citation
	Kalama winter steelhead		
	Washougal fall Chinook (tule)		
	Washougal coho		
	Walla Walla spring Chinook		
	Ringold Springs steelhead		
	Ringold Springs coho[1]		
	Clearwater River coho restoration project		
	Lostine River coho restoration project;		
	Deep River fall Chinook		
	Klickitat coho		
	Klickitat URB fall Chinook		
	Klickitat spring Chinook		
	Klickitat (Skamania) summer steelhead		
	Beaver Creek summer steelhead		
	Beaver Creek winter steelhead		

Biological Opinion	Programs Authorized in Opinion	Signature Date	Citation
	Beaver Creek (Elochoman) coho[1]		
	South Toutle summer steelhead		
	Coweeman winter steelhead		
	Cathlamet Channel Net-pen spring Chinook		
	Klineline winter steelhead (Salmon Cr.)		
	Washougal summer steelhead (Skamania Hatchery)		
	Washougal winter steelhead (Skamania Hatchery)		
	Rock Creek winter steelhead		
	Kalama spring Chinook		
	Umatilla River coho		
	Sandy River spring Chinook		
	Sandy River winter steelhead		
	Sandy River summer steelhead		
	Sandy River coho		

Biological Opinion	Programs Authorized in Opinion	Signature Date	Citation
	Carson National Fish Hatchery spring Chinook		
	Little White Salmon National Fish Hatchery spring Chinook		
	Willard National Fish Hatchery fall Chinook		
	Eagle Creek National Fish Hatchery winter steelhead		
	Eagle Creek National Fish Hatchery coho		
	Chief Joseph summer/fall Chinook		
Issuance of a Tribal 4(d) Rule Determination for a Tribal Resource Management Plan (TRMP) submitted by the Confederated Tribes of the Colville Reservation (CTCR), and Funding and Carrying out Activities Pursuant to that TRMP	Chief Joseph spring Chinook	February 24, 2017	NMFS (2017a)
	Okanogan River steelhead		
	Mid-Columbia Coho Restoration Program		
Mid-Columbia Coho Salmon Restoration	Wallowa summer steelhead	February 28, 2017	NMFS (2017b)

Biological Opinion	**Programs Authorized in Opinion**	**Signature Date**	**Citation**
Program: Operation and Construction			
Four Lower Snake River Steelhead Hatchery Programs	Little Sheep Creek/Imnanha summer steelhead	July 11, 2017	NMFS (2017c)
	Lyons Ferry summer steelhead		
	Tucannon River summer steelhead		
	Leavenworth National Fish Hatchery Spring Chinook		
Leavenworth National Fish Hatchery Spring Chinook Salmon Program (Reinitiation 2016)	Little White Salmon National Fish Hatchery URB fall Chinook (Corps)	September 29, 2017	NMFS (2017d)
Little White Salmon National Fish Hatchery Upriver Bright Fall Chinook Salmon Program	Wells Complex summer steelhead	October 5, 2017	NMFS (2017l)
Two Steelhead Hatchery Programs in the Methow River	Winthrop National Fish Hatchery summer steelhead	October 10, 2017	NMFS (2017f)
	Rapid River spring Chinook		
Five Snake River Basin Spring/Summer	Hells Canyon spring Chinook	November 27, 2017	NMFS (2017g)
	South Fork Salmon River (SFSR) summer Chinook		

Biological Opinion	Programs Authorized in Opinion	Signature Date	Citation
Chinook Salmon Hatchery Programs	Johnson Creek Artificial Propagation and Enhancement Project summer Chinook		
	South Fork Chinook Eggbox Project summer Chinook		
	Kooskia spring Chinook		
Five Clearwater River Basin Spring/Summer Chinook Salmon and Coho Salmon Hatchery Programs	Clearwater Fish Hatchery spring/summer Chinook	December 12, 2017	NMFS (2017n)
	Nez Perce Tribal Hatchery spring/summer Chinook		
	Dworshak spring Chinook		
	Clearwater River coho (at Dworshak and Kooskia)		
	Steelhead Streamside Incubator (SSI) Project		
Nine Snake River Steelhead Hatchery Programs and one Kelt Reconditioning Program in Idaho	Dworshak National Fish Hatchery B-Run Steelhead	December 12, 2017	NMFS (2017h)
	East Fork Salmon Natural A-run Steelhead		
	Hells Canyon Snake River A-run Summer Steelhead		
	Little Salmon River A-run Summer Steelhead		

Biological Opinion	Programs Authorized in Opinion	Signature Date	Citation
	Pahsimeroi A-run Summer Steelhead		
	South Fork Clearwater (Clearwater Hatchery) B-Run Steelhead		
	Upper Salmon River A-Run Steelhead		
	Salmon River B-Run		
	Snake River Kelt Reconditioning		
	Chelan Falls summer/fall Chinook		
Four Summer/Fall Chinook Salmon and Two Fall Chinook Salmon Hatchery Programs in the Upper Columbia River Basin	Wenatchee summer/fall Chinook	December 26, 2017	NMFS (2017i)
	Methow summer/fall Chinook		
	Wells summer/fall Chinook		
	Priest Rapids fall Chinook		
	Ringold Springs fall Chinook		
	Yankee Fork spring Chinook		
Four Salmon River Basin Spring/Summer Chinook Salmon Hatchery Programs in the Upper	Panther Creek summer Chinook	December 26, 2017	NMFS (2017j)
	Panther Creek summer Chinook egg box		
	Upper Salmon River spring Chinook		

Biological Opinion	Programs Authorized in Opinion	Signature Date	Citation
Salmon River Basin	Pahsimeroi summer Chinook		
	Hood River spring Chinook		
Hood River Spring Chinook Salmon and Winter Steelhead Hatchery Programs	Hood River winter steelhead	February 13, 2018	NMFS (2018c)
	Touchet endemic summer steelhead		
Five Middle Columbia River Summer Steelhead and Spring Chinook Hatchery Programs	Umatilla summer steelhead	February 13, 2018	NMFS (2017k)
	Round Butte spring Chinook		
	Touchet River spring Chinook		
	Walla Walla spring Chinook		
	Elwha Channel Hatchery summer/fall Chinook		
Five Elwha River Hatchery Programs	Lower Elwha Fish Hatchery steelhead	December 2014	NMFS (2014i)
	Lower Elwha Fish Hatchery coho		
	Lower Elwha Fish Hatchery chum		
	Lower Elwha Fish Hatchery odd and even year pink salmon		
	Dungeness River Hatchery spring Chinook		

Biological Opinion	Programs Authorized in Opinion	Signature Date	Citation
Three Dungeness River Hatchery Programs	Dungeness River Hatchery coho	May 31, 2016 September 24, 2019 June 9, 2022	NMFS (2016s), NMFS (2019k), NMFS (2022l)
	Dungeness River Hatchery pink		
	Lyons Ferry Hatchery		
Four Snake River fall Chinook Hatchery Programs	Fall Chinook Acclimation Project	September 13, 2018	NMFS (2018a)
	Nez Perce Tribal Hatchery		
	Idaho Power Company		
	Hoodsport Fall Chinook		
Ten Hood Canal Hatchery Programs	Hoodsport fall chum	March 8, 2022	NMFS (2022c)
	Hoodsport pink		
	Enetai Hatchery fall chum		
	Quilcene National Fish Hatchery coho		
	Quilcene Bay net pens coho		
	Port Gamble Hatchery fall chum		
	Hamma Hamma Chinook		
	Hood Canal steelhead supplementation		
	Port Gamble Bay net pens coho		

Biological Opinion	Programs Authorized in Opinion	Signature Date	Citation
	Dungeness early winter steelhead		
Three Early Winter Steelhead Programs in Dungeness, Nooksack, and Stillaguamish River Basins	Kendall Creek winter steelhead	April 13, 2016	NMFS (2016t)
	Whitehorse Ponds (Stillaguamish) early winter steelhead		
	Wallace/Reiter early winter steelhead		
Two Hatchery Programs for Early Winter Steelhead in the Snohomish River basin	Tokul Creek winter steelhead	April 15, 2016	NMFS (2016u)
	Soos Creek Hatchery fall Chinook		
Ten Hatchery Programs in the Green/Duwamish Basin	Keta Creek coho (w/ Elliot Bay net pens)	April 15, 2019	NMFS (2019f)
	Soos Creek Hatchery coho		
	Keta Creek Hatchery coho		
	Soos Creek Hatchery coho		
	Keta Creek Hatchery chum		
	Marine Technology Center coho		
	Fish Restoration Facility (FRF) coho		
	FRF fall Chinook		
	FRF steelhead		

Biological Opinion	Programs Authorized in Opinion	Signature Date	Citation
	Green River native late winter steelhead		
	Soos Creek Hatchery summer steelhead		
	Stillaguamish summer Chinook		
Four Hatchery Programs in the Stillaguamish River Basin	Stillaguamish fall Chinook	June 20, 2019	NMFS (2019d)
	Stillaguamish coho		
	Stillaguamish fall chum		
	Bernie Kai-Kai Gobin Salmon Hatchery "Tulalip Hatchery" subyearling summer Chinook		
Six Hatchery Programs in the Snohomish River Basin	Wallace River Hatchery summer Chinook	September 27, 2017 May 3, 2021 December 13, 2022	NMFS (2017p), NMFS (2021e), NMFS (2022d)
	Tulalip Bay Hatchery coho		
	Wallace River Hatchery coho		
	Everett Bay net pen coho		
	Tulalip Bay Hatchery chum		
	Lake Ozette sockeye		
Hatchery Programs for Lake Ozette Sockeye	South Fork Skykomish River Summer Steelhead	June 9, 2015	NMFS (2015d)

Biological Opinion	Programs Authorized in Opinion	Signature Date	Citation
A Hatchery Program for Summer Steelhead in the Skykomish River and the Sunset Falls Trap and Haul Fishway Program in the South Fork Skykomish River (Corrected)	Upper Skagit Chum Salmon Chum Salmon Remote Site Incubator (RSI) Skagit River Fall Chum Salmon	October 27, 2021	NMFS (2021f)
Three Hatchery and Genetic Management Plans for Skagit River Basin Chum Salmon	North Santiam spring Chinook	October 26, 2022	NMFS (2022e)
Six Hatchery Programs for Spring Chinook, Summer Steelhead, and Rainbow Trout in the Upper Willamette River Basin	South Santiam spring Chinook	May17, 2019	NMFS (2019a)
	McKenzie spring Chinook		
	Middle Fork Willamette spring Chinook		
	Upper Willamette summer steelhead		
	Upper Willamette rainbow trout		
	Rogue River spring Chinook		
Hatchery Programs for Hatchery Programs on the Oregon Coast	Rogue River summer steelhead	October 19, 2017	NMFS (2017r)
	Rogue/Applegate River winter steelhead		
	Indian Creek STEP fall Chinook		

Biological Opinion	Programs Authorized in Opinion	Signature Date	Citation
	Elk River fall Chinook		
	Chetco River fall Chinook		
	Chetco River winter steelhead		
	Coquille River winter steelhead		
	Coquille River fall Chinook		
	Coos River fall Chinook		
	Coos River winter steelhead		
	Tenmile Lakes winter steelhead		
	Tenmile Lakes rainbow trout		
	North Umpqua River spring Chinook		
	North Umpqua River summer steelhead		
	Calapooya Creek fall Chinook		
	Lower Umpqua River fall Chinook		
	Umpqua River coho		
	South Umpqua River winter steelhead		

Biological Opinion	Programs Authorized in Opinion	Signature Date	Citation
	Munsel Creek coho (STEP)		
	Siuslaw River winter steelhead		
	Alsea Hatchery/Lakes rainbow trout		
	Alsea River winter steelhead		
	Yaquina Bay fall Chinook		
	Siletz River winter steelhead		
	Siletz River summer steelhead		
	Salmon River fall Chinook		
	Nestucca River summer Steelhead		
	Nestucca River spring Chinook		
	Little Nestucca River spring Chinook		
	Nestucca River STEP fall Chinook		
	Nestucca River winter steelhead		
	Wilson River winter steelhead		
	Trask River coho		
	Trask River fall Chinook		
	Trask River spring Chinook		

Biological Opinion	Programs Authorized in Opinion	Signature Date	Citation
	Wilson River winter steelhead		
	Trask River Spring Chinook (Whiskey Creek STEP)		
	North Fork Nehalem coho		
	Nehalem River winter steelhead		
	Rogue River coho		
Rogue River Coho Hatchery Program	Rowdy Creek steelhead	January 1999	NMFS (1999)
Two Rowdy Creek Hatchery Programs	Rowdy Creek Chinook	June 11, 2019	NMFS (2019i)
	Trinity River steelhead		
Two Trinity River Hatchery Programs	Trinity River Chinook	August 20, 2018	NMFS (2018h)
	Trinity River coho salmon		
One Trinity River Hatchery Program	Mad River steelhead	June 11, 2020	NMFS (2020h)
One Mad River Hatchery Program	Russian River coho (captive brood)	December 22, 2016	NMFS (2016)
One Russian River Hatchery Program	Iron Gate coho	September 14, 2020	NMFS (2020i)
One Iron Gate Hatchery Program	Central Valley fall-run Chinook salmon	October 29, 2014	NMFS (2014)

Biological Opinion	Programs Authorized in Opinion	Signature Date	Citation
Three Hatchery Programs at Coleman National Fish Hatchery	Central Valley late-fall Chinook salmon	February 6, 2014	NMFS (2014)
	California Central Valley steelhead		
	Sacramento River Winter Chinook (Integrated-Recovery Supplementation)		
Two Hatchery Programs at Livingston Stone National Fish Hatchery	Sacramento River Winter Chinook (Captive Broodstock)	September 27, 2017	NMFS (2017s)
	Central Valley spring-run Chinook		
One San Joaquin Hatchery Program	University of Washington Aquatic Research Facility Hatchery - Fall Chinook Salmon	August 22, 2018	NMFS (2018)
Five Hatchery Programs for Salmon in the Lake Washington Drainage	University of Washington Aquatic Research Facility Hatchery - Facility Hatchery coho	December 23, 2021	NMFS (2021k)
	Issaquah Fall Chinook Hatchery Program	December 23, 2021	
	Issaquah coho Hatchery Program	December 23, 2021	
	Lake Washington Sockeye Program	December 23, 2021	
		December 23, 2021	

[1] Proposed future program.

APPENDIX D. METHODS FOR SRKW ANALYSES

Methods for assessing baseline prey availability

We calculated coastwide Chinook salmon (age 3+) abundance estimates for most stocks using the Chinook salmon FRAM post-season runs (Round 7.1.1 of base period calibration; 9.8.2021[74]), where these are validated with data on what occurred and calculated retrospectively (not future projections); these are termed "post-season validation runs." Abundance estimates for FRAM stocks[75] are calculated using stock-specific terminal run size estimates by age and mark status provided by regional technical staff. Stock-specific terminal run sizes are then expanded by maturation rates, fishing mortality, and natural mortality estimates to derive a pre-fishing starting abundance. The abundance estimates are specific to time periods in FRAM for an annual cycle: October to April, May to June, and July to September. Abundance estimates in these years have been validated using data on observed terminal run sizes and fishery catches and then retrospectively back-calculated and therefore have less uncertainty. For additional details related to calculations of FRAM starting abundances, please refer to PFMC (2020) or https://framverse.github.io/fram_doc/index.html.

Abundances are presented for five spatial regions: the California Coast (Horse Mountain to the U.S./Mexico border), the Oregon Coast (Cape Falcon to Horse Mountain), the North of Falcon Area (U.S./Canada border to Cape Falcon), Southwest Vancouver Island, and the Salish Sea. These regions were established by the PFMC Ad Hoc SRKW workgroup PFMC (2020) based on overlap with SRKW distributions and represented one or more of the finer-scale regions defined in Shelton et al. (2019) (these regions also overlap with SRKW critical habitat). These finer-scale regions were refined in a subsequent publication (Shelton et al. 2021), specifically by adding a Strait of Juan de Fuca region and combining the southern and central Oregon coastal regions into a single southern Oregon coastal region. Table D.1 provides a crosswalk between the five regions and the finer-scale regions used in Shelton et al. (2019) and Shelton et al. (2021).

Table D.1. The five aggregate spatial regions assessed in this Opinion, and the associated regions in Shelton et al. (2019) and Shelton et al. (2021).

Region	**Shelton et al. (2019); Figure 1**	**Shelton et al. (2021); Figure 1**
Southwest Vancouver Island	SWVI	SWVI
Salish Sea	SGEO, PUSO	SGEO, PUSO, SJDF
North of Falcon	WAC, COL	WAC, COL
Oregon Coast	NOR, COR, SOR, NCA	NOR, SOR, NCA
California Coast	MEN, SFB, MONT	MEN, SFB, MONT

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[74] FRAM base period calibration gets updated periodically to incorporate updated information.

[75] FRAM stocks are available here: https://framverse.github.io/fram_doc/calcs_appendices.html#Appendix_2_Chinook_FRAM_stocks

Regional abundance estimates are calculated by applying estimates of the proportion of each stock found in each area during each season from the Shelton et al. ocean distribution model to estimates of total (age 3+) cohort sizes, primarily derived by FRAM. Because the stocks in the two models (FRAM and the Shelton et al. (2019) model) were not identically defined, the Workgroup matched up individual FRAM stocks to units of analysis in the Shelton et al. (2019) model as described in (PFMC 2020) (and see (NMFS 2021c)).

Following adoption by the PFMC (see https://www.pcouncil.org/november-2022-decision-summary-document/) and NMFS review (NMFS 2021c), FRAM-Shelton modeling methods now utilize updated distributions from a more recent publication, Shelton et al. (2021), replacing information from Shelton et al. (2019), while maintaining the same aggregated spatial areas previously used in PFMC 2020. As such, given the models were updated in 2022, values reported here cannot be directly compared to previous fisheries consultations, such as those for PFMC ocean salmon fisheries and Amendment 21 (NMFS 2021c), nor the previous analysis for SEAK fisherie s (NMFS 2019e). This analysis uses recent model updates to both the Shelton et al. and FRAM models and the same methodology as in the Puget Sound Chinook salmon fisheries consultation for 2024 (NMFS 2024c).

Prey abundances are presented in two types of units: pre-fishing and post-fishing. Pre-fishing abundances for a given time step are the starting abundances of age 3+ Chinook salmon in that time step prior to any removals from either natural mortality or fishery mortality. Post-fishing abundances are estimated by subtracting the fishery-related mortality of age 3+ Chinook salmon that occurs during a given time step from the pre-fishing abundance in that time step. Note that Chinook salmon expected to die via natural mortality are still included in these abundances. The pre-fishing abundance in a subsequent time step results from removing expected natural mortality, fishery mortality, and fish expected to mature and return to spawn from the pre-fishing abundance of the previous time step.

Methods for assessing percent prey reductions

Regional abundance reductions resulting from a given set of fisheries were estimated by comparing the post-fishing abundances between two sets of model runs, one with and one without the fisheries of interest “turned on.” The original model runs for each scenario described previously represent the runs with the fisheries turned on. For each suite of fisheries (i.e., SEAK, Canada, PFMC, Puget Sound, all U.S.), an alternative set of model runs was developed based on the original scenario where the fisheries of interest were closed (i.e., fishery inputs set to zero). In these “fisheries off” runs, the fisheries that remained on were modeled using the fishery rates (as opposed to a fixed number of fish) from the original scenario in order to allow increased catch due to the additional abundance available resulting from the closure of the fisheries of interest. The model accounts for natural mortality as an age-specific rate that gets applied to the starting cohort sizes at the beginning of each model time step, so as the abundances increase due to the fishery closures, the projected natural mortality will also increase. For each suite of fisheries the post-fishing abundances from the “fisheries on” model runs were subtracted from the post-fishing abundances from the “fisheries off” model runs to estimate the effect of the fisheries in terms of an abundance reduction for each spatial area. These estimates of abundance reduction for each time step are then converted into percent reductions by dividing them by the pre-fishing abundance from the October – April time step.

Methods for assessing effect of prey hatchery program on SRKW prey

Regional abundance increases resulting from increased hatchery production were estimated by comparing the ending abundances between two sets of model runs, one with and one without the increased hatchery production “turned on.” The original model runs for each scenario described previously represent the runs without the increased hatchery production, as they were based on postseason runs through 2018, prior to the implementation of the prey increase program. To estimate abundances that might occur with the increased production “turned on,” we first determined an assumed level of production associated with the increased production. This was based on the federally funded increased production that actually occurred in 2023 and is detailed by facility and mapped to FRAM stocks in Table D.2. We next conducted a series of queries of the Regional Mark Information System (RMIS) in order to determine the number of adipose fin-clipped Chinook released by brood year for each relevant FRAM stock (Table D.3). These releases produced the subsequent age-specific cohorts contained in the postseason model runs, for example, the brood year 2010 adipose-clipped releases of a given stock would produce the age 3 adipose-clipped starting cohort in the 2013 postseason FRAM run and the age 4 adipose-clipped starting cohort in the 2014 FRAM run. We then calculated a set of stock and brood year-specific expansion factors by summing the actual production for a given stock/brood with the assumed increased production for that stock and dividing by the actual production. These expansions were then applied to the respective stock/age-specific starting cohort sizes in each model run to simulate the proportional increases in abundance that would be expected with the increased hatchery production relative to the production that actually occurred. All fishery inputs were converted to effort scalars to allow for increased catches that would be expected to occur with higher abundances under the same levels of effort.

For this exercise we focused only on the adipose-clipped components of each stock because we know the number of releases that produced the estimated starting cohorts, whereas the total production that produced the un-clipped cohorts is generally unknown due to uncertainty regarding the number of naturally-produced Chinook. As a result of this, we limited the analysis to a time frame that began with return year 2009, as mass-marking became less consistent for brood years that contributed to earlier years. Once these models with the simulated increased hatchery production were run, we calculated the pre- and post-fishing abundances by region using the FRAM/Shelton approach described above. For each region/year combination we calculated percent increases due to the increased hatchery production by subtracting the post-fishing abundances from the original runs without the mitigation from the runs with the simulated mitigation then dividing by the starting abundance of the original runs.

Table D.2. Number of Chinook salmon released in 2022 and 2023 as part of the hatchery mitigation program, by FRAM stock and funding source.

FRAM Stock	2022 Releases			2023 Releases		
	Federal	WA State	Total	Federal	WA State	Total
Cowlitz River Spring	NA	268,950	268,950	NA	290,165	290,165
CR Bonneville Pool Hatchery	66,294	NA	66,294	NA	NA	NA
CR Oregon Hatchery Tule	250,000	NA	250,000	234,871	NA	234,871
CR Upriver Bright	127,931	574,715	702,646	NA	154,835	154,835
CR Upriver Summer	564,734	520,239	1,084,973	623,952	514,075	1,138,027
Mid PS Fall Fing	2,784,026	1,011,685	3,795,711	3,137,191	1,061,249	4,198,440
NA	380,578	775,387	1,155,965	1,065,673	712,010	1,777,683
Nooksack Spr Hatchery	NA	1,134,890	1,134,890	NA	1,798,920	1,798,920
Nooksack/Samish Fall	NA	1,449,640	1,449,640	NA	1,563,646	1,563,464
Skagit Spring Year	NA	128,022	128,022	NA	703,483	703,483
Snohomish Fall Fing	NA	1,049,421	1,049,421	NA	1,151,558	1,151,558
South PS Fall Fing	NA	291,083	291,083	NA	419,058	419,058
Tulalip Fall Fing	958,415	NA	958,415	1,808,692	NA	1,808,692
WA North Coast Fall	NA	446,651	446,651	NA	500,000	500,000
White River Spring Fing	NA	753,977	753,977	NA	749,886	749,886
Willamette River Spring	1,507,467	NA	1,507,467	1,430,813	NA	1,430,813
Willapa Bay	NA	2,686,054	2,686,054	NA	1,910,660	1,910,660
Grand Total	6,639,445	11,090,714	17,730,159	8,301,192	11,608,678	19,909,870

Table D.3. RMIS query results for adipose fin clipped hatchery releases by a) Puget Sound FRAM stock and b) Columbia River and Washington Coastal FRAM stock for brood years that contributed to the 2009-2018 return years.

a)

Brood Year	Nooksack/ Samish Fall	Nooksack Spring	Skagit Spring	Snohomish Fall	Tulalip Fall	Mid-Puget Sound Fall	South Puget Sound Fall	White River Spring
2004	4,131,337	575,946	329,764	864,068	871,052	7,850,399	9,298,328	1,207,892
2005	3,076,746	644,700	453,274	665,931	631,876	8,029,038	10,325,435	943,587
2006	3,428,802	538,117	325,670	908,596	1,406,909	10,067,592	10,664,882	956,430
2007	4,725,746	649,793	279,957	813,010	1,454,572	8,725,073	11,143,657	1,615,426
2008	5,685,216	573,135	331,769	959,818	1,269,856	8,636,504	11,169,211	1,993,986
2009	5,215,421	619,980	349,117	1,050,308	1,212,932	8,576,246	8,691,804	1,244,325
2010	5,254,095	615,849	320,033	802,361	2,350,291	10,172,139	10,976,905	1,258,454
2011	5,039,573	611,457	293,714	1,562,009	2,400,654	9,020,533	8,626,100	879,573
2012	5,227,155	961,169	373,394	863,093	1,704,712	8,907,625	9,865,846	911,704
2013	5,116,893	845,678	370,591	841,453	2,069,986	5,408,199	9,031,590	1,475,086

Brood Year	Nooksack/ Samish Fall	Nooksack Spring	Skagit Spring	Snohomish Fall	Tulalip Fall	Mid-Puget Sound Fall	South Puget Sound Fall	White River Spring
2014	5,023,502	884,463	465,154	857,206	2,351,392	7,300,402	9,289,473	566,384
2015	5,391,056	871,655	443,600	891,121	2,260,025	8,961,833	7,515,973	783,585
2016	3,786,085	830,408	388,387	758,966	1,936,200	8,303,974	9,105,392	1,227,522

b)

Brood Year	Cowlitz Spring	Willamette Spring	Columbia Summer	Columbia Upriver Bright	Columbia or Tule	Columbia Bonneville Pool Hatchery	Washington North Coast Fall	Willapa Bay Fall
2004	2,164,087	7,327,150	1,959,956	5,660,272	268,564	14,103,694	1,486,682	597,053
2005	2,530,768	7,109,765	1,166,611	11,015,277	234,079	14,790,728	1,025,323	2,438,315
2006	2,109,163	7,795,601	2,098,215	5,625,472	4,210,265	15,022,357	969,218	9,178,859
2007	2,651,585	6,990,827	1,960,353	11,565,752	4,018,254	14,448,272	1,288,519	7,205,850
2008	2,622,600	8,290,048	3,881,758	14,637,321	7,960,365	12,746,912	1,417,014	7,244,549
2009	2,268,888	8,130,635	4,266,996	15,880,918	8,573,093	12,147,017	1,090,685	4,630,642
2010	2,933,697	7,966,999	3,372,056	14,601,170	7,715,779	12,261,685	1,387,827	7,100,337
2011	2,999,836	7,792,413	3,628,913	15,455,031	7,901,326	12,352,339	1,904,334	5,993,346
2012	3,606,838	7,452,389	2,680,540	16,537,660	7,428,683	12,682,866	1,253,514	6,612,844
2013	3,713,648	7,080,269	3,812,867	16,418,912	8,644,922	10,336,664	1,035,603	6,923,821
2014	3,677,188	6,727,818	3,872,978	16,813,047	9,252,691	10,020,574	1,478,578	6,906,901
2015	3,043,928	6,799,252	3,236,338	15,657,840	9,096,236	9,765,769	1,781,165	4,126,030
2016	3,065,965	6,673,263	3,599,085	16,882,494	5,379,154	10,369,524	956,335	5,810,492

APPENDIX E. MODELING RESULTS FOR SRKW EFFECTS

Table E.1. a) Percent prey reductions due to SEAK salmon fisheries under the 2009 PST Agreement (and all other fisheries operating under the 2019 PST Agreement and other likely domestic constraints; Scenario 3). b) Expected percent prey reductions due to SEAK salmon fisheries under the 2019 PST Agreement (and all other fisheries operating under the 2019 PST Agreement and other likely domestic constraints). See Appendix D and PFMC (2020) for a description of the spatial regions.

a)

SEAK Fisheries Expected reductions under 2009 PST Agreement (all other fisheries under 2019 PST Agreement)															
	Oct-Apr					**May-Jun**					**Jul-Sep**				
	Region														
Year	**SWWCVI**	**Salish**	**NOF**	**OR**	**Cali**	**SWWCVI**	**Salish**	**NOF**	**OR**	**Cali**	**SWWCVI**	**Salish**	**NOF**	**OR**	**Cali**
1999	0.20%	0.12%	0.17%	0.05%	0.02%	0.64%	0.43%	0.20%	0.04%	0.00%	3.64%	1.00%	4.02%	0.84%	0.01%
2000	0.51%	0.46%	0.34%	0.06%	0.04%	1.00%	0.95%	0.27%	0.03%	0.00%	3.62%	1.57%	3.32%	0.40%	0.01%
2001	0.20%	0.18%	0.13%	0.03%	0.03%	0.49%	0.57%	0.14%	0.03%	0.00%	1.85%	0.97%	1.94%	0.40%	0.01%
2002	0.20%	0.19%	0.13%	0.03%	0.02%	0.42%	0.49%	0.12%	0.02%	0.00%	2.79%	1.33%	3.22%	0.60%	0.01%
2003	0.31%	0.20%	0.23%	0.05%	0.04%	0.51%	0.45%	0.16%	0.03%	0.00%	3.22%	1.20%	3.97%	0.58%	0.02%
2004	0.23%	0.19%	0.19%	0.06%	0.04%	0.56%	0.51%	0.17%	0.04%	0.00%	3.81%	1.29%	3.72%	0.78%	0.02%
2005	0.42%	0.37%	0.32%	0.08%	0.04%	0.96%	0.92%	0.33%	0.07%	0.01%	5.04%	1.84%	6.31%	1.10%	0.02%
2006	0.40%	0.34%	0.30%	0.09%	0.05%	0.98%	0.86%	0.34%	0.09%	0.01%	5.04%	1.56%	5.50%	1.52%	0.03%
2007	0.44%	0.36%	0.38%	0.09%	0.09%	1.20%	0.87%	0.35%	0.06%	0.01%	7.93%	1.74%	6.11%	1.11%	0.04%
2008	0.14%	0.13%	0.09%	0.03%	0.04%	0.58%	0.55%	0.19%	0.06%	0.02%	2.69%	1.10%	2.92%	0.83%	0.06%
2009	0.31%	0.35%	0.19%	0.04%	0.05%	0.96%	1.05%	0.31%	0.07%	0.02%	4.68%	1.97%	5.17%	0.78%	0.07%
2010	0.39%	0.43%	0.28%	0.09%	0.15%	0.67%	0.90%	0.23%	0.05%	0.02%	2.42%	1.37%	3.07%	0.67%	0.05%
2011	0.48%	0.47%	0.33%	0.09%	0.11%	0.86%	0.94%	0.28%	0.06%	0.01%	4.31%	1.62%	4.39%	0.90%	0.04%
2012	0.39%	0.36%	0.27%	0.05%	0.04%	0.78%	0.77%	0.22%	0.03%	0.01%	3.81%	1.49%	3.90%	0.56%	0.02%
2013	0.15%	0.16%	0.11%	0.02%	0.01%	0.40%	0.50%	0.18%	0.04%	0.00%	1.63%	0.88%	3.10%	0.42%	0.01%
2014	0.51%	0.40%	0.30%	0.07%	0.05%	0.85%	0.93%	0.37%	0.10%	0.01%	3.69%	1.99%	7.79%	1.22%	0.05%

SEAK Fisheries
Expected reductions under 2009 PST Agreement (all other fisheries under 2019 PST Agreement)

	Oct-Apr					May-Jun					Jul-Sep				
	Region														
Year	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali
2015	0.27%	0.38%	0.19%	0.05%	0.07%	0.54%	0.89%	0.22%	0.06%	0.02%	1.93%	1.30%	3.29%	0.59%	0.05%
2016	0.50%	0.39%	0.39%	0.16%	0.17%	1.05%	0.93%	0.41%	0.16%	0.03%	4.98%	1.65%	7.09%	1.97%	0.09%
2017	0.45%	0.34%	0.36%	0.12%	0.16%	0.89%	0.68%	0.31%	0.09%	0.02%	4.09%	1.03%	4.31%	1.03%	0.06%
2018	0.15%	0.15%	0.12%	0.02%	0.02%	0.38%	0.34%	0.12%	0.02%	0.00%	3.07%	1.02%	3.12%	0.50%	0.02%

b)

SEAK Fisheries
Expected percent reductions under 2019 PST Agreement

	Oct-Apr					May-Jun					Jul-Sep				
	Region														
Year	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali
1999	0.17%	0.11%	0.15%	0.04%	0.02%	0.55%	0.37%	0.17%	0.04%	0.00%	3.18%	0.87%	3.54%	0.73%	0.01%
2000	0.44%	0.40%	0.30%	0.05%	0.03%	0.87%	0.83%	0.23%	0.03%	0.00%	3.18%	1.38%	2.92%	0.35%	0.01%
2001	0.18%	0.16%	0.12%	0.03%	0.03%	0.43%	0.49%	0.12%	0.02%	0.00%	1.62%	0.85%	1.71%	0.36%	0.01%
2002	0.18%	0.17%	0.11%	0.02%	0.02%	0.37%	0.43%	0.11%	0.02%	0.00%	2.46%	1.17%	2.85%	0.53%	0.01%
2003	0.26%	0.17%	0.20%	0.04%	0.04%	0.44%	0.39%	0.14%	0.03%	0.00%	2.77%	1.03%	3.42%	0.50%	0.01%
2004	0.23%	0.19%	0.19%	0.06%	0.04%	0.57%	0.52%	0.17%	0.04%	0.00%	3.90%	1.32%	3.82%	0.80%	0.02%
2005	0.40%	0.35%	0.30%	0.07%	0.04%	0.91%	0.87%	0.31%	0.06%	0.01%	4.77%	1.74%	5.97%	1.04%	0.02%
2006	0.36%	0.31%	0.27%	0.08%	0.05%	0.89%	0.78%	0.31%	0.08%	0.01%	4.58%	1.42%	5.00%	1.38%	0.03%
2007	0.42%	0.34%	0.36%	0.08%	0.08%	1.14%	0.83%	0.33%	0.06%	0.01%	7.59%	1.66%	5.83%	1.06%	0.03%
2008	0.13%	0.12%	0.09%	0.03%	0.04%	0.56%	0.53%	0.18%	0.06%	0.02%	2.62%	1.07%	2.85%	0.80%	0.06%
2009	0.29%	0.33%	0.18%	0.04%	0.05%	0.90%	0.99%	0.29%	0.06%	0.02%	4.40%	1.86%	4.88%	0.74%	0.06%
2010	0.36%	0.39%	0.26%	0.08%	0.14%	0.62%	0.83%	0.21%	0.05%	0.02%	2.25%	1.27%	2.86%	0.62%	0.05%
2011	0.43%	0.42%	0.30%	0.08%	0.10%	0.77%	0.85%	0.25%	0.06%	0.01%	3.92%	1.47%	3.99%	0.82%	0.04%

SEAK Fisheries
Expected percent reductions under 2019 PST Agreement

	Oct-Apr					May-Jun					Jul-Sep				
Year	Region SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali
2012	0.39%	0.36%	0.27%	0.05%	0.04%	0.78%	0.77%	0.22%	0.03%	0.01%	3.81%	1.49%	3.90%	0.56%	0.02%
2013	0.12%	0.12%	0.09%	0.02%	0.01%	0.32%	0.40%	0.15%	0.03%	0.00%	1.34%	0.72%	2.56%	0.35%	0.01%
2014	0.43%	0.34%	0.26%	0.06%	0.04%	0.72%	0.79%	0.31%	0.08%	0.01%	3.15%	1.70%	6.67%	1.05%	0.04%
2015	0.23%	0.33%	0.16%	0.05%	0.06%	0.47%	0.77%	0.19%	0.05%	0.01%	1.69%	1.13%	2.88%	0.52%	0.04%
2016	0.47%	0.37%	0.37%	0.15%	0.16%	0.99%	0.87%	0.38%	0.15%	0.03%	4.69%	1.56%	6.68%	1.86%	0.08%
2017	0.44%	0.33%	0.35%	0.12%	0.16%	0.87%	0.67%	0.30%	0.09%	0.02%	4.01%	1.01%	4.23%	1.01%	0.06%
2018	0.15%	0.15%	0.12%	0.02%	0.02%	0.37%	0.33%	0.12%	0.02%	0.00%	2.98%	0.99%	3.04%	0.49%	0.02%

Table E.2. Expected nominal reductions (number of age 3+ Chinook salmon) by SEAK salmon fisheries under the 2019 PST Agreement.

SEAK Fisheries
Expected reductions (# Chinook salmon) under 2019 PST Agreement

	Oct-Apr					May-Jun					Jul-Sep				
Year	Region SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali	SWWCVI	Salish	NOF	OR	Cali
1999	845	1,126	915	222	143	2,757	3,902	1,088	199	21	15,959	9,166	22,178	4,146	84
2000	1,904	3,400	2,252	521	337	3,755	7,048	1,740	269	32	13,679	11,757	22,071	3,604	90
2001	1,366	2,043	1,602	351	253	3,319	6,458	1,693	276	33	12,536	11,153	23,531	4,179	94
2002	1,585	1,997	1,652	365	231	3,271	5,124	1,612	294	33	21,681	13,861	42,322	7,881	176
2003	2,308	2,239	2,747	673	463	3,854	5,106	1,919	382	39	24,387	13,608	46,989	7,612	168
2004	2,026	2,323	2,457	658	412	4,948	6,250	2,182	411	47	33,819	15,809	49,158	8,894	198
2005	2,643	3,515	2,658	565	352	6,058	8,685	2,713	494	51	31,919	17,413	52,258	8,200	178
2006	2,153	3,497	2,007	373	200	5,230	8,851	2,260	352	38	27,028	16,170	36,817	6,226	136
2007	1,836	2,984	1,959	403	276	5,004	7,268	1,803	278	32	33,261	14,529	31,930	5,227	117

SEAK Fisheries

Expected reductions (# Chinook salmon) under 2019 PST Agreement

	Oct-Apr					May-Jun					Jul-Sep				
	Region														
Year	**SWWCVI**	**Salish**	**NOF**	**OR**	**Cali**	**SWWCVI**	**Salish**	**NOF**	**OR**	**Cali**	**SWWCVI**	**Salish**	**NOF**	**OR**	**Cali**
2008	785	1,294	656	114	55	3,334	5,614	1,385	213	22	15,531	11,349	21,710	2,771	78
2009	1,403	2,488	1,272	223	100	4,395	7,513	2,061	338	33	21,605	14,154	34,344	4,068	123
2010	2,935	4,626	3,280	710	449	5,056	9,795	2,644	418	52	18,226	14,941	35,839	5,445	163
2011	2,862	3,974	2,840	591	335	5,142	7,970	2,382	413	43	26,055	13,884	37,535	5,851	143
2012	2,569	3,182	2,632	647	368	5,100	6,777	2,198	402	46	24,886	13,078	38,247	6,918	158
2013	1,295	1,314	1,081	217	105	3,361	4,210	1,738	372	33	14,233	7,660	30,247	3,885	100
2014	3,821	3,586	3,032	574	245	6,386	8,333	3,688	808	71	27,823	18,029	78,491	10,277	258
2015	2,316	3,141	2,157	464	209	4,640	7,355	2,570	501	48	16,811	10,827	38,426	5,117	139
2016	2,985	3,342	2,869	602	356	6,207	7,875	2,997	607	57	29,502	14,011	52,240	7,596	184
2017	2,680	3,525	2,590	533	332	5,373	7,089	2,192	405	43	24,666	10,706	30,922	4,413	119
2018	786	1,485	783	136	85	1,929	3,322	784	113	14	15,727	9,972	20,172	2,919	84

APPENDIX F. HABITAT RESTORATION PROJECTS FUNDED BY FISCAL YEAR WITH PST APPROPRIATED FUNDS

FY20 Habitat Projects
Dungeness Floodplain Restoration - Rivers Edge
Dosewallips Powerlines Preliminary Design
Norht Fork Nooksack Farmhouse Restoration
Middle Fork Nooksack Diversion Dam
Barnaby Reach Restoration
Hansen Creek Restoration
Reiner Farm Riparian Property Conservation
Gold Basin Habitat Restoration

FY21 Habitat Projects
Trafton Nursery Site Restoration
Cicero Restoration Design and Construction
Gold Basin Restoration
South Fork Nooksack Fish Camp Planning Area 90% Design
South Fork Nooksack River Upper and Lower Fobes Reach Phase 2 Restoration
Smokehouse Tidal Marsh Restoration (Final Design)
Snohomish Floodplain Acquisitions Phase I
Upper Dungeness Large Wood Restoration Phase 3
McGlinn Island Fish Passage (Feasibility)

FY22 Habitat Projects
South Fork Homesteader Phase 2 Restoration
Middle Fork Porter Creek Reach Phase 2 Restoration Final Design
Similk Beach Restoration Final Design
Swinomish Channel Tidal Marsh Restoration Construction
Holy Cross Levee Removal & Enhancement

FY23 Habitat Projects
Trafton Floodplain Restoration

APPENDIX G. IMPLEMENTATION OF 2019 PST AGREEMENT, CHINOOK SALMON ANNEX THROUGH 2023.

As explained in Section 1.3, Proposed Federal Action, the PST 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. This appendix details the allowed changes made under these terms since adopting a new Chinook salmon Annex in 2019.

For 2019 - 2022, SEAK AABM catch limits were determined based on the annual CPUE values specified in Table G1, which was originally Table 2 in Chapter 3 of the 2019 PST Agreement, which contained seven abundance tiers with associated catch limits.

Table G1. Catch limits for the SEAK AABM fishery and the CPUE-based tiers.

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

For the SEAK AABM fishery in 2020 and 2021, both the pre-season annual catch limit and the observed catch exceeded the post-season annual catch limit, requiring further action as identified in subparagraphs 7(b)(i) and 7(b)(ii) of Chapter 3 of the 2019 PST Agreement (CTC 2023). In response, the PSC suspended use of the CPUE approach in 2023 and adopted a multivariate model in combination with a new, seventeen tier table that associates abundance index ranges to catch limits (PSC CTC 2023) (Table G2). The multivariate model included additional data and predictors when compared with the previous model including output from the PSC CTC Chinook salmon model. While Table G2 was newly adopted in 2023, the abundance levels and associated catch ceilings are tied directly to the relationships in Table 2, as the equations in Table 2 were used to translate the abundance index midpoints into the catch limits for each tier in G2.

Table G2. Abundance tiers and associated catch limits used to set the 2023 annual catch limit for the SEAK AABM fishery (PSC CTC 2023)[1].

Tier	Abundance Index Range	AI Midpoint	Catch Limit
1	Less than 0.895	NA	Commission Determination
2	Between 0.895 and 0.945	0.92	107,498
3	Between 0.945 and 0.985	0.965	111,888
4	Between 0.985 and 1.035	1.01	116,278
5	Between 1.035 and 1.105	1.07	127,130
6	Between 1.105 and 1.175	1.14	142,101
7	Between 1.175 and 1.245	1.21	157,072
8	Between 1.245 and 1.345	1.295	191,963
9	Between 1.345 and 1.455	1.4	206,027
10	Between 1.455 and 1.555	1.505	220,091
11	Between 1.555 and 1.665	1.61	252,358
12	Between 1.665 and 1.765	1.715	267,594
13	Between 1.765 and 1.875	1.82	282,830
14	Between 1.875 and 2.015	1.945	314,799
15	Between 2.015 and 2.145	2.08	335,288
16	Between 2.145 and 2.285	2.215	355,778
17	Greater than 2.285	2.285	373,801

1. The PSC adopted a new method and tier structure for setting the 2023 SEAK catch limit on February 16, 2023; revisions to Chapter 3 Table 2 are under consideration.

In 2024 following the first review specified in paragraph 7(d) of Chapter 3, the PSC did not reach agreement on continued use of the multivariate model (Table G2) for setting the SEAK AABM catch limit for 2024; therefore, per Chapter 3, subparagraph 7(e), the PSC Chinook Model estimate of the AI and Table 1 in Chapter 3 of the 2019 Agreement was used, and with Canadian expectations it will continue to be used to determine the annual pre-season and post-season catch limits moving forward (CTC 2024). With the return to use of the PSC Chinook Model for setting SEAK AABM catch limits, the PSC agreed to afford the same 10% exceedance rule that applies to the NBC and WCVI AABM fisheries in defining the triggers for paragraphs 7(b)(i) and 7(b)(ii).