UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall Suite 5-100
Sacramento, California 95814

May 21, 2024

Via Electronic Mail

Refer to NMFS No: WCRO-2024-00942

Mr. Bryan Mercier, Regional Director
Northwest Regional Office
Bureau of Indian Affairs (BIA)
911 N.E. 11th Avenue
Portland, Oregon 97232-4169
brian.mercier@bia.gov

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Impacts of the Role of the BIA Under its Authority to Assist with the Development of the 2024-2025 Puget Sound Chinook Harvest Plan, the Role of the U.S. Fish and Wildlife Service in Activities Carried out under the Hood Canal Salmon Management Plan and the Office of Conservation Investment funding to the Washington Department of Fish and Wildlife under the Sport Fish Restoration Act in 2024-25, and the Role of the National Marine Fisheries Service in authorizing fisheries consistent with management by the Fraser Panel and Funding Provided to the Washington Department of Fish and Wildlife for Activities Related to Puget Sound Salmon Fishing in 2024-2025

Dear Mr. Mercier:

Thank you for your letter of May 3, 2024, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to Section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for Impacts of the Role of the BIA Under its Authority to Assist with the Development of the 2024-2025 Puget Sound Chinook Harvest Plan. Enclosed is a biological opinion prepared by NMFS assessing the effects of that action on ESA-listed species and issued under the authority of Section 7 of the Endangered Species Act of 1973 (ESA), as amended (ESA; 16 U.S.C. 1536).

We also reviewed the likely effects of the BIA's proposed action on Essential Fish Habitat (EFH), pursuant to Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA; 16 U.S.C. 1855(b)). We concluded that the action would adversely affect EFH for stocks managed under the Pacific Coast Groundfish Fishery Management Plans. Therefore, we have included the conservation recommendations in this document.

The biological opinion evaluates the impacts of the proposed fisheries on the following ESA-listed species:

- Puget Sound Chinook Salmon Evolutionarily Significant Unit (ESU),
- Puget Sound Steelhead Distinct Population Segment (DPS),
- Southern Resident killer whale DPS,
- two Puget Sound/Georgia Basin rockfish DPSs (yelloweye and bocaccio), and
- two Humpback whale DPSs (Mexico and Central America)

Other ESA-listed species occurring in the Action Area are either covered under existing, long-term ESA biological opinions or 4(d) determinations, or we anticipate the proposed actions are not likely to adversely affect the species. This biological opinion and EFH consultation expire on May 14, 2025.

We have concluded in this biological opinion that the action, if conducted consistent with the terms of the Incidental Take Statement, is not likely to jeopardize the continued existence of the listed species that are subject of the opinion, or to destroy or adversely modify critical habitat. The Incidental Take Statement includes non-discretionary terms and conditions that must be implemented to provide an exemption from the prohibited acts outlined in Section 9 of the ESA. The biological opinion also includes discretionary Conservation Recommendations that are intended to help your agency comply with the affirmative conservation responsibilities of Section 7(a)(1) of the ESA.

NMFS also concluded that the programs would adversely affect EFH for groundfish managed under the MSA. Therefore, enclosed are several Conservation Recommendations, provided under Section 305(b)(4)(a) of the MSA, that would avoid or minimize those adverse effects. As required by Section 305(b)(4)(B) of the MSA, BIA, USFWS and NMFS must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

As prescribed by ESA Section 7 regulations, consultation on the programs administered by the BIA involving these Puget Sound salmon and steelhead fisheries must be re-initiated if:

> (1) the amount or extent of taking specified in the Incidental Take Statement is exceeded for any of the actions identified in the biological opinion;
>
> (2) new information reveals effects of these actions that may affect listed species or critical habitat in a manner or to an extent not previously considered;
>
> (3) any of the identified actions are subsequently modified in a manner that causes

an effect to the listed species that was not considered in the biological opinion; or

(4) a new species is listed or critical habitat designated that may be affected by the identified actions.

Please contact James Dixon in our Sustainable Fisheries Division (360.522.3673, james.dixon@noaa.gov) if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

Ryan J. Wulff
Assistant Regional Administrator
For Sustainable Fisheries

Enclosure

cc: Rudy Peone, Bureau of Indian Affairs
Ashton Harp, Bureau of Indian Affairs

bcc: Susan Bishop, Sustainable Fisheries Division, NMFS West Coast Region
Sheila Lynch, General Counsel, Northwest

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

Impacts of the Role of the Bureau of Indian Affairs Under its Authority to Assist with the Development of the 2024-2025 Puget Sound Chinook Harvest Plan, the Role of the U.S. Fish and Wildlife Service in Activities Carried out under the Hood Canal Salmon Management Plan and the Office of Conservation Investment funding to the Washington Department of Fish and Wildlife under the Sport Fish Restoration Act in 2024-2025, and the Role of the National Marine Fisheries Service in authorizing fisheries consistent with management by the Fraser Panel and Funding Provided to the Washington Department of Fish and Wildlife for Activities Related to Puget Sound Salmon Fishing in 2024-2025

NMFS Consultation Number: WCRO-2024-00942

Action Agency: Bureau of Indian Affairs (BIA)
National Marine Fisheries Service (NMFS)
U.S. Fish and Wildlife Service (USFWS)

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?
Puget Sound Chinook Salmon (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	No	NA
Puget Sound Steelhead (*O. mykiss*)	Threatened	Yes	No	No	NA
Puget Sound/Georgia Basin (PS/GB) bocaccio (*Sebastes paucispinis*)	Endangered	Yes	No	Yes	No
PS/GB yelloweye rockfish (*S. ruberrimus*)	Threatened	Yes	No	Yes	No
Southern Resident killer whales (*Orcinus orca*)	Endangered	Yes	No	Yes	No
Sunflower Sea Stars (*Pycnopodia helianthoides*)	Proposed Threatened	No	No	NA	NA
Eulachon (*Thaleichthys pacificus*)	Threatened	No	NA	No	NA
Green Sturgeon (*Acipenser medirostris)*	Threatened	No	NA	No	NA
Humpback whale (*Megaptera novaeangliae)* Mexico DPS	Threatened	Yes	No	No	No
Humpback whale Central America DPS	Endangered	Yes	No	No	No

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Groundfish	Yes	Yes

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

Issued by:

Ryan J. Wulff, Assistant Regional Administrator
for Sustainable Fisheries
West Coast Region
National Marine Fisheries Service

Date: May 21, 2024 (***Date expires: May 14, 2025***)

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ACOE	Army Corps of Engineers
B.C.	British Columbia
BIA	Bureau of Indian Affairs
BRT	Biological Review Team
C&S	Ceremonial and Subsistence
CA	California
CFD	Cape Flattery deep
CFI	Cape Flattery index
CFM	Cape Flattery mid shelf
CFO	Cape Flattery offshelf
CFR	Code of Federal Regulations
CHART	Critical Habitat Analytical Review Team
cm	centimeters
CNP	Central North Pacific
CO2	Carbon Dioxide
CPUE	Catch Per Unit Effort
CRS	Columbia River System
CWT	Coded Wire Tag
dB	Decibels
DDT	Dichlorodiphenyltrichloroethane
DEIS	Draft Environmental impact statement
DFO	Department of Fisheries and Oceans
DIP	Demographically Independent Population
DNA	Deoxyribonucleic Acid
DPER	Daily Energy Prey Requirement
DPS	Distinct Population Segment
DTAGs	Digital Acoustic Recording Tags
E	Endangered
EAR	Ecological Acoustical Recorder
EFH	Essential Fish Habitat

ER	Exploitation Rates
ESA	Endangered Species Act
ESCA	Endangered Species Conservation Act
ESS	Early Summer-run Steelhead
ESU	Evolutionarily Significant Unit
EWS	Early Winter Steelhead
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FR	Federal Regulation
FRAM	Fishery Regulation Assessment Model
GB	Georgia Basin
GSI	Genetic Stock Identification
HCSMP	Hood Canal Salmon Management Plan
HGMP	Hatchery and Genetic Management Plan
HOR	Hatchery-Origin
HPA	Hydraulic Project Approval
HR	Harvest Rate
HUC5	Fifth-Field Hydrologic Unit Code
ITP	Incidental Take Permit
ITS	Incidental Take Statement
JF	Juan de Fuca
kcal	kilocalorie
kg	kilogram
kHz	kilohertz
km	kilometers
LAT	Low Abundance Thresholds
LCR	Lower Columbia River
LOAF	List of Agreed Fisheries
LOF	List of Fisheries
LWSC	Lake Washington Ship Canal
m	Meters
M/SI	Mortality and Serious Injury
MA	Marine Area

MIT	Muckleshoot Indian Tribe
MMAP	Marine Mammal Authorization Program
MMPA	Marine Mammal Protection Act
MPG	Major Population Group
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSF	Mark Selective Fishery
mtDNA	Mitochondrial deoxyribonucleic acid
MSY	Maximum Sustainable Yield
mu	major unit
NAS	Naval Air Station
NF	North Fork
NL	Not Listed
NMFS	National Marine Fisheries Service
nmi	nautical mile
NOAA	National Oceanic and Atmospheric Administration
NOF	North of Falcon
NOR	Natural-Origin
NPFMC	North Pacific Fisheries Management Council
NPGO	North Pacific Gyre Oscillation
NR	Non Retention
NRC	Natural Resource Consultants
NRCS	Natural Resources Conservation Service
NRKWs	Northern Resident Killer Whales
NWFSC	Northwest Fishery Science Center
NWIFC	Northwest Indian Fisheries Commission
NWTRC	U.S. Navy’s Northwest training range complex
OA	Ocean Acidification
OR	Oregon
OWSN	Ocean Wise Sightings Network
PAH	Polycyclic Aromatic Hydrocarbon
PAL	Passive Aquatic Listener
PBDEs	polybrominated diphenyl ethers

PBFs	Physical or Biological Features
PBR	Potential Biological Removal
PCBs	polychlorinated biphenyls
PCE	Primary Constituent Element
PCSRF	Pacific Coastal Salmon Recovery Fund
PDO	Pacific Decadal Oscillation
PFMC	Pacific Fishery Management Council
Plan	Puget Sound steelhead recovery plan
POP	Persistent Organic Pollutant
ppb	Parts per Billion
PRA	Population Recovery Approach
PS	Puget Sound
PSA	Puget Sound Anglers
PSC	Pacific Salmon Commission
PSFTF	Puget Sound Federal Task Force
PSIT	Puget Sound Treaty Indian Tribes
PSSMP	Puget Sound Salmon and Steelhead Management Plan
PSSTRT	Puget Sound Steelhead Technical Recovery Team
PST	Pacific Salmon Treaty
PSTRT	Puget Sound Technical Recovery Team
PVA	Population Viability Analysis
PWWA	Pacific Whale Watchers Association
QD	Quinault Deep
QET	Quasi-extinction Threshold
r	intrinsic rate of natural increase
r/s	recruits/spawner
RAAMF	Risk Assessment and Adaptive Management Framework
RCA	Rockfish Conservation Area
RCW	Revised Code of Washington
RERs	Rebuilding Exploitation Rates
rm	river mile
RMP	Resource Management Plan
ROV	Remotely Operated Vehicle

RPA	Reasonable and Prudent Alternative
SAR	Stock Assessment Report
SBC	Southern British Columbia
SEAK	Southeast Alaska
SF	South Fork
SJF	Strait of Juan de Fuca
SP/LP	Sand Point and La Push
SPLASH	Structure of Populations, Levels of Abundance, and Status of Humpbacks
SR	Snake River
SRKW	Southern Resident Killer Whale
SSPS	Shared Strategy for Puget Sound
SUS	Southern United States
SWFSC	Southwest Fishery Science Center
SWVCI	Southwest Vancouver Island
T	Threatened
TRT	Technical Recovery Team
TTS	Temporary Threshold Shifts
UCR	Upper Columbia River
US	United States
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VRAP	Viable Risk Assessment Procedure
VSP	Viable Salmonid Populations
WA	Washington
WCVI	West Coast Vancouver Island
WDFW	Washington Department of Fish and Wildlife
WCR	West Coast Region
WNP	Western North Pacific
Workgroup	ad hoc southern resident killer whale workgroup
YR	Year
µPa	Micropascal

1.0 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 the NMFS West Coast Regional Lacey, WA office.

This document constitutes the NMFS' opinion under Section 7 of the ESA and MSA EFH consultation for federal actions proposed by NMFS, the Bureau of Indian Affairs (BIA), and the United States Fish and Wildlife Service (USFWS). The federal actions include:

(1) The BIA's authority to assist with the development and implementation of the co-managers 2024-2025 Puget Sound Harvest Plan, and expenditure of funding to support implementation of federal court decisions including *U.S.* v. *Washington*, as reflected in BIA's May 3, 2024 request for consultation to NMFS,

(2) USFWS actions that it funds or carries out as a signatory to the Hood Canal Salmon Management Plan (*U.S.* v. *Washington*, Civil No. 9213, Ph. 1 (Proc. 83-8)), from May 15, 2024-May 14, 2025 (dates of analysis). Past NMFS Biological opinions have erroneously stated that USFWS authorizes fisheries as a party to the Hood Canal Salmon Management Plan. USFWS does not authorize any fisheries in Puget Sound.

(3) Two actions associated with the management of the 2024 U.S. Fraser Panel sockeye and pink fisheries under the Pacific Salmon Treaty (PST):

  (a) Federal approval of the Pacific Salmon Commission's (PSC) recommended fishing regime for the annual Fraser River sockeye and pink salmon fishing season, and;

  (b) NMFS' issuance of orders that establish fishing times and areas consistent with the in-season implementing regulations of the Fraser River Panel of the PSC.

(4) NMFS' funding of WDFW activities associated with managing Puget Sound salmon fisheries, primarily through appropriations for purposes of implementing the PST.

(5) USFWS’ Office of Conservation Investment funding to WDFW under the Sport Fish Restoration Act to conduct the Comprehensive Puget Sound Recreational Fisheries Sampling Program. In 2024-2025, these funds are anticipated to be used for activities including fishery monitoring, biological and coded-wire tag sampling and processing, and technical management and support.

This opinion considers impacts of the proposed actions on the Puget Sound Chinook salmon Evolutionarily Significant Unit (ESU), the Puget Sound steelhead Distinct Population Segment (DPS), the Southern Resident killer whale DPS, the Mexico DPS of humpback whales, the Central America DPS of humpback whales, two listed Puget Sound rockfish DPSs, and their critical habitat. Other listed species, and critical habitat, occurring in the action area are either covered under existing, long-term ESA opinions or 4(d) determinations as shown in Table 1, or NMFS has determined that the proposed actions are not likely to adversely affect the species (Section 2.12).

1.2 Consultation History

On July 10, 2000, NMFS issued the ESA 4(d) Rule establishing take prohibitions for 14 threatened salmon ESUs and steelhead DPSs, including the Puget Sound Chinook Salmon ESU (65 Fed. Reg. 42422, July 10, 2000). The ESA 4(d) Rule provides limits on the application of the take prohibitions, i.e., take prohibitions would not apply to the plans and activities set out in the rule if those plans and activities met the rule's criteria. One of those limits (Limit 6, 50 CFR 223.203(b)(6)) applies to joint tribal and state resource management plans. In 2005, as part of the final listing determinations for 16 ESUs of West Coast salmon, NMFS amended and streamlined the previously promulgated 4(d) protective regulations for threatened salmon and steelhead (70 Fed. Reg. 37160, June 28, 2005). Under these regulations, the same set of 14 limits was applied to all threatened Pacific salmon and steelhead ESUs or DPSs. As a result of the Federal listing of the Puget Sound Steelhead DPS in 2007 (72 Fed. Reg. 26722, May 11, 2007), NMFS applied the 4(d) protective regulations adopted for the other Pacific salmonids (70 Fed. Reg. 37160, June 28, 2005) to Puget Sound steelhead (73 Fed. Reg. 55451, September 25, 2008).

Beginning in 2001 and running 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 4(d) Rule. 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. NMFS consulted under ESA Section 7 and issued biological opinions on its 4(d) determinations for each of these RMPs, and related federal actions including BIA planning and implementation assistance for Puget Sound tribal fisheries, for USFWS Hood Canal Salmon Plan-related actions, and U.S. Fraser Panel fishery actions. The most recent RMP, approved in 2011, expired April 30, 2014 (NMFS 2011c).

Since the most recent RMP expired in 2014, NMFS has consulted under Section 7 of the ESA on single-year actions by the BIA, USFWS, and NMFS similar to those described above in section 1.1. These consultations considered the effects of Puget Sound salmon fisheries on listed species on single-year fishery management plans PSIT and WDFW agreed to. These plans have incorporated the general management framework described in the 2010-2014 RMP, and certain management objectives from that RMP, but include year-specific objectives to address certain stock management issues. In 2023, the co-managers developed an annual plan that incorporates the conservation objective framework developed for their updated, 10-year RMP (see following paragraph). NMFS issued one-year opinions for the 2014, 2015, 2016[1], 2017, 2018, 2019, 2020, 2021, 2022 and in 2023 Puget Sound fishery cycles that considered BIA's, USFWS's and NMFS' actions related to the implementation of the PSIT and WDFW plans for managing the Puget Sound fisheries (NMFS 2014b; 2015d; 2016f; 2016d; 2016e; 2017c; 2018d; 2019d; 2020b; 2021f; 2022c; 2023c). In each of these opinions NMFS concluded that the proposed fisheries were not likely to jeopardize the continued existence of listed Puget Sound Chinook salmon, Southern Resident killer whales, Puget Sound steelhead, Puget Sound/Georgia Basin Boccaccio, Puget Sound/Georgia Basin yelloweye rockfish, or the Central America or Mexico DPS of Humpback whales (from 2018 forward).

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' review of the draft determined that there were a small number of items that needed further discussion and work. In October of 2022, NMFS determined that the RMP is sufficient to proceed with its formal 4(d) Rule determination process. However, the process leading to a decision on approval of the plan under the 4(d) rule takes significant time, and thus will not be complete in time for implementation of the 2024-25 fishing plan. Therefore, the action agencies (BIA, USFWS, and NMFS) are consulting on their respective actions related to implementation of the 2024-25 fishing plan.

On May 3, 2024, the BIA formally requested consultation on its authority to assist with the development and implementation of the co-managers 2024-2025 Puget Sound Harvest Plan, and expenditure of funding to support implementation of federal court decisions including US v. Washington (Mercier 2024). The request included a joint plan produced by the WDFW and the PSIT for the proposed 2024-2025 Puget Sound salmon and hatchery steelhead fisheries, along with several additional management and technical documents supporting the plan (See section 1.3). This plan describes the framework within which the tribal and state jurisdictions jointly manage all recreational, commercial, ceremonial, subsistence and take-home salmon and hatchery steelhead fisheries, and considers the total fishery-related impacts on Puget Sound Chinook salmon and other ESA-listed species from those fisheries, within the greater Puget Sound area. NMFS initiated formal consultation, under ESA and MSA on May 8, 2024.

This opinion is based on information provided in the letter from the BIA requesting consultation with NMFS and associated documents provided with the consultation request (Mercier 2024), discussions with Puget Sound tribal, WDFW and Northwest Indian Fisheries Commission staffs,

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[1] In 2016 a total of three biological opinions related to the 2016-2017 Puget Sound fisheries were issued – NMFS (NMFS 2016f; 2016d; 2016e).

consultations with Puget Sound treaty tribes, published and unpublished scientific information on the biology and ecology of the listed species in the action area, and other sources of information.

As noted above, for a number of species affected by the Puget Sound salmon fisheries we have completed long-term opinions or ESA 4(d) Rule evaluation and determination processes. Table 1 identifies those opinions and determinations still in effect that address impacts to salmonid species affected by the Puget Sound salmon fisheries considered in this opinion. In each determination listed in Table 1, NMFS concluded that the proposed actions were not likely to jeopardize the continued existence of any of the listed species. NMFS also concluded that the actions were not likely to destroy or adversely modify designated critical habitat for any of the listed species. The determinations listed in Table 1 take into account the anticipated effects of the Puget Sound salmon fisheries each year through pre-season planning and modeling. Any impacts to the species listed in Table 1 from the proposed actions under consultation in this opinion were accounted for and within the scope of the associated Table 1 jeopardy determinations. Therefore, effects of the fisheries on those species are not analyzed in this opinion.

Table 1. NMFS ESA determinations regarding listed species that may be affected by Puget Sound salmon fisheries and the duration of the decision (4(d) Limit or biological opinion (BO)). Only the decisions currently in effect and the listed species represented by those decisions are included. Therefore, effects of the fisheries on those species are not analyzed in this opinion.

Date (Coverage)	Duration	Citation	ESU considered
April 1999 (BO) *	until reinitiated	(NMFS 1999)	S. Oregon/N. California Coast coho Central California Coast coho Oregon Coast coho
September 2001 (4(d) Limit)	until withdrawn	(NMFS 2001b)	Hood Canal summer-run chum
April 2001 (BO) *	until reinitiated	(NMFS 2001a)	Upper Willamette River Chinook Columbia River chum Ozette Lake sockeye Upper Columbia River spring-run Chinook Ten listed steelhead DPSs
December 2008 (BO)*	until reinitiated	(NMFS 2008i)	Snake River spring/summer and fall Chinook and sockeye
April 2012 (BO)*	until reinitiated	(NMFS 2012)	Lower Columbia River Chinook
April 9, 2015 (BO) *	until reinitiated	(NMFS 2015c)	Lower Columbia River coho

* Focus is fisheries under Pacific Fishery Management Council (PFMC) and United States (US) Fraser Panel jurisdiction. For ESUs and DPSs from outside the Puget Sound area, the effects assessment incorporates impacts in Puget Sound, and fisheries are managed for management objectives that include impacts that occur in Puget Sound salmon fisheries.

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 biological 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). The actions that are subject of this opinion require consultation with NMFS because Federal agencies (BIA, USFWS, NMFS) are authorizing, funding, or carrying out actions that may adversely affect listed species (Section 7(a)(2) of the ESA). NMFS is grouping these proposed Federal actions in this consultation pursuant to 50 CFR 402.14 (c) because they are similar actions occurring within the same geographical area.

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).

***BIA**:*

The BIA has requested consultation on its authority to assist with the development and implementation of the co-managers 2024-2025 Puget Sound Chinook Harvest Plan, and expenditure of funding to support implementation of federal court decisions including US v. Washington.[2] This plan describes the framework within which the tribal and state jurisdictions jointly manage all recreational, commercial, ceremonial, subsistence and take-home salmon and steelhead fisheries. Additionally, this plan considers the total fishery-related impacts on Puget Sound Chinook salmon and steelhead from those fisheries within the greater Puget Sound area. As proposed by the Puget Sound co-managers, the 2024-2025 Puget Sound Chinook Harvest Plan describes the agreed-to conservation objectives for ESA-listed Puget Sound Chinook salmon and steelhead for the one-year term of its implementation, and describes the suite of fisheries planned to keep impacts within these objectives. The 2024-2025 Puget Sound Chinook Harvest Plan also contains management area-specific details on fishery time periods, gear restrictions, and catch allocation, and bag limits, subject to in-season adjustment, where applicable, anticipated to occur during the period (Mercier 2024). The Chinook Harvest Plan encompasses:

- Proposed Exploitation Rates and Management Thresholds for listed Puget Sound Chinook Populations;
- Summary of annual Management Objectives for Nooksack Early, Skagit summer-fall, Skagit spring, Stillaguamish, Snohomish, Lake Washington (Cedar River), Green, White River spring, Puyallup, Nisqually, Skokomish, Mid-Hood Canal, Dungeness and Elwha;
- the 2024-2025 List of Agreed Fisheries (LOAF), which provides specific details about individual anticipated fisheries by location, gear, time and management entity;

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[2] BIA's role is consistent with Secretarial Order #3206, Appendix Sec. 2(c), 3(c).

- an addendum related to on-going management of the late-timed fall Chinook hatchery program in the Skokomish River;
- Stock Management Plan for the Nisqually Fall Chinook Recovery;
- a description of actions to be taken in the WDFW-managed fisheries for the 2024-2025 season beneficial for Southern Resident Killer Whales;
- a summary assessment of the tribal salmon fishing impacts associated with the proposed 2024-2025 Puget Sound Chinook Harvest Plan on Southern Resident killer whales
- an assessment of the impacts of implementing the planned fisheries to Puget Sound steelhead;
- PSC, Chum Technical Committee genetic stock composition research study;
- Piscivorous warm-water test fishery, commercial fishery, and research study (Muckleshoot Tribe and WDFW)

The BIA is the lead federal action agency on this consultation.

***USFWS**:*

The USFWS proposes to fund or carry out actions that are consistent with the implementation of the Hood Canal Salmon Management Plan (Hood Canal Salmon Management Plan 1986; HCSMP) from May 15, 2024 through May 14, 2025. The USFWS, along with the co-managers within the Hood Canal, is party to the HCSMP, which is a regional plan and stipulated order related to the Puget Sound Salmon and Steelhead Management Plan (PSSMP). The state and tribal parties to the Hood Canal Plan establish management objectives for stocks originating in Hood Canal including listed Chinook and summer-run chum stocks. USFWS coordinates with and provides technical assistance to the state and tribal parties and also provides them with estimates of hatchery returns to Quilcene National Fish Hatchery. Some of the management actions under the HCSMP may affect those fisheries where Hood Canal salmon stocks are caught.

In addition, the USFWS Office of Conservation Investment program partially funds WDFW under the Sport Fish Restoration Act to conduct its Comprehensive Puget Sound Recreational Fisheries Sampling Program. Under this grant, WDFW designs and implements creel surveys for recreational fisheries for Chinook and coho salmon, halibut, and other marine fish to monitor Puget Sound fisheries catch by species, angling effort, stock composition, and fishery impacts. Methods may include dockside creel surveys, on-the-water boat surveys, test fishing, and voluntary Salmon Trip Reports/Catch Record Card data. Test fisheries will be conducted by WDFW staff to estimate the adipose mark rate of Chinook salmon during the mark-selective Chinook salmon fishery for both legal size and sub-legal size Chinook salmon. WDFW also collects coded-wire tag (CWT) information for Chinook and Coho salmon and biological data on salmon and other marine fish species (e.g., scales for age analysis, length measurements, tissue samples for genetic stock identification, weights for some species). This fishery monitoring data is summarized and results are communicated to both tribal co-managers and the public.

***NMFS**:*

Between May 15, 2024 and May 14, 2025, NMFS will take three actions associated with Puget

Sound salmon and steelhead fisheries. Two are associated with NMFS' role in domestic implementation of the PST, for Fraser Panel fisheries occurring in U.S. Panel waters; the third action is NMFS' funding to WDFW for activities involved in the implementation, management, and monitoring of Puget Sound fisheries, consistent with the PST.

The Fraser Panel of the PSC manages sockeye and pink salmon fisheries conducted in the Strait of Juan de Fuca and San Juan Island regions in the U.S., the southern Georgia Strait in the U.S. and Canada, and the Fraser River in Canada, and certain high seas and territorial waters westward from the western coasts of Canada and the U.S. between 48 and 49 degrees N. latitude (PSC 2022). The Fraser Panel typically proposes regulations governing commercial and subsistence fisheries in these waters from July 1 through September, although the exact date depends on the fishing schedule in each year and in-season assessments of fish abundances. Fisheries in recent years have occurred from late July into late August in non-pink salmon years and into September in pink years. These fisheries are commercial and subsistence net fisheries using gillnet, reef net, and purse seine gear to target Fraser River-origin sockeye—all years, and pink salmon in odd-numbered years (e.g., 2013, 2015, 2017, 2019, 2021, and 2023). Other salmon species are caught incidentally in these fisheries. The U.S. Fraser Panel fisheries are managed, in-season, to meet the objectives described in Chapter 4 of the PST (the Fraser Annex). The season structure and catches are modified in-season in response to changes in projected salmon abundance, fishing effort or environmental conditions in order to assure achievement of the management objectives, and in consideration of safety concerns. U.S. Fraser Panel area fisheries are also managed together with the suite of other Puget Sound and PFMC fisheries to meet conservation and harvest management objectives for Chinook, coho, and chum salmon.

NMFS will take two actions during the 2024 fishing season to implement the PST's provisions regarding management of the Fraser River sockeye and pink fisheries in U.S. Fraser Panel Waters. One action concurs, in consultation with the Department of State, on the regulatory regime agreed on by the PSC's Fraser River Panel for the U.S. Fraser Panel Area Waters. The other action is NMFS' issuance of in-season orders that give effect to Fraser Panel in-season actions in the U.S. portion of the Fraser Panel Area. The PST Act of 1985 (16 U.S.C. 3631 et seq.) grants the Secretary of Commerce authority to issue regulations implementing the PST. Implementing regulations at 50 CFR 300.97 authorize the Secretary to issue orders that establish fishing times and areas consistent with the annual PSC regime and in-season orders of the Fraser River Panel. This authority has been delegated to the Regional Administrator of NMFS' West Coast Region.

NMFS provides funding to WDFW which is used for activities associated with managing Puget Sound salmon fisheries. Primarily, this funding comes through a grant of a portion of funds appropriated by Congress for purposes of implementing the PST. Additionally, funds provided to WDFW through the Pacific Coastal Salmon Recovery Fund (PCSRF) program have been used for similar activities. In 2024 these funds are anticipated to be used for activities including fishery monitoring and sampling, coded-wire tag application, processing of coded-wire tags and data, and technical and management support for Puget Sound fisheries.

We considered, under the ESA, whether or not the proposed action would cause any other activities.

The co-managers have submitted a plan for joint management[3] of the 2024-2025 Puget Sound salmon fisheries. Puget Sound treaty Indian salmon fisheries and related enforcement, research, and monitoring projects associated with fisheries, other than those governed by the U.S. Fraser Panel, would occur as a consequence of the proposed federal actions. Non-tribal salmon fisheries and related enforcement, research, and monitoring projects associated with fisheries would also occur as a consequence of the proposed actions. Collectively the proposed federal actions allow the fisheries to operate in a manner that is consistent with the various plans, court orders, and applicable law. Without these actions the fisheries would not likely occur in the manner proposed under the co-management framework of the 2024-2025 Puget Sound annual harvest plan (Mercier 2024). We consider the effects of these activities in the effects analysis of this opinion.

Many salmon populations impacted in the Puget Sound salmon fisheries are also taken in other marine fisheries outside of the Puget Sound region. The conservation objectives developed for Puget Sound Chinook described in the 2024-2025 Puget Sound Chinook Harvest Plan include objectives for the Southern United States[4] (SUS) as well as “total” objectives that take into account all marine and freshwater fishery impacts. The objectives are expressed as: exploitation rates (ER), which are the rates at which fisheries impact a particular population: and escapement -based objectives, which describe the number of fish expected to return to the spawning grounds after fishery removals have occurred. We consider the effects of Puget Sound fishery impacts on Puget Sound Chinook salmon stocks in the context of their overall harvest in salmon fisheries along the Pacific west coast (including Southeast Alaska [SEAK] and Canadian fisheries), ocean fisheries off the coasts of Washington and Oregon, and fisheries in the marine, estuarine, and freshwater areas of Puget Sound (Puget Sound salmon fisheries). The effects of all these fisheries were considered in this opinion, as appropriate, in order to determine whether conservation objectives are being met. The Fraser Panel fisheries are included in the mix of Puget Sound salmon fisheries.

Puget Sound salmon fisheries are managed consistent with the provisions of the PST, which also governs fisheries in SEAK, those off the coast of British Columbia, the Washington and Oregon coasts, and the Columbia River. Canadian and SEAK salmon fisheries impact salmon stocks from the states of Washington, Oregon, and Idaho as well as salmon originating in SEAK and Canadian waters. Fisheries off the U.S. West Coast and in inland waters, such as the Puget Sound, harvest salmon originating from U.S. West Coast and Canadian rivers. The PST provides a framework for managing salmon fisheries in those waters of the U.S. and Canada that fall within the PST’s geographical scope. The overall purpose of the fishing regimens is to

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[3] As provided under the Puget Sound Salmon Management Plan, implementation plan for *U.S. v Washington* (see 384 F. Supp. 312 (W.D. Wash. 1974)).

[4] Southern United States or SUS fisheries are those salmon fisheries conducted in U.S. waters, including state waters, south of the Southern Canadian border. These fisheries do not include those fisheries conducted north of the Southern Canadian border, including those in the state or federal waters off Alaska.

accomplish the conservation, production, and harvest allocation objectives set forth in the PST (https://www.psc.org/publications/pacific-salmon-treaty/). The PST provides for the U.S. and Canada to each manage their own fisheries to achieve domestic conservation and allocation priorities, while remaining within the overall limits agreed to under the PST. In 2018, U.S. and Canadian representatives reached agreement to amend versions of five expiring Chapters of Annex IV (Turner and Reid 2018); both countries have since executed this agreement. As Puget Sound Chinook salmon are listed under the ESA, and are subject to management under the PST, objectives for Puget Sound salmon fisheries are designed to be consistent with these laws.

The 2019-2028 PST Agreement includes reductions in harvest impacts for all Chinook salmon fisheries within its scope, including Puget Sound. The 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 percent, respectively, compared to the previous agreement. The level of reduction depends on the overall Chinook abundance in a particular year. This comes on top of the reductions of 15 and 30 percent for those same fisheries that occurred as a result of the prior 10-year agreement (2009 through 2018). Harvest rates on Chinook salmon stocks caught in southern British Columbia and U.S. salmon fisheries, including those in Puget Sound waters, are reduced by up to 15% from the previous agreement (2009 through 2018). Provisions of the updated agreement were specifically designed to reduce fishery impacts in all fisheries to respond to conservation concerns for a number of U.S. and Canadian stocks.

2.0 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 such impacts.

The NMFS determined the proposed action is not likely to adversely affect: southern DPS green sturgeon, southern DPS eulachon, or their critical habitat, sunflower sea star (proposed threatened), or critical habitat for the Mexico or Central America DPSs of humpback whales. Our concurrence is documented in the "Not Likely to Adversely Affect" Determinations section (Section 2.12).

2.1 Analytical Approach

This biological 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 biological 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: Puget Sound Chinook salmon, Puget Sound steelhead, Souther Resident Killer Whale; Puget Sound/Southern Georgia Basin rockfish use the term 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, 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 likely to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their critical habitat using an exposure-response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects on 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 appreciable 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 or critical habitat as a whole for the conservation of a listed species.

- If necessary, suggest a reasonable and prudent alternative to the proposed action.

2.2 Range-wide 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 marine environments that make up the designated critical habitat, and discusses the function of the PBFs that are essential for the species conservation.

2.2.1 Status of Listed Species

Climate change and other ecosystem effects

One factor affecting the status of salmonids, Puget Sound/Georgia Basin rockfishes, SRKWs, humpback whales, and aquatic habitat at large, is climate change. The average annual Northwest air temperature has increased by approximately 1.8°F (1°C) since 1900, which is nearly twice that for the previous 100 years, indicating an increasing rate of change (ISAB 2007), summer temperatures, under the A1B emissions scenario (a "medium" warming scenario), are likely to continue during the next century as average temperatures are projected to increase another 3-10°F, with the largest increases predicted to occur in the summer (Mote et al. 2014). The frequency of 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 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).

The following section describes climate change and other ecosystem effects on ESA-listed species affected by the Proposed Action.

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

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. 2008; 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 the adult migration, spawn timing, fry emergence timing, and 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. 2008).

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.

In the marine ecosystem, salmon may be affected by warmer water temperatures, 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, Mantua and Myers (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 percent by the 2080s, with an even larger contraction (86-88 percent) 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.

Climate change has included increasing water temperatures, increasing acidity, more harmful algae, the loss of forage fish and some marine commercial fishes, changes in marine plants, and increased populations of some marine mammals (i.e., seals and porpoises)(Salish Sea Marine Survival Project 2015). Preliminary work conducted as part of the Salish Sea Marine Survival Project reported that approximately 50 percent of steelhead smolts that reached the Hood Canal Bridge did not survive in the 2017 and 2018 outmigration years. Of the steelhead that did not survive, approximately 80 percent were consumed by predators that display deep diving behavior, such as pinnipeds (Moore and Berejikian 2019). Climate change plays a part in steelhead mortality, but more studies are needed to determine the specific causes of this marine survival decline in Puget Sound. Marine survival rates for steelhead in Washington State have declined in the last 25 years, with the Puget Sound steelhead populations declining to a greater extent than other regions (i.e., Washington Coast and Lower Columbia River steelhead). Abundance of Puget Sound steelhead populations is at near historic lows (Moore et al. 2014).

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). Any rebound in VSP parameters for Puget Sound steelhead are likely to be constrained under these conditions (NWFSC 2015a; Ford 2022).

In Washington State, most models project warmer air temperatures, increases in winter precipitation, and decreases in summer precipitation. Average temperatures in Washington State are likely to increase 0.1-0.6ºC per decade (Mote and Salathé 2009). Warmer air temperatures will lead to more precipitation falling as rain, rather than snow. As snowpack diminishes, seasonal hydrology will shift to more frequent, severe, and early large storms, changing streamflow timing and increasing peak river flows, which may limit salmon survival (Mantua, Tohver and Hamlet 2009). The largest in-river driver of climate-induced decline in salmon and steelhead populations is projected to be the impact of increased winter peak flows, which scour the streambed and destroy salmonid eggs (Battin et al. 2007; Mantua, Tohver and Hamlet 2009).

Higher water temperatures and lower spawning flows, together with increased magnitude of winter peak flows, are all likely to increase salmonid mortality. Higher ambient air temperatures will likely cause water temperatures to rise (ISAB 2007). Salmonids require cold water for spawning and incubation. As climate change progresses and stream temperatures warm, thermal refugia will be essential to persistence of many 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 superoptimal temperatures. To avoid waters above summer maximum temperatures, juvenile rearing may increasingly occur only at the confluence of colder tributaries, or other areas of cold water refugia (Mantua, Tohver and Hamlet 2009). Summer steelhead populations within the Puget Sound DPS may be more vulnerable to climate change since there are few summer run populations that belong to the DPS as compared to winter run populations, they exhibit relatively small abundances, and they occupy limited upper river tributary habitat.

Forest fires can increase stream temperatures dramatically in short time-spans by removing riparian cover (Koontz, Steel and Olden 2018). Streams that lose their snowpack with climate change may see the largest increases in stream temperature due to the removal of temperature buffering (Yan et al. 2021). These processes may threaten some habitats that are currently considered refugia, though Isaak et al. (2018) concluded that most stream habitats will likely remain suitable for salmonids in the near future. Along with warming stream temperatures and concerns about sufficient groundwater to recharge streams, a recent study projects a nearly complete loss of existing tidal wetlands along the U.S. West Coast due to sea-level rise (Thorne et al. 2018). Rising ocean temperatures, stratification, ocean acidity, hypoxia, algal toxins, and other oceanographic processes will alter the composition and abundance of a vast array of oceanic species. Adult Chinook salmon also have high likelihood of exposure to excess sea surface temperatures. Risk at the estuarine life stage is considered to have moderate risk associated with sea-level rise (Crozier et al. 2019).

Impacts from climate change will also exacerbate the current ecosystem pressures facing steelhead (Battin et al. 2007). Hydrologically, many snowmelt-based streams in Puget Sound are expected to become rain dominated by the end of this century (Isaak et al. 2012). This change will leave steelhead especially vulnerable during summer low flows and elevated peak flows during winter (Wade et al. 2013). The period of peak snowmelt runoff will occur earlier in the year, which may impact spawning timing of adults and outmigration timing of smolts. A higher magnitude and frequency of peak winter flows caused by climate change will reduce overwinter survival rates of juvenile steelhead throughout the region (Wade et al. 2013). Because less water will be retained as snow over the winter, summer flows in areas affected by snowmelt runoff are expected to substantially drop below current base flows conditions. These reductions in base flows may limit the carrying capacity for juvenile steelhead during the summer and fall in many areas. Hydrologic factors could also decrease steelhead habitat capacity and population abundance by shifting available flows away from the times when the fish most need it. Climate change will also warm stream temperatures in the summer (Isaak et al. 2012). Because many steelhead streams are already nearing elevated temperature thresholds, riparian and floodplain habitat management efforts will need to meaningfully improve to ameliorate the effects of climate change.

Puget Sound steelhead are expected to have moderate, increased risk of exposure to summer “water deficit” and a high risk of exposure to excess stream temperatures and flooding during their freshwater life stages from future climate change. However, the early life stage (incubating eggs) has a low-moderate risk of exposure to winter flooding because of later spawning windows than other salmonids. Vulnerability of the freshwater life stages to these climate-habitat effects is considered low to moderate. Exposure to excess sea surface temperatures is considered high, and sensitivity of this species at the marine life stage is moderate (Crozier et al. 2019).

Southern Resident Killer Whales: 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. 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).

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 salmon, coho, and sockeye runs were more vulnerable stemming 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 greater 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 2020e; 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 based on ocean distribution of fall-run Chinook salmon stocks in the Northeast Pacific, sea surface temperature data associated with each stock, and future ocean climate predictions to estimate 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 the California Central Valley stock 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 interannual natural climate variability can also impact SRKWs by way of impacts on their prey, and this natural climate variability is predicted to be 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, Mantua and Francis 1999; Benson and Trites 2002; Dalton, Mote and [Eds.] 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, Mantua and Francis 1999; NMFS 2008j). Also, 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, Peterson and Rykaczewski 2015).

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.

Humpback whales: Similar to SRKW, there have been few targeted studies of the impacts of climate change on humpback whales. Some studies indicate that the impacts from climate change, such as increased marine heatwaves, may result in changes in migration routes and the use of breeding grounds (Cartwright et al. 2019; Meynecke and Liebsch 2021; Pelayo-González et al. 2022). Humpback whale prey species, such as anchovy, may change their distributions as a result of changes in environmental conditions (Muhling et al. 2020). Humpback whales may follow the habitat shift of their prey or switch target species, which may result in changes in humpback whale occurrence. A recent study projects that humpback whales in the California Current Ecosystem may lose up to 60 percent of their core habitat as a result of climate change, causing the whales to shift further northeast and towards the coast (Lezama-Ochoa et al. 2024). In turn, this may result in increased overlap of whales and human uses, such as during the larger Pacific marine heatwave in 2016 when an unprecedented number of humpback whales were entangled in Dungeness crab pot fishing gear (Santora et al. 2020).

Rockfish: Changes in surface temperature have already modified, and is likely to continue to modify, marine habitats of listed rockfishes. There is still a great deal of uncertainty associated with predicting specific changes in timing, location, and magnitude of future climate change and species-specific impacts on rockfish.

Climate change effects that have influenced, and will continue to influence, rockfish habitat include: increased ocean temperature; increased stratification of the water column; decreased pH; and intensity and timing changes of coastal upwelling (ISAB 2007). These continuing changes will alter primary and secondary productivity, thereby shifting marine community structure (Doney et al. 2012). These perturbations may, in turn, alter listed rockfish trophic dynamics, growth, productivity, survival, and habitat usage. Increased concentration of CO2 (termed Ocean Acidification, or OA) reduces carbonate availability for shell-forming invertebrates. Ocean acidification adversely affects calcification, or the precipitation of dissolved ions into solid calcium carbonate structures, for a number of marine organisms, which alters spatiotemporal prey availability (Feely et al. 2010). Further research is needed to understand the possible implications of OA on trophic functions in Puget Sound to understand how they may affect rockfishes. Thus far, studies conducted in other areas have shown that the effects of OA will be variable (Ries, Cohen and McCorkle 2009) and species-specific (Miller et al. 2009).

In addition to ecological disruptions from OA in marine systems, increased acidity can directly impact the physiology and behavior of individual fish. Munday et al. (2009) demonstrated that larval orange clownfish (*Amphiprion percula*) detect and respond differently to olfactory cues when pH levels are varied over a range (7.6-8.15) predicted to occur in natural systems by 2100. Simpson et al. (2011) later demonstrated that deleterious effects on hearing also occurred in this species, reducing response to reef noise and avoidance of habitats where predation pressure was high. Larval Atlantic herring (*Clupea hargenus*) exposed to elevated carbon dioxide levels during rearing exhibited reduced growth, degraded body condition, and severe tissue damage in several organs (Frommel et al. 2014). While there have been very few studies to date on the direct effect OA may have on rockfishes, in a laboratory setting OA has been documented to affect rockfish behavior (Hamilton, Holcombe and Tresguerres 2014). After juvenile splitnose rockfish (*S. diploproa*) spent one week under OA conditions projected for the next century in the California shore they spent more time in unlighted environments compared to the control group. Davis et al. (2018) also reported metabolic and behavior changes in juvenile rockfish with regard to predator avoidance; however, they reported that many of the effects were effectively compensated for and adapted to after 3 weeks of exposure. Research conducted to understand adaptive responses to OA on other marine organisms has shown that although some organisms may be able to adjust to OA to some extent, these adaptations may reduce the organism’s overall fitness or survival (Wood, Spicer and Widdicombe 2008). Yelloweye rockfish and bocaccio are likely able to adapt to long-term shifts in water chemistry to some degree, but thresholds at which such adaptation becomes unlikely or impossible have not been identified. More research is needed to further understand rockfish-specific responses, and possible adaptations, to OA.

Future climate-induced changes to rockfish habitat with the ability to alter their productivity have been identified (Drake et al. 2010). Harvey (2005) created a generic bioenergetic model for rockfish, showing that their productivity is highly influenced by climate conditions. For instance, El Niño-like conditions generally lowered growth rates and increased generation time. The negative effect of the warm water conditions associated with El Niño appear to be common across rockfishes (Moser et al. 2000). Recruitment of all species of rockfish appears to be correlated at large scales. Field and Ralston (2005) hypothesized that such synchrony was the result of large-scale climate forcing. Exactly how climate influences rockfish in Puget Sound is unknown; however, given the general importance of climate to rockfish recruitment, it is likely that climate strongly influences the dynamics of listed rockfish population viability (Drake et al.

2010). The consequences of climate change to rockfish productivity, however, will likely be small.

2.2.1.1 *Status of Puget Sound Chinook*

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

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

"Diversity" refers to the distribution of traits within and among populations. These range in scale from deoxyribonucleic acid (DNA) sequence variation at single genes to complex life history traits (McElhany et al. 2000).

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

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

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

The Puget Sound Chinook ESU was listed as a threatened species in 1999. Its threatened status was reaffirmed June 28, 2005 (70 FR 37160), and again on April 14, 2014 (79 FR 20802). Critical Habitat for Puget Sound Chinook salmon was designated on September 2, 2005 (70 FR 52629). 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 14208).

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[5];
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.

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[5] 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.

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 2). 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[6] (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). 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). NMFS issued its final rule in December of 2020 (85 FR 81822). This final 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; Harvey Creek Hatchery Program; Whitehorse Springs Hatchery Program; 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 2. 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

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[6] 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.

Geographic Region	Population (Watershed)
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 2010b) 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's 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 2010b)(Figure 1). 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. 2002a; 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 2005a; 2008i; 2008g; 2010a; 2011c; 2013c; 2014b; 2015d; 2016f; 2017c; 2018d; 2019d; 2020b; 2021f).

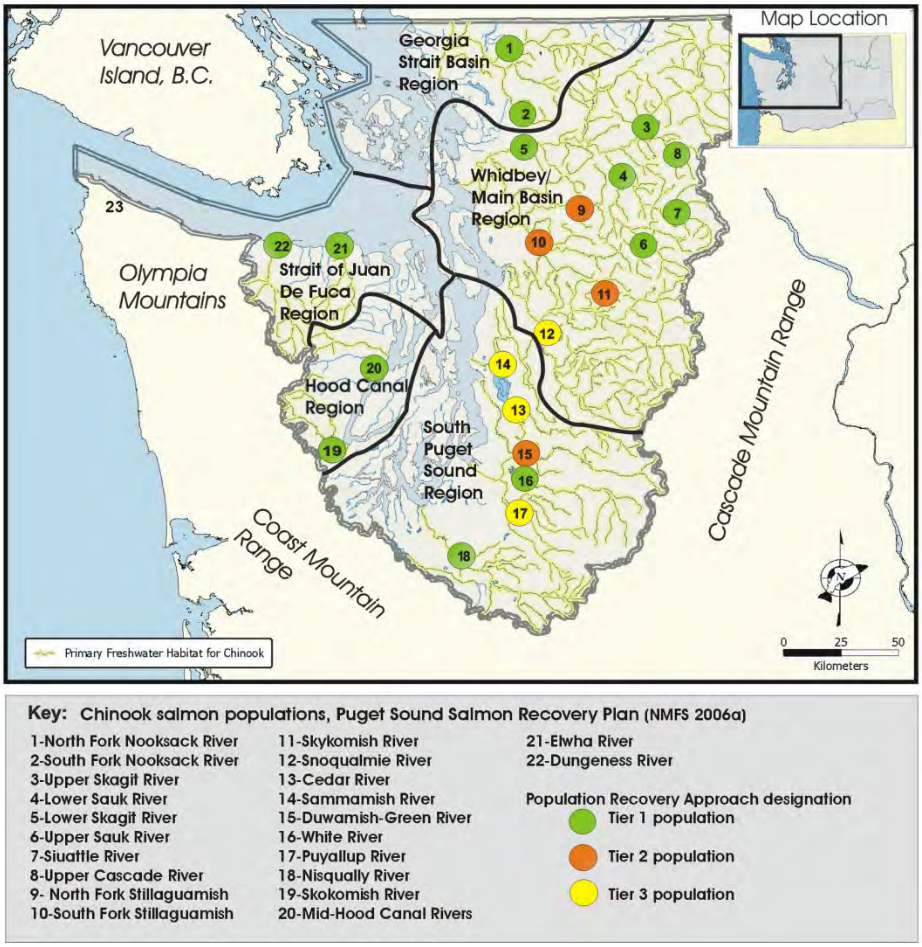

Figure 1. Map of Puget Sound Chinook salmon populations.

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 (fish produced in the wild) vs. hatchery-origin spawners (fish produced in an artificial environment for at least part of their life) 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 3). 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 3). 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 3.

Table 3. Five-year mean of fraction of natural-origin Chinook salmon spawners[7] (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

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[7] 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.

Population	1995-1999	2000-2004	2005-2009	2010-2014	2015-2019
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[8], Green, Nisqually, Cedar, and Skokomish populations have been substantially reduced or impeded by the loss of access to the upper portions of those tributary basins due to flood control activities and hydropower development. Habitat conditions conducive to salmon survival in most other watersheds have been reduced significantly by the effects of land use, including urbanization, forestry, agriculture, and development (NMFS 2005b; SSDC 2007; NMFS 2008c; 2008e; 2008b). It is likely that genetic and life history diversity has been significantly adversely affected by this habitat loss.

Abundance and Productivity

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 2, 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.

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[8] 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.

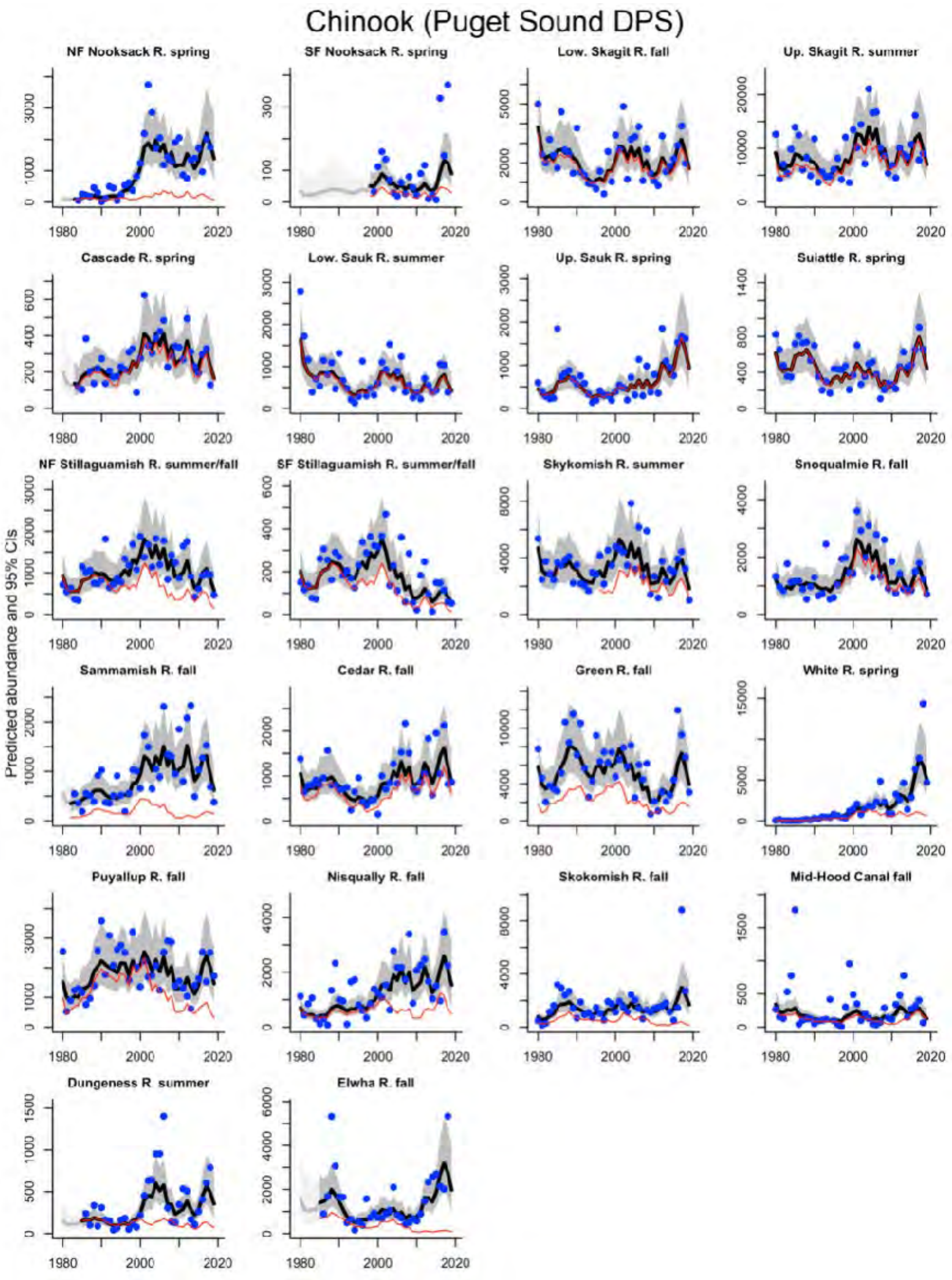

Figure 2. Smoothed trend in estimated total (thick black line) and natural-origin (thin red line) Puget Sound Chinook Salmon ESU individual populations spawning abundance. Points show the annual raw spawning abundance estimates (Ford 2022).

Abundance across the Puget Sound ESU has generally increased since the last status review, 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 4). 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 3), 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 2022c).

Table 4. 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)

Population	Region	1990-1994	1995-1999	2000-2004	2005-2009	2010-2014	2015-2019	Percent Change
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)
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 5). Long-term, natural-origin mean escapements for eight populations are at or below their critical thresholds[9]. 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 5). When hatchery spawners are included, aggregate average escapement is over 1,000 for one of the

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

two populations in each of these three regions, reducing the demographic risk to the populations in these regions. Additionally, hatchery spawners help one of the remaining three of these populations, the Dungeness, achieve total spawner abundances above its critical threshold, and one achieve total spawner levels very close to the critical level—South Fork Nooksack, helping reducing demographic risk. Nine populations are above their rebuilding thresholds[10], 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[11] 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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[10] The rebuilding threshold is defined as the escapement that will achieve Maximum Sustainable Yield (MSY) under current environmental and habitat conditions (NMFS 2000b). Thresholds were based on population-specific data, where available.

[11] 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 (PSIT and WDFW 2022)(Green River MUP).

Table 5. Long-term estimates of total Natural escapement, Natural-origin escapement and productivity (recruits/spawner) for Puget Sound Chinook populations. Populations at or below their critical natural-origin escapement threshold are bolded. Populations exceeding their rebuilding natural-origin escapement threshold are underlined.

Region	Population (MU=Management Unit)	1999 to 2021 Run Year Geometric mean Escapement (Spawners)		NMFS Escapement Thresholds		Recovery Planning Abundance Target in Spawners (productivity)	Average % hatchery fish in escapement 1999-2021 (min-max)[5]
		Natural [1]	Natural-Origin (Productivity[2])	Critical[3]	Rebuilding[4]		
Georgia Basin	Nooksack MU	1,5378	210	*400*	500		
	NF Nooksack	1, 346	**149** (0.3)	*200*[6]	-	3,800 (3.4)	87 (63-97)
	SF Nooksack	191	**61** (1.9)	*200*[6]	-	2,000 (3.6)	68 (33-94)
Whidbey/Main Basin	Skagit Summer/Fall MU						
	Upper Skagit River	9,240	8,345 (2.7)	738	5,740	5,380 (3.8)	11 (2-36)
	Lower Sauk River	515	491 (3.1)	*200*[6]	371	1,400 (3.0)	5 (0-33)
	Lower Skagit River	1877	1,721 (2.8)	281	2,131	3,900 (3.0)	9 (0-23)
	Skagit Spring MU						
	Upper Sauk River	654	646 (2.2)	130	470	750 (3.0)	1 (0-5)
	Suiattle River	379	379 (2.0)	170	223	160 (2.8)	0
	Upper Cascade River	264	241 (1.5)	130	148	290 (3.0)	7 (0-25)
	Stillaguamish MU						
	NF Stillaguamish R.	736	492 (0.9)	300	550	4,000 (3.4)	27 (3-79)
	SF Stillaguamish R.	127	**63** (1.2)	*200*[6]	300	3,600 (3.3)	47 (9-79)
	Snohomish MU						
	Skykomish River	3,108	2,159 (1.5)	400	1,491	8,700 (3.4)	28 (0-62)
	Snoqualmie River	1,413	1,129 (1.3)	400	816	5,500 (3.6)	22 (0-38)
Central/South Sound	Cedar River	905	631 (2.7)	*200*[6]	324[7]	2,000 (3.1)	29 (10-50)
	Sammamish River	1,073	**164** (0.5)	*200*[6]	*1,250*[6]	1,000 (3.0)	81 (36-96)
	Duwamish-Green R.	3,976	1,525 (1.4)	400	1,700	-	59 (27-79)
	White River[9]	1,920	611 (0.8)	*200*[6]	410[7]	-	60 (14-91)
	Puyallup River[10]	1,739	794 (1.2)	*200*[6]	1,170[7]	5,300 (2.3)	50 (19-79)
	Nisqually River	1,632	589 (1.5)	*200*[6]	1,200[8]	3,400 (3.0)	57 (17-87)
Hood Canal	Skokomish River	1,432	**257** (0.8)	452	1,160	-	73 (7-97)
	Mid-Hood Canal Rivers[11]	**127**		*200*[6]	*1,250*[6]	1,300 (3.0)	36[11] (2-87)
Strait of Juan de Fuca	Dungeness River	398	**114**(1.0)	*200*[6]	925[8]	1,200 (3.0)	71 (39-96)
	Elwha River[12]	1,337	**187**(1.02)	*200*[6]	*1,250*[6]	6,900 (4.6)	75 (27-98)

[1] Estimates includes naturally spawning hatchery fish as well as natural-origin spawning fish (estimates represent 1999-2021 geo-mean except for: Sammamish 1999-2019) from Abundance and Productivity Tables from NWFSC database and (WDFW and PSTIT 2023b).

[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; 2018a).

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

[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 1999-2021, except for: Skagit spring pops – 1999-2018; Skagit summer-fall pops – 1999-2017; Sammamish – 1999-2019; Puyallup – 2002-2021; mid-Hood Canal – 1999-2018; and Dungeness – 2001-2021.

[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 2010b).

[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 Tables 5 and 6 from those in the NWFSC Biological Viability Assessment (Ford 2022) (Tables 3 and 4, above) are related to the data source, method, and time period analyzed (e.g., 5-year vs 20-year estimates).

Long-term growth rate of natural-origin escapement are generally higher than growth rate of natural-origin recruitment (i.e., abundance prior to fishing) indicating some stabilizing influence on escapement, possibly from past reductions in fishing-related mortality (Table 6). 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 6). Additionally, most populations are consistently well below the productivity goals identified in the recovery plan (Table 5). Although long-term trends (1990 forward) vary for individual populations across the ESU, currently 21 populations exhibit a stable or increasing long-term trend in total natural escapement (Table 6). 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 6).

Table 6. Long-term trends[12] 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
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 of 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 adult recruit 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 estimate 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.

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[12] Differences in results reported in Tables 5 and 6 from those in the NWFSC Biological Viability Assessment (Ford 2022) (Tables 3 and 4, above) are related to the data source, method, and time period analyzed (e.g., 5-year vs 20-year estimates).

Even given some of the incremental increases in natural-origin spawner abundances in the most recent five-year period (Table 4), the long-term trends in both abundance and productivity, in most Puget Sound populations, are well below the levels necessary for recovery (Table 6).

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. 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 3 through Figure 5). Long term trends in ER for Puget Sound stocks are currently only 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 percent from 1992 to 1999, have since decreased to an average of 26 percent between 2009 and 2018 (Figure 3). Total ERs for the Mid-Hood Canal population averaged 34 percent between 1992 and 1999 but have since decreased to an average of 25 percent between 2009 and 2018 (Figure 3). Total ERs for the Skokomish population averaged 42 percent between 1992 and 1999. After a period of increased harvest from 2000 through 2008 where the ER averaged 58 percent, the ER on the Skokomish population decreased slightly, and has averaged 56 percent since 2009 (Figure 3). The distribution of mortality accrued in marine fisheries is described in detail in the Environmental Baseline (Section 2.4.1).

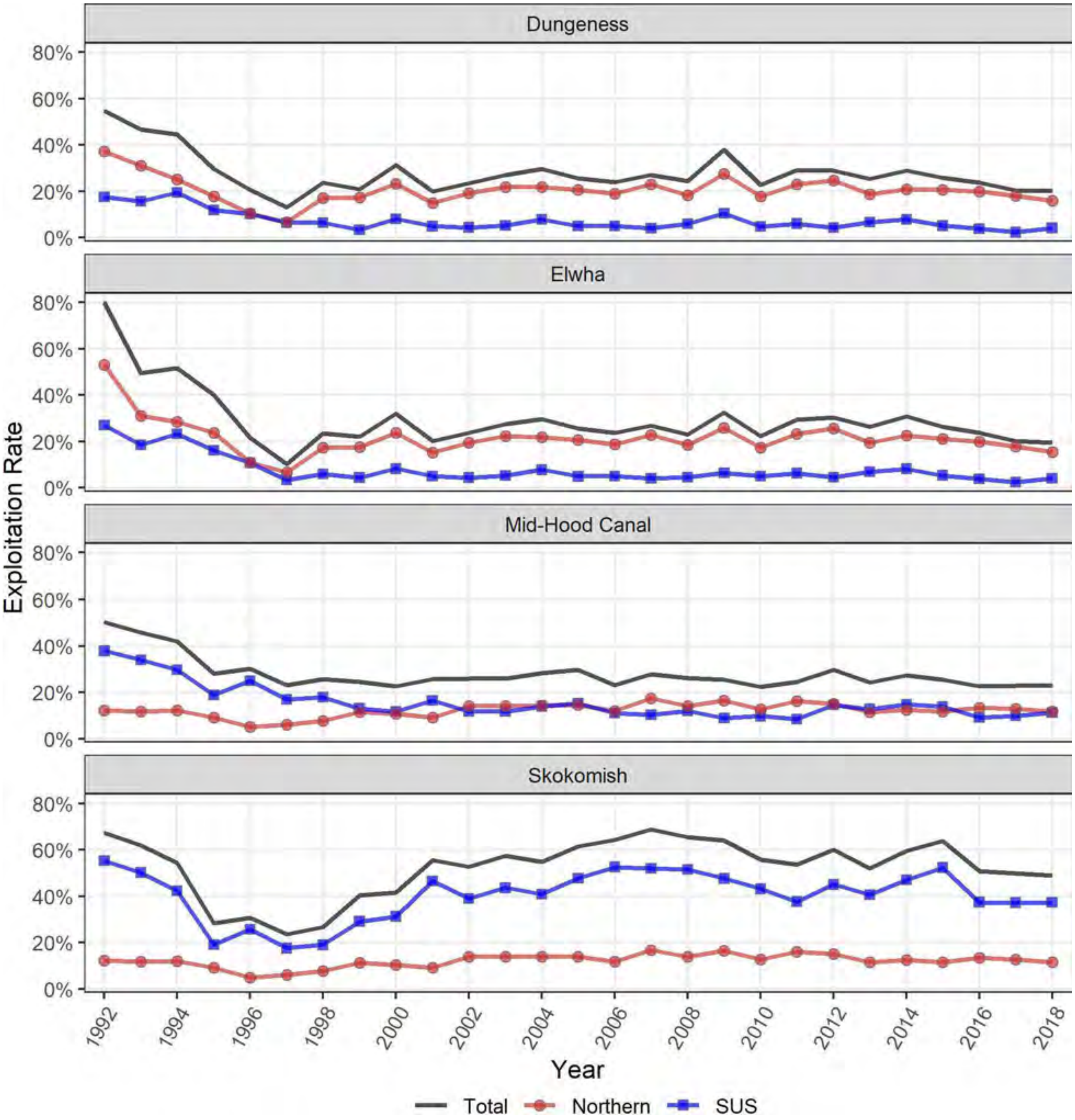

Figure 3. Total harvest exploitation of Hood Canal and Strait of Juan de Fuca Puget Sound Chinook salmon populations from (pers. comm. J. Carey, NMFS WCR). SUS=Southern United States.

ERs on populations in northern Puget Sound have steadily declined since the mid-1980s. From 1992 to 1999, the total ER on Nooksack River spring Chinook salmon averaged 41 percent (Figure 4). Between 2009 and 2018 the total ER for all northern fisheries declined to an average of 31 percent (Figure 4). From 1992 to 1999, average total ERs were 41 percent for Stillaguamish River Chinook salmon and 45 percent for Skagit River summer/fall stocks (Figure 4). Between 2009 and 2018, total ERs declined to averages of 31 percent for Stillaguamish River

Chinook salmon and 44 percent for Skagit River summer/fall stocks (Figure 4)(see Environmental Baseline for geographic distribution of the ERs).

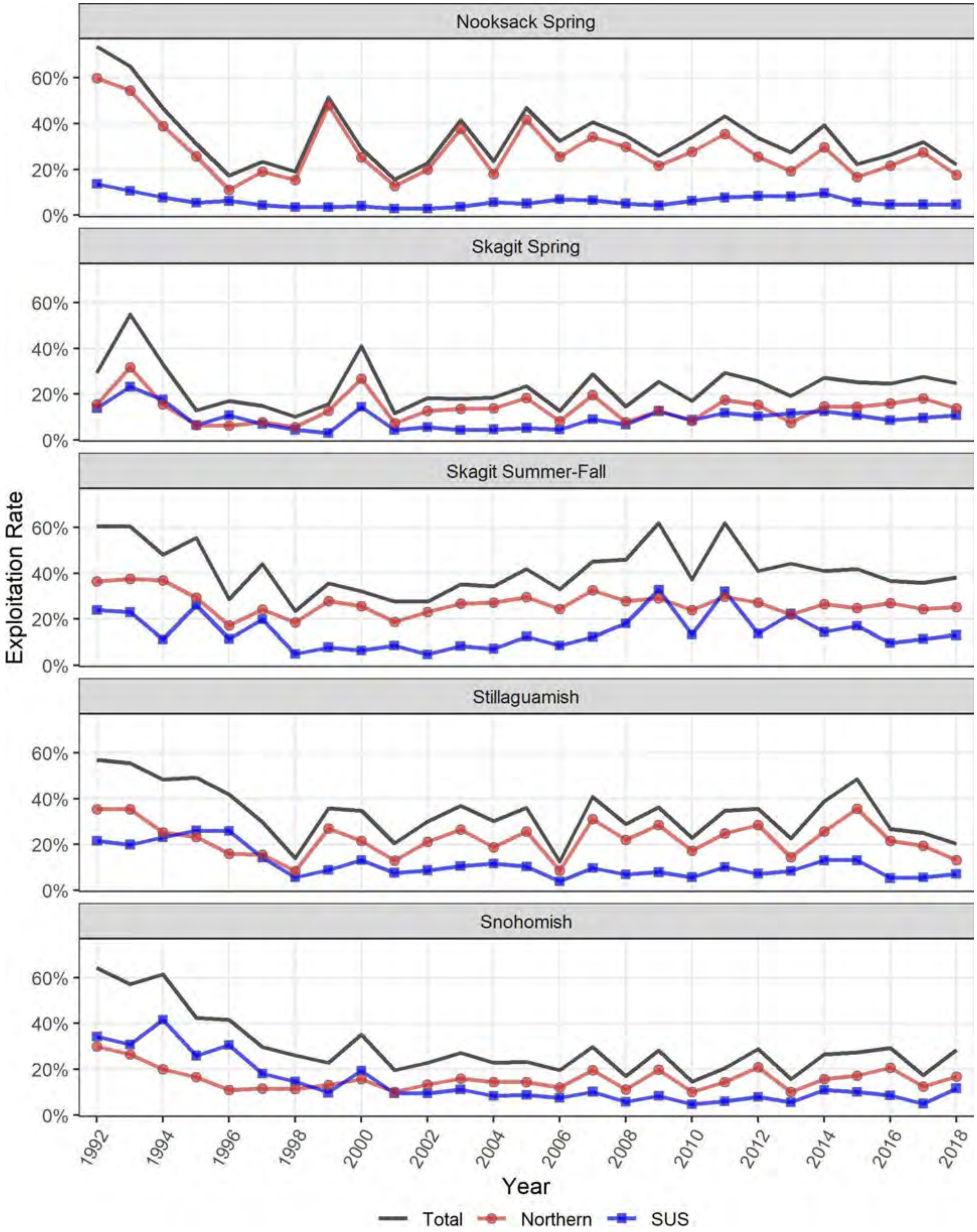

Figure 4. Total harvest exploitation of northern Puget Sound Chinook salmon populations from (pers. comm. J. Carey, NMFS WCR).

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 5). Figure 5 depicts the changes in ER over time for the populations in these regions. From 1992 to 1999, average total ERs ranged from 30 percent (White River Spring) to 74 percent (Nisqually). Between 2009 and 2018, total ERs averaged 24 (White River Spring) percent to 52 percent (Nisqually) representing a decrease of 28 to 55 percent in ERs (Figure 5) (see Environmental Baseline for geographic distribution of the ERs).

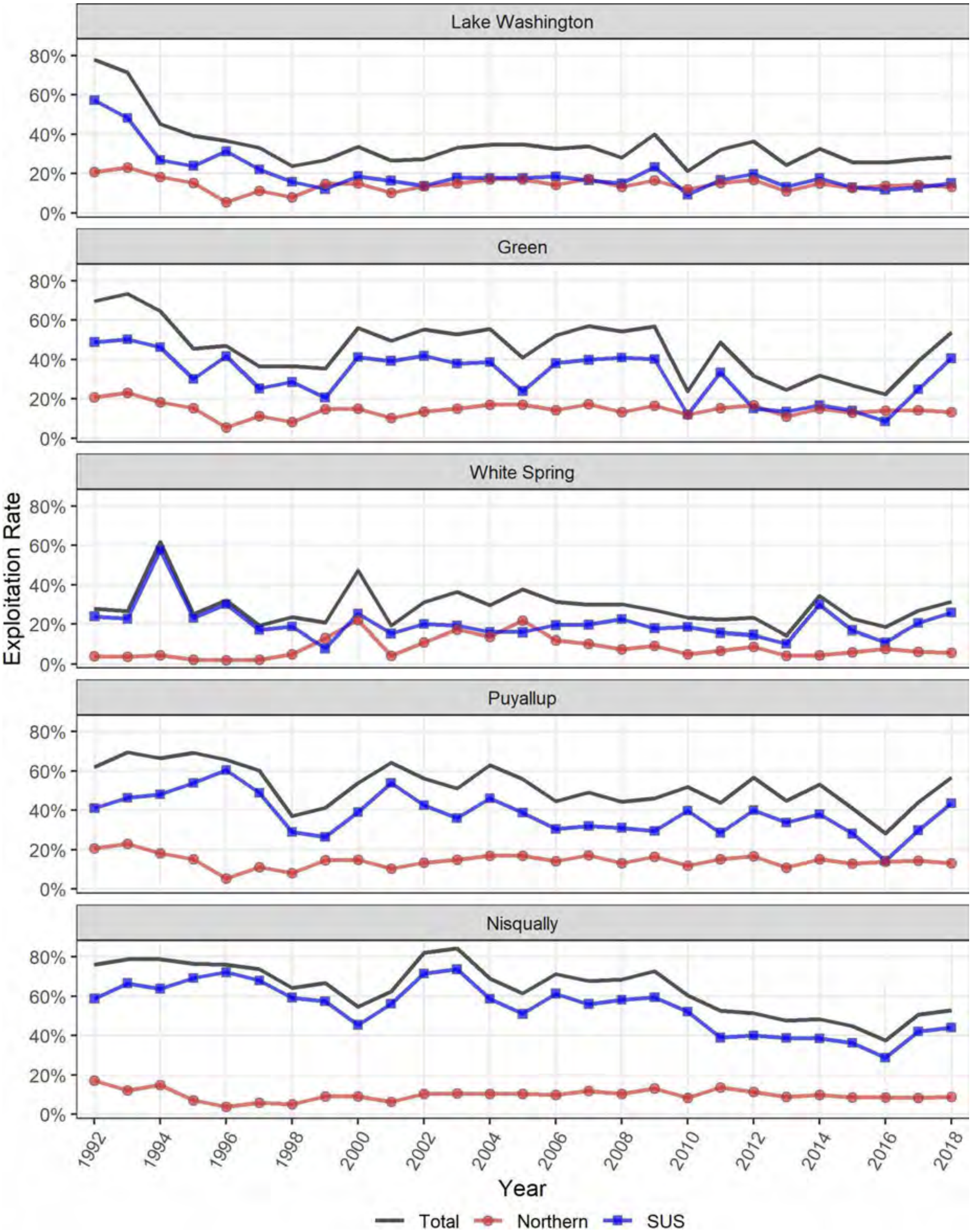

Figure 5. Total harvest exploitation of mid- and south-Puget Sound Chinook salmon populations from (pers. comm. J. Carey, NMFS WCR).

Limiting factors and other areas of concern

Limiting factors described in SSDC (2007) and reiterated in NMFS (2016b) 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 2015b). 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) (Table 13) 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, 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.

2.2.1.2 *Status of Puget Sound Steelhead*

The Puget Sound steelhead DPS was listed as a threatened species under the ESA on May 11, 2007 (72 FR 26722). Subsequent status assessments of the DPS after the ESA-listing decision have found that the status of Puget Sound steelhead regarding risk of extinction has not changed substantially (81 FR 33468, May 26, 2016)(Ford et al. 2011a; NMFS 2016b; Ford 2022). As mentioned above, on October 4, 2019 NMFS published a Federal Register notice (84 FR 53117), announcing NMFS' intent to initiate a new 5-year status review for 28 listed species of Pacific salmon and steelhead and requesting updated information from the public to inform the most recent five-year status review. On March 24, 2020, NMFS extended the public comment period, from the original March 27, 2020, through May 26, 2020 (85 FR 16619). The NWFSC finalized its latest viability assessment, for Pacific Northwest salmon and steelhead listed under the ESA, in January of 2022 (Ford 2022). The NMFS' WCR is currently preparing the five-year status review documents for the Puget Sound region, with anticipated completion in 2024.

At the time of listing, the PSSBRT considered the major risk factors associated with spatial structure and diversity of Puget Sound steelhead to be: (1) the low abundance of several summer run populations; (2) the sharply diminishing abundance of some winter steelhead populations, especially in south Puget Sound, Hood Canal, and the Strait of Juan de Fuca; and (3) continued releases of out-of-DPS hatchery fish from Skamania-derived summer run and Chambers Creek-derived winter run stocks (Discussed further in section 2.4.1; Hard et al. 2007; Hard et al. 2015). Loss of diversity and spatial structure were judged to be "moderate" risk factors (Hard et al. 2007). In 2011 the BRT identified degradation and fragmentation of freshwater habitat, with consequential effects on connectivity, as the primary limiting factors and threats facing the Puget Sound steelhead DPS (Ford et al. 2011a). The BRT also determined that most of the steelhead populations within the DPS continued to show downward trends in estimated abundance, with a few sharp declines (Ford et al. 2011a). The 2015 status review concurred with the earlier BRT review that harvest and hatchery production of steelhead in Puget Sound were at low levels and not likely to increase substantially in the foreseeable future, thus these risks have been reduced since the time of listing. However, unfavorable environmental trends previously identified (Ford et al. 2011a) were expected to continue (Hard et al. 2015). The Ford (2022) assessment also indicated that poor environmental conditions, including warm stream temperatures, reduced summer river flow, and low marine survival are expected to continue and will likely constrain any rebound in VSP parameters for Puget Sound steelhead in the near term

As part of the recovery planning process, NMFS convened The Puget Sound Steelhead Technical Recovery Team (PSSTRT) in 2011 to identify historic populations and develop viability criteria for the recovery plan. The PSSTRT delineated populations and completed a set of population viability analyses (PVAs) for these Demographically Independent Populations (DIPs) and Major Population Groups (MPGs) within the DPS that are summarized in the final draft viability criteria reports (Puget Sound Steelhead Technical Recovery Team 2011; PSSTRT 2013; NWFSC 2015a). This framework and associated analysis provided a technical foundation for the recovery criteria and recovery actions identified in the subsequent Puget Sound Steelhead Recovery Plan (NMFS 2019h) at the watershed scale, and higher across the Puget Sound Steelhead DPS.

The populations within the Puget Sound steelhead DPS are aggregated into three extant MPGs containing a total of 32 DIPs based on genetic, environmental, and life history characteristics (Puget Sound Steelhead Technical Recovery Team 2011; Hard et al. 2015; Ford 2022). Populations include summer steelhead only, winter steelhead only, or a combination of summer and winter run timing (e.g., winter run, summer run or summer/winter run). Figure 6 illustrates the DPS, MPGs, and DIPs for Puget Sound steelhead.

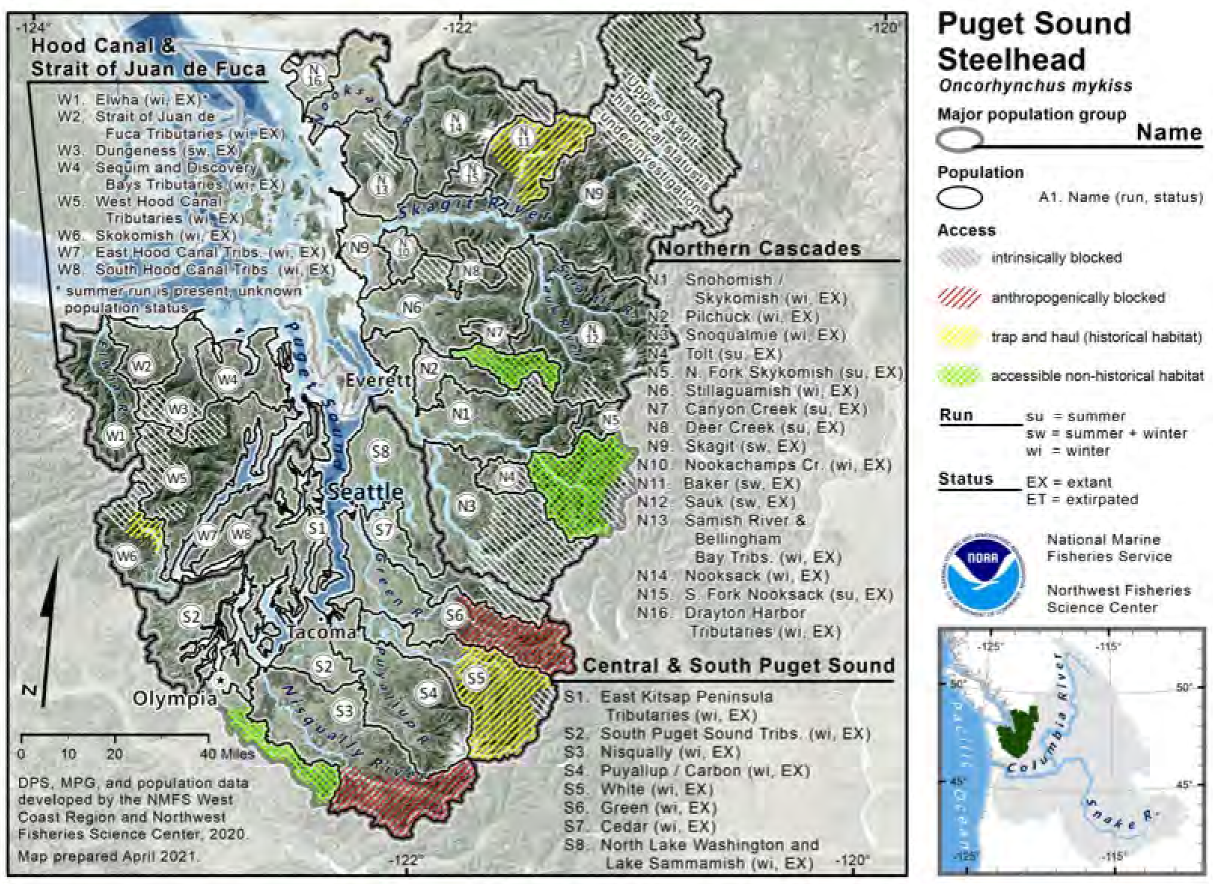

Figure 6. Map of the Puget Sound Steelhead DPS's spawning and rearing areas, identifying 32 demographically independent populations (DIPs) within 3 major population groups (MPGs). The 3 steelhead MPGs are Northern Cascades, Central & South Puget Sound, and Hood Canal & Strait of Juan de Fuca. Areas where dams block anadromous access to historical habitat is marked in red cross-hatching; and areas where historical habitat is accessible via trap and haul programs is marked in yellow cross-hatching. Areas where the laddering of falls has provided access to non-historical habitat is marked in green cross-hatching. Finally, historically inaccessible portions of watersheds are marked in grey and white cross-hatching (Ford 2022).

NMFS adopted a recovery plan for Puget Sound Steelhead on December 20, 2019 (https://www.fisheries.noaa.gov/resource/document/esa-recovery-plan-puget-sound-steelhead-distinct-population-segment-oncorhynchus). The Puget Sound Steelhead Recovery Plan (Plan) (NMFS 2019h) provides guidance to recover the species to the point that it can be naturally self-sustaining over the long term. To achieve full recovery, steelhead populations in Puget Sound need to be robust enough to withstand natural environmental variation and some catastrophic events, and they should be resilient enough to support harvest and habitat loss due to human population growth. The Plan aims to improve steelhead viability by addressing the pressures that contribute to the current condition: habitat loss/degradation, water withdrawals, declining water quality, fish passage barriers, dam operations, harvest, hatcheries, climate change effects, and reduced early marine survival. NMFS is using the recovery plan to organize and coordinate recovery of the species in partnership with state, local, tribal, and federal resource managers, and the many watershed restoration partners in the Puget Sound. Consultations, including this one, will incorporate information from the Plan (NMFS 2019h).

In the Plan, NMFS and the PSSTRT modified the 2013 and 2015 PSSTRT viability criteria to produce the viability criteria for Puget Sound steelhead, as described below:

- All three MPGs (North Cascade, Central-South Puget Sound, and Hood Canal-Strait of Juan de Fuca) (Figure 6) must be viable (Hard et al. 2015). The three MPGs differ substantially in key biological and habitat characteristics that contribute in distinct ways to the overall viability, diversity, and spatial structure of the DPS.
- There must be sufficient data available for NMFS to determine that each MPG is viable.

The Plan (NMFS 2019h) also established MPG-level viability criteria. The following are specific criteria are required for MPG viability:

- At least 50 percent of steelhead populations in the MPG achieve viability.
- Natural production of steelhead from tributaries to Puget Sound that are not identified in any of the 32 identified populations provides sufficient ecological diversity and productivity to support DPS-wide recovery.
- In addition to the minimum number of viable DIPs (50%) required above, all DIPs in the MPG must achieve an average MPG-level viability that is equivalent to or greater than the geometric mean (averaged over all the DIPs in the MPG) viability score of at least 2.2 using the 1–3 scale for individual DIPs described under the DIP viability discussion in the PSSTRT Viability Criteria document (Hard et al. 2015). This criterion is intended to ensure that MPG viability is not measured (and achieved) solely by the strongest DIPs, but also by other populations that are sufficiently healthy to achieve MPG-wide resilience. The Plan allows for an alternative evaluation method to that in Hard et al. (2015) may be developed and used to assess MPG viability.

The Plan (NMFS 2019h) also identified specific DIPs in each of the three MPGs which must attain viability. These DIPs, by MPG, are described as follows:

For the **North Cascades MPG** eight of the sixteen DIPs in the North Cascades MPG must be viable. The eight (five winter-run and three summer-run) DIPs described below must be viable to meet this criterion:

- Of the eleven DIPs with winter or winter/summer runs, five must be viable:

- Nooksack River Winter-Run;
- Stillaguamish River Winter-Run;
- One from the Skagit River (either the Skagit River Summer-Run and Winter-Run or the Sauk River Summer-Run and Winter-Run);
- One from the Snohomish River watershed (Pilchuck, Snoqualmie, or Snohomish/Skykomish River Winter-Run); and
- One other winter or summer/winter run from the MPG at large.

The rationale for this is that there are four major watersheds in this MPG, and one viable population from each will help attain geographic spread and habitat diversity within core extant steelhead habitat (NMFS 2019h). Of the five summer-run DIPs in this MPG, three must be viable, representing each of the three major watersheds containing summer-run populations (Nooksack, Stillaguamish, Snohomish rivers). Therefore, the priority summer-run populations are as follows:

- South Fork Nooksack River Summer-Run;
- One DIP from the Stillaguamish River (Deer Creek Summer-Run or Canyon Creek Summer-Run); and
- One DIP from the Snohomish River (Tolt River Summer-Run or North Fork Skykomish River Summer-Run).

As described, these priority populations in the North Cascades MPG include specific, winter or winter/summer-run populations from the Nooksack, Stillaguamish, Skagit or Sauk, and Snohomish River basins and three summer-run populations from the Nooksack, Stillaguamish, and Snohomish basins. These populations are targeted to achieve viable status to support MPG viability. Having viable populations in these basins assures geographic spread, provides habitat diversity, reduces catastrophic risk, and increases life-history diversity (NMFS 2019h).

For the **Central and South Puget Sound MPG** four of the eight DIPs in the Central and South Puget Sound MPG must be viable. The four DIPs described below must be viable to meet this criterion:

- Green River Winter-Run;
- Nisqually River Winter-Run;
- Puyallup/Carbon rivers Winter-Run, or the White River Winter-Run; and
- At least one additional DIP from this MPG: Cedar River, North Lake Washington/Sammamish Tributaries, South Puget Sound Tributaries, or East Kitsap Peninsula Tributaries.

The rationale for this prioritization is that steelhead inhabiting the Green, Puyallup, and Nisqually River watersheds currently represent the core extant steelhead populations and these watersheds contain important diversity of stream habitats in the MPG.

For the **Hood Canal and Strait of Juan de Fuca MPG** four of the eight DIPs in the Hood Canal and Strait of Juan de Fuca MPG must be viable. The four DIPs described below must be viable to meet this criterion:

- Elwha River Winter/Summer-Run (see rationale below);
- Skokomish River Winter-Run;
- One from the remaining Hood Canal populations: West Hood Canal Tributaries Winter-Run, East Hood Canal Tributaries Winter-Run, or South Hood Canal Tributaries Winter-Run; and
- One from the remaining Strait of Juan de Fuca populations: Dungeness Winter-Run, Strait of Juan de Fuca Tributaries Winter-Run, or Sequim/Discovery Bay Tributaries Winter-Run.

The rationale for this prioritization is that the Elwha and Skokomish rivers are the two largest single watersheds in the MPG and bracket the geographic extent of the MPG. Furthermore, both Elwha and Skokomish populations have recently exhibited summer-run life histories, although the Dungeness River population was the only summer/winter run in this MPG recognized by the PSTRT in Hard et al. (2015). Two additional populations, one population from the Strait of Juan de Fuca area and one population from the Hood Canal area, are needed for a viable MPG to maximize geographic spread and habitat diversity.

Lastly, the Plan (NMFS 2019h) also identified additional attributes, or characteristics which should be associated with a viable MPG.

- All major diversity and spatial structure conditions are represented, based on the following considerations:
- Populations are distributed geographically throughout each MPG to reduce risk of catastrophic extirpation; and
- Diverse habitat types are present within each MPG (one example is lower elevation/gradient watersheds characterized by a rain-dominated hydrograph and higher elevation/gradient watersheds characterized by a snow-influenced hydrograph).

Federal and State steelhead recovery and management efforts will provide new tools and data and technical analyses to further refine Puget Sound steelhead population structure and viability, if needed, and better define the role of individual populations at the watershed level and in the DPS.

Spatial Structure and Diversity

The Puget Sound Steelhead DPS includes all naturally spawned anadromous *O. mykiss* (steelhead) populations originating below natural and manmade impassable barriers 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. Non-anadromous ‘‘resident’’ *O. mykiss* occur within the range of Puget Sound steelhead but are not part of the DPS due to marked differences in physical, physiological, ecological, and behavioral characteristics (Hard et al. 2007). In October of 2016, NMFS proposed revisions to inclusion of the hatchery programs as part of Pacific salmon ESUs and steelhead DPSs listed under the ESA (81 FR 72759). NMFS issued its final rule in December of 2020 (85 FR 81822). This final rule includes steelhead from five artificial propagation programs in the Puget Sound steelhead DPS: the Green River Natural Program; White River Winter Steelhead Supplementation Program; Hood Canal Steelhead Supplementation Program; the Lower Elwha Fish Hatchery Wild Steelhead Recovery Program;

and the Fish Restoration Facility Program (85 FR 81822, December 17, 2020).

In 2013, the PSSTRT completed its evaluation of factors that influence the diversity and spatial structure VSP criteria for steelhead in the DPS. For spatial structure, this included the fraction of available intrinsic potential rearing and spawning habitat that is occupied compared to what is needed for viability.[13] For diversity, these factors included hatchery fish production, contribution of resident fish to anadromous fish production, and run timing of adult steelhead. Quantitative information on spatial structure and connectivity was not available for most Puget Sound steelhead populations, so a Bayesian Network framework was used to assess the influence of these factors on steelhead viability at the population, MPG, and DPS scales. The PSSTRT concluded that low population viability was widespread throughout the DPS and populations showed evidence of diminished spatial structure and diversity. Specifically, population viability associated with spatial structure and diversity was highest in the Northern Cascades MPG and lowest in the Central and South Puget Sound MPG (Puget Sound Steelhead Technical Recovery Team 2011). Diversity was generally higher for populations within the Northern Cascades MPG, where more variability in viability was expressed and diversity generally higher, compared to populations in both the Central and South Puget Sound and Hood Canal and Strait of Juan de Fuca MPG, where diversity was depressed and viabilities were generally lower (NWFSC 2015a). Most Puget Sound steelhead populations were given intermediate scores for spatial structure and low scores for diversity because of extensive hatchery influence, low breeding population sizes, and freshwater habitat fragmentation or loss (NWFSC 2015a). The Puget Sound Steelhead Technical Recovery Team (PSSTRT) concluded that the Puget Sound DPS was at very low viability, considering the status of all three of its constituent MPGs, and many of its 32 DIPs (Hard et al. 2015). For spatial structure there were a number of events that occurred in Puget Sound during the last review period (since 2015) that are anticipated to improve status populations within several of the MPGs within the DPS. These will be discussed further in the Environmental Baseline Section 2.4.1.

Since the PSSTRT completed its 2013 review, there have been a number of genetic studies related to Puget Sound steelhead population structure and hatchery-origin steelhead introgression. Additional analyses of Puget Sound steelhead population demographics, distribution, and habitat are provided in the 2019 recovery Plan (Ford 2022). Since publication of the NWFSC report in 2015, reductions in hatchery programs founded from non-listed and out-of-DPS stocks (i.e., Skamania) have occurred. The magnitude of these changes will be discussed in detail in Section 2.4.1. In addition, the fraction of out-of-DPS hatchery steelhead spawning naturally are low for many rivers (NWFSC 2015a; NMFS 2016h; 2016g). The fraction of natural-origin steelhead spawners was 0.9 or greater for the 2005-2009 and 2010-2014 time periods for all populations where data was available. For 17 of 22 DIPs across the DPS, the five-year average for the fraction of natural-origin steelhead spawners exceeded 0.75 from 2005 to 2009; this average was near 1.0 for 8 populations, where data were available, from 2010 to 2014 (NWFSC 2015a). However, the fraction of natural-origin steelhead spawners could not be estimated for a substantial number of DIPs during the 2010-2014 period, or for the most recent

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[13] Where intrinsic potential is the area of habitat suitable for steelhead rearing and spawning, at least under historical conditions (Puget Sound Steelhead Technical Recovery Team 2011; PSSTRT 2013).

2015-2019 timeframe (Ford 2022). In some river systems, such as the Green River, Snohomish/Skykomish Rivers, and the Stillaguamish Rivers the estimated levels of hatchery-origin spawners were higher than some guidelines recommend (e.g., no more than 5% hatchery-origin spawners on spawning grounds for isolated hatchery programs (HSRG 2009) over the 2005- 2009 and 2010-2014 timeframes. The 2022 NWFSC Biological Viability Assessment (Ford 2022) states that a third of the 32 Puget Sound steelhead populations continue to lack monitoring of abundance data, and in most cases it is likely that abundances are very low. Steelhead hatchery programs are discussed in further detail in the Environmental Baseline (Section 2.4.1).

Early winter-run fish produced in isolated hatchery programs are derived from Chambers Creek stock in southern Puget Sound, which has been selected for early spawn timing, a trait known to be inheritable in salmonids.[14] Summer-run fish produced in isolated hatchery programs were historically derived from the Skamania River summer stock in the lower Columbia River Basin (i.e., from outside the DPS). The production and release of hatchery fish of both run types (winter and summer) may continue to pose risk to diversity in natural-origin steelhead in the DPS, as described in Hard et al. (2007) and Hard et al. (2015). However, the 2022 NWFSC Biological Viability Assessment (Ford 2022) states that risks to natural-origin Puget Sound steelhead that may be attributable to hatchery-related effects has decreased since the 2015 status review due to reductions in production of non-listed stocks, and the replacement with localized stocks. The three summer steelhead programs continuing to propagate Skamania derived stocks from outside of Puget Sound should be phased out completely by 2031(NMFS 2019a; Ford 2022). Lastly, annual reporting from the operators and current science suggest that risks remain at the same low to negligible levels as evaluated in 2016 and 2019 (NMFS 2016c; 2019a; 2019h).

More information on Puget Sound steelhead spatial structure and diversity can be found in NMFS's PSSTRT viability report and NMFS's status review update on salmon and steelhead (NWFSC 2015a; Ford 2022).

Abundance and Productivity

Steelhead abundance estimates are available for seven of the 11 winter-run DIPs and one of the five summer-run DIPs in the Northern Cascades MPG,[15] five of the eight winter-run DIPs in the Central and South Puget Sound MPG,[16] and seven of the eight winter-run DIPs in the Hood Canal and Strait of Juan de Fuca MPG.[17] Little or no data is available on summer run

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[14] The natural Chambers Creek steelhead stock is now extinct.

[15] Nooksack River, Samish River/Bellingham Bay Tributaries, Skagit River, Pilchuck River, Snohomish/Skykomish River, Snoqualmie River, and Stillaguamish River winter-run DIPs as well as the Tolt River summer-run DIP.

[16] Cedar River, Green River, Nisqually River, North Lake Washington/Lake Sammamish, Puyallup River/Carbon River, and White River winter-run DIPs.

[17] Dungeness River, East Hood Canal Tributaries, Elwha River, Sequim/Discovery Bays Tributaries, Skokomish River, South Hood Canal Tributaries, Strait of Juan de Fuca Tributaries, and West Hood Canal Tributaries winter-run DIPs.

populations to evaluate extinction risk or abundance trends. Due to their small population size and the complexity of monitoring fish in headwater holding areas, summer steelhead have not been broadly monitored. Data continue to only be available for one summer-run DIP, the Tolt River steelhead population in the Northern Cascades MPG for the 2015-2019-time frame.

Long-term abundance of steelhead in populations for which data are currently available (Figure 7) has shown a generally declining trend across much of the DPS over the full period of the abundance data available for each DIP; however, the latest biological viability assessment update notes that in the nearer term, there has been a relative improvement in abundance and productivity (Ford 2022). Since 2015, 14 of the 22 populations indicate small to substantive increases in abundance,[18] though most steelhead populations remain small. From 2014 to 2019, eight of the 22 steelhead populations had fewer than 250 natural spawners annually, and 12 of the 22 steelhead populations had 500 or fewer natural spawners (Table 7).

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[18] South Hood Canal, Skokomish River, Westside Hood Canal Tributaries, Elwha River, Samish River/Bellingham Bay Tributaries, Nooksack River, Skagit River, Stillaguamish River, Pilchuck River, Cedar River, Green River, Puyallup River, Carbon River, and Nisqually River Nooksack River, Samish River/Bellingham Bays Tributaries, Skagit River, Stillaguamish River, Pilchuck River, Cedar River, Green River, Puyallup River, and Nisqually River show increasing trends (see Table 7) (Ford 2022).

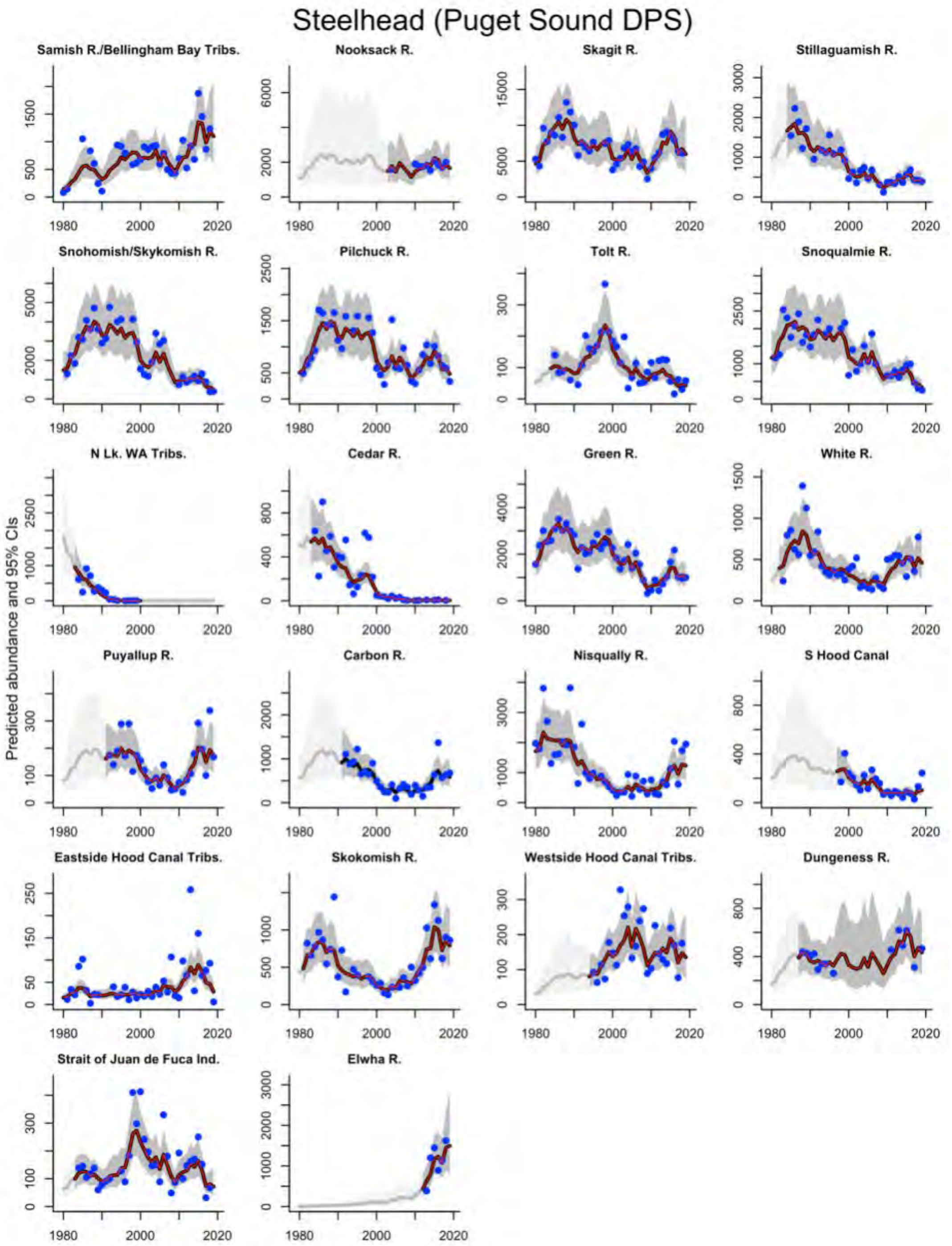

Figure 7. Smoothed trends of estimated total (thick black line, with 95% confidence interval in gray) and natural (thin red line) Puget Sound steelhead population spawning abundances. In portions of a time series where a population has no annual estimates, but smoothed spawning abundance is estimated from correlations with other populations, the smoothed estimate is shown in light gray. Points show the annual raw spawning abundance estimates. For some trends, the smoothed estimate may be influenced by earlier data points not included in the plot. Note; for this DPS, all abundance data are only natural-origin spawners. No information on hatchery fraction is available (Ford 2022).

Table 7. Five-year geometric mean of raw natural spawner counts for Puget Sound steelhead. This is the raw total spawner count times the fraction natural estimate, if available. In parentheses, the 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 none or only one estimate of natural spawners was available. A single value not in parentheses means that the fraction natural was 1.0 and thus, the total count was the same as the natural-origin count. 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 was used to compute the geometric mean. Percent change between the most recent two 5-year periods is shown on the far right. Key: HCSJF = Hood Canal & Strait of Juan de Fuca MPG; NC = Northern Cascades MPG; CPSC = Central & South Puget Sound MPG; W = winter; Su = summer (Ford 2022).

Population	MPG	1990-94	1995-99	2000-04	2005-09	2010-14	2015-19	% Change
South Hood Canal W	HCSJF	—	263	176	145	69	91	32
Eastside Hood Canal Tributaries W	HCSJF	27	21	25	37	60	54	–10
Skokomish River W	HCSJF	385	359	205	320	533	938	76
Westside Hood Canal Tributaries W	HCSJF	—	97	208	167	138	150	9
Dungeness River Su and W	HCSJF	356	—	—	—	517	448	–13
Strait of Juan de Fuca and Independent Tributaries W	HCSJF	89	191	212	118	151	95	–37
Elwha River W	HCSJF	—	—	—	—	680	1,241	82
Samish River/Bellingham Bay Tributaries W	NC	316	717	852	535	748	1,305	74
Nooksack River W	NC	—	—	—	—	1,745	1,906	9
Skagit River Su and W	NC	7,202	7,656	5,419	4,677	6,391	7,181	12
Stillaguamish River W	NC	1,078	1,166	550	327	386	487	26
Snohomish/Skykomish Rivers W	NC	3,629	3,687	1,718	2,942	975	690	–29
Pilchuck River W	NC	1,225	1,465	604	597	626	638	2
Snoqualmie River W	NC	1,831	2,056	1,020	1,250	706	500	–29
Tolt River Su	NC	112	212	119	70	108	40	–63
North Lake Washington Tributaries W	CSPS	60	4	—	—	—	—	—
Cedar River W	CSPS	241	295	37	12	4	6	50
Green River W	CSPS	2,062	2,585	1,885	1,045	662	1,289	95
White River W	CSPS	524	311	301	173	514	451	–12
Puyallup River W	CSPS	167	196	93	72	85	201	136
Carbon River W	CSPS	969	800	335	246	290	735	153
Nisqually River W	CSPS	1,200	754	409	446	477	1,368	187

The current abundance for Puget Sound steelhead populations, as estimated for the 2015-2019 time period (NMFS 2019h; WDFW 2021b; Ford 2022) is based on data for less than 40 percent of the DIPs (WDFW 2021b). However, these data indicate that the Puget Sound steelhead DPS is currently at less than 25% of recovery goals, as identified for the DIPs which had sufficient data to assess (WDFW 2021b). Where recent five-year abundance information is available, 30% (6 out of 20) of the populations are at less than 10% of their High Productivity Recovery Targets (lower abundance target), 65% (13 out of 20) of the populations are between 10% and 50% of lower abundance recovery targets, and 5% (1 out of 20) of populations are at 50% and 100% of the recovery target (Table 8)(Ford 2022).

Table 8. Recent (2015–19) 5-year geometric mean of raw natural spawner counts for Puget Sound steelhead populations and population groups compared with Puget Sound steelhead recovery plan high and low productivity recovery targets (). Asterisks indicate that the abundance is only a partial population estimate. Superscript *1*s (1) indicate that these populations have a combined target. Abundance is compared to the high-productivity individual DIP targets. Colors indicate the relative proportion of the recovery target currently obtained: red = <10%, orange = 10% > *x* < 50%, yellow = 50% > *x* < 100%, green = >100% (Ford 2022).

		Abundance		
			Target	
MPG	**Population**	**2015–19**	**High productivity**	**Low productivity**
HCSJF	South Hood Canal	91	2,100	7,100
HCSJF	Eastside Hood Canal Tributaries	93	1,800	6,200
HCSJF	Skokomish River	958	2,200	7,300
HCSJF	Westside Hood Canal Tributaries	150	2,500	8,400
HCSJF	Dungeness River	408	1,200	4,100
HCSJF	Strait of Juan de Fuca Independent Tributaries	95	1,000	3,300
HCSJF	Elwha River	1,241	2,619	2,619
HCSJF	Sequim and Discovery Bay Tributaries	n/a	500	1,700
NC	Samish River/Bellingham Bay Tributaries	1,305*	1,800	6,100
NC	Nooksack River	1,906	6,500	21,700
NC	Skagit River	7,181[1]	15,000	15,000
NC	Stillaguamish River	487	7,000	23,400
NC	Snohomish/Skykomish Rivers	690	6,100	20,600
NC	Pilchuck River	638	2,500	8,200
NC	Snoqualmie River	500	3,400	11,400
NC	Tolt River (SU)	40	300	1,200
NC	Drayton Harbor Tributaries	n/a	1,100	3,700
NC	South Fork Nooksack River (SU)	n/a	400	1,300
NC	Sauk River	[1]	15,000	15,000

NC	Nookachamps River	[1]	15,000	15,000
NC	Baker River	[1]	15,000	15,000
NC	Canyon Creek (SU)	n/a	100	400
NC	Deer Creek (SU)	n/a	700	2,300
NC	North Fork Skykomish River (SU)	n/a	200	500
CSPS	North Lake Washington Tributaries	n/a	4,800	16,000
CSPS	Cedar River	n/a	1,200	4,000
CSPS	Green River	1,282	5,600	18,700
CSPS	White River	130	3,600	12,000
CSPS	Puyallup/Carbon Rivers	136	4,500	15,100
CSPS	Nisqually River	1,368	6,100	20,500
CSPS	East Kitsap Tributaries	n/a	2,600	8,700
CSPS	South Sound Tributaries	n/a	6,300	21,200

Steelhead productivity has been variable for most populations since the mid-1980s (Figure 8). Since around 2000, productivity has fluctuated around replacement for Puget Sound steelhead populations, but the majority have predominantly been below replacement (NWFSC 2015a; Ford 2022). Some steelhead populations have shown signs that productivity has been above replacement in the most recent years for which data are available (2015-2019) (Figure 8). Steelhead populations with recent productivity estimates generally above replacement include the Samish River, Nooksack River, Skagit River, Green River, White River, Puyallup River, Nisqually River, the South, East, and West Hood Canal Tributaries, the Skokomish River, and the Elwha River (Figure 8)(NWFSC 2015a; Ford 2022).

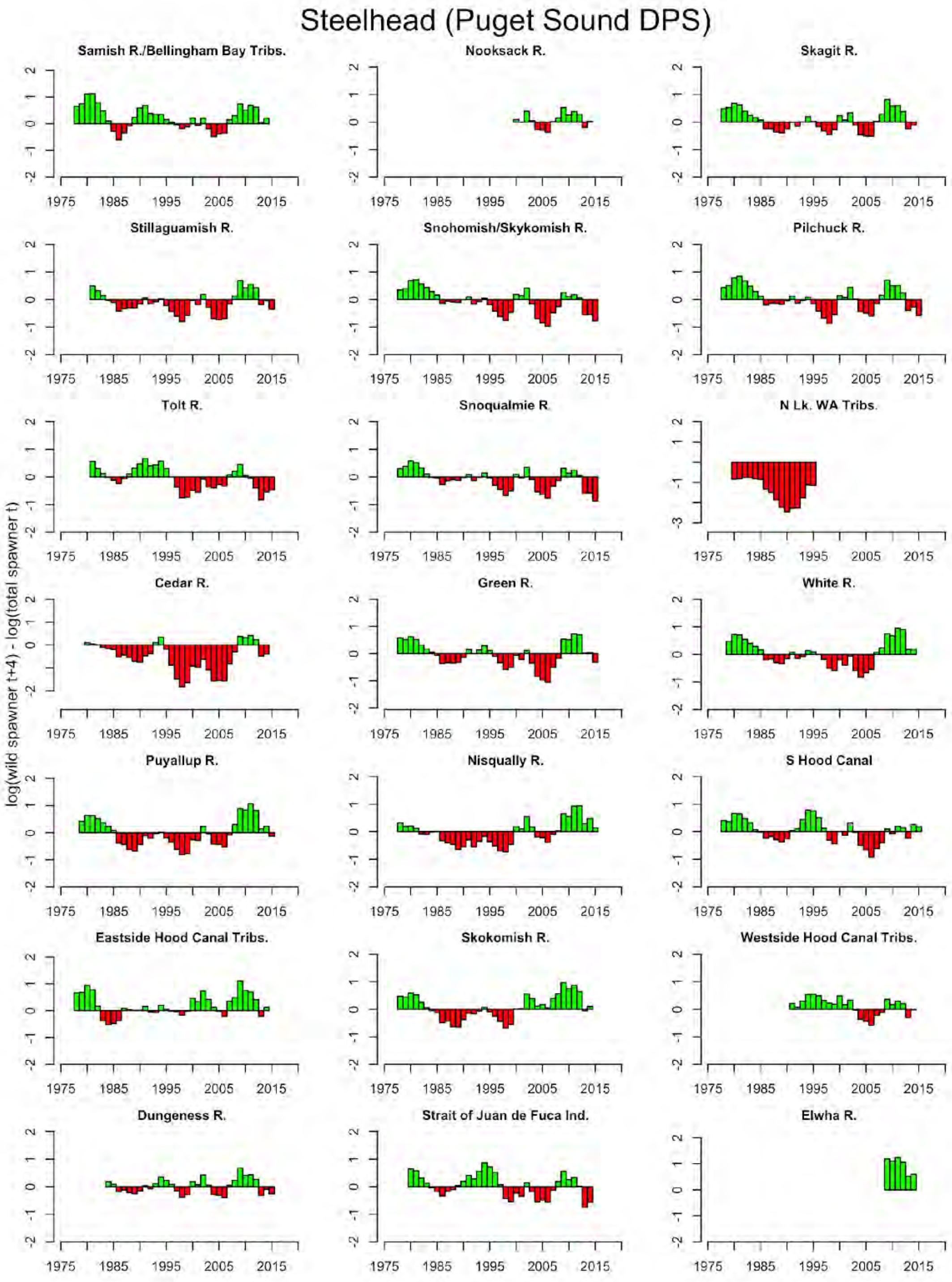

Figure 8. Trends in population productivity of Puget Sound steelhead, estimated as the log of the smoothed natural spawning abundance in year t minus the smoothed natural spawning abundance in year (t – 4) (Ford 2022).

Harvest can affect the abundance and overall productivity of Puget Sound steelhead. Since the 1970s and 1980s, harvest rates have differed greatly among various watersheds, but all harvest rates on Puget Sound steelhead in the DPS have declined (NWFSC 2015a). From the late 1970s to early 1990s, harvest rates on natural-origin steelhead averaged between 10% and 40%, with some populations in central and south Puget Sound[19] at over 60%. Harvest rates on natural-origin steelhead vary widely among watersheds, but have declined since the 1970s and 1980s, and are now stable at generally less than 5% (see Figure 9)(NWFSC 2015a; WDFW and PSTIT 2016a; WDFW and PSIT 2017; WDFW and PSTIT 2018a; 2019; 2020; Ford 2022).

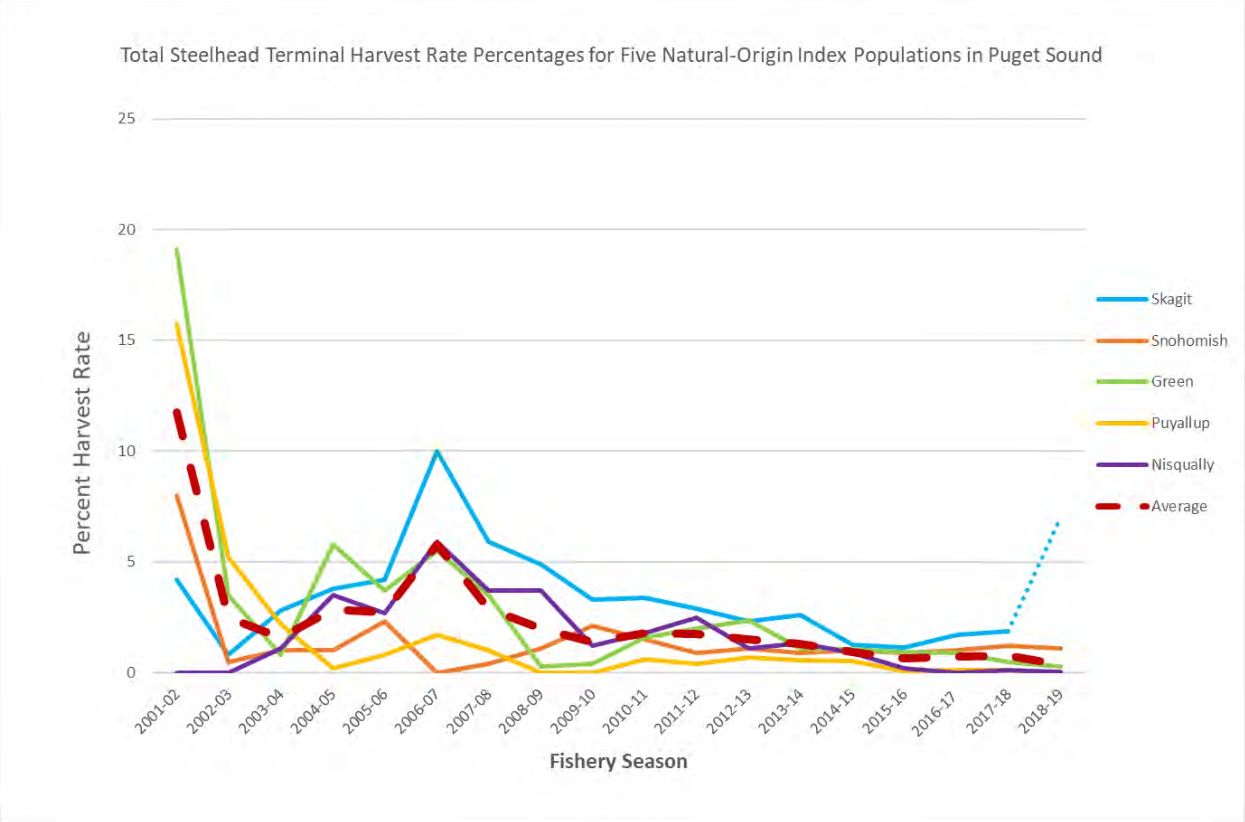

Figure 9. Total Steelhead Terminal Harvest Rate Percentages for Five Natural-Origin Index Populations in Puget Sound from 2001-2019 (NWFSC 2015a; WDFW and PSIT 2016; 2017; WDFW and PSTIT 2018a; 2019; 2020). The dotted line represents harvest rates specific to natural-origin steelhead within the Skagit basin, as reported annually under the Skagit Steelhead Resource Management Plan (RMP) approved by NMFS in 2018 (NMFS 2018c).

Overall, the status of steelhead based on the best available data on spatial structure, diversity, abundance, and productivity has improved since the last status review in 2015 (Ford 2022). Recent increases in abundance observed for the majority (15 out of 21) of steelhead DIPs where data are available from 2015-2019 have been modest, and are generally within the range of variability observed in the time series for which data is available (NWFSC 2015a). The

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[19] Green River and Nisqually River populations.

production of hatchery fish founded from non-listed stocks of both run types (Chambers (EWS) winter and Skamania (ESS) summer) continues to pose risk to diversity to natural-origin steelhead in the DPS (Hard et al. 2007; Hard et al. 2015; NMFS 2019h; Ford 2022). However, hatchery production has declined in recent years across the DPS, especially for non-listed stocks, and the fraction of hatchery spawners are low for many rivers. In addition, discontinuation of the release of Skamania hatchery-origin summer-run steelhead from the three programs currently operating is planned for the near future (Ford 2022).

Increasing estimates of productivity for a few steelhead populations during the 2011-2015 time frame are encouraging but included only one to a few years, thus, the patterns of improvement in productivity were not widespread, or considered certain to continue into the 2015-2019 time frame (Hard et al. 2015), nor where they widespread or consistent across the MPGs for the 2015-2019 period based on the Ford (2022) assessment. Total harvest rates continue to be at the low levels considered in the last two status updates (NWFSC 2015a; Ford 2022), and the Recovery Plan (NMFS 2019h) to be unlikely to substantially reduce spawner abundance for most Puget Sound steelhead populations. These rates are unlikely to increase substantially in the foreseeable future. Recovery efforts in conjunction with improved ocean and climatic conditions have resulted in improved status for the majority of populations in this DPS; however, absolute abundances are still low, especially summer-run populations, and the DPS remains at high to moderate risk (Ford 2022).

Limiting factors

NMFS, in its listing document and designation of critical habitat (77 FR 26722, May 11, 2007; 76 FR 1392, January 10, 2011), noted that the factors for decline for Puget Sound steelhead also persist as limiting factors. Limiting factors are defined as impaired physical, biological, or chemical features (e.g., inadequate spawning habitat, high water temperature, insufficient prey resources) and associated ecological processes and interactions experienced by the fish that result in reductions in VSP parameters (abundance, productivity, spatial structure, and diversity). This analysis, combined with Ford (2022) and the Puget Sound Steelhead Recovery Plan (NMFS 2019h), identified the following factors, as well as ten primary pressures associated with the listing decision for Puget Sound steelhead, and subsequent affirmations of the listing, as those limiting steelhead recovery:

- In addition to being a factor that contributed to the present decline of Puget Sound steelhead populations, the continued destruction and modification of steelhead habitat is the principal factor limiting the viability of the Puget Sound steelhead DPS into the foreseeable future. This includes agriculture, residential, commercial and industrial development (including impervious surface runoff), timber management activities, water withdrawals and altered flows.
- Fish passage barriers at road crossings and dams.
- Reduced spatial structure for steelhead in the DPS.
- Reduced habitat quality through changes in river hydrology and temperature profile, which are expected to increase with continuing climate change.
- Reduced downstream gravel recruitment, and reduced movement of large woody debris.

- In the lower reaches of many rivers and their tributaries in Puget Sound, urbanization has caused increased flood frequency and peak flows during storms, and reduced groundwater-driven summer flows. Altered stream hydrology has resulted in gravel scour, bank erosion, and sediment deposition.
- Dikes, hardening of banks with riprap, and channelization, which have reduced river braiding and sinuosity, have increased the likelihood of gravel scour and dislocation of rearing juveniles.
- Widespread declines in adult abundance (total run size), despite significant reductions in harvest over the last 25 years. Harvest is not considered a significant limiting factor for PS steelhead due to low harvest rates.
- Threats to genetic diversity and of ecological interactions posed by use of two hatchery steelhead stocks (Chambers Creek and Skamania) inconsistent with wild stock recovery throughout the DPS. However, the risk to the species' persistence that may be attributable to hatchery-related effects has declined since the last status review, based on hatchery risk reduction measures that have been implemented. Improvements in hatchery operations associated with on-going ESA review and determination processes are expected to reduce hatchery-related risks. Further, hatchery releases of steelhead founded from non-native or out of DPS stocks have declined, and are expected to decrease further or cease as a term of recent 4(d) authorizations.
- Declining diversity in the DPS, including the uncertain, but likely weak, status of summer run fish in the DPS.
- High rates of juvenile mortality in estuarine and marine waters of Puget Sound, attributed to marine mammal predation, parasite prevalence, and contaminant loads.
- Concerns regarding existing regulatory mechanisms, including: lack of documentation or analysis of the effectiveness of land-use regulatory mechanisms and land-use management plans, lack of reporting and enforcement for some regulatory programs, certain Federal, state, and local land and water use decisions continue to occur without the benefit of ESA review. State and local decisions have no Federal nexus to trigger the ESA Section 7 consultation requirement, and thus certain permitting actions allow direct and indirect species take and/or adverse habitat effects.

2.2.1.3 *Status of Puget Sound/Georgia Basin Rockfish*

Detailed assessments of yelloweye rockfish (*Sebastes ruberrimus*) and bocaccio (*S. paucispinis*) can be found in the recovery plan (NMFS 2017g) and the 5-year status review (Tonnes et al. 2016), and are summarized here. We describe the status of yelloweye rockfish and bocaccio with nomenclature referring to specific areas of Puget Sound and the Strait of Georgia. Though these water bodies, together with the Strait of Juan de Fuca, collectively make up the Georgia Basin, or Salish Sea, we use Puget Sound in the broad sense to refer to all U.S. waters of the listed DPSs of bocaccio and yelloweye rockfish (Figure 10 and Figure 11). Using this nomenclature, U.S. waters north of the San Juan Islands are considered part of Puget Sound, despite cartographically being the southern Strait of Georgia.

Puget Sound is the second largest estuary in the United States, located in northwest Washington

State and covering an area of about 900 square miles (2,330 square km), including 2,500 miles (4,000 km) of shoreline. We subdivide Puget Sound into five interconnected subbasins defined by the presence of shallow areas called sills, which restrict water flow and prolong flushing rates such that water chemistry and biology vary substantially. These subbasins largely align with the WDFW Marine Catch Areas (MCAs), defined as: (1) the San Juan/Strait of Juan de Fuca/southern Strait of Georgia Basin, also referred to as “North Sound” (the portion of MCA 6 east of Port Angeles and all of MCA 7); (2) Main Basin (MCAs 9, 10, and 11); (3) Whidbey Basin (MCAs 8–1 and 8–2); (4) South Sound (MCA 13); and (5) Hood Canal (MCA 12). We use the term “Puget Sound proper” to refer collectively to all basins except North Sound.

The Puget Sound/Georgia Basin DPS of yelloweye rockfish is listed under the ESA as threatened, and the Puget Sound/Georgia Basin DPS of bocaccio is listed as endangered (75 FR 22276, April 28, 2010). On January 23, (2017b) (82 FR 7711), we extended the yelloweye rockfish DPS, which initially aligned with the DPS of bocaccio, further north in the Johnstone Strait area of Canada, a difference apparent by comparing Figure 10 and Figure 11. This extension was the result of new genetic analysis of yelloweye rockfish. The DPSs include all yelloweye rockfish and bocaccio found in waters of Puget Sound, the Strait of Georgia, and the Strait of Juan de Fuca east of the Victoria Sill (Figure 10 and Figure 11) regardless of their origin.

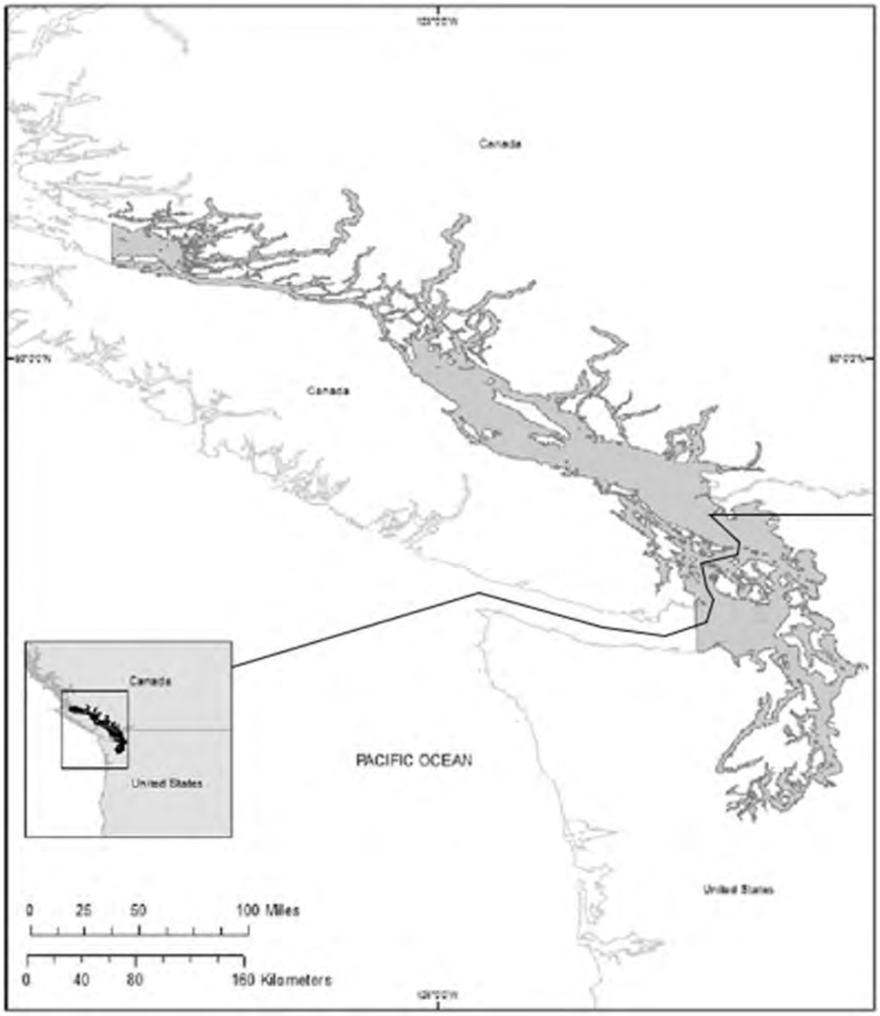

Figure 10. Geographic scope of the yelloweye rockfish distinct population segment (DPS), spanning the U.S.-Canadian border.

Figure 11. Geographic scope of the bocaccio distinct population segment (DPS), spanning the U.S.-Canadian border.

The life histories of yelloweye rockfish and bocaccio include a larval/pelagic juvenile stage, followed by demersobenthic juvenile, subadult, and adult stages. Much of the life history and habitat use for these two species is similar, with important differences noted below. All species of rockfish fertilize their eggs internally and the young are extruded as larvae. A mature female yelloweye rockfish or bocaccio can produce from several thousand to well over a million eggs each breeding cycle (Love, Yoklavich and Thorsteinson 2002; Arthur et al. 2022). Breeding cycles tend to occur annually, but skip spawning (i.e., biennial reproductive cycle for some individuals) has been recorded in various rockfish species (e.g., Nichol and Pikitch 1994a; Hannah and Parker 2007; Thompson and Hannah 2010; Lefebvre and Field 2015; Head et al. 2016), including yelloweye (Gertseva and Cope 2017; COSEWIC 2020; Arthur et al. 2022) and bocaccio (He et al. 2015). Larvae can make small local movements to pursue food immediately after birth (Tagal et al. 2002), but are likely initially passively distributed with prevailing currents until they are large enough to progress toward preferred habitats. Larvae and pelagic juveniles of some species, especially splitnose rockfish (S. diploproa), have been observed under free-floating algae, seagrass, and detached kelp (Buckley et al. 1995; Shaffer et al. 1995; Love, Yoklavich and Thorsteinson 2002), but are also distributed throughout the water column (Weis

2004). Unique oceanographic conditions within Puget Sound proper result in most larvae staying within the subbasin where they are released (e.g., Hood Canal) rather than being broadly dispersed (Drake et al. 2010), but dispersal patterns are highly variable among subbasin and season of larval release (Andrews et al. 2021). Larvae released in North Sound may disperse widely throughout inland waters of the DPSs, as well as offshore waters of Washington and British Columbia, before reaching the end of their planktonic period.

When bocaccio reach sizes of 1 to 3.5 inches (3 to 9 cm), or approximately 3 to 6 months old, they settle onto shallow nearshore waters in rocky or cobble substrates with or without kelp (Love, Carr and Haldorson 1991; Love, Yoklavich and Thorsteinson 2002). These habitat features offer a beneficial mix of warmer temperatures, food, and refuge from predators (Love, Carr and Haldorson 1991). Areas with floating and submerged kelp species support the highest densities of most juvenile rockfish (Carr 1983; Haldorson and Richards 1987; Matthews 1989; Hayden-Spear 2006). Unlike bocaccio, juvenile yelloweye rockfish do not typically occupy intertidal waters (Love, Carr and Haldorson 1991; Studebaker, Cox and Mulligan 2009), but settle in 98 to 131 feet (30 to 40 m) of water near the upper depth range of adults (Yamanaka and Lacko 2001), and have been observed initially settling as shallow as 49 feet (15 m) during their first summer.

Subadult and adult yelloweye rockfish and bocaccio typically utilize habitats with moderate to extreme steepness, complex bathymetry, and rock and boulder-cobble complexes (Love, Yoklavich and Thorsteinson 2002). Within the boundaries of the DPSs, both species have been documented in areas of high relief rocky and non-rocky substrates such as sand, mud, and other unconsolidated sediments (Washington 1977; Miller and Borton 1980; Pacunski, Palsson and Greene 2013; Andrews et al. 2018; Pacunski et al. 2020; Lowry et al. 2022a). Yelloweye rockfish remain near the bottom and have small home ranges, while bocaccio have larger home ranges, move long distances, and spend time suspended in the water column (Love, Yoklavich and Thorsteinson 2002). Adults of each species are most commonly found between 131 to 820 feet (40 to 250 m) (Orr, Brown and Baker 2000; Love, Yoklavich and Thorsteinson 2002).

Yelloweye rockfish are one of the longest-lived of the rockfishes, with some individuals reaching more than 100 years of age (Yamanaka et al. 2006). They reach 50 percent maturity at sizes around 16 to 20 inches (40 to 50 cm) and ages of 15 to 20 years (Rosenthal et al. 1982; Yamanaka and Kronlund 1997a). In waters off California, however, they may reach maturity as early as 6 to 8 years of age (Wyllie-Echeverria 1987). Bocaccio are notoriously difficult to age, and their maximum age has been reported as being as high as 57 years (Ralston and Ianelli 1998). Application of advanced aging techniques, however, places the maximum age closer to 40 years (COSEWIC 2002; Pearson, Lefebvre and He 2015), with evidence that this attribute varies with latitude. Bocaccio reach reproductive maturity between ages 3 and 8 (Wyllie-Echeverria 1987; Love, Yoklavich and Thorsteinson 2002).

In the following section, we summarize the condition of yelloweye rockfish and bocaccio at the DPS level according to the following demographic viability criteria: abundance and productivity, spatial structure/connectivity, and diversity. These viability criteria are outlined in McElhany et al. (2000) and reflect concepts that are well founded in conservation biology and are generally applicable to a wide variety of species. These criteria describe demographic risks that individually and collectively provide strong indicators of extinction risk (Drake et al. 2010). There are several common risk factors detailed below at the introduction of each of the viability criteria for each listed rockfish species. Habitat- and species-limiting factors can affect abundance, productivity, spatial structure, and diversity parameters, and are described.

Abundance and Productivity

There is no single reliable historical or contemporary population estimate for the yelloweye rockfish or bocaccio within the full range of the Puget Sound/Georgia Basin DPSs (Drake et al. 2010; NMFS 2017g). Despite this limitation, there is clear evidence each species' abundance declined dramatically since the 1970s, and has not yet rebounded (Drake et al. 2010; Williams, Levin and Palsson 2010; NMFS 2017g; Keppel and Olsen 2019). Analysis of SCUBA surveys, recreational catch, and WDFW trawl surveys indicated total rockfish populations in the Puget Sound region are estimated to have declined between 3.1 and 3.8 percent per year for the past several decades, which corresponds to a 69 to 76 percent decline from 1977 to 2014 (Tonnes et al. 2016; Tolimieri et al. 2017). For yelloweye rockfish in the Puget Sound region, models based on recent remotely operated vehicle (ROV) survey data indicate that populations are slowly increasing but still fall well short of recovery goals (Min et al. 2023). For bocaccio, encounter rates within the DPS are now so low that reliably determining a population status trend is impossible.

Catches of yelloweye rockfish and bocaccio declined as a proportion of overall rockfish catch (Palsson et al. 2009; Drake et al. 2010) until fisheries were closed in 2010 in response to the ESA listings. Yelloweye rockfish were 2.4 percent of the harvest in North Sound during the 1960s, occurred in 2.1 percent of the harvest during the 1980s, but then decreased to an average of 1 percent from 1996 to 2002 (Palsson et al. 2009). In Puget Sound proper, yelloweye rockfish were 4.4 percent of the harvest during the 1960s, only 0.4 percent during the 1980s, and 1.4 percent from 1996 to 2002 (Palsson et al. 2009).

Bocaccio made up 8 to 9 percent of the overall rockfish catch in the late 1970s and declined in frequency, relative to other species of rockfish, from the 1970s to the 1990s (Drake et al. 2010). From 1975 to 1979, bocaccio averaged 4.6 percent of the catch. From 1980 to 1989, they were 0.2 percent of the 8,430 rockfish identified (Palsson et al. 2009). In the 1990s and early 2000s, bocaccio were not observed by WDFW in the dockside surveys of the recreational catch (Drake et al. 2010). Despite concerted efforts to obtain bocaccio specimens for genetic research over the last decade, only a handful of individuals have been observed by the WDFW with their ROV, and even fewer have been successfully captured (Pacunski, Palsson and Greene 2013; Lowry et al. 2022a).

Productivity is the measurement of a population's growth rate through all or a portion of its life cycle. Life history traits of yelloweye rockfish and bocaccio suggest generally low levels of inherent productivity because they are long-lived, mature slowly, and have sporadic episodes of successful reproduction (Tolimieri and Levin 2005; Drake et al. 2010). Overfishing can have dramatic impacts on the size or age structure of the population, with effects that can influence ongoing productivity. When the size and age of females decline, there are negative impacts on reproductive success. These impacts, termed maternal effects, are evident in a number of traits. Larger and older females of various rockfish species have a higher weight-specific fecundity (number of larvae per unit of female weight)(Boehlert, Barss and Lamberson 1982; Bobko and Berkeley 2004; Sogard, Berkeley and Fisher 2008). A consistent maternal effect in rockfishes relates to the timing of parturition. The timing of larval birth can be crucial in terms of corresponding with favorable oceanographic conditions because most larvae are released typically once annually, with a few exceptions in southern coastal populations and in yelloweye rockfish in Puget Sound (Washington, Gowan and Ito 1978). Several studies of rockfish species have shown that larger or older females release larvae earlier in the season compared to smaller or younger females (Nichol and Pikitch 1994b; Sogard, Berkeley and Fisher 2008). Larger or older females provide more nutrients to larvae by developing a larger oil globule released at parturition, which provides energy to the developing larvae (Berkeley, Chapman and Sogard 2004; Fisher, Sogard and Berkeley 2007) and, in black rockfish, enhances early growth rates (Berkeley, Chapman and Sogard 2004).

Contaminants such as polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), and chlorinated pesticides appear in rockfish collected in urban areas (West et al. 2001; Palsson et al. 2009). While the highest levels of contamination occur in urban areas, toxins can be found in the tissues of fish throughout Puget Sound (West et al. 2001). Although few studies have investigated the effects of toxins on rockfish ecology or physiology, other fish in the Puget Sound region that have been studied show a substantial impact, including reproductive dysfunction of some sole species (Landahl et al. 1997). Reproductive function of rockfish is also likely affected by contaminants (Palsson et al. 2009) and other life history stages may be affected as well (Drake et al. 2010). Larvae may be especially sensitive, given their inability to avoid areas containing high levels of toxic contaminants and the underdeveloped nature of organs, such as the liver, that play a role in detoxification.

Yelloweye Rockfish Abundance and Productivity

Yelloweye rockfish within U.S. waters of the Puget Sound/Georgia Basin are very likely most abundant within the San Juan Basin. The San Juan Basin has the most suitable rocky benthic habitat ((Palsson et al. 2009; Pacunski, Palsson and Greene 2013; Lowry et al. 2022a) and historically was the area in which anglers most frequently encountered, and retained, this species (Moulton and Miller 1987; Olander 1991).

Productivity for yelloweye rockfish is influenced by long generation times that reflect intrinsically low annual reproductive success. Natural mortality rates have been estimated from 2 to 4.6 percent (Yamanaka and Kronlund 1997a; Wallace 2007). Productivity may also be particularly impacted by Allee effects, which occur as adults are removed by fishing and the density and proximity of mature fish decreases. Adult yelloweye rockfish typically occupy relatively small ranges (Love, Yoklavich and Thorsteinson 2002) and it is unknown the extent to which they may move to find suitable mates. Exploratory tagging and focal individual drop-camera survey efforts in Hood Canal have demonstrated that yelloweye rockfish may occupy an area of less than 20 sq ft over the course of several weeks (NOAA Fisheries, personal communication).

In Canada, yelloweye rockfish biomass is estimated to have declined 68 to 88 percent between 1918 and 2019, such that it is now 12 percent of the unfished stock size on the inside waters of Vancouver Island (DFO 2011; COSEWIC 2020). In 2020, the COSEWIC status of this population was changed from Species of Concern to Threatened, acknowledging persistently depressed abundance. There are no analogous biomass estimates in the U.S. portion of the yelloweye rockfish DPS. However, the WDFW has generated several population estimates of yelloweye rockfish in recent years. ROV surveys in the San Juan Island region in 2008 (focused on rocky substrate) and 2010 (across all habitat types) estimated a population of 47,407±11,761 and 114,494±31,036 individuals, respectively (Pacunski, Palsson and Greene 2013; Pacunski et al. 2020). A 2015 ROV survey of that portion of the DPSs south of the entrance to Admiralty Inlet encountered 35 yelloweye rockfish, producing a preliminary population estimate of 66,998±7,370 individuals (final video review is still under way)(WDFW 2016).

Bocaccio Abundance and Productivity

Bocaccio in U.S. waters of the Puget Sound/Georgia Basin were historically most common within the South Sound and Main Basin (Drake et al. 2010). Though bocaccio were never a predominant segment of the multi-species rockfish abundance within the Puget Sound/Georgia Basin (Drake et al. 2010), their present-day abundance is likely a small fraction of their pre-contemporary fishery abundance. Bocaccio abundance may be very low in large segments of the Puget Sound/Georgia Basin, and, though noting their occasional occurrence in the Strait of Georgia, assessments of the species in Canadian waters do not account for fish occurring in any portion of the DPS (COSEWIC 2013; Fisheries and Oceans Canada 2020). Productivity is driven by high fecundity and episodic recruitment events, largely correlated with environmental conditions. Thus, bocaccio populations do not follow consistent growth trajectories and sporadic recruitment drives population structure (Drake et al. 2010). In 2016, a settlement event that was 44 times normal levels was documented in coastal Canada, dramatically modifying predictions of stock status and fishery potential (Fisheries and Oceans Canada 2020).

Natural annual mortality is estimated to be approximately 8 percent (Palsson et al. 2009). Tolimieri and Levin (2005) found that the bocaccio population growth rate is around 1.01, indicating a very low intrinsic growth rate for this species. Demographically, this species demonstrates some of the highest recruitment variability among rockfish species, with many years of failed recruitment being the norm (Tolimieri and Levin 2005). It is not yet known how, or if, the dramatic settlement event noted in 2016 on the outer coast may affect populations of bocaccio within the DPS. As a result of modifications made to the definition of the DPS in 2017 (82 FR 7711), individuals born on the outer coast but settling within the boundaries of the DPS would be granted ESA-listed status. Obtaining a genetic profile for the population residing within the DPS prior to this settlement event (i.e., that are too old to be part of the 2016 cohort) will be crucial to evaluating any long-standing genetic differentiation between the coast and inland waters. Given their severely reduced abundance in inland waters, Allee effects may be particularly acute for bocaccio, even considering the propensity of some individuals to move long distances and potentially find mates.

In Canada, the median estimate of bocaccio biomass is 3.5 percent of its unfished stock size (though this only assessed Canadian waters outside of the boundary of the DPS) (Stanley, McAllister and Starr 2012; COSEWIC 2013). There are no analogous biomass estimates in the U.S. portion of the bocaccio DPS. However, the ROV survey of the San Juan Islands in 2008 estimated a population of 4,606±4,606 (based on four fish observed along a single transect)(Pacunski, Palsson and Greene 2013), but no estimate could be obtained in the 2010 or 2012-13 ROV survey because this species was not encountered (Pacunski et al. 2020; Lowry et al. 2022a). A single bocaccio encountered in the 2015 ROV survey produced a statistically invalid population estimate for that portion of the DPS lying south of the entrance to Admiralty Inlet and east of Deception Pass. A handful of bocaccio have been caught in genetic surveys (Andrews et al. 2018; NOAA Fisheries, personal communication) and by recreational anglers in Puget Sound proper (Kraig 2023) in the past several years.

In summary, though abundance and productivity data for yelloweye rockfish and bocaccio is relatively imprecise, both abundance and productivity have been reduced largely by fishery removals within the range of each Puget Sound/Georgia Basin DPS. Recent increases in yelloweye abundance have occurred, and evidenced by higher encounter rates of various early life history age classes during ROV and dive surveys, but data are insufficient to assess changes in abundance for bocaccio.

Spatial Structure and Connectivity

Spatial structure consists of a population’s geographic distribution and the processes that generate that distribution (McElhany et al. 2000). A population’s spatial structure depends on habitat quality, spatial configuration, and dynamics as well as dispersal characteristics of individuals within the population (McElhany et al. 2000). Prior to contemporary fishery removals from the 1970s through the 1990s, each of the major subbasins in the range of the DPSs likely hosted relatively larger populations of yelloweye rockfish and bocaccio (Washington 1977; Washington, Gowan and Ito 1978; Moulton and Miller 1987). This distribution allowed both species to utilize the full suite of available habitats to maximize their abundance and demographic characteristics, thereby enhancing their resilience (Hamilton 2008). This distribution also enabled each species to potentially exploit ephemerally good habitat conditions, and in turn receive protection from smaller-scale and negative environmental fluctuations. These types of fluctuations may change prey abundance for various life stages and/or may change environmental characteristics and water quality parameters (e.g., temperature, pH, nitrate concentration) that influence the survival and development of new recruits. Spatial distribution also provides a measure of protection from larger-scale anthropogenic changes that decrease habitat suitability, such as oil spills or hypoxia that may be isolated to a single subbasin. Rockfish population resilience is sensitive to changes in connectivity among various groups of fish (Hamilton 2008). Hydrologic connectivity of the subbasins of Puget Sound is naturally restricted by relatively shallow sills located at Deception Pass, Admiralty Inlet, the Tacoma Narrows, and in Hood Canal (Burns 1985). The Victoria Sill, which marks the western edge of the DPSs, bisects the Strait of Juan de Fuca, runs from east of Port Angeles north to Victoria, and regulates water exchange (Drake et al. 2010). Given that these sills regulate water exchange among subbasins, they also moderate the movement of rockfish larvae (Drake et al. 2010; Andrews et al. 2021). When localized depletion of rockfish occurs, it can reduce stock resiliency (Hilborn et al. 2003; Hamilton 2008). The effects of localized depletions of rockfish are likely exacerbated by the natural hydrologic constrictions within Puget Sound.

Yelloweye Rockfish Spatial Structure and Connectivity

Yelloweye rockfish spatial structure and connectivity is threatened by the reduction of fish within each subbasin, and the naturally sedentary disposition of adults. This reduction is likely most acute within the subbasins of Puget Sound proper, given complex geography and prominent sills that restrict larval transport among subbasins. Yelloweye rockfish are probably most abundant within the San Juan Basin, and transport of larvae to other subbasins is affected by seasonal flow patterns, the exact location of larval release, and the depth of larval release (Andrews et al. 2021). While connectivity may be high at times, distinct genetic traits of at least the portion of the population occupying Hood Canal have arisen (Andrews et al. 2018).

Bocaccio Spatial Structure and Connectivity

Most bocaccio may have been historically spatially limited to several subbasins. They were historically most abundant in the Main Basin and South Sound (Drake et al. 2010) with no documented occurrences in the San Juan Basin until 2008 (WDFW 2011; Pacunski, Palsson and Greene 2013). Positive signs for spatial structure and connectivity come from the propensity of some adults and pelagic juveniles to migrate long distances, which could re-establish aggregations of fish in formerly occupied habitat (Drake et al. 2010). The apparent reduction of populations of bocaccio in the Main Basin and South Sound represents a further impairment in the historically spatially limited distribution of bocaccio, and adds risk to the viability of the DPS.

In summary, spatial structure and connectivity for each species have been adversely impacted, mostly by fishery removals. These impacts on species viability are likely most acute for yelloweye rockfish because of their sedentary nature as adults.

Diversity

Characteristics of diversity for rockfish include fecundity, timing of the release of larvae and their condition, morphology, age at reproductive maturity, physiology, and molecular genetic characteristics. In spatially and temporally varying environments, there are three general reasons why diversity is important for species and population viability: (1) diversity allows a species to use a wider array of environments; (2) diversity protects a species against short-term spatial and temporal changes in the environment; and (3) genetic diversity provides the raw material for surviving long-term environmental changes.

Yelloweye Rockfish Diversity

Yelloweye rockfish size and age distributions have been truncated, based on recreational fishery encounter rates (Figure 12). Yelloweye rockfish caught in the 1970s spanned a broad range of sizes. By the 2000s, there was some evidence of fewer older fish in the population (Drake et al. 2010). As a result, the reproductive burden may be shifted to younger and smaller fish. This shift could alter the timing and condition of larval release, which may be mismatched with habitat conditions within the range of the DPS, potentially reducing the viability of offspring (Drake et al. 2010). Yelloweye rockfish retention has been prohibited in recreational fisheries since 2010, thus comparable fisheries dependent data to estimate size ranges are not available after this time. Only a handful of adult yelloweye rockfish have been observed within WDFW ROV surveys in U.S. waters of the DPS (Lowry et al. 2022a; Lowry et al. 2024), and all observed fish in 2008 and 2010 in the San Juan Basin were less than 8 inches long (20 cm) (Pacunski, Palsson and Greene 2013; Pacunski et al. 2020). Since these fish were observed several years ago, any that have survived will have grown bigger (Pacunski, Palsson and Greene (2013)); Pacunski et al. (2020) did not report a precise size for these fish; thus, we are unable to provide a precise estimate of their likely size now). Size distribution data from more recent surveys in 2015, 2018, and 2020-21 are not yet available (WDFW, personal communication).

Recent genetic information for yelloweye rockfish further confirmed the existence of fish genetically differentiated within the Puget Sound/Georgia Basin compared to the outer coast (NMFS 2016a; Andrews et al. 2018) and that yelloweye rockfish in Hood Canal are genetically divergent from the rest of the DPS. Yelloweye rockfish in Hood Canal are addressed as a separate population in the recovery plan (NMFS 2017g), and reaching the recovery goal for the DPS at large requires viability of this population unit.

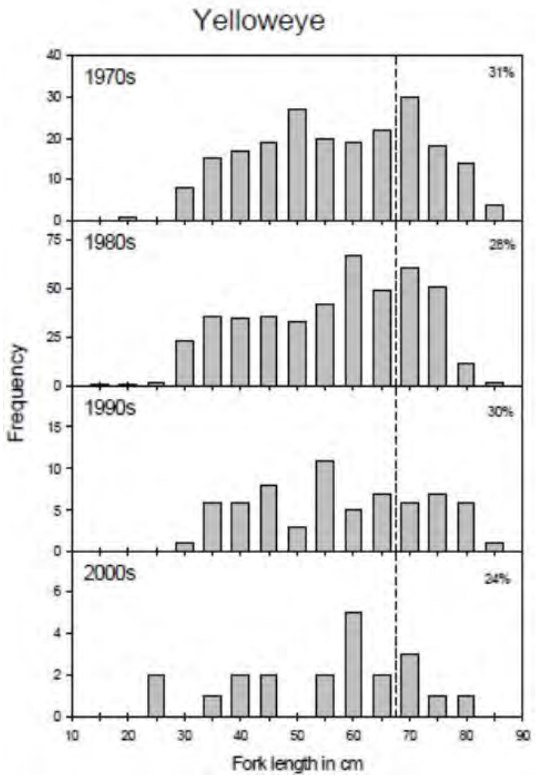

Figure 12. Yelloweye rockfish length frequency distributions (cm) from recreational fisheries binned within four decades. The vertical line depicts the size at which about 30 percent of the population comprised fish larger than the rest of the population in the 1970s, as a reference point for later decades. Retention of yelloweye rockfish was prohibited in 2010, so no data are available after this.

<u>Bocaccio Diversity</u>

Size-frequency distributions for bocaccio in the 1970s indicate a wide range of sizes, and two distinct cohorts, with recreationally caught individuals from 9.8 to 33.5 inches (25 to 85 cm) (Figure 13). This size distribution profile indicates a spread of ages, with successful episodic recruitment over many years. A similar range of sizes is also evident in the 1980s catch data, though size truncation at the upper end of the distribution is beginning to be apparent. Through the 1990s encounters with bocaccio became rare, with larger fish disappearing altogether from the catch data. By the 2000s, no size distribution data for bocaccio were available due to a nearly complete lack of encounters. Assessments of bocaccio in Canadian waters identify occasional occurrences of the species in the Salish Sea, but biomass estimations and harvest recommendation efforts are focused on fish occupying coastal waters (Fisheries and Oceans Canada 2020). Bocaccio in the Puget Sound/Georgia Basin may have physiological or behavioral adaptations because of the unique habitat conditions in the range of the DPS. The potential loss of diversity in the bocaccio DPS, in combination with their relatively low productivity, may result in a mismatch with habitat conditions and further reduce population viability (Drake et al. 2010).

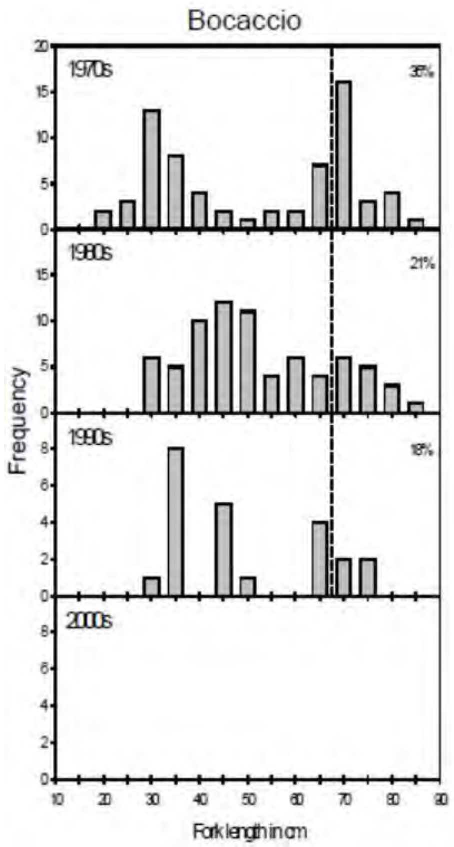

Figure 13. Bocaccio length frequency distributions (cm) from recreational fisheries within four decades. The vertical line depicts the size at which about 30 percent of the population comprised fish larger than the rest of the population in the 1970s, as a reference point for a later decade. Retention of bocaccio was prohibited in 2010, so no data are available after this.

In summary, diversity for both rockfish species has likely been adversely impacted by historical fishery removals, though minimal removals have occurred since 2010 due to harvest prohibitions. In turn, the ability of fish to utilize habitats within the action area, find mates, and perform important ecological roles has been compromised.

Limiting Factors

Ecosystem Effects

There are natural biological and physical functions in regions of Puget Sound, especially in Hood Canal and South Sound, that cause the water to be corrosive and hypoxic, such as restricted circulation and mixing, respiration, and strong stratification (Newton and Van Voorhis 2002; Feely et al. 2010). However, these natural conditions, typically driven by climate forcing, are exacerbated by anthropogenic sources such as OA, nutrient enrichment, and land-use changes (Feely et al. 2010). By the next century, OA will increasingly reduce pH and saturation states in Puget Sound (Feely et al. 2010). Areas in Puget Sound susceptible to naturally occurring hypoxic and corrosive conditions are also the same areas where low seawater pH occurs, compounding the conditions of these areas (Feely et al. 2010). Given that the population of yelloweye rockfish inhabiting Hood Canal displays a divergent genetic profile from populations elsewhere in the DPS (Andrews et al. 2018), impacts from corrosive water and hypoxia in this area may substantially impede recovery.

Commercial and Recreational Bycatch

Listed rockfish are encountered as bycatch in some recreational and commercial fisheries in Puget Sound. This bycatch is described in harvest and bycatch effects in Section 2.4.2 Environmental Baseline. In addition, NMFS permits limited take of listed rockfish for scientific research purposes. This take is described in Sections 2.4.5 Scientific Research and 2.7.3 Integration and Synthesis for Puget Sound/Georgia Basin Rockfish.

Other Limiting Factors

The yelloweye rockfish DPS abundance is much lower than it was historically, though recent analysis suggests historical estimates were erroneously high and resulted in an unrealistic baseline for comparison (Min et al. 2023). The fish face several threats, including bycatch in some commercial and recreational fisheries, non-native species introductions, chemical contamination, and habitat degradation. NMFS has determined that this DPS is likely to be in danger of extinction in the foreseeable future throughout all of its range.

The bocaccio DPS exists at very low abundance and observations are relatively rare. Their low intrinsic productivity, combined with continuing threats from bycatch in commercial and recreational harvest, non-native species introductions, loss and degradation of habitat, and chemical contamination, increase the extinction risk. NMFS has determined that this DPS is currently in danger of extinction throughout all of its range.

In summary, despite some limitations on our knowledge of past abundance and specific current viability parameters, characterizing the viability of yelloweye rockfish and bocaccio includes their severely reduced abundance from historical times, which in turn hinders productivity and diversity. Spatial structure for each species has also likely been compromised because of a probable reduction of mature fish of each species distributed throughout their historical range within the DPSs (Drake et al. 2010).

2.2.1.4 *Status of the Southern Resident Killer Whale DPS*

The SRKW DPS, composed of J, K, and L pods, was listed as endangered under the ESA on November 18, 2005 (70 FR 69903). A 5-year review under the ESA completed in 2021 concluded that SRKWs should remain listed as endangered and includes recent information on the population, threats, and new research results and publications (NMFS 2021j). NMFS considers SRKWs to be currently among ten species at high risk of extinction as part of NMFS's

Species in the Spotlight initiative[20] 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.[21]

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

Abundance, Productivity, and Trends

Killer whales, including SRKWs, are a long-lived species and sexual maturity can occur at age 10 (review in NMFS (2008j)). Females produce a low number of surviving calves (n < 10, but generally fewer) over the course of their reproductive lifespan (Bain 1990; Olesiuk, Bigg and Ellis 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 2022). 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 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 reported 75 SRKWs in the population, including two calves that were born in 2023 (CWR 2022) (Figure 14). Since the 2023 census, one adult male is presumed dead, bringing the population size to 74. The previously published historical estimated abundance of SRKWs was 140 animals (NMFS 2008j), 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

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

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

ended.

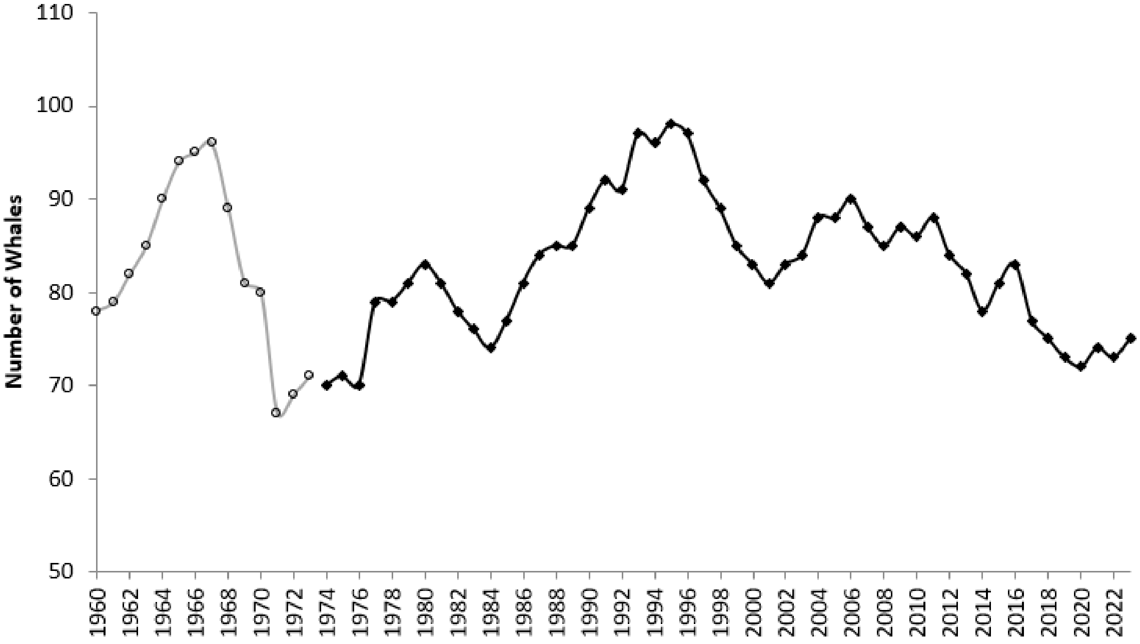


Figure 14. Population size and trend of SRKWs, 1960-2022. Data from 1960-1973 (open circles, gray line) are number projections from the matrix model of Olesiuk, Bigg and Ellis (1990). Data from 1974-2023 (diamonds, black line) were obtained through photo-identification surveys of the three pods (J, K, and L) and were provided by the CWR (unpublished data) and NMFS (2008j). 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, Ellis and Ford (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 forms 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 (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. 2004a), the science panel review (Hilborn et al. 2012; Ward et al. 2013), and previous 5-year status reviews (NMFS 2011d; 2016j). Subsequently, population estimates, including data from the most recent five years (2017-2021), project a downward trend over the next 25 years (Figure 15). 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 15). 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. 2011c; 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.

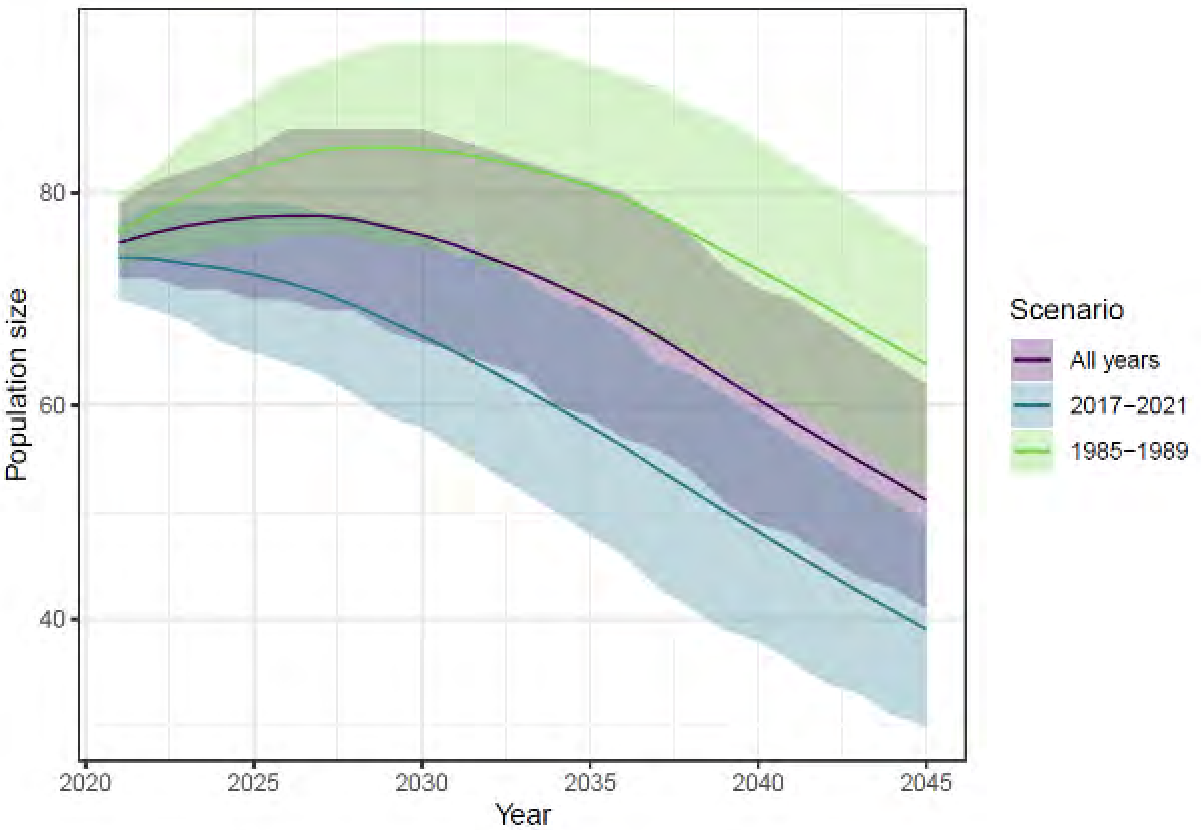


Figure 15. SRKW population size projections from 2020 to 2045 using three scenarios: (1) projections using fecundity and survival rates estimated over the entire time series (1985-2021), (2) projections using rates estimated over the last five years (2017-2021), and (3) projections using the highest survival and fecundity rates estimated, during the period 1985-1989 (figure from NMFS (2021j)).

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 harvesting that occurred into the early 1970s (Figure 16). 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 16). 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 17). 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.

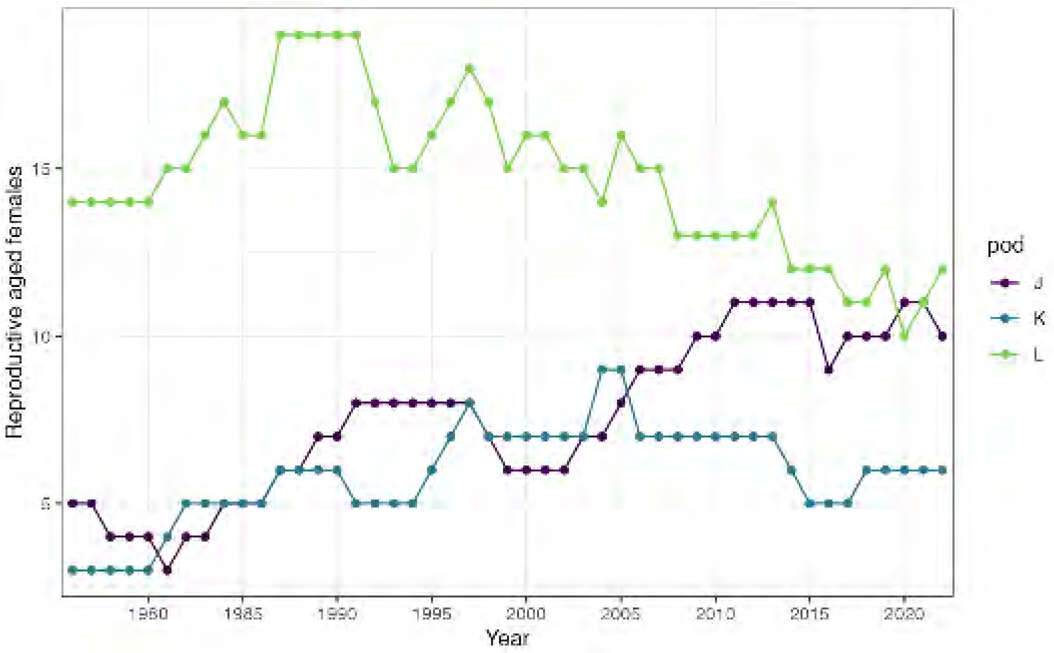


Figure 16. Time series of reproductive age females (10-42, inclusive) for SRKWs by year since 1976 (reproduced from Ward (2021)).

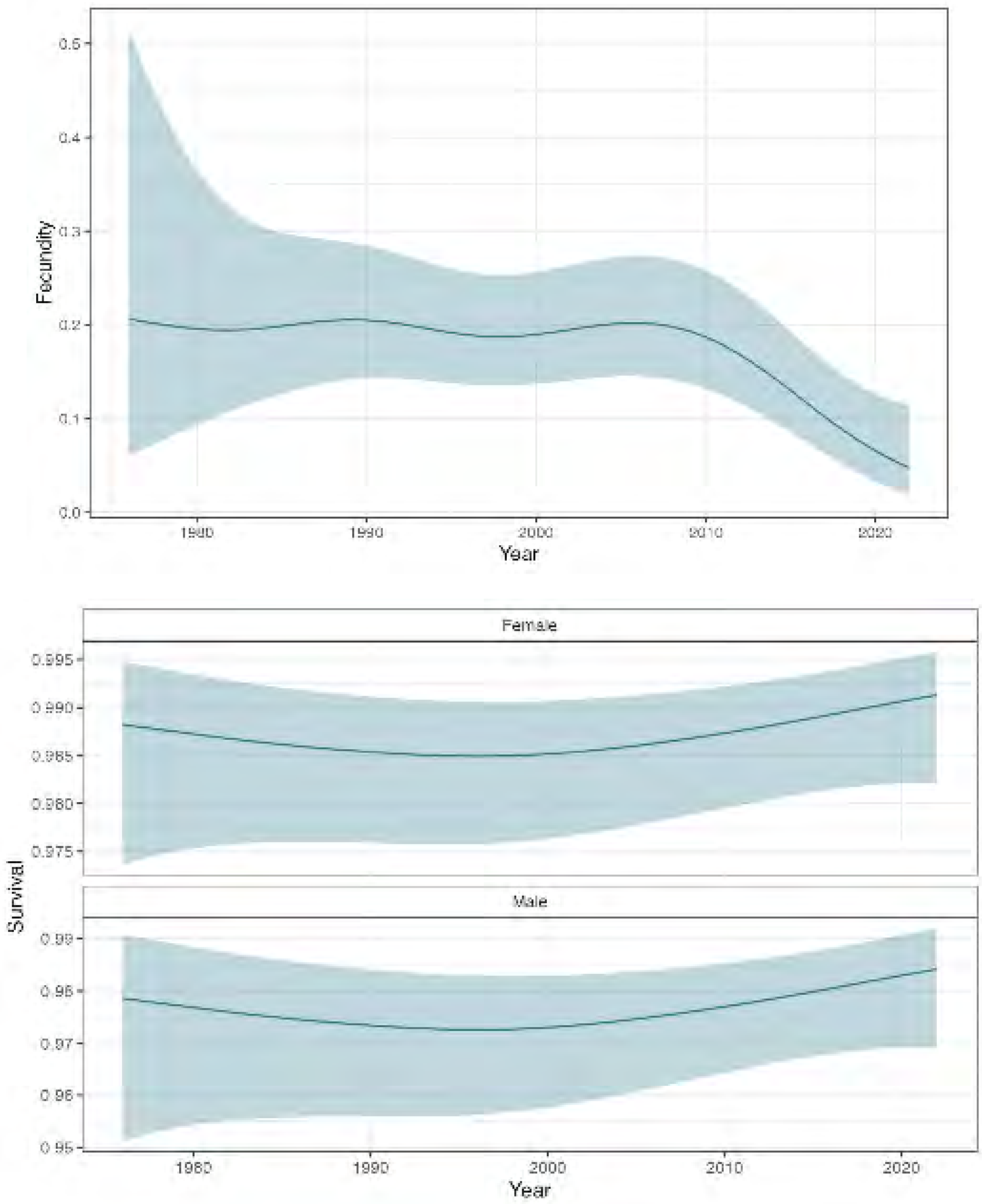


Figure 17. Time series of predicted fecundity rates for a 20-year old SRKW and survival rates for a 20-year old female and male. Estimates are generated from the Bayesian logistic regression models, using priors from the NRKW population. Ribbons represent 95% CIs (reproduced from Ward (2021)).

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, Fearnbach and Barrett-Lennard 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.

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 2008j; Hanson et al. 2013; Carretta et al. 2023b)(Figure 18), 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, Ellis and Balcomb 2000; Krahn et al. 2002; Hauser et al. 2007; Olson et al. 2018; NMFS 2021j; 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. 2010; 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 19) (Olson et al. 2018; NMFS 2021j), with late arrivals and fewer days present in recent years (NMFS 2021j; Ettinger et al. 2022; Shields 2023) (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 salmon returns.

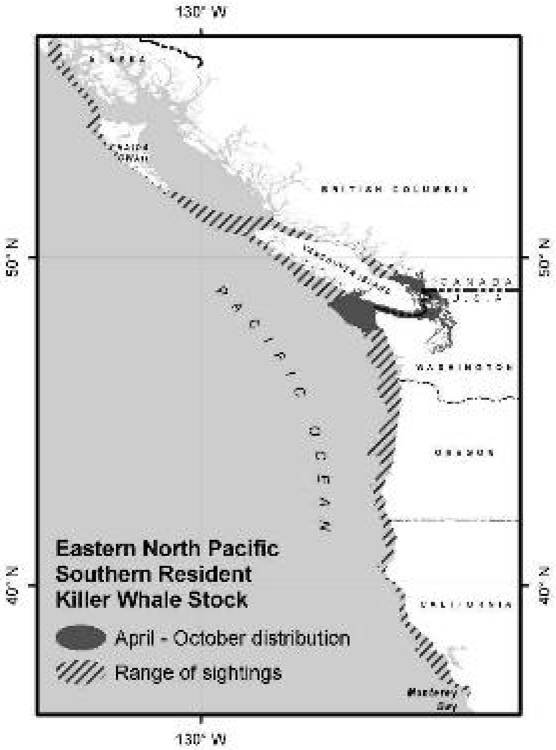
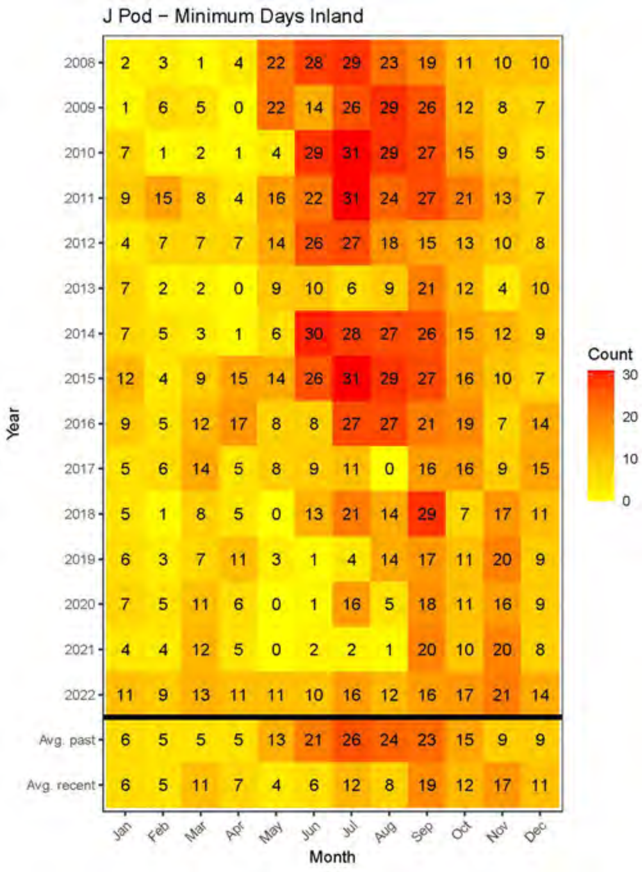
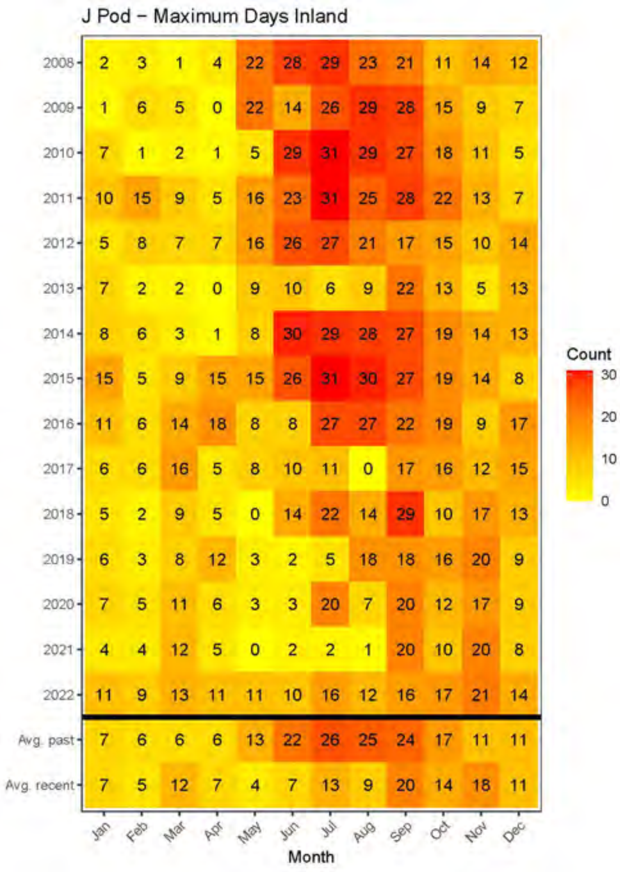


Figure 18. Geographic range of SRKWs (reprinted from Carretta et al. (2023b)).



Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	2	3	1	4	22	28	29	23	19	11	10	10
2009	1	6	5	0	22	14	26	29	26	12	8	7
2010	7	1	2	1	4	29	31	29	27	15	9	5
2011	9	15	8	4	16	22	31	24	27	21	13	7
2012	4	7	7	7	14	26	27	18	15	13	10	8
2013	7	2	2	0	9	10	6	9	21	12	4	10
2014	7	5	3	1	6	30	28	27	26	15	12	9
2015	12	4	9	15	14	26	31	29	27	16	10	7
2016	9	5	12	17	8	8	27	27	21	19	7	14
2017	5	6	14	5	8	9	11	0	16	16	9	15
2018	5	1	8	5	0	13	21	14	29	7	17	11
2019	6	3	7	11	3	1	4	14	17	11	20	9
2020	7	5	11	6	0	1	16	5	18	11	16	9
2021	4	4	12	5	0	2	2	1	20	10	20	8
2022	11	9	13	11	11	10	16	12	16	17	21	14
Avg. past	6	5	5	5	13	21	26	24	23	15	9	9
Avg. recent	6	5	11	7	4	6	12	8	19	12	17	11



Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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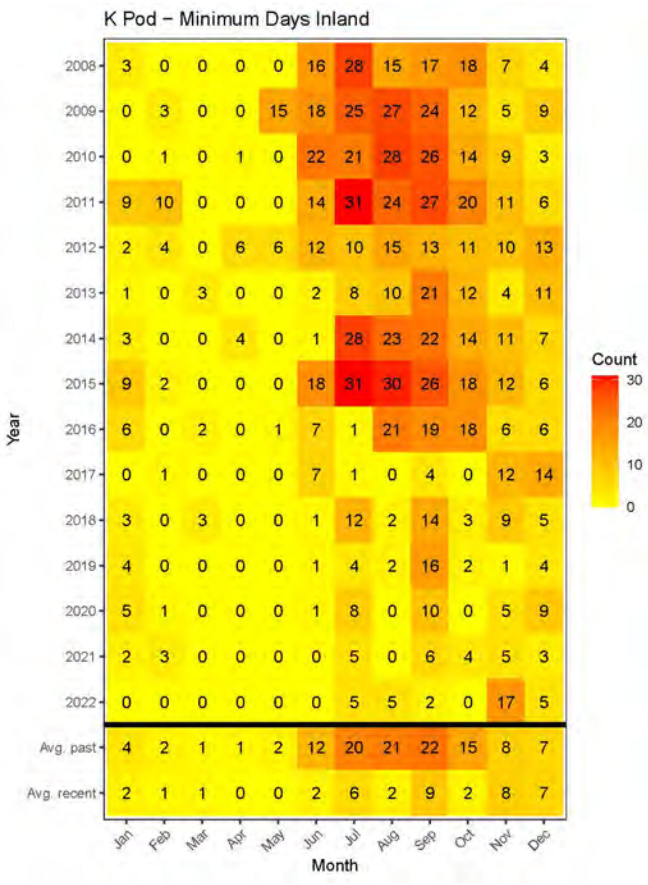
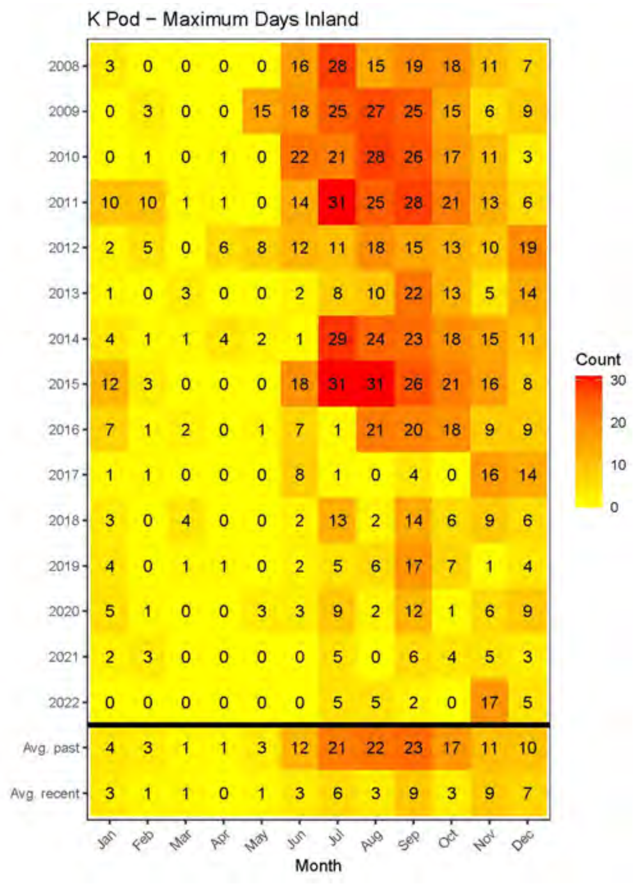
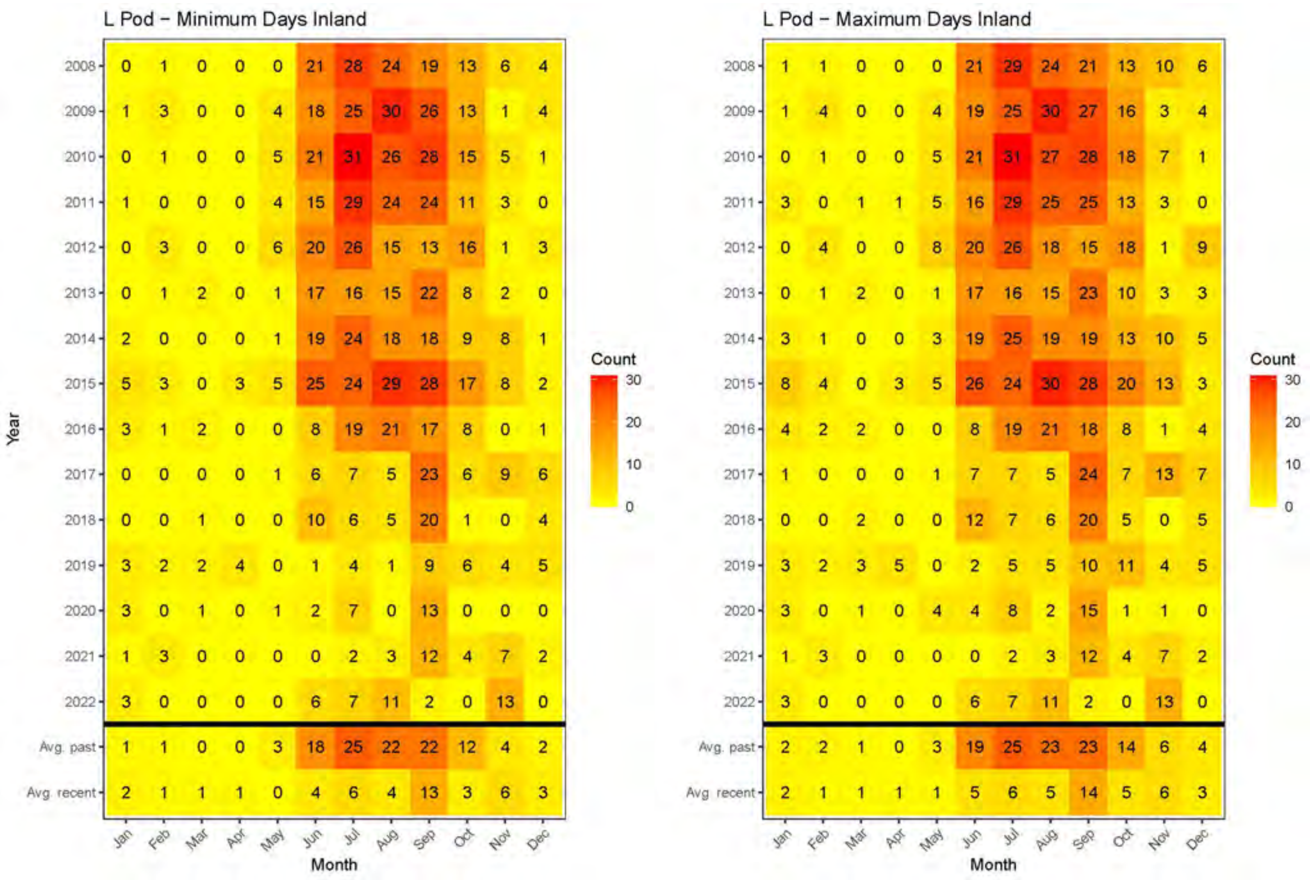
2009	1	6	5	0	22	14	26	29	28	15	9	7
2010	7	1	2	1	5	29	31	29	27	18	11	5
2011	10	15	9	5	16	23	31	25	28	22	13	7
2012	5	8	7	7	16	26	27	21	17	15	10	14
2013	7	2	2	0	9	10	6	9	22	13	5	13
2014	8	6	3	1	8	30	29	28	27	19	14	13
2015	15	5	9	15	15	26	31	30	27	19	14	8
2016	11	6	14	18	8	8	27	27	22	19	9	17
2017	6	6	16	5	8	10	11	0	17	16	12	15
2018	5	2	9	5	0	14	22	14	29	10	17	13
2019	6	3	8	12	3	2	5	18	18	16	20	9
2020	7	5	11	6	3	3	20	7	20	12	17	9
2021	4	4	12	5	0	2	2	1	20	10	20	8
2022	11	9	13	11	11	10	16	12	16	17	21	14
Avg. past	7	6	6	6	13	22	26	25	24	17	11	11
Avg. recent	7	5	12	7	4	7	13	9	20	14	18	11



Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	3	0	0	0	0	16	28	15	17	18	7	4
2009	0	3	0	0	15	18	25	27	24	12	5	9
2010	0	1	0	1	0	22	21	28	26	14	9	3
2011	9	10	0	0	0	14	31	24	27	20	11	6
2012	2	4	0	6	6	12	10	15	13	11	10	13
2013	1	0	3	0	0	2	8	10	21	12	4	11
2014	3	0	0	4	0	1	28	23	22	14	11	7
2015	9	2	0	0	0	18	31	30	26	18	12	6
2016	6	0	2	0	1	7	1	21	19	18	6	6
2017	0	1	0	0	0	7	1	0	4	0	12	14
2018	3	0	3	0	0	1	12	2	14	3	9	5
2019	4	0	0	0	0	1	4	2	16	2	1	4
2020	5	1	0	0	0	1	8	0	10	0	5	9
2021	2	3	0	0	0	0	5	0	6	4	5	3
2022	0	0	0	0	0	0	5	5	2	0	17	5
Avg. past	4	2	1	1	2	12	20	21	22	15	8	7
Avg. recent	2	1	1	0	0	2	6	2	9	2	8	7



Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	3	0	0	0	0	16	28	15	19	18	11	7
2009	0	3	0	0	15	18	25	27	25	15	6	9
2010	0	1	0	1	0	22	21	28	26	17	11	3
2011	10	10	1	1	0	14	31	25	28	21	13	6
2012	2	5	0	6	8	12	11	18	15	13	10	19
2013	1	0	3	0	0	2	8	10	22	13	5	14
2014	4	1	1	4	2	1	29	24	23	18	15	11
2015	12	3	0	0	0	18	31	31	26	21	16	8
2016	7	1	2	0	1	7	1	21	20	18	9	9
2017	1	1	0	0	0	8	1	0	4	0	16	14
2018	3	0	4	0	0	2	13	2	14	6	9	6
2019	4	0	1	1	0	2	5	6	17	7	1	4
2020	5	1	0	0	3	3	9	2	12	1	6	9
2021	2	3	0	0	0	0	5	0	6	4	5	3
2022	0	0	0	0	0	0	5	5	2	0	17	5
Avg. past	4	3	1	1	3	12	21	22	23	17	11	10
Avg. recent	3	1	1	0	1	3	6	3	9	3	9	7



L Pod – Minimum Days Inland

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	0	1	0	0	0	21	28	24	19	13	6	4
2009	1	3	0	0	4	18	25	30	26	13	1	4
2010	0	1	0	0	5	21	31	26	28	15	5	1
2011	1	0	0	0	4	15	29	24	24	11	3	0
2012	0	3	0	0	6	20	26	15	13	16	1	3
2013	0	1	2	0	1	17	16	15	22	8	2	0
2014	2	0	0	0	1	19	24	18	18	9	8	1
2015	5	3	0	3	5	25	24	29	28	17	8	2
2016	3	1	2	0	0	8	19	21	17	8	0	1
2017	0	0	0	0	1	6	7	5	23	6	9	6
2018	0	0	1	0	0	10	6	5	20	1	0	4
2019	3	2	2	4	0	1	4	1	9	6	4	5
2020	3	0	1	0	1	2	7	0	13	0	0	0
2021	1	3	0	0	0	0	2	3	12	4	7	2
2022	3	0	0	0	0	6	7	11	2	0	13	0
Avg. past	1	1	0	0	3	18	25	22	22	12	4	2
Avg. recent	2	1	1	1	0	4	6	4	13	3	6	3

L Pod – Maximum Days Inland

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008	1	1	0	0	0	21	29	24	21	13	10	6
2009	1	4	0	0	4	19	25	30	27	16	3	4
2010	0	1	0	0	5	21	31	27	28	18	7	1
2011	3	0	1	1	5	16	29	25	25	13	3	0
2012	0	4	0	0	8	20	26	18	15	18	1	9
2013	0	1	2	0	1	17	16	15	23	10	3	3
2014	3	1	0	0	3	19	25	19	19	13	10	5
2015	8	4	0	3	5	26	24	30	28	20	13	3
2016	4	2	2	0	0	8	19	21	18	8	1	4
2017	1	0	0	0	1	7	7	5	24	7	13	7
2018	0	0	2	0	0	12	7	6	20	5	0	5
2019	3	2	3	5	0	2	5	5	10	11	4	5
2020	3	0	1	0	4	4	8	2	15	1	1	0
2021	1	3	0	0	0	0	2	3	12	4	7	2
2022	3	0	0	0	0	6	7	11	2	0	13	0
Avg. past	2	2	1	0	3	19	25	23	23	14	6	4
Avg. recent	2	1	1	1	1	5	6	5	14	5	6	3

Figure 19. 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 2021j)(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 include 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 2021i). 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 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 9). 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 9). 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 20). 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 21) (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 20 and Figure 21).

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 9. 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

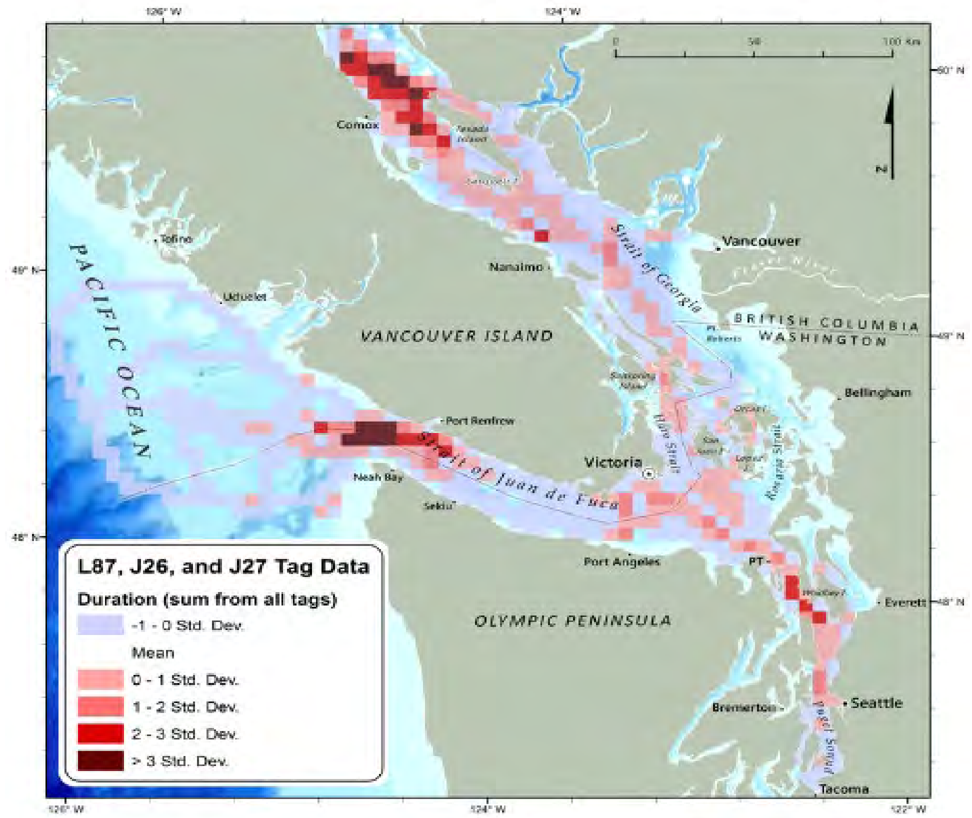


Figure 20. Duration of occurrence model output for J pod tag deployments (Hanson et al. 2017). “High use areas” or hot spots are illustrated by the 0 to > 3 standard deviation pixels.

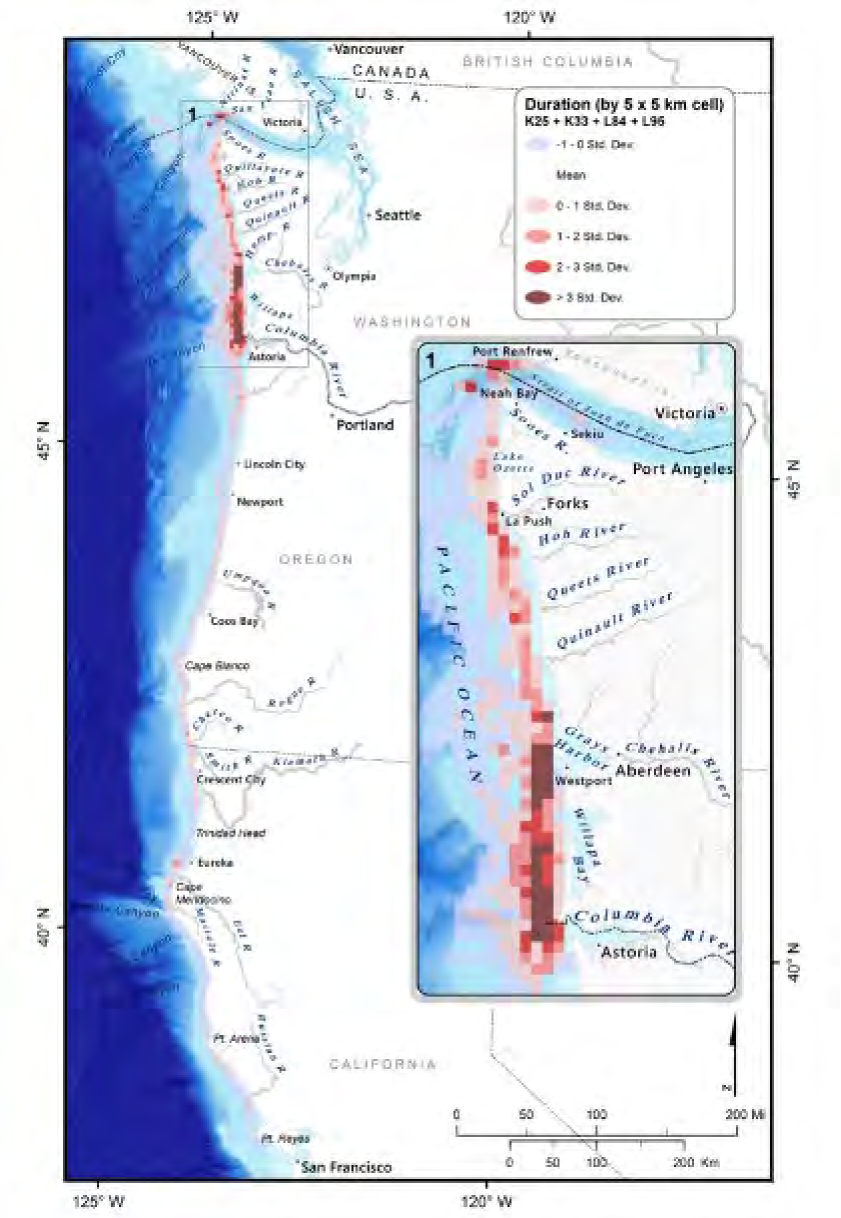


Figure 21. Duration of occurrence model for all unique K and L pod tag deployments (Hanson et al. 2017). "High use areas" or hot spots are illustrated by the 0 to > 3 standard deviation pixels.

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, Hanson and Lammers 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 22, Figure 23). From 2006-2011, PALs and EARs were deployed in areas thought to be used frequently by SRKWs based on previous sightings (Figure 22)(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 23) 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, Hanson and Lammers 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.

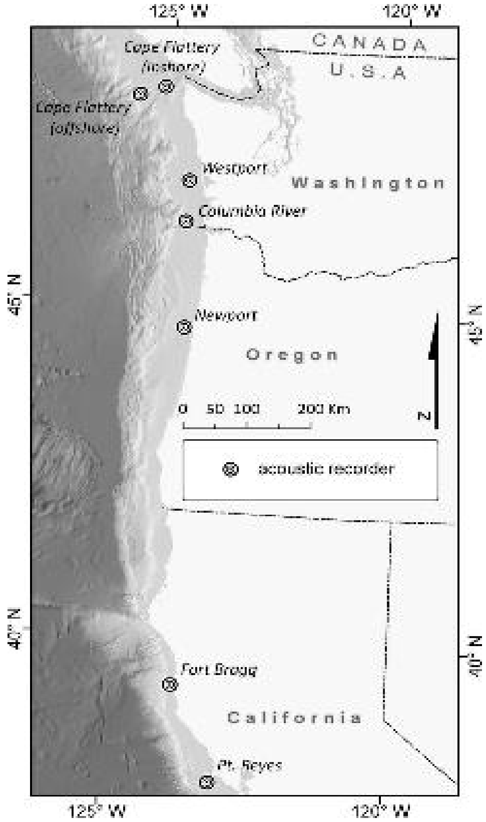


Figure 22. Deployment locations of acoustic recorders on the U.S. west coast from 2006 to 2011 (Hanson et al. 2013).

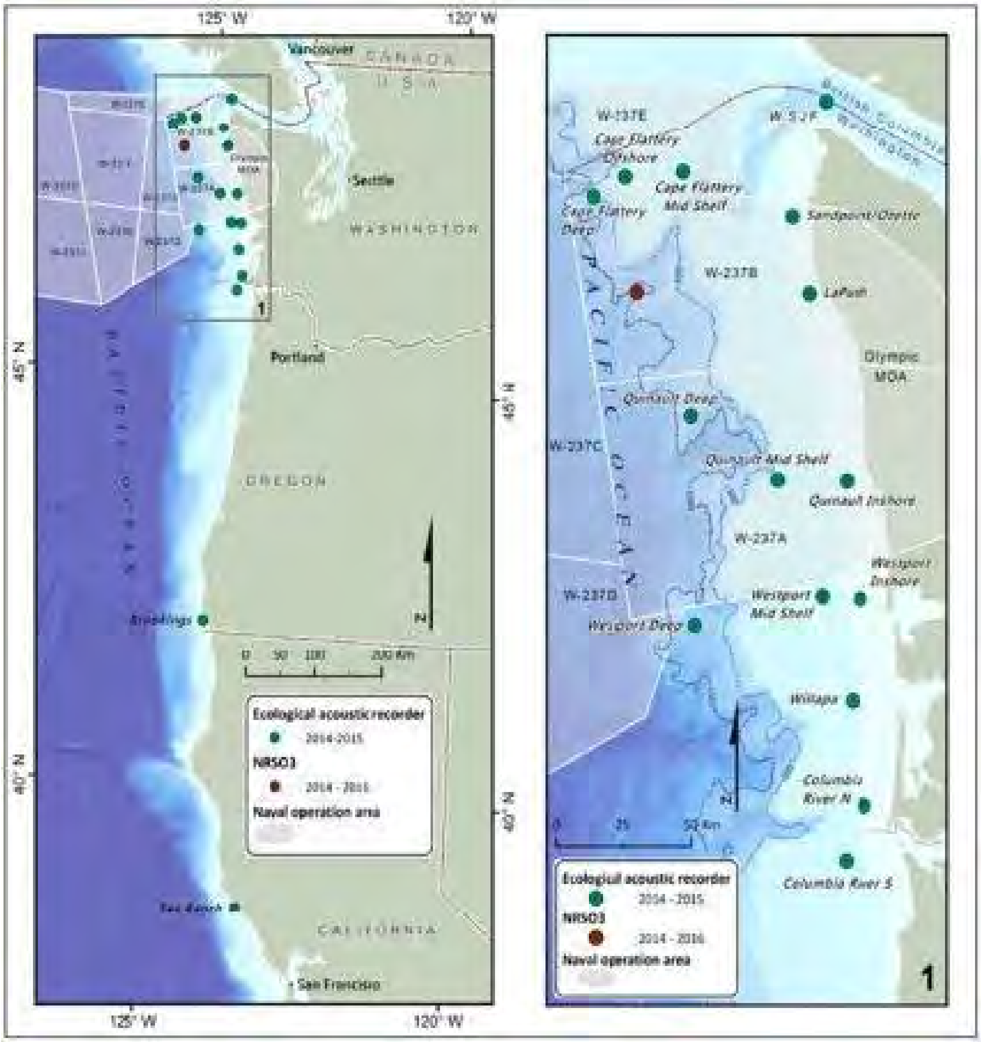


Figure 23. Locations of passive acoustic recorders deployed beginning in the fall of 2014 (Hanson et al. 2017).

There were acoustic detections off of the Washington coast in all months of the year (Figure 24), 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, Hanson and Lammers 2021). Acoustic recorders were deployed off Newport, Fort Bragg, and Port Reyes from 2008-2013 and SRKW were detected 28 times (Emmons, Hanson and Lammers 2019). Between 2014-2017, all three SRKW pods were detected in Northern acoustic recorder sites (sites in Figure 23), but only K and L pods were detected in more Southern sites (Emmons, Hanson and Lammers 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 25 (Riera et al. 2019). SRKWs were detected on 163 days with 175 encounters (see Figure 26 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 more often (87% of calls and 89% of calls, respectively), between May and September. J pod was heard most often during winter and spring (76 percent of calls during December and February through May; 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).

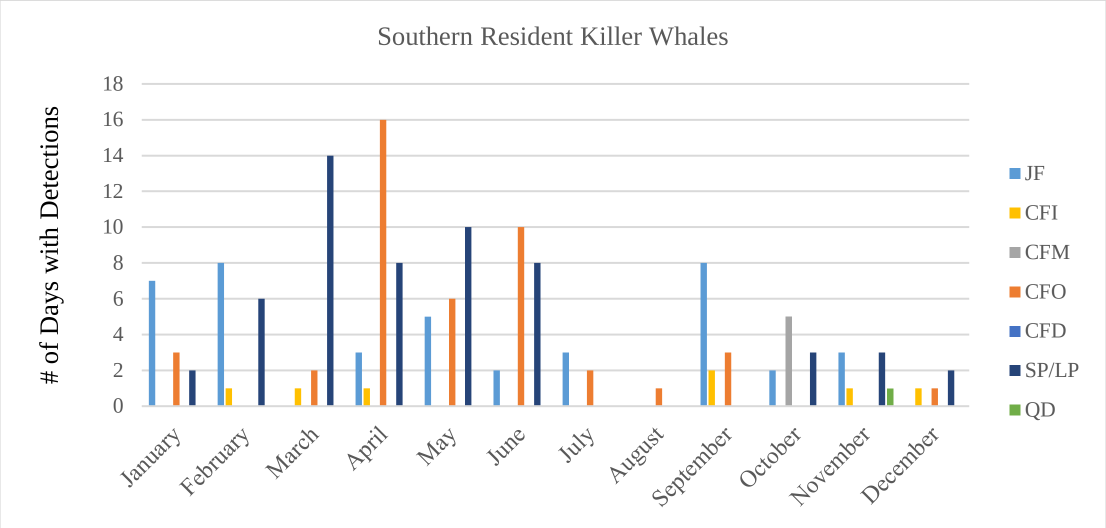


Figure 24. Counts of detections at each northern recorder site by month from 2014-2017 (Emmons, Hanson and Lammers 2019). Areas include Juan de Fuca (JF); Cape Flattery Inshore (CFI); Cape Flattery Mid Shelf (CFM); Cape Flattery Offshelf (CFO); Cape Flattery Deep (CFD); Sand Point and La Push (SP/LP); and Quinault Deep (QD).

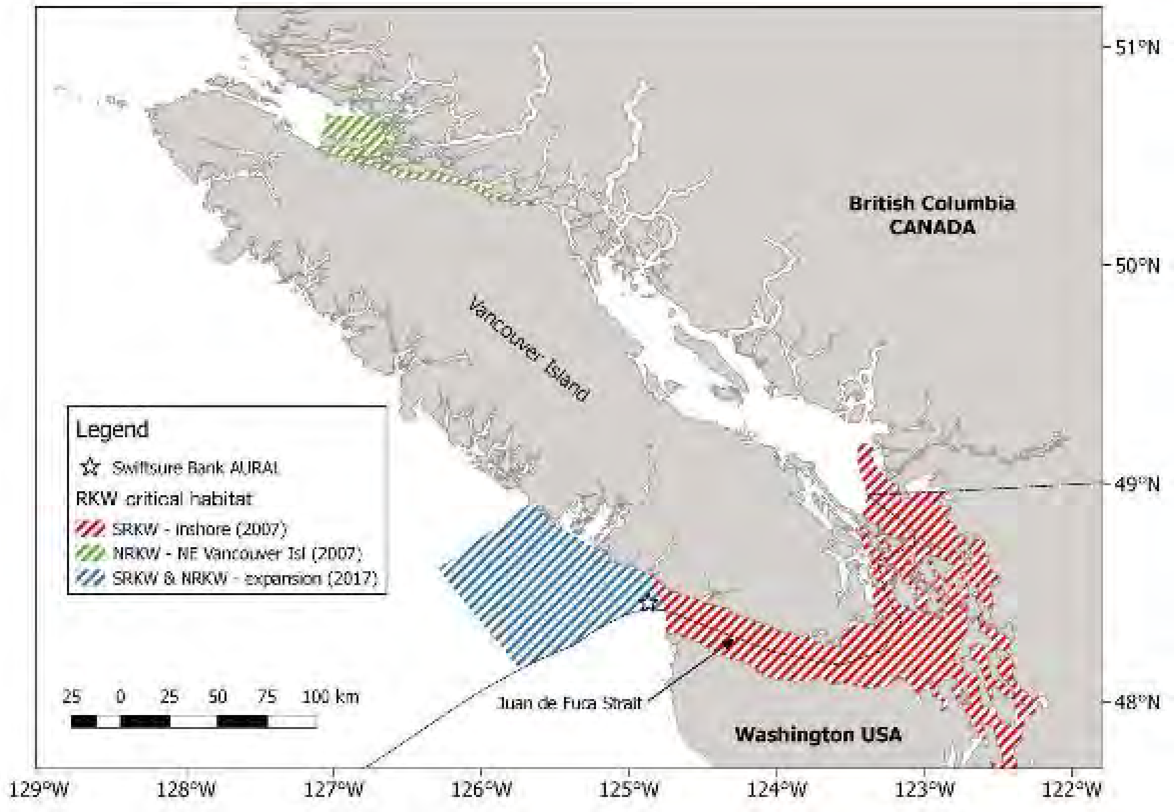


Figure 25. Swiftsure Bank study site off the coast of British Columbia, Canada in relation to the 2007 Northern Resident critical habitat (Northeast Vancouver Island) and 2007 SRKW critical habitat (inshore waters) and the 2017 Northern Resident and Southern Resident expansion of critical habitat (Riera et al. 2019).

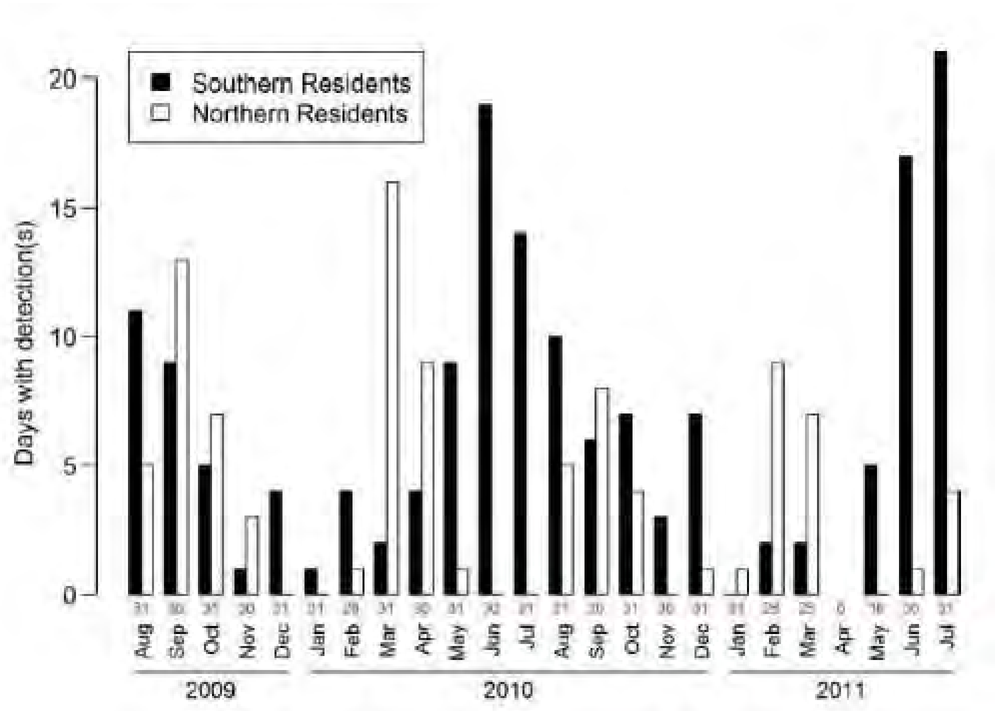


Figure 26. Number of days with acoustic detections of SRKWs at Swiftsure Bank from August 2009-July 2011. Red numbers indicate days of effort (Riera et al. 2019).

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)).

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 2008j; Murray et al. 2021; NMFS 2021j).

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. There are many limitations to interpreting the specific results, and unquantified uncertainty in the model (see *Indirect Effects: Reduction of primary prey* in section 2.5.4 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, Ellis and Balcomb 2000; Ford and Ellis 2006; Hanson et al. 2010; 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, Ylitalo and West 2014). For example, in order for a killer whale to obtain the total energy value of one 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, Ylitalo and West 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, Horne and Jones 2010). Though SRKW don't 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 sallmon 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 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).

<u>May – September</u>

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. 2010; 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 percent 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. 2010). 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. 2010; 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. 2021b). 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. 2021b). 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 27). 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. 2021b). These data indicate that the whale diet diversifies when Chinook salmon are less abundant (Hilborn et al. 2012; Ford et al. 2016; Hanson et al. 2021b). 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. 2021b). 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 27). 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. 2021b).

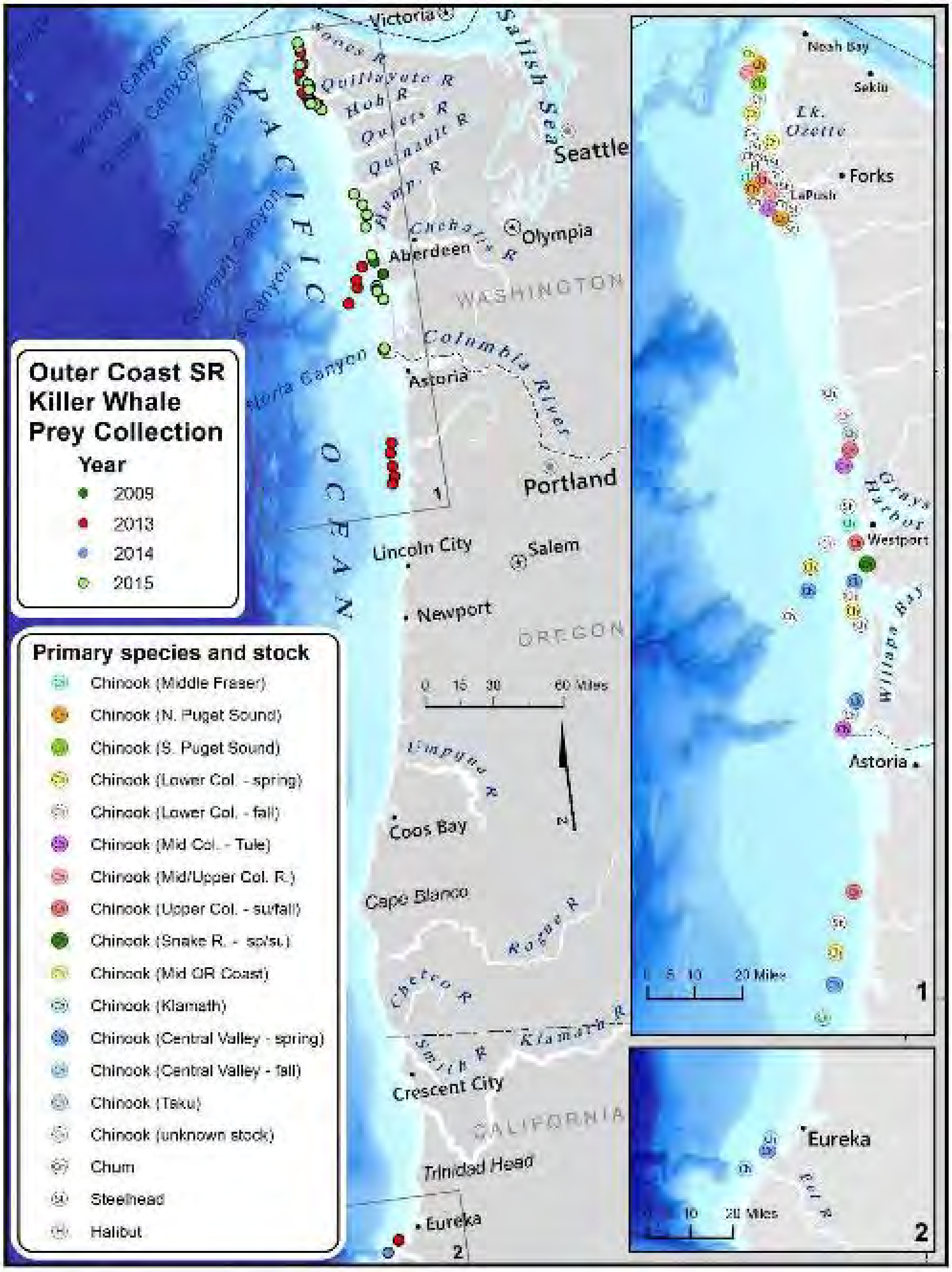


Figure 27. Location and species for scale/tissue samples collected from SRKW predation events in outer coastal waters (stock IDs are considered preliminary)(NMFS 2021i).

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).[22] 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 report was designed only to prioritize recovery actions for SRKW; currently, stock-specific abundance estimates have not been factored into the report, therefore it is not intended to assess fisheries actions or prey availability by area. 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 (2021f).

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 2008j). 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. 2010). 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, Solazzi and Johnson 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-

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

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.

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[23] (NOF) areas. For K pod, the best model 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. 2021a), 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, Trites and Gauthier 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, Trites and Gauthier 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, Schultz and Carmichael 2010), and where recent observations have identified travel as the predominant behavior (DFO Canada 2021). Sato, Trites and Gauthier (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

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[23] The NOF management area encompasses the Washington coast and northern Oregon (the coastal waters from U.S./Canadian border to Cape Falcon, 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. (2023a) 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. 2023a). 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. 2021b), 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, Deerenberg and Dijkstra (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. 2016a; Maggini, Pierre and Calder 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 28)(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 2008j). 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.

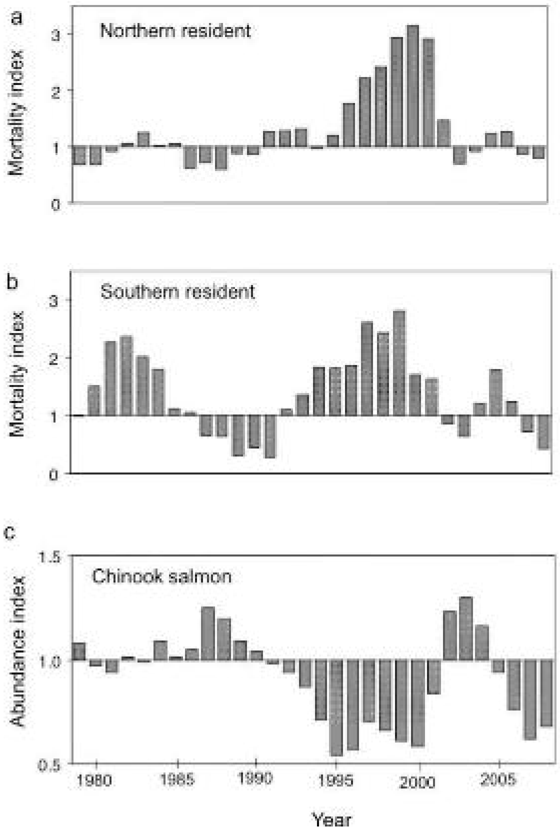

Figure 28. Annual mortality indices for a) Northern Resident and b) SRKWs and c) abundance index of Chinook salmon from 1979 to 2003 (reprinted from Ford et al. (2010)).

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” 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, Fredriksson and Eriksson 2003; Ylitalo et al. 2005; Fonnum, Mariussen and Reistad 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. (2023a) 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. (2023b) 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. (2023b). Low molecular weight PAHs are generally associated with pyrogenic sources such as petroleum and liquid fossil fuel combustion (Lee et al. 2023b). 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. 2016a). 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 2008j). There is a growing body of evidence documenting effects from vessels on small cetaceans and other marine mammals (NMFS 2010c; 2018g; 2021j). 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, unpublished; Lusseau et al. 2009; Noren et al. 2009; Williams et al. 2010; Holt et al. 2021a; Holt et al. 2021b; Tennessen et al. 2023b), or 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. 2021b). 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. 2021b).

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, Lusseauc and Hammond 2006; Lusseau et al. 2009; Noren et al. 2009; Noren et al. 2012; Noren and Hauser 2016; Holt et al. 2021a; Holt et al. 2021b). 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. 2006; 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. 2021a). 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 the 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. 2021a). 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). 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, Mongillo and Barre 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, Mongillo and Barre (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). 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 24th, 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[24]. 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. 2021a).

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

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

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 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 (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)(NOAA Fisheries 2017). 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).

2.2.1.5 *Status of the Mexico and Central America DPS of Humpback Whales*

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

- North Atlantic
    - West Indies
    - Cape Verde Islands/Northwest Africa
- North Pacific
    - Western North Pacific (WNP)
    - Hawaii

  - Mexico
  - Central America
- Northern Indian Ocean
  - Arabian Sea
  - Brazil
  - Gabon/Southwest Africa
  - Southeast Africa/Madagascar
  - West Australia
  - East Australia
  - Oceania
  - Southeastern Pacific

We used information available in the recovery plan (NMFS 1991), recovery outline with interim guidance[25], status review (Bettridge et al. 2015), most recent stock assessments (Carretta et al. 2021b; Carretta et al. 2021c; Muto et al. 2021), reports on estimated abundance and migratory destinations for North Pacific humpback whales (Calambokidis and Barlow 2020; Wade 2021), and recent opinions to summarize the status of the species, as follows. NOAA Fisheries is in the process of updating the recovery plan for humpback whales, including Mexico and Central America DPSs. The updated plan will replace the species-wide recovery plan published in 1991.

The 2015 status review relied in large part on the results from field efforts conducted on all known winter breeding regions (2004-2006) and all known summer feeding areas (2004, 2005) for humpback whales in the North Pacific (Structure of Populations, Levels of Abundance and Status of Humpbacks (SPLASH). This study, representing one of the largest international collaborative studies of any whale population ever conducted, was designed to determine the abundance, trends, movements, and population structure of North Pacific humpback whales as well as to examine human impacts on the population (Calambokidis et al. 2008). The SPLASH study continues to be relied upon for abundance estimates as well as movement proportions between wintering (breeding) and summer (foraging) grounds (Bettridge et al. 2015; Wade 2021), even though the field efforts took place nearly fifteen years ago.

NMFS has identified three DPSs of humpback whales that may be found off the coasts of Washington, Oregon, and California. These are the Hawaiian DPS (found off Washington and southern British Columbia [SBC] and the North Pacific) which is not listed under the ESA; the Mexico DPS (found all along the U.S. west coast) which is listed as threatened under the ESA; and the Central America DPS (found predominately off the coasts of Oregon and California) which is listed as endangered under the ESA. Photo-identification matching is ongoing to assess which DPSs are present in inland U.S. waters and in what proportions,with the most recent estimate of proportions in Wade et al. (2022). A study by DFO using photo-identifications found

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[25] DPS specific recovery plans are currently being developed to replace the species-wide recovery plan from 1991. A recovery outline with interim guidance during the development of the recovery plan (along with the existing species-wide recovery plan) was published in June of 2022 (here: https://www.fisheries.noaa.gov/resource/document/recovery-outline-central-america-mexico-and-western-north-pacific-distinct).

that the proportion of Mexico DPS whales sighted in all of British Columbia, including but extending beyond the Canadian portion of the Salish Sea, decreased with an increase in latitude (McMillan et al. 2023). This study included whales from the Northern Washington/South British Columbia feeding group (which would include whales within the action area) and whales from the Northern British Columbia/ Southeastern Alaska feeding group (which are found outside of the action area) so the overall trend may be applicable to the proportion of different DPSs in the action area, but the total proportions encountered may not be. An assessment to answer that question is currently underway. In addition to photo-identification matching to DPS, studies are ongoing to use genetic samples to match individuals to a DPS (Lizewski et al. 2021). These two lines of evidence suggest different proportions of the three DPSs along the U.S. West Coastwith more whales from the Mexico DPS under the genetic line of evidence and more whales from the Hawaii DPS under the photo id. At this point in time the photo-identification matching is considered a more reliable source of identification than the genetic sampling given the larger database available to compare across (Paul Wade, pers. Comm October, 2023). To attempt to resolve the conflicting proportions between the two data sources (i.e., genetics and photo-identification) for Washington state, the SWFSC and AFSC developed a weighted mean between Wade et al. (2022) and Lizewski et al. (2021) (Table 10; Jim Carretta, pers. comm. November 21, 2023).

Table 10. Weighted proportional estimates of each DPS from Wade et al (2022) and Lizewski et al. (2021) for the Northern Washington/Southern British Columbia area. E=Endangered, T=Threatened. NL = Not Listed.

Feeding Area	Central America DPS (E)	Mexico DPS (T)	Hawaii (NL)
Northern Washington/ SBC	9%	18%	63%

Based on this weighted proportion, the majority of humpback whales observed in coastal waters of Washington and British Columbia are from the Hawaiian breeding population.

NMFS manages humpback whales that occur in waters under the jurisdiction of the U.S. as five separate stocks under the MMPA. New humpback whale stocks for the North Pacific were finalized in the 2022 SARs for the Pacific and Alaska (Carretta et al. 2023b; Young et al. 2023b). The previous CA/OR/WA stock has been divided into two separate stocks: the Central America/Southern Mexico – CA-OR-WA stock and the Mainland Mexico- CA-OR-WA stock, which more closely aligns with the DPS designations. Additionally, humpback whales that winter off Hawaii and feed off Washington are considered as part of the Hawaii stock, which is composed entirely of the non-listed Hawaii DPS.

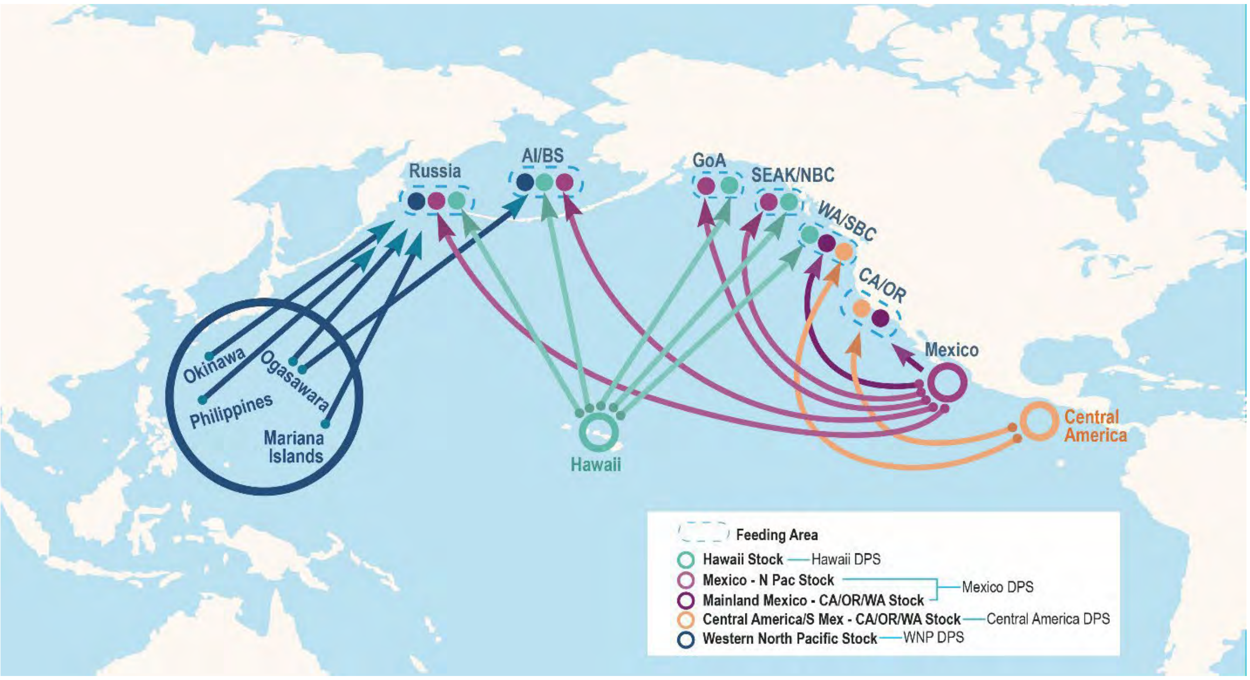

Figure 29. Map of humpback whale stocks and DPS ranges as defined in the 2022 Pacific SAR (Carretta et al. 2023b).

The most recent SAR for the Central America/Southern Mexico-CA/OR/WA and Mainland Mexico-CA/OR/WA stocks relies on the summer to winter area movement probabilities from Wade (2021) to address the proportion of the stocks that may be found in Washington waters (Table 11).

Table 11. Proportional estimates of each stock that will be applied in coastal and inland waters off of Washington/South British Columbia. E=Endangered, T=Threatened. NL = Not Listed (adapted from Wade (2021)).

Feeding Area	**Central America/Southern Mexico -CA/OR/WA Stock** (Nmin = 1,284 (1.6% growth))**	**Mainland Mexico-CA/OR/WA Stock** (Nmin= 3,185 (8.2% growth))**	**Hawaii Stock** (Nmin = 7,265)***
Washington/SBC*	6%	25%	69%

* Note that a portion of humpbacks that may be found in the Salish Sea and off WA are moving north of the U.S. border and feeding off SBC.
** Nmin for the Central America DPS/Central America/Southern Mexico- CA/OR/WA stock are from Curtis et al. (2022).
*** The growth rate for the Hawaii stock is currently unknown following declines associated with the marine heatwave in 2014-2016 (Young et al. 2023a).

While the new stock designations do not fully align with the DPS designations, given the similarities and the intention to have the new stocks more closely align with the DPS designations, we assume that they are equivalent for understanding the proportions of the DPSs in the Action Area for this analysis. The estimates in Wade (2021) include a slightly larger proportion of Mainland Mexico- CA/OR/WA individuals (Table 11) compared to the weighted proportions presented above in Table 10. Given the uncertainty in the proportion of DPSs in the action area, this consultation will rely on the proportions from Table 11 (Wade 2021) to fully account for the potential risk posed to the most commonly occurring ESA-listed DPS in the action area. As such, this opinion evaluates impacts on both the Central American and Mexico DPSs of humpback whales as both are assumed to occur in the action area in the relative proportions described in Table 11. To the extent that impacts are evaluated at an individual animal level, the proportions from Wade (2021) would be used as the likelihood that an affected animal is from either DPS.

Geographic Range and Distribution

Humpback whales are widely distributed in the Atlantic, Indian, Pacific, and Southern Oceans. Individuals generally migrate seasonally between warmer, tropical and sub-tropical waters in winter months (where they reproduce and give birth to calves) and cooler, temperate and sub-Arctic waters in summer months (where they feed). In their summer foraging areas and winter calving areas, they tend to occupy shallower, coastal waters; though during seasonal migrations they disperse widely in deep, pelagic waters and tend to avoid shallower coastal waters (Winn and Reichley 1985). North Pacific humpback whales are a distinct subspecies due to differences in mitochondrial DNA compared to the North Atlantic humpback whales and the Southern Hemisphere humpback whales (Baker et al. 2013). Exchange between the North Pacific breeding groups is rare (Calambokidis et al. 2001; Calambokidis et al. 2008). The Mainland Mexico-CA-OR-WA and Central America/Southern Mexico-CA-OR-WA stocks as described in the 2022 SARs spend the winter (breeding season) primarily in coastal waters of Mexico and Central America, and the summer (feeding season) along the West Coast from California to British Columbia, with the Mainland Mexico-CA-OR-WA stock also found feeding in Alaska. The Hawaii stock is consistent with the Hawaii DPS and winters in Hawaii and summers in British Columbia/Southeast Alaska, Southern British Columbia/Washington, the Gulf of Alaska, the Bering Sea/Aleutian Islands, and Russia. The Hawaii DPS's distribution partially overlaps with that of the Central America and Mexico DPSs off the coast of Washington and British Columbia (Clapham 2009).

Humpback whales in the North Pacific generally exhibit strong site fidelity and movement between feeding and breeding regions, but movements between feeding and breeding areas are complex and varied (Calambokidis et al. 2008; Barlow et al. 2011). An overall pattern of migration has emerged. Asia and Mexico/Central America are the dominant breeding areas for humpback whales that migrate to feeding areas in lower latitudes and more coastal areas on each side of the Pacific Ocean, such as California and Russia. The Revillagigedo Archipelago and Hawaiian Islands are the primary winter migratory destinations for humpback whales that feed in the more central and higher latitude areas (Calambokidis et al. 2008). However, there are exceptions to this pattern, and it seems that complex population structure and strong site fidelity coexist with lesser known, but potentially high, levels of plasticity in the movements of humpback whales (Salden et al. 1999; Bettridge et al. 2015). For instance, two whales were documented in both Mexico and Hawaii during the same winter seasons (Darling et al. 2022).

Abundance, Productivity and Trends

Mexico DPS

The Mexico DPS consists of whales that breed along the Pacific coast of mainland Mexico, the Baja California Peninsula and the Revillagigedos Islands. The DPS consists of two MMPA stocks: Mainland Mexico- CA/OR/WA stock (which is composed of one DIP) and the Mexico-North Pacific stock (which is composed of one unit made up of multiple DIPs) (Martien et al. 2021; Carretta et al. 2023b). The Mainland Mexico-CA/OR/WA stock/DIP primarily winter off of the mainland Mexico states of Nayarit and Jalisco and summer off of the U.S. West Coast, including the Salish Sea (Martien et al. 2021), Southern British Columbia, Alaska, and the Bering Sea (Carretta et al. 2023b). The Mexico-North Pacific unit is likely composed of multiple DIPS, based on movement data (Martien et al. 2021; Wade 2021; Wade, Oleson and Young 2021; Carretta et al. 2023b). Whales in this unit winter off of Mexico and the Revillagigedo Archipelago and spend summers primarily in Alaska waters (Martien et al. 2021). This DPS was determined to be discrete based on significant genetic differentiation as well as evidence for low rates of movements among breeding areas in the North Pacific based on sighting data. The Mexico DPS was also determined to be significant due to the gap in breeding grounds that would occur if this DPS were to go extinct and the marked degree of genetic divergence to other populations. This DPS also differs from some other North Pacific populations in the ecological characteristics of its feeding areas (Bettridge et al. 2015).

Population Status and Trends

Recently, (Wade 2021) estimated the abundance of the Mexico DPS to be 2,913 whales based on a revised analysis of the SPLASH data. Because the SPLASH estimates are more than 8 years old, and humpback whales in the Pacific have recently experienced positive growth rates, they are not considered a reliable estimate of current abundance (NOAA 2016; Carretta et al. 2021c). Although no specific estimate of the current growth rate of this DPS is available, it is likely that the positive growth rates of humpback whales along the U.S. West Coast and in the North Pacific at large that have been documented are at least somewhat reflecting growth of this DPS, given its relative population size. Because the Mexico DPS forages widely in the North Pacific, including areas off British Columbia and Alaska, it is difficult to estimate the abundance of this DPS based on the recent MMPA minimum abundance estimates for the two Mexico stocks. Therefore, if we assume that the population estimated by Wade (2021) based on information from 2004-2006 (2,913 animals) has increased by 6 percent annually in the last 16 years, the current abundance estimate of the Mexico DPS would be 7,400 animals. However, there is uncertainty in this estimate.

Curtis et al. (2022) estimated the abundance of the Mainland Mexico-CA/OR/WA DIP in the U.S. West Coast EEZ based on the total abundance in the area (4,973 whales; Calambokidis and Barlow 2020) minus the abundance estimate for the Central America/Southern Mexico – CA/OR/WA DIP (1,496 whales) at 3,477 whales.

Central America DPS

The Central America DPS is composed of whales that breed along the Pacific coast of Costa Rica, Panama, Guatemala, El Salvador, Honduras and Nicaragua. Genetic and movement data collected since the DPS designation indicate that this DPS also extends into southern Mexico (Martinez-Loustalot et al. 2020; Taylor et al. 2021). Whales from this breeding ground feed almost exclusively offshore of California and Oregon in the eastern Pacific, with only a few individuals identified at the northern Washington–southern British Columbia feeding grounds. This DPS was determined to be discrete based on re-sight data as well as findings of significant genetic differentiation between it and other populations in the North Pacific. The genetic composition of the DPS is also unique in that it shares mitochondrial DNA (mtDNA) haplotypes with some Southern Hemisphere DPSs, suggesting it may serve as a conduit for gene flow between the North Pacific and Southern Hemisphere. The breeding ground of this DPS occupies a unique ecological setting, and its primary feeding ground is in a different marine ecosystem from most other populations. Loss of this population would also result in a significant gap in the range of the species (Bettridge et al. 2015).

Population Status and Trends

The Central America DPS of humpback whales occurs along the U.S. West Coast, although individuals are more likely to be found off the coast of California and Oregon. This DPS corresponds with a single DIP, the Central America/Southern Mexico-CA/OR/WA DIP. Curtis et al. (2022) estimated the population size of this DIP at 1,496 whales. This estimate comes from the use of spatial capture-recapture methods based on photographic data collected between 2019 and 2021 and differs from previous estimates (such as those in Wade (2021)) because it includes individuals wintering in southern Mexico as part of the same DIP based on recent genetics and movement data (Taylor et al. 2021). Because of the inclusion of southern Mexico individuals in this DIP, it is difficult to estimate the annual growth rate. Curtis et al. (2022) believe that the growth rate for the Central American population is considerably lower than the growth rate for the full U.S. West Coast humpback whale population, possibly as low as 1.6% compared to the 8.2% estimated in Calambokidis and Barlow (2020).

Current Assessment of Abundance and Distribution of ESA-listed Humpback Whale DPSs

Because the data used to determine the probability rates in summer feeding areas off of CA/OR in (Wade 2021) are 15 years old, the probabilities and populations sizes calculated are assumed to be outdated. Therefore, to consider what probabilities/proportions of the DPSs would be off of the U.S. west coast, we considered the combination of the most recent abundance estimates with reasonable assumptions of population growth rates since 2004-2006 to derive proportional estimates for the current populations of humpback whales off the coasts of CA, OR, and WA.

The best estimate of current abundance for all humpback whales off of the U.S. West Coast is based on the most-recent 4 years (2015-2018) of mark-recapture data and a Chao model that accounts for heterogeneity of capture probabilities, resulting in an estimate of 4,973 (CV=0.048) whales (Calambokidis and Barlow 2020). This estimate primarily counts the number of humpback whales off of California and Oregon, but is assumed to include the individuals found in Washington waters too given the interchange between the areas during migrations. Additionally, estimates for Washington from this model may overestimate the number of humpback whales in U.S. waters given the movement between the U.S. and British Columbia (Calambokidis and Barlow 2020). Becker et al. (2020) also estimated humpback whale abundance in California, Oregon, and Washington waters based on habitat models and 1991-2018 line-transect data. Their most-recent estimate for 2018 is 4,784 whales (CV=0.31). However, the mark-recapture estimate is considered the best estimate because 1) it has better precision and 2) the line-transect estimate reflects only whale densities within the study area during summer and autumn when surveys were conducted.

For WA/SBC, we do not have an estimate of the abundance of humpbacks that may be foraging north of CA/OR and only within U.S. waters, only that they represent a small proportion of the minimum abundance estimate for the CA/OR/WA stock, as designated under the MMPA, with portions of the humpbacks feeding north of the U.S. border. Researchers are actively collecting data on the DPS proportions in the WA/SBC feeding area. As noted above, to capture the full potential impacts of the proposed action on the most commonly occurring ESA-listed humpback whale DPS, we will continue to use the stock/DPS proportions presented in Wade (2021) and shown in Table 11. Given this, the majority of the humpback whales (69 percent) feeding in this area would originate from the non-listed Hawaii DPS.

Limiting Factors and Threats

The humpback whale species was originally listed as endangered because of past commercial whaling. While commercial whaling of humpback whales no longer occurs, it continues to have lasting impacts on the populations. Additional threats to the species include ship strikes, fisheries interactions (including entanglement), noise, loss of habitat, loss of prey (for a variety of reasons including climate variability), and pollutants. Brief descriptions of threats to humpback whales follow.

Natural Threats

The most common predator of humpback whales is the killer whale, likely transient killer whales (*Orcinus orca*, Jefferson, Stacey and Baird (1991)), although predation by large sharks may also be significant (attacks are mostly undocumented). Shark bite marks on stranded whales may often represent post-mortem feeding rather than predation, i.e., scavenging on carcasses (Long and Jones 1996). There is also evidence of shark predation on calves and entangled whales (Mazzuca, Atkinson and Nitta 1998). Rare attacks by false killer whales have also been reported or suggested (Fleming and Jackson 2011). Predation by killer whales on humpback calves has been inferred by the presence of distinctive parallel ‘rake’ marks from killer whale teeth most commonly across the trailing edge of the flukes (Shevchenko 1975). 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.

While killer whale attacks of humpback whales are rarely observed in the field (Ford and Reeves 2008), the proportion of photo-identified whales from a grouping of long-term studies bearing rake scars is between zero and 40 percent, with the greater proportion of whales showing mild scarring (1-3 rake marks) (Mehta et al. 2007; Steiger et al. 2008). Whales from the Mexico wintering ground and the California feeding area experience higher incidences of rake marks (Steiger et al. 2008). This suggests that attacks by killer whales on humpback whales vary in frequency across regions. It also suggests either that most killer whale attacks result in mild scarring, or that those resulting in severe scarring (4 or more rakes, parts of fluke missing) are more often fatal. Most observations of humpback whales under attack from killer whales reported vigorous defensive behavior and tight grouping where more than one humpback whale was present (Ford and Reeves 2008). Corsi et al. (2022) found that 19 percent (n = 87) of humpback tail flukes from an eastern North Pacific ID catalog displayed signs of predatory scarring. This is a smaller proportion than the percentages for both blue whales and gray whales determined by the same study. Approximately 15 percent of humpback whales with no scarring visible in their first catalog photo were later photographed with rake marks, which is an accumulation rate similar to or higher than observed in other regions (Testino et al. 2019; Corsi et al. 2022).

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

Anthropogenic Threats

Fleming and Jackson (2011), Bettridge et al. (2015), and the 1991 Humpback Whale Recovery Plan (NMFS 1991) list the following range-wide anthropogenic threats for the species including fishery interactions including entanglement in fishing gear, vessel strikes, pollution, and acoustic disturbance. Here we briefly discuss these threats.

Prey Interactions

Humpback whales exhibit flexible feeding strategies, sometimes foraging alone and sometimes cooperatively (D'Vincent, Nilson and Hanna 1985). In many locations, feeding in the water column can vary with time of day, with whales bottom feeding at night and surface feeding near dawn (Friedlaender et al. 2009; Bettridge et al. 2015). Humpback whales have a diverse diet that slightly varies across feeding aggregation areas. The species is known to feed on both small schooling fish and on euphausiids (krill). Known prey organisms on the West Coast include species representing Clupea (herring), Scomber (mackerel), Ammodytes (sand lance), Sardinops (sardine), Engraulis (anchovy), Mallotus (capelin), and krills such as *Euphausia*, *Thysanoessa*, and Meganyctiphanes (Baker 1985; Geraci et al. 1989; Clapham et al. 1997; Clapham 2009).

Climate change may lead to shifts in the distributions and prey selection by humpback whales. The California Current System has experienced elevated sea surface temperatures associated with marine heatwaves in recent years. During these periods, sardines exhibited northern shifts while anchovy maintained their historical distributions (Muhling et al. 2020). An upwelling habitat compression during the 2014-2016 marine heatwave, as described at the beginning of this section, may have resulted in humpback whales switching from feeding offshore on krill to feeding inshore on anchovy (Santora et al. 2020). Additionally, warmer waters may be associated with decreases in adult krill body length (Killeen et al. 2021). A recent study of humpback whales in the North Pacific Ocean found that the population has declined since 2012, with a large part of this attributed to changes in the Hawaii DPS (Cheeseman 2024). The authors hypothesize that the depression in biological productivity and prey abundance that resulted from the 2014-2016 marine heatwave may have been responsible for some of this decline.

Fishery Entanglements

Entanglement in fishing gear is a documented source of injury and mortality to cetaceans. Entanglement may result in only minor injury or may potentially significantly affect individual health, reproduction, or survival (Fleming and Jackson 2011). Entanglement can lead to decreased foraging ability, risk of infection, hemorrhaging, severe tissue damage, and draining of energy of whales (Moore and Hoop 2012); individuals may also die from starvation or drowning if the gear holds them in place (Lebon and Kelly 2019). Bettridge et al. (2015) report that fishing gear entanglements may moderately reduce the population size or the growth rate of the Mexico and Central America DPSs.

The impact of fisheries on the CA/OR/WA humpback whale stock is likely underestimated, since the serious injury or mortality of large whales due to entanglement in gear may go unobserved because whales swim away with a portion of the net, line, buoys, or pots. Pot and trap gear are the most commonly documented source of mortality and serious injury to humpback whales off the U.S. West Coast (Carretta et al. 2022a; Carretta et al. 2023b) and entanglement reports have increased considerably since 2014. Between 2016 and 2020, 257 large whales were reported as having human-caused serious injuries or mortalities. Of these, 153 were humpback whales (Carretta et al. 2022a). An additional 34 humpback whales were confirmed as entangled from 2021 to 2022 (NOAA Fisheries 2022; 2023). There was a record high of 53 reported entanglements in 2016, of which 48 were confirmed (Saez, Lawson and DeAngelis 2021). From 2015-2019 the mean serious injury/ mortality estimates for the CA/OR/WA stock due to commercial fishery entanglements (at least 24.9/yr[26]), non-U.S. commercial sources (1.4/yr[27]) and estimated ship strikes (22/yr) equals 48.3 animals, which exceeds the stock's Potential Biological Removal (PBR) of 29.4 animals in U.S. waters (Carretta et al. 2022b). Based on strandings and at-sea observations, annual humpback whale mortality and serious injury in commercial fisheries (24.9/yr) is less than the PBR of 29.4; however, if methods were available to correct for undetected serious injury and mortality, total fishery mortality and serious injury

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[26] Includes at least 2.0 humpback whales per year estimated form the unidentified fishery interactions involving unidentified whales prorated to humpback whales.

[27] Includes recreational Dungeness crab pot fisheries (1.75/yr) and tribal fisheries (3.5/yr)

would likely exceed PBR.

The estimates of whale entanglements and ship strikes are minimum counts since many of these interactions likely go unnoticed. Tackaberry et al. (2022) found that the entangled whales were resighted less often than control groups. They also found that the risk of entanglement may be higher for younger whales than for mature individuals who may be able to self-release from gear more successfully.

Vessel Strikes and Disturbance

Vessel strikes often result in life-threatening trauma or death for cetaceans. It is estimated that at most 10 percent of the vessel strikes that occur are documented (Carretta et al. 2021b). Vessel strikes are likely the second greatest cause of death for humpback whales along the U.S. west coast, behind entanglements (Rockwood, Calambokidis and Jahncke 2017). 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-force 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).

Humpback whales, especially calves and juveniles, are highly vulnerable to ship strikes (Stevick, Carlson and Balcomb 1999) and other interactions with non-fishing vessels. Humpback whales spend the vast majority of their time within 30 meters of the sea surface (90 percent at night and 69 percent during daytime), increasing their risk of vessel strike (Calambokidis et al. 2019). Off the U.S. west coast, humpback whale distribution overlaps significantly with the transit routes of large commercial vessels, including cruise ships, large tug and barge transport vessels, and oil tankers, along with fishing vessels (Rockwood, Calambokidis and Jahncke 2017; Greig et al. 2020; Redfern, Becker and Moore 2020). This type of overlap also occurs within the proposed action area. Ship speeds of greater than 10 knots are likely to be fatal (Vanderlaan and Taggart 2007; Conn and Sibler 2013; Nichol et al. 2017). Rockwood, Calambokidis and Jahncke (2017) modeled ship strikes along the west coast and determined there were an average of 2.8 humpback whale strikes per year from 2006 to 2016, with a minimum of 8.2 and a best estimate of 28 deaths over the 10-year time period based on carcass buoyancy. Rockwood et al. (2017) used a probability of avoidance of 55 percent based on existing data. However, other studies have shown a greater avoidance behavior by large whales (Lesage et al. 2017; Garrison et al. 2022), including humpbacks (Schuler et al. 2019), so the encounter rate may be lower than estimated in Rockwood, Calambokidis and Jahncke (2017). Additional studies have refined the Rockwood, Calambokidis and Jahncke (2017) model and applied it to two areas of the West Coast: outside of San Francisco Bay and the Santa Barbara Channel. Rockwood et al. (2020) modeled an estimated average annual spring/summer mortality of 7.0 humpback whales from 2012 to 2017 near San Francisco Bay. Rockwood et al. (2020) examined vessel strike risk in the Santa Barbara Channel and estimated, for 2012-2018, that there was an average of 4.6 fatal humpback vessel strikes during summer/fall and 5.7 fatal strikes during winter/spring annually. Combining the recent model estimates together gives a fatal vessel strike rate of 17.3 humpback whales per year within two portions of California alone. (Nichol et al. 2017) modeled the western portion of the Strait of Juan de Fuca to be a relatively high-risk area for humpback vessel strikes, along with areas near the shelf edge of Vancouver Island, and within the Strait itself. While the models provide estimates of vessel strike rates and do not represent confirmed deaths, they provide evidence of a large threat that humpback whales are facing throughout the West Coast.

Whale watching boats and research activities directed toward whales may have direct or indirect impacts on humpback whales as harassment may occur, preferred habitats may be abandoned, and fitness and survivability may be compromised if disturbance levels are too high. The presence of whale watching vessels near humpback whales in both their breeding and feeding grounds can lead to high-energy stress behaviors (i.e. breaches, tail slaps), changes in behavior, and changes in the use of areas (Schuler et al. 2019; Amrein et al. 2020). Currie et al. (2021) found that swimming speeds of humpback whales increased as whale-watching vessels approached. Mothers and calves may move away from nearshore areas in response to vessel presence throughout the day within the Hawaiian breeding ground (Pack, Waterman and Craig 2022).

Pollution

Humpback whales can accumulate persistent organic pollutants (POPs) and pesticides (e.g. Dichlorodiphenyltrichloroethane (DDT)) in their blubber, as a result of feeding on contaminated prey (bioaccumulation). High levels of mercury have also been recorded in humpback whale baleen from stranded individuals in Alaska, with especially high levels in a lactating female (Lowe et al. 2022). The health effects of different doses of contaminants are currently unknown for humpback whales (Krahn et al. 2004b). Similar to other cetaceans, mothers may offload contaminants to their calves through gestation and lactation (Metcalfe et al. 2004).

Elfes et al. (2010) compared POPs, in biopsy samples collected from humpback whales from different feeding areas in the North Pacific and North Atlantic. These feeding areas included the coastal waters off California, Washington, and Alaska, and off the Gulf of Maine. In general, POP levels were higher in humpback whales from the North Atlantic than whales from the North Pacific (Elfes et al. 2010). However, levels of PCBs, DDTs, and PBDEs were still high along the US. West Coast, with the highest concentrations in samples from Southern California and Washington. DDT levels in North Atlantic humpback whales were slightly less than that measured in humpback whales feeding in southern California. DDTs in humpback whales off California were remarkably high, and when compared between the two California feeding regions, the whales feeding in the southern region had levels more than 6 times those measured in whales feeding in northern California. In fact, all POP classes were higher in the blubber of humpback whales off southern California than in other feeding regions in the North Pacific. The authors note this difference was not surprising because this area, similar to portions of the action area, is highly urbanized and impacted by more pollutant inputs (such as wastewater and stormwater) than northern California, and humpback whales demonstrate strong site fidelity to feeding areas.

Humpback whales from Alaskan waters had the lowest concentrations of POPs compared to those found in the other feeding regions off California and Washington (Elfes et al. 2010). These relatively low levels of POPs in humpback whales are not isolated to the less urbanized waters off Alaska. Stranded juvenile humpback whales in Hawaii had levels that overlapped the lower end of that found in humpbacks from Alaska (Bachman et al. 2014). Furthermore, Dorneles et al. (2015) measured POPs in humpbacks from the southern hemisphere (Antarctic Peninsula) and found concentrations were lower than that described in humpbacks from the Northern hemisphere. Baugh et al. (2023) measured POP concentrations in blubber in female humpback whales in the Gulf of Maine and saw signs of maternal offloading of contaminants to calves.

Besseling et al. (2015) found evidence of microplastic in the gastrointestinal tract of a humpback whale carcass in the Netherlands. Because humpback whales are filter feeders, it is likely that other individuals are also accumulating microplastics from their diet although the impacts from ingesting microplastics are largely unknown.

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 baleen whales, 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. Both male and female humpbacks produce social sounds associated with breeding, feeding, and migration (Cerchio and Dahlheim 2001; Cholewiak et al. 2018). Cholewiak et al. (2018) examined vessel noise acoustic masking for baleen whales in the Stellwagen Bank National Marine Sanctuary. For humpback whales, fishing and whale-watching noise led to a 30 percent decrease in communication space (the area over which an individual’s sounds can be detected by the intended receiver). When combined with commercial shipping noise, the communication space for humpback social sounds had a 99 percent decrease.

Preliminary analyses of humpback whale calls in Alaska during the absence of cruise ships as a result of the COVID-19 pandemic indicate that the decrease in vessel noise may have led to an increase in the amount or detection of calls, implying anthropogenic noise is impeding the ability for individuals to communicate (Fournet, Matthews and Gabriele 2021). A similar study in Iceland found that humpback whale call detections increased nearly 2-fold in 2020 when whale-watching trips was reduced by 68.6 percent despite similar ambient noise levels in pre-pandemic summer months (Laute et al. 2022).

Vessel noise may also cause behavioral disturbance. Frankel and Clark (2000) found that the distance between surfacing by humpback whales increased with a greater received sound level in Hawaii, showing some behavioral reaction to experiencing louder noises by these whales. Similarly, Sprogis, Videsen and Madsen (2020) determined that vessel noise was a driver of behavioral disturbance to mothers and calves, leading to decreased resting and increased respiration rates and swimming speeds.

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).

2.2.2 Status of Critical Habitat

Section 3(5)(A) of the ESA defines critical habitat as "(i) the specific areas within the geographical area occupied by the species, at the time it is listed . . . on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographical area occupied by the species at the time it is listed . . . upon a determination by the Secretary that such areas are essential for the conservation of the species."

We review the status of designated critical habitat affected by the proposed actions by examining the condition and trends of essential PBFs throughout the designated area. These features are essential to the conservation of the listed species because they support one or more of the species' life stages (e.g., sites with conditions that support spawning, rearing, migration and foraging).

2.2.2.1 *Puget Sound Chinook and Steelhead Critical Habitat*

<u>Puget Sound Chinook Salmon Critical Habitat</u>

Critical habitat for Puget Sound Chinook salmon was designated on September 2, 2005 (70 FR 52630). Critical habitat includes 1,683 miles of streams, 41 square mile of lakes, and 2,182 miles of nearshore marine habitat in Puget Sound. The designation also includes some nearshore areas occupied by the 22 populations, because of their importance to rearing and migration for Chinook salmon and their prey. The designation includes nearshore areas extending from the extreme high water point out to a depth of 30 meters and adjacent to watersheds, but does not otherwise include offshore marine areas. Puget Sound Chinook salmon critical habitat includes estuarine areas and certain river reaches associated with the following subbasins: Strait of Georgia, Nooksack, Upper Skagit, Sauk, Lower Skagit, Stillaguamish, Skykomish, Snoqualmie, Snohomish, Lake Washington, Duwamish, Puyallup, Nisqually, Deschutes, Skokomish, Hood Canal, Kitsap, and Dungeness/Elwha (70 FR 52630).

There are 61 watersheds within the range of this ESU. Of the stream and nearshore habitat eligible for designation, 3,865 miles are designated critical habitat while the remaining 740 miles were excluded because they are lands controlled by the military, overlap with Indian lands, or the benefits of exclusion outweighed the benefits of designation (70 FR 52630). It does not include marine or open ocean waters. Critical habitat information for Puget Sound Chinook salmon can be found online at: https://www.fisheries.noaa.gov/west-coast/endangered-species-conservation/puget-sound-chinook-salmon.

The Puget Sound Chinook salmon ESU has 61 freshwater and 19 marine areas within its range. Of the freshwater watersheds, 41 are rated high conservation value, 12 low conservation value, and eight received a medium rating. Of the marine areas, all 19 are ranked with high conservation value from NOAA Fisheries' CHART (NMFS 2005b; 2022b). For the Puget Sound steelhead DPS, nine watersheds received a low conservation value rating, 16 received a medium rating, and 41 received a high rating to the DPS from CHART (NMFS 2015b; 2022b).

The Puget Sound recovery domain CHART determined that only a few watersheds for Chinook salmon (Skagit River/Gorge Lake, Cascade River, Upper Sauk River, and the Tye and Beckler rivers) are in good-to-excellent condition with no potential for improvement (NMFS 2005b). Most HUC_5 watersheds are in fair-to-poor or fair-to-good condition. However, most of these watersheds have some or a high potential for improvement (Table 12) (NMFS 2005b; 2022b).

Table 12. Puget Sound Recovery Domain habitat quality status and potential quality of HUC_5 watersheds identified as supporting historically independent populations of ESA-listed Chinook salmon (CK) and chum salmon (CM) (NMFS 2005b).

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name(s) and HUC_5 Code(s)	**Listed Species**	**Current Quality**	**Restoration Potential**
Strait of Georgia and Whidbey Basin #1711000xxx			
Skagit River/Gorge Lake (504), Cascade (506) & Upper Sauk (601) rivers, Tye & Beckler rivers (901)	CK	3	3
Skykomish River Forks (902)	CK	3	1
Skagit River/Diobsud (505), Illabot (507), & Middle Skagit/Finney Creek (701) creeks; & Sultan River (904)	CK	2	3
Skykomish River/Wallace River (903) & Skykomish River/Woods Creek (905)	CK	2	2
Upper (602) & Lower (603) Suiattle rivers, Lower Sauk (604), & South Fork Stillaguamish (802) rivers	CK	2	1
Samish River (202), Upper North (401), Middle (402), South (403), Lower North (404), Nooksack River; Nooksack River (405), Lower Skagit/Nookachamps Creek (702) & North Fork (801) & Lower (803) Stillaguamish River	CK	1	2
Bellingham (201) & Birch (204) bays & Baker River (508)	CK	1	1
Whidbey Basin and Central/South Basin #1711001xxx			
Lower Snoqualmie River (004), Snohomish (102), Upper	CK	2	2

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name(s) and HUC$_5$ Code(s)	**Listed Species**	**Current Quality**	**Restoration Potential**
White (401) & Carbon (403) rivers			
Middle Fork Snoqualmie (003) & Cedar rivers (201), Lake Sammamish (202), Middle Green River (302) & Lowland Nisqually (503)	CK	2	1
Pilchuck (101), Upper Green (301), Lower White (402), & Upper Puyallup River (404) rivers, & Mashel/Ohop(502)	CK	1	2
Lake Washington (203), Sammamish (204) & Lower Green (303) rivers	CK	1	1
Puyallup River (405)	CK	0	2
Hood Canal #1711001xxx			
Dosewallips River (805)	CK/CM	2	1/2
Kitsap – Kennedy/Goldsborough (900)	CK	2	1
Hamma Hamma River (803)	CK/CM	1/2	1/2
Lower West Hood Canal Frontal (802)	CK/CM	0/2	0/1
Skokomish River (701)	CK/CM	1/0	2/1
Duckabush River (804)	CK/CM	1	2
Upper West Hood Canal Frontal (807)	CM	1	2
Big Quilcene River (806)	CK/CM	1	1/2
Deschutes Prairie-1 (601) & Prairie-2 (602)	CK	1	1
West Kitsap (808)	CK/CM	1	1
Kitsap – Prairie-3 (902)	CK	1	1
Port Ludlow/Chimacum Creek (908)	CM	1	1
Kitsap – Puget (901)	CK	0	1
Kitsap – Puget Sound/East Passage (904)	CK	0	0
Strait of Juan de Fuca Olympic #1711002xxx			
Dungeness River (003)	CK/CM	2/1	1/2
Discovery Bay (001) & Sequim Bay (002)	CM	1	2
Elwha River (007)	CK	1	2
Port Angeles Harbor (004)	CK	1	1
Watershed Name(s) and HUC$_5$ Code(s)	**Listed Species**	**Current Quality**	**Restoration Potential**
Strait of Georgia and Whidbey Basin #1711000xxx			
Skagit River/Gorge Lake (504), Cascade (506) & Upper Sauk (601) rivers, Tye & Beckler rivers (901)	CK	3	3
Skykomish River Forks (902)	CK	3	1

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name(s) and HUC$_5$ Code(s)	**Listed Species**	**Current Quality**	**Restoration Potential**
Skagit River/Diobsud (505), Illabot (507), & Middle Skagit/Finney Creek (701) creeks; & Sultan River (904)	CK	2	3
Skykomish River/Wallace River (903) & Skykomish River/Woods Creek (905)	CK	2	2
Upper (602) & Lower (603) Suiattle rivers, Lower Sauk (604), & South Fork Stillaguamish (802) rivers	CK	2	1
Samish River (202), Upper North (401), Middle (402), South (403), Lower North (404), Nooksack River; Nooksack River (405), Lower Skagit/Nookachamps Creek (702) & North Fork (801) & Lower (803) Stillaguamish River	CK	1	2
Bellingham (201) & Birch (204) bays & Baker River (508)	CK	1	1
Whidbey Basin and Central/South Basin #1711001xxx			
Lower Snoqualmie River (004), Snohomish (102), Upper White (401) & Carbon (403) rivers	CK	2	2
Middle Fork Snoqualmie (003) & Cedar rivers (201), Lake Sammamish (202), Middle Green River (302) & Lowland Nisqually (503)	CK	2	1
Pilchuck (101), Upper Green (301), Lower White (402), & Upper Puyallup River (404) rivers, & Mashel/Ohop(502)	CK	1	2
Lake Washington (203), Sammamish (204) & Lower Green (303) rivers	CK	1	1
Puyallup River (405)	CK	0	2
Hood Canal #1711001xxx			
Dosewallips River (805)	CK/CM	2	1/2
Kitsap – Kennedy/Goldsborough (900)	CK	2	1
Hamma Hamma River (803)	CK/CM	1/2	1/2
Lower West Hood Canal Frontal (802)	CK/CM	0/2	0/1
Skokomish River (701)	CK/CM	1/0	2/1
Duckabush River (804)	CK/CM	1	2
Upper West Hood Canal Frontal (807)	CM	1	2
Big Quilcene River (806)	CK/CM	1	1/2
Deschutes Prairie-1 (601) & Prairie-2 (602)	CK	1	1
West Kitsap (808)	CK/CM	1	1
Kitsap – Prairie-3 (902)	CK	1	1

Current PCE Condition	Potential PCE Condition
3 = good to excellent	3 = highly functioning, at historical potential
2 = fair to good	2 = high potential for improvement
1 = fair to poor	1 = some potential for improvement
0 = poor	0 = little or no potential for improvement

Watershed Name(s) and HUC$_5$ Code(s)	**Listed Species**	**Current Quality**	**Restoration Potential**
Port Ludlow/Chimacum Creek (908)	CM	1	1
Kitsap – Puget (901)	CK	0	1
Kitsap – Puget Sound/East Passage (904)	CK	0	0
Strait of Juan de Fuca Olympic #1711002xxx			
Dungeness River (003)	CK/CM	2/1	1/2
Discovery Bay (001) & Sequim Bay (002)	CM	1	2
Elwha River (007)	CK	1	2
Port Angeles Harbor (004)	CK	1	1

Major management activities affecting PBFs are forestry, grazing, agriculture, channel/bank modifications, road building/maintenance, urbanization, sand and gravel mining, dams, irrigation impoundments and withdrawals, river, estuary and ocean traffic, wetland loss, and forage fish/species harvest.

Landslides can occur naturally in steep, forested lands, but inappropriate land use practices likely have accelerated their frequency within designated critical habitat and increased the amount of sediment delivered to streams. Fine sediment from unpaved roads has also contributed to stream sedimentation. Unpaved roads are widespread on forested lands in the Puget Sound basin, and to a lesser extent, in rural residential areas. Historical logging removed most of the riparian trees near stream channels. Subsequent agricultural and urban conversion permanently altered riparian vegetation in the river valleys, leaving either no trees, or a thin band of trees. The riparian zones along many agricultural areas are now dominated by alder, invasive canary grass and blackberries, and provide substantially reduced stream shade and large wood recruitment (SSDC 2007; NMFS 2022b).

Diking, agriculture, revetments, railroads, and roads in lower stream reaches have caused significant loss of secondary channels in major valley floodplains in this region. Confined main channels create high-energy peak flows that remove smaller substrate particles and large wood. The loss of side-channels, oxbow lakes, and backwater habitats has resulted in a significant loss of juvenile salmonid rearing and refuge habitat. When the water level of Lake Washington was lowered 9 feet in the 1910s, thousands of acres of wetlands along the shoreline of Lake Washington, Lake Sammamish and the Sammamish River corridor were drained and converted to agricultural and urban uses. Wetlands play an important role in hydrologic processes, as they store water that ameliorates high and low flows. The interchange of surface and groundwater in complex stream and wetland systems helps to moderate stream temperatures. Forest wetlands are estimated to have diminished by one-third in Washington State (FEMAT 1993; Spence et al. 1996; SSDC 2007; NMFS 2022b).

Loss of riparian habitat, elevated water temperatures, elevated levels of nutrients, increased nitrogen and phosphorus, and higher levels of turbidity, presumably from urban and highway runoff, wastewater treatment, failing septic systems, and agriculture or livestock impacts, have been documented in many Puget Sound tributaries (SSDC 2007; NMFS 2022b).

Peak stream flows have increased over time due to paving (roads and parking areas), reduced percolation through surface soils on residential and agricultural lands, simplified and extended drainage networks, loss of wetlands, and rain-on-snow events in higher elevation clear cuts (SSDC 2007). In urbanized Puget Sound, there is a strong association between land use and land cover attributes and rates of coho spawner mortality likely due to runoff containing contaminants emitted from motor vehicles (Feist, Anderson and Miyamoto 1996; NMFS 2022b).

In urbanized Puget Sound, there is a strong association between land use and land cover attributes and rates of coho spawner mortality likely due to runoff containing contaminants emitted from motor vehicles (Feist, Anderson and Miyamoto 1996). After years of forensic investigation, the urban runoff coho mortality syndrome has now been directly linked to motor vehicle tires, which deposit the compound 6PPD and its abiotic transformation product 6PPD-quinone onto roads. 6PPD or [(N-(1, 3-dimethylbutyl)-N'-phenyl-p-phenylenediamine] is used to preserve the elasticity of tires. 6PPD can transform in the presence of ozone (O3) to 6PPD-quinone. 6PPD-quinone is ubiquitous to roadways (Sutton 2019) and was identified by Tian et al. (2021) as the primary cause of urban runoff coho mortality syndrome described by Scholz et al. (2011). Laboratory studies have demonstrated that juvenile coho salmon, juvenile steelhead, and juvenile Chinook salmon are also susceptible to varying degrees of mortality when exposed to urban stormwater (Chow et al. 2019; French et al. 2022). Fortunately, recent literature has also shown that mortality can be prevented by infiltrating road runoff through soil media containing organic matter, which removes 6PPD-quinone and other contaminants (McIntyre et al. 2015; Spromberg et al. 2016; Fardel et al. 2020). Research and corresponding adaptive management surrounding 6PPD is rapidly evolving. Although Chinook salmon did not experience the same level of mortality as coho, tire leachate is still a concern for all salmonids. Traffic residue also contains many unregulated toxic chemicals such as pharmaceuticals, polycyclic aromatic hydrocarbons (PAHs), fire retardants, and emissions that have been linked to deformities, injury and/or death of salmonids and other fish (Trudeau 2017; Young et al. 2018; NMFS 2022b).

The nearshore marine habitat has been extensively altered and armored by industrial and residential development near the mouths of many of Puget Sound's tributaries. A railroad runs along large portions of the eastern shoreline of Puget Sound, eliminating natural cover along the shore and natural recruitment of beach sand (SSDC 2007; NMFS 2022b).

Degradation of the near-shore environment has occurred in the southeastern areas of Hood Canal in recent years, resulting in late summer marine oxygen depletion and significant fish kills. Circulation of marine waters is naturally limited, and partially driven by freshwater runoff, which is often low in the late summer. However, human development has increased nutrient loads from failing septic systems along the shoreline, and from use of nitrate and phosphate fertilizers on lawns and farms. Shoreline residential development is widespread and dense in many places. The combination of highways and dense residential development has degraded certain physical and chemical characteristics of the near-shore environment (HCCC 2005; SSDC 2007).

NMFS has completed several Section 7 consultations on large-scale habitat projects affecting listed species in Puget Sound. Among these are the Washington State Forest Practices Habitat Conservation Plan (NMFS 2006a), and consultations on Washington State Water Quality Standards (NMFS 2008c), the National Flood Plain Insurance Program (NMFS 2008e), the Washington State Department of Transportation Preservation, Improvement and Maintenance Activities (NMFS 2013b), and the Elwha River Fish Restoration Plan (Ward et al. 2008; NMFS 2014c; 2019f; 2020d).

In 2012, the Puget Sound Action Plan was also developed with several Federal agencies (e.g., Environmental Protection Agency [EPA], NOAA Fisheries, the Army Corps of Engineers, Natural Resources Conservation Service [NRCS], United States Geological Survey [USGS], Federal Emergency Management Agency [FEMA], and USFWS), created the Puget Sound Federal Task Force (PSFTF). The PSFTF developed a five-year Action Plan (2017-2021) which collaborated on an enhanced approach to implement the Puget Sound Action Plan. The purpose of the Puget Sound Federal Task Force Action Plan is to contribute toward realizing a shared vision of a healthy and sustainable Puget Sound ecosystem by leveraging Federal programs across agencies and coordinating diverse programs on a specific suite of priorities.

In 2021, the PSFTF produced a progress report describing how 99 of the 127 priority Federal actions to protect and restore Puget Sound were ‘implemented as described’ from the 2017-2021 Action Agenda. These actions included a variety of projects including, but not limited to, improvement to fish passage, restoration of floodplains, riparian, and in-stream habitat, improvements in and monitoring of nearshore and estuary habitat, and investigating and minimizing harmful stormwater runoff (Puget Sound Federal Task Force 2021). In addition to the 2021 report, in 2022 the PSFTF completed an action plan for 2022-2026 to continue to integrate Federal activities and capabilities into implementation of the Puget Sound Action Agenda (Puget Sound Federal Task Force 2022).

While a few Puget Sound indicators of habitat function show mixed results or decline, two are improving according to the Puget Sound Partnership’s 2023 State of the Sound report. These indicators, estuaries and streams and floodplains, are both important parts of salmon and steelhead critical habitat. The Puget Sound Partnership (PSP) reports that since 2006, restoration activities have improved connectivity to 3,240 acres of wetland area, equivalent to four percent of total wetland area, primarily in the Snohomish, Nisqually, Skagit, Stillaguamish, and Skokomish deltas. In addition, the PSP reports that since 2011, approximately 3,500 floodplain acres have been reconnected through restoration activities, even though this represents a small percentage of total floodplain area and more than 200,000 acres remain disconnected (Puget

Sound Partnership 2023).

Dams constructed for hydropower generation, irrigation, or flood control have substantially affected Puget Sound salmon and steelhead populations in a number of river systems. Habitat utilization by Chinook salmon and steelhead in the Puget Sound area has also been historically limited by large dams and other manmade barriers in a number of drainages, including the Nooksack[28], Skagit, White, Nisqually, Skokomish, and Elwha River basins. In addition to limiting habitat accessibility, dams affect habitat quality through blocked access to spawning and rearing habitat, changed flow patterns, resulted in elevated temperatures and stranding of juvenile migrants, and degraded downstream spawning and rearing habitat by reducing recruitment of spawning gravel and large wood to downstream areas (SSDC 2007). These actions also tend to promote downstream channel incision and simplification (Kondolf 1997), limiting fish habitat. Water withdrawals reduce available fish habitat and alter sediment transport. Hydropower projects often change flow rates, stranding and killing fish, and reducing aquatic invertebrate (food source) productivity (Hunter 1992; NMFS 2022b). Such changes can have significant negative impacts on salmonids (e.g., increased water temperatures resulting in decreased disease resistance) (Spence et al. 1996; McCullough 1999).

Juvenile mortality occurs in unscreened or inadequately screened diversions. Water diversion ditches resemble side channels in which juvenile salmonids normally find refuge. When diversion headgates are shut, access back to the main channel is cut off and the channel goes dry. Mortality can also occur with inadequately screened diversions from impingement on the screen, or mutilation in pumps where gaps or oversized screen openings allow juveniles to get into the system. Blockages by dams, water diversions, and shifts in flow regime due to hydroelectric development and flood control projects are major habitat problems in many Puget Sound tributary basins (SSDC 2007; NMFS 2022b).

However, over the past several years, modifications have occurred to existing barriers, which have reduced the number of basins with limited anadromous access to historical habitat. The completion of the Elwha and Glines Canyon dam removals occurred in 2014. The response of fish populations to this action is still being evaluated. It is clear; however, that Chinook salmon and steelhead are accessing much of this newly available habitat. Hatchery operations in the North Fork Skokomish River are ongoing to supplement the winter steelhead population in the lower North Fork, below the Cushman dams. Passage facilities are operational at the dams that would allow access to habitat in the upper North Fork when or if steelhead are passed in the future. A new fish collection facility is operational at the Mud Mountain Dam (White River Basin). Improvements are ongoing to increase the collection efficiency and survival rates, but the facility is expected to improve adult survival and utilization of habitat above the dam. The recent removal of the diversion dam on the Middle Fork Nooksack Dam (16 July 2020) and the Pilchuck River Dam (late 2020) will provide access to important headwater salmonid spawning and rearing habitats. Similarly, the proposed modification of Howard Hanson Dam for upstream fish passage and downstream juvenile collection in the longer term (NMFS 2019f) will allow winter steelhead to return to historical habitat (Ford 2022; NMFS 2022b).

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[28] A dam that blocked upstream passage to fish on the Middle Fork Nooksack River was removed in July of 2020.

Puget Sound Steelhead Critical Habitat

Critical habitat for Puget Sound steelhead was designated on February 24, 2016 (81 FR 9252). Steelhead critical habitat includes 2,031 stream miles. Critical habitat for Puget Sound steelhead includes freshwater spawning sites, freshwater rearing sites, and freshwater migration corridors.

There are 66 watersheds within the range of this DPS (NMFS 2022b). NMFS also designated approximately 90 stream miles of critical habitat on the Kitsap Peninsula, which were originally proposed for exclusion, after considering public comments and determining that the benefits of exclusion did not outweigh the benefits of designation. The final designation also includes areas in the upper Elwha River where the recent removal of two dams now provides access to areas that were previously unoccupied by Puget Sound steelhead at the time of listing, but are essential to the conservation of the DPS.

NMFS (2015b) could not identify “specific areas” within the marine and ocean range that meet the definition of critical habitat. Offshore marine waters were not designated as critical habitat for this species. Additionally, designated critical habitat for Puget Sound steelhead does not include nearshore areas, as this species does not make extensive use of these areas during the juvenile life stage. Instead, NMFS considered the adjacent marine areas in Puget Sound when designating steelhead freshwater and estuarine critical habitat. Approximately 138 stream miles, in areas where the conservation benefit to the species was relatively low (compared to the economic impacts of inclusion), were also excluded. Additionally, an approximate 1,361 stream miles covered by four habitat conservation plans, and approximately 70 stream miles on tribal lands, were excluded because the benefits of exclusion outweighed the benefits of designation. Critical habitat information for Puget Sound steelhead can be found online at: http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/salmon_and_steelhead_listings/steelhead/puget_sound/puget_sound_steelhead_proposed_critical_habitat_supporting_information.html.

Physical or biological features involve those sites and habitat components that support one or more life stages, including general categories of: (1) water quantity, quality, and forage to support spawning, rearing, individual growth, and maturation; (2) areas free of obstruction and excessive predation; and (3) the type and amount of structure and complexity that supports juvenile growth and mobility. For salmon and steelhead, NMFS ranked watersheds within designated critical habitat in terms of the conservation value they provide to each listed species they support at the scale of the fifth-field hydrologic unit code (HUC5). The conservation rankings are high, medium, or low. To determine the conservation value of each watershed to species viability, NMFS’s critical habitat analytical review teams (CHARTs) evaluated the quantity and quality of habitat features (for example, spawning gravels, wood and water condition, side channels), the relationship of the area compared to other areas within the species’ range, and the significance to the species of the population occupying that area (NMFS 2005b; 2022b).

As of 2019 approximately 8,000 culverts that block steelhead habitat have been identified in

Puget Sound (NMFS 2019h), with plans to address these blockages being extended over many years. Smaller scale improvements in habitat, restoration of riparian habitat and reconnecting side- or off-channel habitats, will allow better access to habitat types and niche diversification. While there have been some significant improvements in restoring access, it is recognized that land development, loss of riparian and forest habitat, loss of wetlands, demands on water allocation all continue to degrade the quantity and quality of available fish habitat (Ford 2022; NMFS 2022b).

In summary, even with restoration success, like dam removal and blocked culverts being addressed, critical habitat for salmon and steelhead throughout the Puget Sound basin continues to be degraded by numerous management activities, including hydropower development, loss of mature riparian forests, increased sediment inputs, removal of large wood, intense urbanization, agriculture, alteration of floodplain and stream morphology (i.e., channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, dredging, armoring of shorelines, marina and port development, road and railroad construction and maintenance, logging, and mining. Changes in habitat quantity, availability, and diversity, and flow, temperature, sediment load and channel instability are common limiting factors in areas of critical habitat. As mentioned above, development of shoreline and estuary areas of Puget Sound is expected to continue to adversely impact the quality of marine habitat for PS salmonids. Projected changes in nearshore and estuary development based on documented rates of developed land cover change in Bartz et al. (2015) show that between 2008 and 2060, an additional 14.7 hectares of development of shoreline areas and 204 hectares of estuary development can be expected.[29]

2.2.2.2 *Puget Sound/Georgia Basin Rockfish Critical Habitat*

Critical habitat was designated for both species of ESA-listed rockfish in 2014 (79 FR 68041, November 13, 2014). The specific areas designated for bocaccio include approximately 1,083.11 square miles (1,743.10 sq. km) of deepwater (< 98.4 feet [30 meters(m)]) and nearshore (> 98.4 feet [30 m]) marine habitat in Puget Sound. The specific areas designated for yelloweye rockfish include 438.45 square miles (705.62 sq. km) of deepwater marine habitat in Puget Sound, all of which overlap with areas designated for bocaccio.

Based on new genetic information that allowed better definition of yelloweye populations (Andrews et al. 2018), the DPS boundary was extended northward into Johnstone Strait, B.C., in 2017 (82 FR 7711). However, critical habitat is not designated in areas outside of U.S. jurisdiction; therefore, although waters in Canada are part of the DPSs' ranges for each species, critical habitat was not designated in that area. We also excluded 13 of the 14 Department of Defense Restricted Areas, Operating Areas, and Danger Zones, and waters adjacent to tribal lands from the critical habitat designation.

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[29] Memorandum from Tim Beechie, Northwest Fisheries Science Center, to Kim Kratz, et al. NMFS, regarding projected developed land cover change in Puget Sound nearshore and estuary zones. (June 23, 2020).

Based on the best available scientific information regarding natural history and habitat needs, we developed a list of PBF essential to the conservation of adult and juvenile yelloweye rockfish and bocaccio, and relevant to determining whether proposed specific areas are consistent with the above regulations and the ESA Section (3)(5)(A) definition of “critical habitat.” The PBFs essential to the conservation of yelloweye rockfish and bocaccio fall into major categories reflecting key life history phases (79 FR 68041).

Adult bocaccio and adult and juvenile yelloweye rockfish:
We designated sites deeper than 98 feet (30 m) that possess (or are adjacent to) areas of complex bathymetry. These features are essential to conservation because they support growth, survival, reproduction, and feeding opportunities by providing the structure to avoid predation, seek food, and persist for decades. Several attributes of these sites affect the quality of the area and are useful in considering the conservation value of the feature in determining whether the feature may require special management considerations or protection, and in evaluating the effects of a proposed action in a Section 7 consultation if the specific area containing the site is designated as critical habitat. These attributes include: (1) quantity, quality, and availability of prey species to support individual growth, survival, reproduction, and feeding opportunities; (2) water quality and sufficient levels of dissolved oxygen to support growth, survival, reproduction, and feeding opportunities; and (3) structure and rugosity (measure of complexity) to support feeding opportunities and predator avoidance.

Juvenile bocaccio only:
Juvenile settlement sites located in the nearshore with substrates such as sand, rock, and/or cobble compositions that also support kelp. These features are essential for conservation because they enable forage opportunities and refuge from predators, and enable behavioral and physiological changes needed for juveniles to occupy deeper adult habitats. Several attributes of these sites affect the quality of the area and are useful in considering the conservation value of the feature in determining whether the feature may require special management considerations or protection, and in evaluating the effects of a Proposed Action in a Section 7 consultation if the specific area containing the site is designated as critical habitat. These attributes include: (1) quantity, quality, and availability of prey species to support individual growth, survival, reproduction, and feeding opportunities; and (2) water quality and sufficient levels of dissolved oxygen to support growth, survival, reproduction, and feeding opportunities.

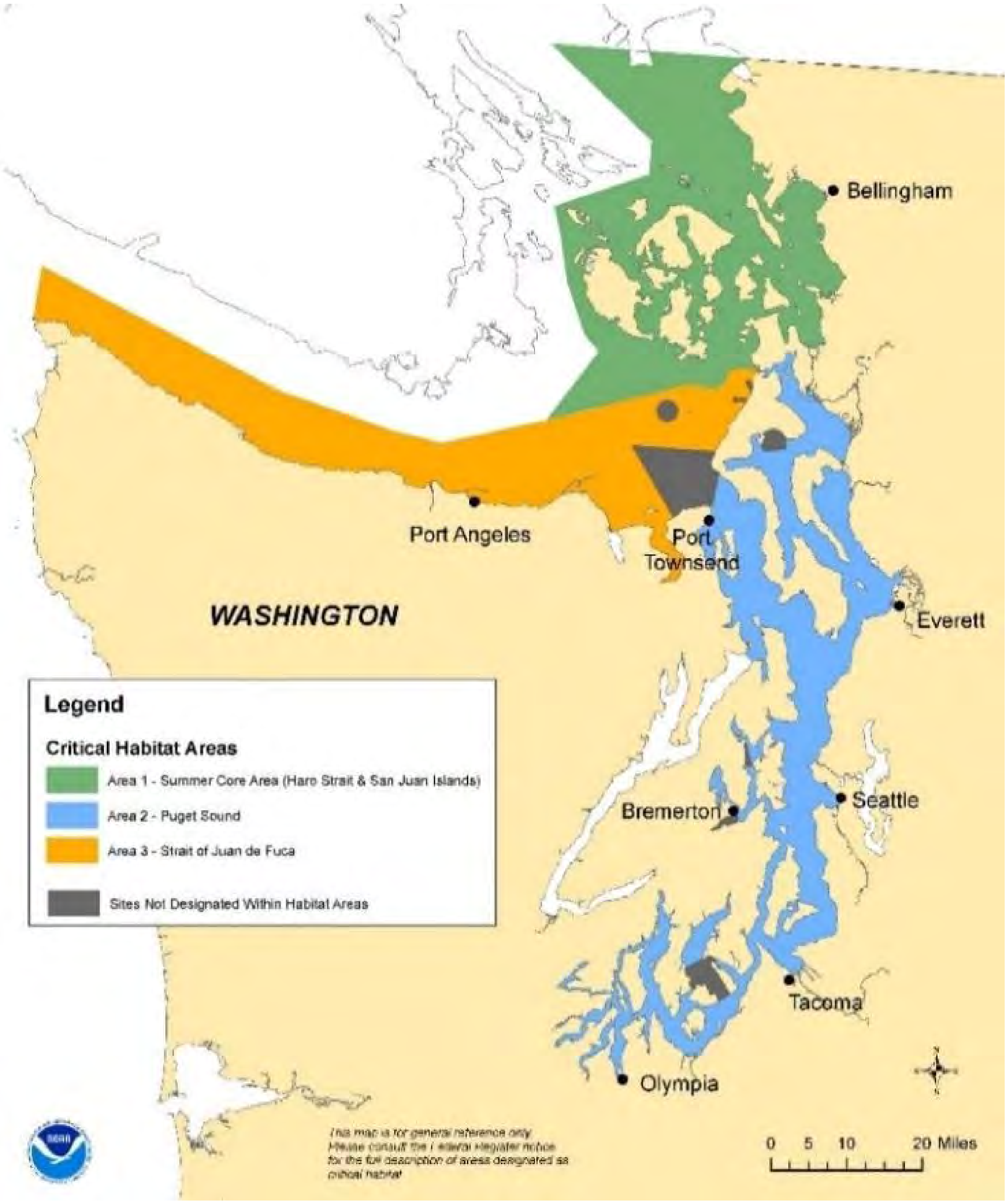
Regulations for designating critical habitat at 50 C.F.R. § 424.12(b) state that the agencies shall consider PBFs essential to the conservation of a given species that “may require special management considerations or protection.” Joint NMFS and USFWS regulations at 50 C.F.R. § 424.02(j) define “special management considerations or protection” to mean “any methods or procedures useful in protecting physical and biological features of the environment for the conservation of listed species.” We identified a number of activities that may affect the PBFs essential to yelloweye rockfish and bocaccio such that special management considerations or protection may be required. Major categories of such activities include: (1) nearshore development and in-water construction (e.g., beach armoring, pier construction, jetty or harbor construction, pile driving construction, residential and commercial construction); (2) dredging and disposal of dredged material; (3) pollution and runoff; (4) underwater construction and operation of alternative energy hydrokinetic projects (tidal or wave energy projects) and cable laying; (5) kelp harvest; (6) fisheries; (7) non-indigenous species introduction and management; (8) artificial habitat creation; (9) research activities; (10) aquaculture, and (11) activities that lead to global climate change.

Overall, the status of critical habitat in the nearshore is impacted in many areas by the degradation from coastal development and pollution. The status of deep-water critical habitat is impacted by remaining derelict fishing gear and degraded water quality, among other factors. The input of pollutants affects water quality, sediment quality, and food resources in the nearshore and deep-water areas of critical habitat.

2.2.2.3 *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 30). 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 31). 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 30), as well as 15,910 square miles (mi^2) (41,207 square kilometers (km^2)) of marine waters along the U.S. west coast 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 to conservation for 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.

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 2.2.1.4). 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 2021i).



This map is for general reference only. Please consult the Federal Register notice for the full description of areas designated as critical habitat

Figure 30. 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 31. Specific areas of coastal critical habitat containing essential habitat features (86 FR 41668, August 2, 2021).

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[30]. 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.

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

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

habitat.

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 impacts foraging behavior (review in NMFS (2010c), Ferrara, Mongillo and Barre (2017), and see "Disturbance by Vessels and Sound" in the SRKW Status Section 2.2.3.1).

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 (2021i)).

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).

This action area includes the areas where fishing under the proposed action will take place, and where the effects of that fishing on listed fish species considered in this opinion will occur. For listed fish, the action area (Figure 32) includes all fishing areas in Puget Sound marine waters and rivers entering into Puget Sound and the western Strait of Juan de Fuca to Cape Flattery within the United States; and certain high seas and territorial waters westward from the U.S. coast between 48- and 49-degrees N. latitude where U.S. Fraser Panel fisheries occur (a detailed description of U.S. Panel Area waters can be found at 50 CFR 300.91, Definitions). Within this area, the fisheries described in the 2024-2025 Puget Sound Chinook Management Plan occur in all of the fishing areas (Figure 32), and U.S. Fraser Panel fisheries occur in the Catch Reporting Areas 4B, 5, and 6C, and in the San Juan Islands region Catch Reporting Areas 6, 6A, 7, and 7A. The action area also includes remaining portions of the river systems that enter into the Puget Sound region in which fishing addressed in the 2024-2025 Puget Sound Chinook Management Plan occurs. These areas may be affected by the fisheries as fish that could otherwise return as spawners would be intercepted by the fisheries.

To assess the effects of the proposed actions on the Southern Resident killer whale DPS, we considered the geographic area of overlap in the marine area where the abundance of Chinook salmon is expected to be affected by the action, and the range of Southern Resident killer whales. This marine area in which the salmonids affected by the proposed action occur during and following the planned fisheries overlaps with the whales' range in inland U.S. marine waters from the U.S./Canada Southern border at the southern Strait of Georgia (below Vancouver and Nanaimo B.C.) to southern Puget Sound and the Strait of Juan de Fuca (Figure 32), therefore any portion of this area extending beyond the action area described for the fish species is also included in the action area. Effects of the action on humpback whales are expected to occur where presence of the whales overlap with the planned fisheries, which would occur within the area described above.

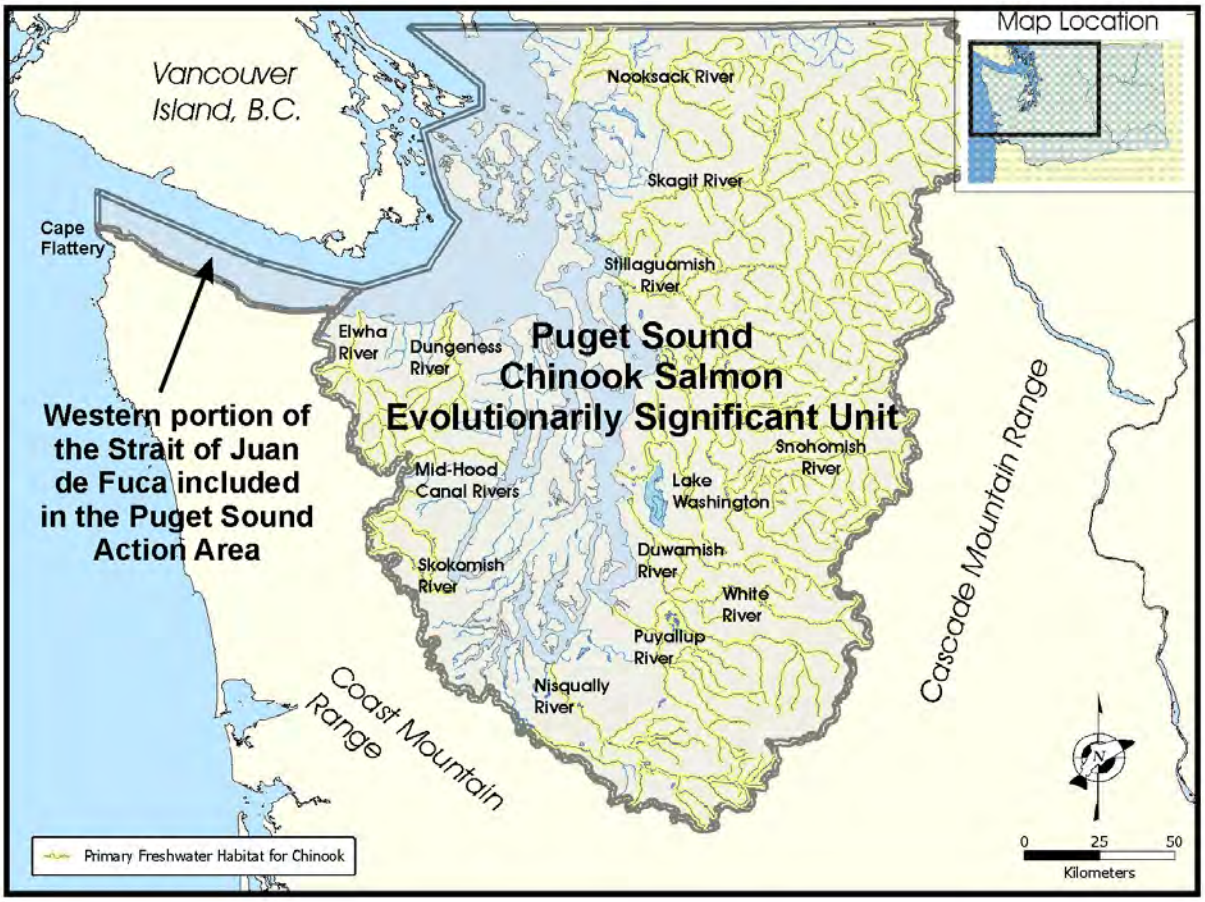

Figure 32. Puget Sound Action Area, which includes the Puget Sound Chinook ESU and the western portion of the Strait of Juan de Fuca in the United States.

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 consultation, 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).

NMFS recognizes the unique status of treaty Indian fisheries and their relation to the environmental baseline. Implementation of treaty Indian fishing rights involves, among other things, application of the various legal principles regarding sharing established in *United States v. Washington*. Exploitation rate calculations and harvest levels to which the sharing principles apply, in turn, are dependent upon various biological parameters, including the estimated run sizes for the particular year, the mix of stocks present, the allowable fisheries and the anticipated fishing effort. The treaty fishing right itself exists and must be accounted for in the environmental baseline, although the precise quantification of treaty Indian fishing rights during a particular fishing season cannot be established by a rigid formula.

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

2.4.1 Puget Sound Chinook and Steelhead

2.4.1.1 *Climate change and other ecosystem effects*

More detailed discussions about the likely effects of large-scale environmental variation on salmonids, including climate change, are found in Section 2.2.1 of this opinion, as well as opinions on the Snohomish Basin Salmonid Hatchery Operations (NMFS 2021e) and the implementation of the Mitchell Act (NMFS 2017d). Warmer streams, ocean acidification, lower summer stream flows, and higher winter stream flows are projected to negatively affect salmonids ((Blum, Kanno and Letcher 2018). Increased stream temperatures are expected to increase metabolic rates in salmon requiring increased food availability (Myrvold and Kennedy 2018), making the persistence of cold water "refugia" within rivers and the diversity among salmon populations critical in helping salmon populations adapt to future climate conditions. Similar types of effects on salmon may occur in the marine ecosystem including warmer water temperatures, loss of coastal habitat due to sea level rise, ocean acidification, and changes in water quality and freshwater inputs (Mauger et al. 2015; Thorne et al. 2018).

2.4.1.2 *Harvest*

Chinook Salmon Harvest

In the past, fisheries in Puget Sound, and fisheries in the ocean that harvest Puget Sound stocks, were generally not managed in a manner appropriate for the conservation of naturally spawning Chinook salmon populations. Fisheries exploitation rates were, in most cases, too high, especially in light of the declining productivity of most natural Chinook salmon stocks as describe in Section 2.2.1.1. In response, over the past several decades, fishery managers have implemented harvest objectives that are more consistent with the underlying productivity of the natural populations, resulting in substantially reduced harvest impacts on most stocks relative to pre-listing impacts. Selective gear types and time and area closures are some of the management tools used to reduce catches of weak stocks, and to reduce Chinook salmon bycatch in fisheries targeting other salmon species. Other management measures (i.e. size limits, bag limits, mark-selective fisheries, and requirements for the use of barbless hooks in all recreational fisheries) are also used to achieve these objectives while providing harvest opportunities. Total exploitation rates for most of the Puget Sound Chinook salmon management units have been reduced substantially since the late 1990s compared to years prior to listing (the years 1992-1998 are used here for comparison) (see Table 13)(average reduction = -23%, range of change= -50 to +31%).

The effect of these overall reductions in harvest has been to improve the baseline condition and help to alleviate the effect of harvest as a limiting factor for Puget Sound Chinook salmon. Since 2010, the state and tribal fishery co-managers have managed Chinook salmon mortality in Puget Sound salmon and tribal steelhead fisheries to meet the conservation and allocation objectives described in the applicable jointly-developed plan – starting with the 2010-2014 Puget Sound Chinook Harvest RMP (PSIT and WDFW 2010c), and subsequently in annual plans that include objectives similar to but modified from the 2010-14 RMP based on new data (Grayum and Anderson 2014; Redhorse 2014b; Grayum and Unsworth 2015b; Shaw 2015; 2016; Speaks 2017a; Shaw 2018b; Norton 2019b; Mercier 2020; 2021a; 2022; 2023; 2024). The 2010-2014 Puget Sound Chinook Salmon Harvest RMP was adopted as the harvest component of the Puget Sound Salmon Recovery Plan for the Puget Sound Chinook salmon ESU (NMFS 2011c). Recent year exploitation rates and historical reference rates are summarized in Table 13 **(**FRAM validation runs, version 7.1.1, October 2023**)**.

Fifty percent or more of the recent-year harvest of 8 of the 14 Puget Sound Chinook salmon management units occurs in salmon fisheries outside the Action Area, primarily in Canadian waters (Table 13). Salmon fisheries in Canadian waters are managed under the terms of the PST and Canadian domestic law. Ocean salmon fisheries in contiguous U.S. Federal waters are managed by NMFS and the PFMC, under the MSA and under the terms of the PST. For salmon fisheries off of the Southeast coast of Alaska in Federal waters, the North Pacific Fisheries Management Council (NPFMC) has delegated its management authority to the State of Alaska. These fisheries are also managed under the terms of the PST. The effects of the Northern fisheries (SEAK and Canada) and the PFMC fisheries on Puget Sound Chinook salmon were assessed in previous opinions (NMFS 2004b; 2008g; 2019b). As with Puget Sound fisheries, in recent years these ocean fisheries have been reduced through agreements under the PST in the case of the northern fisheries, and in order to address impacts to ESA-listed stocks and other stocks in the case of the PFMC fisheries.

Table 13. Average 1992 to 2020 total and SUS exploitation rates, and percentage of the total exploitation rate attributable to northern fisheries for Puget Sound Chinook salmon management units (see Table 5 for correspondence to populations). This table encompasses the provisions of the 1999-2008 and the 2009-2018 Pacific Salmon Treaty Chinook Annex – a new PST Chinook Annex was adopted for use in the 2019-2028 period. (all values from FRAM 7.1.1 validation set; October 2023)

Management Unit	1992-1998 (Pre-listing)			1999-2008			2009-2020		
	Average Total ER	Average SUS ER (PFMC and PS combined)	Average percentage of Total Annual ER attributable to AK/CAN Fisheries	Average Total ER	Average SUS ER (PFMC and PS combined)	Average percentage of Total Annual ER attributable to AK/CAN Fisheries	Average Total ER	Average SUS ER (PFMC and PS combined)	Average percentage of Total Annual ER attributable to AK/CAN Fisheries
Nooksack early	0.39	0.07	81%	0.34	0.05	85%	0.30	0.07	77%
Skagit spring	0.25	0.12	52%	0.20	0.06	70%	0.27	0.13	53%
Skagit summer/fall	0.46	0.17	62%	0.36	0.09	72%	0.42	0.17	60%
Stillaguamish	0.42	0.19	54%	0.31	0.09	71%	0.30	0.08	73%
Snohomish	0.46	0.28	39%	0.24	0.10	58%	0.23	0.08	66%
Lake Washington	0.47	0.32	31%	0.31	0.16	48%	0.28	0.14	49%
Duwamish/Green	0.53	0.39	27%	0.51	0.36	29%	0.37	0.24	37%
White	0.31	0.28	11%	0.31	0.18	42%	0.23	0.17	25%
Puyallup	0.61	0.47	24%	0.52	0.38	29%	0.47	0.34	29%
Nisqually	0.75	0.65	13%	0.69	0.59	14%	0.50*	0.41	19%
Skokomish	0.42	0.33	22%	0.56	0.43	23%	0.55*	0.43	22%
Mid-Hood Canal	0.35	0.26	26%	0.26	0.13	50%	0.23	0.11	54%
Dungeness	0.33	0.13	62%	0.25	0.05	80%	0.24	0.05	79%
Elwha	0.40	0.15	62%	0.25	0.05	80%	0.24	0.05	80%

*Beginning in 2010, the Skokomish Chinook salmon Management Unit was managed for 50% and the Nisqually Chinook salmon Management Unit was managed for stepped harvest rates of 65% (2010-11) – 56% (2012-2013) – 52% (2014-2015), 50% (2016), 47% (2017-present)

Steelhead Harvest

Similar to Chinook salmon, fishery impacts on Puget Sound steelhead have declined since the DPS was listed in 2007, based on the available harvest data from the Puget Sound co-managers prior to listing through 2023 (WDFW and PSTIT Post Season Data 2004-2023). Puget Sound tribal marine salmon fisheries encounter summer and winter steelhead in fisheries targeting other salmon species. An annual average of 126 (hatchery and wild combined) (range 7 – 266) summer and winter steelhead were landed incidentally in tribal marine fisheries (commercial and ceremonial and subsistence) from all Puget Sound marine areas combined during the 2001/2002 to 2006/2007 time period[31]. An annual average of 51 (hatchery and wild combined) (range 1 – 128) summer and winter steelhead were landed incidentally in tribal marine fisheries from all Puget Sound marine areas combined during the 2008/2009 to 2020/2021 time period (WDFW and PSTIT (2016; 2017; 2018; 2019; 2020; 2021a; 2022; 2023a; 2024).

In Puget Sound marine recreational fisheries, an annual average of 198 (range 102 – 263) hatchery summer and winter steelhead were landed from all Puget Sound marine areas combined during the 2000/2001 to 2006/2007 time period (Leland 2010). Since ESA listing in 2007, an annual average of 107 (range 15 – 213) hatchery summer and winter steelhead have been landed in marine recreational fisheries, from all Puget Sound marine areas combined during the 2007/2008 to 2020/2021 time period (WDFW and PSTIT 2022). The catch of steelhead in Puget Sound marine recreational fisheries has therefore declined by 46% in the years since listing. Washington State prohibits the retention of natural-origin steelhead (those without a clipped adipose fin) in both marine and freshwater recreational fisheries. There is some mortality associated with the catch-and-release of unmarked steelhead in the marine recreational fishery. The mortality rate associated with catch-and-release is estimated at 10 percent (PSIT and WDFW 2010b)(i.e., 10% of the fish caught and released die), making the overall additional total mortality from the marine recreational fisheries low.

In summary, at the time of listing, during the 2000/01 to 2006/07 seasons, an average total of 324 steelhead were caught in marine tribal and non-tribal commercial, ceremonial and subsistence (C&S), and marine recreational fisheries. Since listing, an average total of 159 steelhead have been caught in marine tribal and non-tribal commercial, ceremonial and subsistence, and recreational fisheries (Table 14). These average, annual estimates of steelhead catch in Puget Sound marine areas are a composite catch of ESA-listed and non-listed hatchery-origin and natural-origin winter and summer steelhead (James 2018c; Parker and Susewind 2020; NMFS 2022c). Overall, the average tribal and non-tribal catch in marine area fisheries has declined by 51% compared with the earlier, pre-listing period.

Table 14. Average annual (seasonal) marine area catch of steelhead from 2000/01 to 2006/07 and 2007/08 to 2020/2021 time periods.

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[31] NMFS 2010: Unpublished data on Puget Sound steelhead harvest rates from 2001/2002 to 2006/2007

Time Period	Marine Catch			
	Tribal commercial & C&S	Non-Tribal Commercial	Non-Tribal Recreational	Total
2000/01 to 2006/07	125	1	198	324
2007/08 to 2020/21	51	1	107	159

In Puget Sound freshwater areas, with the exception of the Skagit River, the non-tribal harvest of steelhead occurs in recreational hook-and-line fisheries targeting adipose fin-clipped hatchery summer run and winter run steelhead. Tribal fisheries typically retain both natural-origin and hatchery steelhead. The tribal freshwater fisheries for winter steelhead, with the exception of the Skagit River, target primarily hatchery steelhead by fishing during the early winter months when hatchery steelhead are returning to spawn and natural-origin steelhead are at low abundance. Freshwater fisheries targeting other salmon species may also capture natural-origin summer run steelhead incidentally. However, these impacts are likely low because the fisheries start well after the summer steelhead spawning period, and are located primarily in lower and mid-mainstem rivers where natural-origin summer steelhead (if present) are believed not to hold for an extended period (PSIT and WDFW 2010c).

On April 11, 2018 NMFS approved a five-year, joint tribal and state plan for a tribal harvest and recreational catch and release fishery for natural-origin steelhead in the Skagit River basin under the ESA 4(d) Rule (NMFS 2018c). This plan covered fishing years 2018-2022. The plan also addressed incidental impacts to steelhead in the Skagit River from fisheries targeting other species of salmon. The annual, allowable impact rate to Skagit steelhead in the Skagit area fisheries is determined using a sliding scale system based on the terminal run size forecast for the Skagit River (Table 15). NMFS (2018c) concluded that the effects of the Skagit steelhead fishery on the viability and recovery of the Puget Sound steelhead DPS would be low and that the Skagit steelhead RMP met the requirements of the ESA 4(d) Rule. The 2018 RMP expired on April 30, 2022. On December 8, 2021 the Skagit co-managers submitted a new RMP to NMFS for evaluation under Limit 6 of the salmon and steelhead 4(d) Rule (Sauk-Suiattle Indian Tribe et al. 2021). The new RMP proposed a continuation of the previous management strategy for Skagit River steelhead, including directed steelhead fisheries and fisheries directed at other species of salmon that may affect Skagit steelhead, in the Skagit Terminal Area for a 10-year period. On March 22, 2023, NMFS approved the new Skagit River steelhead fishery RMP under Limit 6 of its 4(d) Rule. This determination exempts the fisheries managed under it from the ESA take prohibition on Puget Sound steelhead for a period of 10 years (through April 30, 2032)(NMFS 2023b).

Table 15. Steelhead impact levels as proposed by the current Skagit River steelhead RMP. Impact levels include both tribal harvest and recreational catch and release fisheries and are tiered based on forecasted terminal run levels for natural-origin steelhead (Sauk-Suiattle Indian Tribe et al. 2016; Sauk-Suiattle Indian Tribe et al. 2021).

Preseason Forecast for Natural-Origin Skagit Steelhead	Allowable Impact Rate Terminal Run
≤ 4,000	4%
4,001 ≤ Terminal Run <6,000	10%
6,001 ≤ Terminal Run <8,000	20%
Terminal Run ≥ 8,001	25%

Recreational steelhead fishing occurred under the Skagit steelhead RMP plan April 14, 2018 until April 29, 2018. No tribal directed steelhead fishery occurred in 2018. The 2018 steelhead run forecast of Skagit wild steelhead was 5,247, which limited the overall annual impact on steelhead to 10 percent. During the short time the Skagit recreational catch-and-release fishery was open in 2018, an estimated total of 568 wild steelhead were caught and released, resulting in an estimated 57 mortalities (WDFW and PSTIT 2018a). When combined with the estimated incidental mortalities from tribal and recreational fisheries targeting other species in the Skagit River, the overall estimated steelhead mortalities during the 2017-18 Skagit steelhead management period, including the April 2018 directed recreational steelhead fishery, were 116. The 2017-18 post season run size estimate was 6,199 wild steelhead (WDFW and PSTIT 2018a), which was larger than the pre-season forecast. The 116 estimated mortalities resulted in an overall impact rate of 1.87 percent, far lower than either the 20 percent or 10 percent limits that the final run size or the forecasted run size, respectively, would have allowed (Table 15).

The 2018/2019 Skagit fishery represented the first full season for the steelhead directed fishery. The preseason forecast was 6,567 adults, which would allow an up to 20 percent terminal impact rate (Table 16). The co-managers post-season report stated total mortality was 326 wild steelhead for the July 1, 2018 through June 30, 2019 management period. The final post-season run size estimate was 4,636, which resulted in a total impact rate of 7.04 percent (WDFW 2019b). This final rate was below both the 20 and 10 percent limits of either the pre-season forecasted rate or the rate associated with the lower post-season run estimate, respectively (Table 16).

Based on the 2019/2020 Skagit basin pre-season steelhead forecast of 3,963 the co-managers did not implement any steelhead-directed fisheries in the Skagit basin for the 2019/2020 season, which ended on June 30, 2020 (WDFW 2020b; 2020c). All incidental impacts to Skagit steelhead in fisheries directed at other species were managed under the 4 percent impact limit (Table 16). The final post-season run size estimate was 3,092. The total incidental fishing mortalities for the 2019/2020 season were 72 steelhead, resulting in an estimated 2.32 percent impact rate, lower than the 4 percent limit.

The 2020/2021 preseason steelhead forecast was 4,297. Based on this the co-managers planned limited direct fisheries to preserve most impacts for use in fisheries targeting other salmon species. The post season runsize estimate was lower than forecast at 3,369. The co-managers 2021/2022 resulted in a total of 209 mortalities for a total impact rate of 5.48 percent (Table 16) less than the limit based on the pre-season forecast (<u>≤</u>10 percent) but higher than rate associated with the post-season runsize (<u>≤</u>4 percent).

For the 2021/2022 steelhead return year, the forecast for total adult was 3,833 and the impact rate was limited to 4 percent, with these impacts reserved for incidental mortality in fisheries directed at other species of salmon (WDFW et al. 2022). The co-managers 2021/2022 fisheries resulted in a total of 198 mortalities for a total impact rate of 3.41 percent (Table 16), less than the limit based on the pre-season forecast (≤4 percent).

For 2022/2023 steelhead return year the forecast was for 5,211, resulting in an allowable impact rate of ≤10 percent and some directed steelhead fisheries to occur (WDFW 2023a). The co-managers Skagit area fisheries resulted in a total of 375 mortalities for a total impact rate 7.57 percent (Table 16) less than the limit based on the pre-season forecast (≤10 percent).

Table 16. Summary of Skagit steelhead harvest results under the Skagit River steelhead harvest RMP (WDFW and PSTIT 2018b; 2019; 2020; 2021a; 2022; WDFW et al. 2023).

Fishery Season	Pre-Season Run-Size Estimate (steelhead)	Allowable Impact Rate Under the 2016 RMP	Total Estimated Mortalities (steelhead)	Post-Season Run-Size Estimate (steelhead)	Post-Season Estimated Total Impact Rate
2017/2018	5,247	<10%	116	6,199	1.87%
2018/2019	6,567	<20%	326	4,636	7.04%
2019/2020	3,963	<4%	72	3,092	2.32%
2020/2021	4,297	≤10%	209	3,369	5.84%
2021/2022	3,833	≤4%	198	5,805	3.41%
2022/2023	5,211	≤10%	375	4,965	7.57%

As described in Section 2.2.1 (status of the species), available data on escapement of summer and summer/winter steelhead populations in Puget Sound are limited. Given these circumstances, NMFS used available data for five Puget Sound winter and summer/winter steelhead populations with the most complete data to calculate a series of reference terminal harvest rates on Puget Sound natural-origin steelhead prior the listing determination in 2007. The five steelhead populations used (Skagit, Snohomish, Green, Puyallup and Nisqually) will further be referred to within the opinion as reference populations. The use of terminal harvest rates to calculate impacts to natural-origin steelhead populations closely approximates stock-specific rates as almost all harvest occurs within the terminal areas and the mixed-stock pre-terminal harvest is very low when spread across the DIPs in the DPS (WDFW and PSTIT 2017a; 2018a; 2019; 2020; 2021a). NMFS calculated that the harvest rate average, across these five natural-origin steelhead reference populations, was 4.2% annually in Puget Sound terminal fisheries during the 2001/2002 to 2006/2007 time period, just prior to listing (NMFS 2010b)(Table 17). As described above, the Skagit terminal area harvest of steelhead has been covered by a series of two RMPs since the 2017-18 season. The 4.2% rate is consistant for use as a pre-listing reference harvest rate for terminal fisheries across the remaining four reference populations—Snohomish, Green, Puyallup, and Nisqually (Table 17). The average harvest rates across these four natural-origin steelhead reference populations, during the 2007/2008 to 2020/2023 time period, is 0.87%, a 79 percent reduction in harvest rate (Table 17). These terminal harvest rate estimates include sources of non-landed mortality such as hooking mortality and net dropout.

Table 17. Total terminal harvest rate (HR) percentages on natural-origin steelhead for five reference Puget Sound winter steelhead populations (2001/02 – 2006/07), and four[c] reference Puget Sound winter steelhead populations 2007/08 – 2022/2023) (NMFS 2015d; WDFW and PSIT 2017; WDFW and PSTIT 2018a; 2019; 2020; 2021a; 2022).

Year	Skagit	Snohomish	Green	Puyallup	Nisqually[a]
2001-02	4.2	8.0	19.1	15.7	N/A
2002-03	0.8	0.5	3.5	5.2	N/A
2003-04	2.8	1.0	0.8	2.2	1.1
2004-05	3.8	1.0	5.8	0.2	3.5
2005-06	4.2	2.3	3.7	0.8	2.7
2006-07	10.0	N/A[b]	5.5	1.7	5.9
Avg HRs 2001-07	**4.3**	**2.6**	**6.4**	**4.3**	**3.3**
Total Avg HR	**4.2%** total average harvest rate across populations from 2001-02 to 2006-07				
2007-08	5.90	0.40	3.50	1.00	3.70
2008-09	4.90	1.10	0.30	0.00	3.70
2009-10	3.30	2.10	0.40	0.00	1.20
2010-11	3.40	1.50	1.60	0.60	1.80
2011-12	2.90	0.90	2.00	0.40	2.50
2012-13	2.30	1.10	2.38	0.70	1.10
2013-14	2.60	0.89	1.09	0.56	1.33
2014-15	1.25	1.00	1.05	0.54	0.89
2015-16	1.12	0.90	0.92	0.06	0.20
2016-17	1.70	1.00	0.90	0.10	0.00
2017-18	1.87[c]	1.20	0.50	0.10	0.10
2018-19	7.04[c]	1.10	0.30	0.00	0.05
2019-20	2.32[c]	0.90	0.35	0.08	0.00
2020-21	5.84[c]	1.20	0.47	0.00	0.00
2021-22	3.41[c]	1.30	0.42	0.00	0.00
2022-23	7.57[c]	1.14	0.36	0.54	0.00
Avg HRs 2007-23	**-[c]**	**1.11**	**1.03**	**0.29**	**1.04**
Total Avg HR		**0.87%** total average harvest rate across Snohomish, Green, Puyallup, and Nisqually populations from 2007-08 to 2022-23			

[a] Escapement methodology for the Nisqually River was adjusted in 2004; previous estimates are not comparable.

[b] Catch estimate not available in 2006-07 for Snohomish River.

[c] Skagit steelhead terminal harvest rate (impact) limits are managed under the Skagit Steelhead Harvest RMP (NMFS 2018c; 2023b).

As mentioned above, NMFS concluded in the final steelhead listing determination that previous harvest management practices likely contributed to the historical decline of Puget Sound steelhead. However, the elimination of the directed harvest of wild steelhead in the mid-1990s largely addressed the threat of decline to the listed DPS posed by harvest. The NWFSC's last two biological viability reviews concurred that consistently low natural-origin steelhead harvest rates since ESA-listing are not likely to substantially affect steelhead spawner abundance in the DPS (NWFSC 2015a; Ford 2022). The 2019 Puget Sound Steelhead Recovery Plan also concurred with this assessment (NMFS 2019h).

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 opinion, NMFS concluded that salmon are not likely to be caught incidentally in the commercial or tribal halibut fisheries when using halibut gear (NMFS 2018e). The total estimated non-retention mortality of Chinook salmon in Puget Sound recreational halibut fisheries is extremely low, averaging just under two Chinook salmon per year. Of these, the estimated catch of listed fish (hatchery and wild) is between one and two Puget Sound Chinook salmon 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. No steelhead have been observed in the fishery.

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

Coastal Groundfish Fishery

Puget Sound Chinook salmon are incidentally caught in small numbers in the U.S. West Coast groundfish fishery. NMFS reviewed this bycatch and determined that the numbers of Puget Sound Chinook salmon that are caught constitute a very small portion (<1.0%) of the total abundance of the populations, even under the most impactful scenario. NMFS determined that due to the small numbers of Puget Sound Chinook salmon caught, inclusive of hatchery-produced with no take prohibition and the lack of indication of any disproportionate impacts to specific populations, that the coastal groundfish fisheries were not likely to jeopardize Puget Sound Chinook salmon (NMFS 2017f).

2.4.1.3 *Hatcheries*

Hatcheries can provide benefits to the status of Puget Sound Chinook salmon and steelhead by reducing demographic risks and preserving genetic traits for populations at low abundance in degraded habitats. In addition, hatcheries help to provide harvest opportunity, which is an important contributor to the meaningful exercise of treaty rights for the Northwest tribes. The goals of conservation hatchery programs are to restore and support natural populations; other programs are intended to augment harvest. Hatchery-origin fish may also pose risks to listed species through genetic, ecological, or harvest effects. Six factors may pose positive, negligible, or negative effects on population viability of naturally-produced salmon and steelhead. These factors are:

(1) The hatchery program does or does not remove fish from the natural population and use them for hatchery broodstock
(2) Hatchery fish and the progeny of naturally spawning hatchery fish on spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities
(3) Hatchery fish and the progeny of naturally spawning hatchery fish in juvenile rearing areas, migratory corridor, estuary and ocean
(4) RM&E that exists because of the hatchery program
(5) The operation, maintenance, and construction of hatchery facilities that exist because of the hatchery program
(6) Fisheries that exist because of the hatchery program, including terminal fisheries intended to reduce the escapement of hatchery-origin fish to spawning grounds.

Beginning in the 1990s, state and tribal co-managers took steps to reduce risks identified for Puget Sound hatchery programs as better information about their effects became available (PSIT and WDFW 2004), in response to reviews of hatchery programs (e.g., Busack and Currens (1995), HSRG (2000), 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. Hatchery programs in the Pacific Northwest are phasing out use of broodstocks that differ substantially from natural populations, such as out-of-basin or out-of-ESU stocks, and replacing them with fish derived from, or more compatible with, locally adapted populations. This and other reforms have been proposed to ensure that existing natural salmonid populations are preserved, and that hatchery-induced genetic and ecological effects on natural populations are minimized.

Chinook Hatchery Production

Chinook salmon are artificially propagated through more than 33 current programs in Puget Sound (Appendix A, Table 1). Nearly two thirds of the hatchery Chinook salmon programs in Puget Sound are included as part of the ESA-lising (85 FR 81822) and are produced for conservation of the local Chinook populations, harvest augmentation, or for both purposes (Appendix A, Table 1). Use of natural-origin fish in hatchery broodstock for conservation programs is intended to impart viability benefits to the total, aggregate population by bolstering total and naturally spawning fish abundance, preserving the remaining diversity, or improving population spatial structure by extending natural spawning into areas of unused habitat. Integration of natural-origin fish for harvest augmentation programs is intended to reduce genetic diversity risks by producing fish that are no more than moderately diverged from the associated, donor natural population. Incorporating natural-origin fish as broodstock reduces risks to the natural population that may result from unintended straying and spawning by unharvested hatchery-origin adults in natural spawning areas. 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 Coded Wire Tags (CWTs) and/or with a clipped adipose fin so that they can be differentiated and accounted for separately from juvenile and returning adult natural-origin fish. Other methods of additional marking (thermal otolith mark, parental-based genetic sampling, etc) are employed for some programs where there are several Chinook hatchery programs in the same watershed.

Currently, the majority of the hatchery Chinook salmon produced in Puget Sound (by release number) are fall-run (also called summer/fall) stocks produced for harvest augmentation purposes. Conservation hatchery programs in the Nooksack, Dungeness, and Stillaguamish Rivers are currently operating under the PST critical stock program. Funding for these programs is addressed in the consultation on domestic actions associated with implementation of the 2019-2028 PST Agreement (NMFS 2019g), described further below. Hatchery programs are being implemented as conservation measures to recover early returning Chinook salmon operate in the White (Appleby and Keown 1994), Dungeness (Smith and Sele 1995), and North Fork Nooksack rivers, and for summer Chinook salmon on the North Fork Stillaguamish and Elwha Rivers (Fuss and Ashbrook 1995; Myers et al. 1998). Conservation programs are also in operation for early Chinook salmon in the South Fork Nooksack River, fall Chinook salmon in the South Fork Stillaguamish River (Tynan 2010) and spring and late-fall Chinook salmon in the Skokomish River (Redhorse 2014b; Speaks 2017a).

In 2019, NMFS consulted on impacts to ESA-listed species from several U.S. domestic actions associated with the 2019-2028 PST agreement (NMFS 2019g), including federal funding of a conservation program for critical Puget Sound Chinook salmon stocks and a Southern Resident Killer Whale (SRKW) prey enhancement program. The 2019 opinion (NMFS 2019g) included a programmatic consultation on the PST funding initiative, which is an important element of the environmental baseline in this opinion. Thus far, the PST federal appropriations have resulted in funds in FY20 ($5.6 million), FY21 ($7.3 million), FY22 ($6.1 million), and FY23 ($5.6 million) for the SRKW prey enhancement program (Purcell 2022; NMFS 2023f).

Also, in response to recommendations from the Washington State Southern Resident Orca Task Force (2018), the Washington State Legislature provided $25.5 million of funding “prioritized to increase prey abundance for southern resident orcas” (Engrossed Substitute House Bill 1109) for the 2019-2021 and 2021-2023 bienni (July 2019 through June 2023).

As a result of the FY20 through FY22 federal funding and the 2021-2023 Washington State Legislature funding, over 18 million and 19 million additional hatchery-origin Chinook salmon are estimated to have been released in 2022 and 2023, respectively, relative to the base period considered in NMFS’ 2019 biological opinion (NMFS 2019d). In 2022, 52.5 percent of the fish were released in the Puget Sound region, while 47.5 percent of the fish were released in the Columbia River/Washington Coast region. In 2023, 62.6 percent of the fish were released in the

Puget Sound region, while 37.4 percent of the fish were released in the Columbia River/Washington Coast region (NMFS 2023f).

These initiatives currently contribute to the prey base of Chinook salmon for SRKW, as fish released from 2020, 2021 and 2022, depending on life history, are currently reaching adult age (3-5 yo) in the ocean (in 2024). Fish funded by these programs and released to date are expected to contribute to the prey base through 2027, as fish released through the spring of 2023 will take several 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)). NMFS expects that the baseline Chinook abundance in Puget Sound, during 2024-2025 season includes adults from the additional hatchery releases in the SRKW prey programs in Puget Sound in 2020-2022. Federal funding appropriated in 2020 through 2023 and in FY2024 for the PST funding initiative provides a level of certainty that these programs will continue.

NMFS has been applying the following six criteria to determine which hatchery production proposals are prioritized to receive federal funding to increase the SRKW prey base:

Criteria 1: Increased hatchery production should be for Chinook stocks that are a high priority for SRKW (NOAA Fisheries and WDFW 2018; PFMC 2020a).

Criteria 2: Increased production should be focused on stocks that are a high priority for SRKW (NOAA Fisheries and WDFW 2018), but funding should be distributed so that hatchery production is increased across an array of Chinook stocks from different geographic areas and run timings (i.e., a portfolio).

Criteria 3: Increased production cannot jeopardize the survival and recovery of any Endangered Species Act (ESA)-listed species, including salmon and steelhead.

Criteria 4: Because of funding and timing constraints, increased production proposals should not require major capital upgrades to hatchery facilities.

Criteria 5: All proposals should have co-manager agreement, as applicable.

Criteria 6: All increased production must be reviewed under the ESA and National Environmental Policy Act (NEPA), as applicable, before NMFS funding can be used.

NMFS has and will continue to work with hatchery operators and funders to ensure that all increased hatchery production to support SRKWs 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 their critical habitat. For example, NMFS completed an ESA consultation (NMFS 2020c) for the release of hatchery fish into streams and rivers that flow into Puget Sound to identify potential impacts to SRKWs and other non-salmonid ESA-listed species. That analysis looked at all of the proposed hatchery production in the Puget Sound region. NMFS determined that in the short-term (within 3-5 years), as hatchery fish mature and become available as prey, the SRKWs are likely to benefit from an increase in hatchery Chinook salmonprey (NOAA Fisheries and WDFW 2018; NMFS 2019g). NMFS has been working collaboratively with the state and tribal co-managers, and other interested parties, to meet the goals related to increasing prey abundance for SRKW while minimizing the risk to ESA-listed salmon species.

Steelhead Hatchery Production

There are currently 12 hatchery programs in Puget Sound that propagate steelhead. Six of these programs are integrated programs that produce hatchery-origin steelhead that are genetically similar to the natural-origin steelhead populations in the watersheds where those programs release fish (Appendix A, Table 2). These steelhead hatchery programs are designed to conserve and rebuild ESA-listed populations, and allow for natural spawning of hatchery-origin fish. They use broodstock founded from, and integrated with the natural population, for conservation purposes.

In the Central/Southern Cascade MPG, one program operates to rebuild the native White River winter-run steelhead population. In the Green River Basin, upon construction of a new Fish Restoration Facility (NMFS 2019a), a new conservation program[32] will operate to rebuild the native Green River winter-run steelhead population and mitigate for lost natural-origin steelhead abundance associated with the placement and operation of Howard Hanson Dam (Jones 2015). In the Hood Canal and Strait of Juan de Fuca MPG, the Supplementation Program for Hood Canal Steelhead functioned to rebuild native stock winter-run steelhead abundances in the Dewatto, Duckabush, and South Fork Skokomish river watersheds. However, that program has now sunsetted, with the last adult fish produced returning in 2019. A newer recovery program currently operated out of the North Fork Skokomish Hatchery by Tacoma Power and Utilities is currently supporting the recovery of native Skokomish River winter steelhead. The fifth program, the Elwha River Native Steelhead program, preserves and assists in the rebuilding of native Elwha River winter-run steelhead. The sixth program is a summer steelhead hatchery program in the South Fork Skykomish under Limit 6 of the 4(d) Rule (NMFS 2021d). The South Fork Skykomish steelhead program is transitioning to the use of a localized within-basin natural-origin broodstock, and is intended to maintain a locally-adapted population comprised of hatchery broodstock and naturally spawning fish from within the Puget Sound DPS (Ford 2022).

The remaining eight steelhead hatchery programs produce fish for harvest. In 2016, five early winter steelhead hatchery programs producing non-listed fish and operating within the Dungeness, Nooksack, Stillaguamish, Snohomish, and Skykomish River Basins received approval by NMFS under ESA 4(d) Rule, limit 6 for effects on ESA-listed steelhead and Chinook salmon (NMFS 2016g; 2016i). In evaluating and approving the Early Winter Steelhead

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[32] in addition to the one that already exists in the Green

(EWS) programs, founded with Chambers Creek stock, for effects on listed fish (NMFS 2016g; 2016i), and based on analyses of genetic data provided by WDFW (Warheit 2014), NMFS determined that gene flow levels for the five EWS programs were very low and unlikely to pose substantial genetic diversity reduction risks to natural-origin winter-run steelhead populations. One important element to consider for the evaluation of effects of fisheries targeting EWS hatchery returns is that EWS have been artificially selected to return and spawn as adults earlier in the winter than the associated natural-origin Puget Sound winter-run steelhead populations (Crawford 1979). This timing difference, in addition to other factors, including hatchery risk reduction management measures that reduce potential natural spawning of EWS act to reduce the associated genetic risks to natural-origin steelhead.

There is also one remaining harvest augmentation programs currently propagating non-listed early summer-run steelhead (ESS), which were derived from Columbia River, Skamania stock, in the Green (Soos Creek). Prior programs in the Skykomish (Reiter Ponds) and Stillaguamish (Whitehorse Ponds) River Basins were phased out in 2020 and 2022, respectively. The Soos Creek Hatchery summer steelhead program will be transitioned to a within-Puget Sound stock by 2031 (NMFS 2019a).

The EWS and ESS stocks historically reared and released as smolts through the six non-listed programs were considered more than moderately diverged from any natural-origin steelhead stocks in the region and were therefore excluded from the Puget Sound Steelhead DPS. Gene flow from naturally spawning fish produced by these six hatchery programs may pose genetic risks to natural-origin steelhead (NMFS 2016i; Ford 2022). However, these risks have been assessed through the 4(d) approval process, and were determined to be minimal. Based on analyses of genetic data provided by WDFW (Warheit 2014), NMFS determined that gene flow levels for the five EWS programs were very low and unlikely to pose substantial genetic diversity reduction risks to natural-origin winter-run steelhead populations (NMFS 2016g; 2016i). Genetic assessment for the summer Green River program was complete in 2019, and risk from gene flow was determined to be low (NMFS 2019a).

As described in Section 2.2.1.2, NWFSC (2015a) hatchery steelhead releases in Puget Sound have declined in most areas. Between 2007 and 2014 Puget Sound steelhead annual hatchery releases averaged about 2,500,000 annually (NMFS 2014a). Reductions since 2014 from this average total have largely been in response to the need to reduce risks to natural Puget Sound steelhead after the 2007 listing and subsequent risk analyses (NMFS 2014a; Warheit 2014). Reductions were focused on unlisted steelhead programs in response to the risk of introgression between native steelhead populations and hatchery-origin. In addition, Chambers Creek (EWS) releases were discontinued in the Elwha and Skagit River basins during the last five year period (Ford 2022). Currently, hatchery programs propagating unlisted steelhead in Puget Sound total 1,076,000 annually (this total includes 350,000 summer steelhead and 531,000 winter steelhead) in the Puget Sound DPS (Ford 2022), which have been approved under Limit 6 of the 4(d) Rule.

There have also been recent changes associated with several integrated rebuilding programs, including increased production goals for the Green River Native Winter Steelhead and White River Winter Steelhead Supplementation programs; and addition of the North Fork Skokomish

Winter Steelhead program, which first released fish in 2017 (Ford 2022). Once the non-Puget Sound hatchery summer steelhead programs sunset, as required by 4(d) authorization (NMFS 2019a; 2021d), and the integrated programs rebuilding listed populations achieve their intended release goals, by 2031, Puget Sound steelhead hatchery releases will total roughly 1.3 million. This release level represents a 52 percent total reduction in Puget Sound hatchery steelhead releases since listing, and a transition away from programs releasing out of DPS stocks.

2.4.1.4 *Habitat*

Human activities have degraded extensive areas of salmon and steelhead spawning and rearing habitat in Puget Sound (Ford 2022). Most damaging 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).

Land use 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.), polluted 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; NWIFC 2016; Treaty Tribes in Western Washington 2020; Ford 2022). 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; NWIFC 2016; Treaty Tribes in Western Washington 2020). 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 mainstems (Elwha-Dungeness Planning Unit 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). There are substantial habitat blockages by dams in the Skagit and Skokomish River basins, in the Elwha basin until 2014 (prior to the implementation of the Elwha Dam Removal Plan), and minor blockages (including impassable culverts) throughout the region. Historically, low flows resulting from operation of the Cushman dams and habitat degradation of freshwater and estuarine habitat have adversely affected the Skokomish basin. A settlement agreement in 2008 between the Skokomish Tribe and Tacoma Power, the dam operator, resulted in a plan to restore normative flows to the river, improve habitat through on-going restoration activities, and restore an early Chinook salmon life history in the river using supplementation. In general, habitat has been degraded from its pristine condition, and this trend is likely to continue with further population growth and resultant urbanization in the Puget Sound region (Ford 2022).

Habitat utilization by Chinook salmon and steelhead in the Puget Sound area has been historically limited by large dams and other manmade barriers in a number of drainages, including the Nooksack, Skagit, White, Nisqually, Skokomish, and Elwha River Basins (Appendix B in NMFS (2015b)). In addition to limiting habitat accessibility, dams affect habitat quality through changes in river hydrology, altered temperature profile, reduced downstream gravel recruitment, and the reduced recruitment of large woody debris. Such changes can have significant negative impacts on salmonids (e.g., increased water temperatures resulting in decreased disease resistance) (Spence et al. 1996; McCullough 1999). However, over the past several years modifications have occurred to existing barriers, which have reduced the number of basins with limited anadromous access to historical habitat. The completion of the Elwha and Glines Canyon dam removals occurred in 2014, though the response of fish populations to this action is still being evaluated (Ford 2022). It is clear, however, that Chinook salmon and steelhead are accessing much of this newly available habitat (Pess et al. 2020). Passage operations have begun on the North Fork Skokomish River to reintroduce steelhead above Cushman Dam, and although juvenile collection efficiency is still relatively low, further improvements are anticipated. Similarly, improvements in the adult fish collection facility at Mud Mountain Dam (White River Basin) are near completion, with the expectation that improvements in adult survival will facilitate better utilization of habitat above the dam (NMFS 2014c).

The recent removals of the diversion dam on the Middle Fork Nooksack Dam (July 2020) and the Pilchuck River Diversion Dam (late 2020) will provide access to important headwater salmonid spawning and rearing habitats. Similarly, the proposed modification of Howard Hanson Dam for upstream fish passage and downstream juvenile collection in the longer term (NMFS 2019f) will allow winter steelhead to return to historical headwater habitat in the Green River (Ford 2022). It has been hypothesized that summer-run steelhead may have been residualized above Howard Hanson Dam (Myers et al. 2015), and restoring access could restore such a run. However, the effects of these two projects on abundance will not be evident for some time. Four of the top six steelhead populations identified by Cram et al. (2018) as having habitat blocked by major dams are in the process of having passage restored or improved (Ford 2022).

In addition, projects focusing on smaller scale improvements in habitat quality and accessibility are ongoing. As of 2019 approximately 8,000 culverts that block steelhead habitat have been identified in Puget Sound (NMFS 2019h), with plans to address these blockages being extended over many years. Smaller scale improvements in habitat, restoration of riparian habitat and reconnecting side- or off-channel habitats, will allow better access to habitat types and niche diversification. While there have been some significant improvements in restoring access, it is recognized that land development, loss of riparian and forest habitat, loss of wetlands, demands on water allocation all continue to degrade the quantity and quality of available fish habitat (Ford 2022).

Many upper tributaries in the Puget Sound region have been affected by poor forestry practices, while many of the lower reaches of rivers and their tributaries have been altered by agriculture and urban development (Appendix B in NMFS (2015b)). Urbanization has caused direct loss of riparian vegetation and soils, significantly altered hydrologic and erosional rates and processes (e.g., by creating impermeable surfaces such as roads, buildings, parking lots, sidewalks etc.) (NMFS 2019h), and polluted waterways with stormwater and point-source discharges (Appendix B in NMFS (2015b)). Forestry practices, urban development, and agriculture have resulted in the loss of wetland and riparian habitat, creating dramatic changes in the hydrology of many streams, increases in flood frequency during storm events, and decreases in groundwater driven summer flows (Moscrip and Montgomery 1997; Booth, Hartley and Jackson 2002; May et al. 2003). River braiding and sinuosity have also been reduced in Puget Sound through the construction of dikes, hardening of banks with riprap, and channelization of the mainstem (NMFS 2015b). Constriction of river flows, particularly during high flow events, increases the likelihood of gravel scour and the dislocation of rearing juveniles. The loss of side-channel habitats has also reduced important areas for spawning, juvenile rearing, and overwintering habitats. Estuarine areas have been dredged and filled, resulting in the loss of important juvenile rearing areas (NMFS 2015b). In addition to being a factor that contributed to the present decline of Puget Sound Chinook salmon and steelhead populations, the continued destruction and modification of habitat is the principal factor limiting the viability of the Puget Sound Chinook salmon and steelhead into the foreseeable future (72 FR 26722, May 11, 2007). Due to their limited distribution in upper tributaries, summer run steelhead may be at higher risk than winter run steelhead from habitat degradation in larger, more complex watersheds (Appendix B in NMFS (2015b)).

NMFS has completed several Section 7 consultations on large-scale projects affecting listed species in Puget Sound. Among these are the Washington State Forest Practices Habitat Conservation Plan (NMFS 2006a), and consultations on Washington State Water Quality Standards (NMFS 2008c), the National Flood Insurance Program (NMFS 2008e), the Elwha River Fish Restoration Plan (Ward et al. 2008), the Washington State Department of Transportation Preservation, Improvement, and Maintenance Activities (NMFS 2013b), and the Salish Sea Nearshore permitting activities with the Corps (NMFS 2022b). These documents considered the effects of the proposed actions that would occur up to the next 50 years on the ESA-listed salmon and steelhead species in the Puget Sound Basin. Information on the status of these species, the environmental baseline, and the effects of the proposed actions are reviewed in detail in the opinions on these actions. The environmental baselines in these documents consider the effects from timber, agriculture and irrigation practices, urbanization, hatcheries and tributary habitat, estuary, and large-scale environmental variation. These opinions and HCPs, in addition to the watershed specific information in the Puget Sound Salmon Recovery Plan mentioned above, provide a comprehensive overview of baseline habitat conditions in Puget Sound and are incorporated here by reference.

On November 9, 2020, NMFS issued an opinion for 39 habitat modifying projects in the nearshore marine areas of Puget Sound, permitted by the Army Corp of Engineers under the Clean Water Act and the Rivers and Harbors Act (NMFS 2020d). This opinion concluded that the proposed action would not jeopardize the continued existence of, nor adversely modify the critical habitat of Puget Sound steelhead, Hood Canal Summer Run (HCSR) chum salmon, PS/GB yellow rockfish, or PS/GB bocaccio. The opinion concluded that the proposed action would jeopardize the continued existence of, and adversely modify critical habitat for, PS Chinook salmon and SRKWs. The opinion provided an RPA to the proposed action. The RPA utilized a Habitat Equivalency Analysis methodology and the Nearshore Habitat Values Model to establish a credit/debit target of no-net-loss of nearshore habitat quality. The RPA was designed to achieve, at a minimum, a reduction of these debits to zero. The RPA provides a range of options for achieving this goal and avoiding jeopardy of PS Chinook salmon. The expected improvements to Chinook salmon abundance resulting from implementation of the RPA are expected to improve the amount of prey available for SRKWs. As a result, the RPA avoids jeopardy and adverse modification for SRKWs.

In addition to increased hatchery production, the funding initiative for U.S. domestic actions associated with the new PST Agreement included funding for habitat restoration projects to improve habitat conditions for specified populations of Puget Sound Chinook salmon (NMFS 2019g; 2022a). By improving conditions for these populations, we anticipate Puget Sound Chinook salmon abundance would increase, also benefiting SRKW. In FY20, FY21, FY22, and FY23: $8.9 million, $8.8 million, $8.8 million, and $4.1 million, respectively, was directed at habitat restoration projects within the northern boundary watersheds of Nooksack, Skagit, Stillaguamish, Snohomish, Dungeness, and Mid-Hood Canal (Appendix D).

NMFS has developed phased selection criteria to select projects. They are (in rank order):

1) Project supports one or more limiting life stage of at least one of the four Puget Sound critical stocks,
2) Project supports one or more limiting life stage of a high priority population for Puget Sound Chinook salmon recovery,
3) Project supports Puget Sound Chinook salmon population that are priority prey for SRKWs (NOAA Fisheries and WDFW 2018),
4) Project supports the recovery of multiple ESA-listed species (i.e., Chinook salmon and steelhead) in a given watershed, and
5) Project removes a passage barrier for one or more of the four Puget Sound critical stocks or high priority populations for Puget Sound Chinook salmon recovery

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. These projects are reviewed for consistency with the Habitat Restoration Program 4(d) Rule, Limit 8 design constraints specified in NMFS opinion (NMFS 2006d). These constraints are expected to limit the adverse effects of constructing the projects to ESA listed fish. NMFS has ensured projects have ESA and NEPA coverage before they can utilize federal funds. 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.

2.4.2 Puget Sound/Georgia Basin Rockfish

The Puget Sound and Georgia Basin comprise the southern arm of an inland sea located on the Pacific Coast of North America that is directly connected to the Pacific Ocean. Most of the water exchange in Puget Sound proper is through Admiralty Inlet near Port Townsend, and the configuration of sills and deep basins results in the partial recirculation of water masses and the retention of contaminants, sediment, and biota (Rice 2007). Tidal action, freshwater inflow, and ocean currents interact to circulate and exchange salty marine water at depth from the Strait of Juan de Fuca, and less dense fresh water from the surrounding watersheds at the surface produce a net seaward flow of water at the surface (Rice 2007).

Most of the benthic deepwater (e.g., deeper than 90 feet (27.4 m)) habitats of Puget Sound proper consist of unconsolidated sediments such as sand, mud, and cobbles. The vast majority of the rocky-bottom areas of Puget Sound occur within the San Juan Basin, with the remaining portions spread among the rest of Puget Sound proper (Palsson et al. 2009). Depths in the Puget Sound extend to over 920 feet (280 meters).

Benthic habitats within Puget Sound have been influenced by a number of factors. The degradation of some rocky habitat, loss of eelgrass and kelp, introduction of non-native species that modify habitat, and degradation of water quality are threats to marine habitat in Puget Sound (Palsson et al. 2009; Drake et al. 2010). Some benthic habitats have been impacted by derelict fishing gear that include lost fishing nets, and shrimp and crab pots (Good et al. 2010). Derelict fishing gear can continue “ghost” fishing and is known to kill rockfish, salmon, and marine mammals as well as degrade rocky habitat by altering bottom composition and killing numerous species of marine fish and invertebrates that are eaten by rockfish (Good et al. 2010). Thousands of nets have been documented within Puget Sound and most have been found in the San Juan Basin and the Main Basin. The Northwest Straits Initiative has operated a program to remove derelict gear throughout the Puget Sound region. In addition, WDFW and the Lummi, Stillaguamish, Tulalip, Nisqually, and Nooksack Tribes and others have supported or conducted derelict gear prevention and removal efforts. Net removal has mostly concentrated in waters less than 100 feet (33 m) deep where most lost nets are found (Good et al. 2010). The removal of over 4,600 nets and over 3,000 derelict pots have restored over 650 acres of benthic habitat[33], though many derelict nets and crab and shrimp pots remain in the marine environment. Several hundred derelict nets have been documented in waters deeper than 100 feet deep (Antonelis 2014). Over 200 rockfish have been documented within recovered derelict gear. Because habitats deeper than 100 feet (30.5 m) are most readily used by adult yelloweye rockfish and bocaccio, there is an unknown impact from deepwater derelict gear on rockfish habitats within Puget Sound.

Over the last century, human activities have introduced a variety of toxins into the Georgia Basin at levels that can affect adult and juvenile rockfish habitat and/or the prey that support them. Toxic pollutants in Puget Sound include oil and grease, PCBs, phthalates, PBDEs, and heavy metals that include zinc, copper, and lead. Several urban embayments in Puget Sound have high levels of heavy metals and organic compounds (Palsson et al. 2009). There are no studies to date

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[33] Derelict fishing gear removal data in Puget Sound. Available at: http://www.derelictgear.org/.

that define specific adverse health effects thresholds for specific toxicants in any rockfish species; however, it is likely that PCBs pose a risk to rockfish health and fitness (Palsson et al. 2009). About 32 percent of the sediments in the Puget Sound region are considered to be moderately or highly contaminated (PSAT 2007), though some areas are undergoing clean-up operations that have improved benthic habitats (Sanga 2015).

NMFS cannot quantify the effects of degraded habitat on the listed rockfish because these effects are poorly understood. However, there is sufficient evidence to indicate that ESA-listed rockfish productivity may be negatively impacted by the habitat structure and water quality stressors discussed above (Gustafson et al. 2010).

Washington State has a variety of marine protected areas managed by 11 Federal, state, and local agencies (Van Cleve et al. 2009),, though some of these areas are outside of the range of the rockfish DPSs. British Columbia has also designated a broad network of rockfish conservations areas (RCAs) throughout their waters, both within and outside the (Marliave and Challenger 2009; Haggarty, Shurin and Yamanaka 2016). The WDFW has established 25 marine reserves within the DPSs' boundary, and 16 host rockfish (Palsson et al. 2009), though most of these reserves are within waters shallower than those typically used by adult yelloweye rockfish or bocaccio. The WDFW reserves total 2,120.7 acres of intertidal and subtidal habitat. The total percentage of the Puget Sound region within reserve status is unknown, though Van Cleve et al. (2009) estimate that one percent of the subtidal habitats of Puget Sound are designated as a reserve. Most of these MPAs are sited specifically to protect high productivity habitats, however, such that their ecological benefit is likely greater than indicated by their relative percent cover. In Canadian waters, an objective evaluation of the suitability of RCAs to provision rockfishes with adequate habitat found that over 50% of sites were well placed to contribute to conservation and recovery efforts (Fisheries and Oceans Canada 2019). Management of reserves varies greatly by region, including conservation areas with prohibited fishing enforced by the WDFW, to voluntary no-take areas monitored by the local community (Van Cleve et al. 2009). Evidence from Canadian waters, however, indicates that even when regulations prohibit fishing, compliance may be poor, resulting in limited conservation benefits (Haggarty, Martell and Shurin 2016). Compared to fished areas, studies have found higher fish densities, larger average sizes, or reproductive activity in assessed marine reserves (Palsson and Pacunski 1995; Palsson 1998; Eisenhardt 2001; Palsson 2004; LeClair et al. 2018), though not all reserves exibit such effects, and effects may take decades to be detectable. These reserves were established over several decades with unique and somewhat unrelated ecological goals, and encompass relatively small areas (average of 23 acres). The presence of rockfishes, their prey, and their preferred habitats in the WDFW and DFO marine reserves indicates the potential for direct and indirect effects to population status, however a paucity of data and poor compliance with fishery regulations in at least some cases call into question their value to ESA-listed rockfish. The slow population growth rates of listed rockfishes compound this problem, making detection of direct effects difficult, but both the WDFW and DFO are committed to such place-based management as a piece of their long-term recovery strategy.

In 2020, NMFS conducted a programmatic consultation resulting in an opinion (NMFS 2020c) on the effects to rockfish and other non-salmonid listed species for the proposed action to determine that salmon and steelhead hatchery production and release in Puget Sound watersheds within the next 10 years meet the criteria described under limit 6 of the ESA 4(d) rules (50 CFR § 223.203(b)(6)). This analysis looked at 19 bundled hatchery genetic management plans (HGMPs) in the Puget Sound region, and analyzed the estimated consumption of Puget Sound/Georgia Basin yelloweye rockfish or bocaccio larval rockfish by juvenile Chinook and coho salmon produced in those hatchery programs. The model developed to estimate consumption of larval rockfish produced conservative annual take estimates equivalent to four yelloweye and seven bocaccio adult equivalents, and NMFS concluded that the proposed action is not likely to jeopardize the continued existence of Puget Sound/Georgia Basin yelloweye rockfish or bocaccio.

Listed Puget Sound rockfish are taken as bycatch in recreational and commercial fisheries for other species in the action area. In its five-year review of Puget Sound rockfish, NMFS discussed cumulative fisheries management effects pertinent to rockfish that is part of the environmental baseline in the Puget Sound area (NMFS 2016a). These included the analysis of impacts from bycatch of Puget Sound/Georgia Basin yelloweye rockfish or bocaccio in the halibut and other bottom fish fisheries (e.g., recreational bottom fish and shrimp trawl fisheries, (NMFS 2018f)). In 2012, we issued an Incidental Take Permit (ITP) to the WDFW for listed rockfish in these other fisheries, and the WDFW is working on a new ITP application (WDFW 2016). If issued, the new permit would be in effect for up to 15 years. In 2018 we estimated that the halibut fisheries would result in lethal take of up to 270 yelloweye rockfish and 40 bocaccio annually (NMFS 2018f), and we estimated the recreational bottom fish and shrimp trawl fisheries combined would result in lethal take of up to 65 yelloweye rockfish and 17 bocaccio annually. These estimates are used in the Integration and Synthesis (Section 2.7.3, Table 43). In addition, NMFS briefly summarized fisheries management in Canadian waters of the DPSs, as it is relevant to listed rockfish that use waters in Canada and the San Juan area. In 2010, the Washington State Fish and Wildlife Commission formally adopted regulations that ended the retention of rockfish by recreational anglers in Puget Sound and closed fishing for bottom fish in all waters deeper than 120 feet (36.6 m). On July 28, 2010, WDFW enacted the following package of regulations by emergency rule for the following non-tribal commercial fisheries in Puget Sound in order to protect dwindling rockfish populations:

1) Closure of the set net fishery
2) Closure of the set line fishery
3) Closure of the bottom trawl fishery
4) Closure of the inactive pelagic trawl fishery
5) Closure of the inactive bottom fish pot fishery

As a precautionary measure, WDFW closed the above commercial fisheries westward of the listed rockfish DPSs’ boundary to Cape Flattery, to limit impacts to rockfish that also inhabit those waters. The WDFW extended the closure west of the rockfish DPSs’ boundary to prevent commercial fishermen from concentrating gear in that area. The previously active commercial fisheries closures listed above were originally enacted on a temporary basis and WDFW permanently enacted them in February 2011. The inactive pelagic trawl fishery was closed by permanent rule on the same date.

The DPS area for yelloweye rockfish and bocaccio includes areas across the Georgia Basin (Figure 10 and Figure 11), thus the status of the environmental baseline is influenced by rockfish management within both Puget Sound and Georgia Strait. Fisheries management in British Columbia, Canada has been altered to better conserve rockfish populations. In response to declining rockfish stocks, the government of Canada initiated comprehensive changes to fishery policies beginning in the 1990s (Yamanaka and Logan 2010). Conservation efforts were focused on four management steps: (1) accounting for all catch, (2) decreasing total fishing mortality, (3) establishing areas closed to fishing, and (4) improving stock assessment and monitoring (Yamanaka and Lacko 2001). The Department of Fisheries and Oceans (DFO) adopted a policy of ensuring that inshore rockfish are subjected to fisheries mortality no more than half of natural mortality (Walters and Parma 1996; PFMC 2000).

These conservation efforts led to the 2007 designation of a network of Rockfish Conservation Areas (RCAs) that encompasses 30 percent of rockfish habitat of the inside waters of Vancouver Island (Yamanaka and Logan 2010). The Department of Fisheries and Oceans (DFO) defined and mapped “rockfish habitat” from commercial fisheries log Catch Per Unit Effort (CPUE) density data, as well as change in slope bathymetry analysis (Yamanaka and Logan 2010). These RCAs do not allow directed commercial or recreational harvest for any species of rockfish, or the harvest of other marine species if that harvest may incidentally catch rockfish. As the RCAs are relatively new it is uncertain how effective they have been in protecting rockfish populations (Haggarty 2013), but one analysis found that sampled RCAs in Canada had 1.6 times the number of rockfish compared to unprotected areas (Cloutier 2011). There are anecdotal reports that compliance with the RCAs may be low and that some may contain less than optimum areas of rockfish habitat (Haggarty 2013). Systematic monitoring of the RCAs may be lacking as well (Haggarty 2013). The DFO, WDFW, and NMFS conducted fish population surveys of some of the RCAs in 2018 but the results of these surveys are still being processed. Outside the RCAs, recreational fishermen generally may keep one rockfish per day from May 1 to September 30. Commercial rockfish catches in Area 4(b) are managed by a quota system (DFO 2011).

2.4.3 Southern Resident Killer Whales

As described in Section 2.2.1.4 (Status of the Southern Resident Killer Whales) and assessed in the Final Recovery Plan (NMFS 2008j), 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, the small population size, and other ecosystem-level effects (NMFS 2008j). 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 2021j) 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. The following discussion summarizes the principal human and natural factors within the action area (other than the proposed action) that are known to impact the condition of SRKW or their critical habitat in the action area. Below, we briefly discuss prey availability, prey quality, vessels and noise, entrapment and entanglement in fishing gear, and oil spills in the action area. NOAA's Species in the Spotlight Priority Action Plan (NMFS 2021k) identifies high priority actions for SRKW 2021-2025 and ongoing progress towards implementation of recommendations from the Washington state Governor's task force to address all major threats to SRKW. The link to the task force recommendations can be found here: https://orca.wa.gov/.

Prey Availability

Chinook salmon are the primary prey of SRKW throughout their geographic range, which includes the action area (see further discussion in Section 2.3, Action Area). Similar to past opinions (NMFS 2019g; 2019d; 2020b; 2021f; 2022c; 2023c) our analysis of Puget Sound salmon fisheries focuses on effects to Chinook salmon availability to SRKWs (compared to other salmonids) because the best available information indicates that Chinook salmon are the SRKWs primary prey and that other prey species are much more abundant than Chinook (as described in Section 2.2.1.4 Status of Southern Resident Killer Whales), therefore, in the Environmental Baseline, we focus on Chinook salmon prey availability. 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 section, the abundance of Chinook salmon now is significantly less than historical abundance due to a number of human activities. Human activities that likely have adverse effects on ESA-listed and non-ESA-listed salmon include: land use activities that result in habitat loss and degradation, toxins, hatchery practices, harvest and hydropower systems. Also, as described in the Status of the Species, 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. The effects of climate change described in the Status Section would be expected to occur in the action area. These changes would likely have profound effects on marine productivity and food webs, including populations of salmon. Details regarding baseline conditions of ESA-listed Puget Sound Chinook salmon in inland waters are described in 2.4.1. The baseline also includes Chinook salmon that are not ESA-listed that occur in the action area, notably Puget Sound hatchery Chinook salmon stocks that are not part of the listed entity, as well as Fraser River and Georgia Strait stocks of Chinook salmon.

Here we provide a review of previous ESA Section 7(a)(2) consultations covering effects to SRKWs from activities whose effects in the Puget Sound 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 and qualitatively assess the remaining prey available to SRKWs in the action area.

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 2010d; 2014b; 2015d; 2016f; 2017e; 2018d; 2019d; 2020b; 2021f; 2022c; 2023c), Council-area salmon fisheries (NMFS 2008a; 2020a; 2021b), and salmon fisheries managed consistent with provisions of the PST (NMFS 2008g; 2019g), we characterized the short-term and long-term effects these salmon fisheries have on the SRKWs via prey reduction from fishery operation, and we summarize the most recent opinions below. 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 that used evolving models and methodologies so values are not comparable across opinions. Then we provide a comprehensive review of all fisheries that impact SRKW Chinook prey abundance in the action area to estimate baseline prey availability that does use comparable methodologies across fisheries.

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 includes provisions limiting harvest impacts in all Chinook 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 percent, respectively, compared to the previous (2009-2018) Agreement. The level of reduction in any given year depends on the Chinook abundance in that year. This comes on top of the reductions of 15 and 30 percent for those same fisheries that occurred as a result of the prior 10 year agreement (2009-2018). These reductions should result in more salmon returning to the more southerly U.S. Pacific Coast Region 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 agreement, which is seen in the analyses described below.

In the 2019 opinion on domestic actions related to the 2019-2028 PST Agreement (NMFS 2019g)[34], NMFS assumed that the State of Alaska would manage its SEAK salmon fisheries consistent with the provisions of the Agreement. Using methodology similar to previous opinions completed up to that time (e.g., NMFS 2019g), NMFS estimated that the percent reductions of Chinook salmon in inland waters of WA from the SEAK fisheries were expected to range from 0.1% to 2.5% with the greatest reductions occurring in July-September. Percent

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[34] On August 8, 2022, the District Court for the Western District of Washington issued a ruling finding deficiency with the 2019 biop in Wild Fish Conservancy v. Quan. On May 2, 2023, the court issued an order remanding to NMFS and vacating portions of the biop. The parties appealed the decision to the 9th Circuit Court of Appeals. The 9th Circuit granted a stay of the vacatur pending appeal, and oral argument on the case is set for July 18, 2024. However, the portion of the analysis referenced here was not specifically addressed by the district court and we continue to refer to it pending new analysis.

reductions in coastal waters (which would include some proportion of Puget Sound Chinook stocks) of WA and OR from the SEAK fisheries were expected to range from 0.2% to 12.9%[35] and similarly the greatest reductions would occur in July-September. Percent reductions from Canadian salmon fisheries were expected to range up to 13.2% in coastal waters and up to 12.9% in inland waters, with greatest reductions in July-September, and also greater inland water reductions in May-June than Puget Sound or PFMC fisheries (NMFS 2019g). Under the previous PST Agreement (2009), percent reductions of Chinook salmon in inland waters ranged from 0.2% to 2.9% and 0.2% to 15.1% in coastal waters as a result of the SEAK fisheries (NMFS 2019i). Percent reductions of Chinook salmon from the Canadian salmon fisheries under the 2009 PST Agreement ranged up to 13.5% in inland waters and up to 14.6% in coastal waters (NMFS 2019g).

Salmon fisheries in the southern U.S. 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. Fisheries in the EEZ off the U.S. West Coast are managed by the PFMC and NMFS under the MSA. NMFS has issued opinions addressing the effects of these fisheries on all affected ESA-listed species including salmon ESUs and SRKWs, and fisheries are managed consistent with the proposed actions and ITSs in these opinions.

In 2021, the PFMC adopted Amendment 21 to the Pacific Coast Salmon Fishery Management Plan (FMP) to address effects of Council-area ocean salmon fisheries on the Chinook salmon prey base of SRKWs (86 FR 51017, September 14, 2021). The Amendment established a threshold representing a low pre-fishing Chinook salmon abundance in the North of Falcon (NOF) area (including the EEZ and state ocean waters), below which the Council and States will implement specific management measures (NMFS 2021b). 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 (2020b) for more details or PFMC (2022a)), which also included years when SRKWs were in varied health and consecutive years of low Chinook abundance (given reproductive success is likely reliant on several years of optimal prey availability). Under Amendment 21, the threshold may be revised prior to the start of the fishing season using current data and updated methods (PFMC 2022a). The threshold was updated in 2022 to incorporate new scientific information, was approved by the Council including NMFS, and is currently estimated[36] at 623,000 Chinook salmon.

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[35] The methodology to estimate this percent reduction differs from current methods that were derived during the PFMC SRKW Ad Hoc workgroup and updated by the PFMC in November of 2022. Because of this, we are limited in our ability to compare impacts from different fisheries. We provide general percent reductions from SEAK and Canadian salmon fisheries, but this warrants caution in comparing these reductions to those estimated by the Workgroup.

[36] 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 Council developed for Amendment 21 also includes two periods when there were multiple and consecutive years of low Chinook 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

Each year, the preseason estimate of pre-fishing Chinook salmon abundance for the upcoming fishing year is compared to the threshold. In years when the projected preseason abundance of Chinook salmon in the NOF area falls below the low abundance threshold, multiple management actions (e.g. quota adjustments and spatial/temporal closures) are to 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 2021b) 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 for salmon, and addresses the needs of the whales by limiting prey removal from the fisheries in NOF areas and reducing the potential for competition between fisheries and SRKWs in times and areas where/when the fisheries and whales overlap during years with low Chinook abundance. Therefore, NMFS concluded the proposed action is not likely to jeopardize the continued existence of the SRKW DPS or destroy or adversely modify its designated critical habitat (NMFS 2021b). In addition to limiting prey reduction on the coast, this action may limit the reductions of prey by PFMC fisheries on prey in the Salish Sea 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 that observed in the 10-year period considered in the opinion (NMFS 2021b), into the foreseeable future.

In the previous consultation on Puget Sound fisheries, percent reductions in overall abundance from the U.S. Puget Sound salmon fisheries on the inland area abundance of Chinook salmon ("Salish" abundance defined by PFMC (2020b)) in 2023-2024 were estimated at 4.9% relative to starting abundance (NMFS 2023c). The pre-season abundance estimate for Chinook ages 3-5 in the Salish Sea (as defined by PFMC (2020b)) for 2023-2024 was approximately 1,053,300 Chinook salmon, which is higher than but similar to the post-season average abundance estimate of approximately 980,254 fish for the retrospective time period of 2009-2018. Note that models used to calculate Chinook salmon abundance and reduction by Puget Sound fisheries in Puget Sound have been updated and values presented in the Effects Section below (Section 2.5.4) cannot be compared to those in (NMFS 2023c). Although some of the prey reduction due to the Puget Sound fisheries occurs in an area known for its 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 prey reduction in this area was expected to be limited due to recreational fishery restrictions in the summer and winter, very limited commercial fishing, and very limited tribal fishing. Also, additional management measures were implemented to reduce impacts of vessel and noise disturbance.

Finally, fisheries other than salmon fisheries may also catch Chinook salmon as bycatch, and this may include Chinook salmon that would otherwise pass through the action area, but this is likely very limited. Specifically, the PFMC groundfish fisheries catch Chinook salmon as bycatch, but this is likely a small number of adult Chinook salmon from the action area. Bycatch primarily occurs off Oregon and is composed mainly of juveniles, not adults, so not of the size or age

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estimates of abundance, the threshold should be recalculated using the same methodology.

preferred by SRKW as prey. While bycatch does include Fraser and Puget Sound Chinook salmon, the numbers are small and not all Chinook bycatch would survive to adult ages even without fishing (see Lynne Barre (2022)). Recreational halibut fisheries in the action area have very limited bycatch mortality of Chinook (4-22 fish annually, see NMFS (2023d)), commercial and tribal halibut fisheries likely do not have incidental catch, and bottomfish and shrimp trawl fisheries have limited authorized incidental take (lethal take of up to 50 Chinook salmon) (see Section 2.4.1 Environmental Baseline for Puget Sound Chinook and Steelhead).

In summary, these analyses suggest that in the short term, prey reductions from ocean and past Puget Sound fisheries within the action area are small relative to remaining prey available in the action area, though the reductions of Salish Sea prey by most fisheries are highest in summer months (July-September) when the whales primarily occur in the action area. The opinions on salmon fisheries referenced above concluded that the harvest actions cause prey reductions that are 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 Fishery Management Plan for the ocean salmon fisheries, addresses the needs of the whales 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.

Hatchery Actions

Hatchery production of salmonids has occurred for over 100 years. There are approximately 104 hatchery programs that release hatchery salmonids into streams and rivers that flow into the Puget Sound and many more that contribute salmon to Washington and Oregon coastal waters that may move into the action area. Roughly 60% of the southern U.S. West Coast hatchery production comes from hatcheries in Washington state, including Chinook, coho, steelhead, sockeye, and chum juveniles, totaling over 150 million combined juveniles released annually (NMFS unpubl. Data). Hatcheries releasing fish into Puget Sound currently release almost 70 million juvenile Chinook and coho each year (and there are also programs releasing sockeye, chum, steelhead, and pink as well) (see (NMFS 2020c)). Many of these fish contribute to both fisheries and the SRKW prey base in the action area.

NMFS has completed Section 7(a)(2) consultations on more than a hundred hatchery programs in numerous biological opinions (Appendix A (NMFS 2021b)). A detailed description of the effects of these hatchery programs can be found in the site-specific opinions referenced in NMFS (2021b)(Appendix A, Table A.1). 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 SRKW range (Barnett-Johnson et al. 2007; NMFS 2008l). Prey availability has been identified as a threat to SRKW recovery, and we expect these hatchery programs to continue benefiting SRKWs by contributing to their prey base. However, any additional Chinook hatchery output will also be subject to fisheries and predation by other species and other factors that influence survival, so it does not all go to feeding SRKW.

As discussed in detail in the Environmental Baseline for Puget Sound Chinook and steelhead

(Section 2.4.1) 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. These additional releases will contribute towards the goal of increasing adult Chinook salmon abundance in coastal areas during the winter, and inland (Salish Sea) areas during the summer (see section on *Assessing Baseline Prey Availability*). NMFS will continue to work with hatchery operators and funders to ensure that all increased hatchery production to support SRKWs 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.

The funding initiative for U.S. domestic actions associated with the 2019-2028 PST Agreement (PSC 2022) included funding for habitat restoration projects to improve habitat conditions for specified populations of Puget Sound Chinook salmon ($31.2 million[37] over 3 years; FY2020-2022). In FY20, FY21, FY22, and FY23, $8.9 million, $8.8 million, $8.8 million and $4.1 million, respectively, was directed at habitat restoration projects within the 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 populations for SRKW. By improving habitat conditions for these populations, we anticipate Puget Sound Chinook abundance would increase and thereby benefit SRKWs in the long term. See specifics on this action in Section 2.4.1 in the Environmental Baseline for Chinook salmon.

A small proportion of Chinook salmon from coastal Washington/Oregon, Columbia River, and other U.S. locations outside of Puget Sound likely move into the action area, and could be available to SRKW as prey. Specifically, stock composition of catch in U.S. Puget Sound includes Chinook salmon from Columbia River and the Washington Coast (Chinook Technical Committee 2023). Because of this, activities that NMFS has consulted on that affect salmon habitat outside of Puget Sound may to a small degree impact prey within Puget Sound. We do not list all these actions here but refer to summaries in (NMFS 2021b).

Assessing Baseline Prey Availability

Based on actions discussed above that we’ve consulted on, we estimate baseline Chinook salmon abundance/availability to SRKW in the action area, without the action being consulted on in this opinion, using the approach described in the PFMC SRKW Ad Hoc Workgroup Report (PFMC 2020b) but with updated models. This helps assess baseline prey availability for SRKW before/without the action being consulted on. Here, we briefly describe the method the Workgroup developed (for more information see (PFMC 2020b)) to estimate the annual starting

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[37] $31.2 million is the sum total of Congressional appropriations for federal 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.

abundance of Chinook available (age 3 and older), for fishery management years 1992-2020[38] within the action area and for the upcoming year 2024-2025. Note that abundance estimates for 1992-2020 have been validated using data on observed terminal run sizes and fishery catches and then retrospectively back-calculated and therefore have less uncertainty than the predicted abundance for 2024-2025, but we include the past years to show the range of abundances likely and this year's projected to show what is predicted for this year.

We make the assumption that the range of Chinook salmon abundance experienced from 1992-2020 is likely representative of the range of abundances we expect to see in any future year, including this year, and that Chinook salmon availability will continue to be variable as observed during this retrospective time period (1992-2020). In fact, the projected 2024-2025 abundance is within the historical range of estimated abundance. The hatchery production component of the funding initiative related to U.S. domestic actions associated with the 2019-2028 PST Agreement is expected to increase the prey base in 3-5 years following initial implementation of increased production, including in 2024, as some proportion of fish released in 2020, 2021, and 2022, returning as adults in 2024. The Puget Sound Chinook Environmental Baseline Section (2.4.1.) provides details on PST SRKW prey program funding levels for FY20, FY21, FY22, and FY23 as well as criteria that guided selection of hatchery and habitat projects to fund. In the event future years of funding are not provided in time for actions to take effect during the agreement, or if the anticipated actions are not otherwise implemented through other means (e.g., non-fishing related restoration activities, other funding sources) this may constitute a modification to how effects on Puget Sound Chinook salmon and SRKW are considered in this and other opinions and reinitiation of consultations that incorporate the PST funding initiative would therefore need to be considered.

We calculated pre-fishing coastwide adult (age 3 and older) abundance estimates for 1992-2020 for most Chinook salmon stocks using the Chinook FRAM (PFMC 2008a) post-season runs (i.e., Round 7.1.1 of base period calibration; 9.8.2021[39]), where again these are validated with data on what occurred. Abundance estimates for FRAM stocks (see Appendix B; Table 1 for a list of the FRAM stocks) 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. For additional details related to calculations of FRAM starting abundances, please refer to PFMC (2020a) or https://framverse.github.io/fram_doc/index.html.

Coastwide pre-fishing ocean abundances were distributed among spatial boxes, including the Salish Sea, (see PFMC for the full descriptions of all the areas). Spatial abundances were based on estimates of the proportion of each stock found in each area each season, using combinations of FRAM and the state-space model from Shelton et al. (2021) https://www.pcouncil.org/november-2022-decision-summary-document/), PFMC (2020b) (and see NMFS (2021c)). Estimated Chinook salmon pre-fishing abundance aggregated in the Salish

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[38] 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 FRAM model runs were available at the time of this biological consultation.
[39] FRAM base period calibration gets updated periodically to incorporate updated information.

Sea for time step 1 (starting abundance) during the retrospective time period (1992-2020) are provided in Table 18 utilizing FRAM version 7.1.1 and Shelton et al. (2021). These starting abundances are prior to natural or fishery mortality estimates, see (PFMC 2020b))[40]. In the Effects Section (2.5.4), to determine the effects of the Puget Sound fisheries, Puget Sound fishery mortalities from the season under evaluation are removed and compared to the validation runs with all fisheries that occurred (see Effects Section, 2.5.4)[41].

While the FRAM-Shelton models provide estimates of Chinook salmon prey abundance for SRKW, we acknowledge that there are uncertainties and limitations to these methods. Limitations and key uncertainties the Workgroup highlighted in their report (PFMC 2020b) in relation to FRAM-Shelton methods include: (1) uncertainty in Chinook salmon stock abundance estimates, (2) uncertainty in Chinook salmon stock distributions, (3) lack of information on Chinook salmon distributions during winter, (4) limited information on distribution for most spring-run Chinook salmon stocks, (5) effects of changes in Chinook salmon size and age structure, (6) uncertainty in the distribution of SRKWs, (6) Chinook salmon stocks whose abundances are not included in the modeling. While we find this model the best for estimating region-specific and season-specific SRKW Chinook salmon prey abundance at this time, we acknowledge that there are also other potential discrepancies that pertain to FRAM-Shelton methodology including: (1) mis-match of seasonal time steps between FRAM and Shelton, (2) lack of consideration of fishery impacts to juvenile Chinook salmon in FRAM.

Table 18. Beginning Chinook salmon abundances (age 3 and older) for the Salish Sea during 1992-2020 at the start of the FRAM modeled year, time step 1 (October-April), from FRAM validation runs (version 7.1.1) and utilizing Shelton et al. (2021). Also provided are average abundance across the full time series 1992-2020, the most recent decade, and the most historical decade.

Year	Salish Pre-fishing Abundance
1992	942,511
1993	962,580
1994	780,136
1995	863,217
1996	885,175
1997	1,039,093
1998	841,894
1999	1,054,270
2000	852,973
2001	1,314,062
2002	1,180,661

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[40] Starting abundances are the most appropriate initial abundance estimate for the purpose of estimating reductions in area-specific abundance attributable to fishery removals (PFMC 2020b).

[41] Given the models were updated in 2022 with information from the more recent Shelton et al. (2021), values reported here cannot be directly compared to previous fisheries consultations, such as those for PFMC ocean salmon fisheries and Amendment 21 (NMFS 2021b), nor the previous analysis for SEAK fisheries (NMFS 2019g). This analysis uses these recent model updates to both FRAM and Shelton models and the same methodology as in the SEAK salmon fisheries consultation for 2023 (NMFS 2019g, 2023).

Year	Salish Pre-fishing Abundance
2003	1,318,493
2004	1,197,040
2005	999,356
2006	1,140,814
2007	876,223
2008	1,059,407
2009	762,396
2010	1,174,961
2011	941,321
2012	877,935
2013	1,059,295
2014	1,059,875
2015	955,923
2016	900,657
2017	1,060,960
2018	1,009,215
2019	1,024,051
2020	810,150
Average - all years	**998,091**
Average 1992-2001	**953,591**
Average 2011-2020	**969,938**
Projected 2024	**1,181,819**

Using the FRAM and Shelton et al. (2021) models, we also conducted an analysis to evaluate how fisheries, other than fisheries in the action area, are likely affecting the baseline prey available to SRKWs in the action area (affecting the amount of fish returning to the Salish Sea), and therefore prey available to SRKW prior to and during the action. This includes fisheries that can capture Chinook salmon in other areas before they return to the Salish Sea, including Southeast Alaska, British Columbia and coastal U.S. fisheries (PFMC). As such, we assessed a “Likely” scenario to evaluate how baseline fisheries (i.e., those not part of the proposed action) would be expected to impact prey availability for SRKWs in the Salish Sea under the 2019 Agreement fishing levels, using the time period of 1999-2020 for Chinook salmon abundances. In other words, we remodeled the 1992-2020 validated runs with new 2019 agreed fishing levels to reflect reductions that would occur under the 2019 agreement. In general, this scenario represents what we can reasonably expect to occur under both the 2019 Agreement and other likely domestic constraints (e.g. Amendment 21 to PFMC Salmon FMP), but without the proposed action of Puget Sound Chinook fisheries, to assess SRKW prey prior to Puget Sound fishing. We provide estimates of percent reductions for 2024-2025 to estimate how all fisheries other than Puget Sound fisheries impact this year’s abundance returning to Salish Sea and compare this year’s expected prey reduction from all other fisheries to what we expect based on historical abundance. 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[42]. Based on this analysis, SEAK and PFMC fisheries each would annually reduce Chinook salmon in the Salish Sea by ~1.5% on average. Also, British Columbia fisheries on average would reduce Chinook in the Salish Sea by ~8.5% annually. The 2024-2025 estimates for these fisheries are similar to these averages. For BC fisheries, in absence of details on further Canadian constraints, fisheries were modeled using catch limits as set by the 2019 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.

Table 19. Average projected percent prey reductions (Chinook salmon ages 3+) in the Salish Sea by baseline salmon fisheries (i.e., those not part of the proposed action) and FRAM time step, expected to occur under the 2019 Agreement and other likely domestic constraints in a retrospective analysis, averaged over 2001-2020. See Shelton et al. (2021) for a description of the spatial regions.

Fisheries and FRAM Time step	Percent Reduction (average 2001-2020)	Projected 2024 percent reduction
SEAK		
Oct-Apr	0.31%	0.33%
May-Jun	0.78%	0.68%
Jul-Sep	1.54%	1.26%
BC		
Oct-Apr	1.46%	0.90%
May-Jun	4.37%	2.87%
Jul-Sep	8.50%	8.38%
PFMC		
Oct-Apr	0.06%	0.01%
May-Jun	1.21%	1.22%
Jul-Sep	1.18%	1.36%

Other studies/models give some indication of prey availability in the action area but are not used here because of certain limitations. Specifically, Sato, Trites and Gauthier (2021) estimated density of prey in specific regions within the Salish Sea. However, these estimates were spatially restricted and don’t cover the range of the action area or SRKW within the action area. The PSC Chinook model is used to estimate abundance indices for SEAK, NBC, and WCVI. However, the structure of Puget Sound fisheries within the PSC Chinook model is much coarser than that of FRAM, and would not allow for some of the specific modeling scenarios to assess the potential effects of the action, specifically the exclusion of select terminal fisheries from the analysis.

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[42] Percent reductions calculated for fall include effects of fisheries from winter and spring. However, this occasionally produces counter-intuitive values (see PFMC in Table 32) where percent reduction in fall is less than that in spring. This likely is occurring here due to distribution assumptions, specifically that Shelton et al. (2021) distribution parameters vary by season/time-step and that and the model assumption that Chinook salmon redistribute themselves across regions if not caught.

Similarly, the stratification of Puget Sound stocks within the PSC Chinook model is also much coarser than in FRAM and would not allow for some of the necessary fine tuning required in modeling to assess the specific management criteria for individual Chinook populations. Lastly, the PSC Chinook model consists only of a single annual time step and lacks the temporal stratification that FRAM includes (winter, spring, and summer time steps).

Finally, other studies give an indication of which stocks make up the prey available to SRKW in the Salish Sea. Specifically, work by Freshwater et al. Freshwater et al. (2021) looked at specific stock composition in regions within the Salish Sea (though focused on the Canada side). This work showed predominately Puget Sound stocks in the Strait of Juan de Fuca and South Strait of Georgia especially in early months of the year. In Summer and Fall, Fraser and Strait of Georgia stocks increased in relative abundance and in later months, WCVI stocks increased in the Strait of Juan de Fuca. Similarly, Shelton et al. (2019) showed that Puget Sound Chinook salmon are the dominant Chinook present throughout the action area, with Fraser River Chinook contributing significantly to the Strait of Juan de Fuca and north Puget Sound areas and non-Salish Chinook contributing to a lesser degree (based on catch, see Appendix E PSC 2019; also see Shelton et al. (2019).

Metabolic Needs

Here we assess what we know about the prey needs of the whales, including metabolic needs, to consider if baseline prey needs are being met. 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; using methodologies described in previous opinions (e.g. NMFS 2019c). 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 (and depending on 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 the daily consumption rate of a population with 82 individuals over the age of 1 that consumes solely Chinook salmon would consume 289,131–347,000 fish/year by assuming the caloric density of Chinook 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. (2017b) also modeled SRKW prey requirements and found that in the Salish Sea and U.S. West Coast coastal waters[43] the population requires approximately 393,109, 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 these estimates provide a general indication of how many Chinook salmon need to

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

be consumed to meet the biological needs of the whales.

Due to the lack of available information on the whales’ foraging efficiency, it is extremely difficult to precisely estimate how much Chinook or what density of salmon needs to be available to the whales in order 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, and the variability illustrated by the studies described above, the whales likely need more fish available throughout their habitat than what is required metabolically to meet their energetic needs.

In previous opinions (e.g. NMFS 2019c), we estimated the food energy of prey available to the whales relative to the estimated metabolic needs of the whales. The resulting forage ratios 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 in our ESA determinations 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 (2019d)) that Chinook forage ratios in inland waters ranged from 17.57 to 29.77 in October-April, 16.39 to 30.87 in May-June, and from 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 abundance derived from the FRAM validation scenario based on post season information that approximates what actually occurred; see NMFS (2019c) for further details). The abundance estimates in Table 18 are the number of adult Chinook salmon available to the whales 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. (2017b) 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 to predator demands), which likely does not reflect true prey availability to predators. Chasco et al. (2017b) 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 (all ages so including juveniles). The estimate of an increase from 5 million to 31.5 million salmon consumed by marine mammals includes an increase from 1.5 to over 3.9 million adult salmon specifically consumed (as opposed to smolts and adults combined) in the Northeast Pacific on average across model runs. 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. (2017b). 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. (2017b) calculated that when species occur in inland waters of the Salish Sea, SRKWs would consume approximately 190,215 adult salmon (age 2 and older), harbor seals would consume approximately 346,327 salmon age 2+, California sea lions and Steller sea lions combined would 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.

Finally, Parker (2023) and Northwest Indian Fisheries Commission (NWIFC) provided an analysis on past kilocalories available to SRKW. Their analysis provided shows in past years 1992-2018, in all seasons (Oct-April, May-June, July-September), kilocalories from Chinook are higher than the caloric needs of SRKW (though note this is hard to put in context without estimates of foraging efficiency). They also show that kilocalories available to SRKW is most limiting in winter (Oct-April) but is still above the caloric needs of SRKW and they note that other prey species are available in this time step (coho, chum).

In summary, though abundance of Chinook salmon available at the beginning of a year (pre-natural and fishing mortality) is substantially greater than the required amount of salmon needed by SRKWs, there is likely competition between SRKWs and other predators, and natural mortality of Chinook salmon may be high, further reducing Chinook availability to SRKWs. The estimate of Chinook abundance available to the whales in the beginning of the year for the retrospective time period (1992-2018) in the action area (maximum estimates of prey available, Table 18) on average was around 1 million Chinook salmon ages 3-5 according to updated FRAM-Shelton methods. However, prey availability to SRKWs in the action area would also be reduced based on dietary needs of other marine mammals as well as other predators (e.g. pelagic fish and sharks, and birds) in the action area. Additionally, the approximately 1 million Chinook available spans a large region and does not represent the salmon in the immediate proximity to highly mobile SRKWs and thus directly available to SRKWs at any given time. At this time we cannot estimate abundance or density for smaller regions across the entire range of SRKWs in the Salish Sea.

2.4.3.1 *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. (2016b) 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 in inland waters (i.e., Krahn et al. 2007; O'Neill and West 2009; Veldhoen et al. 2010; Mongillo et al. 2016b). 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. 2016b). These populations are primarily distributed within the urbanized waters of the Salish Sea (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 southern U.S. West Coast (Mongillo et al. 2016b). A recent publication found higher levels of 4NPs in SRKWs compared to Transient killer whales which could be related to more association with an estuarine food-chain (Lee et al. 2023a). 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). A recent publication reported levels of PCBs and polybrominated diphenyl ethers (PBDEs) in Puget Sound Chinook salmon that were 10- and 4-fold lower than concentrations reported in 2009, respectively (Holbert et al. 2024). The Chinook sampled for this publication were collected along southwest Vancouver Island or northeast Vancouver Island (Holbert et al. 2024), whereas the Chinook sampled in 2009 were collected either in river or within Puget Sound (O'Neill and West 2009). The Chinook from O’Neill and West may have contained a higher proportion of resident Puget Sound Chinook which remain in Puget Sound while rearing (O'Neill and West 2009). But the levels of both PCBs and PBDEs reported in 2024 were still higher relative to other Chinook populations residing outside of Puget Sound, with the exception of Chinook from the Harrison River and the Cowichan River (Holbert et al. 2024). All three of these populations utilize more coastal habitat close to land-based sources of pollution relative to other Chinook (Holbert et al. 2024). Intermediate levels of PCBs were measured in California and Oregon populations, but Chinook originating from California have been measured to have higher concentrations of DDTs (O’Neill et al. 2006; Mongillo et al. 2016b). 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 2.2.1.4). 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.

Marine construction actions have implications for prey and water quality. For example, a recent Section 7 consultation on removal and replacement of two breakwaters near Port Townsend, WA at Point Hudson was determined to likely adversely affect SRKW and SRKW critical habitat (but not likely to jeopardize or adversely destroy or modify), though the project may have positive impacts on prey quality (NMFS 2022a). As part of removal, creosote treated piles would be replaced with steel piles, leading to net positive conservation credits determined by the Puget Sound Nearshore Habitat Conservation Calculator (see above in this section under *Habitat Actions*) and a possible slight improvement in prey quality by reducing polycyclic aromatic hydrocarbons (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. But criteria for monitoring is 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 in 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. 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. 2019a). Smaller fish have a lower total energy value than larger ones (O'Neill, Ylitalo and West 2014). Therefore, SRKWs need to consume more fish in order to meet their caloric needs as a result of a decrease in average size of older Chinook salmon.

A recent study by Lerner and Hunt (2023) looked at variation in energy content of different runs of Fraser Chinook salmon. Specifically, they found that Spring-5_2 and Summer-5_2 Fraser Chinook salmon management units had greater lipid content then Summer-4_1 and Fall-4_1 management units of Fraser, and that lipid content decreased as Chinook salmon migrated. Authors note that the most lipid rich stocks arrive earliest in the Salish sea and are only available to SRKW for a limited window. Also, because less energy rich fish are available in fall, the authors estimate that 30% more fish are needed for SRKW to meet energy requirements in Fall compared to in the spring.

2.4.3.2 *Vessels and Sound*

Vessels used for a variety of purposes (commercial shipping, military, recreation, fishing, whale watching and public transportation) operate in inland waters of the SRKWs' range. 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, Mongillo and Barre (2017)). These studies 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.

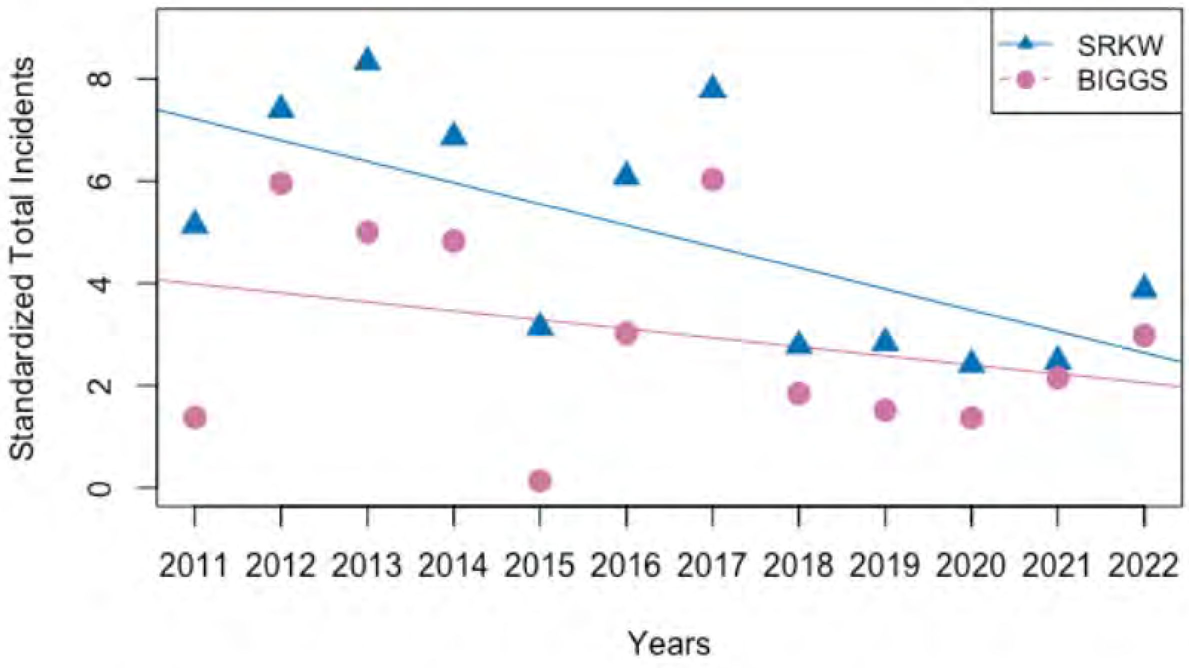
Vessel noise is generated in inland waters by large ships, ferries, tankers and tugs, as well as whale watch vessels and smaller recreational vessels. Commercial sonar systems designed for fish finding, depth sounding, and sub-bottom profiling are widely used on recreational and commercial vessels and are often characterized by high operating frequencies, low power, narrow beam patterns, and short pulse length (NRC 2003). Frequencies fall between 1 and 500 kiloHertz (kHz), which is within the hearing range of some marine mammals including killer whales and may have masking effects (i.e., sound that precludes the ability to detect and transmit biological signals used for communication and foraging). Echosounders used for navigation, commercial and recreational fishing, etc that use an 83 kHz signal as well as those with a 200 kHz signal in deeper water, have emissions that extend outside of 400m (vessel approach distance used in Canada), which can create noise additions of 30 dB above ambient levels (Burnham et al. 2022).

Recently, there have been several studies that have characterized sound from ships and vessels as well as ambient noise levels in the inland waters (Bassett et al. 2012; McKenna, Wiggins and Hildebrand 2013; Houghton et al. 2015; Veirs, Veirs and Wood 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 cargo ships contributed to the majority of the vessel noise budget. Veirs, Veirs and Wood (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 12dB (Hildebrand 2009). Ship noise was identified as a concern because of its potential to interfere with SRKWs communication, foraging, and navigation (Veirs, Veirs and Wood 2016). A recent study 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. 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 received sound levels by the whales (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, Mongillo and Barre 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, average number of vessels within ½ nautical mile was 7 vessels (average monthly between 5 and 6 vessels for SRKW), and the annual 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 recreational 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 percent 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 7kt speed limit within ½ mile of whales followed by within 400 yards in the path of the whales. Data from Soundwatch shows that incidences related to the 7kt speed limit have increased over the last 10 years (for all boat types), but overall incidents have decreased (incidents related to distance rules/guidelines and speed)(Figure 33). 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, Mongillo and Barre 2017).



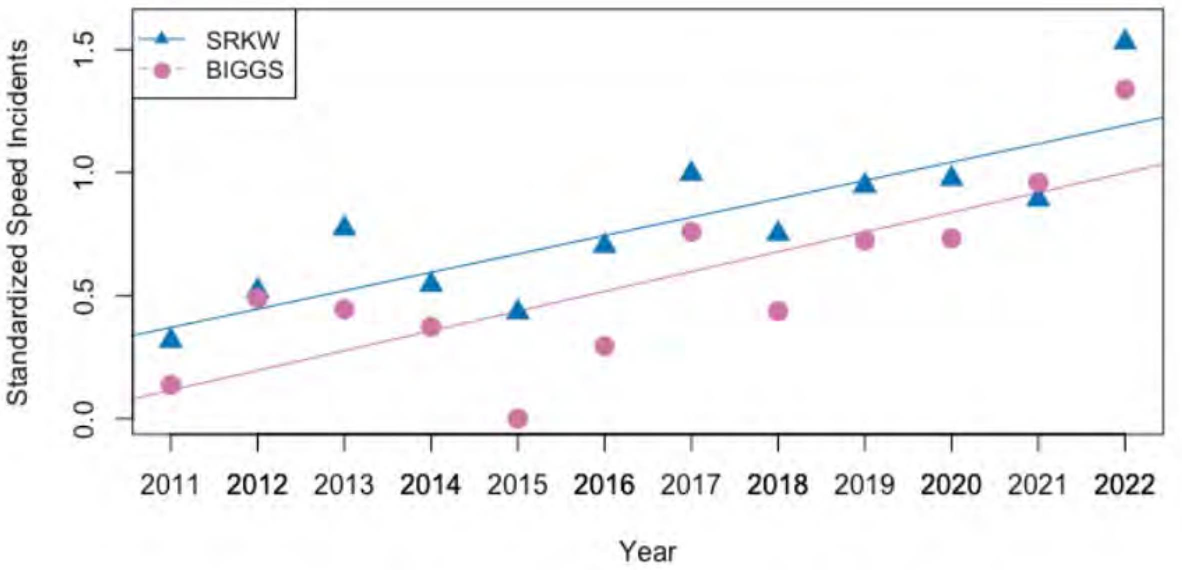


Figure 33. Top is total incidents (inconsistent with Be Whale Wise guidelines and non-compliant with federal regulations, see Frayne (2023)) from 2011-2022 standardized by the amount of time spent with each killer whale ecotype (SRKWs vs Biggs) by Soundwatch. On the bottom is speed incident rates overtime (2011-2022), again standardized by the amount of time spent with each ecotype.

Recent evidence indicates there is a higher energetic cost of surface, active behaviors and vocal effort resulting from vessel disturbance in the Salish Sea (Williams, Lusseauc and Hammond 2006; Noren et al. 2012; Noren et al. 2013; Holt et al. 2015). However, this increased energy expenditure may be less important than the reduced time spent feeding and the resulting potential reduction in prey consumption (Ferrara, Mongillo and Barre 2017) that has also been shown by recent work by Holt et al. (2021a) showing less time in foraging state and fewer prey capture dives with vessels nearby (see status section (Section 2.2.1.4)). Although the impacts of short-term behavioral changes on population dynamics is unknown, it is likely that because SRKWs are exposed to vessels 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, Mongillo and Barre 2017).

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 Army Corps of Engineers (ACOE) was determined to be likely to adversely affect Southern Resident killer whales 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 inland waters 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 1µPa. 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 ACOE under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899 and by the State of Washington under its Hydraulic Project Approval (HPA) program. NMFS conducts 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 2021h) 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.

2.4.3.3 *Entrapment and Entanglement in Fishing Gear*

Drowning and/or injury from accidental entanglement in fishing gear is rare and most reports are from locations outside of the action area. As summarized in Carretta et al. (2023b), the only known case of SRKW mortality due to entanglement in fisheries gear occurred outside the action area (though in Salish Sea). In 1977, an adult male, L8, entangled in gillnet fishing gear near Southeastern Vancouver Island and drowned (Ford et al. 1998; CWR 2015). Upon necropsy, two pounds of recreational fishing lures and lines were found in the stomach but 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. Within the action area, in 2015, J39, a young male southern resident killer whale, was found near False Bay, WA, with a recreational salmon flasher dangling from its mouth (CWR 2015). The whale was seen five days later without the gear attached, appeared energetic, and there was no evidence of injury or behavioral changes over the following weeks (CWR 2015).

Entanglements of marine mammals in fishing gear must be reported in accordance with the MMPA. MMPA Section 118 established the Marine Mammal Authorization Program (MMAP) in 1994. Under MMAP all fishers are required to report any incidental taking (injuries or mortalities) of marine mammals during fishing operations. Any animal that ingests fishing gear or is released with fishing gear entangled, trailing, or perforating any part of the body is considered injured, and must be reported[44]. No entanglements, injuries or mortalities of SRKW have been reported in recent years.

2.4.3.4 *Oil Spills*

As described in the Status of the Species (Section 2.2.1.4), SRKWs are vulnerable to the risks imposed by an oil spill. The inland waters of Washington State and British Columbia remain at risk from serious spills because of the heavy volume of shipping traffic and proximity to petroleum refining centers. The number of spills in Washington has increased since 2013. The total volume of oil spills was less in 2017-2019 than in 2015-2017 but still higher than previous years, and inspections of high-risk vessels have declined since 2009 (Washington Department of Ecology 2019). In 2014, NOAA responded to 16 actual and potential oil spills in Washington and Oregon. Polycyclic aromatic hydrocarbons (PAHs), a component of oil (crude and refined) and motor exhaust, are a group of compounds known to be carcinogenic and mutagenic (Pashin and Bakhitova 1979). Exposure can occur through five known pathways: contact, adhesion, inhalation, dermal contact, direct ingestion, and ingestion through contaminated prey (Jarvela-Rosenberger et al. 2017), all of which could have adverse health effects to killer whales (see discussion in Status 2.2.1.4). 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 of 2022, a 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 near the sheen.

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

2.4.3.5 *Climate Change*

As described in the Status of the Species (Section 2.2.1), 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

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[44] Review of reporting requirements and procedures, 50 CFR 229.6 and http://www.nmfs.noaa.gov/pr/pdfs/interactions/mmap_reporting_form.pdf

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.

2.4.4 Mexico and Central America DPSs of Humpback Whales

As described in the Status of the Species Section, humpback whales face anthropogenic threats from entanglements in fishing gear, vessel interactions, pollution, and acoustic disturbance. As these threats are similar throughout the range of the species, the following section summarizes the primary threats within the action area. Humpback whales in the action area are part of the northern Washington and southern British Columbia feeding group and may belong to the Mexico, Hawaii, or Central America DPSs.

While harvesting of humpback whales no longer occurs within the region, the commercial harvest in the early 1900s effectively removed the population from the Salish Sea and it is only recently beginning to return to historic numbers (Ivashchenko, Zerbini and Clapham 2016). From 2017 to 2022, the Whale Museum, the Orca Network, and the Ocean Wise Sightings Network (OWSN; formerly the B.C. Cetacean Sightings Network) recorded 7,325 opportunistic unique sightings[45] of humpback whales in the greater Salish Sea, of which approximately 3,782 unique sightings were reported in Washington inland waters, with some individual whales reflected across multiple sightings (Unpublished data from the Whale Museum and OWSN)[46]. The largest number of sightings within the U.S. portion of the Salish Sea occurred in the summer and fall months (Figure 34) and research is ongoing to use photo-identification to identify which breeding populations make up the humpback whales seen in inland waters of Washington. Since 2000, 40 humpback whales have stranded in Washington, 14 of which were within the inland waters. The majority of these cases showed signs of vessel interactions or an entanglement (NMFS Stranding Database 2022).

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[45] 'Unique sightings' in this context mean a sighting of a humpback whale in a specific area of the Salish Sea at a specific time. Sightings were grouped by date, latitude and longitude, and the number of whales included in the report. The Whale Museum considers sightings within 15 minutes of each other within the same area to be the same sighting and only records one sighting. The reported sightings here likely include multiple sightings of the same whale on the same day in the same area. As such the number of sightings does not equate to the number of individual whales in the Salish Sea at a given time. These represent rough estimates and the sightings within the action area do not include sightings within Canadian waters.

[46] Data obtained from the Whale Museum and the Ocean Wise Sightings Network were collected opportunistically with limited knowledge of the temporal or spatial distribution of observer effort. As a result, absence of sightings at any location does not confirm absence of cetaceans.

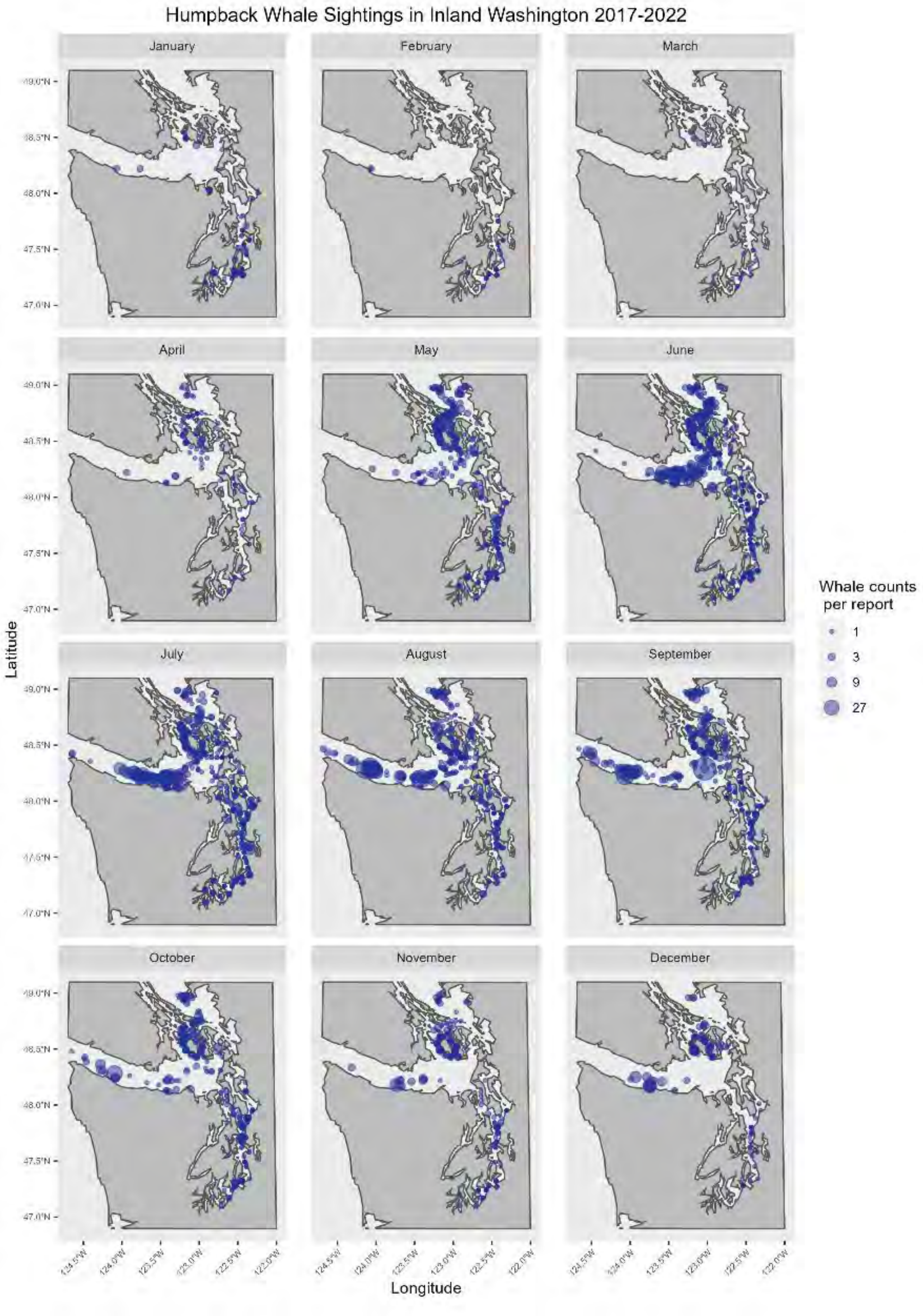

Figure 34. Humpback whale sighting reports from the Whale Museum, OWSN, and Orca Network. Each dot represents a unique sighting report from 2017-2022. The size of the dot is proportional to the number of whales reported in the sighting. Sightings are opportunistic and not corrected for effort. Only reports within the U.S. waters or within a 100-foot buffer of the U.S. waters are reflected here.

Entanglements

There were 250 confirmed humpback whale entanglements in fishing gear on the U.S. West Coast from 2000 to 2022, at least 23 of which were reported in Washington (NOAA Fisheries 2019; 2020; 2021; Saez, Lawson and DeAngelis 2021; NOAA Fisheries 2022; NMFS 2023a). When the origins of entanglements can be identified, which is the case for approximately 50 percent of entanglements, they have largely been from pot/trap fisheries (Saez, Lawson and DeAngelis 2021; Carretta et al. 2022a). These gears are not used as fishing gear in Puget Sound salmon fisheries. NOAA has released entanglement reports for large whales along the West Coast since 2016 (Table 20). From 2016 to 2022, 16 humpback whales were reported as confirmed entanglements in Washington, 10 of which were reported in the inland waters. Additionally, 12 humpback whales were confirmed as entangled in fishing gear that was originally set in Washington. The reporting location of an entanglement is not always the same as the entanglement origin so it is possible that more humpback whales have been entangled in gear from Washington State, including from the inland waters. However, Saez, Lawson and DeAngelis (2021) found that, when the gear type is known, approximately 79 percent of the gear involved in entanglements were set in the same regional area that the report was made.

Table 20. Humpback Whale Entanglements on the West Coast for 2016-2023.

Year	Total Humpback Entanglements	Number of Confirmed Reports in WA	Number of WA Inland Waters Confirmed Reports	Confirmed Humpback Entanglements in Gear Set in WA**
2016	48	1	1	0
2017	17	2	1	2
2018	34	7	3	5
2019	17	3	3	1
2020*	10	1	1	0
2021	17	2	1	2
2022	18	0	0	2
2023	16	1	0	1
Total	154	16	10	12

*The number of reports in 2020 may have been reduced due to the COVID-19 pandemic and reduced entanglement response network capabilities.

** No entanglements of humpback whales have been confirmed as entangled in inland Washington pot/trap gear. However, one entanglement in 2021 may have involved inland Dungeness crab gear.

Natural and Anthropogenic Noise

Humpback whales in the action area are exposed to several sources of natural and anthropogenic noise. Natural sources of underwater noise include wind, waves, precipitation, and biological noise from marine mammals, fishes, and crustaceans. Anthropogenic sources of noise in the action area include: vessels (e.g. shipping, transportation, research); construction activities (e.g.

drilling, dredging, pile-driving); sonars; and aircraft. The combination of anthropogenic and natural noises contributes to the total noise at any one place and time.

Vessel sounds in inland waters are from large ships, passenger and car ferries, tankers and tugs, as well as from fishing vessels, whale watch vessels, and smaller recreational vessels. There have been several studies that have characterized sound from ships and vessels as well as ambient noise levels in the action area (Bassett et al. 2012; McKenna, Wiggins and Hildebrand 2013; Houghton et al. 2015; Veirs, Veirs and Wood 2016). Bassett et al. (2012) assessed ambient noise levels in northern Admiralty Inlet (a waterway dominated by larger vessels). They found that vessel activity contributed most to the variability measured in the ambient noise and cargo ships contributed to the majority of the vessel noise budget. Veirs, Veirs and Wood (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. Although there are several vessel characteristics that influence noise levels, vessel speed appears to be the most important predictor in source levels (McKenna, Wiggins and Hildebrand 2013; Houghton et al. 2015; Veirs, Veirs and Wood 2016; Holt et al. 2017).

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). Because responses to anthropogenic noise vary among species and individuals within species, it is difficult to determine long-term effects. Habitat abandonment due to anthropogenic noise exposure has been found in terrestrial species (Francis and Barber 2013). Clark et al. (2009) identified increasing levels of anthropogenic noise as a habitat concern for whales because of its potential effect on their ability to communicate (i.e. masking). Some research (Parks 2003; McDonald, Hildebrand and Wiggins 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.

Based on studies of humpback whale vocalizations, these whales are estimated to have a hearing sensitivity from tens of Hz to approximately 10kHz, but possibly extend up to 24kHz (Au et al. 2006; Southall et al. 2007; Fisheries and Oceans Canada 2013). Studies have shown that humpback whales continue to produce songs during their migrations and occasionally within their feeding grounds (Vu et al. 2012). A study in the waters around Ogasawara Island found that humpback whales temporarily stopped singing instead of modifying the frequency of their songs in the presence of large, noisy vessels (Tsujii et al. 2018). A study in British Columbia (adjacent to the action area) found that median noise levels decreased the communication space for humpback whales by 52 percent and by 94 percent under noisy conditions (Williams et al. 2014). These studies indicate that vessel noise within the action area may impact humpback whale communication, which could include coordination during feeding.

In-water construction activities are permitted by the ACOE under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899 and by the State of Washington under its HPA program. NMFS has conducted numerous ESA Section 7 consultations related to construction activities and helps project applicants incorporate conservation measures to minimize or eliminate effects of in-water activities, such as pile driving, to marine mammals in Puget Sound. In 2023 through February, 2024, NMFS consulted on pier and marina repairs and maintenance, shoreline repairs, outfalls, bridge and trestle repairs, and netpen installations and maintenance that were found to not likely adversely affect ESA-listed humpback whales due to short construction length, marine mammal monitoring protocols for in-water work, and the low likelihood of humpback whales to be present during the construction period[47]. Although most recent actions have been found to not likely adversely affect humpback whales, some of the consultations have exempted the take (by harassment) of humpback whales from noise emitted during construction activities.

Vessel Interactions

Vessels used for a variety of purposes (commercial shipping, military, recreation, fishing, whale watching and public transportation) occur in the action area and also contribute to anthropogenic sound as well as behavioral disturbance and risk of ship strikes. While there are no federal regulations regarding vessel distances from humpback whales in Washington waters, there are Be Whale Wise guidelines that recommend a 100-yard approach limit along with decreasing vessel speeds to 7 knots and limiting viewing time to 30 minutes[48]. These guidelines are voluntary and cover coastal and inland waters of Washington. Commercial whale watching activities focused on humpbacks are likely increasing with more whale sightings, however, the Pacific Whale Watch Association also has guidelines to minimize impacts from their commercial whale watching activities. Soundwatch reported an average of 2.21 vessel incidents (vessels not following the Be Whale Wise guidelines) per scan for humpback whales in 2020 (Frayne 2021). Straitwatch (2021) found the same incident rate for humpback whales although the COVID-19 pandemic may have influenced the number of incidents documented. Straitwatch South incident reports were centered near Victoria, Race Rocks, and Swiftsure Bank. They found that humpback whale viewing times averaged 34 minutes in 2020. Fraser et al. (2020) found that commercial whale watch vessels in the Salish Sea are more likely to observe voluntary guidelines than recreational boaters with non-compliance rates of 14.4% vs 20% respectively when viewing humpback whales. However, commercial whale watch vessels committed more non-compliant interactions than other vessel types.

Ship strikes and other interactions with vessels occur regularly with humpback whales along the West Coast, with a small number in inland waters. Between 1995 and 2023, there were 39 reported ship strikes on humpback whales along the West Coast, 11 of which were within Washington waters including six strikes in the inland waters (NMFS Stranding Database 2023). Of the 11 whales struck in Washington, all were assumed to have a serious injury or mortality as

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[47] NMFS consultation numbers: WCRO-2023-00770; WCRO-2021-01875; WCRO-2022-00666; WCRO-2021-00669; WCRO-2021-01003; WCRO-2021-01434All consultations may be retrieved from the NOAA repository at: https://repository.library.noaa.gov/.

[48] https://www.fisheries.noaa.gov/topic/marine-life-viewing-guidelines#guidelines-&-distances

a result of the interaction[49]. Because ship strikes are rarely witnessed or reported, these cases are often identified based on examination of carcass with injuries consistent with a ship strike. Multiple studies have found that the Washington outer coast and the eastern end of the Strait of Juan de Fuca represent areas of high risk of vessel strike for humpback whales (Nichol et al. 2017; Rockwood, Calambokidis and Jahncke 2017; Miller 2020). Large vessels within this area are on average traveling at speeds that are likely to result in a fatal strike if a collision were to occur (Miller 2020). Additionally, there is considerable overlap between public sightings of humpback whales and the shipping lanes in the Salish Sea (Miller 2020). There have been five humpback whales found or reported to be involved in a vessel strike within Clallam County, three of which were within the inland waters (NMFS Stranding Database 2022). A humpback whale carcass was found near Neah Bay in 2018 and a necropsy confirmed that the whale was struck by a vessel (NMFS Stranding Database 2021). Two humpback whales were struck by a State ferry within King county in recent years. There is also overlap with humpback whale public sightings and ferry routes within the inland waters (Miller 2020), with a number of sighting reports from individuals on ferries themselves. A humpback whale was spotted with injuries as a result of a strike with a small vessel in South Puget Sound in 2006 (NMFS Stranding Database 2022). No vessel strikes of humpback whales have been confirmed to a Washington commercial fishing vessel, however, given the limited amount of information collected from a whale carcass, we cannot rule out that such interactions have occurred.

Prey

Humpback whales eat krill and forage fish, including anchovy, sardines, herring, and sand lance, within the inland waters of the Salish Sea, similar to their coastal diet. A recent study found that Pacific herring and euphausiids were important prey species for humpback whales in the Strait of Juan de Fuca and the Strait of Georgia, although shrimp may also be important based on its level of detection in fecal samples (Reidy et al. 2022). Fecal samples from the Strait of Juan de Fuca (n = 9) did also include shrimp, salmon (both Chinook and coho), Pacific hake, and eulachon DNA. Chinook and coho salmon were detected in 44 percent (n = 4) and 33 percent (n=3) of the Strait of Juan de Fuca fecal samples. There is also evidence that humpback whales are feeding on juvenile Pollock in the Strait of Juan de Fuca (Reidy et al. 2021; Reidy et al. 2023). Pacific herring stocks in the southern Salish Sea, with the exception of the Hood Canal region, have been in decline for the last decade (Siple et al. 2018; Sandell et al. 2019). No assessment of Northern anchovy or Pacific sand lance abundance in the Salish Sea has been conducted (Penttila 2007), although some studies show an increase in sand lance catch and abundance (Greene et al. 2015).

Fisheries may indirectly affect humpback whales by reducing the amount of available prey or affecting prey species composition. In Puget Sound, fisheries target multiple species including halibut and several salmon populations including Chinook, steelhead, sockeye, and pink salmon, which are not believed to be the primary prey species for humpback whales given they occur in lower densities than forage fish do, and as such, do not compensate for the energetic demand of

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[49] Some of the recent vessel strike reports have not been officially reviewed and assigned a serious injury/mortality level. As such, the percent of strikes resulting in mortality will increase once these reports with initial assignments of mortality have been formally reviewed.

lung feeding (Goldbogen et al. 2008; Chenoweth et al. 2017). There is a herring fishery in Puget Sound, with some areas open year-round, some areas closed January 16 through April 15, and certain areas closed year-round[50]. Because the herring fishery in Puget Sound is small and humpback whales have a diverse prey base, it does not pose a concern for humpback whales in the region. The Pacific Fishery Management Council manages fisheries that target coastal pelagic species on the U.S. West Coast such as mackerel and sardine. The Pacific sardine fishery in Washington state has been closed since 2015 due to low sardine abundance (Wargo and Hinton 2016; Hill, Crone and Zwolinski 2019). When open, these fisheries have the potential to reduce some of the prey available for humpback whales.

Pollutants

Persistent organic pollutants can be highly lipophilic (i.e., fat soluble) and are primarily stored in the fatty tissues in marine mammals (O'Shea 1999; Aguilar, Borrell and Reijnders 2002). Phytoplankton, zooplankton, benthic invertebrates, demersal fish, forage fish, and other fishes can be exposed to and ingest these pollutants. As these exposed organisms are consumed, the contaminants can biomagnify up the food chain and can accumulate in upper-trophic level species. When marine mammals consume contaminated prey they store the contaminants primarily in their blubber. Persistent pollutants can resist metabolic degradation and can remain stored in the blubber or fatty tissues of an individual for extended periods of time. When prey is scarce and when other stressors reduce foraging efficiency, or during times of fasting, a marine mammal metabolizes their blubber lipid stores, causing the pollutants to either become mobilized to other organs or remain in the blubber and become more concentrated (Krahn et al. 2002). Adult females can also transmit large quantities of persistent pollutants to their offspring, particularly during lactation in marine mammals. The mobilized pollutants can then circulate within individuals and may cause adverse health effects. Due to their migratory behaviors and limited research, it is not clear at this time the degree to which pollution in the Salish Sea impacts humpback whales from the two listed DPSs. Sand lance and herring in Puget Sound have been found to have toxic contaminants, including PAHs, alkyphenols, chlorinated paraffins and legacy compounds such as chlorinated pesticides, PCBs, and PBDE’s (Conn et al. 2020) which may be passed on to humpback whales that consume these species.

NMFS has analyzed potential contaminant risk to listed humpback whale DPSs in ESA Section 7 consultations within the action area of this proposed action in recent years, such as in WCRO-2021-02648 and WCRO-2021-01232. Both analyses determined that the projects may affect but were not likely to adversely affect humpback whales due to their infrequent presence in or adjacent to the project areas and the low concentrations of contaminants whales would possibly exposed to while within these areas.

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[50] WDFW. (2020). Commercial Puget Sound herring fishery. Retrieved from: https://wdfw.wa.gov/fishing/commercial/puget-sound-herring.

2.4.5 Scientific Research

The listed salmon, steelhead, rockfish, SRKW, and humpback whales in this opinion are the subject of scientific research and monitoring activities. Most opinions issued by NMFS have conditions requiring specific monitoring, evaluation, and research projects to gather information to aid the preservation and recovery of listed species. Additionally, there are stand-alone research and monitoring activities. The impacts of these research activities pose both benefits and risks. In the short term, take may occur in the course of scientific research. However, these activities have a great potential to benefit ESA-listed species in the long-term. Most importantly, the information gained during research and monitoring activities will assist in planning for the recovery of listed species. Research on all listed fish species in the action area is currently provided coverage under Section 7 of the ESA or the 4(d) research Limit 7, or included in the estimates of fishery mortality discussed in the Effects of the Proposed Action in this opinion.

For the year 2012 and beyond, NMFS has issued several Section 10(a)(1)(A) scientific research permits allowing lethal and non-lethal take of listed species (Table 21). In a separate process, NMFS also has completed the review of state and tribal scientific salmon and research programs under ESA Section 4(d) Limit 7. Table 21 displays the total take for the ongoing research authorized under ESA Sections 4(d) and 10(a)(1)(A) for the listed Puget Sound Chinook salmon ESU, the Puget Sound steelhead DPS, the Puget Sound/Georgia Basin bocaccio DPS, and the Puget Sound/Georgia Basin yelloweye rockfish DPS.

Table 21. Total requested take of the ESA-listed species for scientific research and monitoring already approved for 2024 (Clapp 2024).

Species	Life Stage	Production/Origin	Total Take	Lethal Take
Puget Sound Chinook salmon	Adult	Natural	1,457	51
		Listed hatchery intact adipose	753	23
		Listed hatchery clipped adipose	1,959	129
	Juvenile	Natural	730,180	12,847
		Listed hatchery intact adipose	224,717	5,118
		Listed hatchery clipped adipose	178,656	8,252
Puget Sound steelhead	Adult	Natural	5,066	91
		Listed hatchery intact adipose	427	12
		Listed hatchery clipped adipose	31	6
	Juvenile	Natural	102,460	1,929
		Listed hatchery intact	2,973	46

Species	Life Stage	Production/Origin	Total Take	Lethal Take
		adipose		
		Listed hatchery clipped adipose	10,949	183
PS/GB Bocaccio	Adult	Natural	22	13
	Juvenile	Natural	50	26
PS/GB Yelloweye Rockfish	Adult	Natural	28	18
	Juvenile	Natural	51	31

Actual take levels associated with these activities are almost certain to be substantially lower than the permitted levels for three reasons. First, most researchers do not handle the full number of individual fish they are allowed. NMFS research tracking system reveals that researchers, on average, end up taking about 37% of the number of fish they estimate needing. Second, the estimates of mortality for each proposed study are purposefully inflated (the amount depends upon the species) to account for potential accidental deaths. Therefore, it is very likely that fewer fish (in some cases many fewer), especially juveniles, than allotted would be killed during any given research project. Finally, researchers within the same watershed are encouraged to collaborate on studies (i.e., share fish samples and biological data among permit holders) so that overall impacts to listed species are reduced.

Most of the scientific research conducted on Southern Resident killer whales occurs in inland waters of Washington State and British Columbia. In general, the primary objective of this research is population monitoring or data gathering for behavioral and ecological studies. Research activities are typically conducted between May and October in inland waters and can include aerial surveys, vessel surveys, close approaches, suction cup tagging, and documentation, and biological sampling. Most of the authorized take occurs in inland waters, with a small portion in the coastal range of SRKW. 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 takes steps to limit repeated harassment and avoid unnecessary duplication of effort through conditions included in the permits requiring coordination among permit holders.

Humpback whales are exposed to research activities documenting their distribution and movements throughout their ranges. There are several active research permits that include humpback whales in Washington waters. In general, the primary objective of this research is population monitoring and assessment and gathering data for behavioral and ecological studies. Some 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. No lethal take of humpback whales is authorized under any of the existing research permits and is not anticipated.

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 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 402.17).

As discussed in the Proposed Action Section, we consider the effects of the federal actions covered in this opinion, particularly the fisheries covered by the co-managers' plan for joint management[51] of the 2024-2025 Puget Sound salmon fisheries, including the research consistent with the provisions of that plan described in 2.5.2.3. Puget Sound treaty Indian salmon fisheries and related enforcement, research, and monitoring projects associated with the fisheries, would occur as a consequence of the proposed federal actions and are reasonably certain to occur. Non-tribal salmon fisheries and related enforcement, research, and monitoring projects associated with fisheries would also occur as a consequence of the proposed actions and are reasonably certain to occur. Collectively the proposed federal actions allow the fisheries to operate in a manner that is consistent with the various plans, court orders, and applicable law. Without these actions the proposed 2024-2025 Puget Sound annual salmon fisheries would not likely occur in the manner proposed (Mercier 2024). Additionally, we consider the effects of NMFS' action of regulating U.S. Fraser Panel fisheries in 2024.

2.5.1 Puget Sound Chinook Salmon

2.5.1.1 *Assessment Approach*

NMFS must assess whether the actions will appreciably reduce the survival and recovery of the Puget Sound Chinook ESU. In assessing the effects of the proposed harvest actions on the Puget Sound Chinook salmon ESU, NMFS first analyzes the effects on individual salmon populations within the ESU using quantitative analyses where possible (i.e., where a sufficiently reliable time series of data is available) and more qualitative considerations where necessary. Risk to the survival and recovery of the ESU is then determined by assessing the distribution of risk across the populations within each major geographic region and then accounting for the relative role of each population in the recovery of the ESU. These steps, and considerations relevant to them, are discussed in more detail below.

We use a number of terms repeatedly throughout this analysis of Puget Sound Chinook salmon. While many of these are defined in previous sections, for the convenience of the reader we include these definitions below:

- *Natural-origin*, meaning any fish that spends its entire life-cycle in the natural environment;
- *Hatchery-origin*, meaning a fish that spends at least the early portion of its life

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[51] As provided under the Puget Sound Salmon Management Plan, implementation plan for *U.S.* v *Washington* (see 384 F. Supp. 312 (W.D. Wash. 1974)).

(fertilization, incubation, hatching, early juvenile rearing) in the artificial environment of a salmon hatchery or other man-made environment;

- *Spawner*, referring to a mature fish that participates in reproductive activity in the natural environment, typically in gravel reaches of rivers;
- *Total Spawners*, refers to the summation of both natural- and hatchery-origin spawning fish. On the spawning grounds referred to as *natural spawners* or *natural escapement*;
- *Escapement*, the portion of the mature run of a salmon population that is not harvested in fisheries and returns to the freshwater system to spawn;

The Puget Sound co-managers propose to manage the Puget Sound Chinook fishery based on management units. These units are typically made up of individual river system populations and may also be identified by groups of populations with similar life-histories in the same watershed. Some management units contain one population and others, multiple populations, e.g., the Skagit Summer/Fall Management Unit comprises the Lower Skagit, Lower Sauk and Upper Skagit Chinook populations (Table 22). The co-managers propose to manage each of these units based on either exploitation rate limits at the total, Southern U.S. (SUS), or pre-terminal SUS level, or, escapement abundance (Lake WA, Green-Duwamish, and Puyallup MUs) [52]. This opinion analyzes the effect on each of the populations within each management unit, as described below, and then considers those effects at the region and ESU level.

In making a jeopardy determination in an opinion, NMFS must determine if a proposed action would reduce appreciably the survival and recovery of the species in the wild. The Puget Sound Chinook ESU, includes fish that are produced from parents that spawned in the river (natural-origin fish) and those that are produced from hatcheries that are part of the listed species–the contribution of which varies depending on the management unit (hatchery-origin fish) (see Section 2.4.1, *Chinook Hatchery Production*). However, the focus of recovery for this ESU is to restore enough of the natural-origin components of the populations for the ESU to be self-sustaining. Therefore, in its consultations, NMFS assesses the effects of the action on the individual populations within the ESU, focusing its assessment on the natural-origin components of the populations and taking into account other factors relevant to the natural-origin components of the populations, as described below, in order to evaluate the effect of the proposed action to survival and recovery of the ESU.

The first step in NMFS' analysis, as discussed above, is to assess the effects of the proposed actions on the individual populations in the ESU. To do this, we first determine if the exploitation rate that will result from the proposed action exceeds or meets population-specific rebuilding exploitation rates (RERs), or identified surrogate RERs. The Viable Risk Assessment Procedure (VRAP), detailed in Appendix A, provides estimates of the RERs. These rates are associated with a high probability of attaining escapement levels of natural-origin adults which will maximize the yield from natural production for each population (the rebuilding escapement threshold) and a low probability of escapements falling below levels at which the population may

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[52] Pre-terminal fisheries occur outside the river and areas immediately adjacent to the river systems. Pre-terminal SUS fisheries are pre-terminal fisheries that occur within southern U.S. waters.

become unstable (the critical escapement threshold), due to effects of fisheries. The RERs are an important initial reference for NMFS in determining the likely implications of a proposed fishery on the resilience of that individual population, under current average environmental conditions. When the exploitation rate from a proposed fishery is likely to be at or below the RER, we have reasonable confidence that the likely effects of the fisheries pose a low risk to that population. Where the proposed action would result in an exploitation rate that would exceed the RER for a population, NMFS considers other relevant information in assessing the effects of the action(s) on the population.

NMFS has established RERs for 12 individual populations within the ESU and for the Nooksack Management Unit. NMFS has identified surrogates for population-specific RERs for those populations where data are currently insufficient or where NMFS has not completed population-specific analyses to establish population specific RERs. These "surrogate RERs" are determined based on populations with RERs that are generally similar in population size, life history, productivity, watershed size, and hatchery contribution. NMFS also considers the results of independent analyses conducted using other methods (e.g., analysis of maximum sustained yield (MSY) for the White River Chinook population provided by the co-managers) in determining the appropriate surrogate RER for a specific population. NMFS developed the RERs using coded-wire tag-based models. Because NMFS and the co-managers use FRAM[53] to assess proposed fishery actions in the action area such as those that are the subject of this Opinion, it is necessary for the analysis to convert the cwt-based RERs to FRAM-based equivalents (NMFS and NWFSC 2021c; 2021b; 2021a)(Table 22).

RERs are derived based on specific probabilities of escapement not falling below the critical and exceeding the rebuilding escapement thresholds over a 25-year period. NMFS has developed two escapement thresholds: a critical escapement threshold and a rebuilding escapement threshold. After taking into account uncertainty, the critical escapement threshold is defined as a point below which: (1) depensatory processes are likely to reduce the population below replacement; (2) the population is at risk from inbreeding depression or fixation of deleterious mutations; or (3) productivity variation due to demographic stochasticity becomes a substantial source of risk (NMFS 2000b). The rebuilding escapement threshold is defined as the escapement that represents MSY under our best assessment of average current environmental and habitat conditions (NMFS 2000b)(Appendix A). These thresholds were developed based on population-specific data where available. For most populations, the rebuilding escapement thresholds are well below the escapement levels associated with recovery, however, under current conditions particularly for freshwater habitat, achieving sustained escapement levels necessary for recovery is not possible. As discussed in the Puget Sound Salmon Recovery Plan and TRT document (Ruckelshaus et al. 2002a; Ruckelshaus et al. 2006) recovery goals include paired targets of

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[53] Exploitation rates used to inform the RERs were derived from single-stock cohort reconstructions based on empirical CWT recovery information, whereas FRAM-based exploitation rates are derived using a set of static base-period parameters to apportion total fishery catch into stock-specific impacts. In some cases, estimates of exploitation rates produced from these two different approaches do not align, resulting in a need to convert RER values into "FRAM-equivalents" by comparing FRAM-based postseason exploitation rates with CWT-derived exploitation rates over a common set of years.

abundance and productivity. In most cases, the available habitat is not currently productive enough to sustain the target level of abundance. However, achieving these rebuilding escapement levels under current conditions is a necessary step to eventual recovery when habitat and other conditions are more favorable. Therefore, in determining the rebuilding escapement thresholds, NMFS has evaluated the future performance of populations in the ESU under recent productivity conditions; i.e., assuming that the impact of hatchery and habitat management actions remain as they are now. An important consideration in our assessment of the effects of the action on individual populations, in addition to the RERs, is the level of escapement to the spawning grounds resulting from the proposed fisheries.

The purpose of the RERs is to avoid low abundances that might impact survival of the population and to achieve escapements that fill the capacity of the current habitat when compared to the effects on the population in the absence of fishing. As discussed above, the VRAP model identifies the RER that meets specific probabilities for exceeding the population's rebuilding escapement threshold and not falling below the population's critical escapement threshold (Table 22), when compared with the same productivity and survival conditions under a no harvest scenario over a specified time frame. However, progress towards reaching these escapement goals may occur even though RERs are being exceeded. In deriving the RERs and escapement thresholds, NMFS accounts for and makes conservative assumptions regarding management error, environmental uncertainty, and parameter variability. The RERs are updated periodically to incorporate the most recent information, and assumptions are made conservatively (e.g., assuming low marine survival) to protect against overly optimistic future projections of population performance. However, the observed data may indicate that the population status or environmental conditions are actually better than the conservative assumptions anticipated in the RER derivation (described in Appendix A). For example, the observed information may indicate that marine survival is better than assumed or that a population's escapement has achieved its rebuilding threshold under exploitation rates higher than the RER. Therefore, when assessing the effects of a proposed fishery action, it is important to consider the anticipated exploitation rates and escapements relative to the RERs and abundance thresholds, and the observed information on population status, environmental conditions, and exploitation rate patterns. A population will be initially identified in this opinion as having an increased level of risk[54] when the expected escapement of that population does not meet its critical threshold or the expected exploitation rate exceeds its RER. We then examine the effects of the proposed actions on the status of the population and the degree to which the effects of the fishery action contribute to that status in the context of other relevant factors.[55]

Comparison of the RERs and escapement thresholds to the results of the proposed action establishes an initial map of risk across the populations in the Puget Sound Chinook salmon ESU. However, as discussed above, these are not the only considerations in our evaluation of risk to the individual population or in our overall jeopardy assessment to the ESU, under the

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[54] When compared to a population otherwise at or above its critical threshold.

[55] NMFS has used RERs as part of its assessment of proposed harvest actions on the Puget Sound Chinook ESU in biological opinions and application of take limits under the ESA 4(d) Rule since 1999 (NMFS 1999; 2005a; 2008g; 2010a; 2014d; 2015d; 2016f; 2017c; 2018d; 2019d; 2020b; 2021f; 2022c; 2023c).

ESA. Our analysis considers many other variables, both at the population, the Region, and ESU levels. As detailed in the sections below, the RER analysis together with these additional elements can provide meaningful context for the potential effects of the proposed action to the specific populations. Collectively, when considered across the Regions in the ESU, it informs NMFS' determination as to whether the proposed action would jeopardize the ESU, as a whole.

Table 22. Rebuilding Exploitation Rates by Puget Sound Chinook population. Surrogate FRAM-based RERs are italicized.

Region	Management Unit	Population	Rebuilding Exploitation Rate	FRAM-based Rebuilding Exploitation Rate[1]
Strait of Georgia	Nooksack Early	N.F. Nooksack S.F. Nooksack	5%	5%
Whidbey/Main Basin	Skagit Spring	Upper Sauk River Suiattle River Upper Cascade	38% 55% 53%	24% 32% 35%
	Skagit Summer/Fall	Upper Skagit River Lower Skagit River Lower Sauk River	50% 35% 52%	46% 35% 50%
	Stillaguamish	N.F. Stillaguamish River S.F. Stillaguamish River	38% 28%	31% 17%
	Snohomish	Skykomish River Snoqualmie	37% 44%	23% 25%
South Sound	Lake Washington	Sammamish[a] Cedar[a]	19%	*5%* *24%*
	Green-Duwamish	Duwamish-Green		17%
	White	White[b]		*24%*
	Puyallup	Puyallup[c]		*17-35%*
	Nisqually	Nisqually[d]		*35%*
Hood Canal	Mid-Hood Canal	Mid-Hood Canal[e]		*5%*
	Skokomish	Skokomish	35%	35%
Strait of Juan de Fuca	Dungeness Elwha	Dungeness Elwha[e]		*5%* *5%*

[1] FRAM-based RERs for Stillaguamish, Snohomish, and Skagit Summer/Fall MUs were updated in 2021 for use with latest FRAM base period update (FRAM version 7.1) (NMFS and NWFSC 2021c; 2021b; 2021a)

[a] Uses Upper Sauk River RER as a surrogate for the Cedar (24%) and the Nooksack RER as a surrogate for the Sammamish (5%) given similarity of current abundance and escapement trends, and watershed size.

[b] Uses Upper Sauk River (24%) as surrogate.

[c] Uses range including Skokomish (35%) and Green Rivers fall Chinook as surrogates

[d] Uses Skokomish River (35%) as surrogate.

[e] Uses Nooksack early Chinook (5%) as surrogate.

In addition to the RERs and the escapement thresholds described above, in evaluating the effects of the action on the individual populations and on the ESU as a whole NMFS also considers: its guidance on the number, distribution, and life-history representation of populations within the regions and across the ESU necessary for recovery (NMFS 2006b); the role of associated hatchery programs; observed population status, and trends; and the effect that further constraints on the proposed actions would have on the population. NMFS evaluates all of this information to assess the likely effects of the proposed action on the individual population's viability and then to roll up these assessments to the regional and ESU levels to assess the overall effects on the survival and recovery of the ESU. Some of these factors are discussed in more detail below.

An important consideration for some populations is whether the genetic legacy of the population is intact or if it is no longer distinct within the ESU. 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 adaption to their specific habitats. For populations that 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 the existing populations. However, if the genetic legacy is gone, then the appropriate course is to restore the viability of 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 the fish to adapt to the existing conditions.

Another factor NMFS considers in its analysis is whether the estimated exploitation rates resulting from the fisheries have stayed within the management objectives that are part of the proposed action. That is, the fisheries are managed to stay below their exploitation rate-based management objectives but in some years, fisheries may exceed those rates if the assumptions on which the fisheries were planned preseason changes (e.g., abundance is lower than forecasted). In most cases, for most management units, actual exploitation rates are routinely at or below the specified objectives (Table 23). As explained in Appendix A, incorporation of uncertainty is reflected in the variability in exploitation rates observed in the simulations used to develop the management objectives as well as the RERs. That is, the derivation of RERs assumes that observed exploitation rates will vary over time (above and below the RER), even if fisheries are managed as closely as possible to meet the management objective. The uncertainty includes various sources of variability (management error, environmental variability, forecasting error, variability in parameters in the VRAP model). Therefore, it is reasonable to expect that management objectives will be exceeded on occasion. However, consistent overages may reflect bias in management assumptions. The most recent estimates of observed exploitation rates, relative to their pre-season planned objectives, is available through 2020 based on work completed in 2023 (Table 23).

The co-managers routinely assess the performance of fishery management regimes and the technical tools and information that are used (e.g., abundance forecasts, management models, input parameters). Assessments typically review past performance, by comparing preseason and post season estimates of exploitation rate, identify factors that contributed to any observed overages, and identify remedial actions, when necessary, designed to address any identified problems and to be implemented in future planning years. An in depth assessment was conducted in 2015 for four populations (Skagit summer/falls, Puyallup, Nisqually and Skokomish)(Grayum and Unsworth 2015a). Subsequently the co-managers assessed the efficacy of the actions taken to address problems identified through the 2015 assessments (Adicks 2016). The update of the FRAM model base period in late 2016, provided another opportunity for a high-level overview of management performance. This 2016 update of the FRAM model itself was designed in part to address identified problems and improve management by shifting the base period (reference years) that the model utilizes to a more contemporary period accounting for the structure of more recent salmon fisheries. The co-managers conducted another performance review of two specific populations (Skokomish, Puyallup) in 2018 (James 2018b) when the impacts of fisheries on those populations continued to exceed their exploitation rate ceilings. These performance reviews have generally resulted in fewer exceedances of the annual management objectives and a reduction in the consistent, population-specific exceedance patterns when viewed over the entire time series (Table 23).

Table 23. Estimated exploitation rates compared with the applicable management objective for each Puget Sound Chinook Management Unit. Rates exceeding the annual objective are bolded*.

Region	Management Unit	2011		2012		2013		2014		2015		2016		2017		2018		2019		2020	
		Actual	Obj	Actual	Obj	Actual	Obj	Actual	Obj	Actual	Obj	Actual	Obj	Actual	Obj*	Actual	Obj*	Actual	Obj*	Actual	Obj*
Georgia Basin	Nooksack early	**8%**	7% SUS	**9%**	7% SUS	**8%**	7% SUS	**9%**	7% SUS	6%	7% SUS	4%	7% SUS	4.6%	10.9% SUS	4.7%	10.9% SUS	10.3%	10.9% SUS	8.4%	10.9% SUS
Whidbey/ Main Basin	Skagit spring Skagit	28%	38%	20%	38%	16%	38%	23%	38%	19%	38%	20%	38%	28%	36%	25%	36%	**39%**	36%	**18.3%**	10.7 SUS
	Skagit summer/fall	**61%**	50%	41%	50%	40%	50%	42%	50%	38%	50%	38%	50%	36%	52%	38%	52%	31%	36%	28%	52%
	Stillaguamish	**29%**	25%	22%	25%	14%	25%	**31%**	25%	14%	15% SUS	5%	15% SUS	6%	9% SUS	7%	13% SUS	6%	9% SUS	7%	9% SUS
	Snohomish	**18%**	15% SUS*	20%	21%	12%	21%	**22%**	21%	9%	15% SUS	8%	15% SUS	5.0%	8.3% SUS	**11.7%**	8.3% SUS	6.6%	8.3% SUS	6.2%	8.3%
Central/ South Sound	Lake WA	16%	20% SUS	19%	20% SUS	13%	20% SUS	17%	20% SUS	11%	20% SUS	8%	20% SUS	8% 2,048	15% PTSUS 500 esc	11% 813	15% PTSUS 500 esc	8% 855	15% PTSUS 500 esc	5% 513	14% PTSUS 500 esc
	Duwamish-Green	8% **993**	15% PTSUS 5,800 esc	13% **3,090**	15% PTSUS 5,800 esc	11% **2,042**	15% PTSUS 5,800 esc	13% **2,730**	15% PTSUS 5,800 esc	11% **4,087**	15% PTSUS 5,800 esc	6% 10,063	12% PTSUS 5,800 esc	8% 8,357	15% PTSUS 5,800 esc	11% 6,891	15% PTSUS 2,013 esc	8% 2,976	15% PTSUS 2,013 esc	5% 4,300	14% PTSUS 2,013 esc
	White River	15%	20% SUS	15%	20% SUS	9%	20% SUS	**26%**	20% SUS	11%	20% SUS	5%	20% SUS	21%	22% SUS	**26%**	22% SUS	14%	22% SUS	10%	22% SUS
	Puyallup	46%	50%	**55%**	50%	48%	50%	**52%**	50%	38%	50%	26%	50%	44%	50%	**57%** 11% 2,311	50% 15% PTSUS 1,170 esc	8% 1,688	15% PTSUS 1,170 esc	5.3% 1,750	14% PTSUS 1,170 esc
	Nisqually River	61%	65%	50**%**	56%	48%	56%	50%	52%	46%	52%	37%	50%	**51%**	47%	**53%**	49%**	46%	49%**	34%	49%**

Region	**Management Unit**	**2011**		**2012**		**2013**		**2014**		**2015**		**2016**		**2017**		**2018**		**2019**		**2020**	
		Actual	Obj	Actual	Obj	Actual	Obj	Actual	Obj	Actual	Obj	Actual	Obj	Actual	Obj*	Actual	Obj*	Actual	Obj*	Actual	Obj*
Hood Canal	Mid-Hood Canal R.	8%	12% PTSUS	**14%**	12% PTSUS	12%	12% PTSUS	**14%**	12% PTSUS	**13%**	12% PTSUS	8%	12% PTSUS	10%	13% PTSUS	11%	13% PTSUS	8%	13% PTSUS	6%	13% PTSUS
	Skokomish River	**53%**	50%	**63%**	50%	50%	50%	50%	50%	**63%**	50%	49%	50%	50%	50%	49%	50%	**59%**	50%	44%	50%
Strait of Juan de Fuca	Dungeness River	6%	10% SUS	5%	10% SUS	4%	10% SUS	5%	6% SUS	2%	10% SUS	2%	6% SUS	2%	6% SUS	4%	10% SUS	2%	10% SUS	3%	10% SUS
	Elwha River	5%	10% SUS	5%	10% SUS	4%	10% SUS	5%	10% SUS	2%	10% SUS	1%	10% SUS	3%	10% SUS	4%	10% SUS	2%	10% SUS	4%	10% SUS

*preseason objectives for 2017-2020 are the current co-manager Puget Sound Chinook Harvest RMP (PSIT and WDFW 2022) objectives for each management unit. This is done due to the changes in FRAM base period and version between 2016-2020. “Actual” resulting rates were calculated using FRAM 7.1.1 (post season validated runs, Oct., 2023).

** Includes the base maximum 47% total ER plus an additional 2% ER for use during experimental selective gear research.

The NMFS Supplement to the Puget Sound Recovery Plan provides general guidelines for assessing recovery efforts across individual populations within Puget Sound and determining whether they are sufficient for delisting and recovery of the ESU (Ruckelshaus et al. 2002b; NMFS 2006c). We consider the relative contributions of the various populations to recovery in our ESU-level analysis. As described in Section 2.2.1.1, an ESU-wide recovery scenario should include two to four viable Chinook salmon populations in each of the five geographic regions identified within Puget Sound, depending on the historical biological characteristics and acceptable risk levels for populations within each region (Ruckelshaus et al. 2002b; NMFS 2006c). Unlike other ESUs (e.g., Lower Columbia River (NMFS 2013c)), however, the Puget Sound Recovery Plan and PSTRT guidance did not define the role of each population with respect to the survival and recovery of the ESU which is important in assessing the distribution of risk from specific proposed actions in such a complex ESU. Therefore, NMFS developed the Population Recovery Approach (PRA; see Section 2.2.1.1) to use as further guidance in its consultations. The PRA identifies populations in a series of three “Tiers” relative to their role in the recovery of the ESU. Tier 1 populations include those listed in the Recovery Plan as essential to the recovery of the Puget Sound Chinook ESU. Tier 2 populations are populations that could potentially act as Tier 1 populations, should the long-term achievement of viability of the current Tier 1 populations, in the same recovery region, prove unlikely or unsuccessful. Tier 3 populations generally contribute to the overall stability of the major geographic region within the ESU in which they occur. Guidance from the PSTRT, the Supplement, and the PRA provide the framework to assess risk to the Puget Sound Chinook salmon ESU. The distribution of risk across populations based on the weight of information available in the context of this framework, i.e., the risk to the population from the proposed action relative to its importance to recovery of the ESU, is then used in making the jeopardy determination for the ESU as a whole. For a more detailed explanation of the technical approach (see NMFS 2000b; 2004c; 2011b).

In addition to the biological information, NMFS’ considers its federal trust responsibilities to treaty Indian tribes. In recognition of treaty right stewardship, NMFS, as a matter of policy, has sought not to entirely eliminate tribal harvest (Secretarial Order 3206). This approach recognizes that the treaty tribes have a right and priority to conduct their fisheries within the limits of conservation constraints (Garcia 1998). Because of the Federal government’s trust responsibility to the tribes, NMFS is committed to considering the tribal co-managers’ judgment and expertise regarding conservation of trust resources. However, the opinion of the tribal co-managers and their immediate interest in fishing must be balanced with NMFS’ responsibilities under the ESA. The discussion in the following section summarizes the results of the impact analysis of the proposed actions across populations within each of the five major bio-geographical regions in the ESU.

2.5.1.2 *Effects on Puget Sound Chinook*

Effects on Puget Sound Chinook salmon analyzed in this section occur through implementation of the proposed Puget Sound salmon fisheries and associated research as described earlier (see Sections 1.2 and 1.3). Escapements and exploitation rates expected to result from these fisheries during May 15, 2024 through May 14, 2025 are summarized in Table 24. Exploitation rates are reported by management units and escapements by populations based on the information that the

FRAM model provides. As described in the Environmental Baseline (Section 2.3.1), NMFS has previously consulted on the impacts of U.S. salmon fisheries outside Puget Sound (NMFS 2004a; 2008h; 2019g). However, the harvest objectives proposed by the co-managers to manage their fisheries on Puget Sound Chinook salmon take into account impacts in these other fisheries and in Canada (Mercier 2024). Thus, Table 24 describes the sum of fishing-related mortality anticipated under the proposed 2024-2025 Puget Sound fisheries (except for the 2025 early spring Chinook fisheries in Puget Sound (described below)), as well as, that expected from the PFMC, Canadian, and SEAK fisheries.

Also included in Table 24 are the RERs and critical and rebuilding thresholds discussed above which NMFS considers in evaluating the effects of the proposed actions on populations within the ESU. For management units comprised of multiple populations, Table 24 provides the range of RERs associated with the populations within that management unit. For example, the range of RERs summarized for the Skagit Spring Management Unit represents the Upper Sauk (24%), the Suiattle (32%) and the Upper Cascade (35%) populations. All of the population-specific RERs are shown in Table 22.

Table 24. FRAM adult equivalent exploitation rates expected for the 2024-25 fishing season encompassing ocean and Puget Sound fisheries and escapements expected after these fisheries occur for Puget Sound management units compared with their FRAM RERs and escapement thresholds (surrogates in italics). RERs are in terms of natural-origin or unmarked Chinook. Outcomes expected to exceed at least one population's FRAM RER within a management unit (top half of table) or fall below a population's critical escapement thresholds (bottom half of table) are bolded. Outcomes expected to exceed a population's rebuilding escapement threshold (bottom half of table) are underlined.

Region	**Management Unit**	**Ocean** (AK, CAN, PFMC)	**Puget Sound**	**Ocean + Puget Sound**	**FRAM RER or surrogate RER**	
Georgia Basin	Nooksack early	22.9%	7.5%	**30.4%**	5%	
Whidbey/ Main Basin	Skagit spring	10.2%	14.8%	**25.0%**	24-35%	
	Skagit summer/fall	22.8%	13.5%	**36.3%**	35-50%	
	Stillaguamish	19.5%	7.9%	**27.3%**	17-31%	
	Snohomish	14.2%	6.0%	20.2%	23-25%	
Central/South Sound	Lake Washington	17.1%	19.9%	**37.1%**	*5-24%*	
	Duwamish-Green R	17.1%	39.1%	**56.3%**	17%	
	White River	5.6%	15.2%	20.8%	*24%*	
	Puyallup River	17.1%	40.5%	**57.6%**	*17-35%*	
	Nisqually River	14.6%	30.9%	**45.5%**	*35%*	
Hood Canal	Mid-Hood Canal R.	16.8%	9.2%	**26.0%**	*5%*	
	Skokomish River	16.7%	33.0%	**49.7%**	35%	
Strait of Juan de Fuca	Dungeness River	17.0%	2.8%	**19.9%**	*5%*	
	Elwha River	16.5%	3.4%[3]	**20.0%**	*5%*	
Escapement			**Total Natural (HOR+NOR)**	**NOR**	**Critical**	**Rebuilding**

Georgia Basin	Nooksack Management Unit		361	400	500
	NF Nooksack (early)		**29**	*200*	-
	SF Nooksack (early)		332	*200*	-
Whidbey/ Main Basin	Upper Skagit River (moderately early)	7,355	6,838	738	5,740
	Lower Sauk River (moderately early)	-	317	*200*	371
	Lower Skagit River (late)	-	1,369	281	2,131
	Upper Sauk River (early)	-	815	130	470
	Suiattle River (very early)	-	381	170	223
	Upper Cascade River (moderately early)	-	178	130	148
	Stillaguamish R MU (NF + SF)[1]	836	470		
	NF Stillaguamish R. (early)		400	300	550
	SF Stillaguamish R. (moderately early)		**70**	*200*	300
	Skykomish River (late)		1,919	400	1,491
	Snoqualmie River (late)		684	400	816
Central/South Sound	Cedar River (late)	658	417	*200*	282
	Sammamish River (late)	2,132	**195**	*200*	*1,250*
	Duwamish-Green R. (late)[2]	3,562	1,047	400	1,700
	White River (early)	2,237	747	*200*	410
	Puyallup River (late)	3,082	1,409	*200*	797
	Nisqually River (late)	1,120	811	*200*	1,200
Hood Canal	Mid-Hood Canal Rivers (late)	13	**13**	*200*	*1,250*
	Skokomish River (late)	2,812	**391**	452	1,160
Strait of Juan de Fuca	Dungeness River	1,216	229	*200*	925
	Elwha River	2,961	**141**[3]	*200*	*1,250*

Source: Chin2724_TAMM_Final_BiOpTab.xlsm (J. Carey, NOAA, pers. comm., April, 2024). Model output escapements adjusted to reflect natural-origin (NOR) or natural (hatchery-origin (HOR)+NOR) escapement as closely as possible using FRAM inputs, preseason forecasts or postseason data from previous years.

[1] Co-managers consider the Stillaguamish River to have two populations based on their return timing (early and moderately early) and consideration of genetic information collected after the completion of the Puget Sound Technical Recovery Team assessment. NMFS continues to estimate escapements for the North and South Fork Stillaguamish Rivers separately, consistent with the Puget Sound Recovery Plan and Puget Sound Technical Recovery Team assessment.

[2] Additional NOR adult Chinook salmon will be transported from hatchery traps to augment spawner abundances in the Green River, when necessary.

[3] The exploitation rate of Elwha Chinook in Puget Sound fisheries, and the resulting estimated natural-origin escapement include the effects of all in-river research fisheries.

Test, research, and in-season run size update fisheries, meant to inform harvest management decisions, such as timing of fisheries or specific fishing gear experiments, are included as part of the total fishery-related mortality reflected in Table 25 and included in the rates discussed in the following paragraphs. Other research and monitoring activities that are not part of the proposed harvest, which have broader applicability to stock assessment, such as understanding the run-timing and spatial differences between populations within a management unit, are not included in Table 25. Mortality from this category of projects will not exceed a level equivalent to one percent of the estimated annual abundance (i.e. 1% ER), for any management unit, as described in the proposed action (See Section 2.5.6). A third category of research activities informing Puget Sound salmon fishery management are permitted under Sections 7 and 10 of the ESA, or Limit 7 of the 4(d) Rule and are part of the Environmental Baseline (Section 2.4.5).

Spring Chinook Fisheries

The Puget Sound annual salmon management period begins in the spring on a given year (May) and runs through the winter and into the next spring (May). The timing of this period is centered around the annual forecasting and pre-season planning processes in the PFMC and PSC forums. This presents a unique temporal situation for the harvest management of the spring-timed runs of Chinook salmon, in that, there are segments of two run-years of these populations presented in the annual period, unlike the summer- and fall-run Chinook where the single, annual runs occur fully within the annual management cycle. Mature spring Chinook salmon, from Puget Sound rivers, can begin their migration into freshwater in the late winter to early spring period each year and continue into the early summer period. This means that for annual salmon fishery management, portions of two, distinct annual runs of returning, mature spring Chinook salmon occur under the timeframe of the annual management plan, as demonstrated in Figure 35.

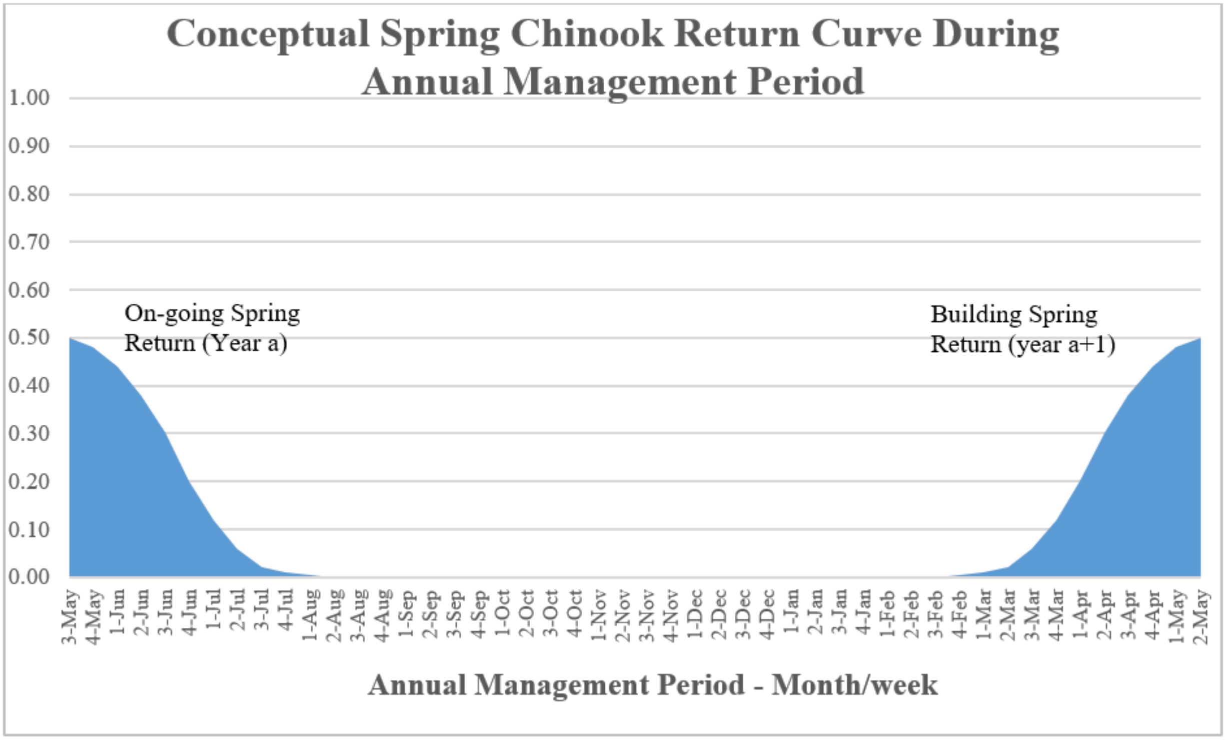

Figure 35. Conceptual representation of the two run-years of spring Chinook salmon encountered during the proposed annual Puget Sound salmon management cycle. Actual proportions of runs over time not accurately represented.

In order to manage the impacts of the spring Chinook fisheries for the full annual management cycle (May, 2024-May, 2025) and apply appropriate management constraints to the two individual run years, the fisheries targeting spring Chinook stocks are managed during the entire annual management period consistent with the following conservation-based management objectives as described in Section 1.3 (Table 25).

Table 25. Management objectives and thresholds for early Chinook stocks in Puget Sound for the 2024-2025 annual management cycle—bolded (Mercier 2024).

Management Unit/Population	**Normal Abundance Regime**			**Minimum Fishing Regime**	
	Exploitation Rate Ceiling		**Escapement Goal**	**Low Abundance Threshold**	**Critical Exploitation Rate**
	Total	**Southern US**			**Southern US**
Nooksack spring NF Nooksack SF Nooksack	Minimum Fishing Regime applies			400 200	**10.9%**/14.1%*
Skagit Spring Suiattle Upper Sauk Cascade	**36%**			1,024** 170 130 170	10.7%
White River		**22%**	1,000	400	15%
Dungeness		**10%**		500	6%

* Expected total SUS exploitation rate will not exceed 10.9% in 4 out of 5 years and 14.1% in 1 out of 5 years
** If either the aggregate goal or any of the individual population goals are not reached, the exploitation rate in Southern US fisheries will not exceed the CERC. Otherwise the total ER ceiling will apply, in accordance with the Skagit MUP

The assessment in this opinion of the proposed fisheries which effect spring Chinook for the May 15, 2024 through May 14, 2025 is structured in two parts. First is an evaluation of the proposed fisheries affecting Puget Sound spring Chinook management units in 2024, based on the 2024 FRAM modeling results and the final 2024-25 List of Agreed Fisheries (Mercier 2024). We then assess the likely impacts on the Puget Sound spring Chinook management units for the April-May 14th period in 2025.

The proposed management objectives for the spring Chinook management units include objectives for normal abundance regimes (above low abundance thresholds) and minimal fishing regimes (at or below low abundance thresholds (Table 25). These low abundance thresholds (LAT) are typically set at or above the population's critical abundance thresholds, as described in Section 2.2.2.1., and reduce the likelihood of short-term demographic risks to the populations. The minimum fishing regime objectives substantially limit the allowable harvest of the spring management units in SUS fisheries. Taken together, these help assure that when low abundance runs are forecasted for these spring MUs, that conservative fishing impact limits are in place to maximize the number of natural-origin spring Chinook adults in escapement. The Nooksack Management Unit exploitation rate limit does not change even if abundance is above the LAT (Table 25). This helps ensure that fishery related impacts from the SUS fisheries, including PS, do not add risk to the status of the Nooksack populations. Three out of the four MUs (Nooksack, White, and Dungeness) have conservation hatchery programs associated with the spring population. These fish help assure that total spawning abundances are maintained near or above the re-building abundance threshold and mitigate demographic risks at low population sizes, also described in Section 2.2.2.1.

When forecasts for the Skagit, White, and Dungeness Management Units are above the LAT, the proposed management objectives allow additional harvest impacts to occur in the fisheries. For Skagit, the exploitation rate limit moves to a total exploitation rate limit in all fisheries (southern US and Northern US/Canada). For the White River and Dungeness, the limit moves to a less restrictive southern US limit. In the cases of Skagit and White River, the rate limits in the normal abundance regime (Table 25) are based on exploitation rates, which on average, should result in meeting or exceeding the rebuilding escapement levels for these populations Table 22. These rates are consistent with exploitation rates in previous management plans for which NMFS has concluded the action would not pose jeopardy to the listed species.

Except for a few years, for individual management units, the Puget Sound spring Chinook fisheries have met the annual management objectives for the individual management units and populations. In most years post season observed exploitation rates are substantially lower than the annual objective (Table 25).

Effects by Geographic ESU Region

Georgia Basin Region: There are two populations within the Strait of Georgia Basin: the North Fork Nooksack River and the South Fork Nooksack River early Chinook salmon populations (Table 2). Both of these populations are genetically unique and thought to represent the indigenous profiles of the populations. They are both classified as PRA Tier 1 populations and both are essential to recovery of the Puget Sound Chinook ESU (NMFS 2006c). The two populations form the Nooksack Early Management Unit. Both populations are expected to be affected by the proposed actions in the action area described in Section 2.3.

Average natural-origin escapement for the North Fork Nooksack is just below its critical escapement threshold and the South Fork Nooksack population is well below its critical escapement threshold (Table 5), indicating risk to the viability of both populations in this Region. Natural-origin spawners average only 149 for the North Fork Nooksack and only 61 for the South Fork Nooksack since the ESU was listed in 1999. For the South Fork Nooksack population, the long-term average natural-origin and total natural spawner estimates (Table 5) do not yet reflect the recent year increases seen in both the total and natural-origin spawner abundances, beginning in 2016, from the South Fork conservation hatchery program. Since 2016, and through 2021, the average number of South Fork adults spawning has been 205 natural-origin and 678 hatchery-origin fish.

Managers have implemented two conservation hatchery programs in the Region. Both programs are essential to recovery of each of the populations in this Region and thus to the ESU. Each program has met its hatchery's egg-take objectives in recent years with few exceptions, and is expected to do so for the foreseeable future (WDFW 2014a; LN 2015; Apgar-Kurtz 2018; Chance 2023), thus ensuring that what remains of the genetic legacy is preserved and can be used to advance recovery. The Kendall Creek Hatchery program is intended to assist in recovery of the North Fork Nooksack early Chinook population by contributing to spawning escapement, thus increasing escapements and potentially productivity in order to buffer risks while improvements in habitat, to address low productivity, occur. An aggressive captive brood stock program to enhance returns of native South Fork Nooksack Chinook began in 2007[56]. The first substantial number of adults to contribute to escapement began returning in 2015 (Chapman 2013; 2016). The 2017 returns from the program were greater than 2015 and 2016 with greater potential contribution to spawning (Apgar-Kurtz 2018). A record number of redds were observed in the South Fork sub-basin in 2018 compared with previous years. An estimated 65 percent of the carcasses were from the South Fork captive-brood program. Unlike previous years (2017) when the majority of spawners from the program were young males, 44 percent of the spawners contributing to escapement from the program in 2018 were female and 97 percent of the spawners were age 3 and older (Apgar-Kurtz 2018). Results for the 2019 return indicate substantial spawners from the supplementation program contributed to the spawning population. This was particularly beneficial since the 4-year old NOR returns were the product of a very low spawning abundance in 2015 (<10 NOR spawners and few supplementation program returns). The South Fork hatchery program at Skookum Creek hatchery has released an average of just over 1.0M juveniles from brood years 2018-21 and the brood year 2022 releases (release in 2023) will total nearly 1.3M juveniles. These release levels have proved to be sufficient to provide future broodstock for continuing the conservation program, as well as providing natural area spawning supplementation (Chance 2023). These results indicate the program is achieving its goal of supplementing the critical South Fork populations and reducing demographic risk. They also are consistent with the expectation of a greater number of returning adults contributing to escapement and more diverse age structure as more brood years return and the supporting hatchery program becomes established. However during the summer of 2021, the South Fork Nooksack experienced extremely low flows along with unseasonably hot temperatures which resulted in significant pre-spawn mortality for the fish that were in the river, particularly in the reaches just above and below the Skookum Creek Hatchery. Estimated pre-spawn mortality from this event was nearly 2,300 fish (pers com. D. Flawd, Lummi Fisheries, April 24, 2023), with more of the total mortalities observed in the reaches below the hatchery. The Skookum Creek Hatchery was able to collect 175 pairs of Chinook adults, for an approximate eggtake of 700K, which should result in enough juveniles for release to minimize impacts to future adult returns from the program (Pers comm. T. Chance, Lummi Natural Resources, October 21, 2021). For 2022 and 2023 broodyears, the program was able to collect over 1.6M eggs in 2022 and over 1.1M eggs in 2023 (Pers comm. T. Chance, Lummi Natural Resources, May 2024).

When hatchery-origin spawners from the conservation programs are included, average total spawning escapement for the North Fork and South Fork Nooksack populations is significantly higher than the NOR-only returns described above. With the conservation program returns included the North Fork average total spawners is 1,346 (Table 5). The South Fork conservation program has brought the post-1999 average total spawning escapement closer to the critical threshold, with 191 spawners and has contributed to total spawning escapements to the South Fork in excess of 600 for the 2016-2021 returns compared with roughly 50 total spawners before the program began and adults from the initial program releases fully recruited to escapement

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[56] The captive broodstock program was discontinued in 2018, having achieved its initial design objectives and has transitioned to a program based on adult returns to the Skookum hatchery.

(2011-2015 average; WDFW and PSTIT (2021b)).

Average productivity (recruits/parent spawners) is 0.3 for the North Fork and 1.9 for the South Fork (Table 5). These results indicate a relative lack of response in terms of North Fork natural-origin production given the much higher total natural escapements and a more positive response from the supplementation program in the South Fork, as described in the above paragraphs. Trends in total escapement (hatchery + natural spawners) are increasing for both the North Fork and South Fork Nooksack populations, respectively (Table 6). The growth rates for both natural-origin escapement and natural-origin recruitment are stable and negative, respectively, for the North Fork and South Fork populations. The growth rate for escapement is the same or higher than the growth rate for recruitment (Table 6). This indicates that the numbers of natural-origin fish that are escaping the fisheries, relative to the parent generation, provide some stabilizing influence for abundance, and reduce demographic risks. However, the slightly negative (0.99; Table 6) growth rate for North Fork Nooksack natural-origin recruitment may indicate a downward trend in productivity over the data period. Growth rates for both natural-origin escapement and recruitment are negative for the South Fork population (Table 6) indicating the population is not maintaining itself relative to the parent generation. The combination of these factors suggests that natural-origin productivity and abundance will not increase much beyond existing levels unless constraints limiting marine, freshwater, and estuary survival for the Nooksack early populations are alleviated (NMFS 2005c; 2008d; PSIT and WDFW 2010a). However, recent-year (2016-21) increasing returns from the South Fork conservation hatchery program and of natural-origin South Fork adults may indicate signs for optimism. These currently short-term increases are not yet affecting the long-term growth rates, given that long history of low levels of system production since 1990 (Table 6).

Exploitation rates during 2009-2020 averaged 30 percent (total) and seven percent (SUS) for the Nooksack spring MU (Table 13). Harvest on this MU is managed under a SUS ER objective[57]. Over the last 10 years of available post-season assessments (2011-2020), the performance of this management has resulted in rates that were lower than the annual objectives (6 of ten years), with four years (2011-2014) that had minor exceedences—one to two percent above objective. There have been no exceedences for the last 6 available years (Table 23). Seventy-seven percent of the harvest-related mortality occurred in Alaskan and Canadian fisheries (Table 13).

The anticipated total exploitation rate for the Nooksack MU resulting from the 2024 PFMC, PST fisheries and proposed actions is 30.4 percent, well above the RER of five percent, although the exploitation rate from the proposed action alone (Puget Sound fisheries) is expected to be a small contributor to the overall rate, i.e., 7.5 percent (Table 24). With the proposed action, natural-origin escapement for the North Fork population is anticipated to be well below its critical threshold (Table 24), which is cause for concern. However, total natural escapement, including the supplementation-program spawners, has been consistently above the rebuilding threshold (Table 5) and is anticipated to be again in 2024 for the North Fork population, given recent year

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[57] The Nooksack management unit was managed for an objective of 7% exploitation rate in southern U.S. fisheries until 2016 when the FRAM model was updated. A comparison of exploitation rate estimates under the old and new FRAM (post 2016) indicated the previous objective of 7% was equivalent to a rate of 11% under the new base period. In light of the new information, co-managers revised their objective to 10.9%. This results in a slightly more conservative objective than in years prior to 2016.

hatchery-origin contribution rates (see Table 5 for comparison of natural spawning escapement and natural-origin spawning escapement). Natural-origin escapement for the South Fork population is expected to exceed its critical threshold for 2024. The total exploitation rate on the Nooksack population has been reduced 23 percent overall since the ESU was listed, with much greater reductions in southern U.S. fisheries (Table 13). Reductions in northern fisheries were negotiated and realized as part of the current PST Chinook annex (PSC 2022) specifically to provide greater protections to critical populations of Puget Sound Chinook, including the Nooksack populations.

Fisheries in the Strait of Juan de Fuca, northern Puget Sound, and the Nooksack River have been managed to limit fishery impacts to Nooksack spring Chinook since the late 1980s. Net, troll, and recreational fisheries in Puget Sound are regulated to minimize incidental natural-origin Chinook mortality while maintaining fishing opportunity on other species such as sockeye and summer/fall Chinook. There have been no directed commercial fisheries on Nooksack spring Chinook in Bellingham Bay since the late 1970s. Incidental harvest of spring Chinook in fisheries directed at fall Chinook in Bellingham Bay and the lower Nooksack River was reduced in the late 1980s by severely reducing and delaying fisheries until after July. Commercial fisheries in Bellingham Bay that target fall Chinook have been delayed until August for tribal fishermen and mid-August for non-tribal fishermen. Since 1997, there have been limited ceremonial and subsistence fisheries in the lower Nooksack River in May through early July. Beginning in 2008, the July fishery was discontinued entirely, and a portion of the ceremonial and subsistence fishery was shifted to the lower North Fork as additional conservation measures to further limit the potential harvest of the South Fork early Chinook population (PSIT and WDFW 2010a). For the last several years, selective gear and natural-origin Chinook non-retention were implemented in the largest component of the SUS fishery to allow for tribal ceremonial and subsistence (C&S) harvest of surplus North Fork hatchery fish. Additionally, in 2020 and 2021, the State of Washington opened a limited mark selective recreational fishery in the North Fork Nooksack River, targeting surplus hatchery-origin returns. Given the very low expected run size for North Fork natural-origin fish for 2024, the sport fishery is not proposed for this year and the tribal C&S fisheries will spread their efforts over a broader timeframe of the return to focus on surplus hatchery fish from both the North Fork and South Fork Nooksack programs. Any proposed extension of the in-river C&S fishery in 2024, beyond June 30, would rely on in-season monitoring and an assessment of impacts to the populations to confirm that such fisheries will not result in exceeding the exploitation rate modeled in the pre-season and analyzed in this opinion (Mercier 2024).

The fishing-related mortality from all the fisheries is summarized in Table 24. In 2024, 90 percent of the harvest mortality of Nooksack early Chinook in Puget Sound fisheries is expected to occur in tribal fisheries; primarily in C&S fisheries in the river (FRAM Chin2024). If the proposed actions were not to occur in 2024, we estimate that, at most, an additional 3 and 33 natural-origin spawners would return to the North and South Fork Nooksack early Chinook escapements, respectively. The Nooksack spring Chinook management unit objectives are developed to minimize the impact of SUS fisheries on natural-origin escapement. Neither the proposed 2024 or spring 2025 fisheries, under the proposed conservation objectives (Table 25), will impact the Nooksack populations at a level that would change the status of the populations, relative to exceeding their critical or rebuilding abundance thresholds.

In summary, the status of the populations given their role in recovery of the ESU is cause for significant concern and so the effects of the harvest resulting from the proposed actions on the populations must be carefully considered. The 2024 anticipated exploitation rates are substantially higher than the RERs. However, the vast majority of harvest occurs in fisheries north of the U.S. border of the lower 48 states, including Canadian fisheries which are outside U.S. jurisdiction. Under the proposed actions, the exploitation rate on Nooksack early Chinook, within the action area, is expected to be low (7.5 percent). The managers propose actions to continue minimizing impacts to Nooksack early Chinook. Most of the harvest of Nooksack early Chinook in SUS fisheries is expected to occur in tribal fisheries; primarily in C&S fisheries. Information suggests that past harvest constraints on SUS fisheries have had limited effect on increasing escapement of returning natural-origin fish, when compared with the return of hatchery-origin fish, and further harvest reductions in 2024 Puget Sound fisheries would not accrue meaningful benefits for either Nooksack population. Both conservation hatchery programs retain the indigenous profile of their respective Nooksack early Chinook populations. Both programs are key components for recovery of the Nooksack early Chinook salmon populations and are providing substantially increased numbers of returning adults to bolster the spawning populations in each population. These increased numbers of total spawners have the benefit of stabilizing and reducing demographic risks to these populations. Therefore, any further constraints to fisheries occurring in 2024 would not significantly change the status or trends of either population from what would occur without the fisheries. The populations will continue to rely on the conservation hatchery programs to preserve the genetic profiles and reduce demographic risks to the populations until factors limiting recovery of the habitat and ecosystem functions are addressed.

Whidbey/Main Basin Region: The ten Chinook salmon populations in the Whidbey/Main Basin Region are genetically unique and thought to represent the indigenous profiles of the Chinook populations in the Skagit, Stillaguamish, and Snohomish Rivers. The ten populations comprise four management units (MUs): Skagit Spring MU (Suiattle, Upper Cascade and Upper Sauk), Skagit Summer/Fall MU (Upper Skagit, Lower Skagit and Lower Sauk), Snohomish MU (Skykomish and Snoqualmie) and the Stillaguamish MU (North Fork Stillaguamish and South Fork Stillaguamish) (Table 2). The six Skagit Chinook populations are in PRA Tier 1, the two Stillaguamish populations and the Skykomish population are in PRA Tier 2, and the Snoqualmie population is in PRA Tier 3 (Figure 1). NMFS has determined that the Suiattle and one each of the early (Upper Sauk, North Fork Stillaguamish), moderately early (Upper Skagit, Lower Sauk, Upper Cascade, South Fork Stillaguamish), and late (Lower Skagit, Skykomish, Snoqualmie) life history types will need to be viable for the Puget Sound Chinook ESU to recover (NMFS 2006c). Hatchery contribution to natural escapement is extremely low (<11%) in the Skagit system and moderate (22%-47%) in the Snohomish and Stillaguamish systems (Table 5). All populations in the Region are expected to be affected by the proposed actions.

Natural-origin average escapement from 1999-2021 is above the rebuilding thresholds for seven populations (Upper Skagit moderately-early, Lower Sauk moderately-early, Upper Sauk early, Suiattle very early, Upper Cascade moderately-early, Skykomish late, and Snoqualmie late), below the critical threshold for the South Fork Stillaguamish moderately-early, and in between critical and rebuilding for the NF Stillaguamish and Lower Skagit populations (Table 5). Long-term observed productivity through the 2015 broodyear is 1.0 or more for all but the North Fork Stillaguamish populations and 2.0 or greater for five of the ten populations (Table 5). Longer term trends (1990-2018) indicate declining growth rate in natural-origin recruitment for five of the 10 populations (Upper Sauk, Suiattle, Upper Cascade, and NF and SF Stillaguamish) and stable growth rate in natural-origin recruitment for the remaining five populations (Upper Skagit, Lower Sauk, Lower Skagit, Skykomish, and Snoqualmie) (Table 6). With the exception of the South Fork Stillaguamish, long term trends in total natural escapement are stable or increasing (Table 6). Growth rates for natural-origin escapements are stable or increasing for nine of the 10 populations (SF Stillaguamish is decreasing) and all but the Upper Skagit are equal-to or higher than the growth rate for recruitment (Table 6). This indicates that sufficient fish are escaping the fisheries to maintain or increase the number of spawners from the parent generation; providing some stabilizing influence for abundance and reducing demographic risks. The critical abundance status and declining total escapement trend and natural-origin growth rates for the South Fork Stillaguamish population indicate additional concern for this population.

Average observed exploitation rates for the populations in the Whidbey/Main Basin Region during 2009-2020 ranged between 23 and 42 percent (total) and 8 to 17 percent (SUS) (Table 13). Between 53 and 73 percent of this total harvest occurred in Alaska and Canadian fisheries. Including the proposed action, total exploitation rates for seven of ten populations (Upper Skagit, Suiattle, Lower Sauk, Upper Cascade, NF Stillaguamish, Skykomish, Snoqualmie) are expected to be below their RERs in 2024 (Table 24). Exploitation rates on three populations (Lower Skagit, Upper Sauk, and South Fork Stillaguamish) are expected to exceed their RERs in 2023. NMFS considers the proposed actions to present a low risk to the seven populations for which exploitation rates would not exceed their RERs. The exploitation rates in 2024 for the Lower Skagit, Upper Sauk, and South Fork Stillaguamish populations are anticipated to exceed their RERs by small to moderate amounts (1.3, 1.0, and 9.7 percentage points, respectively). The exploitation rates in 2024 Puget Sound fisheries are expected to be low across the four Whidbey/Main Basin management units (6.0%-14.8%) (Table 24). All populations in the Region except the South Fork Stillaguamish are expected to exceed their critical escapement thresholds. Five of the 10 populations will also exceed their rebuilding escapement thresholds (Table 24) in 2024. For the South Fork Stillaguamish, if the proposed actions were not to occur in 2024, we estimate that an additional 4 natural-origin spawners would return to the South Fork Stillaguamish, which would not provide sufficient additional natural-origin spawners to meaningfully change the status or trends of the population from what would occur without the fisheries. Additionally, two conservation hatchery programs in the Stillaguamish watershed are expected to escape an additional 366 adult fish to augment the North Fork and South Fork spawning populations, helping to reduce short-term risk for these populations. These two conservation hatchery programs in the Stillaguamish River produce summer-timed Chinook and fall-timed Chinook. Both of these programs are small in size and incorporate natural-origin adults into the hatchery broodstock to maintain genetic integration with the natural-origin fish. Low abundance of natural-origin fish, reflecting low productivity of habitat, in these systems currently limits the size of the programs.

Skagit spring Chinook management unit objectives are developed to achieve escapements that meet or exceed the rebuilding escapement threshold (Table 5) at normal run sizes (Table 25) and provide added protection for runs at critical run sizes by restricting the allowable level of southern US harvest to a rate that provides escapement above the populations' critical escapement thresholds, on average. Total exploitation rates on the Skagit Spring Chinook Management Unit have ranged from 16 to 39 percent over the ten years available, with the majority (8 years) well below the exploitation rate ceiling but with two, more recent years (2019 and 2020) exceeding the annual management objective by small to significant rates—3-7.6%, respectively (Table 23). It is reasonable, given the small proportion of the overall spring Chinook run encountered during the April-May 14, 2025 period, as well as the overall past performance of the management of the MU, to expect the April-May 14, 2025 fisheries to have low levels of impact to the overall natural-origin escapement for the three Skagit spring populations (Upper Sauk, Suiattle, and Cascade). These fisheries are expected to result in only a proportion of the impacts allowed consistent the exploitation rate ceiling, limiting the scale of overall impact to the Skagit Spring Chinook Management Unit and to the individual populations. The managers could adjust the fishery, if needed, to ensure that impacts remain below the applicable exploitation rate ceiling once abundance forecasts for 2025 are available.

In summary, the effects of the proposed actions in 2024 and 2025 in the Whidbey/Main Basin Region are consistent with the recovery plan guidance. With the proposed actions, at least two to four populations representing the range of life histories displayed in the Region will be at low risk, including those specifically identified as needed for recovery of the Puget Sound Chinook ESU. The Whidbey/Main Basin Region is a stronghold of Chinook production in the ESU. Most populations in the Region are doing comparatively well relative to critical and rebuilding abundance criteria given current habitat conditions, representing a diversity of healthy populations in the Region as a whole. Exceedance of the RERs for three of the 10 populations in the Region suggests some potential, short-term risk to viability of these populations, from the proposed fisheries. However, the increasing or stable trends in total escapement (hatchery and natural origin) and growth rate in natural-origin escapement across most of the populations, and the robust status of the populations compared with their escapement thresholds in 2024 for the Upper Skagit, Upper Sauk, Suiattle, Upper Cascade, and Skykomish populations should mitigate any increased risk to overall viability in the Whidbey/Main Basin Region. The continued critical status and trends for the South Fork Stillaguamish and, to a slightly lesser extent, the North Fork Stillaguamish is a cause for concern. However, the moderately early life history type exhibited by the South Fork Stillaguamish population is represented by three other healthier populations in the Region and the North Fork Stillaguamish early life history is represented by two other healthier early-timed populations in the Region, which are all expected to be at low risk from the proposed fisheries in 2024. Additionally, the two Stillagumish conservation hatchery programs provide additional spawner abundance to help stabilize the demographic risk to the populations while preserving the genetic legacy. The number of additional spawners that would be gained from further fishery reductions is very low and would not change the status or trends of the Stillaguamish populations.

Central/South Sound Region: There are six populations within the Central/South Sound Region (Figure 1). Most are genetically similar, likely reflecting the extensive influence of transplanted hatchery releases, primarily from the Duwamish-Green River population. Except for the White River (early) population, Chinook populations in this region exhibit a fall type life history and were historically managed primarily to achieve hatchery production objectives. The White River and Nisqually Chinook salmon population are in PRA Tier 1. The Duwamish-Green population is in PRA Tier 2, and the Cedar, Sammamish, and Puyallup populations are in Tier 3. The six populations constitute five management units under the Puget Sound Harvest Plan: Lake Washington (Cedar and Sammamish), Duwamish-Green, White, Puyallup, and Nisqually. Hatchery contribution to spawning escapement is moderate to high (29%-81%) for the populations within this Region (Table 5). NMFS determined the Nisqually and White River populations must eventually be at low extinction risk (high viability) to recover the ESU (NMFS 2006c). All populations in the Region are expected to be affected by the proposed actions.

The basins in the Central/South Sound Region are the most urbanized and some of the most degraded in the ESU (SSPS 2005). The lower reaches of all these systems flow through lowland areas that have been developed for agricultural, residential, urban, or industrial use. Much of the watersheds or migration corridors for five of the six populations in the MPG are within the cities of Tacoma or Seattle or their metropolitan environments (Sammamish, Cedar, Duwamish-Green, Puyallup and White). Natural production is limited by stream flows, physical barriers, poor water quality, elimination of intertidal and other estuarine nursery areas, and limited spawning and rearing habitat related to timber harvest and residential, industrial, and commercial development, as well as several dams limiting upper watershed access (Cedar, Duwamish-Green, Puyallup/White, and Nisqually). The indigenous Chinook population in the Sammamish, Puyallup and Nisqually Rivers have been extirpated and the objective is to recover the populations using the individuals that best approximate the genetic legacy of the original population, reduce the effects of the factors that have limited their production, and provide the opportunity for them to readapt to the existing conditions and improve their status as impacts of the limiting factors are reduced over time. Managers have implemented a conservation hatchery program for the White River population, where the indigenous population is still present. This program is essential to recovery of the population and thus to the ESU. The program regularly has met its hatchery's egg-take objectives and is expected to do so again in 2024, thus ensuring that what remains of the genetic legacy is preserved and used to advance recovery.

Except for the Sammamish population, average natural-origin escapements since 1999 are well above their critical escapement thresholds. Rebuilding escapement thresholds were updated for the Cedar, Green, Puyallup and White River populations in 2017 and 2018 based on new spawner-recruit analyses (PSIT and WDFW 2017a; NMFS and NWFSC 2018). Average, long-term natural-origin escapement in the Cedar and White rivers exceeds their rebuilding escapement thresholds (Table 5). Observed productivity is 1.0 or more for four of the six populations (Table 5). Total escapement trends are stable or increasing for all populations within the Region (Table 6). Growth rates for natural-origin recruitment are increasing for the White River and Sammamish; declining for the Puyallup and Nisqually, and stable for the Cedar and Duwamish-Green (Table 6). Growth rates for natural-origin escapement are increasing for the White River population and stable for all other populations in the region (Table 6). As with most populations in other Puget Sound regions, the growth rates for escapement are generally higher than growth rates for recruitment, with the exception of Sammamish. The fact that growth rates for escapement (i.e., fish through the fishery) are greater than growth rates for recruitment (i.e., abundance before fishing) for all but one population indicates some stabilizing influence on escapement from past reductions in fishing-related mortality across the region. The declining NOR growth rate in recruitment and stable but low escapement suggests that the Puyallup population may be at a higher risk with respect to reaching viability than other populations in the region. However, the population's average natural-origin escapement is well above its critical escapement threshold (Table 5), it is a Tier 3 population in terms of its role of recovery (not essential) for the ESU (Figure 1) and its life history type is common within the region.

Average observed exploitation rates during 2009-2020 ranged between 23 and 50% (total) and 14 to 41% (SUS) (Table 13). The range of total ERs for this time period are above the RERs for all management units but the White River (Table 22). Overall, a larger proportion of the harvest of these populations occurs in SUS fisheries than for populations in most other regions of Puget Sound; 19 to 49% of the harvest occurred in Alaska and Canadian fisheries depending on the population (Table 13).

Exceedance of the exploitation rate objective in the co-managers' plan for the Puyallup population has been a concern. In 2014, the co-managers examined the available information to identify the factors contributing to the exceedance of Puyallup exploitation rate objective. The estimated exceedances of the annual Puyallup total ER objective (50%) were relatively low, ranging from 1-5%. Based on their review, managers took additional management actions in 2015 and again in 2016 to provide greater assurance that the fisheries would meet the overall exploitation rate limits.[58] In 2018, the co-managers conducted another performance assessment (James 2018b).

As described in the 2018 performance assessment, both Canadian fisheries and a variety of Puget Sound marine sport fisheries were the most consistent contributors to the overages between 2011 and 2014 (James 2018b). Beginning in 2012, managers improved preseason models and shaped fisheries to address the problem. Mark-selective fishing rules have been implemented recently in the sport fishery resulting in low exploitation rates on unmarked Puyallup Chinook salmon. Major sections of the river have been closed during openings for the tribal net fisheries for pink, coho, or Chinook salmon to reduce impacts on Chinook. Since 2015, the annual management objective has only been exceeded in one year (2018) (Table 23)

The 2018 co-manager performance review found that further improvements to estimate age-2 cohort size and to better account for mortality in Canadian fisheries in the FRAM model should reduce the model bias (underestimation of actual rates in these fisheries) in exploitation rate estimation from five to two percentage points (James 2018b). Correction of an error in model inputs for the terminal tribal freshwater fishery and an adjustment factor for the Area 7 marine sport fishery (Dapp and Dufault 2018) are anticipated to further reduce the bias if not eliminate it altogether, which is expected to reduce the frequency of exceeding the pre-season management objectives (Phinney and Patten 2018).

As part of the development of revised management objectives for a new long-term Puget Sound Chinook RMP, the co-managers have produced a spawner/recruit model for the Puyallup Chinook population. Using this modeling the co-managers have produced revised, proposed objectives for minimum aggregate spawner escapement abundances for triggering differing levels of allowable harvest on the population, in pre-terminal SUS fisheries. For 2024, the

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[58] For the purposes of assessing management performance, the objectives in place at the time are compared to the exploitation rates resulting from the FRAM model used at the time (i.e., old base period). The FRAM model was recently updated to a new base period and results using that model are different for some years.

proposed fisheries, utilizing this aggregate escapement objective, will result in 1,409 natural-origin adults escaping fisheries to the spawning grounds (Table 24). This level of natural-origin spawner abundance would be higher than the recent 10-year average, and well above the rebuilding threshold (Table 5). The proposed actions for 2024 are projected to result in an additional 1,673 hatchery origin recruits straying to the spawning grounds for a total natural escapement of 3,082. These outcomes will result in total natural escapement that should result in net positive production from the system, based on the updated spawner-recruit assessment (PSIT and WDFW 2017c).

Exploitation rates in 2024 on four of the five management units in this Region are expected to exceed their RERs or RER surrogates for the populations in those management units (Lake Washington representing the Sammamish and Cedar populations, Duwamish-Green, Puyallup, and Nisqually) (Table 24), by low to substantial amounts (10.5-40.6%). After the proposed fisheries natural-origin spawning escapements in 2024 are expected to be above the critical threshold for all of the populations except for the Sammamish River, above the rebuilding threshold for two of the six—White River, and Puyallup, and between the critical and rebuilding thresholds for three of six populations—Cedar, Duwamish-Green, and Nisqually (Table 24). The additional contribution of hatchery spawners to natural escapement for most of the populations in this region (Table 24) should mitigate short-term demographic risk.

The Cedar, Sammamish and Puyallup River populations are in PRA Tier 3. The populations share a common life history which is also represented by the Nisqually population in the Region. It is also important to remember when assessing the risks to the Sammamish and Puyallup populations that there are no indigenous populations remaining in these watersheds because they were extirpated, so there is not a risk of losing unique genetic life-history diversity from the ESU. The observed increasing trend in total escapement for both the Cedar and Sammamish populations and stable growth rate in natural-origin escapement for the Cedar should mitigate increased risk as a result of exceeding the RER in 2024. In addition, escapement for the Cedar is expected to continue to exceed its rebuilding threshold in 2024 and long-term productivity is 2.7; indicating the population is more than replacing itself (Table 24). If the Puget Sound salmon fisheries closed in 2024, we estimate that an additional 50 natural-origin spawners would return to the Sammamish population. While these additional spawners, in 2024, would increase the natural-origin spawning abundance over the critical threshold (200) this single-year increase would not change the overall status of the population because the number of recruits produced per spawner remains very low indicating that habitat conditions are limiting the population’s ability to grow (Sammamish = 0.5, Table 5). The low productivity of the watersheds given the much higher level of overall escapement (Table 5) suggests natural-origin recruitment will not increase much beyond existing levels unless constraints limiting marine, freshwater, and estuary survival for the Cedar and Sammamish populations are alleviated.

The Duwamish-Green River population is a Tier 2 population in the ESU. A Tier 2 population must recover at a sufficient pace to allow for its potential inclusion as a “Tier 1” population if needed for recovery. The anticipated exploitation rate for this population in the proposed 2024 Puget Sound salmon fisheries is 39.1 percent for a total exploitation rate of 56.3 percent for the 2024 fishing season (Table 24). This rate substantially exceeds its surrogate RER of 17 percent. Exceeding the RER suggests an increased risk to the viability of the population. However, it is important to consider the degree to which other factors and circumstances mitigate the risk. Growth rate for natural-origin escapement is stable and higher than growth rate for recruitment (i.e., abundance before fishing) indicating that current fisheries management is providing some stabilizing influence to abundance and productivity and thereby reducing demographic risks. Anticipated natural-origin escapement in 2024 is below the rebuilding threshold (1,047 out of 1,700) but well above the critical threshold (400) (Table 24). The anticipated 2024 level of natural-origin escapement is below that observed in most years since 2010 (higher than projected 2024 escapement in 7 of 12 years). Natural-origin and total escapements in 2016, 2017, and 2018 were much higher than other recent years because of higher than expected returns coupled with more constrained fisheries in those years due to forecasted low abundance. Anticipated natural-origin spawner escapement in 2024 for the Green River is expected to be below the recent ten-year average (1,047 compared to 1,508 (2012-2021), inclusive of those stronger brood years. When expected hatchery-origin spawners are included, the total spawning escapement in 2024 will be 3,562. Preliminary escapement estimates from 2022 indicate escapement higher than forecast in that year’s preseason (2,153 vs the expected 1,619) and above the rebuilding threshold.

The co-managers have implemented several programs to bolster natural recruitment of the Duwamish-Green River population and take advantage of a gravel supplementation project in the Green River below the Tacoma Headworks Diversion Dam (RM 61.0). Beginning in 2010, all adult Chinook that were surplus to Soos Creek Hatchery program needs were transferred to the spawning grounds and allowed to spawn naturally in the Green River. In 2011, a rebuilding program that acclimates and releases juveniles in the upper river (RM 56.1) was initiated. The resulting increased escapement and shift in spawning distribution to the upper watershed, relative to the years preceding 2014, is hypothesized to be strongly linked to the success of the production provided by the Green River supplementation program in the upper watershed. Since 2017, approximately 30% of redd production has been estimated to come from supplementation returns, much of which can be attributed to redds constructed in the upper watershed (Pers Comm. Jason Schaffler, Muckleshoot Indian Tribe, May 2021). The acclimation of juveniles in the upper river has been made a permanent part of the hatchery programs in the Green River, which received ESA 4(d) Rule coverage in 2019 (NMFS 2019e).

Terminal fisheries in the Duwamish-Green, as planned in the pre-season, occur contingent on confirmation of the pre-season terminal-area forecast. Initial results from the update will be available the first week of August. The co-managers will meet with NMFS by phone to discuss the initial results soon after the test fishery. If needed up to 100% of the natural-origin adults returning to Soos Creek, as well as hatchery-origin fish, surplus to the hatchery program needs, can be transferred to the upper Green River spawning grounds to achieve the spawning escapement goal (NMFS 2019c). There were additional fish (roughly 300 NOR and HOR combined) transported from the Soos Creek Hatchery to the spawning grounds in 2021 but not in any other recent years because early surveys indicated that spawning escapement expectations were beings met (Pers Comm. Jason Schaffler, Muckleshoot Indian Tribe, May 2022). The lower predicted natural-origin escapement in 2024 will represent a departure from recent year escapements near the rebuilding threshold. When considered within the context of recent year escapement levels and preliminary estimates from 2022, 2024 may represent a single, anomalous year of reduced natural-origin spawners. Not much longer than a decade ago, the Green-

Duwamish population experienced a significant period of reduced productivity where natural-origin escapement was frequently below 1,000. Fisheries were scaled back significantly in response to this downturn. As described above, the co-managers implemented significant actions to address both the number of total spawners in those low years as well as projects to increase spawning access to upper system spawning grounds that have had gravel augmentation. These actions, as well as other environmental improvements, resulted in increasing run sizes and escapements of both hatchery and natural-origin runs back to the Green River.Therefore, management of the fisheries and hatchery escapement in 2024 should ensure that the overall gains in recent years to natural-origin and total escapement will not be substantially affected by a single year of reduced natural-origin escapement.

Terminal fisheries directed at the Green River stock are managed based upon an in-season update (ISU) with a test fishery during statistical weeks 30-32 in Elliott Bay that updates the terminal run-size (marked and unmarked adult returns). Terminal fisheries are contingent on confirmation of the pre-season forecast. Initial results from this ISU will be available during statistical week 32 (the 1st week of August). The co-managers will make in-season decisions consistent with the projected run size and natural escapement estimates. NOAA Fisheries will be informed of any subsequent management actions taken by the state and tribal co-managers that deviate from the pre-season fishery structure in the 2024 List of Agreed to Fisheries resulting from the inseason update (Mercier 2024).

The Nisqually population is a Tier 1 population essential to recovery of the ESU. The anticipated exploitation rate in the proposed Puget Sound salmon fisheries is 30.9 percent for a total exploitation rate of 45.5 percent. This rate substantially exceeds its surrogate RER of 35 percent. Exceeding the RER suggests an increased risk to the long-term persistence of the Nisqually population which is also experiencing a declining growth rate in natural-origin recruitment (Table 6) and a relatively low abundance of natural-origin escapement (Table 5). Therefore, it is important to consider the degree to which other factors and circumstances mitigate this risk. The reduction in the total exploitation rate ceiling from 52 percent in 2014-2015, 50 percent in 2016-2017 and to 47 percent in 2017 represents steps in a long term transitional strategy designed to reduce rates over time in concert with improvements in habitat and adjustments in hatchery operations (SSPS 2005; PSIT and WDFW 2010a; Nisqually Chinook Work Group 2011; Turner 2016; Thom 2017). The co-managers completed work on a transitional strategy in a December 2017 plan (Nisqually Chinook Work Group 2017; Mercier 2022; 2023; 2024). The 2017 plan now guides harvest and hatchery actions moving forward, including fisheries in 2024, and includes timelines, performance criteria and performance goals.

The indigeonous Chinook population in the Nisqually River is extirpated and the recovery objective is to recover the population using the individuals that best approximate the genetic legacy of the original, indigenous Chinook salmon population, reduce the effects of the factors that have limited their production, and provide the opportunity for them to readapt to the existing conditions. Currently, there is an increasing trend for total natural escapement and a stable growth rate for natural-origin escapement (Table 6**)**. Growth rate for natural-origin escapement (i.e., fish through the fishery) is higher than growth rates for recruitment (i.e., abundance before fishing) indicating that current fisheries management is providing some stabilizing influence to abundance, in spite of the habitat’s current low productivity, and thereby reducing demographic risks.

In 2022, The Nisqually Indian Tribe's Natural Resources staff completed a 4-year selective fishery gear study in the lower Nisqually River tribal net fishery. The first year (2019) was a pilot year to test various gear effectiveness at catching fish. In 2020, the tribe tested their initial preferred experimental gear[59] for short-term mortality. While the testing was limited due to the 2020 COVID-19 pandemic, they were able to fish for one day, during each of two separate weeks, and capture and hold for a 24-hour period) 10 adult Chinook salmon from each day. The vast majority of the fish were captured and sampled in good condition, with only minor injuries observed on a couple of fish. The fish were transferred into in-river mesh bags to recover and were sampled and released after a 24-hour period. All 20 total fish were released the next day in category 1 condition – no observable injuries or diminished condition. In 2021, 129 adults were captured in the test gear and held for a 24-hour period. Initial results indicate potential low rates of short-term gear-related mortality (Nisqually Indian Tribe 2022). The work during the 2022 period resulted in 128 adults captured and held for a 24-hour period with 126 of the fish released in good condition and two in poor condition. This work was focused on development of effective and usable gear in the tribal net fishery, part of the transition strategy to be able to harvest the surplus hatchery-origin fish while limiting the impacts of the in-river fishery on natural-origin spawners. As was implemented during the 2023 fishing season, under the proposed action for 2024, a portion of the in-river, tribal net fishery will utilize the gear developed during this study, selectively harvesting hatchery-origin fish and returning natural-origin fish to the river, with the impacts of the tribal selective net fishery included in the total exploitation rate (45.5%) on the Nisqually population.

Significant work is occurring in the Nisqually and its environs to improve and restore freshwater and estuarine habitat through land acquisition, estuary improvement, and similar projects. The timing and magnitude of changes in harvest that occur in the Nisqually watershed is part of the longer-term transitional strategy and must be coordinated with corresponding habitat and hatchery actions and take into account the current status of the population (Nisqually Chinook Work Group 2017). The transition will occur over years and perhaps decades as the habitat improves to support better production and the current naturally-produced Chinook salmon population becomes locally adapted and less reliant on hatchery production to sustain it. Over the last 15 years, the co-managers have taken significant steps to transition from solely hatchery goal management to an approach for the Nisqually population where impacts to unmarked Chinook are managed to stay within an exploitation rate ceiling, allowing a proportion of unmarked fish to escape to the spawning grounds.

Given these circumstances, as discussed earlier, it is important to consider the degree to which, collectively, these actions mitigate the identified risk of exceeding the RER. The strategy for populations like the Nisqually, as described in Section 2.3.1, is to recover the extant 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. The reductions in harvest that have occurred in recent years

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[59] Small mesh gill net, fished in short drifts and pulled immediately, similar to a traditional multi-strand tangle net implementing live capture, selective removal.

and the fishery regime for 2024 are a part of the longer-term transitional strategy that is being coordinated with corresponding habitat and hatchery actions (Nisqually Chinook Work Group 2011; 2017). The strategy is to reduce harvest impacts in the short term while system capacity and productivity is tested and to implement the other components of the strategy that will take longer to realize benefits (habitat protection and restoration, hatchery reform). Managers continue to make substantial changes to the fishery in order to better meet preseason expectations and reduce the chances of exceeding the exploitation rate objectives while providing for meaningful exercise of treaty tribal fishing rights. The trends in total escapement and growth rate for natural-origin escapement are increasing and stable, the natural-origin escapement anticipated in 2024 is expected to be above its critical threshold, by nearly three times, lowering short-term demographic risk to the population. As part of the transitional strategy, the co-managers began transporting natural-origin and hatchery-origin adults, recruiting to the Clear Creek Hatchery into the upper Nisqually River basin, during a “recolonization” and productivity-testing period (2018-2022) (Nisqually Chinook Work Group 2017). The resulting juvenile production from these augmented escapements is being used to establish habitat density models and to estimate the spawning success of the adults, by origin, through genetic parentage analysis. All of which is needed for the development of long-term stock management objectives under the Nisqually stock management Plan (Nisqually Chinook Work Group 2017)

The additional risks associated with exceeding the RER in the 2024 fishing year should not affect the long-term persistence of the Nisqually Chinook population. Such a strategy is also consistent with NMFS’ responsibility described earlier to harmonize its tribal trust responsibility and conservation mandates by achieving conservation benefits while reducing disruption of treaty fishing opportunity (Garcia 1998). Tribal fisheries are estimated to account for 72 percent of the harvest of unmarked Nisqually Chinook in 2023 Puget Sound salmon fisheries.

The co-managers may propose fisheries in April 2025, similar to those in 2024, to harvest White River spring Chinook. The fisheries, if proposed would be managed under the White River objectives in Table 25. These objectives limit the allowable SUS exploitation rate to 15% at critical run size and 22% at normal abundance run size. The management of these fisheries has been consistent, with exceedance of the annual objective in only two years out of the most recent 10 years for which data is available (Table 23). In other years, SUS exploitation rates on White River spring Chinook have ranged from 5 to 15 percent, well below the exploitation rate ceiling of 22% and the RER (24%). Therefore, it is reasonable to expect the early spring 2025 fishery (April-May 14, 2025), should it occur, would have a lower impact on natural-origin escapement than the 2024 fisheries, as it would only act on a portion of the 2025 returns, limiting the scale of overall impact to the White River Chinook Management Unit. The managers would adjust the fishery if needed to ensure that impacts remain below the applicable exploitation rate ceiling (15% or 22% SUS ER) once abundance forecasts for 2025 are available. The population, which has been managed annually under the proposed objectives, has performed well, relative to its rebuilding escapement threshold, with a long-term average escapement of natural-origin fish above the rebuilding criteria (Table 5). Additionally, the population shows growth in both long-term natural-origin escapement and recruitment, indicating that harvest rates are not impeding the population from growth.

In summary, given the information and context presented above, the fishing regime represented by the proposed actions should adequately protect five (White, Cedar, Duwamish-Green, Puyallup, and Nisqually) of the six populations in the Region in 2024 and provide results consistent with the recovery plan guidance because it will allow for progress towards viability of two to four populations representing the range of life histories displayed by the populations in the Region, including those specifically identified as needed for recovery of the Puget Sound Chinook ESU (White River and Nisqually). In 2024, the Sammamish population may experience increased risks to the pace of adaptation of the existing local stock given the low abundance of the natural-origin population. However, the native population has been extirpated and potential improvement in natural-origin production is limited by the existing habitat. Analysis suggests further harvest reductions in 2024 Puget Sound fisheries would not measurably affect the status of the Sammamish population, which does have stable growth rates for natural-origin recruitment and escapement (Table 6). This population is not essential for recovery of the Puget Sound Chinook ESU (PRA Tier 3). Both the life history and the Green River genetic legacy of the population are represented by other populations in the Central/South Sound Region.

Hood Canal Region: There are two populations within the Hood Canal Region: the Skokomish River and the Mid-Hood Canal Rivers populations (Figure 1). Each population forms a separate management unit. Both the Skokomish and Mid-Hood Canal Rivers populations are considered PRA Tier 1 populations. The original indigenous Chinook populations have been extirpated in both systems and hatchery contribution to natural escapement is significant for both populations, although available data for the Mid-Hood Canal population is limited (Table 5) (Ruckelshaus et al. 2006). NMFS determined that both populations must be at low extinction risk to recover the ESU, so management of activities affecting both populations will need to transition to natural-origin management over time.

While the overall historical structure of the Hood Canal Chinook salmon populations is unknown, the TRT determined that any early run-timing life history components were extirpated (Ruckelshaus et al. 2006). The largest uncertainty within the Hood Canal populations, as identified by the TRT, is the degree to which Chinook salmon spawning aggregations are demographically linked in the Hamma Hamma, Duckabush, and the Dosewallips rivers. The TRT identified two possible alternative scenarios to the one adopted in the recovery plan for the Mid Hood Canal Rivers population. One is that the Chinook salmon in the Hamma Hamma, Duckabush, and Dosewallips were each an independent population (Ruckelshaus et al. 2006). Habitat differences do exist among these Mid-Hood Canal rivers. For example, the Dosewallips River is the only system in the snowmelt-transition hydroregion. The other scenario is that Chinook salmon spawning in the Hamma Hamma, Duckabush, and Dosewallips rivers were subpopulations of a single, large Hood Canal Chinook salmon population with a primary spawning aggregation in the Skokomish River. Only a few historical reports document Chinook salmon spawning in the mid-Hood Canal streams, which is consistent with one theory that they were not abundant in any one stream before hatchery supplementation began in the early 1900s. In addition, the overall size of each watershed and the area accessible to anadromous fish are small relative to other independent populations (Ruckelshaus et al. 2006). There is evidence to suggest that the declines in abundance in the early to mid-2000's were, in part related, to concurrent reductions and eventual elimination in marine net pen yearling Chinook hatchery production in the area, and therefore not indicative of changes in the status or productivity of the population per se (Adicks 2010). Moreover, recent discontinuation of a supplementation program in the Hamma Hamma River and the resulting decrease in recent year natural-origin returns may indicate the low capacity for production in the absence of supplementation and/or the source stock or river system supplemented may be incompatible. Genetic analysis indicates no difference between fall Chinook salmon originating from the George Adams and Hoodsport hatcheries and those currently spawning naturally in the Skokomish River and the Mid-Hood Canal systems (Marshall 1999; 2000).

Although the TRT ultimately identified two independent populations within Hood Canal Region (the Skokomish and Mid-Hood Canal rivers populations), the TRT noted that important components of the historical diversity may have been lost, potentially due, in part, to the use of transplanted Green River origin fish for hatchery production in the region (Ruckelshaus et al. 2006). The two extant populations reflect the extensive influence of inter-basin hatchery stock transfers and releases in the region, mostly from the Green River (Ruckelshaus et al. 2006). The degree to which this result is influenced by straying of Skokomish River Chinook in addition to the use of George Adams broodstock in the Hamma Hamma supplementation program is uncertain. Beginning in 2005, the co-managers increased mark rates of hatchery fish produced in the Hood Canal Region to distinguish them from natural-origin spawners in catch and escapement; providing better estimates of stray rates between the Mid-Hood Canal rivers and the Skokomish River system. Exchange among the Duckabush and Dosewallips stocks within the Mid-Hood Canal Rivers population, and other Hood Canal natural and hatchery stocks is probable although information is limited due to the very low escapements (PSIT and WDFW 2010a). Uncertainty about the historical presence of a natural population notwithstanding, current habitat conditions may not be suitable to sustain natural Chinook production.

As described in the environmental baseline, historically, low flows resulting from operation of the Cushman dams and habitat degradation of freshwater and estuarine habitat have adversely affected the Skokomish population. A settlement agreement finalized in 2008 between the Skokomish Tribe and Tacoma Power, the dam operator, resulted in a plan to restore normative flows to the river, improve habitat, and restore an early Chinook life history in the river using hatchery supplementation. Elements of the settlement agreement were complemented by additional actions proposed by the co-managers in 2014 (Redhorse 2014a) to develop a late-timed hatchery fall Chinook stock that is better suited to the regime than the existing non-indigenous stock, by re-aligning the Chinook hatchery production at the George Adams Hatchery and adjusting fisheries to coordinate with the later-timed Chinook salmon run. By selectively managing broodstock, the program seeks to re-establish a later-timed fall Chinook population, similar to the dominant life-history that existed historically in the Skokomish watershed. As described in the Environmental Baseline, there can be adverse effects from hatchery programs from competition, predation, genetics, and other factors depending on the specific circumstances. The co-managers' late-fall Chinook program does not include a new hatchery or enlarge the current program, but uses a component of the existing program to reduce demographic risks and improve the long-term prognosis for recovery. The first broodstock for the program was collected in 2014 and the progeny were released in the spring of 2015. Returns from that first release group have been collected in the recent years with full program (200-300K release goal [60]) being collected in 2018, 2019, 2020, and 2021 (WDFW escapement reports). Additional

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[60] On-site release of 200K is primary objective. If additional broodstock are available, additional eggs will be collected to allow for releases of up to 100K additional juveniles into Skokomish River tributaries. Surplus returning late-timed

review and development of the late-timed hatchery program was undertaken in 2015 and 2016. In 2020 and 2021, late-timed hatchery program returns to the hatchery were lower than necessary for full program. The co-managers utilized the latest maturing adults from the normal-timed program fish to generate the full egg-take for the late-timed program (Mercier 2021a; 2022; 2023). For broodyears 2022 and 2023, full program eggtake was achieved in both years, with resulting releases of more than 300K juveniles in the spring of 2023 and 2024 (scheduled) (Mercier 2024).

The expectation is that, with the late-fall program releases from the prior broods, the 2024 return to the hatchery will result in the full program being collected from the late-returning fish.

The late-timed hatchery program complements a similar conservation hatchery program that seeks to reintroduce spring Chinook into the Skokomish River. That program was also initiated in 2014 with the transfer of the first brood stock, from the Skagit River basin, for spawning and subsequent juvenile release. Both the spring and late-fall programs are key components of the co-managers' longer-term transitional strategy to recover natural origin Chinook salmon that is being coordinated with corresponding habitat, hatchery, and harvest actions (Skokomish Indian Tribe and WDFW 2010; Redhorse 2014a; Skokomish Indian Tribe and WDFW 2017) (Unsworth and Grayum 2016; Speaks 2017b; Shaw 2018a; Norton 2019a; Mercier 2020). In addition to the hatchery programs, significant work is occurring to stabilize river channels, restore riparian forests, improve adult Chinook access to the South Fork Skokomish, and improve and restore estuarine habitat through land acquisition, levee breaching and similar projects (PSIT and WDFW 2010a; Redhorse 2014a; PSIT and WDFW 2017b). The timing and magnitude of changes in harvest that occur in the Skokomish watershed as part of the longer-term transitional strategy must be coordinated with corresponding habitat and hatchery actions and take into account the current status of the population. This transition will likely occur over years and perhaps decades as the habitat improves to support better production and the current population becomes locally adapted and less reliant on hatchery production to sustain it. Over the last decade, the co-managers have transitioned from solely hatchery escapement goal management to management for natural spawning ground escapement, including an exploitation rate limit for unmarked (primarily natural origin) Skokomish Chinook salmon of 50% beginning in 2010.

Average natural-origin escapements from 1999-2021, for both the Skokomish and Mid-Hood Canal populations, are below their critical thresholds and productivity in the Skokomish is below 1.0 (Table 5). When hatchery-origin spawners are taken into account, average escapement for the Skokomish exceeds its rebuilding threshold. Growth rates for natural-origin recruitment are declining for both populations and the growth rate for natural-origin escapement is also declining for the Skokomish population. The trend in total, natural escapement for the Skokomish population is stable (Table 6). The escapement levels in the individual rivers comprising the Mid-Hood Canal rivers population have not varied uniformly and the most recent years' very low, post-supplementation returns (2019 forward) are not yet fully factored into the above trend. The TRT suggests that most of the historical Chinook salmon spawning in the Mid-Hood Canal rivers was "likely to [have] occurred in the Dosewallips River because of its larger size and greater area accessible to anadromous fish" (Ruckelshaus et al. 2006). However, production from

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program adults may also be outplanted into tributaries.

the Hamma Hamma Fall Chinook Restoration Program, a hatchery-based supplementation program contributed substantially to the Mid-Hood Canal rivers population. As a result, since 1998, the spawning aggregation in the Hamma Hamma River generally comprised the majority of the Mid-Hood Canal rivers population. In comparison, the other two rivers in the population have seen decreases in escapements during this same time period. Spawning levels have been 20 fish or less since 2010 in the Duckabush and Dosewallips rivers. The goal of the Hamma Hamma restoration program was to restore a healthy, natural-origin, self-sustaining population of Chinook salmon to the Hamma Hamma River. This hatchery production was generally responsible for the increased total natural escapement observed in the Hamma Hamma River. From 2010 to 2018, up to 87% of the Chinook salmon spawning in the Hamma Hamma River were of hatchery origin (WDFW and PSTIT 2009; 2011; 2012; 2013; 2014; 2015; 2016b; 2017b; WDFW and PSIT 2019). The juveniles from brood year 2014 were the last releases from the program and it was discontinued because of the poor returns from the program, indicating additional uncertainty for this population in the future. Adult returns from prior releases contributed to mid-Hood Canal escapements through 2019 (5yo returns). Recent habitat assessment work completed by the co-managers (Mid-Hood Canal Work Group 2022) indicates that the current habitat capacity of the mid-Hood Canal rivers is not conducive to a self-sustaining Chinook population, even under assumed juvenile survival estimates that are well above those seen in recent years.

Total average observed exploitation rates during 2009-2021 were 23 and 55 percent for the Mid-Hood Canal and Skokomish populations, respectively (Table 13), both well above their RERs (Table 22). Southern U.S. exploitation rates during the same period averaged 11 and 43 percent for the Mid-Hood Canal and Skokomish River populations, respectively (Table 13). Alaska and Canadian fisheries accounted for 54 and 22 percent of the harvest of the Mid-Hood Canal and Skokomish rivers populations, respectively (Table 13).

Under the proposed actions, escapement for both populations is expected to be below the critical thresholds (Table 24). Total exploitation rates for both populations are expected to exceed their RER or RER surrogate (Table 24). For the Mid-Hood Canal population, the exploitation rate in 2024 Puget Sound salmon fisheries under the proposed actions is expected to be low (9.2%). The forecasted natural-origin escapement for the Skokomish and Mid-Hood Canal populations is low and very low, respectively, relative to their critical abundance threshold. However, if Puget Sound salmon fisheries were closed in 2024, we estimate that at most one additional natural-origin spawners would return to the Mid-Hood Canal population. Approximately 215 additional natural-origin Chinook spawners would return to the Skokomish River in the absence of Puget Sound salmon fisheries. This would not change the status of the Mid-Hood Canal Rivers population in 2024 relative to its critical and rebuilding thresholds and would likely not meaningfully change the trend of the Skokomish population since it is not replacing itself even accounting for years when escapement has been higher (long-term productivity <1) (Table 5).

For the Skokomish population, the anticipated exploitation rate in 2024 under the proposed actions from Puget Sound salmon fisheries is 33 percent with a total exploitation rate of 49.7 percent. Exceeding the RER suggests an increased risk to the viability of the Skokomish population which is experiencing declining growth rate in natural-origin recruitment and escapement, a stable trend in total escapement (Table 6), low abundance of natural-origin escapement (Table 5) and is essential to the recovery of the ESU. Modelling suggests that a 50 percent exploitation rate, if implemented over a 25-year period, would reduce the probability of the current Skokomish population exceeding the re-building escapement threshold by half (-50%), in that timeframe, compared with achieving the RER of 35 percent. The 50 percent exploitation rate would also result in a very small change (1 percentage point) in the probability of the population falling below the critical escapement level (NMFS 2011a).

In 2015, available estimates indicate that observed exploitation rates for the Skokomish population had exceeded the management objective of 50 percent in all but three years for which data are available since its adoption in 2010, likely resulting in an even greater risk to rebuilding a sustainable population (Table 23). Subsequent analysis showed that, between 2010 and 2016, the ceiling was exceeded by 3 percent to 13 percentage points (average 8.5%) with virtually all of the overage attributable to Hood Canal terminal net fisheries. Areas 6 and 7 marine sport fisheries consistently contributed to a lesser extent (James 2018b). Post season estimates of exploitation rates in preterminal fisheries were generally below expected levels. In a 2014 performance review, errors in forecasting terminal abundance and estimating catch per unit effort were identified as the primary contributing factors. In response, managers tackled the problem on two fronts; improving forecast methods and making changes in both the terminal tribal net and sport fisheries in 2013-2017. Managers increasingly restricted and restructured the tribal net fishery to reduce the harvest rate and meet the target levels. The number of fishing days during the Chinook management period was reduced from 24 in 2010 to 12 days in 2017 with additional delays in the coho fishery. The 2024 proposed fisheries maintain the fishery limits and closures implemented in recent years, resulting in no tribal net fishing in the Skokomish River mainstem over six continuous weeks; the last two weeks of the Chinook management period and the first three weeks of the coho management period. These changes were made to protect returns of late-fall Chinook (hatchery and natural-origin) and bring the total exploitation rate under the ceiling. Skokomish River sport fisheries were closed beginning in 2016 (Bowhay and Warren 2016; Speaks 2017b; Shaw 2018a) and will continue to be closed in 2024 (Mercier 2023; 2024).

The co-managers have presented additional information that indicated some reduction in the chronic exceedance of the exploitation rate has likely occurred as a result of the modifications to the fishery described above, but results were mixed indicating that additional caution was still warranted. The 2018 performance review indicated errors in FRAM model inputs for Canadian fisheries were corrected, adjusting the previous underestimate of fishing mortality by 0.8 percent (James 2018b). With that correction, three of the last four years'(2013-2016) estimates of exploitation rates from the FRAM validation runs were equal to or below the objective (Table 23) (James 2018b; Rose 2018). More recent analysis of post-season FRAM validation runs, through 2020 and using updated validation data (October, 2023) for all years back to 1992, indicate that the annual management objective for the Skokomish has only been exceeded in one year in the most recent five (2019; 9% exceedance) (Table 23). These indicate that the performance review completed in 2018, coupled with the changes implemented in the terminal fisheries, as described above, have resulted in reduced harvest rates and greater certainty of the annual fisheries meeting the pre-season management objective. The shaping of treaty terminal fisheries and additional actions to improve forecasting and model performance should improve the likelihood that the exploitation rate objective will be met in 2024. The conservation objective for Skokomish, developed in the 2010 Puget Sound Chinook RMP (WDFW and PSTIT 2011), was for a 50 percent total exploitation rate ceiling on unmarked adults. The proposed 2024 Puget Sound fisheries, combined with the fisheries that occur outside of Puget Sound, are forecasted to achieve just under a 50% ER (Table 24).

Given these circumstances, as discussed earlier, it is important to consider the degree to which other factors and circumstances mitigate the risk to the viability of the Skokomish Population from exceeding the RER. The indigenous Chinook salmon population is extirpated and the strategy for populations like the Skokomish, as described in Section 2.3.1, is to recover the population using the individuals that best approximate the genetic legacy of the original, indigenous Chinook salmon population, reduce the effects of the factors that have limited their production and provide the opportunity for them to readapt to the existing conditions.

As part of the longer term transitional strategy, and in response to commitments in the 2010 Puget Sound Chinook Harvest RMP (PSIT and WDFW 2010a), the co-managers are implementing a plan to manage broodstock from the existing George Adams Chinook hatchery program to establish a late-timed Skokomish fall Chinook run similar to the historic run timing (see above) (Redhorse 2014a). This action is in addition to the program to reintroduce spring Chinook, that was initiated in 2014, and has been developed further as part of the proposed actions in 2018 (Shaw 2018a), 2019 (Norton 2019a), 2020 (Mercier 2020), 2021 (Mercier 2021b), 2022 (Mercier 2022), 2023 (Mercier 2023), and proposed for 2024 (Mercier 2024). The two-track strategy of reintroduction and local adaptation should maximize the prospect for establishing at least one self-sustaining Chinook population in the Skokomish River. The run-timing for these programs (earlier and later) will be better suited to the environmental conditions in the river on their return (Skokomish Indian Tribe and WDFW 2010; 2017) than the timing of the current Chinook population that returns in late summer when flow and temperatures can cause adverse spawning and incubation conditions. If successful, establishment of a self-sustaining spring Chinook run and/or a late-timed component of the extant fall Chinook population should significantly contribute to recovery of the Skokomish Chinook population. After the 2024 return year, the late program’s effectiveness of meeting its established objectives will be reviewed (Mercier 2024). The long-term (1999-2021) average total escapement is well above the rebuilding threshold (Table 5), the escapement trend of natural spawners is stable and, growth rates for natural-origin escapement are higher than growth rates for recruitment (Table 6). This indicates that current fisheries management is providing some stabilizing influence to abundance and productivity given current habitat conditions; reducing demographic risks. However, the low productivity, continued critical status of natural-origin escapement and negative growth rates in natural-origin recruitment and escapement for the Skokomish Chinook population underscore the importance of meeting the exploitation rate objective such that fisheries do not represent more of a risk than is consistent with a transitional strategy to recovery.

In summary, given the information and context presented above, the fishing regime represented by the proposed actions should adequately limit impacts on the two populations in the region in 2024. Therefore, implementation of the proposed 2024 fisheries is consistent with the recovery plan guidance as it does not impede progress towards the long-term viability of at least two populations representing the range of life histories displayed by the populations in that Region including those specifically identified as needed for recovery of the Puget Sound Chinook ESU (Skokomish and Mid-Hood Canal). The Mid-Hood Canal population may experience increased demographic risk given the extremely low forecast for 2024 (Table 23). However, as with the Skokomish River, the native population has been extirpated and potential improvement in natural-origin production is limited by the existing habitat. Analysis suggests further harvest reductions in 2024 Puget Sound fisheries would not measurably affect the risks to survival or recovery for the Mid-Hood Canal population.

Strait of Juan de Fuca Region: The Strait of Juan de Fuca Region has two watersheds with PRA Tier 1 populations including an early-timed population in the Dungeness, and a summer/fall-timed population on the Elwha (Table 2). Each population is managed as a separate management unit. NMFS determined that both populations must be at low extinction risk to recover the ESU. The status of both populations is constrained by significant habitat-related limiting factors that are in the process of being addressed. Survival and productivity of the Dungeness population are adversely affected by low flows from agricultural water withdrawals and by other land use practices (SSPS 2005; PSIT and WDFW 2010a). Projects have been implemented to pipe irrigation lines to reduce evaporation, improve management of groundwater withdrawal, and purchase available property to contribute to restoration of the flood plain. Until recently all but the lower five miles of the Elwha River was blocked to anadromous fish migration by two dams, and the remaining habitat in the lower river was severely degraded. Ambitious plans to remove the dams and restore natural habitat in the watershed began in 2011. Dam removal was completed in 2014. With dam removal, river channels are cutting through the old dam reservoir lake beds and significant restoration projects are underway to assist riparian regeneration and improve spawning and rearing habitat as the river recovers. The estuary is reforming rapidly as silt previously entrained by the dams moves through the system and out into the Strait of Juan de Fuca. Chinook began moving upstream into previously inaccessible reaches of the watershed almost immediately. The actions and the continuously improving estuarine and river conditions should significantly increase productivity and abundance of Elwha Chinook and enhance spatial structure and diversity. However, the benefits of these improvements are still likely to take years or possibly decades before they are fully realized.

Given the condition of salmon habitat in the Dungeness watershed and the significant disruption to the Elwha system as a result of dam removal, the conservation hatchery programs currently operating in the Dungeness and Elwha are key to protecting the populations for the near-term, and ultimately restoring the Chinook populations in the Strait of Juan de Fuca Region. While the current, long-term productivity of the Dungeness and Elwha natural-origin population show stability (each at 1.0 R/S (Table 5)), analyses of the growth rate of recruitment indicates that the natural-origin production of both populations may be slowing(Dungeness=0.96 growth rate of recruits, Elwha=0.89 growth rate of recruits, (Table 6).

The average natural-origin escapement for both populations is estimated to be below their critical thresholds and productivity for both is at or just above replacement (i.e. 1.0 recruits per spawner) (Table 5). When hatchery-origin spawners are taken into account, average escapement exceeds the critical threshold for the Dungeness and is above the rebuilding threshold for the Elwha (Table 5). The trend for total natural escapement (HOR+NOR) is increasing for both populations (Table 6). Long term growth rates for natural-origin recruitment and escapement are still below 1.0 for the Elwha population while the Dungeness long-term growth rates for natural-origin escapement looks to be stabilizing (Table 6). These statuses are not surprising given the historically poor conditions in these two watersheds. However, growth rates for natural-origin escapement (i.e., fish through the fishery) are higher than growth rates for recruitment (i.e., abundance before fishing) for both populations (Table 6). This indicates that current fisheries management is providing some stabilizing influence to abundance, in spite of the habitat's current low productivity, and thereby reducing demographic risks.

The conservation hatchery programs operating in the Dungeness and Elwha Rivers buffer demographic risks and preserve the genetic legacies of the populations as degraded habitat is recovered. Average observed exploitation rates during 2009-2020 were 24 percent (total) and 5 percent each (SUS) for the both Dungeness and Elwha River populations (Table 13), both above their RERs (Table 22). For 2024, when all fishing-related mortality is taken into account, including the proposed Puget Sound fisheries, natural-origin escapement is expected to be above the critical escapement threshold for the Dungeness but below critical for the Elwha populations (Table 24). When hatchery spawners are taken into account, escapements to the Elwha are much higher, with total spawners exceeding its rebuilding threshold (Table 5 and Table 24). Total exploitation rates for both populations are expected to exceed their RER surrogates by a substantial margin. On average, over 79 percent of the harvest that occurs on these two populations occurs in Alaskan and Canadian fisheries (Table 13) while exploitation rates in 2024-2025 Puget Sound salmon fisheries are expected to be 2.8% and 3.4% for the Dungeness and Elwha populations, respectively (Table 24). If Puget Sound salmon fisheries closed in 2024, we estimate that one additional natural-origin spawner would escape to each of the Dungeness and Elwha Rivers. Therefore, further constraints on 2024 Puget Sound fisheries would not measurably affect the risks to survival or recovery for the Dungeness or Elwha populations by providing sufficient additional natural-origin spawners to significantly change its status or trends than what would occur without the fisheries.

2.5.1.3 *Effects on Critical Habitat*

Critical habitat for Puget Sound Chinook is located in many of the areas where the fisheries under the proposed actions would occur. However, fishing activities will take place over relatively short time periods in any particular area. The PBFs most likely to be affected by the proposed actions are (1) water quality, and forage to support spawning, rearing, individual growth, and maturation; and, (2) the type and amount of structure and rugosity that supports juvenile growth and mobility.

Most of the harvest related activities in Puget Sound occur from boats or along river banks, with most of the fishing activity in the marine and nearshore areas. Effects of these activities likely include loss of some fishing gear that will become derelict gear, impacts to riparian vegetation and habitat from human traffic, boats and gear operating along the shore or in the nearshore, and a reduction in the number of adults returning to the spawning grounds which could in turn reduce the nutrient contribution from decaying fish carcasses. Impacts to the substrate are generally not a result of the proposed fishing activities. The gear fishermen use includes hook-and-line, drift and set gillnets, beach seines, and to a limited extent, purse seines. These types of fishing gear in general actively avoid contact with the substrate because of the resultant interference with fishing and potential loss of gear.

Derelict fishing gear can affect habitat in a number of ways including barring passage, harming eelgrass beds or other estuarine benthic habitats, or occupying space that would otherwise be available to salmon. The proposed action is likely to result in some increase in derelict gear in the action area, however, due to previous and outreach and assessment efforts (i.e. Gibson 2013), and development of lost net inventories (Beattie and Adicks 2012; Beattie 2013; James 2017) it is likely that fewer nets will become derelict in the upcoming 2024/25 fishing season, and beyond, compared to several years and decades ago (previous estimates of derelict nets were 16 to 42 annually (NRC 2010)). In 2022, an estimated twelve nets became derelict, and seven of them were recovered (James and Low 2023). In 2021, an estimated seven nets became derelict, and six of them were recovered (James and Low 2022). In 2020, an estimated three nets became derelict, and all three of them were recovered (James and Low 2021). In 2019, an estimated seven nets became derelict, and five of them were recovered (James 2020). In 2018, an estimated eight nets became derelict, and six of them were recovered (James 2019). In 2017, an estimated 11 nets became derelict (though not all of them may have been associated with a salmon fishery) and 10 were recovered (James 2018a). In 2016, an estimated 14 nets became derelict, and nine of them were recovered (James 2017), in 2014 an estimated 13 nets became derelict, 12 of which were recovered (James 2015), and in 2013 and estimated 15 nets were lost, 12 of which were recovered (Beattie 2014) and in 2012, eight nets were lost and six were recovered (Beattie and Adicks 2012). The Northwest Straits Foundation—from June 2012 to February 2016—reported a total of 77 newly lost nets were reported, and only 6 of these were reported by commercial fishermen (Drinkwin 2016). We do not yet have estimates for the number of nets lost in the 2023/24 salmon fisheries. Based on reported derelict nets, we estimate that a range of three to 20 gill nets may be lost in the 2024/25 fishing season, and beyond, but up to 75%-80% of these nets would be removed within days of their loss.

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. These impacts would be localized and transitory in nature. The proposed fishery implementation plan includes actions that would minimize these impacts if they did occur, such as area closures. Any impact to water quality from vessels transiting critical habitat areas on their way to the fishing grounds or while fishing would be short term and transitory in nature and minimal compared to the number of other vessels in the area (NMFS 2004d). Construction activities related to salmon fisheries are limited to maintenance and repair of existing facilities (such as boat launches), and are not expected to result in any additional impacts on riparian habitats.

By removing adults that would otherwise return to spawning areas, harvest could affect water quality and forage for juveniles by decreasing the return of marine derived nutrients to spawning and rearing areas, although this has not been identified as a limiting factor for the ESU. The proposed actions incorporate management for maximum sustainable spawner escapement and implementation of management measures to prevent over-fishing. Both of these actions have been recommended as ways to address the potential adverse effects of removing marine derived nutrients represented by salmon carcasses (PFMC 2014a). Because of the various measures described above are part of the proposed actions, there will be minimal disturbance to vegetation, and negligible harm to spawning or rearing habitat, water quantity and water quality from the proposed actions.

2.5.2 Puget Sound Steelhead

2.5.2.1 *Effects on Species*

In the listing determination for Puget Sound steelhead in 2007, NMFS determined that the harvest management strategy that eliminated the direct harvest of natural origin steelhead that the co-managers implemented beginning in the 1990s, prior to listing, largely addressed the threat of harvest to the listed DPS (72 Fed. Reg. 26722, May 11, 2007). Just prior to listing, the incidental terminal harvest rates in fisheries directed at other salmon species averaged 4.2% from 2001-2007, across the reference populations in Puget Sound (Table 17). Although available information on harvest rates continues to be limited, NMFS concluded in status reviews subsequent to listing that the status of Puget Sound steelhead has not changed significantly since the time of listing (Ford et al. 2011b; NWFSC 2015b; NMFS 2017a; NWFSC 2020) and reaffirmed the observation that harvest rates on natural-origin steelhead continue to decline and are unlikely to substantially affect the abundance and productivity of Puget Sound steelhead (NWFSC 2015b). This was also supported in the 2019 Puget Sound Steelhead Recovery Plan (NMFS 2019i). Consequently, NMFS continues to rely on the logic described above.

A key consideration in opinions addressing the effect of harvest to natural origin steelhead is therefore whether incidental harvest rates continue to remain low since listing in both the marine and terminal areas which would reinforce the conclusion that the threat harvest poses to the DPS continues to be low. To assess this premise for marine areas, NMFS compared the average catch of total steelhead in mixed stock marine area fisheries (Table 14, Environmental Baseline); from the time of listing to the average catches since listing (2007/08 to 2020/21) and concluded that average catch had declined by 51% (Table 14). Comparing more recent average harvest rates on the natural-origin steelhead reference populations in the terminal areas (Table 17) showed that the rates declined from 4.2% to 0.87% in Puget Sound fisheries during the 2007/2008 to 2022/2023 time period, a 79% reduction in harvest rate since listing (Table 17) supporting the conclusion that harvest rates Puget Sound natural-origin steelhead continue to be very low.

We then compare the estimated catch in marine areas described in Section 2.4.1, from the proposed 2024-2025 fisheries, to the best available information on expected abundance of the Puget Sound steelhead DPS to determine if marine catch levels should continue to be low in 2024 relative to the pre-listing period. Due to data limitations for many Puget Sound steelhead populations, it is not possible to determine the total abundance of steelhead within the DPS at this time. However, it is possible to provide a minimum estimate based on information for the populations that are available. The recent year annual minimum average abundance of 35,375 steelhead includes listed and unlisted hatchery fish, and listed natural-origin fish based on fisheries data provided by co-managers (WDFW and PSTIT 2021a; WDFW et al. 2021). The estimate includes total run size information for five reference populations out of the 32 extant steelhead populations (i.e., Skagit River summer/winter run; Snohomish winter run; Green winter run; Puyallup winter run; and Nisqually winter run). It also includes escapement estimates for 10 additional steelhead populations, although it does not include their associated harvest because the population specific catch data are not available. The estimate does not include anything for 17 of the 32 extant steelhead populations, or any fish that return to the hatchery racks for either the listed or unlisted hatchery programs. It also does not include anything related to Canadian and non-listed Olympic Peninsula steelhead populations that are also part of the composition of steelhead affected by Puget Sound marine area fisheries. Therefore, the estimate of just over 35,000 is a partial and very conservative estimate of the overall abundance of Puget Sound steelhead that may be impacted by marine area fisheries. Nonetheless, it provides some useful perspective about the likely impact of marine area fisheries.

We then consider the impact in both marine and terminal areas affect harvest rates under the proposed actions compares to the rates at the time of listing and in more recent years i.e., do the harvest rates under the proposed actions continue to be low? Figure 36 illustrates the marine and terminal areas where fisheries occur.

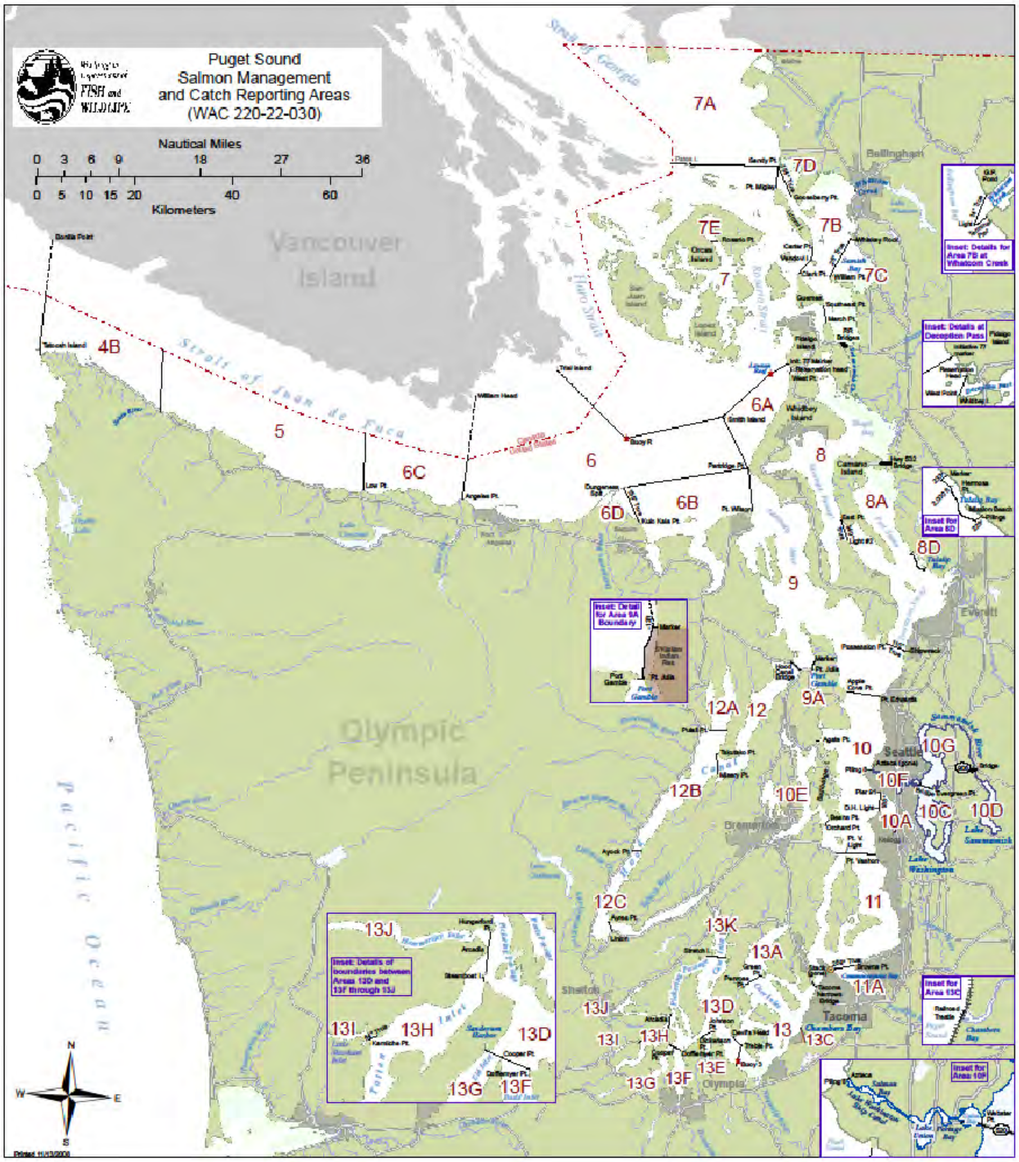

Figure 36. Puget Sound Commercial Salmon Management and Catch Reporting Areas (https://wdfw.wa.gov/sites/default/files/2019-03/wac_220-022-030.pdf).

To assess whether marine fishery impacts on steelhead continue to be low under the proposed action, we first estimate the marine harvest rate from the proposed action. Previous opinions have assessed fisheries impacts of up to 324 steelhead in Puget Sound marine waters from 2000/2001 through 2006/2007 as described in Section 2.4.1;(Table 14)(NMFS 2011c; 2014b; 2015a; 2016f; 2017c; 2018d; 2019d; 2020b; 2021f; 2022c). This number represents unlisted and listed steelhead taken in tribal and non-tribal marine area salmon fisheries under fishing regimes that had eliminated the directed harvest of wild steelhead. This estimate is consistent with the assessment of impacts at the time of listing that provided the basis for the conclusion that the regime had largely addressed the threat of decline to the listed DPS posed by harvest. Under the proposed actions for 2024-2025, the estimated impact on steelhead caught in Puget Sound marine fisheries from implementation of the proposed fisheries could be as high as 325 during the 2024-2025 season (Mercier 2024). Impacts of up to 325 steelhead would represent an estimated overall marine harvest rate on steelhead in Puget Sound waters, as a whole, of 0.92 percent (325/35,375 = 0.92). As described above, because the estimate of overall steelhead abundance is likely low, this is a conservative estimate (likely high) of what the harvest rate to Puget Sound steelhead in marine area fisheries is likely to be. The reported catch of steelhead in marine area fisheries in recent years averaged 159 from 2007/08 – 2020/21(Table 14), well below the 324 reported at the time of listing. This catch represents a harvest rate of 0.44 percent (159/35,375 = 0.44). As described in Section 2.4.1 and summarized in Table 14, the marine harvest rate in the more recent period (07/08-20/21) represents a 51% decline from the period prior to listing.

The average harvest rate in terminal area fisheries for the four reference populations (Snohomish winter run; Green winter run; Puyallup winter run; and Nisqually winter run) under implementation of the proposed actions is anticipated to be below 4.2 percent based on the similarity of anticipated fishing effort, catch patterns and fishing regulations in each of the four river systems (Mercier 2024). This expectation is substantiated by the consistent pattern of significantly lower harvest rates observed in recent years, described in Section 2.4.1 and summarized in Table 17, which represents a 79% reduction in the average terminal harvest rate for the four reference populations since 2007/2008. As described in the Assessment Approach Section (2.5.2.1), above, the harvest rate of 4.2 percent was the assessment of impacts at the time of listing that provided the basis for the conclusion that the fishing regime had largely addressed the threat of decline to the listed DPS posed by harvest.

Therefore, based on the best available information, the anticipated impacts to Puget Sound steelhead populations under the proposed actions, are expected to remain low and consistent with levels that NMFS has previously concluded are unlikely to substantially affect the abundance and overall productivity of Puget Sound steelhead.

2.5.2.2 *Effects on Critical Habitat*

Steelhead critical habitat is located in many of the areas where Puget Sound recreational and commercial salmon fisheries occur. However, fishing activities will take place over relatively short time periods in any particular area. The PBFs most likely to be affected by the proposed actions are (1) water quality, and forage to support spawning, rearing, individual growth, and maturation; and, (2) the type and amount of structure and rugosity that supports juvenile growth and mobility.

Most of the harvest related activities in Puget Sound occur from boats or along river banks with the majority of the fishing activity occurring in the marine and nearshore areas. Effects of these activities likely include loss of some fishing gear that will become derelict gear, impacts to riparian vegetation and habitat from human traffic, boats and gear operating along the shore or in the nearshore, and a reduction in the number of adults returning to the spawning grounds which could in turn reduce the nutrient contribution from decaying fish carcasses. Impacts to the substrate are generally not a result of the proposed fishing activities. The gear that would be used includes hook-and-line, drift and set gillnets or stake nets, beach seines, and to a limited extent, purse seines. These types of fishing gear in general actively avoid contact with the substrate because of the resultant interference with fishing and potential loss of gear. As a result, fishermen endeavor to keep gear from being in contact or entangled with substrate and habitat features because of the resultant interference with fishing and potential loss of gear. Derelict fishing gear can affect habitat in a number of ways including barring passage, harming eelgrass beds or other estuarine benthic habitats, or occupying space that would otherwise be available to salmon.

As indicated in the Chinook salmon section above (Section 2.5.1.2), the proposed action may result in some increase in derelict gear in the action area, however, due to recent additional outreach and assessment efforts (i.e. Gibson 2013), and recent lost net inventories (Beattie and Adicks 2012; Beattie 2013; James 2017) it is likely that fewer nets will become derelict in the upcoming 2024/25 fishing season, and beyond, compared to several years and decades ago (previous estimates of derelict nets were 16 to 42 annually (NRC 2010)). In 2022, an estimated twelve nets became derelict, and seven of them were recovered (James and Low 2023). In 2021, an estimated seven nets became derelict, and six of them were recovered (James and Low 2022). In 2020, an estimated three nets became derelict, and all three of them were recovered (James and Low 2021). In 2019, an estimated seven nets became derelict, and five of them were recovered (James 2020). In 2018, an estimated 8 nets became derelict, and six of them were recovered (James 2019). In 2017, an estimated 11 nets became derelict (though not all of them may have been associated with a salmon fishery) and 10 were recovered (James 2018a). In 2016, an estimated 14 nets became derelict, and nine of them were recovered (James 2017), in 2014 an estimated 13 nets became derelict, 12 of which were recovered (James 2015), and in 2013 and estimated 15 nets were lost, 12 of which were recovered (Beattie 2014) and in 2012, eight nets were lost and six were recovered (Beattie and Adicks 2012). In a more recent report - from June 2012 to February 2016 a total of 77 newly lost nets were reported, and only 6 of these were reported by commercial fishermen (Drinkwin 2016). We do not have estimates for the number of nets lost in the 2023/24 salmon fisheries. Based on this new information we estimate that a range of three to 20 gill nets may be lost in the 2024/25 fishing season (in total and inclusive of those described in Section 2.5.1.2, above), and beyond, but 75% or more of these nets would be recovered within days of their loss 20 gill nets may be lost in the 2024/25 fishing season, and beyond, but 75% or more of these nets would be recovered within days of their loss.

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. These impacts would be localized and transitory in nature. The proposed fishery implementation plan includes actions that would minimize these impacts if they did occur, such as area closures. Any impact to water quality from vessels transiting critical habitat areas on their way to the fishing grounds or while fishing would be short term and transitory in nature and minimal compared to the number of other vessels in the area (NMFS 2004d). Also, these activities would occur to some degree through implementation of fisheries or activities other than the Puget Sound salmon fisheries, i.e., recreational boating and marine species fisheries.

Any impact to water quality from vessels transiting critical habitat areas on their way to the fishing grounds or while fishing would be short term and transitory in nature and minimal compared to the number of other vessels in the area (NMFS 2004d). Construction activities related to salmon fisheries are limited to maintenance and repair of existing facilities (such as boat launches), and are not expected to result in any additional impacts on riparian habitats. Also, these activities would occur to some degree through implementation of fisheries or activities other than the Puget Sound salmon fisheries (i.e., recreational boating and marine species fisheries).

By removing adults that would otherwise return to spawning areas, harvest could affect water quality and forage for juveniles by decreasing the return of marine derived nutrients to spawning and rearing areas, although this has not been identified as a limiting factor for the DPS. The proposed actions incorporate management for maximum sustainable spawner escapement and implementation of management measures to prevent over-fishing. Both of these actions have been recommended as ways to address the potential adverse effects of removing marine derived nutrients represented by steelhead carcasses. Because of the various measures described above are part of the proposed actions, there will be minimal disturbance to vegetation, and no more than minor effects to spawning or rearing habitat, water quantity and water quality from the proposed actions.

2.5.2.3 *Fishery Related Research Affecting Puget Sound Chinook Salmon and Steelhead*

Two research projects are included under the proposed actions. Each of these projects has the potential to affect Puget Sound Chinook salmon and steelhead. These research projects are described and their impacts on listed Chinook and steelhead summarized below. The proposed fishery related research projects are designed and planned to contribute no more than 1% of ER to any one of the Puget Sound Chinook management unit’s conservation objectives in 2024, as a provision of the 2010-2014 Puget Sound Chinook harvest RMP as continued in the 2024-2025 harvest plan.

Lake Washington/Lake Sammamish Warmwater Invasive Species Research and Removal Efforts: Muckleshoot Indian Tribe (MIT) and WDFW predator removal test fisheries, MIT Pilot small-scale predator removal commercial effort, and MIT invasive species population size research

Several research activities are proposed to occur within the Lake Washington area for the 2024-2025 management period. These studies are all designed to remove warm water fish species that prey on salmon and steelhead in the Lake Washington watershed, to further inform the development of warm water fish predator removal fisheries, or to further inform the predation risk posed by the species. The proposed projects, operated by the MIT and WDFW are summarized here and incorporated by reference (Mercier 2024).

MIT Warm-water Species Test Fishery

The Muckleshoot Indian Tribe (MIT) proposes to continue implementation of a test fishery to collect information on the composition and general abundance trends and encounter rates of warm water fish species in the Lake Washington Basin. This work has occurred, annually, since the spring of 2015 but the purpose of the test fishery has evolved from assessing the feasibility of warm water fisheries (see next Section) to monitoring changes in composition and catch rates at a series of consistent sites around the Lake Washington basin. The proposed 2024-2025 test fishery will take place from May 1 to June 30th, 2024 and from January 1-April 30, 2025. Over the past nine years, the MIT has developed a warm water test fishing study area which is divided into eight zones (Figure 37). The test fishery timing and locations will minimize encounters with ESA-listed species, including steelhead, and will use gear designed to avoid these species as well (Mercier 2024). The test fisheries proposed for 2024-2025 will focus on central and southern Lake Washington zones 1-4, with additional effort in zones 5-6 (Mercier 2024)(Figure 37). During the first three years of the study, 2017, 2018 and 2019, no steelhead or adult Chinook salmon were encountered in the test fisheries (Warner 2019). There were a small number of rainbow trout captured in the test fisheries (1 in 2017, 11 in 2018, 0 in 2019) but these were determined by size, mark status, physical appearance, to not be steelhead. The 2020 spring work was limited to two weeks before being suspended due to COVID-19 restrictions. No Chinook or steelhead were encountered in 2020 (Warner 2021). In 2021 and 2022, there were no steelhead encountered and one and four natural-origin Chinook salmon mortalities (Warner 2021; 2022; 2023). In 2023 there were no steelhead encountered and eight unmarked Chinook (juvenile) mortalities (Warner 2023). In the last seven years, the MIT test fishery has fished 3,823 net nights and has encountered 101 marked Chinook sub-adults, 27 unmarked sub-adults and no adult migratory Chinook. Anticipated take from the 2024-2025 warm water test fishery is summarized in Table 26.

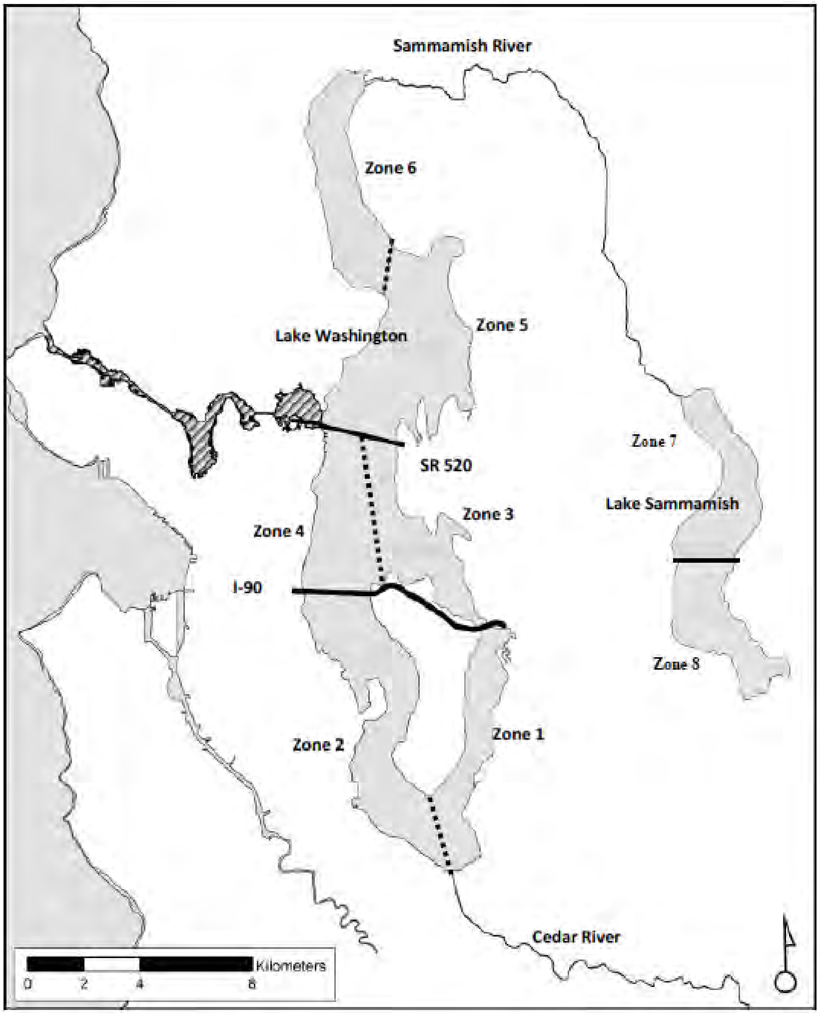

Figure 37. Muckleshoot Indian Tribe proposed warm water test fishery zones (1-8) and exclusion areas (cross-hatched) that will not be fished in order to minimize the potential for adult steelhead encounters (Mercier 2024).

MIT Warm-water Commercial Net Fishery

In addition to the continued test fishery described above, the MIT have proposed to conduct a small-scale commercial fishery, targeting non-native warm water species, and based on the findings of the prior years' testing. This small-scale commercial effort is planned for March 1-April 30, 2025 and would occur in warm water test fishery zones 5 and 6 (Figure 37) in North Lake Washington. The small-scale effort includes thorough monitoring of the fisheries as a transition to potential larger scale warm water fisheries in the future. The proposed locations and timing of the fisheries (in the north Lake Washington zones (Figure 37)) is also designed to reduce potential encounters of listed adult Chinook salmon or steelhead, due to the later run-timing of the extant Chinook and the North Lake Washington tributaries having observed no adult steelhead spawning in the area for the last several years (Table 27). Anticipated take in this fishery is summarized in Table 26.

MIT Warm-water Lake Sammamish Electrofishing

One of the underlying pieces of missing information, with regard to development of a potential management plan for warm water fisheries in Lake WA, is an estimate of the overall abundance of these non-native fish in the system. To date, the MIT test fisheries have focused on the efficacy of gear types and development of locations with adequate catch numbers to foster interest and participation. To get at the overall viability of a fishery, in terms of time horizon for effective overall removal of these species, an assessment of the scale of the populations in Lake WA and Lake Sammamish is being proposed to continue in 2024. The MIT have proposed to conduct an electrofishing survey and mark-recapture tagging program in Lake Sammamish. Lake Sammamish was chosen due to its smaller size, the presumed smaller population of the target fish species, and for the lower likelihood of encounters with ESA-listed species utilizing seasonal migratory corridors (Mercier 2024). The 2024 Sammamish electrofishing work is proposed for the May 15 1-June 30 period and and during October and November, 2024. The work would start back up in mid-March of 2025 (personal com., Jason Schafler, MIT, May 2024). MIT proposes to employ best practices in conducting this electrofishing work, utilizing the protocols developed for electrofishing for warm water species (Bonar, Bolding and Divins 2000), including areas were listed non-target species of fish exist (Mercier 2024). Anticipated take is summarized in Table 27.

WDFW Lake Washington Piscivore Monitoring and Mitigation Study

For 2024 and 2025 WDFW proposes to implement monitoring activities for warm water species predation on native salmonids in Lake Washigton, Lake Sammamish, and the Ship Canal (Figure 37). The monitoring work outlined in this study plan would attempt to identify times and locations where strategic piscivore removal efforts could increase survival for juvenile salmonids. Due to the large size of Lakes Washington and Sammamish, the identification of predation hotspots or seasonal congregations of piscivores will likely be a multi-year process. Similar work conducted in recent years indicates that this monitoring project will remove many piscivorous fish from the LWSC and other areas of the Lake Washington watershed that would otherwise prey on juvenile salmon, and this project is therefore likely to benefit juvenile salmonids in the watershed. This project is widely supported at the local level and is fully endorsed by the WRIA 8 Salmon Recovery Council and the WRIA 8 Technical Advisory Group (Mercier 2024).

Gill netting will occur between January and June of 2024 and 2025. Variable-mesh monofilament gill nets will be set during the salmon fry-rearing and smolt out-migration period within the study area (Figure 1). Netting effort will be concentrated in areas where predation on salmon fry or smolts is most likely to occur. Nets will be deployed at night with 12-16 hour set times and a range of mesh sizes (1-inch stretch to 5-inch stretch) will be used. All species captured will be measured and recorded. Stomach contents of some piscivorous fishes caught at selected locations will be assessed for evidence of predation on juvenile salmonids. Merwin Traps or other trap nets may also be deployed in Lake Sammamish or Lake Washington between January and June of 2024 and 2025. Traps will be checked regularly with all species caught being recorded.

As indicated in the results from the MIT research, above, Small numbers of hatchery and non-hatchery Chinook sub-adults will be present in the Lake Washington system during the proposed project period. A thermal barrier in the LWSC that forms each year during the latter portion of the Chinook out-migration period is thought to cause a number of juvenile Chinook smolts to remain in the Lake (residualize) instead of migrating to marine waters. Juvenile Chinook smolts that fail to migrate to marine waters to mature and instead remain in Lake Washington are considered sub-adults. Previous monitoring suggests the number of sub-adult Chinook in Lake Washington may have increased in recent years. Increases in sub-adult Chinook in Lake Washington are likely the result of the thermal migration barrier in the LWSC developing earlier in the year, possibly associated with the changing climate and generally warmer conditions in the Region. Chinook sub-adults will be present in Lake Washington during the proposed project and will be encountered in the sampling gear.

Anticipated take from all (MIT and WDFW) 2024-2025 Lake Washington Area warmwater predator removal projects

The potential for take of listed Chinook salmon and steelhead, as well as the life-history of the fish that could be impacted varies between the three components of the overall MIT warm water fisheries proposed above. The continued warm water test fishery, in the South Lake Washington, and the small-scale commercial fishery in the North Lake Washington are not likely to result in mortality of juvenile Chinook or steelhead, due to the size of the gill nets utilized (larger than these fish so the fish would swim through) and based on the results of the prior years' work. However, they could lethally impact these species at sub-adult or adult sizes through encounters with the fishing gear. The timing and location of the fisheries, during the late spring and early summer (May 1-June 12) will reduce the potential for interaction with adult Chinook and steelhead, given the fall run-timing of the Chinook and the winter run-timing of potential steelhead encountered.

Unlike the net fisheries involved with the test and pilot commercial efforts, the electrofishing gear affect any species and life history that it comes into contact with, including juvenile listed Chinook and steelhead. The choice of Lake Sammamish and the period of March 1-June 30 should reduce the likelihood of encounters with adult Chinook salmon, while the extremely low observed numbers of adult steelhead in the Lake Washington system in general and in the North Lake Washington tributaries specifically (Mercier 2024), reduce the likelihood of encountering adult steelhead significantly. As such, and based on results from previous years, the MIT has proposed the following levels of allowable take, in the form of mortalities, for each fishery component of the 2024-2025 proposal in Table 27.

For the WDFW monitoring project, based on past work in Lake Washington by WDFW and the work done over the last few years by the MIT (see above), WDFW expects to encounter both hatchery and natural-origin Chinook salmon, at various life stages in its 2024 and 2025 research. There is less of a chance to encounter natural-origin steelhead in the Lake Washington system, given the lack of presense in the system in the recent decades. However, as a precaution, wdfw has estimated the potential for encountering potential steelhead in its work in 2024-2025 (Mercier 2024).

Table 26. Expected maximum levels of incidental mortality of ESA-listed Lake Washington Chinook and steelhead, by life stage, associated with the 2024-2025 MIT and WDFW Warmwater predator-removal research.

MIT Warmwater predator removal component	unmarked Chinook juveniles	Unmarked Chinook sub-adults	Unmarked Chinook adults	Unmarked Steelhead juveniles	Unmarked Steelhead Adults
Lake WA test fishery cont.	0	12	5	0	3
Lake WA Commercial Net fishery	0	16		0	
Lake Sammamish Electrofishing	7	1	0	3	0
MIT Total	7	29	5	3	3
WDFW Warmwater Monitoring Project	unmarked Chinook juveniles	Unmarked Chinook sub-adults	Unmarked Chinook adults	Unmarked Steelhead juveniles	Unmarked Steelhead Adults
WDFW Total	4	40	4	4*	1
Overall Mortality Levels	**11**	**69**	**9**	**7**	**4**

*May include up to three non-mature life history O. mykiss. Source: (Mercier 2024)

The MIT proposals also state that there would be monthly reporting on status of work, in general, and immediate reporting of NOR Chinook and steelhead encountered in these proposed fisheries.

Summary

As outlined above the proposed fishery-related research activities in the Lake Washington system, from both the MIT and WDFW, they would not expect the impact to Lake Washington Chinook salmon MU to exceed a level equivalent to 1% of the estimated annual abundance (i.e. 1% ER). The total expected maximum mortality of Lake Washington Chinook salmon, from the MIT warm water predator removal work would be up to 9 unmarked adults, which would represent 1.1% of the Lake Washington terminal run size based on the 2024 pre-season forecast for terminal run size of 765. However, the additional exploitation rate limit of 1% is calculated based on the total 2024 runsize of the natural-origin Chinook salmon (age 3-5) produced from the Lake Washington MU. When the non-returning (harvested) adult recruits are factored into the total runsize of natural-origin adults produced from the MU, the ER from the MIT and WDFW research work would be: 765 x 1.371(ER from fisheries)=1,048; 9/1,048=0.009 (0.9%

ER). Potential, additional impacts to sub-adult and juvenile Chinook of up to 80 will not add substantively to this adult impact level given the low natural survival rates of juvenile and immature Chinook to adult.

The PSSTRT identified two steelhead populations in the proposed test fishing area: North Lake Washington/Lake Sammamish winter-run and Cedar River winter-run (PSSTRT 2013). These DIPs are part of the Central and South Puget Sound MPG).

Table 27. 5-year geometric mean of raw natural steelhead spawner counts for the Lake Washington/Lake Sammamish watershed, where available (NWFSC 2020).

MPG	DIP	1990-1994	1995-1999	2000-2004	2005-2009	2010-2014	2015-2020	% Change
Central and South Puget Sound	North Lake WA/ Lake Sammamish winter	60	4	-	-	-	-	-
	Cedar River winter	241	295	37	12	4	6	50

After considering the above factors, take from the test fishery proposals if they were to occur are largely negative on the population level for steelhead, but encounters with steelhead are considered unlikely to occur and have not occurred in previous years of the MIT studies. The studies will reduce predator populations that could be a substantial mortality factor on salmonids thereby providing a benefit to the populations. The studies could also provide future evidence to resolve questions regarding the presence of ESA-listed steelhead in Lake Washington.

2.5.3 Puget Sound/Georgia Basin Rockfish

To evaluate the effects of proposed fisheries on individual yelloweye rockfish and bocaccio, we first assessed the general effects of the action, followed by the population-level effects. We analyzed direct effects on listed rockfish in two steps. First, we estimated the number of listed rockfish likely to be caught in the salmon fishery and assessed both the sublethal and lethal effects on individuals. Second, we considered the consequences of those sublethal and lethal effects at the population/DPS level. We analyzed indirect effects by considering the potential impacts of fishing activities on benthic habitats. Throughout, we identified data gaps and uncertainties, and explained how the assumptions in the analysis are based on the best available science.

Hook and Line Fishing

Recreational fishermen targeting salmon use a broad array of lures and bait (both natural and artificial) that can incidentally catch yelloweye rockfish and bocaccio. Under the proposed actions, recreational salmon fisheries would occur within all areas of the U.S. portion of the PS/GB DPSs (WDFW Marine Catch Areas 6 through 13). When rockfish are caught in salmon fisheries, injuries may include hook damage to the mouth, face, eyes, esophagus, and/or stomach, as well as stress or damage from handling and releasing. Handling and releasing stress/damage results from differences in water temperatures (between the sea and surface), hypoxia upon exposure to air, and a variety of blunt force trauma and abrasion sources associated with boating, restraining, dehooking, and discarding the animal. For rockfish caught in waters deeper than 60 feet (18.3 m), the primary cause of injury and death is barotrauma. Barotrauma occurs when rockfish are brought up from depth, and rapid decompression causes over-inflation and/or rupture of the swim bladder. This can result in multiple injuries, including organ torsion, stomach eversion, development of gas bubbles in various organs, and exophthalmia (bulging eyes), among other damages (Parker et al. 2006; Jarvis and Lowe 2008; Pribyl et al. 2011). These injuries cause various levels of disorientation, which can result in fish remaining at the surface after they are released and making them subject to predation, damage from solar radiation, and gas embolisms (Hannah and Matteson 2007; Hannah, Parker and Matteson 2008; Palsson et al. 2009; Hochhalter and Reed 2011).. The severity of injuries associated with capture and release is dictated by the size of the fish, depth from which the fish was brought, water temperature, dissolved oxygen level at the depth of capture, amount of time that fish are held out of the water, and their general treatment while aboard (Hannah, Parker and Matteson 2008; Wegner et al. 2021). Physical trauma may lead to predation after fish are released (Palsson et al. 2009; Pribyl et al. 2011) by birds, marine mammals, or other fish (such as lingcod). Behavioral and physiological effects of capture and release, even when recompression devices are used (see below), may last hours to weeks (Rankin et al. 2017; Wegner et al. 2021; Davies et al. 2022).

A number of devices have been invented and used to return rockfish to the depth of their capture as a means to mitigate barotrauma, collectively termed recompression or descending devices. When rockfish are released at depth, there are many variables that may influence long-term survival, such as angler experience and handling time, in addition to thermal shock and depth of capture (Schroeder and Love 2002; Jarvis and Lowe 2008; Pribyl et al. 2009; Pribyl et al. 2011; Wegner et al. 2021). A study of boat-based anglers in Puget Sound revealed that few anglers who incidentally captured rockfish released them at depth (approximately 3 percent), while a small number of anglers attempted to puncture the swim bladder (Sawchuk 2012), which could cause bacterial infections or mortality. However, since 2014 NMFS has provided funding to the Pacific States Marine Fisheries Commission (PSMFC), Washington Department of Fish and Wildlife (WDFW), and Puget Sound Anglers (PSA) to purchase and distribute descending devices to local fishermen. Together, these collaborators have distributed the devices to many saltwater fishing guides that operate in the Puget Sound area, as well as thousands of recreational anglers. Since 2014, bottomfish anglers must have a descending device rigged and ready for immediate use when fishing for or possessing bottomfish or halibut within the DPSs (https://www.eregulations.com/washington/fishing/marine-area-rules-definitions). The vast majority of anglers target salmon by trolling with downriggers (Sawchuk 2012). There may be greater injury to listed–rockfish caught by anglers targeting salmon by trolling with downriggers because the fish may not trigger the release mechanism and be dragged for a period of time prior to being reeled in. However, as of 2024, salmon anglers are not required to have a descending device rigged and ready when fishing inside the DPSs.

In the consultations for a WDFW Incidental Take Permit for the recreational bottomfish fishery, and on the halibut fishery in Puget Sound, we used depth and mortality information to estimate the proportion of listed rockfish killed as a result of fisheries with the state regulation limiting gear deeper than 120 feet deep (consultation number F/NWR/2012/1984/ and WCR-2017-8426). This allowed us to use similar methods as the PFMC (2008b) to estimate the mortality rate for yelloweye rockfish and bocaccio by fishermen targeting bottomfish. The recreational salmon fishery , however, does not have a 120-foot rule, nor is depth of capture reported to creel samplers, complicating the assessment of survival estimates of listed rockfish caught at various depths while targeting salmon. Research has found that short term (48 hours) survival for recompressed yelloweye rockfish was 95.1 percent (Hannah, Rankin and Blume 2014), and that female yelloweye rockfish can remain reproductively viable for at least two years after recompression (Blain and Sutton 2016; Blain-Roth and Sutton 2019). As a result of this research on the effects of barotrauma and survivability of recompressed fish, the PFMC adopted revised mortality estimates for recreationally caught and released yelloweye rockfish in 2022 based on the depth of capture for fish released at the surface (Table 28;(PFMC 2022b)).

Table 28. Mortality estimates (%) by depth bin for canary rockfish and yelloweye rockfish released at the surface, from PFMC (2022b).

Capture Depth Range (feet)	Canary Rockfish Surface Release Mortality (%)	Yelloweye Rockfish Surface Release Mortality (%)
0 - 60	21	22
60 - 120	37	39
120 - 180	53	56
180 - 300	100	100
300 - 600	100	100
> 600	100	100

Though some anglers, and presumably most fishing guides, will release listed rockfish with descending devices, there is no rule to do so while targeting salmon. As such we make the conservative assumption that for the 2024/25 fishing season, and beyond, listed rockfish caught in salmon fisheries will be released at the surface. As such, we use the current "surface release mortality" estimates in (PFMC 2022b) as described above to estimate mortality rates for these fisheries.

There are no release mortality estimates for bocaccio analogous to those provided for yelloweye rockfish, thus for this species we used the release mortality estimates provided by the PFMC for canary rockfish (Table 28). These two species have generally similar life history and physiology, spending considerable time in the water column, associating with kelp and other vegetation, and feeding on a broad prey base of forage fish and small crustaceans (Drake et al. 2010; NMFS 2017g). The above-referenced report estimated mortality rates for surface-released fish captured from the surface to over 600 feet deep. There is no reported depth of capture from anglers targeting salmon that incidentally catch rockfish for us to partition mortality rates for each depth range, as done by the PFMC. To estimate mortalities by anglers targeting salmon, we used the release mortality rates estimates from the 120 to 180 feet depth range. We chose this depth range as a conservative estimate for bycaught listed rockfish given that most anglers likely target salmon at shallower depths than 180 feet deep (Robert Pacunski, WDFW, personal communication; Ron Garner, PSA President, personal communication), but note that bycatch from depths greater than 180 feet deep occurs.

Net-based Fishing

Most commercial salmon fishers in the Puget Sound use purse seines and gill nets (PSIT and WDFW 2010a; Speaks 2017b). A relatively small amount of salmon is harvested within the DPSs by reef nets and beach seines. Gillnets and purse seines rarely catch rockfish of any species. From 1990 to 2008, no rockfish were recorded caught in the purse seine fishery (WDFW 2010). In 1991, one rockfish (of unknown species) was recorded in the gill net fishery, and no other rockfish were caught through 2008 (WDFW 2010). From 2015-2023, between zero to three rockfish were caught in commercial purse seines in a given year, with a total of seven caught across those years (WDFW 2024b), and none were ESA-listed species. Low encounter rates are attributable to a variety of factors. For each net type, mesh size restrictions that target salmon based on size tend to allow juvenile rockfish to pass through. Gill net and purse seine operators also tend to avoid fishing over rockfish habitat, as rocky reef structures can damage their gear. In addition, nets are deployed in the upper portion of the water column away from deep-water rockfish habitat, thus avoiding interactions with most adults. In the mid-1990s commercial salmon net closure zones for non-tribal fisheries were established in northern Puget Sound for seabird protection, though tribal fishermen may still access these areas. Some of these closed areas overlap with rockfish habitat, reducing to some degree the potential for encounters. Specific areas are: (1) a closure of the waters inside the San Juan Islands; (2) a closure extending 1,500 feet along the northern shore of Orcas Island; and (3) a closure of waters three miles from the shore for all waters inside the Strait of Juan de Fuca (WDFW 2010).

The greatest risk to rockfish posed by gill nets and purse seines comes from the nets’ inadvertent loss. Derelict nets generally catch on bottom structure such as rocky reefs and large boulders that are also attractive to rockfish (Good et al. 2007; Natural Resources Consultants Inc. 2007; 2008). Dead rockfish of non-listed species have been found in derelict nets (Good et al. 2010; Drinkwin et al. 2023) because the net can continue to ‘fish’ when a portion of it remains suspended near the bottom and is swept by the current. Aside from killing fish, derelict nets alter habitat suitability by trapping fine sediments out of the water column, creating a layer of soft sediment over rocky areas that suppresses settlement of, and use by, benthic organisms (Natural Resources Consultants Inc. 2007; Good et al. 2010). This gear covers habitats used by rockfish for shelter and pursuit of food, and may thereby deplete food sources. For example, a study of several derelict nets in the San Juan Islands reported an estimated 107 invertebrates and 16 fish (of various species) entangled per day (Natural Resources Consultants Inc. 2008). One net had been in place for 15 years, entangling an estimated 16,500 invertebrates and 2,340 fish (Natural Resources Consultants Inc. 2008). Though these estimates are coarse, they illustrate the potential impacts of derelict gear on habitat and prey resources within the DPSs. In 2012, the state of Washington passed a law (Senate Bill 5661) requiring non-tribal fishermen to report lost fishing nets within 24 hours of the loss, and has established a no-fault reporting system for lost gear (Drinkwin et al. 2023). There are no devices installed on nets to track their location after they are lost, which complicates the recovery effort. In 2013 a NOAA-funded report was issued that assessed the reasons for gill net loss, best practices to prevent loss, and potential gear changes that may aid in the prevention of derelict nets (Gibson 2013). In response, the WDFW now offers a commercial fishing best practices and net retention class annually for interested fishers.

Reef nets are deployed near rockfish habitat in the San Juan Islands, and are subject to the same area closures as gill nets and purse seines. Beach seines are used next to sandy or gravelly beaches, and in each fishery all non-targeted fish are released. Because most adult yelloweye rockfish and bocaccio occupy waters much deeper than surface waters fished by reef nets and beach seines, the bycatch of adults is minimal to non-existent. Similarly, such nets are not likely to catch juvenile rockfish because most are small enough to pass through the mesh. Moreover, juvenile yelloweye rockfish and bocaccio are unlikely to be caught in beach seines because the seines are generally not used along kelp areas where juvenile bocaccio could occur in appreciable numbers (WDFW 2010). If adult or juvenile yelloweye rockfish and bocaccio were to be caught, the released fish would have a high likelihood of survival if quickly handled and released. Being caught so near the surface, barotrauma effects would be small, with post-release mortality likely below the ~20 percent value estimated by the PFMC for the 0-60 foot capture depth range (Table 28).

Based on data presented by Good et al. (2010) and Drinkwin et al. (2023) regarding the depth of derelict nets that are recovered, we presume that most newly lost nets would catch on bottom habitats shallower than 120 feet, where they would present a limited risk to most adult ESA-listed rockfish. Any derelict nets still remain a risk for some juveniles, subadults, and adult listed rockfish, however, until removed.

2.5.3.1 *Bycatch Estimates and Effects on Abundance*

Given the nature of the fisheries described above, we do not anticipate that any adult or juvenile yelloweye rockfish or bocaccio will be incidentally caught by actively fished nets, though some listed rockfish could be caught in recreational hook and line fisheries. It is likely that some gill nets would become derelict near rockfish habitat and may kill listed rockfish, though we are unable to quantify the number of fish killed from new derelict nets because listed species have not been directly encountered in the removal of historic nets (Drinkwin et al. 2023). This lack of occurrence suggests a low mortality rate for listed rockfishes, but spatial patterns of historically and newly lost nets likely differ, given shifts in fishing regulations, and environmental factors influencing salmon migration.

Many methods of recreational salmon fishing in marine waters have the potential to encounter ESA-listed rockfish. The WDFW estimates annual bycatch of rockfish from dockside interviews with anglers targeting salmon, halibut, bottomfish, and ‘other’ marine fishes. These localized, time- and area-specific bycatch estimates are then expanded to the unsampled portion of the fishing public using a phone-based effort estimator. There are a number of uncertainties regarding the WDFW recreational fishing bycatch estimates because: (1) they are based on dockside (boat launch) interviews of 10 to 20% of fishers, and anglers whose trips originated from a marina or private launch are generally not surveyed; (2) since rockfish can no longer be retained by fishermen, the surveys rely upon fishermen being able to recognize and remember rockfish released by species. Research has found the identification of rockfish to species is poor; only 5% of anglers could identify bocaccio and 31% yelloweye in a study based throughout Puget Sound (Sawchuk et al. 2015); and (3) anglers may intentionally under-report the numbers of released fish to influence bycatch impact estimates. A study in Canadian waters compared creel survey reports to actual observer-generated information on recreational fishing boats in the Southern Georgia Strait. Substantial differences were documented, with the number of released rockfish observed significantly higher than the number reported by recreational anglers during creel surveys (Diewert, Nagtegaal and Hein 2005). These factors could make the actual bycatch of yelloweye rockfish or bocaccio differ from WDFW's estimates. In an effort to address factor two, the WDFW, NOAA Fisheries, the Puget Sound Anglers, and the Pacific State Marine Fisheries Commission have produced and distributed thousands of at-sea, waterproof identification guides for an array of rockfish species within the DPSs, and encourage anglers to actively log bycatch using a wax pencil to mark the laminated aides.

In our previous consultations on salmon fisheries, we used WDFW bycatch estimates from the 2003 through 2009 time period[61] and supplemented our analysis when the WDFW provided us catch estimates for the 2003 through 2011 time period (WDFW 2014b). Since 2017, annual updates have been published, each including retrospective patterns back to 2003 (Table 29) (WDFW 2018; 2019a; 2020a; 2021a; 2022; 2023b; 2024a). Of the estimated 97 bocaccio encountered (i.e., caught and released, or retained) since 2003 by anglers targeting salmon within the DPS, all were caught in three WDFW Marine Catch Areas (MCA): 1) San Juan Islands (MCA 7); 2) Admiralty Inlet (MCA 9); and Tacoma-Vashon Island (MCA 11). Over two thirds of these fish were encountered in the San Juan Islands. The estimated 177 yelloweye rockfish encountered since 2003 were caught in a total of seven different MCAs, the same three as bocaccio as well as: 1) East Juan de Fuca Strait (MCA 6); 2) Seattle-Bremerton Area (MCA 10); 3) Ports Susan and Gardner (MCA 8-2); and 4) Hood Canal (MCA 12). Approximately 36% of these fish were caught in the San Juan Islands, with 11-16% each coming from the East Strait of Juan de Fuca, Admiralty Inlet, and Seattle-Bremerton Area, respectively. Bocaccio have been reported as retained in only two years since 2003 (2009 and 2015, each in the region of Admiralty Inlet), and no yelloweye rockfish have reportedly been retained since 2003 (Table 29). The WDFW estimates are highly variable, thus we used the highest available catch estimates for bocaccio and yelloweye rockfish from anglers targeting salmon to form a precautionary analysis. We consider bycatch estimates from previous years useful because we anticipate that recreational salmon fisheries proposed for future years will result in generally similar fishing techniques, locations, and anticipated numbers of angler-trips as in the past 10 to 20 years.

Estimates of rockfish bycatch must be combined with recreational salmon fishery effort data to create encounter rate estimates that are comparable across years (i.e. catch per unit effort). The WDFW produces such effort estimates from telephone surveys conducted annually (Table 29) (WDFW 2018; 2019a; 2020a; 2021a; 2022; 2023b; 2024a). Over the last ten years for which data are complete (2014 to 2023, the annual recreational salmon fishing effort within the listed rockfish DPSs has averaged 248,358 trips per year. From 2020 to 2022, however, the global COVID-19 pandemic affected fishing effort because of restrictions on businesses and personal contact, so a more representative 10-year average likely covers the years from 2010 to 2019. Over this adjusted period, the average annual number of salmon trips within the listed rockfish DPSs was 340,163 per year.

Table 29. Estimated rockfish bycatch in recreational salmon fisheries since 2003. Fish identified as released were not retained by anglers nor inspected dockside during interviews, but reported verbally to samplers. Effort is the estimated total estimated annual angler trips targeting salmon in WDFW Marine Catch Areas 6-13 (i.e., areas that overlap the DPSs).

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[61] WDFW 2011: Unpublished catch data 2003-2009

	Bocaccio		Yelloweye Rockfish		
Year	**Released**	**Retained**	**Released**	**Retained**	**Effort**
2003	0	0	0	0	405,161
2004	0	0	0	0	326,797
2005	0	0	14	0	343,941
2006	0	0	0	0	328,187
2007	0	0	11	0	354,370
2008	4	0	9	0	281,033
2009	6	6	46	0	591,963
2010	4	0	14	0	313,371
2011	0	0	5	0	451,103
2012	0	0	9	0	422,661
2013	0	0	0	0	524,846
2014	35	0	11	0	391,957
2015	22	8	0	0	397,886
2016	0	0	9	0	135,897
2017	0	0	5	0	246,912
2018	0	0	4	0	218,351
2019	7	0	26	0	298,648
2020	0	0	9	0	228,344
2021	0	0	5	0	158,981
2022	5	0	0	0	172,240
2023	0	0	0	0	234,363

As described above in Section 2.2.1.3, Status of Puget Sound/Georgia Basin Rockfish, the best available abundance data for each species come from the WDFW ROV surveys (Pacunski, Palsson and Greene 2013; WDFW 2017), and we used these surveys as a fundamental source to understand the total abundance of the U.S. portion of the DPSs. The structure of this analysis likely underestimates the total abundance of each species within the U.S. portion of the DPS because: (1) we used the lower confidence interval population estimates available for yelloweye rockfish; and (2) we used the WDFW population estimate of bocaccio for the San Juan Island and Eastern Strait of Juan de Fuca area and note that it is generated within only 46 percent of the estimated habitat of bocaccio within the U.S. portion of the DPS. The rest of the area, including the Main Basin, South Sound and Hood Canal, were likely the most historically common area used by bocaccio (Drake et al. 2010). The structure of these assessments likely underestimates the total abundance of each DPS, resulting in a conservative abundance scenario and potential overestimate when evaluating cumulative fishery bycatch mortality for each species.

2.5.3.1.1 Yelloweye Rockfish

We used annual estimated bycatch of yelloweye rockfish from salmon anglers of 4 (WDFW 2014b) to 117 fish (WDFW and PSIT 2011)(Table 30). These fish would be released, and using the PFMC methodology we estimate that 56% would likely perish from barotrauma and related hooking injuries and/or predation induced by injury.

Table 30. Yelloweye rockfish bycatch estimates.

Species	Low Estimate (number mortalities)	High Estimate (number mortalities)	Estimated Percent Mortality	Abundance Scenario	Percent of DPS killed (low estimate)	Percent of DPS killed (high estimate)
Yelloweye Rockfish	4 (2)	117 (66)	56%	143,086	0.001	0.05

2.5.3.1.2 Bocaccio

We used annual estimated bycatch of bocaccio from salmon anglers from 2 (WDFW 2014b) to 145 (WDFW 2015) fish (Table 31). These fish would be released, and using the PFMC methodology we estimate that 53% would likely perish from barotrauma and related hooking injuries and/or predation induced by injury.

Table 31. Bocaccio bycatch estimates.

Species	Low Estimate (number mortalities)	High Estimate (number mortalities)	Estimated Percent Mortality	Abundance Scenario	Percent of DPS killed (low estimate)	Percent of DPS killed (high estimate)
Bocaccio	2 (1)	145 (77)	53%	4,606	0.02	1.67

In addition to fishery mortality, rockfish are killed by derelict fishing gear (Good et al. 2010), though we were unable to quantify the number of yelloweye rockfish and bocaccio killed by pre-existing derelict gear or new gear that would occur as part of commercial fisheries addressed in the proposed actions. As elaborated in Section 2.4.3.4, due to changes in state law, additional outreach and assessment efforts (i.e. Gibson 2013), and recent lost net inventories (Beattie and Adicks 2012; Beattie 2013; James 2017; James and Low 2023) it is likely that fewer nets (likely three to 20 annually) will become derelict each year in the upcoming 2024/25 fishing season, and beyond, compared to several years and decades ago. Because of the low number of anticipated derelict gill nets per year, it is likely that few (if any) yelloweye rockfish and bocaccio mortalities will occur from new derelict gill nets, and that any additional mortality would not result in additional risk to any population.

2.5.3.2 Effects on Populations

To assess the effect of the mortalities expected to result from the proposed actions on population viability, we adopted methodologies used by the PFMC for rockfish species. The decline of West Coast groundfish stocks prompted the PFMC to reassess harvest management (Ralston 1998; Ralston 2002). The PFMC held a workshop in 2000 to review procedures for incorporating uncertainty, risk, and the precautionary approach in establishing harvest rate policies for groundfish. The workshop participants assessed best available science regarding “risk-neutral” and “precautionary” harvest rates (PFMC 2000). The workshop resulted in the identification of risk-neutral harvest rates of 0.75 of natural mortality, and precautionary harvest rates of 0.5 to 0.7 (50 to 70 percent) of natural mortality for rockfish species. These rates are supported by published and unpublished literature (Walters and Parma 1996; PFMC 2000), and guide rockfish conservation efforts in British Columbia, Canada (Yamanaka and Lacko 2001; Department of Fish and Oceans 2010). Fishery mortality of 0.5 (or less) of natural mortality was deemed most precautionary for rockfish species, particularly in data-limited settings, and was considered a rate that would not hinder population viability (Walters and Parma 1996; PFMC 2000).

For yelloweye rockfish and bocaccio, mortalities from the proposed salmon fisheries in the range of the DPSs would be well below the precautionary level as described above (0.5 (or less) of natural mortality) and risk-neutral level (0.75 or less) for each of the abundance scenarios.

Annual natural mortality rate for bocaccio is approximately 8 percent (as detailed in Section 2.4.2) (Palsson et al. 2009); thus, the precautionary level of fishing would be 4 percent and risk-neutral would be up to 6 percent. Lethal takes from the proposed salmon fisheries would be well below the precautionary and risk-neutral levels for each of the abundance scenarios.

Annual natural mortality rates for yelloweye rockfish range from 2 to 4.6 percent (as detailed in Section 2.4.2) (Yamanaka and Kronlund 1997b; Wallace 2007); thus, the precautionary range of fishing and research mortality would be 1 to 2.4 percent and risk-neutral would be 1.5 to 3.45 percent. Lethal takes from the salmon fisheries in the DPS would be below the precautionary and risk-neutral level for each of the abundance scenarios.

2.5.3.3 Effects on Spatial Structure and Connectivity

Bycatch that results in mortality of listed-rockfish in derelict gear could alter spatial structure. If fishermen incidentally catch a greater proportion of the total population of yelloweye rockfish or bocaccio in one or more of the regions of the DPSs, the spatial structure and connectivity of each DPS could also be degraded. However, the lack of reliable population abundance estimates from the individual basins of Puget Sound complicates an assessment of the risks associated with impacts from bycatch and derelict fishing gear. Yelloweye rockfish are the most susceptible to spatial structure impacts because of their sedentary nature. Localized losses of yelloweye rockfish are less likely to be replaced by roaming fish, compared to bocaccio, which are better able to recolonize habitats due to the propensity of some individuals to travel long distances. There is currently no single, reliable historical or contemporary abundance estimate for the yelloweye rockfish or bocaccio individual basins in the Puget Sound/Georgia DPS (Drake et al. 2010).

2.5.3.4 Effects on Diversity and Productivity

Bycatch of listed rockfish can alter diversity primarily by the removal of larger fish. Larger fish of each species are able to target baits and lures more so than juveniles, and typically enter fisheries at or near 12 inches long (30 centimeters) as they also approach sexual maturity - thus bycatch disproportionately kills larger yelloweye rockfish and bocaccio. The loss of fish that are reproductively mature, or nearly so, would hinder the demographic diversity (and productivity) of each species. However, there is currently no single, reliable historical or contemporary abundance estimate for the yelloweye rockfish or bocaccio individual basins in the Puget Sound/Georgia DPS (Drake et al. 2010).

2.5.3.5 Effects on Critical Habitat

Critical habitat is located in some of the areas fished by fishermen targeting salmon within the Puget Sound/Georgia Basin. We do not have spatial information at a fine enough scale to determine the proportion of the fishery occurring inside or outside of critical habitat. NMFS designated critical habitat in some waters shallower than 98 feet (30 m) for bocaccio and critical habitat in some waters deeper than 98 feet (30 m) for each ESA-listed rockfish. For each species of listed rockfish NMFS designated deepwater habitats for sites deeper than 98 feet (30 m) that possess or are adjacent to areas of complex bathymetry consisting of rocky and/or highly rugose habitat (Section 2.2.2.3). Several attributes of these habitats are essential to the conservation of listed rockfish. These attributes include: (1) quantity, quality, and availability of prey species to support individual growth, survival, reproduction, and feeding opportunities; (2) water quality and sufficient levels of dissolved oxygen to support growth, survival, reproduction, and feeding opportunities; and (3) the type and amount of structure and rugosity that supports feeding opportunities and predator avoidance.

Motors used by commercial fishermen have the potential to pollute waters through the discharge of small levels of hydrocarbons. However, engines have become more efficient and less polluting in response to better technology and improved standards, which are administered by the Environmental Protection Agency (75 Fed. Reg. 179, September 16, 2010). As such, it is extremely unlikely that water quality and dissolved oxygen attributes of rockfish critical habitat would be adversely affected by the proposed actions.

Effects to listed-rockfish critical habitat come from lost commercial salmon nets. Nets are lost due to inclement weather, tidal and current action, catching upon the seafloor, the weight of catch causing submersion, vessels inadvertently traveling through them, or a combination of these factors (NRC 2008). Nets fished in rivers and estuaries can be lost from floods and/or as large logs are caught moving downstream, and a few of these nets can drift to the marine environment. Nets can persist within the marine environment for decades because they do not biodegrade and are resistant to chemicals, light, and abrasion (NRC 2008). In some cases, nets can drift relatively long distances before they catch on the bottom or wash up on the shore (NRC 2008). When derelict nets drift, they can entangle crab pots, thereby recruiting more derelict gear (NRC 2008). Most nets hang on bottom structure that is also attractive to rockfish. This structure consists of high-relief rocky substrates or boulders located on sand, mud or gravel bottoms (Good et al. 2010). The combination of complex structure and currents tend to stretch derelict nets open and suspend them within the water column, in turn making them more deadly for marine biota (Akiyama, Saito and Watanabe 2007; Good et al. 2010)(Figure 38).

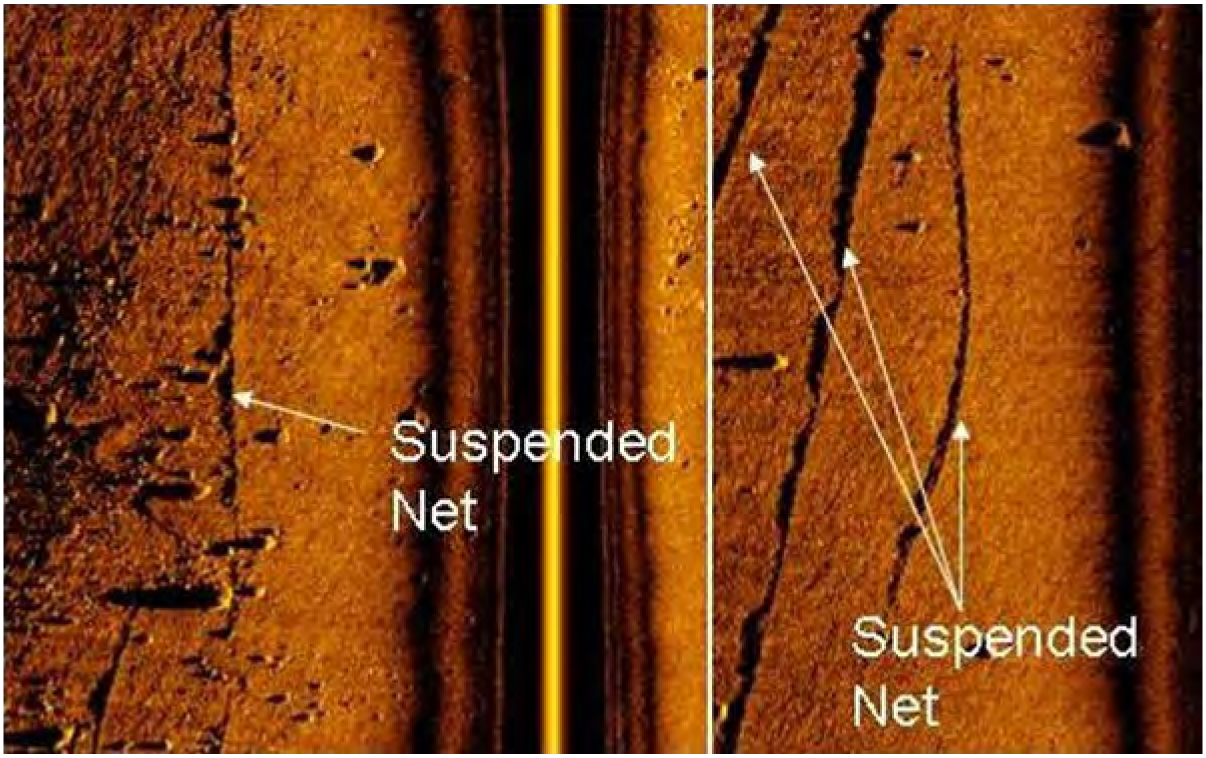

Figure 38. Sidescan sonar images of derelict nets located on Point Roberts Reef of the San Juan basin. Suspended nets have a larger acoustic shadow than nets flush with the bottom. Image used by permission of Natural Resource Consultants (NRC).

Derelict nets alter habitat suitability by trapping fine sediments out of the water column. This makes a layer of soft sediment over rocky areas, changing habitat quality and suitability for benthic organisms (Good et al. 2010). Nets can also cover habitats used by rockfish for shelter and pursuit of food, rendering the habitat unavailable. Nets can reduce the abundance and availability of rockfish prey that include invertebrates and fish (Good et al. 2010).

Though we cannot estimate the number of yelloweye rockfish or bocaccio killed on an annual basis from newly lost nets, we can estimate the amount of habitat altered by them. Most recovered nets are fragments of their original size; drift gill nets can be as long as 1,800 feet, and skiff gill nets can be as long as 600 feet, yet most recovered derelict nets cover an area of only about 7,000 square feet (Good et al. 2010), suggesting that fishers may cut nets free if they are caught on the bottom or otherwise damaged. For most derelict nets, the maximum suspension off the bottom (for a portion of the net) was less than 1.5 meters when they were recovered (Good et al. 2010), and we consider suspended and non-suspended nets to degrade benthic habitats.

Due to additional outreach and assessment efforts (i.e. Gibson 2013), and recent lost net inventories (Beattie and Adicks 2012; Beattie 2013; James 2017) it is likely that fewer nets will become derelict in the upcoming 2024/25 fishing season, and beyond, compared to several years and decades ago (previous estimates of derelict nets were 16 to 42 annually (NRC 2010)). In 2022, an estimated twelve nets became derelict, seven of them were recovered, and one was awaiting recovery operations at the time of the report (James and Low 2023). In 2021, an estimated seven nets became derelict, and six of them were recovered (James and Low 2022). In 2020, an estimated three nets became derelict, and all three of them were recovered (James and Low 2021). In 2019, an estimated seven nets became derelict, and five of them were recovered (James 2020). In 2018, an estimated eight nets became derelict, and six of them were recovered (James 2019). In 2017, an estimated 11 nets became derelict (though not all of them may have been associated with a salmon fishery) and 10 were recovered (James 2018a). In 2016, an estimated 14 nets became derelict, nine of which were recovered (James 2017). In 2014, an estimated 13 nets became derelict, and 12 of them where recovered (James 2015), in 2013 an estimated 15 nets became derelict, 12 of which were recovered (Beattie 2013), and in 2012 eight nets were lost, and six were recovered (Beattie and Adicks 2012). A separate analysis from June 2012 to February 2016 a total of 77 newly lost nets were reported, and only 6 of these were reported by commercial fishermen (Drinkwin 2016) We do not have estimates of the number of nets lost in the 2023/24 salmon fisheries. Based on reported derelict nets, we estimate that a range of three to 20 gill nets may be lost in the 2024/25 fishing season, and beyond, but up to 75%-80% of these nets would be removed within days of their loss and have little potential to damage rockfish critical habitat. In the worst-case analysis assuming that 20 nets are lost and five of these become derelict they would damage up to 35,000 square feet (0.8 acre) of habitat (assuming an average of 7,000 square feet). Even presuming that all lost nets would be in critical habitat (438.45 square miles for yelloweye rockfish and 1,083.11 square miles for bocaccio), they would damage a fraction of the total area and not degrade the overall condition of critical habitat for listed rockfish.

2.5.4 Southern Resident Killer Whales

2.5.4.1 *Effects on the Species*

The proposed fishing may affect SRKWs through the direct effects of vessel activities and gear interactions, and through the indirect effects of reduction of their primary prey, Chinook salmon, across the entire action area, particularly in areas of high SRKW occurrence. This section evaluates first the overlap of the proposed fisheries and SRKWs which is relevant to both the direct and indirect effects of the proposed action. There is also information on the number of vessels participating in fishing in the area near the whales compared to vessels engaging in other activities to provide context for potential effects. Next, we discuss the direct effects on killer whales from vessel activities and potential for gear interactions and finally the indirect effects of fisheries reducing the prey available to the whales. NMFS has incorporated analyses from the PFMC Salmon Fishery Management Plan Impacts to Southern Resident Killer Whales Risk Assessment May 2020 (PFMC 2020b), and modifications of methods from that assessment for application to Puget Sound fisheries into this opinion where appropriate. NMFS has also incorporated analyses from WDFW (Cunningham 2024) and the NWIFC (Parker 2024) regarding the 2024-2025 fisheries and SRKWs to assess the direct and indirect effects of the Puget Sound salmon fisheries on SRKWs.

Overlap of Puget Sound Salmon Fisheries and SRKWs

This analysis of the overlap of Puget Sound salmon fisheries and SRKWs relies on several sources of data about the distribution, movement patterns, and foraging areas of the whales and information provided by the co-managers on the presence of fishing vessels and/or effort of fishing in marine fishing areas in Puget Sound. First, we describe SRKW occurrence and location in inland waters. The distribution of SRKW in inland waters of the Salish Sea by month and year for each pod is determined by sightings data. Visual and acoustic observations are also used to identify known SRKW areas of high use and foraging, which we refer to as “hot spots” within this Effects section. These data are compared to information from the co-managers about the operations of the fisheries including: the location of marine fishing areas, the average number of non-tribal and tribal commercial fishing vessels per day (or FRAM time step per day) in each marine fishing area (fishing effort), overlap of fishing effort with SRKW sighting frequency, recreational fishing information by area and month (proxies for fishing effort including number of anglers and number of vessels), recreational vessel distribution within fishing areas of high overlap with SRKW, and location and timing of state-managed fishery area closures or additional fishing management measures (non-retention, mark selective, etc.) in SRKW hot spots. Additionally, the Soundwatch program provides data on the occurrence of fishing vessels operating near the whales. Overlap between SRKW occurrence and fishing effort informs both the analysis of potential direct effects of vessels and gear on SRKWs and indirect effects of prey removal in foraging areas.

SRKW Occurrence

As described in the Status Section, Southern Residents occur in inland waters throughout the year and have typically spent a majority of their time in the summer months along the west side of San Juan Island (Hauser et al. 2007, Whale Museum sightings database). Prey samples were collected in this area following observed foraging events (Figure 39C)(Hanson et al. 2010; Shedd 2019; Hanson et al. 2021b) so this area is often used for feeding (versus other behaviors such as transiting). Recent work by Ocean Initiatives observed high use of the west/southwest side of San Juan Island for foraging/feeding by SRKW as well (https://www.sjcmrc.org/media/20037/oi-srkw-feeding-final-report-2021.pdf). SRKW have also been sighted frequently near Pt. Roberts and the mouth of the Fraser River in all seasons, but especially in summer. On average, the three pods have been observed in inland waters more often starting in May and June through September (Olson et al. 2018) than at other times of year. All three pods generally remain in the Georgia Basin through October and make frequent trips to the outer coasts of Washington and southern Vancouver Island and are occasionally sighted as far west as Tofino and Barkley Sound (Ford, Ellis and Balcomb 2000; Hanson and Emmons 2010; Whale Museum unpublished data). SRKW are sighted more often off the west side of San Juan island in Summer compared to Spring, Fall/Winter though they are sighted there in all seasons. There are also sightings to the North near the U.S.-Canadian border, that extend into Canada near the Fraser River mouth, but even more so in Summer than the Fall/Winter or Spring. SRKW are sighted more often in Admiralty Inlet and central Puget Sound in Fall/Winter than Spring or Summer but have been sighted there in all seasons (Figure 41). Also work by Fisheries and Oceans Canada (DFO Canada 2021) used effort-corrected sightings from whale watching and from encounter data from DFO surveys from May-October 2009-2020 to show presence of SRKW in each of those months in the Northern range of the action area extending into Canada. They observed high occurrence off the west side of San Juan Island/Haro strait from May-October (but especially in July-September), high occurrence near Swiftsure bank and the mouth of the Strait of Juan de Fuca especially from July-September, and high occurrence near Point Roberts and the mouth of the Fraser from mainly from June-September.

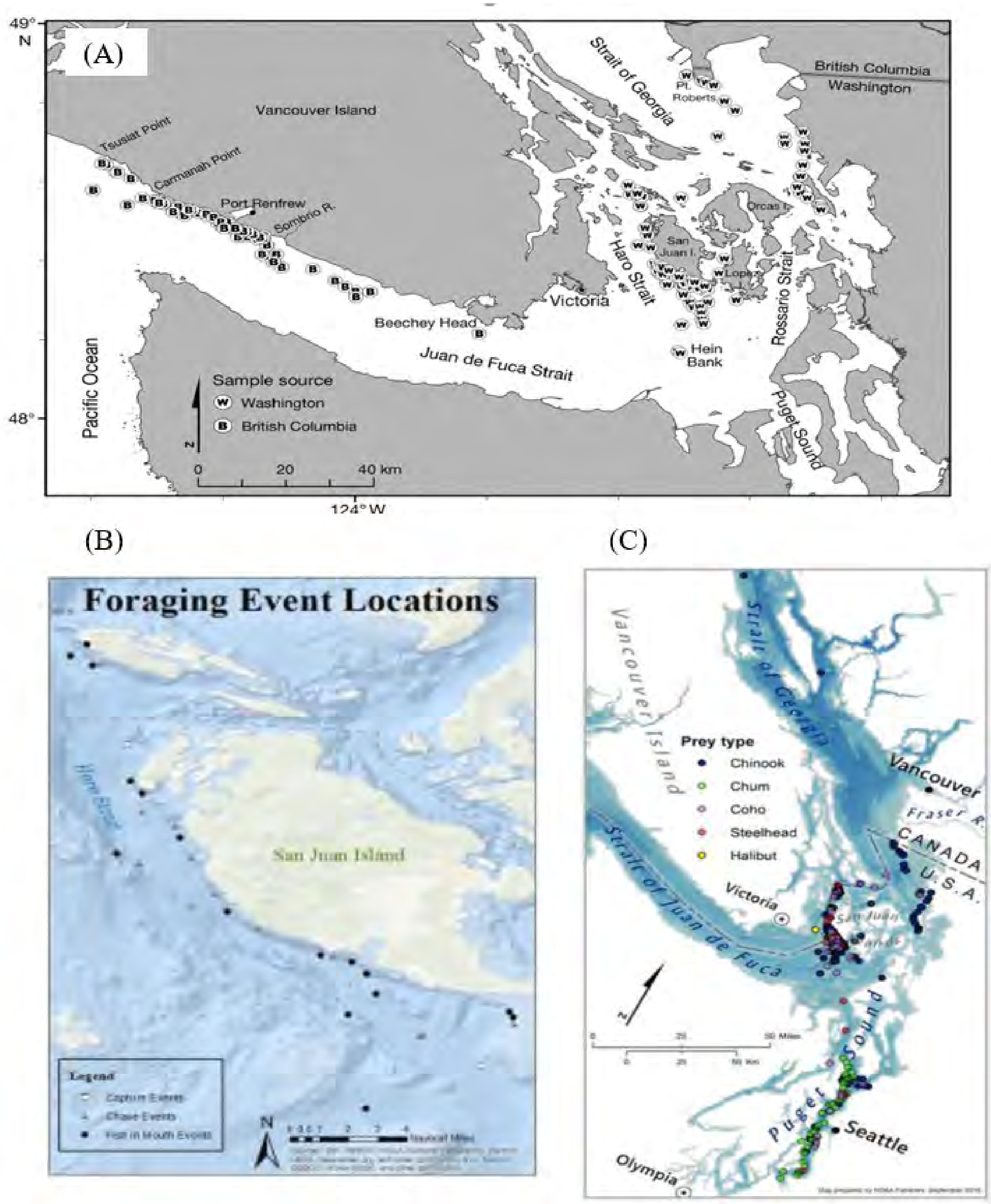

Figure 39. Multiple data sources showing important foraging areas in Salish Sea for SRKW over the last 15+ years. (A) Foraging events observed in the Salish Sea from May to September 2004 to 2008 (Hanson et al. 2010). (B) Foraging events observed in the Salish Sea in September 2017 (Shedd 2019). (C) Location and species of Southern Resident killer whale prey from scale/tissue samples collected in the Puget Sound, Strait of Juan de Fuca/San Juan Islands, and northern Georgia Strait in 2004-2017 ((Hanson et al. 2010), NMFS unpubl. data).

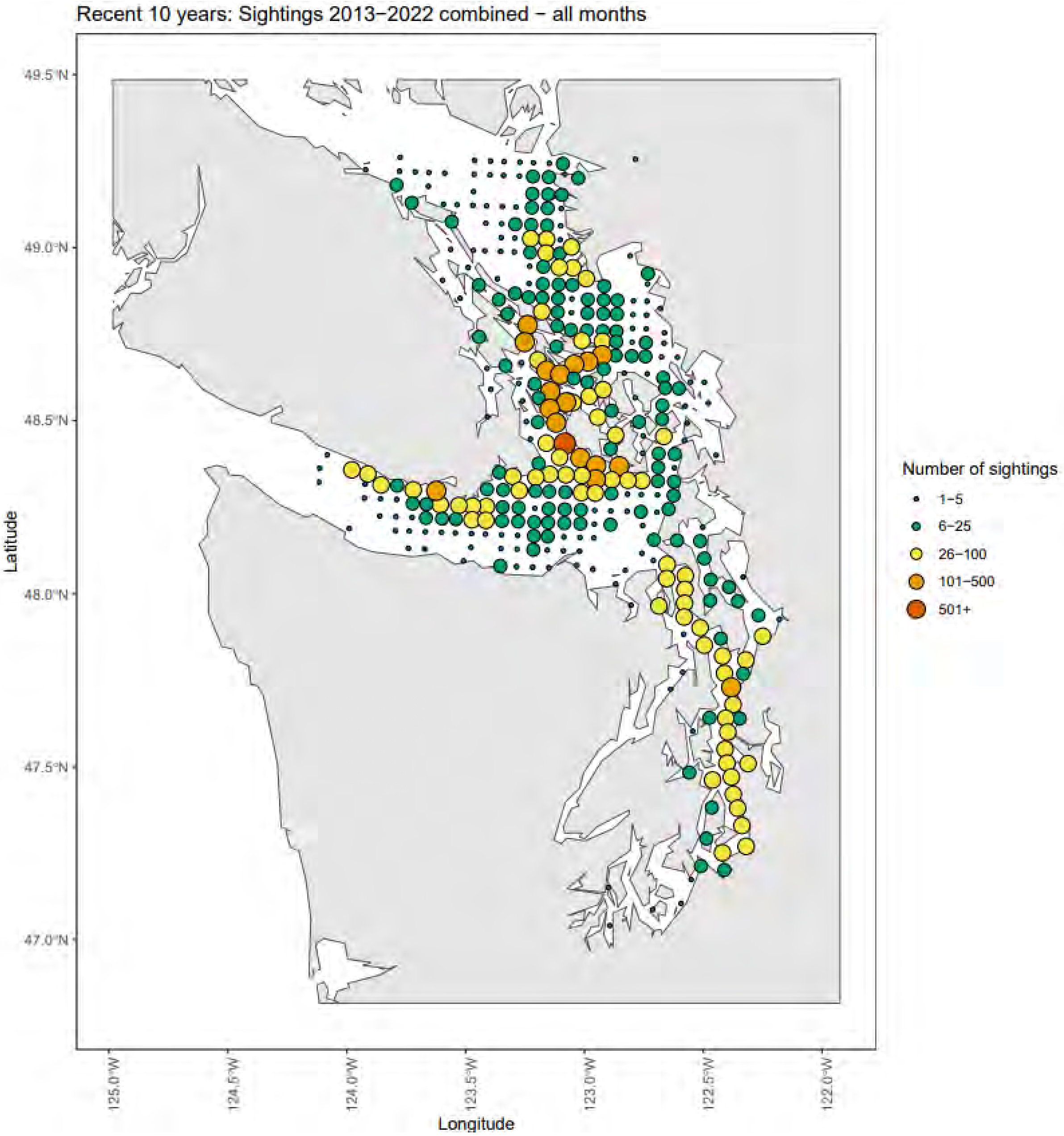

Figure 40. Opportunistic sightings of SRKW in inland waters for each Whale Museum quadrant (see (Olson et al. 2018) for quadrants) for 2013-2022 combined (Whale Museum unpublished data). Duplicate sightings per day were removed so counts of sightings represent unique sightings by day summed across the years (total across 2013-2022). Note that quadrant 14 from the Whale Museum extends into Vancouver Harbor near Vancouver, B.C. Canada, and therefore, the quadrant centroid appears to fall on land due to lack of precision in the shoreline shapefile, though the actual SRKW sighting was closer to open water.

In 2023, SRKWs were also most often observed off the west side of San Juan Island and north of San Juan by the Soundwatch program compared to other summer critical habitat areas, but SRKW presence was also noted by Soundwatch off Point Roberts and Race Rocks (as well as other locations see Figure 11 in Frayne (2024). In 2023, Soundwatch observed SRKW in May through September for a total of 20 days. The number of observations is much less than the 35 days SRKW were seen in 2022. This demonstrates a continued trend of spatial and temporal dispersal, including a change in the time and duration of use, of summer critical habitat areas.

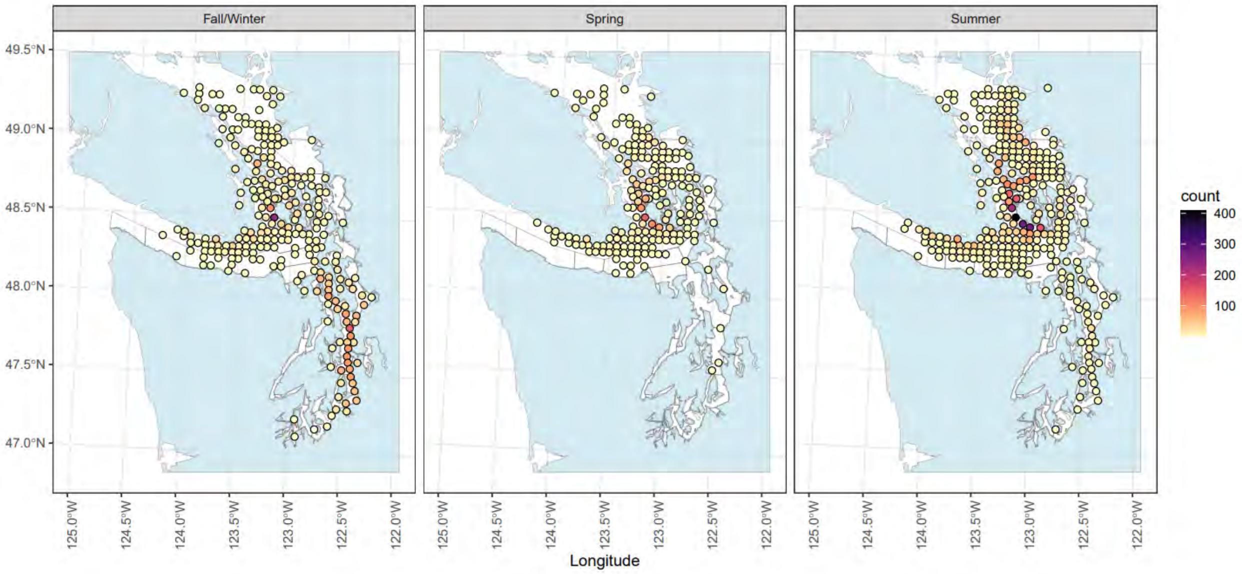

Figure 41. Unique daily counts of sightings of SRKW in Whale Museum Quadrants across the action area for years 2011-2020 separated by seasons (as defined within salmon FRAM models - Fall/Winter (October-April), Spring (May-June), and Summer (July-September)). Commercial marine area boundaries are also plotted but see Figure 42 below for further visualization of fishing areas.

As discussed in the Status Section, the whales' seasonal movements are only somewhat predictable because there can be large inter-annual variability in arrival time and days present in inland waters from spring through fall. Late arrivals and fewer days present in inland waters have been observed in recent years (Hanson and Emmons (2010); The Whale Museum unpublished data)(Figure 19). Ettinger et al. (2022) modeled the probability of occurrence of SRKW in inland waters over the years 2001-2017 and found that peak occurrence during each year is variable and that the peak probability of whale occurrence in the Salish Sea has shifted over time (about 1-5 days later per year). For example, K pod presence has been highly variable in June, ranging from 0 days of occurrence in inland waters to over 25 days (Figure 19).

The recent pattern of observations of SRKWs in the Salish Sea is substantially different from patterns observed in previous years. We used data from 2008 – 2022 (most recent 15 years) from The Whale Museum as a reliable indicator of whale presence to estimate the number of days that members of specific pods spent in the Salish Sea in recent years compared to past years Figure 19. Figure 19 includes the minimum and maximum counts of days spent in the Salish Sea from 2008-2022 (The Whale Museum data for 2023 are not yet available) to reflect the uncertainty of identification by pod for certain sighting reports in The Whale Museum data set. Occurrence of whales in recent years, particularly 2017-2022, has diverged from patterns in most years prior. Before 2017, the average number of days K and L pods spent in the Salish Sea in the summer months (July – September) was 21-22 for K pod and 23-25 for L pod depending on the month (using maximum counts) (Figure 19). From 2017 to 2022, K and L pod were both sighted <10 days in June, July, and August on average, and K pod was sighted only 9 days on average in September. Prior to 2017, J pod was observed in inland waters on average 22-26 days in the months of June-September, but in 2017-2021 was only seen 6-12 days in July-August (depending on month, using maximum counts). J pod is still frequently observed in inland waters in September (17-29 days 2017-2021). Finally, in 2022, J pod was present for around half the days of every month year-round (more frequent occurrence in spring compared to 2018-2021; Figure 19) Note also that there's been a slight increase in the number of days J pod have been seen in inland waters in November on average between 2017-2022 compared to previous years. Altogether, this illustrates the variability in occurrence in the Salish Sea, especially in recent years. Overall, on average, encounters with J pod in inland waters occur more often than encounters with K and L pods, and though occurrence in inland waters has declined overall since 2017, all pods are still mainly encountered more frequently in the Salish Sea in summer months, especially September, than in late fall to spring months (November-May; but see November-December 2017)(Figure 19). Recent work by Stewart et al. (2023) showed a significant relationship between the number of days SRKW are in inland waters and the CPUE of Fraser Chinook salmon stocks by the Albion test fishery.

To determine the geographic extent of the overlap between SRKW and fisheries, we overlaid SRKW sightings data with fishing areas for the months during which fishing activities are expected to take place using sightings from the Whale Museum database for years 2013-2022. For all sightings, we removed those specified as transients, "not orcas", Northern residents, and the general broad category of "orcas", and only kept sightings that were either confirmed as SRKW or where the DPS identity was named but in question. We first mapped these sightings by season: Summer (July-September), Fall/Winter (October-April), and Spring (May-June) (same seasons used in FRAM salmon models) and by Whale Museum quadrant (keeping only 1 sighting per quadrant per day), to determine general potential overlap between SRKW and the fisheries across each season (see Figure 41). Note that even if only recent years (2017-2022) are used when SRKW have been seen less frequently in inland waters, we see the same pattern as in Figure 41, just fewer sightings.

To determine the degree of temporal overlap with fishing activities, we tabulated the number of sightings in each commercial fishing area in Summer (July, August, September), when most areas are open to fishing and recreational effort is highest (see below info on number of anglers per month). We then took all sightings with a specified Whale Museum quadrant number (see Olson et al. 2018) and determined the best latitude and longitude for each sighting, where the "best" is a GPS coordinate if provided for the sighting, or the quadrant centroid latitude and longitude if GPS coordinates were not provided. Using shape files of commercial fishing catch areas, the whale sightings were mapped to a marine fishery catch area based on sighting latitude and longitude (st_intersection function in R to find the marine area geometry that each sighting overlaps with). We then removed sightings with duplicated date, quadrant, marine area combinations to get "unique sightings days". In other words, if multiple sightings have the same day, month, year, quadrant, and marine area, we only kept one sighting, in order to only have one count per day for an area. Two sightings in adjacent quadrants on the same day were kept as unique sightings, and sightings in quadrants that spanned two fishing areas were maintained as multiple sightings. Finally, we summed the number of sightings in each marine area for summer months.

To overlay SRKW sightings with different fishing areas, all Puget Sound commercial and recreational marine fishing areas are shown in Figure 42 (A and B, respectively) and commercial areas are plotted with seasonal whale occurrence (Figure 41) and sightings are summed across the commercial marine areas (Table 32, areas with >0 sightings). We used commercial fishing areas for plotting (Figure 41) and summed counts (Table 32) because these are at finer spatial resolution and can be combined into the larger recreational areas. The primary Puget Sound fishing zones associated with areas of occurrence for SRKWs (based on sightings) include area 6 (including 6A), 7 (including 7A for commercial fisheries), 8A, 9, 10, and 11 (Figure 41, Table 32. Though Whale Museum quadrants do not extend to the mouth of the Strait of Juan de Fuca, SRKW do occur in marine areas 4, 5, and 6 (Figure 41 and see DFO (2021)). In this section, we refer to recreational fishing marine areas as R-MA and commercial fishing as C-MA and note that R-MA 7 encompasses the area of C-MA 7 and 7A-E see (see Figure 42).

Table 32. Commercial marine areas with summed daily unique sightings of SRKW of greater than 0 sightings for the entire period of 2013-2022 in Summer months (July, August, September). Note that we no longer include sightings specified only to "orcas" since we can't confirm these were SRKWs, so these values aren't comparable to this table in biological opinions for fisheries from previous years but the trends in occurrence are similar.

Commercial MA	# Sighting days in Summer
4B	2+ (whale museum quadrants don't cover whole area but Whale Museum data have additional sightings in the area without a quadrant number)
5	3+ (Whale Museum quadrants don't cover whole area but Whale Museum data have additional sightings in the area without a quadrant number)
6	56
6A,B,C	6A = 15, 6B = 2, 6C = 2

7, 7A, 7B	7 = 548, 7A = 147, 7B = 3
8, 8A	*8* = *4*, 8A = 8
9	54
10	10 = 14
11	4
12	1[62]
13	4

We note certain important caveats for the SRKW sightings data. Sightings data are managed by The Whale Museum and while the data are predominately opportunistic sightings from a variety of sources (public reports, commercial whale watching, Soundwatch, Lime Kiln State Park land-based observations, and independent research reports), the SRKWs are highly visible in inland waters, and widely followed by the interested public and research community, so are likely complete. The dataset does not account for level of observation effort by season, location or time of day; however, it is the most comprehensive long-term dataset available to evaluate broad-scale habitat use by SRKWs in inland waters. For these reasons, NMFS relies on the number of past sightings to assess the likelihood of SRKW presence in the action area when fishing would occur. Effort corrected data shows similar spatial patterns (Olson et al. 2018; DFO Canada 2021). Previous analysis of these sightings data indicates that while SRKWs may be detected and reported at least one time within a given day they spend in the inland waters (The Whale Museum unpubl. data), not all of their movements and locations throughout the day are documented. In addition, SRKWs are highly mobile and can travel up to 86 nm (160 km) in a single day (Erickson 1978; Baird 2000).

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[62] This is one sighting of J and L pod. All other sightings of J and L pod this day were in MA 7 and Canada 19C. While it is possible that J and L pod made it to MA 12, this could be an error. The sighting coordinates are close to the border between MA 9 and MA 12.

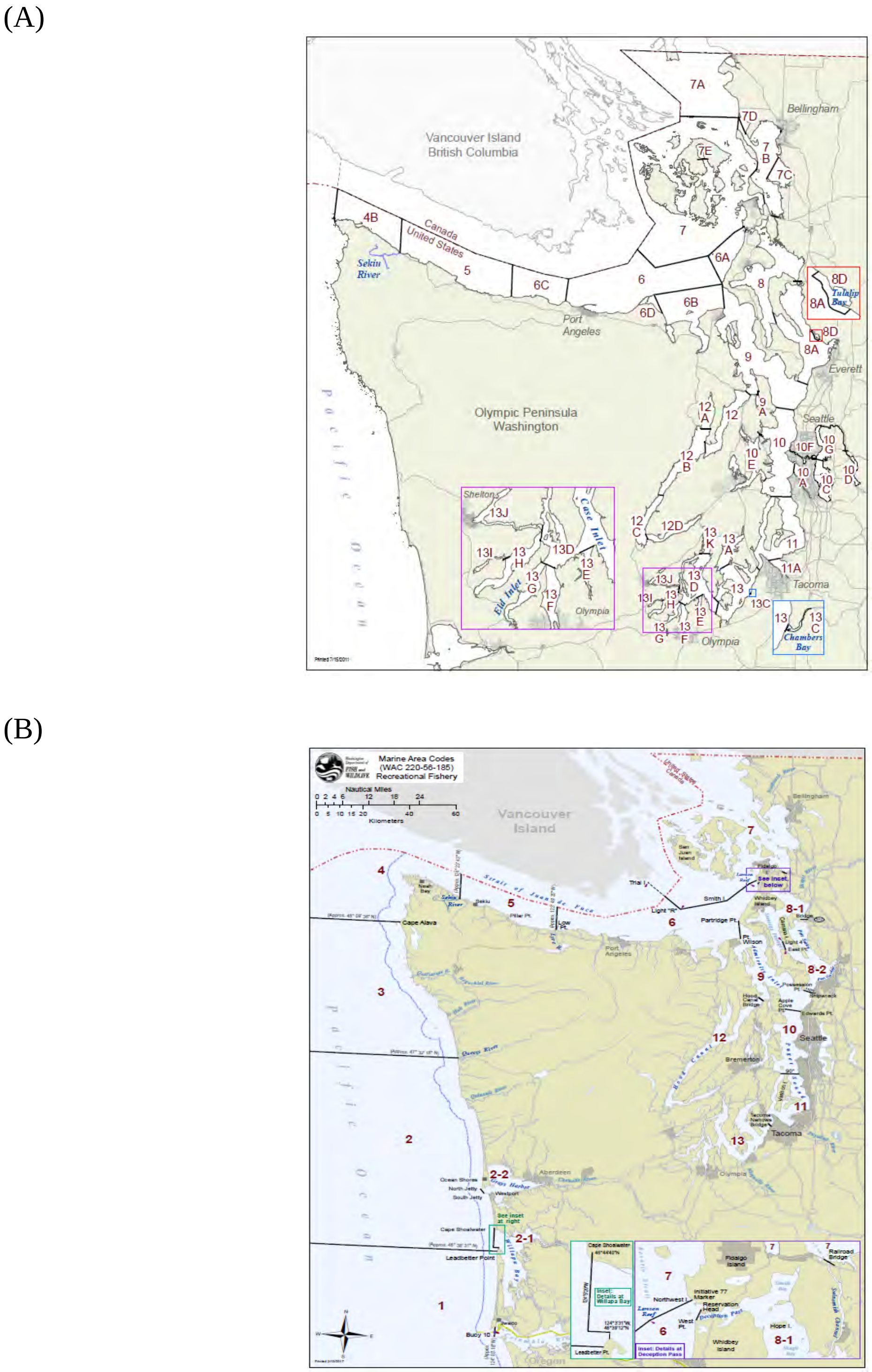

Figure 42. (A) Puget Sound Commercial Salmon Management and Catch Reporting Areas and (B) Puget Sound Recreational Salmon Management and Catch Reporting Areas (reprinted from (Cunningham 2022)).

In summary, Puget Sound salmon fisheries have the potential to overlap in space and time with SRKW depending on the specific fishery regime in any particular year, particularly in the San Juan Island area, or recreational marine area 7 (R-MA 7) (Figure 41, Figure 42) in July through September (shown here and as described in previous Puget Sound fishery opinions, e.g. NMFS (2019d)) based on occurrence/frequency of SRKWs and fishery area management. SRKWs also forage near the US-Canadian border, which is also part of R-MA 7, and is part of C-MA 7a (Figure 42). As noted above, SRKW have been sighted less frequently in inland waters, especially in summer, and especially for K and L pod, in recent years (particularly since 2017), but the factors driving these changes are still being investigated. There is some recent evidence linking Fraser Chinook salmon abundance to distribution (Stewart et al. 2023) and it is unknown if the recent pattern will continue. When the whales are present in inland waters, they show similar patterns of occurrence in specific areas as they have done since prior to 2017 and still occur more frequently in July-September and into early fall. The following sections examine the effects of the proposed actions.

Fishing Vessel Presence/Effort

We now consider the vessel presence and effort caused by the proposed action before summarizing the potential effects of this presence on SRKW.

Non-Tribal

Non-Tribal fishing includes recreational fisheries primarily targeting Chinook salmon and coho, as well as commercial salmon fisheries (primarily targeting sockeye in summer months). Both fisheries (commercial and recreational) encounter Chinook either as a target species or as bycatch. We have data on effort by non-tribal recreational fisheries across recreational marine areas through data on angler trips targeting salmon (all salmonids, not just Chinook) in each R-MA (recreational anglers), the previous catch of Chinook in each area (recreational and commercial non-tribal) for both commercial and recreational non-tribal, and also data on commercial landings per week in each C-MA (to calculate boats/day, i.e. vessels that landed salmon by week). At a finer spatial scale, to look at occurrence in SRKW hot spot off San Juan Island, we look at aerial surveys of recreational boats in R-MA 7 during dates of Chinook salmon retention provided by WDFW and anglers in area R-MA 7 (see Figure 48; Table 35). Data for angler trips for recreational sports fisheries by area came from WDFW (provided by Eric Kraig, WDFW, and see for example (Garber and Kloempken 2020) – (https://wdfw.wa.gov/sites/default/files/publications/02153/wdfw02153.pdf) and (Kraig and Scalici 2021) - https://wdfw.wa.gov/sites/default/files/publications/02257/wdfw02257.pdf), and data for Chinook salmon landed catch by area by both commercial and recreational came from FRAM salmon model input (provided by J. Carey, NOAA NMFS, FRAM version 7.1.1). While there can be multiple anglers per boat, the number of trips provides relative vessel presence across areas and some measure of effort.

Figure 43 shows the number of recreational angler trips (where three anglers equals three angler trips) by R-MA averaged across years 2010-2019. Most angler trips occur in Summer months, July through September, with anglers spread out across the areas and the highest number of anglers in R-MA 5, 7, 9, 10, and 11.

Table 33 from Cunningham (2023) shows the number of recreational angler trips in R-MA 7 for the last 14 years (2009-2023), and that since 2016, the average numbers of anglers in R-MA 7 in summer during Chinook retention and non-retention have declined especially in the most recent 2-years. A different data set of vessel counts shows the number of boats has increased in some years since 2016, see below, Figure 43.

For catch of Chinook by area (which is not effort but gives a way to compare across fisheries), we limit the data to the non-tribal fisheries (Tribal fishery effort is discussed below) and present data by fishery-area for years 2009-2018 for commercial and recreational non-tribal fisheries (Figure 44(A)). In 2018, catch of Chinook was highest in the non-tribal MA 6 sport, non-tribal MA 9 sport, non-tribal MA 7 sport, and non-tribal MA 10 sport fishery (see Figure 44, where both sport and commercial are plotted but sport had the highest catch). Note that because we do not have data on total abundance by each area, it is unknown how much the fishery is reducing the overall prey abundance in each area and this is only a proxy of effort, not of total prey reduction (which is discussed in the Indirect effects Section). MA 7 catch (Figure 44(B)) is highest for the non-tribal sport fishery compared to non-tribal net fisheries, in recent years, and this sport catch has increased somewhat over this time period (2009-2018, average ~4130), but has decreased in recent years (1,800 in 2022, 2,181 in 2023, 2,181 in 2024 (WDFW and PSTIT 2024)).

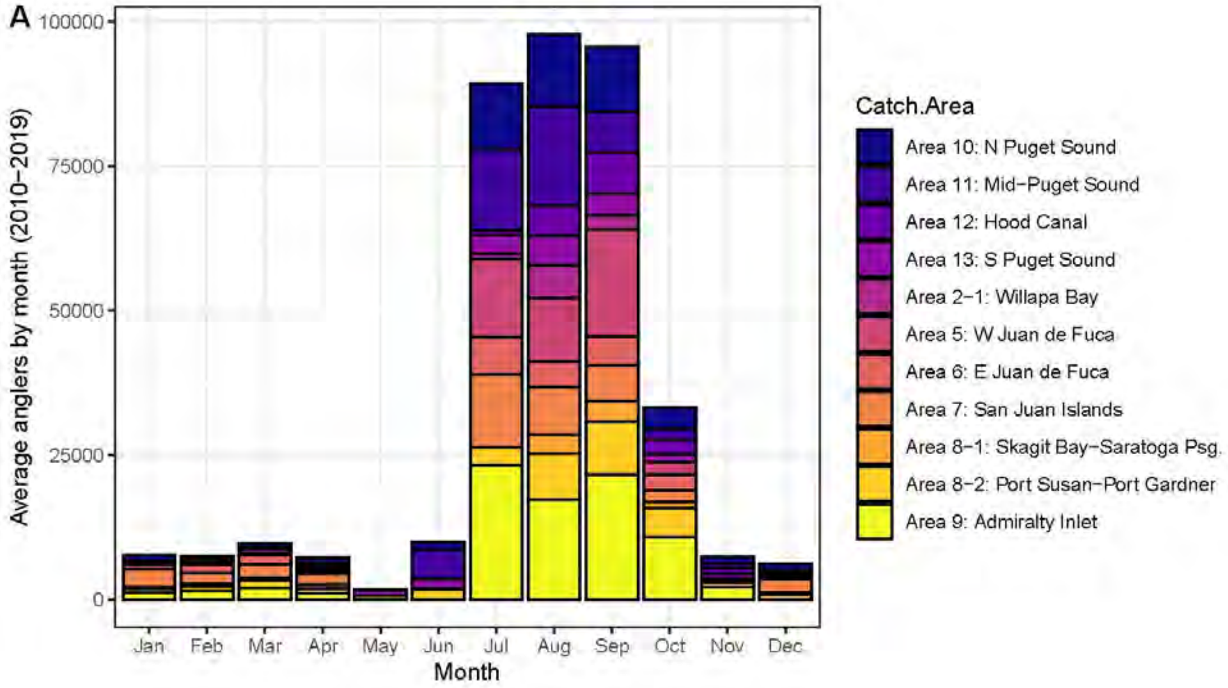

Figure 43. Angler trips targeting salmon by (A) recreational marine areas for each month averaged across 2010-2019, and (B) for each summer month for MA 7 for years 2010-2019, where angler trips equals

effort for recreational fisheries. Data provided by Eric Kraig from WDFW and reported each year (see for example Garber and Kloempken (2020) - https://wdfw.wa.gov/sites/default/files/publications/02153/wdfw02153.pdf, and Kraig and Scalici (2021) - https://wdfw.wa.gov/sites/default/files/publications/02257/wdfw02257.pdf)

Table 33. Estimated recreational angler trips and number of days open during Chinook directed and Chinook non-retention recreational fisheries in R-MA 7 in summer. R-MA 7 includes commercial sub-areas such as 7A, 7B, 7C, and 7D. Estimates of angler trips during the non-retention period for 2023 are not finalized yet as they require catch record card estimates, which will be available in 2025 for the 2023 fishing year. Taken from Cunningham (2024). *Estimates of angler trips during the non-retention period for 2023 are not finalized yet as they require catch record card estimates, which will be available in 2025 for the 2023 fishing year.

Year	Period	Days Open to Chinook Retention	Angler Trips During Chinook Retention	Angler Trips Per Day of Chinook Retention	Total Angler Trips Including Non-Retention Period
2009	Summer	92	27,676	301	27,676
2010	Summer	92	21,005	228	21,005
2011	Summer	92	28,048	305	28,048
2012	Summer	92	27,396	298	27,396
2013	Summer	92	32,299	351	32,299
2014	Summer	92	41,307	449	41,307
2015	Summer	92	35,841	390	35,841
2016	Summer	92	22,044	240	22,044
2017	Summer	92	25,340	275	25,340
2018	Summer	65	15,557	240	18,719
2019	Summer	31	11,275	364	17,077
2020	Summer	41	22,804	556	25,482
2021	Summer	7	6,839	977	9,338
2022	Summer	9	6,397	711	9,185
2023	Summer	6	6,504	1,084	NA*

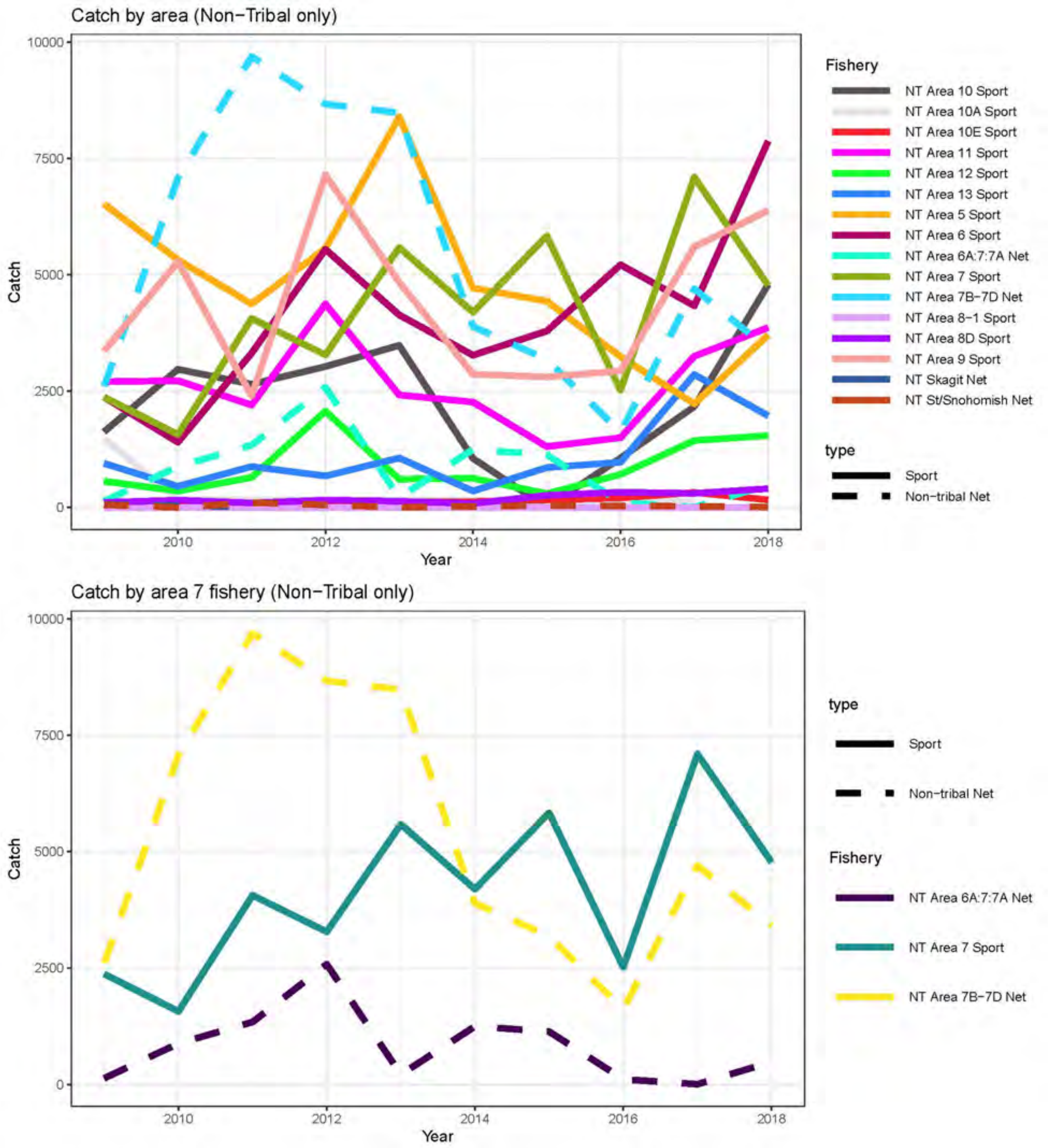

Figure 44. (A) Chinook catch by each MA and non-tribal fishery for years 2009-2018 and (B) catch in MA 7 by each MA 7 fishery for years 2009-2018. Data provided by J. Carey, NOAA NMFS from FRAM version 7.1.1. Note that catch does not represent reduction of prey in each area as total abundance in each area is not known but is a proxy for effort.

In 2024, the R-MA 7 recreational fishery will be closed to all salmon fishing (including Chinook) in the first half of July (1-17th). Then, the recreational Chinook salmon mark-selective (retain hatchery only) fishery (MSF) in R-MA 7 will open for 3 days (Thursday, Friday, Saturday) from July 18-20, with additional 3-day openings prior to August 16th contingent on sufficient remaining impacts (relative to quota which assumes an amount of encounters that will not surpass ER) based on in-season monitoring (Table 34); Cunningham (2024). Anglers will be allowed to catch two salmon including 1 hatchery Chinook salmon and must release chum, wild coho, and wild Chinook salmon. R-MA 7 will be a non-retention fishery for Chinook salmon in the second half of August (17-31) and all of September. Note, R-MA 7 will be mark-selective for coho in the second half of July, all of August (2 fish limit, release wild coho, all Chinook, all sockeye, and all chum), and open to coho in September (2 fish limit, release chum, sockeye, and Chinook), so boats will likely be present targeting salmon other than Chinook. Overall, the 2024-2025 recreational Chinook season in R-MA 7 is reduced by 2 months relative to historical years (WDFW and PSTIT 2024).

The R-MA 7 area is a key foraging area for the whales during summer months, especially in September of recent years for all pods, and the non-retention requirements in the recreational fishery are anticipated to 1) potentially reduce impacts from vessels (we anticipate lower fishing effort, and less vessel traffic in non-retention fisheries, however, boats are still present and can retain other salmonids (see Table 34 below and Figure 46) and 2) reduce impacts to prey available (as discussed below) to SRKWs in the times and areas of high importance. There are no Chinook recreational fisheries (closed) in the Strait of Juan de Fuca (MA 5) in May - June and the second half of October and November - February, and none in San Juan Islands, Georgia Strait, Admiralty Inlet, and Port Susan/Port Gardner areas (MAs 6-9) in October (except for non-retention the first half of October for MA 6 and 8-1)- first half of July - (except for mark-selective in MA 6 in July) (WDFW and PSTIT 2024). Therefore, this year there is a complete winter closure to Chinook salmon fishing in R-MA 6, 7, 8, and 9. MA 7, 8-1, 8-2, and 9 are also primarily non-retention for Chinook in July-September (except some mark-selective in 6, 7 and 9 in July). In addition, fishing in MA 10 and 11, where SRKW are observed foraging in the Fall months though likely not primarily consuming Chinook salmon (Figure 39), does not allow retention of Chinook in October and the first half of November, and are closed in the second half of November and December - February. Mark-selective fishing is allowed in March and half of April as well as summer months in 10 and 11 (WDFW and PSTIT 2024). MA 12 is closed December- June and while this is not an area frequented by SRKW, fish from this area can redistribute out to other areas that overlap more with SRKW.

Table 34. Puget Sound Marine Pre-Season Recreational Chinook Seasons in MA7 (2017 – 2024). MSF- Mark Selective Fishing; NS- Non-Selective; NR- Non-Retention; Gray shaded cells indicate closed season. Months with split cells change management mid-month).

Year	May	Jun	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
2017	▨	▨	MSF	NS	NS	▨	▨	▨	MSF	MSF	MSF	MSF

Year	May	Jun	July		Aug		Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	
2018	▨	▨	MSF		NS		NR	▨	▨	▨	MSF	MSF	MSF	MSF	▨
2019	▨	▨	MSF		▨		NR	▨	▨	▨	▨	MSF	MSF	MSF	▨
2020	▨	▨	MSF		NR	MSF	NR	▨	▨	▨	▨	▨	▨	▨	
2021	▨	▨	MSF		NR	MSF	NR	▨	▨	▨	▨	▨	▨	▨	
2022	▨	▨	▨	MSF[63]	MSF[1]	NR	NR	▨	▨	▨	▨	▨	▨	▨	
2023	▨	▨	▨	MSF[64]	MSF[2]	NR	NR	▨	▨	▨	▨	▨	▨	▨	
2024	▨	▨	▨	MSF[65]	MSF[3]	NR	NR	▨	▨	▨	▨	▨	▨	▨	

Though certain months are non-retention for recreational fishing on Chinook in R-MA 7 in 2024 and there is an expectation that non-retention months will have fewer recreational fishing vessel trips, this may not necessarily result in fewer recreational fishing vessels in R-MA 7 in those months. While the total number of anglers in R-MA 7 during the summer has declined, so has the number of days of recreational Chinook retention in this area (Figure 45). Since the number of days of Chinook retention has declined faster than the total number of anglers, the number of anglers per day of Chinook retention allowed has increased since 2016 (Figure 45). This suggests that there is a greater opportunity for vessel disturbance from more highly concentrated fishing effort on the days when Chinook retention is allowed when the whales are present than what may have occurred historically. Creel survey data from WDFW of vessel counts shows the number of boats has increased in some years since 2016, see below, Figure 46.

Using creel survey data from WDFW, we estimated the average number of recreational boats per

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[63] Chinook salmon fishing in this area will open for 3 days from July 14-16 and additional fishery openings will occur prior to August 16 contingent on the remaining sufficient impacts relative to the pre-season fishery plan which will be monitored for in-season.

[64] July 13th start, 3-day opener (Thursday, Friday, Saturday), with additional openings pending impact availability.

[65] July 18th start, 3-day opener (Thursday, Friday, Saturday), with additional openings pending impact availability.

day in R-MA 7 for years 2010-2020 in July, August, and September, where September became non-retention starting in 2018. Note for July that there was a shift in sampling methods beginning after 2015 so it is difficult to compare July boat presence before 2015 to after 2015. For September, though R-MA7 became non-retention for Chinook beginning in 2018, average boats per day in R-MA 7 increased from 2018 to 2020 (Figure 46). This is likely because anglers can still target coho in R-MA 7 in September. It is difficult to know if the increase would have been even more pronounced if Chinook harvest was not non-retention. Also, though creel boat survey data shows an increase in recreational fishing boats, there has been a reduction in angler trips in R-MA 7 in recent years even when Chinook is non-retention (see Table 34).

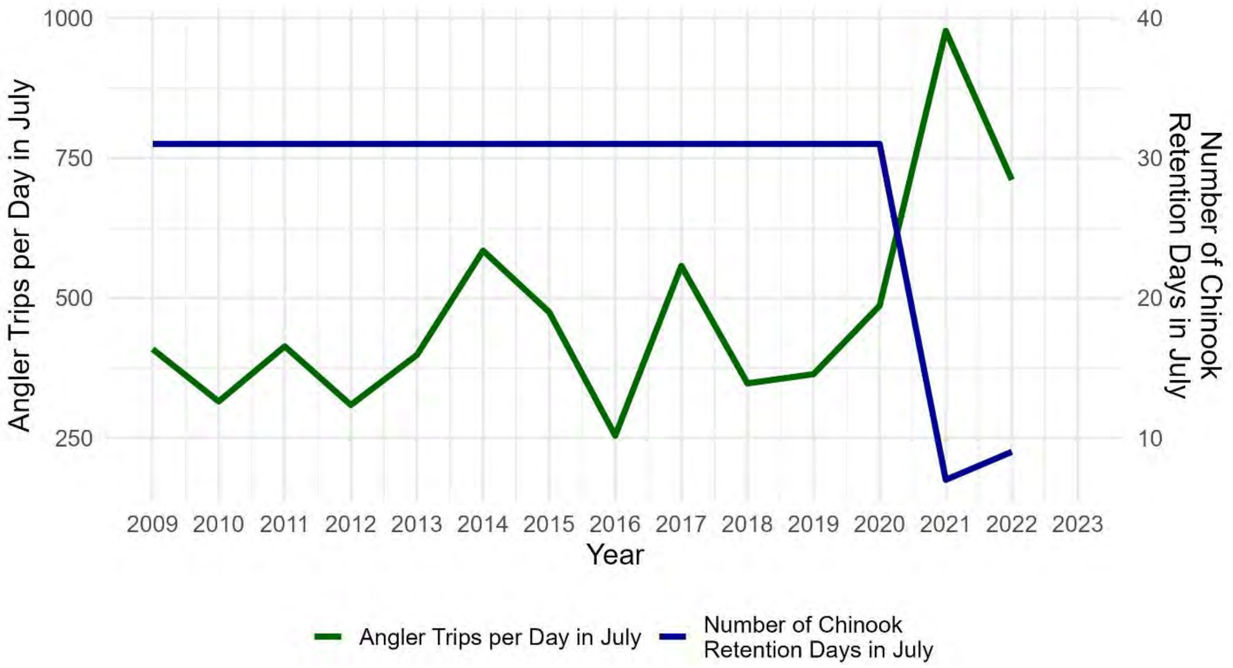


Figure 45. The number of recreational angler trips per day on days in July when R-MA 7 allows Chinook retention over time and number of days that the fishery is open to retention of Chinook in July by year. The leftmost y-axis shows the change in angler trips per day in July and the rightmost y-axis shows the change in the number of days of Chinook retention in July. Values for angler trips in July for 2009-2022 are from J. Carey querying the most current CRC database.

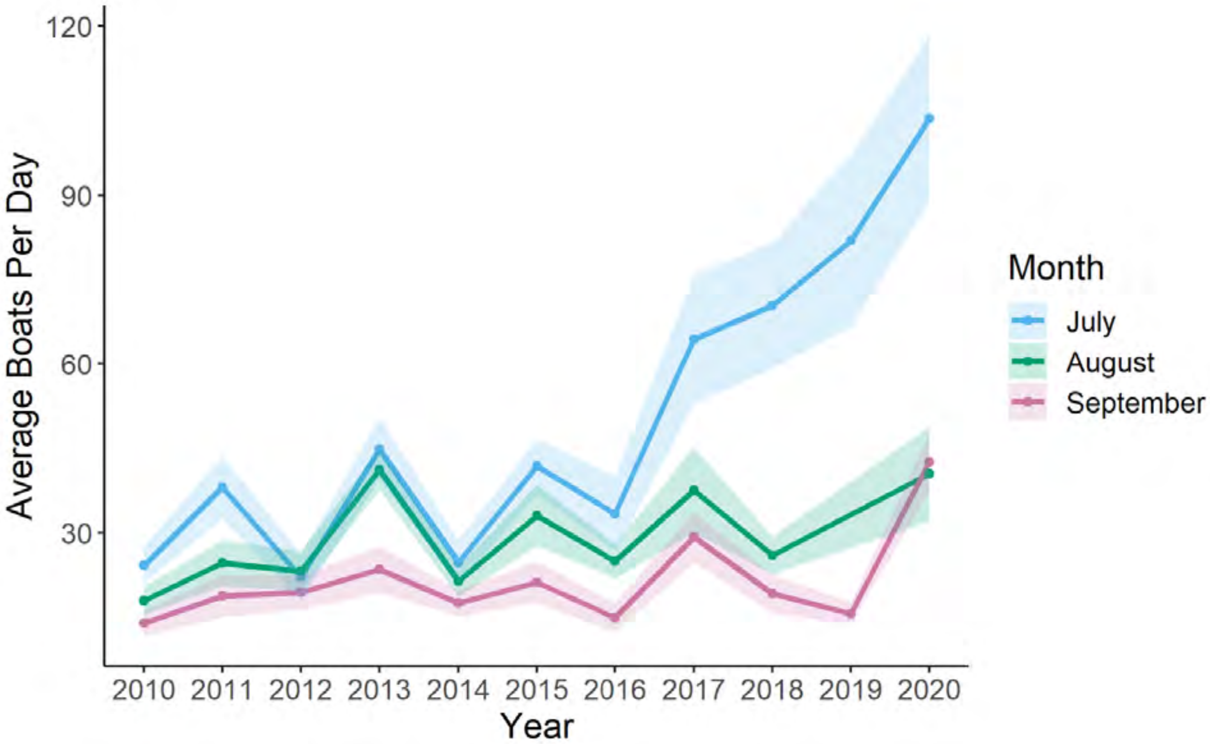


Figure 46. Line graph of the average recreational fishing vessels that fished in R-MA 7 from July to September in 2010-2020. The line represents the mean of each year and the shaded regions represent the standard error, using creel survey data from WDFW. There was shift in sampling method in July beginning in 2016.

Given the number of days that SRKW are found in R-MA 7 and its importance for foraging, we determined the number of days that SRKW were spotted when the recreational fishery allowed Chinook retention over the past few years. This provides information on how often fishing vessels may be disturbing SRKW. We filtered the Whale Museum sightings data to include all killer whale sightings specified to SRKW but also included sightings that are thought to be SRKW, but are not confirmed in R-MA 7. This approach accounts for uncertainty in the sightings data as unconfirmed sightings may be SRKW and here we are assessing the potential full degree of overlap. Sightings data from 2020 to 2022 showed that Chinook retention in R-MA 7 overlapped with SRKW presence 27 days of 47 days the fishery was open (57%) in 2020, 2 of 7 days (29%) in 2021 and 5 of 9 days (56%) in 2022 (Figure 47)(Whale Museum sightings database).

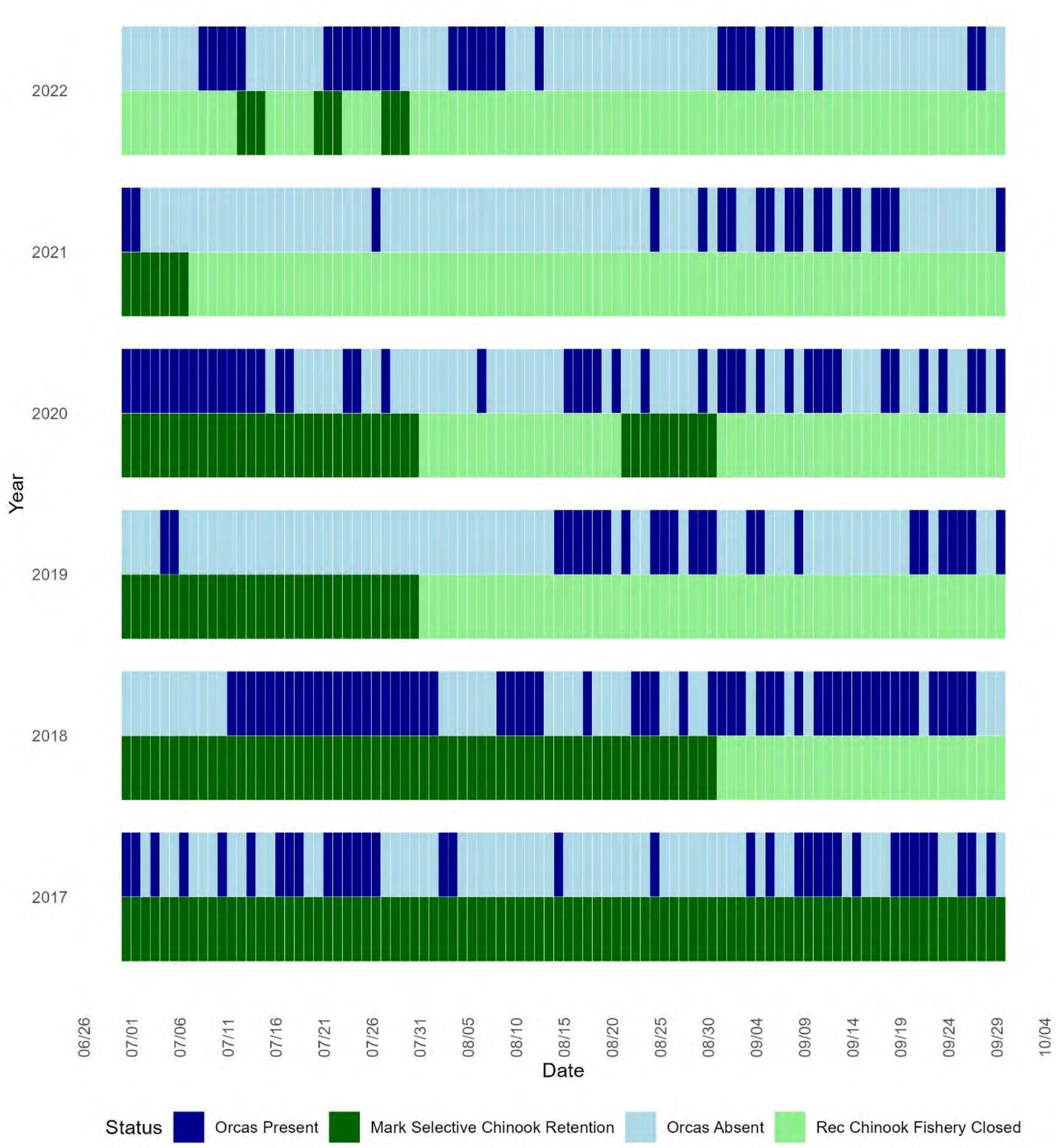


Figure 47. SRKW presence in R-MA 7 (Whale Museum sightings database) and days that recreational fisheries in R-MA 7 allowed Chinook retention in recent years.

Using aerial survey information from WDFW, we looked at the distribution of recreational fishing vessels within R-MA 7 during Chinook retention periods, as SRKW are often most commonly observed off the West side of San Juan Island. Two caveats with this information is that (1) sighting location may vary somewhat due to the location of the aerial survey cameras and (2) it is difficult to differentiate between a recreational fishing vessel and other recreational vessels (Figure 48). However, it is the best available information on location of fishing vessels. This data shows that vessels are dispersed across R-MA 7 (Cunningham 2024), but there is considerable variation from year to year (see Table 35). Even with the annual variation, there is never more than 25% of the recreational fishing boats off the West side of San Juan Island, and we expect similar vessel concentrations in 2024, assuming similar conditions as in recent years.

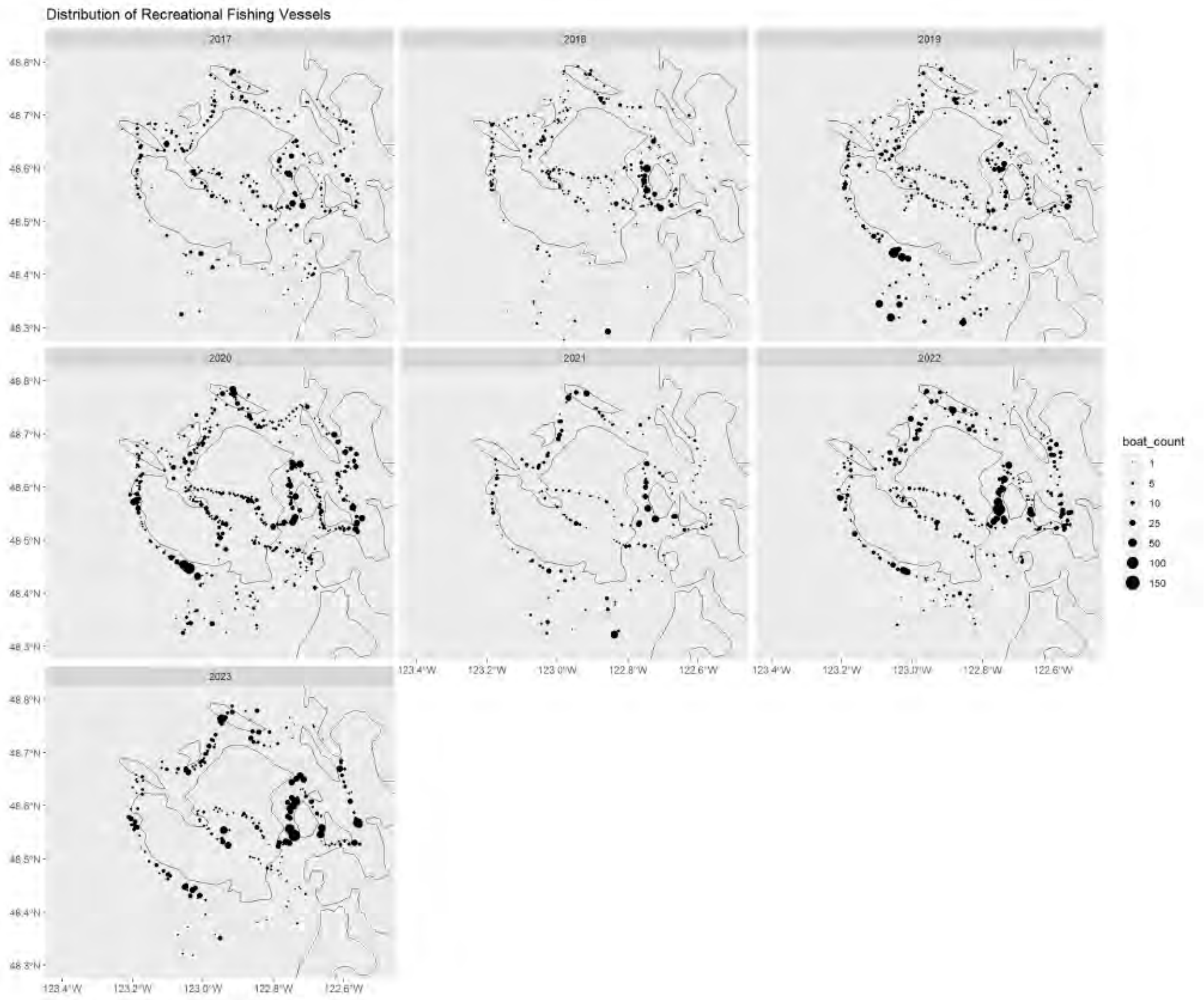
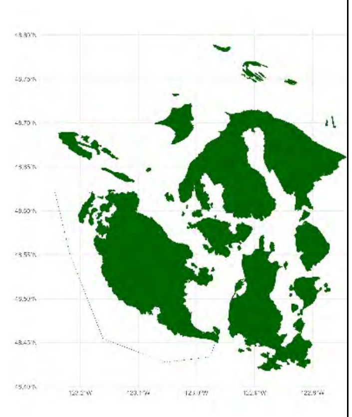


Figure 48. Total recreational fishing vessel counts from aerial surveys from 2017-2023. Note that total surveys varied by year with 5 in 2017, 5 in 2018, 6 in 2019, 8 in 2020, 3 in 2021, 6 in 2022, and 4 in 2023. Therefore, general distribution of vessels can be compared from year to year but not total vessels from this figure. Size of each circle reflects total boat count.

Based on the number of recreational fishing vessels recorded by aerial surveys and the total number of surveys each year, we can calculate the average number of fishing boats per survey in

R-MA 7, which equates to average vessels per day (during aerial surveys), because only one survey is done per day. We can also look at average boats per survey (or day) specifically along the West side of San Juan Island, a hot spot for SRKWs. Average boats per day off the West side of San Juan Island range from 10-78 depending on year, but in 2022, the number of boats in a single day (single survey) off the west side of San Juan Island was as great as 248. WDFW's survey? methods are targeting recreational fishing vessels, but this may be an overestimate, because it's difficult in an aerial survey to only count fishing boats (as opposed to boats engaged in other activities; see https://wdfw.wa.gov/sites/default/files/publications/01357/wdfw01357.pdf).

Table 35. Recreational fishing vessel counts per aerial survey per year in R-MA 7 and off the West side of San Juan Island (area with the blue dotted boundary on the map in the final column).

Year	Total # of surveys	Average total boats per survey (or day)	Average total boats WSJI per survey (or day) (min-max)*	Percent of boats on average off WSJI	
2017	5	234	15 (1-36)	6.41	
2018	4	155	12 (4-21)	7.74	
2019	6	274	47 (0-91)	17.15	
2020	8	327	61 (13-146)	18.65	
2021	3	431	34 (29-39)	7.89	
2022	6	363	78(13-248)	21.49	
2023	4	463	50 (6-92)	10.8	

*We did exclude counts of 0 boats on 2017-07-22, 2018-07-08 and 2021-07-03 because on these dates locations of vessels were inaccurate due to challenges in the location functionality of the form used for data collection during the aerial surveys.

We also note that effort likely varies by management week in R-MA 7. Particularly, data from previous years on boats per day for R-MA 7 and sport fishing shows the greatest number of boats at the start of Chinook retention (data from WDFW MSF summer annual reports). Therefore, if surveys occur at the beginning of July, aerial surveys may not accurately reflect the number of vessels later on in the season.

We next describe the overlap between the non-tribal commercial fisheries and SRKW. Here, we describe the non-tribal commercial fisheries included in the co-managers' plan for 2024-2025. Commercial salmon purse seine and gillnet fisheries managed by WDFW targeting Fraser sockeye operate in C-MA 7, 7A in the vicinity of San Juan Island and Point Roberts areas, and are regulated through in-season orders issued by NMFS giving effect to orders of the PSC's Fraser River Panel (Cunningham 2024; WDFW and PSTIT 2024). For the most part, commercial fishing vessels operating within ¼ mile of San Juan Island utilize purse seine gear. Beyond ¼ mile of the island there is a mix of gillnet and purse seine vessels. Cunningham (2024) noted that any target fisheries of sockeye are unlikely in 2024 due to the predicted poor return for sockeye, but any open days will be determined in-season by the Fraser River Panel based on test fishing and hydroacoustic data collected. Fraser chum directed purse seine and gillnet fisheries can also occur in C-MA7 and 7A in October, dependent on DFO in-season evaluation, but in four of the last five years, chum has not been above the critical threshold for fisheries to occur. If these fisheries do occur (sockeye, or chum), non-target species (Chinook and coho) are required to be released from purse seine gear. Reef nets can retain ad-clipped hatchery Chinook up to a cap of 300. Commercial fisheries targeting Puget Sound coho managed by WDFW will occur in late September to early October in C-MA 7 with reef netting in 7A which is a fixed gear fishery (no moving vessels). There is commercial Chinook fishing in the Bellingham Bay area (7B and C) which reduces prey through indirect effects described later in this section, however SRKW are rarely observed in this area in summer.

For non-tribal commercial effort by C-MA, WDFW provided gillnet and purse seine landings by month, year, and C-MA (as part of the information provided for the Humpback whale effects analysis; WDFW, unpublished data). Monthly landings estimates can be interpreted as boat-days, meaning each unit is a single fishing boat on a single day (divide monthly counts by the amount of days in that month to get effort per day). Within a month, the same boat could be counted more than once if it occurred on multiple days. Table 36 shows that in recent years non-tribal commercial effort has declined in all C-MA for both purse seine and gillnet in August and September. We expect similar lower effort boats/day on average each week in future years as seen in 2018-2022 (or the 2016-2022 average).

Table 36. (A) Gillnet and (B) purse seine landings for years 2010-2022 by Puget Sound Marine Area and month, including average landings per marine area for 2010-2015 and 2016-2022 (replicated from WDFW). Does not include reef net or beach seine effort.

(A)

Marine Area	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2010-2015 Avg**	**2016-2022 Avg**
August															
7	197	108	43	6	118	14		1	67				18	**81**	**29**
8		10		16										**13**	**-**
10				3		5								**4**	**-**
07A	269	73	37	11	229	29			146			1	33	**108**	**60**
07B	31	37	14	40	5	14	14	1	16	2	15	10	12	**24**	**10**
07C	80	240	278	301	78	142	69	140	86	92	58	34	101	**187**	**83**
08A		3		16		5								**8**	**-**
09A	9	33	65	35	13	1	47	20			11	2	14	**26**	**19**
September															
7	31	4		8	7	1								**10**	**-**
8		3		8		1								**4**	**-**
06D	22	34	41	29	12	2	51	42	40	30	47	49	53	**23**	**45**
07A	52	6		13	85									**39**	**-**
07B	194	414	299	401	118	47	113	74	95	42	76	83	97	**246**	**83**
07C	20	14	71	41	61	24	5	68	55	65	2	6	70	**39**	**39**
08A		1												**1**	**-**
08D	2	9	3	2										**4**	**-**
09A	14	43	67	15	10	4	43	40	2	2	20	11	16	**26**	**19**
12A			1											**1**	**-**

(B)

Marine Area	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2010-2015 Avg**	**2016-2022 Avg**
August															
7	93	86	8	32	64	40			49	6		7	11	**54**	**18**
8		17		5		2								**8**	**-**
10		10		21		13		1				9		**15**	**5**
07A	46	47	7	23	69	11			35	1		2	12	**34**	**13**
07B	1		3		1	1	1		2					**2**	**2**
07C			3	1									7	**2**	**7**
08A		66		67		24								**52**	**-**
September															
7	20	63		76	2	2						4		**33**	**4**
8		1		10		5								**5**	**-**
10						4								**4**	**-**
07A	36	83		124	88	8		2				5		**68**	**4**
07B	10	10	7		6	2	4	1						**7**	**3**
07C	1		4					1					1	**3**	**1**
08A	1	4	3	2	1	14			2					**4**	**3**

We also looked at temporal overlap of commercial fisheries in R-MA 7 targeting sockeye (and pink in odd-numbered years) and SRKW presence using the same methodology as listed above for Figure 47 (Figure 49) but note that these fisheries are (1) not targeting Chinook (though do have Chinook as bycatch) and (2) there are fewer commercial vessels than recreational. Also note that commercial fisheries here include both non-tribal and tribal (all Fraser panel) and then non-tribal opened by WDFW after Fraser panel. We have other metrics (specifically boats per day) presented in these sections to look at effort for specifically tribal vs. non-tribal.

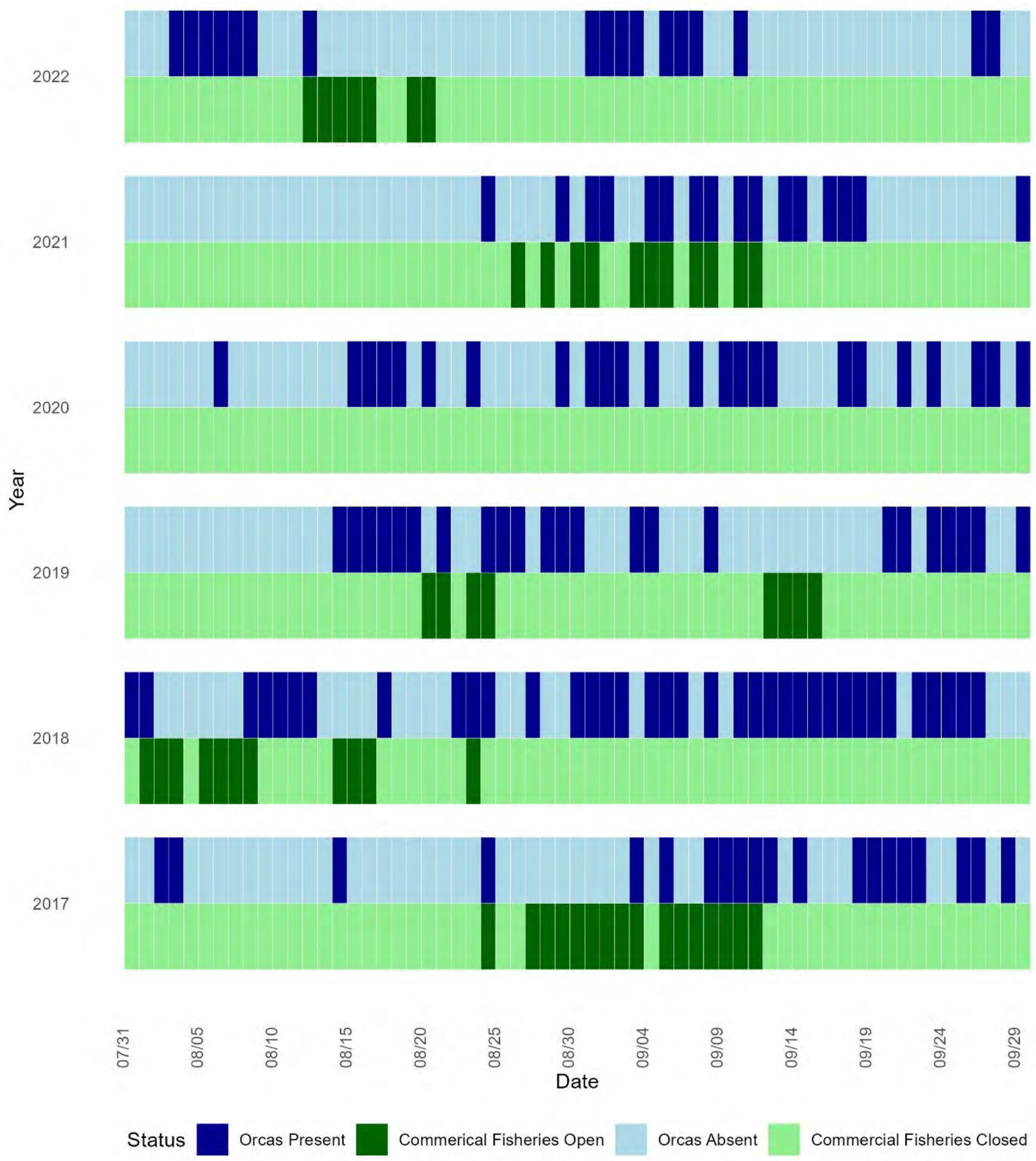


Figure 49. SRKW presence in R-MA 7 (Whale Museum sightings database) and days that commercial fisheries for sockeye salmon (and pink salmon in odd-numbered years) in C-MA 7/7A occurred.

There are certain exclusion zones closed to non-tribal commercial salmon take but these are primarily outside of SRKW areas of high occurrence (see WAC 220-345-080 at https://app.leg.wa.gov/WAC/default.aspx?cite=220-354-080, and https://wdfw.wa.gov/sites/default/files/2021-07/2021_comm_final.pdf). And similarly, for recreational non-tribal fisheries (here: https://www.eregulations.com/washington/fishing/marine-area-7).

In summary, non-tribal recreational fisheries in recent years include thousands of angler trips and catch thousands of Chinook salmon in Puget Sound. Recreational fishing vessels overlap within important foraging areas for SRKW, particularly in R-MA 7 during the summer. As the Chinook recreational fishery in R-MA 7 has decreased the number of days open to retention, the number of days that SRKW are present in R-MA 7 when Chinook retention is allowed has declined, which suggests more limited impacts to SRKW through vessel noise. Considering that the West side of San Juan (within R-MA 7) is recognized as a foraging hot spot for SRKW, and less than a quarter of recreational fishing boats in R-MA 7 have been observed in this region, the likelihood of fisheries causing significant local prey depletion is low. There will be fishery management measures in place for the 2024-2025 season, such as periods of non-retention and catch limits, which will limit potential impacts from both recreational fishing vessels and removals of Chinook salmon. Closures during winter months will also reduce potential impacts on SRKW. For non-tribal commercial fisheries, there is also catch of thousands of Chinook salmon expected, however, there are a very limited number of days fishing with potential for fishing vessel impacts expected during the 2024-2025 season. There are also caps in place for some gear types, and some commercial fisheries occur in areas that don’t have significant overlap with SRKW (WDFW and PSTIT 2024).

Tribal Fishing

For tribal fishing in pre-terminal areas within Puget Sound, Chinook salmon harvest predominately occurs in fisheries directed at other salmon species (sockeye, pink, coho or chum) with Chinook salmon catch being incidental and/or in times and areas where SRKW encounters are not expected (Parker 2024). Most tribal harvest occurs in times and areas when/where SRKWs are less likely to overlap and/or fisheries are directed at species other than Chinook. Furthermore, the majority of tribal fisheries’ mortalities on Chinook is in terminal areas (freshwater or in marine waters proximal to the river mouth, impacting mature returning Chinook of local stock, with 62 percent of fisheries being terminal and only 38 percent of fisheries occurring in areas considered pre-terminal)(Parker 2024). Therefore, tribal harvest occurs most frequently in areas outside the reach of SRKW. We don’t expect the temporal and seasonal effort observed in recent years for tribal fisheries to change substantially for the 2024-2025 season (Parker 2024).

To assess the potential spatial/temporal overlap of tribal vessels with SRKWs within the inland waters in 2024-2025, we considered the NWIFC analysis of tribal salmon fisheries effort (defined in terms of boat days per time step as measured by unique fish tickets) in previous years (average from 2011-2022) overlapping with SRKW sightings (Parker 2024). The recent 5-year average tribal fleet size in the Salish Sea (as defined by unique fish tickets) is 1,475 vessels. Assessing the potential for interaction utilizing the SRKW sightings (including in SRKW “hot spots”) and unique fish ticket data indicates that there is minimal overlap between SRKWs and tribal salmon fisheries (Figure 50). This assessment indicates that the areas of highest use by the whales, particularly the San Juan Islands, where the greatest interaction with tribal fisheries yields1-2.5 vessels per time step day (time steps from FRAM salmon models, see Figure 50, across 92 days of fishing in July-September time step). There are similar vessel occurrences (2.5 to 5.0 vessels per time step day) north of this area (area near Point Roberts, Canada border) in July-September but with somewhat less occurrence of SRKWs. In October-April and May-June, there are fewer tribal vessels per time step day (<1), in the areas with the greatest SRKW observations. Therefore, even where tribal fisheries do have the highest potential to overlap with SRKW, such as off the west coast of San Juan Island, tribal effort is low, and we expect this to continue into 2024 given the similar conditions. The limited overlap between tribal fisheries and SRKW suggest that there is low potential for localized prey reduction resulting from removal of Chinook by tribal fisheries.

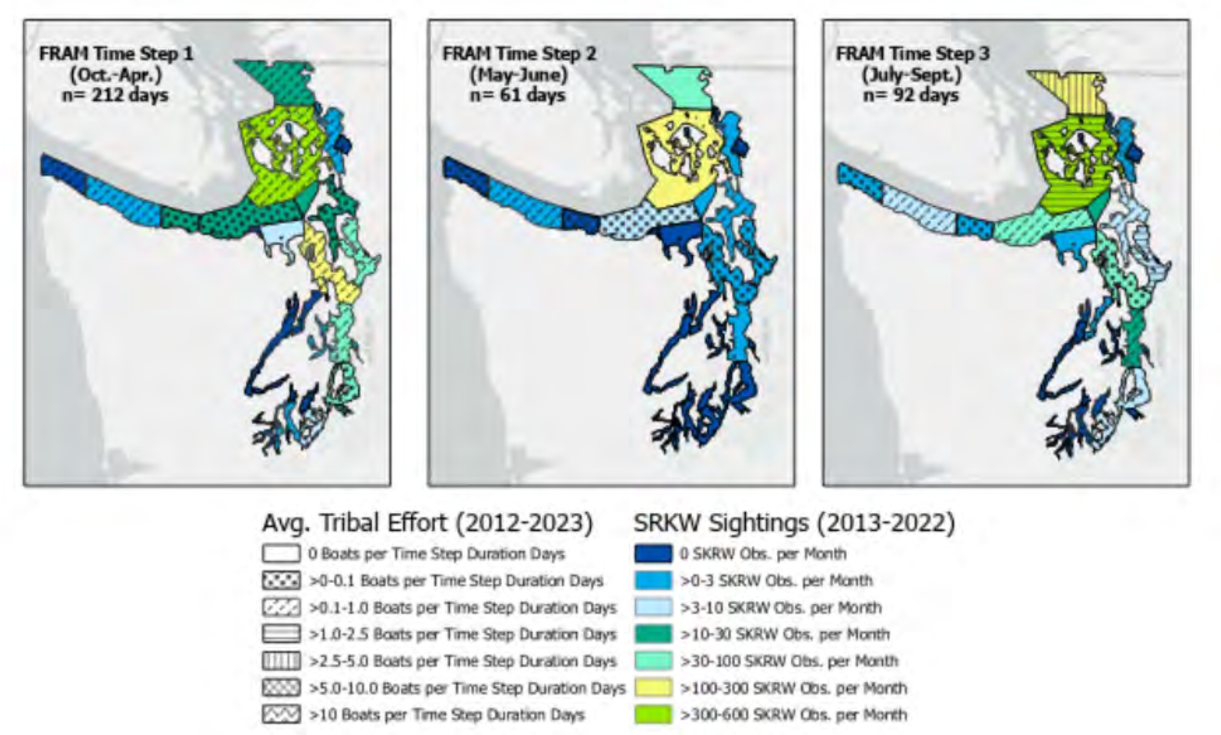


Figure 50. Average overlap of tribal fishing vessels (measured by unique fish tickets) and Southern Resident killer whale sightings in all FRAM time steps (Time step 1 Oct-Apr.; Time step 2 May-June; and Time step 3, July – September) for years 2013-2022 (reprinted from Parker (2024).

Potential SRKW Disturbance, Likelihood of Interaction, and Existing Mitigations

The information above highlights that there is potential for direct interaction between SRKW and fishing vessels and gear in the action area because of the high degree of spatial and temporal overlap between the whales' distribution in the inland waters and the distribution and timing of the proposed fisheries. We consider here how direct effects from vessel activities and gear interactions associated with the proposed fishery may impact the fitness of SRKWs. Above we described the general predicted overlap of the whales and the 2024-2025 fisheries using recent seasonal SRKW sightings and considering fishery management measures in place for the upcoming season that may reduce overlap. Here we describe the potential for direct interactions (e.g., vessel strike, gear interaction, vessel or acoustic disturbance) and incidents inconsistent with Be Whale Wise and vessel regulations (compared to other types of vessels), potential responses by the whales (e.g., mortality, serious injury, behavioral changes), and also the additional education and outreach actions by WDFW that likely limit interactions. Our conclusion based on the available information presented below is that interactions with vessels or fishing gear associated with the proposed action are not likely to have more than minor effects on SRKWs.

Interactions with Puget Sound fishing vessels could occur while vessels are fishing or while they are transiting to and from the fishing grounds. Vessel strikes or instances of gear interaction with marine mammals are rare, though a recent paper did determine vessel strike as the cause of death for three stranded killer whales (one Southern Resident, one Northern Resident, and one transient, for 22 whales where a definitive cause of death could be determined from 2004 to 2013)(Raverty et al. 2020). One Southern Resident that had a confirmed death from vessel strike was habituated to humans (L98) while another Southern Resident included in the data set for body condition analysis (J34) had trauma consistent with a vessel strike. Several other killer whales, including one Southern Resident (L112), had blunt force trauma of unknown origin (see Status Section 2.2.1.4). Interactions of killer whales and fishing gear in general have been observed (as described in the Environmental Baseline Section 2.4.3, Status Section 2.2.1.4) and as documented in Dahlheim, Cahalan and Breiwick (2022) for Alaska, however, entanglements are rare. Fatal fisheries interactions are infrequent for all killer whales (see (Raverty et al. 2020)), and no such interaction has ever been observed in association with Puget Sound salmon fisheries.

NMFS, through its List of Fisheries (LOF), monitors and categorizes bycatch of marine mammals in all commercial fisheries according to relative risks of mortality and serious injury (M/SI)[66]. The LOF lists U.S. commercial fisheries by categories (I, II, and III) according to the relative levels of interactions (frequent, occasional, and remote likelihood of interaction or no known interactions, respectively) that kill or seriously injure marine mammals. Commercial fishers in all categories participating in U.S. fisheries are required to report incidental marine mammal injuries and mortalities (with the exception of tribal tribal fisheries, but tribes voluntarily report such interactions). The current LOF classified the “WA Puget Sound Region salmon drift gillnet” fisheries (Treaty Indian fishing excluded) as Category II fisheries (i.e., occasional interactions that result in M/SI) due to incidental takes of harbor porpoise, Dall’s porpoise, and harbor seals (88 FR 16899, March 21, 2023). The overall take of marine mammals in this fishery is unlikely to have increased since the fishery was last observed in 1993, owing to reduction in the number of participating vessels and available fishing time since 1994. All other

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[66] Stocks as defined under the MMPA. These may not necessarily coincide with ESA-listed populations of marine mammals.

Washington commercial salmon fisheries are classified as Category III fisheries (i.e., remote likelihood of/no known interaction that would result in M/SI). Although vessel strikes and gear entanglement with SRKWs are unlikely, NMFS will evaluate the need for additional actions if fishery interactions with SRKWs are reported (in accordance with provisions of the MMPA, 50 CFR 229.7).

There is substantial vessel traffic within the action area, particularly into and out of major ports. Private vessels commonly come within ½ mile of the whales in inland waters (Frayne 2023), and some private vessel operators are likely to be recreational and commercial fishers associated with the proposed action, as shown by the data on overlap presented above. It is reasonable to expect that authorization of the proposed fisheries will result in more recreational and commercial fishing vessels in proximity to the whales than there would be if no fishing is authorized, and therefore based on the information presented previously, we expect that the proposed action may result in some additional exposure of SRKWs to the physical presence or sound generated by vessels participating in salmon fisheries if SRKWs were present nearby. There is a potential for SRKW/fishery vessel interaction during all months the fishery is occurring, with the highest likelihood for interaction occurring in R-MA 7 in the summer months (especially in July-September) where the potential for overlap of the whales and fisheries are the greatest (highest occurrence and likelihood of all pods in the area in recent years).

For fishing vessels, if interactions were to occur, vessel and acoustic disturbances may cause behavioral changes, avoidance, or a decrease in foraging. As discussed in the Status of the Species and Environmental Baseline Sections, several studies have addressed the potential consequences, both physiological consequences and the increase in energetic costs, from the behavioral responses of killer whales to vessel presence, including changes in behavior state, swimming patterns and increased surface active behaviors (e.g., (Williams, Lusseauc and Hammond 2006; Noren et al. 2013; Holt et al. 2015; Holt et al. 2021b)). Even more of a concern for SRKWs than an increase in energy expenditure from increased surface active behaviors and increased vocal effort is the cost of the loss of foraging opportunities and the probable reduction in prey consumption (Ferrara, Mongillo and Barre 2017). Several cetacean species worldwide forage less in the presence of vessels (Senigaglia et al. 2016). As mentioned above, Southern Residents spent 17 to 21% less time foraging in the Salish Sea in the presence of vessels depending on the distance of vessels (see (Ferrara, Mongillo and Barre 2017)). Most recently, Holt et al. (2021b) demonstrated that SRKW subsurface behavior changes significantly when vessels are close (< 400 yd), with fewer foraging dives and less time spent in this state compared to when vessels were at a distance > 400 yd. In particular, females were more impacted than males, being more likely than males to switch to a non-foraging state when vessels were close. Reduced foraging opportunities may be especially detrimental for females as they were more likely to switch to non-foraging behavior in vessel presence ((Holt et al. 2021b), and have high energetic needs for reproduction. Increases in energetic costs because of behavioral disturbance and reduced foraging can both decrease individual whales' fitness and health (Dierauf and Gulland 2001; Lusseau and Bejder 2007). Currently, the degree of impact from repeated vessel-caused disruptions of foraging and energy intake is unknown. However, decreasing the number of repeated disruptions from vessels would likely reduce the impact on foraging and, in turn, reduce the potential for nutritional stress.

Some of the disturbances from vessels participating in fishing may result in less efficient foraging by the whales than would occur in the absence of the vessel effects. However, it is difficult to estimate the number of disturbances likely to result in behavioral changes or avoidance, and not possible to quantify effects on foraging efficiency. The greatest effects would be expected to occur in MA 7 in the summer months where the potential for overlap of the whales and fisheries are the greatest. Additionally, with winter fishery closures discussed above (and see Cunningham (2024)), recognizing that winter fisheries in Puget Sound are typically of a low magnitude (both effort and catch) relative to other Chinook-directed fisheries along the West Coast, there may be reduced impacts as a result of these closures to J pod given their occurrence in inland waters throughout the year.

Based on Soundwatch data for the last several years, we assess the likely increase in vessel presence specifically in close proximity to SRKW from the proposed action and the likelihood for violations of state and federal distance regulations and other incidents inconsistent with Be Whale Wise guidelines that likely cause disturbance to the whales. Our analysis focuses on summer and R-MA 7 because of high occurrence of SRKW and high fishing effort in summer. To put the number of Puget Sound salmon fishing vessels in R-MA7 in the summer months in context (focus on summer and MA 7 because of high occurrence of SRKW in that area in summer and high fishing effort in summer), we use the Soundwatch Boater Education Program's long-term data set because it provides insight into annual trends of vessel activity near killer whales (note this is not exclusive to SRKW and includes transients). The Soundwatch Boater Education Program collects data on the number and types of vessels (including fishing vessels) and vessel activity within ½ mile of killer whales during the summer months in inland waters. Vessel activity categories include transiting, whale-oriented, fishing (defined as moving or stationary with poles or nets in the water), research, enforcement, acoustic (not in a ½ a mile range but within acoustic or visual range), and other. These data provide information on the number of vessels engaged in fishing near killer whales versus other activities as well as the likelihood for incidents of vessels inconsistent with Be Whale Wise guidelines or state/federal regulations (and thus likely causing disturbance). Given the 2024-2025 recreational and tribal fisheries seasons are similar to recent years (2021, 2022, and 2023) or reduced compared to past years (less days open to mark-selective fishing in 2024-2025, MA 7 fishing reduced by 2 months relative to recent years, especially prior to 2019), we would expect a similar potential for overlap of the vessels with the whales observed in recent years (if we assume similar average SRKW seasonal movements). However, because of poor sockeye returns, there may be no sockeye directed commercial fishery this year (see Cunningham (2024)) so we expect limited non-tribal commercial fisheries vessels.

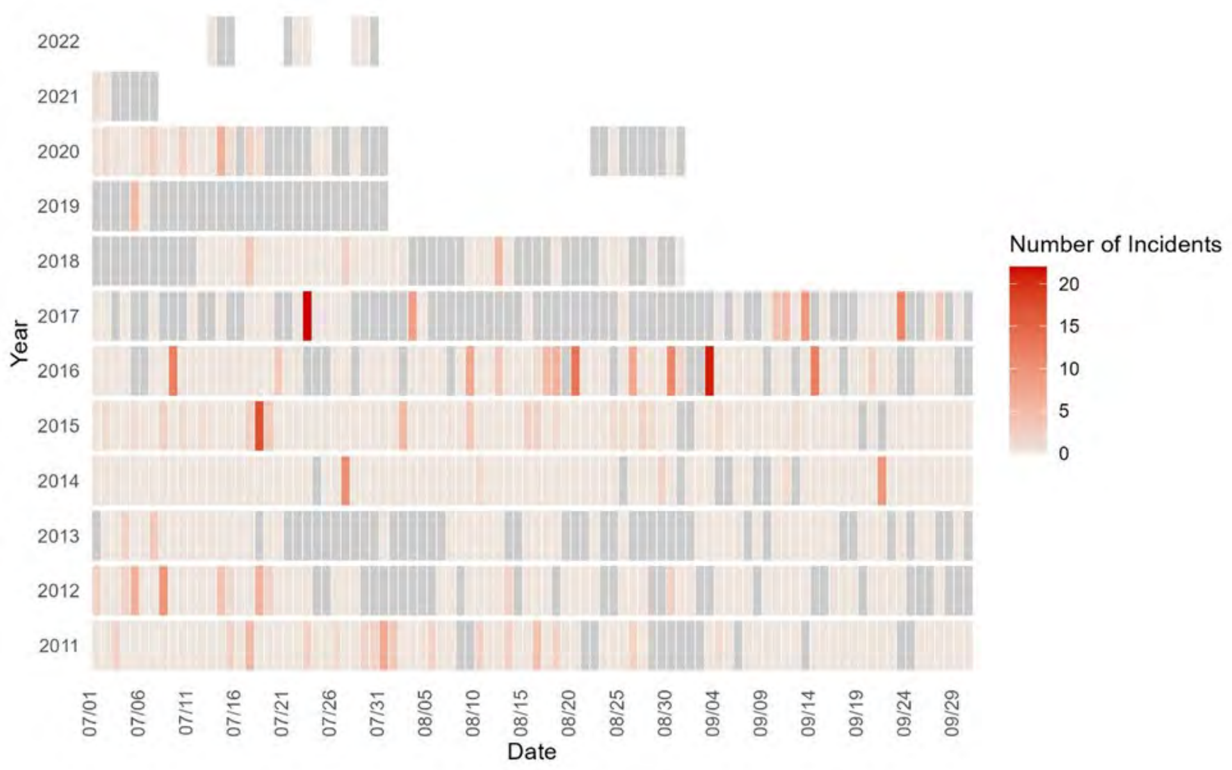
As described in the Environmental Baseline, the Be Whale Wise viewing guidelines and the 2011 federal vessel regulations (www.bewhalewise.org) were designed to reduce behavioral impacts, acoustic masking, and risk of vessel strike to SRKWs in inland waters of Washington State. Although whale watching vessels are more likely to interact with Southern Residents than fishing vessels, the Soundwatch data suggests fishing activities do significantly influence trends in vessel presence near the whales. For example, the maximum number of vessels with the whales (SRKW and/or transients) in 2017 occurred on a sport fish opener in September, when 69 vessels were observed within ½ mile radius of the whales (Figure 51)(Seely 2017). The annual variations in the maximum number of fishing vessels near the whales are dependent largely on the fishing season and the presence of killer whales in popular fishing locations (Shedd 2019). In most recent years a very small percentage of Be Whale Wise incidents involved fishing vessels. In 2018, the percentage was higher, but this appears to be an outlier as the percentage has been much lower since then (Shedd 2019; Frayne 2023).

Since R-MA 7 is a SRKW hot spot, we determined the number of incidents inconsistent with Be Whale Wise committed by fishing vessels, around SRKW specifically, per day on days when salmonid fishing occurred in MA 7 (Figure 51). Soundwatch incident data was filtered to only include incidents within the bounds of R-MA 7 (encompasses C-MA 7/7A) and those involving fishing vessels (includes commercial fishing vessels, private vessels engaged in fishing and vessels that indicated fishing as their activity to Soundwatch) in the presence of SRKW. These incidents were then overlapped with days that R-MA 7 allowed recreational Chinook retention (Figure 51 (A)) or when commercial (tribal and non-tribal) fisheries targeting sockeye and pink in C-MA 7/7a were open (Figure 51 (B)). Further, these dates were overlapped with SRKW presence in MA 7 to consider the fact that incidents with SRKW cannot occur on days in which they were not present in the area. It is important to note that one vessel can commit multiple incidents per day so the number of incidents on a day does not always correlate to the number of vessels close to the SRKW on a given day. Also, the number of incidents reported is likely an underestimate since Soundwatch cannot be present in every place where SRKW and vessels might interact. Overall the number of days that R-MA 7 is open to Chinook retention has declined (fishing seasons reduced compared to historical seasons, beginning in 2018) and the number of days with 10 or more incidents has decreased (Figure 51). The average number of incidents per day on days when R-MA is open to recreational Chinook retention has decreased since its peak in 2016 (Figure 51 (A)). Other than one day in 2013 (13 incidents on September 8th), the number of incidents between commercial fishing vessels and SRKW has not exceeded 3 incidents in any given day since 2013 (Figure 51 (B)). Additionally, the number of incidents per year has not exceeded 5 incidents since 2013 (Figure 51 (B)).

In 2016 and 2017, the days with the highest incidents per day (from recreational vessels fishing) were weekends. The day with the highest number of incidents in 2016 was during the Labor Day holiday weekend on September 3rd ((Figure 51 (A); number of incidents = 21). The incidents on this day were mostly with private recreational fishing vessels. The day with the highest incidents per day in 2017 was July 23rd (Figure 51 (A); number of incidents = 22). On July 23rd, 2017, the vessels with recorded incidents were mostly private motor fishing vessels, with many vessels committing several incidents (up to 4). The second highest number of incidents per day in 2017 was September 23rd (number of incidents = 11), which is the day with a sport fish opener (Seely 2017). All together in R-MA 7, only looking at days fishing was open (or Chinook retention for the case of recreational fisheries), between 2018-2022, recreational vessels participating in fishing committed 0-8 incidents per day (0.21 per day on average across all days open to Chinook retention), commercial vessels committed 0-9 incidents per day (0.14 per day on average when open), and together (recreational and commercial combined, either or both open to fishing) had 0-9 incidents per day or 0.21 per day on average.

In summary, incidents involving fishing, whether for commercial or recreational purposes, constitute only a small fraction of all yearly incidents across marine areas. In the context of incidents reported by Soundwatch in R-MA 7, fishing vessels (including recreational and commercial) have not made up more than 7% of the total incidents reported in any given year since 2017. In R-MA 7, fishing within 200 yards of the SRKW was the most common incident type between recreational fishing vessels and SRKW. One of the most common types of incidents committed by commercial fishing vessels was staying inshore of the SRKWs when they are traveling within ½ mile from shore (unknown if tending gear). The relatively low number of days with incidents by fishing vessels in MA 7 despite the amount of overlap between the SRKW and fisheries suggests that their level of disturbance to SRKW foraging and behavior caused by these incidents is expected to be minimal when considered alongside all other incidents.

(A)



(B)

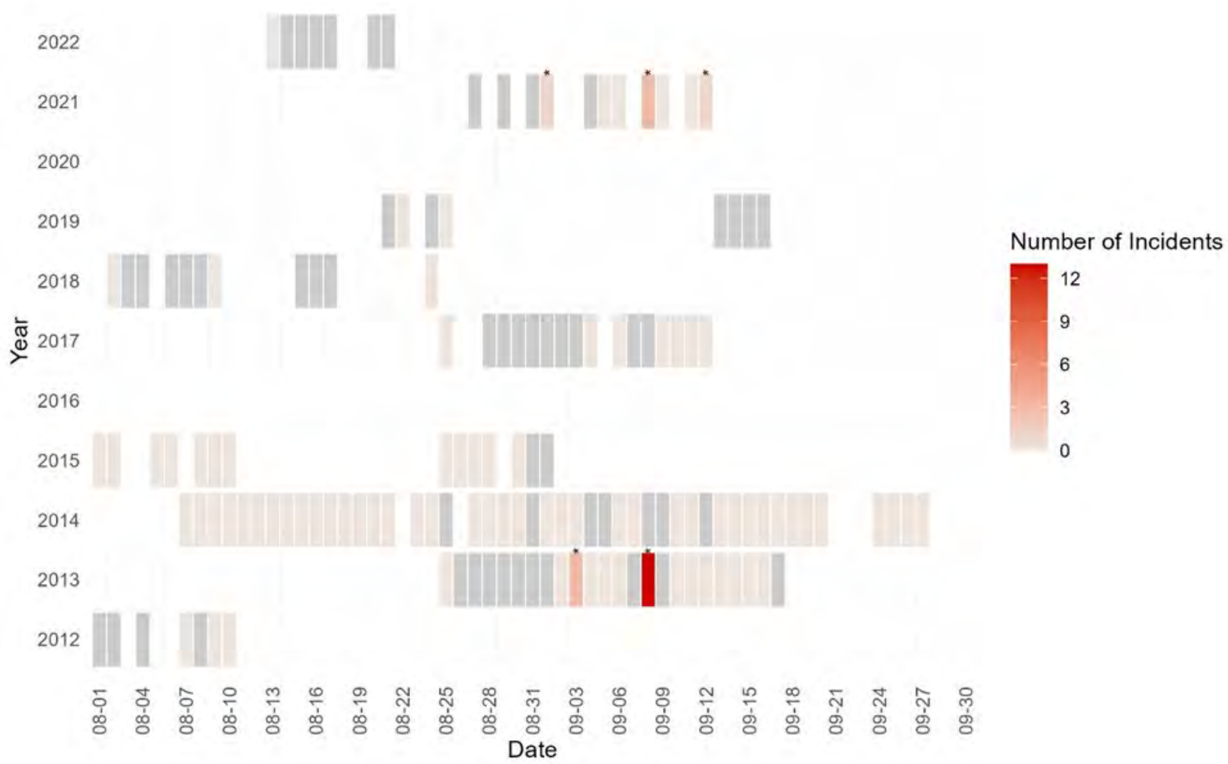


Figure 51. Number of incidents with fishing vessels on days when Chinook retention was allowed in R-MA 7 from 2011 to 2022 (Soundwatch data). Panel A shows the number of incidents between recreational fishing vessels (private vessels engaged in fishing) and SRKW on days when recreational Chinook-retention fishing was allowed in MA-7. Panel B shows the number of incidents between commercial fishing vessels and SRKW on days when commercial fishing was allowed in MA-7 (targeting sockeye and pink salmon). One vessel can have multiple incidents in one day. There are bars on days when R-MA 7 was open for Chinook retention (A) or commercial fishing (for sockeye and pink, B) and white space when the fishery did not allow Chinook retention and/or no commercial fishing. Light gray bars represent days open to Chinook retention/commercial fishing when no SRKW were spotted in R-MA 7. Colored bars represent days that SRKW were spotted in R-MA 7. Darker red bars indicate more incidents per day and lighter tan bars indicate fewer incidents per day. Bars with black stars represent days when SRKW were present in R-MA 7 and there was at least one incident. Sightings data was filtered to remove sightings of northern residents and transients but includes any sightings without a DPS identified or when the observer was not sure if the orca was a SRKW so this could be an overestimate, however we note Soundwatch is not able to observe all areas with SRKW and vessels, particularly when the whales are spread out in multiple groups.

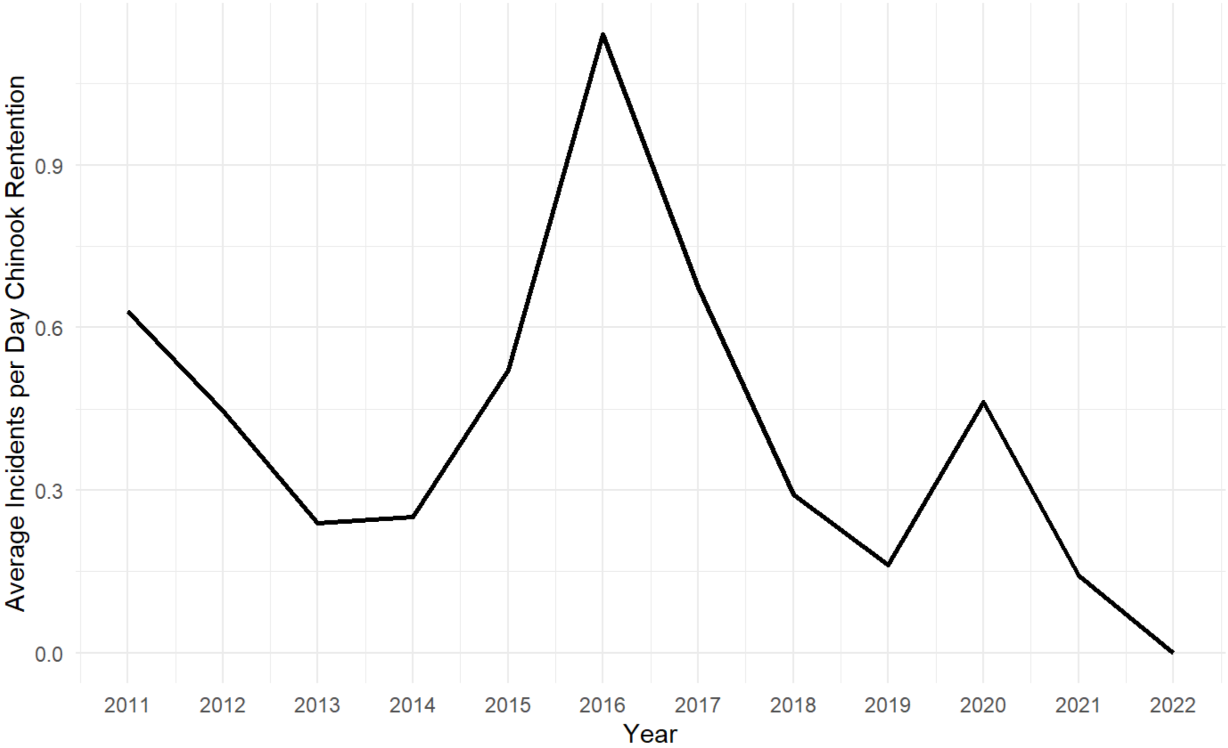


Figure 52. Average number of incidents with recreational fishing vessels (includes private vessels engaged in fishing and vessels that indicated fishing as their activity) per day on days when Chinook retention was allowed in R-MA 7 from 2011 to 2022 (Soundwatch data). One vessel can have multiple incidents in one day.

Two factors that influence the likelihood and extent of disturbance are the use of propulsion, sonar, and depth finders (acoustic effects) and vessel speed. A recent paper looking at all vessels found that echosounders with 83 kHz signals as well as those with 200 kHz signals in deeper water, have emissions that extend outside of 400m (the vessel approach distance used in Canada), which can create noise additions of 30 dB above ambient levels ((Burnham et al. 2022), therefore fishing vessels could be adding to noise around SRKWs. Additionally, a recent study by SMRU Consulting (2021) characterized the noise levels from all vessels off the west side of San Juan Island (where SRKW forage) in summer months, including noise from 50 khz echosounder use and found more noise from 50 khz during weekends, but found less during commercial fishing openers (tribal and non-tribal). This is likely due to the fact that standard practice for tribal pre-terminal fishing does not generally include sonar and depth finders (so limited to propulsion as a source of disturbance from tribal fishing)(Parker 2024). Similarly, non-tribal commercial gillnet and purse seine also do not typically use sonar or fish finding for fishing specifically instead it is used for navigation. Vessels operators could also turn off echosounders when stationary/fishing and/or use 200 khz instead of 83 khz, to limit exposure. In addition, fishing vessels operate at slow speeds or in idle when actively fishing. When in transit, vessels would likely travel at faster speeds with potential to affect the whales' behavior; however, fishing vessels do not target whales, and any disturbance that may occur would likely be transitory. Non-retention measures in R-MA 7 recreational fisheries in half of August and all of September may result in more limited vessel presence and sonar use in the area, compared to if open or mark-selective, though there has been an overall increase in the number of recreational fishing vessels in R-MA 7 (see Figure 43, Table 33 with angler trips).

WDFW included additional measures as part of the proposed action to further reduce impacts from non-tribal fishing vessels on Southern Resident killer whales including (summarized or reproduced from Cunningham (2024):

1. Continued promotion and enforcement of the State's regulations for vessels operating near SRKW (speed limit of 7 knots within ½ nautical mile, prohibition on approaching the whales within 300 yards on the sides and 400 yards in the front and back of the whales). During the consultation period, in 2025, new state legislation setting a 1,000 yard vessel distance requirement from SRKW will go into effect.
2. WDFW has increased communications efforts to promote messaging about Be Whale Wise guidelines and regulations and Southern Resident killer whale recovery. The Department is continuing to share Be Whale Wise messaging with boaters in the greater Puget Sound area through targeted and organic social media, traditional online and print advertising, video slots on streaming services, and earned media coverage. Other ongoing communications tactics include print materials including the Whale Wise promotional decal, on-the-ground signs and continued collaboration with Be Whale Wise partners in Washington and Canada. The Department has also developed lesson plan materials and provided live "career connection" style events.
3. Continued promotion of the voluntary "No-Go" Whale Protection Zone along the western side of San Juan Island in R-MA and C-MA7 for all recreational vessels. The geographic extent of this area stretches from Eagle Point in the southeast to Mitchell Point in the north and extend offshore ¼ mile between these locations and ½ mile centered on Lime Kiln Lighthouse. This area is consistent with that already promoted by San Juan County, proposed by NOAA Fisheries as *Alternative 4* in the 2009 Environmental Assessment on New Regulations to Protect SRKWs from Vessel Effects in Inland Waters of Washington, and represents the area most frequently utilized for foraging and socialization in the San Juan Islands. The area is closed to commercial whale watching activities, save a hundred-yard corridor along the shoreline for commercial sea kayak tours. Commercial salmon fishing vessels licensed by WDFW operate in the vicinity of San Juan Island. This includes the area identified below in Figure 53 as the Voluntary "No-Go" Whale Protection Zone. However, with the current forecast there is no harvestable surplus available for harvest in commercial fisheries management by WDFW.
4. Given that a 200 kHz frequency is outside of SRKW hearing ranges, WDFW will encourage fishers to use this frequency when interactions with SRKWs are possible. If SRKWs are present in the area, WDFW will encourage fishing vessels to temporarily turn echo sounders off, if it is safe to do so, or switch to a 200 kHz frequency. In 2022, WDFW disseminated information regarding echo sounders and their potential impact on Southern Resident killer whales to the public via the WDFW website (see here: https://wdfw.wa.gov/species-habitats/at-risk/species-recovery/orca), the 2022-23 Washington sportfishing regulations pamphlet in the Marine Area 7 section (page 120; this section was continued in the 2023-24

pamphlet, and anticipate including this in future pamplets), public recreational fishing meetings, and the Puget Sound sportfishing advisors. WDFW encouraged Puget Sound sportfishing advisors to provide additional outreach to constituents on the importance of using 200 kHz transducer frequencies for SRKW.

5. Other actions related to commercial whale watching regulations and the Quiet Sound program, not included in the action but that may limit effects to SRKW, are covered in the Cumulative Effects Section.

Figure 53. An approximation of the Voluntary "No-Go" Whale Protection Zone, from Mitchell Bay to Cattle Point (Shaw 2018b). See https://wdfw.wa.gov/fishing/locations/marine-areas/san-juan-islands

Direct Effects Conclusion

In summary, the proposed action is expected to result in Puget Sound fishing vessels occurring in areas known to be important to SRKW. From the information presented above, fishing vessels mainly overlap with SRKW occurrence in R-MA 7 and C-MA 7/7A off the west coast of San Juan island because SRKW typically spend the majority of their time foraging in this area in summer months and fishing vessels are active in the area particularly in summer (with additional overlap in other areas and times of year outlined above). The highest vessel occurrence comes from non-tribal recreational fisheries that include tens of thousands of angler trips and hundreds of boats per day in R-MA 7. Recreational fishing management measures in summer (non-retention requirements) will likely limit effort targeting Chinook in the area (especially in late August and September), however, recreational boats targeting coho may be present. Tribal effort in the area is low in summer months (few boats on average) compared to other areas, and occurs primarily in terminal areas. Commercial fishing presence for sockeye salmon off the west side of San Juan Island in summer is unlikely to occur, across all of areas 7/7A in 2024. Information about the overlap of fishing vessels/effort and occurrence of SRKWs is used in the effects analyses below: potential direct effects of fishing vessels and gear on SRKW and indirect effects of fishing through prey removal in foraging areas. For direct effects, the analysis includes discussion of potential vessel and acoustic disturbance, gear interaction, and ship strike impacts of SRKW, based on the spatial, temporal overlap between vessels and SRKWs illustrated in this section. Within indirect effects, overlap between SRKW and fishing vessel presence informs discussions on the potential for vessels to deplete prey availability in SRKW foraging hot spots and management measures that likely reduce any impacts.

Vessels affect whale behavior and reduce effectiveness in locating and consuming sufficient prey through acoustic interference and physical disturbance. Although vessel and acoustic disturbance are potential threats to SRKWs, fishing vessels operate at slow speeds or are idle when actively fishing, which has less impact on SRKWs. When in transit, vessels would likely travel at faster speeds with greater potential to affect the whales' behavior but since fishing vessels do not target whales, any disturbance that may occur would likely be transitory. The number of Be Whale Wise incidents for fishing vessel are low (0-9 a day depending on recreational or commercial and less than half an incident per day on average) and only make up around 7% of the incidents committed by all vessels. This in addition to the fact that there have been no reported gear interactions of Puget Sound fishing vessels and SRKWs, indicate that vessel disturbance from fishing vessels would likely only result in short-term changes to the whales' behavior or avoidance. If echosounders are in use when recreational vessels are fishing, this could add to the noise levels experienced by SRKWs, but there are efforts to educate the public to minimize effects.

Fishing vessels are subject to state regulations when transiting state waters that protect SRKWs, which includes vessel viewing distances of 300 yards to the side of the whales (400 yards in the path of and behind the whales) and vessel speed within ½ nautical mile of the whales of seven knots over ground (see RCW 77.15.740), and otherwise subject to guidelines to avoid impacts to whales. In 2025, the vessel viewing distance will increase to 1,000 yards. Implementation of 1,000 yard distance rule should reduce close approaches to the whales. There is a small number of tribal fishing vessels in the areas the whales spend the majority of their time in (e.g. <1-2.5 vessels per day near San Juan Island and near Point Roberts/near north US-Canada border in summer months), and sonar use and depth finders are not standard practice for pre-terminal tribal fisheries.In addition, with the current sockeye salmon abundance forecasts, there may be no fishing for the commercial Fraser River sockeye fishery. If fisheries do occur they are likely to be limited.

Overall, the direct impacts from recreational and commercial fishing vessels are expected to be relatively low in 2024-2025 and similar to previous years (comparable to 2020-2023). This is based on the reduced presence of fishing vessels in the key foraging areas (e.g. the reduced vessel impacts likely to occur in foraging hot spots along the west side of San Juan Island and low tribal vessel presence off the west side of San Juan Island, i.e. <=2.5 vessels a day, likely no harvestable sockeye). Also, there will be increased outreach and education efforts to the fishing community (including educational material on adjusting or silencing sonar in the presence of SRKWs), and continued promotion of the no-go zone off the West Coast of San Juan Island. As a result, we expect that any transitory, small amount of disturbance caused directly by the fishing vessels' presence and sound is not likely to disrupt normal behavioral patterns. Ongoing monitoring of vessel activities near the whales will allow for tracking reductions in fishing vessel activity when whales are in key foraging areas. We anticipate any interactions from vessels or gear attributed to the proposed action are not expected to result in take of SRKWs.

Indirect Effects: Reduction of primary prey

We evaluated the potential indirect effects of the Puget Sound salmon fisheries on SRKWs based on the best scientific information about the whales' diet and distribution and the reduction in Chinook salmon caused by the Puget Sound salmon fishing. Following the independent science panel approach on the effects of salmon fisheries on Southern Resident killer whales (Hilborn et al. 2012), NMFS and partners have actively engaged in research and analyses to fill data gaps and reduce uncertainties raised by the panel in their report. More recently, the PFMC formed the ad-hoc SRKW workgroup (Workgroup) to reassess the effects of PFMC-area ocean salmon fisheries on the Chinook salmon prey base of SRKW. The Workgroup presented a final risk assessment at the June 2020 PFMC meeting. We rely on the PFMC SRKW Ad Hoc Workgroup report (PFMC 2020b) and methods where appropriate for our effects analysis in this Opinion (analyses that included Salish Sea), recent updates to these based on the best available information, as well as the analyses described in Cunningham (2024) and (2023); Parker (2024) that assess the impacts of recreational, commercial, and tribal fishing to SRKWs.

Similar to past opinions (NMFS 2018d; 2019d; 2020b; 2021f; 2022c; 2023c) our analysis of the effects of Puget Sound salmon fisheries focuses on effects to Chinook salmon availability and not other prey species (as described in Section 2.2.1.4 Status of Southern Resident Killer Whales). We focus on Chinook salmon because while SRKW consume other salmonids and other species, Chinook salmon are their preferred prey and comprise the majority of their diet, and other salmonids and species are less of a limiting factor. This analysis considers whether effects of that prey reduction may impact the fitness of individual whales.

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) see following subsection. In the absence of a predictive analytical tool to evaluate this relationship, we use a weight-of-evidence approach to consider all of the information we have--identifying a variety of metrics or indicators with varying degrees of confidence (or weight)—in order to assess the impacts of the proposed action.

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 2021b; 2021f) and is summarized here. We then discuss our evaluation of the potential indirect effects of changes in prey availability from the Puget Sound salmon fisheries in 2024-2025. 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.

Relationship between Chinook Salmon Abundance and SRKW Demographics and other data limitations

Several studies in the past have found correlations between Chinook salmon abundance indices and SRKW demographic rates (e.g. fecundity and mortality)(Ford, Ellis and Olesiuk 2005; Ford et al. 2009; Ward, Holmes and Balcomb 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 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 and we rely on more recent analyses, such as the PFMC Workgroup efforts described below (PFMC 2020b). The updated population viability analysis in Murray et al. showed that no single threat alone could replicate observed SRKW past demographic trajectories (and see NMFS (2021b) 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. 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.

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 from extensive pink salmon abundance in odd years that alter food web dynamics across the Pacific, including the NE Pacific and Washington waters. In those years, Chinook salmon abundance could be reduced due to higher competition for prey and may impact SRKW access to Chinook. 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's 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, 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 (also see Agenda Item B.2, May 23, 2019). 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 2008j; Towers, Ellis and Ford 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 2020b). 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 2020b) and (NMFS 2021b). 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 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 2020a, 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 2020b). Multiple limitations and key uncertainties for these analyses are highlighted by the Workgroup in their report (PFMC 2020b).

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 2021b), 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 2021b), 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.” (Agenda E.4.a, Supplemental SSC Report 1, November 2019).

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 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 condition, compared to >86% median probability when abundance was above 750,000. For L pod, the best fit model showed a relationship with the probability 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, the median probability of stable or increasing 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. Model results also suggested that whales in poorest body condition have a higher probability of mortality. Additional efforts to relate sample sizes, for SRKWs and other populations, and relate body condition and demographic rates, including reproduction, are ongoing. We note that these Chinook abundance values were derived using older versions of FRAM and are not comparable to abundance estimates we present in the next section. But, below, we updated abundance estimates and re-ran models from Stewart et al. (2021) to re-calibrate levels of Fraser abundance at which probabilities of body condition decline are greater for J-pod. The re-calibrated Fraser abundances are presented below (see *Current Body Condition Status* Section), but Puget Sound was not re-calibrated because Puget Sound abundance varies less dramatically between the two model versions.

Effects of reductions in Chinook salmon abundance is 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 2020b). 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). Impacts on prey availability attributed to fisheries are expected to reduce prey availability at all abundance levels, but removals present more risk to SRKWs at lower 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). Intuitively, at some low Chinook 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). 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. 2016a). 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, failure to conceive, or miscarriage, successfully nurse calves, etc.), and effects of prey availability on reproduction should 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 (2024) for pod body conditions for 2023 show that 40% of L pod are in the poorest body condition (out of five body condition groups, an increase in the percent in poorest condition from 13% in 2022) and 32% of J pod are in the poorest body condition (an increase in the percent in poorest condition from 20% in 2022); this is less for K pod 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%, L pod has the lowest proportion of individuals above normal body condition (below 35%, vs. ~50% and ~80% for J and K pods).

Energetic costs and changes in behavior (more time spent searching for prey and less time for socialization, reproduction) also mean that there is higher risk to the whales when prey is reduced at smaller spatial scales directly where SRKW are foraging. Concentrated fisheries and prey reductions could cause local depletions of prey at smaller spatial scales than the action area as a whole. Reducing local abundance of prey from the proposed fishing could result in the whales leaving areas in search of more abundant prey. This could result in a potential increase in energy demands, which would have the same effect on an animal’s energy budget as reductions in available energy, such as one would expect from reductions in prey. Localized depletions caused by direct overlap between foraging whales and the fisheries, would increase competition for fish, and in some conditions, the whales may not always be able to meet their energetic needs (i.e., the prey available to the whales may not be sufficient to allow for successful foraging). However, we do not have estimates of prey availability at smaller spatial scales than the larger regions used by the PFMC adhoc workgroup.

Researchers have studied the total amount of Chinook needed in the environment for SRKWs to successfully forage and meet their metabolic needs. However, there is significant uncertainty in this line of inquiry. Though there are estimates of the bioenergetic 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), 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 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. Analysis by Holt et al. (2021b) 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 needed in their environment or what density is needed for the population to be able to consume this amount. So 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 and therefore 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 that is predicted to cause adverse effects to SRKWs, the PFMC recently adopted an amendment to the 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 2021, and see killer whale environmental baseline, Section 2.4.3) 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 abundance in the north of Cape Falcon 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 where/when the fisheries and whales overlap and potential for localized depletion by fisheries in SRKW foraging locations. 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 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 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 survival and recovery (i.e., mortality and reproduction) and for body condition, connections to Chinook 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 information we have, identifying a variety of metrics or indicators with varying degrees of confidence, in order to assess the indirect impacts from 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 Council-area fisheries management based on low abundance thresholds recognize the higher risk to SRKW demography in low Chinook salmon abundance years.

Effects of Prey Reduction Caused by the Proposed Action

We analyzed the effects of prey reduction in two steps. First, we consider the pre-season forecast of Chinook salmon abundance for 2024-2025 in comparison to previous years. We also compare the magnitude of reductions in prey available to the whales expected from the proposed fisheries based on the pre-season abundance and expected Chinook catch by the Puget Sound salmon fisheries, e.g., percent reduction in overall abundances from the fisheries both annually and seasonally (for marine fisheries only, freshwater fisheries were not considered in the analysis). Second, we considered information to help put the reduction in context because of the likely higher risk to SRKWs if Chinook abundance is low (see discussion above). We haven't identified a low abundance threshold specifically for Puget Sound and assessing availability of prey compared to the needs of the whales is another way to evaluate risk (though there are data gaps that limit interpretation as discussed above). Therefore, our analysis also includes: 1) translating the reductions of Chinook salmon from the proposed fishing into biological context by relating it to the whales' energy requirements; 2) considering the Chinook prey available compared to the whales' Chinook needs, based on diet studies of SRKWs and their predominant consumption of large Chinook; 3) considering the body condition status of SRKW and connections to Fraser Chinook and Puget Sound Chinook runs; and 4) considering additional aspects of the action that could have negative consequences, specifically the potential for localized prey depletion, but also specific management measures (area closures, limits, etc.) that may reduce negative consequences. This analysis highlights our level of confidence in the available data, and identifies where there is uncertainty in light of data gaps and where we made conservative assumptions.

In order to estimate how prey reduction from Puget Sound fisheries affects SRKWs, we refer to methodology developed by the PFMC Workgroup (PFMC 2020b), but with key additional modifications for use in Puget Sound. The analysis of the effects of Puget Sound fishing on salmon availability for 2024-2025 has modifications from analyses used in previous opinions, including last year's opinion (see NMFS (2021b)) therefore we caution that percent reductions and abundance in this opinion are not comparable to previous Puget Sound fisheries opinions. We use methods similar to those used for the 2022 and 2023 opinions, related to updating FRAM methods for use in Puget Sound compared to the PFMC ad-hoc workgroup methods. The FRAM-Shelton models used to analyze the effects of salmon fisheries that are the subject of this Opinion were updated after the 2022 consultation, so values for 2024 are not directly comparable to 2022. It should be noted that NOAA, the Puget Sound treaty tribes, and WDFW continue to explore specific application of outcomes from the PFMC Workgroup to Puget Sound and potential improvements to the analytical approach for impacts of future fisheries in the Salish Sea, many of which are incorporated here but further modifications could occur for future analyses. In addition, the uncertainties and limitations of the PFMC Workgroup methods that are briefly discussed above (in the previous section on the relationship between SRKWs and Chinook salmon abundance, in the Environmental Baseline for SRKW (Section 2.4.3), and discussed more extensively in PFMC (2020b) and NMFS (2021b) are also applicable to our analysis here to the extent we are relying on the Workgroup's methods. Also, we note 1) these methods do not incorporate impacts of Puget Sound fisheries on immature Chinook salmon and 2) applying Shelton time steps to FRAM time step periods creates assumptions that the estimated number of Chinook are present uniformly throughout a time step period (though we recognize Chinook are migrating through areas within time steps).

Because the Workgroup was focused mainly on PFMC fisheries, there are two main areas where it makes biological sense to adjust specifics of the PFMC modeling work and assumptions made by the ad-hoc Workgroup (see Section 5.6 of PFMC (2020b)) for Puget Sound, and we make these adjustments this year similar to the 2022 and 2023 Puget Sound biological opinions (NMFS 2022c). [1] First, all PFMC fisheries are mixed stock ocean fisheries that would be expected to reduce, to some degree, the number of Chinook available to SRKW as prey. Thus, all

PFMC fisheries were included in the Workgroup's assessment and "turned off" in the relevant "ZeroPFMC" model scenario to assess reduction specifically by the PFMC fishery versus other fisheries. In Puget Sound, some fisheries might not be expected to affect the number of Chinook available to SRKW as prey because either (A) the fishery occurs in an area outside the observed range of SRKW, or (B) the fishery occurs in a terminal area where majority of catch are mature fish returning to nearby freshwater systems that would have already exited areas where they may have been encountered as prey. [2] Second, ocean (PFMC) areas are larger, more pre-terminal and contain Chinook with a range of ages (i.e., mixed maturity), and contain fish that are migrating back to their natal rivers, so it is reasonable to assume that these salmon are likely to end up in a different region if not caught in fisheries. However, in Puget Sound, most of the Chinook present in the summer are mature fish returning to spawn in systems that empty into the Salish Sea, while those present in the winter are resident blackmouth Chinook. Thus, if not caught in fisheries, the majority of Chinook may ultimately remain in the Salish Sea or enter natal rivers rather than swim out into a different region.

Therefore, for our analysis to calculate prey abundance and percent reduction by fisheries, we made two key modifications from PFMC Ad-hoc Workgroup methods. [1] We first determine the fisheries/areas that have overlap, or high potential for overlap, with SRKW Chinook prey in each time step. We focused on excluding certain areas/fisheries from the model primarily in the summer time step (July-September, time step 3 [TS3] in FRAM) when more fisheries occur in areas where Chinook are no longer available to the whales as prey, i.e. "terminal" fisheries where catch is primarily local stocks near, or in, mouths of rivers, and uncaught Chinook salmon would migrate into in freshwater outside the range of SRKW instead of remaining in marine waters and available to SRKW if not caught. Areas that did not have overlap (no occurrence of SRKW), or those that only contained terminal fisheries, were excluded from the model because of the low chance of fisheries removing Chinook salmon that would be prey. In other time steps (Oct-April and May-June) the majority of fisheries are not terminal; therefore, there is a higher likelihood that Chinook salmon not caught could overlap with SRKW because the Chinook salmon would stay in the marine system (see below for exceptions). Then in subsequent modeling steps, we only analyze reduction by the fisheries in the areas that we include because of overlap with SRKW prey. Our second modification – [2] when using similar FRAM-Shelton methods as the PFMC Ad-hoc Workgroup and detailed in PFMC (2020b) but for the Puget Sound area, for certain Puget Sound fisheries in certain seasons (mainly summer, TS3), within the model we do not redistribute salmon to other geographic regions (outside of Salish Sea) if not caught (which varies from Workgroup methods) because salmon returning to spawn would not likely return to the ocean/other regions.

We discussed in detail in our biological opinion from 2022 (NMFS 2022c) our criteria for which fishing areas within Puget Sound to include, in each modeled season, in the analysis of reductions of SRKW Chinook prey. This included information on 1) occurrence of SRKW in an area, and if SRKW were not seen in an area recently (but were historically there or near there), 2) how large is Chinook catch in that area, 3) how likely is it that Chinook salmon could become prey in another area and or other time (i.e., local/non-local stock mix) if not caught, and/or 4) how is catch treated in the FRAM modeling framework? Again, we consider this because fisheries in certain areas are “terminal” fisheries where catch is primarily local stocks that are near, or in, mouths of rivers, and uncaught Chinook salmon would migrate into in freshwater outside the range of SRKW instead of remaining in marine waters if not caught. Therefore “terminal” fisheries in those areas are likely not removing Chinook prey that SRKW can access. We do not repeat details here on the analysis of which areas to include and we have not updated that analysis at this time because SRKW sightings in 2021 and 2022 match known previous occurrences (see discussion in the Section “*Overlap of Puget Sound Salmon Fisheries and SRKWs*”) and we do not have vetted data on 2023 sightings. A final list of areas included in further analyses by time-step are listed in Table 37. Also, NOAA, the Puget Sound treaty tribes, and WDFW are continuing to explore potential improvements to the analysis approach for assessing impacts of future fisheries in the Salish Sea, so we will revisit sightings by fishing regions as discussions continue and new data or analysis of overlap become available.

Table 37. Final list of fishery (where NT = non-tribal and Tr = Tribal), time, area combinations included (or excluded) in modeling SRKW prey reduction by Puget Sound fisheries. Highlighted in green is included, red excluded, and grey means there is no fishery modeled (no fishery or small catch modeled with summer catch) in that area/timestep.

	KEY:	🟩 INCLUDE	🟥 EXCLUDE
	Winter	Spring	Summer
Fishery Title in FRAM[67]	Oct-Apr	May-Jun	Jul-Sep
Tr Area 3:4:4B Troll	🟩	Council Jurisdiction	
NT Area 7 Sport	🟩	🟩	🟩
NT Area 6A:7:7A Net	🟩	⬜	🟩
Tr Area 6A:7:7A Net	🟩	⬜	🟩
NT Area 7B-7D Net	🟩	⬜	🟩
Tr Area 7B-7D Net	🟩	⬜	🟩
Tr Juan De Fuca Troll	🟩	🟩	🟩
NT Area 5 Sport	🟩	🟩	🟩
NT Juan De Fuca Net	🟩	🟩	🟩
Tr Juan De Fuca Net	🟩	⬜	🟩
NT Area 8-1 Sport	🟩	🟩	🟩
NT Skagit Net	⬜	⬜	🟩
Tr Skagit Net	🟩	🟩	🟩
NT Area 8D Sport	⬜	🟥	🟥
NT St/Snohomish Net	⬜	⬜	🟩
Tr St/Snohomish Net	⬜	⬜	🟩
NT Tulalip Bay Net	🟩	⬜	🟥
Tr Tulalip Bay Net	🟩	⬜	🟥
NT Area 9 Sport	🟩	🟩	🟩

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[67] 6D, 7E, 11A, 13C are all considered extreme terminal, not represented in FRAM

NT Area 6 Sport	🟩	🟩	🟩
Tr Area 6B:9 Net	🟩	⬜	🟩
NT Area 10 Sport	🟩	🟩	🟩
NT Area 11 Sport	🟩	🟩	🟩
NT Area 10:11 Net	🟩	⬜	🟩
Tr Area 10:11 Net	🟩	⬜	🟩
NT Area 10A Sport	🟩	⬜	🟥
Tr Area 10A Net	🟩	⬜	🟥
NT Area 10E Sport	🟩	⬜	🟥
Tr Area 10E Net	🟩	⬜	🟥
NT Area 12 Sport	🟩	🟩	🟥
NT Hood Canal Net	🟩	⬜	🟥
Tr Hood Canal Net	🟩	⬜	🟥
NT Area 13 Sport	🟩	🟩	🟩
NT South Puget Sound Net	🟩	⬜	🟥
Tr South Puget Sound Net	🟩	⬜	🟥
NT Area 13A Net	🟩	⬜	🟥
Tr Area 13A Net	🟩	⬜	🟥

Chinook Abundance and Percent Reduction by Fisheries

To assess retrospective Chinook abundance before fishing and reductions in prey availability from the Puget Sound fisheries, the FRAM stocks were combined into coarser aggregate stocks using the state-space model developed by Shelton et al. (2021), which updated distribution information from Shelton et al. (2019). For more specifics on methods for FRAM-Shelton see (PFMC 2020b), (NMFS 2021c), and Environmental Baseline Section 2.4.3). Estimated reductions in Chinook abundance attributable to Puget Sound fisheries removals were determined by taking the post-fishery abundances in the Salish Sea, with all fisheries removals (validation runs), and comparing these to the post-fishery abundances calculated with no Puget Sound salmon fisheries in 2024-2025 (all other salmon fisheries that reduce Salish Sea Chinook abundance were still included, such as PFMC salmon fisheries, Southeast Alaska salmon fisheries, British Columbia fisheries). The annual effect of Puget Sound fisheries on the abundance of Chinook prey in the Salish Sea was calculated as the difference between the post-fishing July-September Salish Sea abundance in the "No Puget Sound fishery" model run and the corresponding model run with all fisheries occurring. The “No Puget Sound fishery” model run only turns off fisheries/areas that are included based on our analysis of overlap with SRKW prey (see Table 38) (referred to as “analyzed fisheries”). The excluded fisheries/areas that are likely not removing SRKW prey are not included in calculations of percent reduction by the Puget Sound fishery. Also, for local stocks (originating from the region in which the fishery occurs), we assign mortalities to the region in which the fishery occurs (e.g., mortalities of Puget Sound stocks in Puget Sound fisheries would all be assigned to the Salish region) because fish that are not caught are not likely to return to marine areas outside the Salish Sea. For non-local stocks (originating from outside the region in which the fishery occurs), we assign mortalities to region based on the stock-specific Shelton distribution parameters. Updates to FRAM-Shelton methods have been applied since previous analyses, therefore, we again caution that these values cannot be compared to values presented in previous opinions for Puget Sound fisheries given updates in methodology used here.

Table 38. Estimated starting abundance (beginning of FRAM timestep 1; October) of age 3-5 Chinook in the "Salish" area Shelton et al. (2021). Estimates are from the post-season FRAM runs (validation round 7.1.1) for years 1992-2018 and projections for 2024. FRAM version 7.1.1 and Shelton et al. (2021) are used to estimate the retrospective years and projection for 2024 so abundances are comparable. The annual abundance reduction and percent reduction are the difference between post-fishing September Chinook abundance from the validation runs and Chinook FRAM validation runs with no Puget Sound fishing using analysis from the Workgroup but with modifications specified (and again using FRAM version 7.1.1). Average values indicated in bold font are presented for the whole time series as well as the most recent 10 years of validation years (2009-2018) and the first 10 years of validation 1992-2001). We also present percent reductions from earlier seasons (winter, spring) where spring effects are cumulative of spring and winter and annual is cumulative of winter, spring, and summer[68]. Annual reduction is cumulative of winter, spring, and summer so summer reduction is included in the Annual reduction, and note that the majority of the cumulative annual reduction occurs in summer (based on the difference

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[68] Effects are cumulative across time steps. The percent reductions that are calculated for the summer time step include the effects of fisheries that occurred in both the winter and spring time steps, in addition to the summer time step. Also, spring time step includes those that occurred both in winter and spring. There will occasionally be some counter-intuitive instances where the percent reduction for the subsequent time step is less than the percent reduction for the previous, which is a function of the combined effects of (1) Shelton distribution parameters that vary across time steps and (2) assuming that all fish redistribute themselves to align with the Shelton distribution parameters at the beginning of each time step.

between the “spring” and annual reduction estimates).

Year	Annual Starting Abundance	Annual reduction	Winter	Spring	Annual percent reduction / Cumulative of Winter, Spring, Summer
1992	942,509	95,208	7.49%	5.50%	10.10%
1993	962,585	83,045	4.31%	3.41%	8.63%
1994	780,132	52,515	4.07%	2.53%	6.73%
1995	863,220	57,112	5.51%	3.86%	6.62%
1996	885,172	58,264	4.37%	3.53%	6.58%
1997	1,039,095	70,331	3.40%	3.13%	6.77%
1998	841,888	45,345	2.38%	1.26%	5.39%
1999	1,054,268	49,997	1.30%	0.73%	4.74%
2000	852,976	44,588	1.10%	0.61%	5.23%
2001	1,314,057	78,199	1.48%	0.85%	5.95%
2002	1,180,664	59,140	1.30%	0.64%	5.01%
2003	1,318,497	41,637	0.76%	0.42%	3.16%
2004	1,197,036	30,298	0.73%	0.51%	2.53%
2005	999,355	33,621	1.69%	1.26%	3.36%
2006	1,140,814	50,685	0.79%	0.54%	4.44%
2007	876,213	51,292	1.73%	1.05%	5.85%
2008	1,059,405	41,557	1.48%	0.89%	3.92%
2009	762,397	35,175	1.20%	1.05%	4.61%
2010	1,174,966	49,389	0.77%	0.53%	4.20%
2011	941,321	51,957	0.85%	0.55%	5.52%
2012	877,928	61,195	1.01%	0.57%	6.97%
2013	1,059,289	56,481	1.05%	0.71%	5.33%
2014	1,059,880	39,214	1.15%	0.69%	3.70%
2015	955,926	37,029	1.18%	0.61%	3.87%
2016	900,653	29,348	1.29%	0.62%	3.26%
2017	1,060,961	47,757	1.55%	0.79%	4.50%
2018	1,009,218	50,667	1.34%	0.88%	5.02%
2019	1,024,051	33,662	1.72%	0.90%	3.29%
2020	810,150	25,753	0.69%	0.41%	3.18%
Avg 1992-2001	**953,590**	**63,460**	**3.54%**	**2.54%**	**6.67%**
Avg 2011-2020	**969,939**	**43,306**	**1.18%**	**0.67%**	**4.46%**
Avg all years	**998,091**	**50,361**	**1.99%**	**1.35%**	**5.12%**
2024	**1,181,819**	**55896**	**0.33%**	**0.37%**	**4.02%**

Table 38 provides abundances that represent annual starting (October) Chinook salmon (pre-fishing) abundances in the Salish region (aggregated Puget Sound, San Juan Islands, Juan de Fuca, and Georgia Strait), and the annual and percent reductions of Chinook salmon from the Puget Sound fisheries (that were included due to overlap with SRKW prey) throughout the entire management year[69]. The estimated starting abundance (prior to natural or fishing mortality) of Chinook (age 3-5 years) in 2024 in the "Salish" region in October is approximately ~1,181,819 Chinook salmon. This is higher than the recent 10-year post-season starting abundance average of approximately 969,938 total abundance (2011 through 2020; Table 38) and higher than the overall average for the entire validation time series (1992-2020). 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 FRAM model runs were available at the time of the analysis. The percent reduction has generally been reduced in recent years so we focus on the most recent 10 years of the retrospective time period. Note that modeling for the 2024 projection takes into account fisheries management changes since 2018, including the 2019 PST agreement and PFMC Amendment 21, but the retrospective validation abundances for years 1992-2020 do not include those management measures as those management measures were implemented beginning in 2019. Also, some hatchery Chinook salmon produced in 2021 and 2022, under the PST funded SRKW prey program, would be expected to return as adults in 2024. The estimate of abundance for 2024 includes fish produced in 2020 and 2021 using funds for the PST-related prey increase program.

Reductions to Salish Sea Chinook abundances caused by Puget Sound fisheries (those listed in Table 38, which includes specific sport, non-tribal, and tribal commercial fisheries) have primarily decreased over time (see Table 38, Figure 54), even with starting abundance remaining relatively similar over time ((NMFS 2021c) Table 38). Annual analyzed fisheries are estimated to reduce the overall abundance of Chinook by an average of approximately 4.5% in the Salish Sea relative to starting abundance (from2011-2020) compared to 5.1% across the whole time series or 6.7% in the first decade of validation years (1992-2001). The 2024 projected abundance is higher than recent and historic averages and the corresponding 2024 projected percent reduction (4.0%) is similar but slightly lower compared to the average percent reduction over the last 10 years (4.5% 2011-2020), but is lower than the percent reduction over the whole time series. There is more concern when abundance is low in a particular year compared to other years and percent reduction is higher than average or not proportionate to abundance, which is not the case this year (higher abundance and similar reduction).

The largest proportion of these reductions by Puget Sound salmon fisheries occurs in the July-September (summer) time period compared to other seasons (J. Carey pers. comm.). The predicted 2024-2025 return of adult Puget Sound Chinook salmon that will escape pre-terminal

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[69] Percent reduction represents a full year of reduction by fisheries but given the time periods of the FRAM model, technically represents Oct. 2022- Sept 2023 due to biology of Chinook salmon which mainly spawn in Fall. However, winter and spring reductions are small and have varied very little over the last 10 years, and the majority of reduction happens in the summer, so winter and spring reductions contribute little to the overall reduction by the end of summer.

fisheries is forecasted to be greater than (+6%) the most recent ten-year average that escaped pre-terminal fishing and greater than the average abundance that escaped pre-terminal fisheries for the full available data series 1975-2020 (+13%) [70] (see table in Cunningham (2024)) and is within the observed range of variation seen from year to year. The above average starting abundance of Chinook salmon in 2024, coupled with abundance escaping pre-terminal fisheries within the observed range, and similar fishing effort as that from recent years (described above), suggests similar conditions of prey availability (if not slightly better) for SRKWs in the action area in 2024-2025 compared to the average conditions over this last decade. NMFS expects the level of Puget Sound fisheries in 2024-20245 to be similar to recent years, given the critical status of several Chinook salmon populations and the more restrictive harvest limits under the PS Harvest plan and obligations under the 2019-2028 PST (compared to 2009-2018 PST agreement).

For 2023, the Fraser River sockeye run is forecasted to have no allowable catch. Should non-tribal commercial fisheries open, they are subject to constraints on bycatch/release mortality for Chinook. In 2024-2025, the assumed mortalities of Chinook for FRAM-Shelton modeling in commercial fisheries (non-tribal and tribal) directed at sockeye, coho, and chum in CMA 7 and 7A in the summer are 6,042 retained hatchery and wild Chinook and 300 incidental mortality from release. These assumed mortalities (formulated annually based on expected effort and long-term Chinook bycatch ratios in the non-tribal fishery) are accounted for in the calculations of the 2024-2025 percent reduction (included in the 4.0%) and numeric abundance reduction. See Table 39 below with previous annual catch of Chinook salmon in Fraser sockeye/pink fisheries.

Additionally, using the FRAM-Shelton methods outlined here that apportion impacts by area, the estimated effect of Puget Sound fisheries on the abundance of Chinook salmon in coastal NOF waters in past years has on average been approximately 0.2% annually, which is small compared to the 815,869 Chinook starting abundance in NOF this year. While these fisheries are not occurring on the coast they do encounter some fish that, had they not been caught, are assumed, based on ad-hoc Workgroup methods, to otherwise move out into the coastal region.

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[70] Historic data (1975-2020) comes from the Puget Sound Chinook salmon run reconstruction.

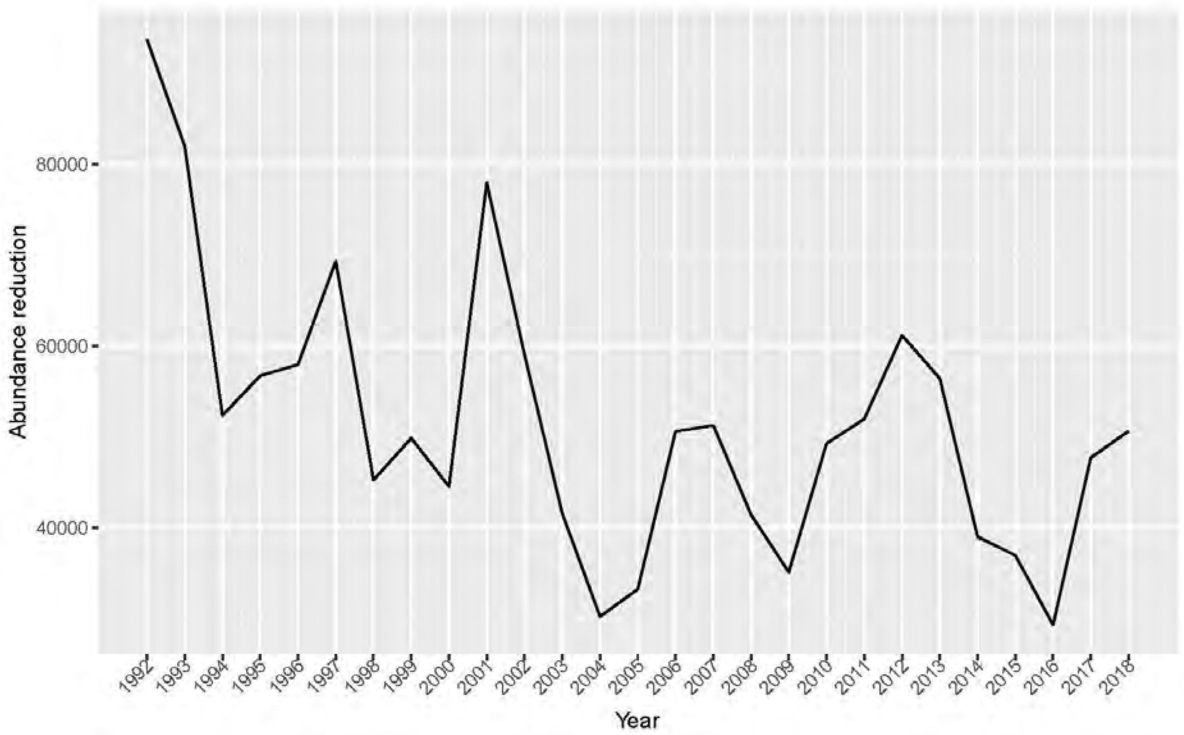

Figure 54. Reduction to abundance caused by Puget Sound fisheries by the end of FRAM time step 3 from 1992 to 2018 (using post-fishery validation years) using PFMC Ad-hoc Workgroup methods with modifications for Puget Sound, described above in this section, and using FRAM version 7.1.1. Similar to figure provided in Cunningham (2024).

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Table 39. Net harvest of sockeye, Pink, and Chinook salmon in Washington fisheries under Fraser Panel Management, 2012-2020 reprinted from 2022 Comprehensive Management Plan for Puget Sound Chinook: Harvest Management Component (2022) (https://wdfw.wa.gov/sites/default/files/publications/02309/wdfw02309.pdf)

Species		2012	2013	2014	2015	2016	2017	2018	2019	2020
Strait of Juan de Fuca	Chinook	1,568	620	1,300	820	258	48	2,200	40	73
	Pink	21	10,537	45	2,118	17	0	8	2	0
	Sockeye	15,682	4,510	4,012	1,040	1,453	0	60,170	0	0
Rosario and Georgia Straits	Chinook	432	3,913	6,835	4,781	19	2,565	3,348	3,640	39
	Pink	1,744	4,070,275	638	694,238	4	125,368	102	303,039	0
	Sockeye	103,605	22,884	709,840	51,653	68	1,531	941,151	470	0

Uncertainties in Workgroup methods and Chinook salmon modeling methodology are outlined above in the discussion on quantifying the relationship between SRKWs and Chinook salmon abundance, in the baseline for SRKW (Section 2.4.3), and in the ad-hoc Workgroup report (PFMC 2020b). Different limitations and model assumptions may bias percent reduction estimates, but FRAM-Shelton methods are currently the best available methodology (see further discussion in the baseline for SRKW, Section 2.4.3). Finally, there is a low probability that all the Chinook salmon caught by the fishery would instead be intercepted and consumed by SRKWs if there was no fishery; this adds additional uncertainty to the estimate of reduction of prey available to SRKWs by the fishery in that the reduction in Chinook salmon abundance from the fishery does not directly translate to a 4.0% loss to SRKWs. Finally, though we are reporting values produced by our analysis, these abundance and percent reduction values, and methods used to produce them, match values produced, and methods used, by WDFW (Cunningham 2024).

Furthermore, for tribal fisheries (Parker 2024) anticipate that the proposed Puget Sound Chinook Harvest Plan and the current PST Chinook salmon agreement will lead to a fishing pattern similar to the last 10 years (Parker 2024). A significant portion of Puget Sound tribal fisheries on Chinook salmon occur in terminal areas compared to pre-terminal areas and tribal pre-terminal fisheries primarily target sockeye, pink or chum salmon and not Chinook directly (but can have Chinook bycatch that is included in estimates of percent reduction). The NWIFC estimated that average annual impact on Chinook salmon is split approximately 62/38 between terminal and pre-terminal tribal fisheries (Parker 2024), so the majority of tribal Chinook mortality is in terminal areas aka local catch that would move to freshwater areas if not caught and generally in areas that are not frequently used by SRKW. Also see below for expected reduction in prey kilocalories available based on NWIFC analysis.

In addition to the location and extent of fisheries the timing of fisheries is also important in evaluating effects to prey availability for SRKWs. First, reductions in prey availability by Puget Sound fisheries in inland waters is highest in summer months (annual reductions in Table 38 are cumulative but accumulate the most in the final time step, summer). Some evidence suggests that there is a higher likelihood of SRKWs having reduced body condition in winter months, so potentially prey reductions in winter are additionally concerning but there are caveats to this body condition work and winter has low fishery reduction compared to summer (see Table 35 where percent reduction is cumulative across seasons but winter is still substantially lower, <0.4% projected for 2024 vs. ~4% in summer). In addition, Chinook salmon biology suggests fish are more concentrated in the summer than the winter, possibly making it more difficult to find prey in winter if salmon density in an area is low. SRKW dietary studies also suggest greater diet diversification during the winter and recent photogrammetry data has recorded J pod body condition declining over the winter period (as described in the Status Section, though there may also be seasonal or water temperature impacts on blubber thickness). We are concerned with body condition in all seasons, as some whales have been reported in the poorest body condition in summer, and many then subsequently died soon after (see Stewart et al. (2021)). Unlike K and L pods, which typically distribute along the West Coast in the winter, J pod primarily remains in the Salish Sea during the winter. Puget Sound fishery closures in 2024-2025 focus on the winter time period (October-April.) and include the complete winter and spring closure to recreational Chinook fishing in R-MA 6, 7, 8, and 9 and also further non-retention restrictions and other closures in other areas (MA 10 and 11 in mid-November-February for example), likely limiting impacts to prey availability during winter months. Although the winter fisheries in Puget Sound are typically of a low magnitude (both effort and catch) relative to other Chinook-directed fisheries along the West Coast, these closures/management measures may additionally limit fishery impacts on prey availability for J pod in winter months.

Energetic Requirements

It is helpful to consider the magnitude of prey reductions in the context of each season (FRAM time-step seasons) and also the energetic needs of the whales. To consider the prey reduction from Puget Sound fisheries in context of the energetic needs of the whales, in previous opinions we have estimated the ratio of Chinook food energy available to the whales compared to their metabolic needs. As described above, the analysis in this year's opinion uses a similar approach to last year, updated from previous years. Under this approach we 1) compare the NWIFC (Parker 2024) estimates of SRKW daily prey energy requirements to our estimates of daily prey requirements based on demographics of the SRKW population similar to methods in previous opinions (e.g., NMFS (2019d)), and 2) use the Shelton et al. (2021) model and FRAM to estimate Chinook kilocalories available. to provide a comparison of Chinook food energy available compared to SRKW metabolic needs.

The NWIFC (Parker 2024) estimated the energetic needs of the whales. Their analysis shows that the entire population of whales requires between 11.8 million kcal (lower bound) and 14.2 million kcal (upper bound) per day. Those daily estimates were expanded by the number of months in each FRAM time step to estimate the population need: time step 1 (212 days, lower bound: 2.5 billion kcal, upper bound: 3.0 billion kcal), time step 2 (61 days, lower bound: 720 million kcal, upper bound: 864 million kcal) and time step 3 (92 days, lower bound: 1.1 billion kcal, upper bound: 1.3 billion kcal).

The NWIFC estimated available kilocalories available to the whales in the action area using FRAM-Shelton methods to determine total abundance of stocks in the area and the following method (Parker 2024). Salmon fork lengths calculated by FRAM were transformed into kcal according to the formula kcal = 0.000011 * (fork length ^ 3.122) ((O'Neill, Ylitalo and West 2014), formula 15). The NWIFC calculated adult Chinook have on average between 3,944 kcal/fish and 10,944 kcal/fish depending on the area (O'Neill, Ylitalo and West 2014). From Noren 2011, NWIFC assumed that the daily energy requirements for adult male SRKW is approximately 15 to 16 Chinook salmon required a day; adult females are estimated to eat 9 to 13 adult Chinook salmon each day. NWIFC note that estimates of the amount of prey needed for SRKW vary considerably based on assumptions of the overlap in time/space of Chinook and SRKW, cohort size of the fish, selectivity of capture, and the fraction of energy that comes from Chinook salmon (Parker 2024). NWIFC also included the availability of chum and coho salmon as prey.

We compare the NWIFC approach to estimating the amount of Chinook salmon per day required by the whales with the approach we have used in previous consultations (specifically (NMFS 2019c)), that considers occurrence of SRKW in Salish Sea, and use this approach to estimate kcals removed by all Puget Sound fisheries. We estimated the daily prey energy requirements

(DPER) for the current population of SRKWs based on methods (outlined in (NMFS 2019c)) and using body mass equations (from (Noren 2011)) for upper (maximum) and lower (minimum) bounds on energy requirements and based on specific energy requirements by age and sex. 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 maximum daily prey energy requirement information with the population census data to estimate daily energetic requirements for all members of the SRKW population, based on the population size as of December 2023 (74 whales >1 year of age in 2024, see https://www.orcanetwork.org/births-and-deaths) and using ages for this upcoming year (2024, therefore including calves born in 2023 as being age = 1 in 2024). K34 was assumed deceased based on information from Center for Whale Research, and therefore not included. We multiplied the daily energy requirements of each pod by the average number of days that the pod was in inland waters for each FRAM time period (Oct-April; May-June; July-Sept), using both the average inland waters occurrence from 2008-2016 (see Figure 19), using maximum likely occurrence) and using average inland water occurrence from 2017-2022 to represent a minimum occurrence scenario as the whales occurred less frequently in the action area in recent years (Figure 19). Next, we summed the energy requirements across pods by time periods and multiplied by the percent of Chinook in the diet for each time period (55% for October-April; 97% for May-June; 71% for July-September; diet proportions (used in (NMFS 2019c)). These estimates are presented in Table 40. With this approach, we are assuming that the whales' diet and needs in the past are representative of what they need in the future (i.e., does not account for potential differences in population abundance and sex / age structure over time, potential differences in time spent in inland vs. coastal waters, changes in diet composition, etc.).

Table 40. Minimum and Maximum seasonal prey energy requirements for the SRKW population of 73 individuals using the average number of days in inland waters for 2007-2016 (maximum occurrence) and the average number of days inland for 2017-2022 (recent years with lower occurrence, but using maximum estimate from recent years) for the three FRAM (version 7.1.1) time periods and prey energy requirements from Chinook salmon for each time step based on diet proportions.

FRAM Time period	Average inland (2008-2016)		Min. inland - average 2017-2022	
	Min energy needs	Max energy needs	Min energy needs	Max energy needs
Oct-April	558,371,463	670,126,836	478,555,068	574,335,572
May-June	310,327,443	372,437,994	90,353,551	108,437,381
July-Sept	894,741,717	1,073,819,984	364,452,920	437,396,425
Annual total	1,763,440,623	2,116,384,814	933,361,539	1,120,169,378
Total for Chinook based on diet proportion				
Oct-April	307,104,305	368,569,760	263,205,287	315,884,564
May-June	301,017,620	361,264,854	87,642,944	105,184,260
July-Sept	635,266,619	762,412,189	258,761,573	310,551,462
Total	1,243,388,544	1,492,246,803	609,609,805	731,620,286

Based on our analysis, the overall yearly energetic needs of SRKWs while in inland waters ranged from 609 million kcal to 1.49 billion kcal (for Chinook salmon prey), with the highest kcals from Chinook in summer time step (July-Sept), specifically approximately 259 million to 762 million kcal depending on the SRKW presence scenario. Chinook abundance projections for 2024 provided above were converted to kcal available based on the estimated lipid content of specific stocks by size and age (data from O'Neill, Ylitalo and West (2014)) (and same as methods used in the 2019 Puget Sound consultation, (NMFS 2019d)). Based on this, there are over 8.2billion kcals of Chinook estimated to be available at the start of the year, which is 5-13 times greater than the total needs for in Puget Sound for the year, so we expect there will be more Chinook kcals available than what is required metabolically by the whales.

The whales have spent fewer days in the Salish Sea in recent years and if that trend continues even after reductions in prey from the fishery, we would expect there would still be more energy available to the whales compared to the estimates of their metabolic needs (see Table 40). However, we are very limited in our interpretation these values given our lack of knowledge on foraging efficiency of the whales.

The NWIFC analyses did not show any years with prey below the needs of the killer whales in any time step (Parker 2024). Also, not all three pods are present in the Salish Sea every day and SRKWs consume other prey including coho and chum, particularly in fall and/or winter that add to the available calories for SRKW, and which NWIFC consider in their analyses.

Also, NWIFC concluded that the ratio of kilocalories of Chinook available versus the estimated caloric needs of the whales is virtually the same with or without fishing and that there is more interannual variability in available kilocalories. They also note that Chinook availability is lowest in winter compared to SRKW needs. However, we note that the difference in kcals and number of fish available with and without fishing is greatest in summer. Given the 2024-2025 pre-fisheries Chinook abundance in October is estimated to be above average (compared to the recent 10 years, 20011-2020), we anticipate the prey available in 2024-2025 will be relatively average in winter. Furthermore, with closures of recreational fishing in winter months in multiple areas for 2024-2025, and low tribal effort throughout Puget Sound (less than 10 boats per day for most main areas and even less in areas with the most overlap with SRKWs; (Parker 2024) we would expect only a minor effect from the Puget Sound fisheries in the time period NWIFC found to have the lowest ratios. Finally, we and NWIFC both note that it is difficult to put available kilocalories into context without further knowledge on foraging efficiency of SRKW.

As discussed in the Status of the Species (Section 2.2.1.4), SRKW body condition is more likely to be reduced when Chinook salmon may be less available, such as in winter months. However, as described above, winter Chinook abundance for 2024 in the Salish Sea is expected to be slightly above average and Chinook salmon reduction attributed to the Puget Sound salmon fisheries is relatively low during winter. In contrast, the greatest reduction in the available prey attributed to the proposed action primarily occurs in the summer months (July-September, based on knowledge of fisheries and that the greatest accumulation in reduction occurs in the time step that includes summer); however, we are unable to quantify how a small change in prey availability from fishing in the summer months for 2024-2025 (majority of the annual - 4.0% prey reduction) compared to the whales' caloric needs would affect foraging efficiency of the whales. As described in the Environmental Baseline, because there is no available information on the whales' foraging efficiency, it is unknown how many fish, when, where and at what density need to be available in order for the whales to consume enough prey to meet their needs and it is difficult to evaluate the impacts of changes in the ratio of available kcals to needs on the whales' ability to forage to meet their energy requirements. Because of the data gaps around foraging efficiency, we have low confidence in our understanding of how the change in ratios affect the whales, however, we consider them as an indicator to help focus our analysis on the time and location where prey availability may be lowest and where the action may have the most significant effect on the whales. Hilborn et al. (2012) cautioned that forage ratios provide limited insight into prey limitations without knowing the whale fitness/vital rates as a function of the supply and demand, however, they suggested ratios may be informative in an ecosystem context (by species or region, e.g. Chasco et al. (2017a)).

Also, the degree to which killer whales are able to or willing to switch to non-preferred prey sources (*i.e.*, prey other than Chinook salmon) is also largely unknown, and likely variable depending on the time and location. Prey studies have indicated that SRKWs switch from Chinook to other salmon in fall months (particularly coho and chum salmon; (Ford et al. 2016; Hanson et al. 2021a)). Given Chinook salmon are consumed throughout the whales' range and prey samples indicate they are consumed the majority of the time, we assume the whales prey switch if their primary prey, i.e. Chinook salmon, are not available.

Current Body Condition Status

Based on data collected in 2023 by Fearnbach and Durban (2024), 32% of J pod and 40% of L pod, are in the lowest body condition category (poor body condition). Fearnbach and Durban were unable to sample K pod in 2023, but as of data collected in 2022 only 6% of K pod was in the lowest body condition category (Fearnbach and Durban 2023). Due to the connection between J pod body condition and Fraser cohort abundance shown by Stewart et al. (2021), we would have some level of concern if Fraser abundance is low and a high percent of J pod is in the poorest body condition. Though we have not developed any management thresholds from this study, it is helpful to consider relationships from Stewart et al. (2021) for context.

Fraser abundance is projected to be above average this coming year (1,020,016 fish). Fraser Chinook cohort of age 3-5 at the start of Summer time step, see Cunningham 2024, compared to an average from 1992-2020 of 843, 684), which is near levels where Stewart et al. (2021) shows high probability of increase or stable change in body condition for J pod. Stewart et al. (2021) used Chinook abundance information produced by a previous version of FRAM. Therefore, to make that analysis, and Chinook abundance levels at which probability of body condition decline are more likely, comparable to the Chinook retrospective abundances provided above, authors of Stewart et al. (2021) re-ran analyses with abundance values from FRAM version 7.1.1.

Unfortunately, we could not get updated 2019 abundance using the new FRAM version and so the data set has one less year. For J pod and Fraser River “cohort” abundance (abundance of the stocks from Fraser), with new FRAM there is a 0.881 probability of a negative relationship between probability of declining condition and increasing Fraser Chinook (Stewart et al. 2021; Fearnbach and Durban 2023). With this, the probability of declining body condition was highest in 2012 and 2017 (~46% probability and 43%, respectively) and these are the two lowest Fraser cohort abundances (495,274 and 473,337, respectively) in their data set. In short, this work showed that, if abundance is below 643,000 fish for Fraser, the probability of a declining body condition for J pod is >0.35 or below 500,000 fish, the probability of decline is >0.4. This year’s projected Fraser abundance is well above those values and above the average of validated retrospective Fraser abundance from 1992-2020, so though 32% of J pod are in poor body condition, predicted Fraser runs could indicate high probability of stable or increasing body condition. Also, Cunningham (2024) noted that projected Fraser Chinook mortalities are projected to be low in 2024 at 11,029 age 3-5, in non-tribal Puget Sound fisheries.

Stewart et al. (2021) also showed a relationship between Puget Sound stock abundances and L pod body condition. Though the model with Puget Sound “cohort” (total abundance of those stocks not only abundance in a region, see Stewart et al. (2021)) abundance was the best predictor of L pod body condition, there was high uncertainty in this relationship (large confidence intervals) and it did not perform substantially better than the null model. Still, looking at Puget Sound cohort abundance for this year, Puget Sound cohort abundance is predicted to be 378, 984 Chinook (cohort age 3-5 at the start of the Summer time step), which is larger than the lower level of 235,000 that Stewart et al. (2021) highlight as a value where probability of a stable or increase in body condition is quite low. Authors did not provide a new value using the updated FRAM at which L pod probability of body condition decline is greater but analyses comparing cohort abundances between versions of FRAM showed that Puget Sound cohort abundances had minor differences (~100s) between versions (6.2 vs 7.1.1) while the Fraser cohort had greater variation between model runs (~10,000s) (Carey et al. 2022, Appendix A). Given the high uncertainty with the relationship between the L pod and Puget Sound abundance and the relatively high predicted abundance for Puget Sound cohort of stocks this year compared to lower levels in Stewart et al., even though 40% of L pod are in poor body condition, estimated Chinook abundances are at levels with a high probability of stable or increasing body condition according to Stewart et al. (2021). While this is a relatively high proportion of L pod individuals that are in poor body condition with a substantially higher proportion from last year (13% in poor body condition in 2022), the abundance of Puget Sound Chinook salmon have been above the threshold specified in Stewart et al. (2021) for the past two years which suggests other factors may be contributing to the decline in body condition.

Local Spatial Effects

Another context to consider for prey reductions from fisheries is the potential for localized depletions. SRKWs have been observed foraging in certain areas (hot spots, especially the West side of San Juan Island) more than others (see above section on overlap), and to the extent the fisheries remove Chinook salmon that might otherwise be available in these areas, they may limit

SRKW access to those fish. It is noted that localized depletion can possibly occur if a species is managed at a spatial scale that is larger than the scale of ecological processes and fisheries (Ames 2004; Walters and Martell 2004; McGilliard et al. 2011), such as concentrated fishing on spawning aggregations (see de Mitcheson (2016) and sources therein). On their return to their natal rivers as adults, salmon may congregate in marine areas adjacent to the rivers. Because of their life histories and the location of their natal streams, adult salmon are not evenly distributed across inland waters during the summer and early-fall months when SRKWs occur in this general area. Therefore, it is possible that the overall reduction in prey resulting from the proposed action would not be evenly distributed across Puget Sound/Salish Sea, especially if fisheries are concentrated in certain areas. Concentrated fisheries and reductions could cause local depletions of prey. Reducing local abundance of prey from the proposed fishing could result in the whales leaving areas in search of more abundant prey. This could result in a potential increase in energy demands, which would have the same effect on an animal's energy budget as reductions in available energy, such as one would expect from reductions in prey. Localized depletions caused by direct overlap between foraging whales and the fisheries, would increase competition for fish, and in some conditions, the whales may not always be able to meet their energetic needs (i.e., the prey available to the whales may not be sufficient to allow for successful foraging). For example, if there are localized prey depletions in foraging hot spots in R-MA 7, the whales may increase their searching effort and move to other potential foraging areas within their geographic range. The Southern Residents regularly make trips to coastal waters during the summer months and have access to additional prey in nearby waters. This was particularly true in recent years when the whales have spent more time off the coast than in inland waters.

It is difficult to assess potential for localized depletions because the prey reduction during July through September throughout the action area or in inland waters may not accurately predict reductions in prey available in known foraging hot spots. For example, an approximate 4.0% reduction in food energy in the inland waters applies to a broad area with varying overlap with the whales. A reduction in Chinook salmon in south Puget Sound during summer months when the whales are primarily off the west side of San Juan Island will have a different effect on reduced prey availability than that same percent reduction off the west coast of San Juan Island. While we have detailed information on the whales' distribution, unfortunately, the current Chinook abundance models are not able to analyze prey reductions at a finer scale.

Because we do not have abundance estimates at smaller spatial regions than the entire action area, and because we do not have information on SRKW foraging efficiency or density of prey needed to successfully forage, there remains substantial uncertainty about the effects of the fishery at smaller scales and quantitative analyses of localized depletion and direct competition are difficult.

When determining the potential effect of the prey reduction caused by Chinook fisheries in Puget Sound on SRKW at a more localized spatial scale, it is informative to consider how much Chinook salmon the fishery has extracted in previous years in the area of highest overlap with SRKW to help inform our assumptions of what is likely to occur in the future. In R-MA 7, an area important for SRKW foraging, the amount of Chinook salmon caught each year in the recreational fishery is projected using FRAM and then compared to the postseason reported value by co-managers each year. Since 2012, the amount of Chinook caught each year in the summer has exceeded the projected amount most years, with the exception of 2016, 2020, 2022 and 2023, and actual catch has ranged from <2000 to >6000 fish Figure 55. The percent that actual catch exceeded projected catch has decreased in recent years. This decrease could be partially attributed to the fact that the amount of days that R-MA 7 was open for Chinook retention (either mark-selective or non-selective) decreased starting in 2018. Before 2018, Chinook retention was allowed July through September in R-MA 7. Starting in 2016, R-MA 7 was at least partially mark-selective. From 2016 to 2019, the fishery was mark-selective in July. In 2020, the fishery was intended to be mark-selective the entire summer season and open for the entire month of July and the second half of August. But due to the number of Chinook salmon encounters in July, the reopening of the fishery was delayed by six days until August 22, 2020. Again, 2021 was supposed to be mark-selective and open for the entire month of July and the second half of August. Due to the total number of Chinook salmon encounters e+xceeding the preseason projection in July, the fishery was closed on July 7 by emergency regulation. In 2022 and 2023, the entire season was mark-selective. In 2024, the quota set for R-MA 7 which recreational fisheries can't exceed is 2,181 Chinook salmon, but this is a maximum catch limit (and it is less than was seen in some previous years like 2017, which was above 7,000).

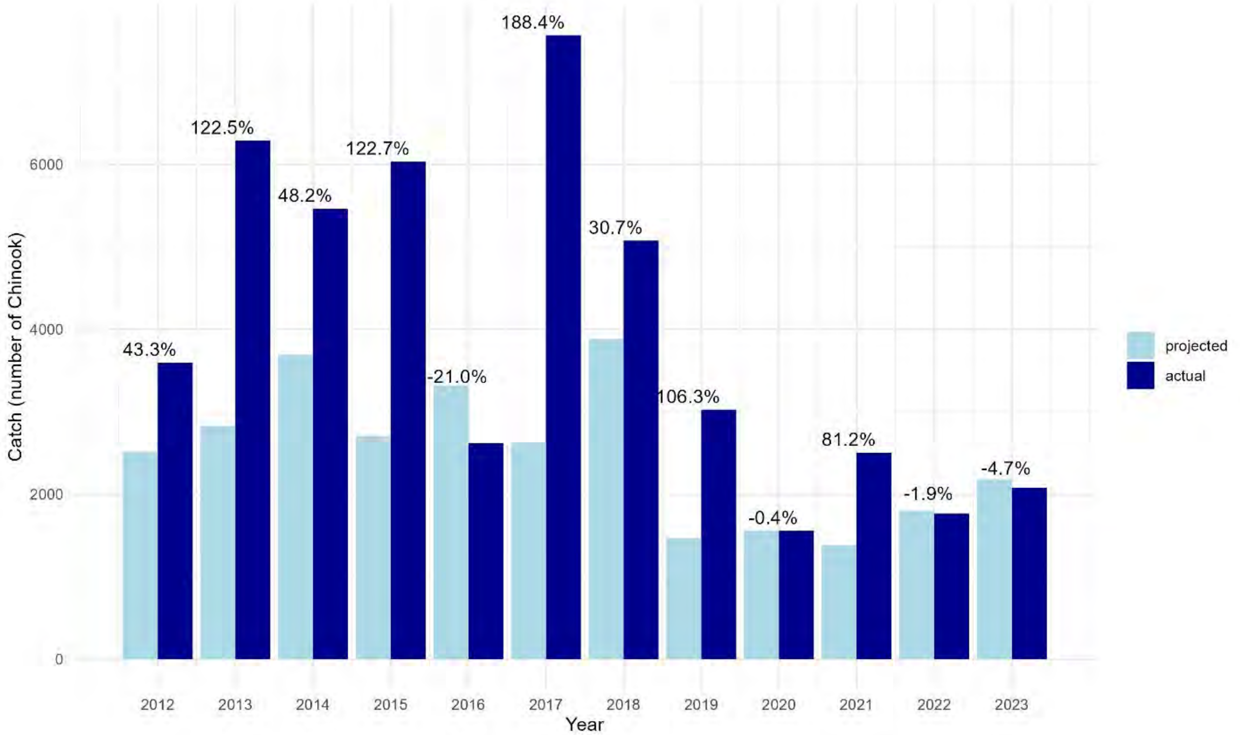

Figure 55. Actual vs projected catch of Chinook salmon in R-MA 7 from 2012 to 2023. Percentage values on top of the bars indicate the percent overage, which is calculated by actual catch minus projected catch divided by projected catch then multiplied by 100. Projected values are estimates using FRAM. FRAM was updated in 2012 and 2017. Actual values are reported using intensive sampling and/or creel data. For fisheries without intensive sampling and/or creel data available, catch will be estimated using

CRC data and data from baseline dockside sampling of marine fisheries. Baseline sampling provides data on catch per unit effort (CPUE), species composition, as well as CWT and biological sampling data.

Additionally, as mentioned above, bycatch and retention of Chinook salmon in the commercial Fraser sockeye fishery, or Puget Sound coho or chum fisheries in CMA 7 and 7A (tribal and non-tribal) for 2024-25 includes 6,042 retained hatchery and wild Chinook and 300 incidental mortality from release. More specifically, during the study years of 2013-2022 actual bycatch in San Juan net fisheries was lower than the FRAM projections every year except 2014, and actual bycatch in the most recent 5 years with data ranges from 63-5,386 per year (Figure 56). It is important to note that the values include non-retention mortality in the non-tribal purse seine fishery. Likely less than 50% of purse seine and around 10% of gillnet occur off the West side of San Juan Island (see above Fishing Vessel Presence). Finally, Parker (2023) show that in the Summer time step, the highest tribal Chinook impacts occur in C-MA 7B/7C/7D (~20-25% of all mortalities) compared to C-MA 7/7A/7E/6A (<12.5%) where SRKW are seen more frequently. In other times of the year, the majority of mortalities from tribal fisheries occur in C-MA 4B/5/6/6B/6C.

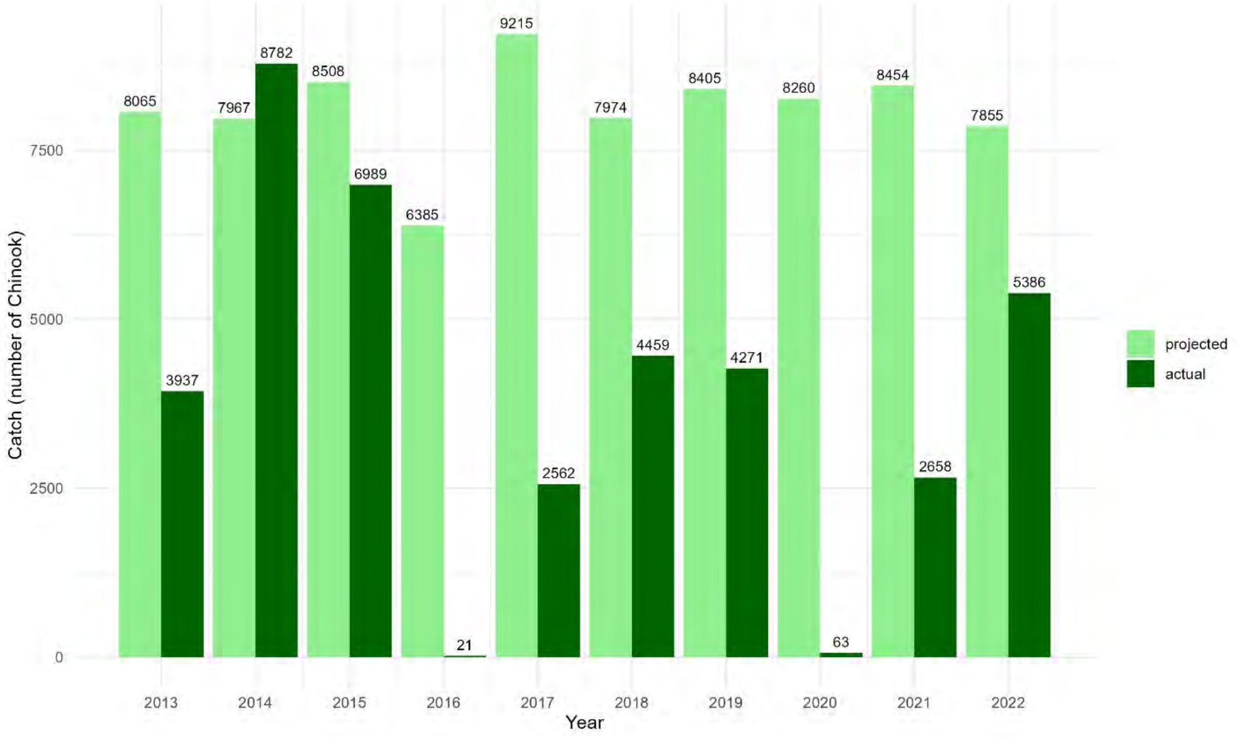

Figure 56. Actual vs projected bycatch of Chinook in commercial San Juan salmon fisheries (tribal and non-tribal) for 2013-2022.

We can also look at proposed fisheries measures in 2024-2025 compared to previous years that may help limit the potential for localized depletion. As described above, the 2024-2025 fishery includes some changes in recreational fishing to reduce impacts to Chinook salmon including reduced impacts in R-MA 7. For example, recreational salmon fisheries in Puget Sound, which directly overlap in time and space with SRKW foraging activity, have been curtailed in recent years (e.g., 2019-2023 and this year) including changes from non-selective fishing to closure, non-retention, or mark selective fishing to address conservation needs for various stocks of ESA-listed Puget Sound Chinook salmon. Again, tribal fisheries are mainly terminal (62/38 split terminal vs. pre-terminal) and therefore occurring in areas where the salmon would no longer be available to the whales, and pre-terminal fishery effort/vessels is highest in times/areas where SRKWs are less common (Parker (2024) and Figure 50). Even at their highest levels tribal fisheries have a limited number of vessels (<1-2.5 boats on average per day) in the San Juan island area during summer. Finally, winter closures of recreational fisheries in MA 6, 7, 8, 9, 12, and some in 10 and 11 should limit prey removal from these areas which may limit impacts to J-pod (more common in inland waters in Fall/Winter than K and L pods). Although difficult to quantify, these actions should limit the removal of potential prey in important foraging areas of Southern Residents, and should therefore have a reduced impact on the amount of Chinook salmon prey available to Southern Resident killer whales than fisheries in previous years (e.g., 2017 and 2018 when fisheries in R-MA 7 were non-selective in summer months and there were fewer winter closures).

In summary, the proposed actions are expected to cause an approximate 4.0% reduction in abundance of age 3-5 Chinook salmon in inland waters in 2024-2025 which is relatively low compared to previous decades, and similar to the average for the last decade. The starting Chinook salmon abundance in 2024-2025 (i.e. October TS1 abundance) is also estimated to be slightly higher than the recent 10-year average and at levels where prey energy available is greater than that required metabolically by the whales. The estimated reduction is highest in inland waters during July through September compared to the other seasons, but not all of the fish caught in the fishery would have been intercepted and consumed by the whales. Some of the prey reduction occurs in an area known for its high use and is considered a foraging hot spot (e.g., R-MA 7) but recreational fishery restrictions in the summer (mark selective in July and especially non-retention in half August and all of September) and winter (closure), and minimal tribal fishing (approximately <1-2.5 boats per day in the San Juan islands), will likely limit the impacts in this hot spot. Additionally, Fraser Chinook salmon abundance is above average this year. Because SRKW are already stressed due to the cumulative effects of multiple stressors that could be additive or synergistic, small percent reductions can lead to reduced fitness, increased foraging effort, and less energy acquired. We would expect increased energy expenditure or reduced foraging to have more significant impacts on the health and reproduction of the whales in times of low Chinook salmon abundance (see discussion above), especially if certain Chinook groups are low (Fraser, Puget Sound), but overall 2024 abundance is expected to be slightly above average level and cohort relative abundance of Fraser and Puget Sound runs are not expected to be particularly low. Though fishing will reduce prey compared to no fishing in the area, we anticipate limited reductions in prey in 2024-2025 similar to recent years, in part because of reduction in fishing to protect vulnerable salmon populations (as described in the Chinook salmon Effects Section) and the additional measures WDFW (area closures, non-retention, etc.) proposed to further reduce impacts from vessels that may also reduce impacts to prey availability. We do not expect these effects from fishing to persist or be so large that they result in more than a minor change to the overall health of any individual whale. Efforts to reduce fishing in the primary foraging area along the west side of San Juan Island (especially in August and September) will reduce the potential for prey reductions to result in significant localized depletions or prey depletions at levels that would cause injury or impair reproduction.

2.5.4.2 *Effects on Critical Habitat*

In addition to the direct and indirect effects to SRKWs discussed above, the proposed action affects critical habitat designated for Southern Resident killer whales in inland waters of Washington. Based on the natural history of the Southern Residents and their habitat needs, we identified three physical or biological features essential to conservation in designating critical habitat: (1) Water quality to support growth of the whale population and development of individual whales, (2) Prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth, and (3) Passage conditions to allow for migration, resting, and foraging. This analysis considers effects to these features. As indicated in Section 2.4.1, Puget Sound salmon fisheries are managed consistent with the recovery of Chinook salmon, therefore, we expect limited impacts to future production of salmon from Puget Sound, based on the proposed fisheries. Consequently, we would not expect impacts to salmon (i.e., prey feature) in coastal killer whale critical habitat along the coast, where young salmon originating from the action area could move to and be available to the whales in future years, or any other feature of coastal critical habitat. Also, reduction to NOF coastal abundance by Puget Sound fisheries is relatively low (0.2%). Therefore, we focus this analysis on designated inland critical habitat that overlaps with the proposed action.

The proposed actions have the potential to affect all three features of critical habitat: water quality; quantity, quality, and availability of prey; and passage conditions. Southern Resident killer whale critical habitat remains at risk from serious oil spills because of the heavy volume of shipping traffic and proximity to petroleum refining centers. As mentioned in the Status Section, in August 2022, a commercial fishing vessel sank off the west side of San Juan Island and an oil sheen was seen[71]. 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. However, these incidents, specifically from fishing vessels, are rare based on those that are reported. Specifically, in the NOAA Office of Response and Restoration, Environmental Response Management Application (ERMA) database of reported spills, there has only been ~1 on average reported from fishing vessels each year since 2020 in Puget Sound. Additionally, fishing vessels do not carry large amounts of oil and

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

response protocols are in place making the risk from spills minor. Therefore, there is a small chance a similar oil spill would occur, so the likelihood of an effect to water quality from an oil spill specifically from a fishing vessel is low.

The critical habitat feature related to prey includes prey quantity, quality, and availability and this analysis draws on the analysis of the effects on prey to the whales themselves. The proposed action has the potential to affect quantity and therefore availability of prey, but likely little effect on prey quality. We would not expect any impacts from the proposed action on the quality of prey with respect to levels of harmful contaminants (except for in the small likelihood of an oil spill from a fishing vessel). However, as described in the Environmental Baseline for SRKWs (Section 2.4.3), 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 is 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 (in the Environmental Baseline Section 2.4.3). The declining trend in the proportion of older ages in Washington stocks was observed but slightly weaker than that in Alaska. In a follow-up paper, authors found that reasons for this shift may be largely due to direct effects from size-selective removal by marine mammals and fisheries (Ohlberger et al. 2019b). As noted above, SRKW mainly consume larger (age 3 and older) salmon, and larger fish typically have higher energy content. Ohlberger et al. (2019b) through simulation modeling did find that harvest, in comparison to predation, had a “weaker effect” on the observed changes in Chinook 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 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 would appreciably decrease Chinook size (i.e., quality) thereby reducing the conservation value of the prey feature.

Effects of the proposed action reduce prey quantity and availability in critical habitat resulting from the harvest of adult Chinook salmon. The extent of reductions in adult Chinook salmon in the action area due to Puget Sound salmon fisheries is described in detail in the Effects analysis for the whales. The pre-season estimate for starting abundance (i.e., in October and does not include natural or harvest mortality) of age 3-5 Chinook in designated critical habitat is approximately 1,181,819which is slightly above the recent 10-year average of approximately 969,938 (2011 through 2020) and the proposed action is likely to result in reductions in prey quantity and availability by approximately 4.0% (similar to average impacts in this last decade).

As described above, our analyses and analyses by the NWIFC (Parker 2024) estimated the Chinook salmon food energy available to the whales and compared available kilocalories to needs and evaluated the ratio after reductions from the proposed fishing. We anticipate the prey available in 2024-2025 will be relatively average (i.e., not relatively low) and at levels where prey energy available is greater than that required metabolically by the whales (based on our analysis and NWIFC analysis of energy requirements of the current SRKW population). Though NWIFC found that Chinook availability is most limiting in winter in relation to SRKW caloric needs, Chinook salmon reduction attributed to the Puget Sound salmon fisheries is relatively low during winter and in contrast, the greatest reduction in the available prey attributed to the proposed action primarily occurs in the summer months. Given the 2024-2025 pre-fisheries Chinook abundance in October is estimated to be slightly above average (compared to the recent 10 years, 2011-2020), we anticipate the prey available in 2024-2025 will be relatively average in winter. Overall, the Puget Sound fisheries (compared to no fishery) would reduce the available prey and slightly lower the ratio of prey available compared to the metabolic needs of the whales. However, we are unable to quantify how this reduction affects foraging efficiency of the whales and therefore 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.

As described in the Effects Section above, the proposed action is expected to cause an approximate 4.0% reduction in abundance of age 3-5 Chinook salmon in designated inland critical habitat in 2024-2025 which is similar to the average of this last decade. The starting Chinook abundance in 2024-2025 is also estimated to be above the recent 10-year average. It is difficult to assess how reductions in prey abundance may vary throughout critical habitat and we have less confidence in our understanding of how reductions could result in localized depletions in the areas of critical habitat. Reductions in local abundance of prey from salmon fishing may result in the whales leaving inland critical habitat areas in search of more abundant prey. Prey reduction throughout critical habitat may not accurately predict reductions in prey available in their “Core Summer” area of designated critical habitat, including off the west side of San Juan Island in MA 7, a known foraging hot spot especially in summer but where whales are sighted in other months as well. The estimated reduction by fisheries is highest in inland waters during summer months, July through September, compared to the other seasons. Although some of the reduction occurs in the Core Summer area (e.g., R-MA 7), recreational fishery restrictions in the summer (mark selective, non-retention and limited duration) and winter (closure), minimal tribal fishing in summer (approximately <1-2.5 boats per day), and that non-tribal commercial vessels don’t target Chinook in C-MA 7/7A will likely limit the impacts in this hot spot. Winter closures of recreational fisheries in MA 6,7,8,9, and 12 should limit prey removal from these areas which may limit impacts to J-pod (more common in inland waters in Fall/Winter than K and L pods). We anticipate limited reductions in prey in 2024-2025 in critical habitat similar to recent years, in part because of reduction in fishing to protect vulnerable salmon populations (as described in the Chinook salmon Effects Section) and the additional measures WDFW proposed to further reduce impacts from vessels that may also reduce impacts to prey availability for SRKWs (1,000-yard rule).

Effects of the proposed fishing include the potential for exposure of whales to the physical presence and sound generated by vessels associated with the proposed action. This increase in vessel presence and sound in critical habitat and in a key foraging area, contribute to total effects on passage conditions for SRKWs. As described above, the vessels associated with the fishing activities overlap with the whales, particularly in July through September in R-MA 7, an area defined as the whales' summer core area in Haro Strait and waters around the San Juan Islands. Although we cannot quantify the increase in vessels around the whales likely to result from the proposed action (compared to if there was no fishing), it is reasonable to expect that authorization of the proposed fishery will result in more vessels in core areas of the whales' critical habitat than there would be if no fishing is authorized, and there may be an increase in vessels per day with shorter fishing seasons, albiet for fewer total days, compared to years prior when the fishery for Chinook retention was open for more days.

For reasons described in the Effects on the Species and summarized here, if interactions between SRKW and fishing vessels were to occur the amount of disturbance caused by the fishing vessels may affect whale behavior including causing them to spend more time traveling and performing surface active behaviors and less time foraging and resting in their critical habitat. The fishing vessels may also reduce the whales' effectiveness in locating and consuming sufficient prey through acoustic and physical interference. These impacts may also reduce overall foraging at times and may cause whales to move to areas with less disturbance outside of currently designated critical habitat. However, as described above, vessel impacts are expected to be lower compared to prior to the most recent 5 years, and should be similar to the most recent 5 years (2019-2023, based on the reduction in overlap of fisheries and whales in MA 7 (included in the area called "summer core area" in critical habitat) due to for example: (1) limited commercial fisheries of Fraser sockeye and pink salmon expected to not occur or limited, similar to recent years (pink salmon only caught in odd years), (2) mark selective (contingent on impacts based on quota and not surpassing ER) recreational fisheries in July (with limited days open) and non-retention in half of August and September, and (3) small tribal fishery presence (<1-2.5 boats in the summer months, in the San Juan island area of MA 7), (4) winter closures in recreational fisheries in multiple areas as described above. Furthermore, SRKW have only been in their known hot spot off the West side of San Juan island in around 50% of the days that the recreational fishery is open for Chinook retention. In addition, WDFW will continue to promote adherence to a voluntary "No-Go" Whale Protection Zone along the western side of San Juan Island in MA 7, extending from Mitchell Point to Cattle Point, offshore for ¼ mile (or ½ mile at Lime Kiln lighthouse), for all recreational boats—fishing and non-fishing—and commercial fishing vessels (with the exception of the Fraser Panel sockeye/pink, if that fishery occurs). WDFW will also encourage fishers to silence vessel sonar in the presence of Southern Residents and when fishing gear is deployed (especially those transmitting within the hearing range of killer whales (Branstetter et al. 2017), encouraging the use of 200 kHz frequency outside of SRKW hearing range) and information on this has been included in the fishing regulation pamphlet and on the WDFW website. Finally, conservation efforts by WDFW will include education to fishing vessels to maintain slow transit speeds (restricted to 7 knots or less) at a minimum, adhere to distance regulations around SRKW (including a new regulation that prohibits most vessels from within a 1,000 yards of the whales), and minimize echosounder effects. The new 1,000 yard vessel distance rule would span the voluntary no-go zone when the whales are present. Therefore, we anticipate adverse effects to passage conditions from fishing vessels, but these are expected to be small and mitigated by several conservation efforts. It is unlikely that any direct effect from small transitory disturbance that might occur would have more than a momentary effect on passage in the proposed critical habitat.

2.5.5 Central America and Mexico DPSs of Humpback Whales

Humpback whales (Central America DPS, Mexico DPS) may be directly affected by the proposed action by interaction with vessels or gear, or indirectly affected by reduced prey availability.

Humpback whales consume a variety of prey such as small schooling fishes, krill, and other large zooplankton. Because the proposed fishing targets species that are not the primary prey for humpback whales, it is not expected to reduce their prey. Any reduction in prey would be extremely minor, not primary prey species, and an extremely small percent of the total prey available to the whales in the action area and therefore impacts on the species would be insignificant. No impacts to humpback whale critical habitat are anticipated. This is discussed further in Section 2.12, “Not Likely to Adversely Affect” Determinations.

Vessel traffic and fishing effort associated with the proposed fisheries are anticipated to be similar to past levels in inland waters of Washington. Between 2004 and 2023, there were 11 reports of a vessel strike of a humpback within Washington waters, six of which occurred since 2016 (NMFS Stranding Database 2022). As described in Section 2.4.4 of the Environmental Baseline, there have been a number of recent vessel strikes within the inland waters (NMFS Stranding Database 2022). However, there are no recorded cases of a collision between a salmon fishing vessel and humpback whales in the action area. The proposed action includes a tribal troll fishery that operates from May to October in C-MAs 5, 6, and 6C. This is an area and time of year that humpback whales are present (see Figure 34). Because the trolls operate at low speeds (generally 1-4 knots) they pose very limited risk to humpback whales from vessel strikes while actively fishing. However, the fishing vessels do operate at faster speeds while transiting to and from the fishing grounds. Fishing vessels do not target marine mammals, operate at relatively slow speeds, remain in idle, or the engine is off when actively fishing. Additionally, transiting non-tribal and tribal fishing vessels are required to slow down to 7 knots or less when they are within ½ nautical mile of a Southern Resident killer whale (RCW77.15.740) and are encouraged to reduce speeds to 7 knots or less when around any whale species under the Be Whale Wise Guidelines. These required and/or recommended speed reductions decrease the chance of a vessel strike occurring and the chance of a potential strike leading to a serious injury or mortality for a humpback whale. Therefore, we consider a strike from a fishing vessel to be unlikely and the effects relating to vessel strikes are expected to be insignificant. While the fishing vessels do produce noise, the amount of additional noise produced within the action area is unlikely to cause harm to the humpback whales. Vessels would have a short-term presence in any specific location and any disturbance from vessels and noise would be minimal. Echosounders and depth finders generally emit frequencies from 10 kHz up to several hundred kHz (Lurton 2015). Humpback whales can likely hear sounds between 15Hz and 3 kHz, with peak sensitivity around 1 kHz (Tubelli et al. 2018), and are thought to be sensitive to low-frequency sounds. Because of this, noise from these devices is not anticipated to impact individuals. As such, the low level of potential disturbance from vessels and noise is likely to be insignificant.

Entanglement of ESA-listed marine mammals is known to be an issue with commercial fishing gear on the U.S. West Coast (Saez et al. 2013; Saez, Lawson and DeAngelis 2021). For humpback whales that may co-occur with the proposed fisheries, there is a risk of becoming captured/entangled in the proposed fishing gear either through unintentionally swimming through the gear or as a result of being attracted to fishing gear. Humpback whales are known to be tactile animals and reports of individuals interacting with seaweed are common (Owen, Dunlop and Donnelly 2012). Given this, humpback whales may intentionally interact with fishing gear and become entangled.

This analysis will therefore focus on the interactions between Puget Sound salmon fisheries gear and ESA-listed humpback whales. We first summarize available information on interactions that have occurred in the past, then we assess the likelihood of future interactions based on the co-occurrence of ESA-listed populations of humpback whales with Puget Sound salmon fisheries. Finally, we consider and describe the potential extent of impacts that may occur for ESA-listed populations of humpback whales based on the available information on the extent of Puget Sound salmon fisheries.

Previous Interactions of Humpback Whales with Puget Sound Salmon Fisheries

Bycatch of marine mammals in all commercial fisheries is monitored and categorized according to relative risks of mortality and serious injury (M/SI) for marine mammal stocks[72] by NMFS through the List of Fisheries (LOF) as required by the MMPA. The LOF lists U.S. commercial fisheries (not including tribal fisheries occurring under this plan) by categories (I, II, and III) according to the relative levels of interactions (frequent, occasional, and remote likelihood of interaction or no known interactions, respectively) that result in mortality/serious injury (M/SI) of marine mammals. In order to accomplish this task, NMFS often relies upon data provided by the use of fisheries observers. NMFS also considers entanglements from analogous fishing gear when categorizing fisheries with limited observer information.

The LOF for 2024 classifies the WA salmon seine (formerly named the WA salmon purse seine), WA salmon reef net, and CA/OR/WA salmon troll fisheries all as a category III (i.e., remote likelihood of/no known incidental mortality or serious injury of marine mammals) (89 FR 12257, February 16, 2024). The prediction of future interactions between humpback whales and these fisheries occurring when there has never been a documented interaction to have occurred before, is challenging because these risks cannot be completely eliminated. At this time, we conclude that the lack of historical incidental capture or entanglements between purse seine, salmon reef net, and troll gear and humpback whales within the action area, even when risks of such interactions have been and continue to remain possible, is a reflection of the low co-occurrence of the species and the fishing effort and/or of the limited risk of entanglement these specific nets and gear provide to humpback whales, making interactions extremely unlikely. Therefore, we consider the potential for effects relating to these gear types to be discountable.

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[72] Stocks as defined under the MMPA. These may not necessarily coincide with ESA-listed populations of marine mammals.

For 2007 to 2021, gillnet entanglements represented 6.6 percent of all reported humpback whale entanglements along the West Coast of the U.S., with the most gillnet entanglements occurring in 2018 (5 incidents) (Carretta et al. 2013; Carretta et al. 2015; Carretta et al. 2020; Carretta et al. 2021a; Carretta et al. 2023a). There were were 12 gillnet entanglements reported in California, including four identified to California specific fisheries, and 6 entanglements reported in Washington, including three identified to Washington-specific fisheries (18 in total along the US west coast)(Table 41). Because the location of an entanglement report is not necessarily the same as the entanglement origin, it is possible that whales reported as entangled in gillnets in California were entangled in Washington and vice versa. However, three of the Washington reports were identified to tribal gillnet fisheries in Washington, all of which occurred in 2018.

Table 41. Gillnet Entanglements by year. Unknown gillnet fisheries are listed as "GILLNET FISHERY"

Year	State Reported In	Gillnet Fishery
2007	CA	CA HALIBUT AND WHITE SEABASS SET GILLNET FISHERY
2009	CA	CA SWORDFISH DRIFT GILLNET FISHERY
2010	CA	GILLNET FISHERY
2015	CA, WA	3 GILLNET FISHERY
2016	CA	2 GILLNET FISHERY
2017	WA	GILLNET FISHERY
2018	CA	GILLNET FISHERY
2018	CA, WA	2 GILLNET FISHERY, 3 TRIBAL SALMON GILLNET
2020	CA	GILLNET FISHERY
2021	CA	2 CA SWORDFISH DRIFT GILLNET FISHERY, GILLNET FISHERY

The Puget Sound region salmon drift gillnet fishery (defined in the LOF 2024 as that which includes all inland waters south of US-Canada border and eastward of the Bonilla-Tatoosh line-Treaty Indian fishing is excluded) is listed as a Category II fishery, meaning it has an occasional likelihood of marine mammal interactions that can result in M/SI. However, humpback whales are not one of the species that led to this classification[73]. In 1993, observers were placed onboard vessels in the Puget Sound region drift gillnet fisheries as part of a pilot program to monitor sea

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[73] Harbor porpoise, inland WA is driving the current classification. Dall's porpoise CA/OR/WA and harbor seal, WA inland stocks are also included in the categorization.

turtle and marine mammal interactions. No incidental takes of humpback whales were documented. This fishery has not been observed by marine mammal observers since 1994.

NMFS also relies upon other records of entanglements/interactions that are reported to Marine Mammal Stranding Programs to evaluate the relative impact of interactions by marine mammal stocks with commercial fisheries and other human sources. The most current information on these data on the West Coast are available in the marine mammal SARs (Carretta et al. 2023b), the Serious Injury and Mortality Report published annually (Carretta et al. 2023a) and the annual West Coast Region entanglement summaries (NOAA Fisheries 2022; 2023). These data are collected opportunistically and typically have not been extrapolated within the SARs into more comprehensive estimates of total strandings or human interactions that may have occurred, and we understand these totals to represent minimum totals of overall impacts. Below we describe the available information on humpback whale interactions with Puget Sound fisheries (not just those that lead to M/SI) that can be found in the most recent versions of these reports and NMFS's entanglement response database. We acknowledge uncertainty of the severity of injury and the impacts to the humpback population around the most recent data because they have not yet gone through the serious injury determination process.

From 2007 to 2014, there were no documented humpback whale entanglements in gear that was identified as salmon fishing gear in Puget Sound although one whale was reported entangled in unidentified gillnet gear in Monterey, CA (Carretta et al. 2013; Carretta et al. 2017). In 2015 and 2017, there was one humpback whale reported entangled in gillnet gear of unknown origin in Clallam County and off of San Juan Island, respectively. The whale in 2015 has not been resighted since then, although the whale from 2017 was resighted with no gear, meaning the entangling fishery was never identified in either case. Four humpback whales were reported in unidentified gillnet gear in California during the same time period. In 2018, three humpback whales were reported as entangled in tribal gillnet gear that was part of the Puget Sound salmon fishery in the inland Washington waters, in the Strait of Juan de Fuca (Carretta et al. 2021a). One additional entangled humpback whale was reported off the coast of Port Angeles, WA that was also confirmed to have a gillnet entanglement, but the specific fishery of origin is unknown. Of the three gillnet entanglements in 2018, one resulted in the death of the whale, and the status of the other two is unknown. An additional humpback whale was reported in unidentified gillnet gear in California in 2018. While there have been occurrences of entanglements of humpback whales in Washington gillnet fisheries, these have been infrequent (Carretta et al. 2023a).

There were three reports of humpback whale entanglements in inland waters of WA in 2019 with unidentified gear (NOAA Fisheries 2019). There was one humpback whale reported as entangled in the inland waters in both 2020 and 2021, also in unidentified gear (NOAA Fisheries 2021; 2022). While it is possible that these whales were entangled in gear from the WA salmon fishery, the entanglement reports included descriptions of lines that are likely not used in this fishery (NMFS Stranding Database 2022). There were no humpback whales reported entangled in unidentified gear or in gillnet gear in Washington in 2022 or 2023 (NOAA Fisheries 2023; NMFS 2024).

Likelihood of Interactions in 2024

This review focuses on the degree of overlap of humpback whales with gillnet fisheries based on the interactions with this gear type discussed above. While there have been reports of interactions with reef net gear in other areas, these have been infrequent and have not happened in the Salish Sea. To determine the likelihood of interactions of humpback whales with Puget Sound pre-terminal (open marine waters) gillnet salmon fisheries in 2024 that are part of this action, we assessed the overlap of humpback whale sightings in recent years and active pre-terminal gillnet fisheries. We assume that the areas with greater overlap will also have a greater likelihood for potential interactions. This analysis further refines the analysis conducted for the last four years of consultations on this fishery. We examined opportunistic public sighting reports of humpback whales to the Whale Museum on Friday Harbor, the Orca Network, a non-profit organization dedicated to raising awareness of whales of the Pacific Northwest, and the OWSN, a non-profit organization based in British Columbia[74], during each year within C-MA (Figure 34) that were open in 2017 through 2022[75]. A total of 3,782 unique sightings[76], representing 6,328 humpback counts, were reported over the six-year period. The number of humpback whale unique sightings reported does not reflect the total number of whales in the Salish Sea due to the opportunistic nature of public sighting reports and the inability to correct for effort with these sources. The location of the sightings were then compared with the LOAFs[77] for the last six seasons to assess areas of overlap between whales and fisheries that are the subject of this Opinion. The humpback whale counts from the unique sighting reports per C-MA by month and year is also represented in Figure 57. The LOAFs group some C-MAs together (i.e. 4B, 5, 6C). To be consistent with these groupings, our analysis similarly grouped sightings within these areas. Other areas were grouped to better reflect the movement of the whales through those portions of the Salish Sea (i.e. C-MAs 13-13K). Each sighting report was given a 100m buffer to capture individuals that were reported at the boundary between the C-MAs and the U.S.-Canada international border as individuals may have been moving between areas or the location was skewed based on the coordinate rounding to group sightings. Humpback whale sightings within Canadian waters, beyond the 100m buffer, were not included in the estimates of humpback whale sightings. Of the 3,782 reports made during the five-year period, 3,505 reports (representing 5,996 humpback counts), were located within C-MAs that are open to pre-terminal

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[74] Sightings from these sources are opportunistic by nature and are not corrected for effort. They demonstrate presence of humpback whales, but they do not demonstrate absence of individuals from an area. Only sightings within U.S. waters were analyzed, excluding all sightings within Canadian waters, except for sightings with an intersecting buffer.

[75] While we have included 2020 in the recent years, it is not yet clear how the COVID-19 pandemic affected the number of opportunistic sightings of humpback whale in the action area. As such, these numbers may underestimate report and whale counts.

[76] 'Unique sightings' in this context mean a sighting of a humpback whale(s) in a specific area of the Salish Sea at a specific time. To remove duplicate sightings, the sighting reports were grouped by date, coordinates rounded to two decimal degrees, and the number of whales reported per sighting. Each of these groupings was treated as a unique sighting. A best estimate on the number of whales for each sighting was included based on the comments included, with sightings that didn't include a comment assigned as 1 whale. These sightings likely still include duplicate reports and represent rough estimates. We did not consider movement of whales between the Marine Areas. They do not provide a total number of humpback whales within the Salish Sea at a given time.

[77] Fisheries may not occur as often as provided for in the LOAF.

gillnet fishing for a portion of the year within the action area.

Table 42. Average number of humpback whale sightings and overlap with active fisheries, including test fisheries, in 2017 through 2022. The values are Reports (Number of Whales). The shading of the cells reflects the anticipated effort for the 2024-2025 season based on the LOAF and previous seasons, with darker shading indicated more effort. Observations in bold signify the month with the highest number of reports and/or the highest number of whales counted per C-MA. Fraser River Panel Control was assumed to allow gillnet fishing. For each month the number of "unique" whale sightings are listed as "reports" and include reports to the Whale Museum, Orca Network, and the OWSN. The estimate of "whale count" (in parentheses) is a total of the number of whales included in each report.

Five Year Average Humpback Whale Reports (Whale Counts)						
C-MA Group	June	July	August	September	October	November
4B, 5, 6C	3(12)	**7(45)**	5(49)	7(40)	2(11)	1(7)
6, 7, 7A	**74(124)**	57(114)	38(56)	29(62)	26(42)	23(36)
9	12(13)	10(12)	12(13)	**13(16)**	**12(16)**	4(5)
10, 10A, 10E	**8(9)**	**7(11)**	6(6)	4(4)	7(9)	3(4)
11, 11A	8(10)	9(10)	3(3)	8(8)	**16(17)**	5(5)
13-13K	8(8)	**10(11)**	1(1)	1(2)	2(2)	4(4)

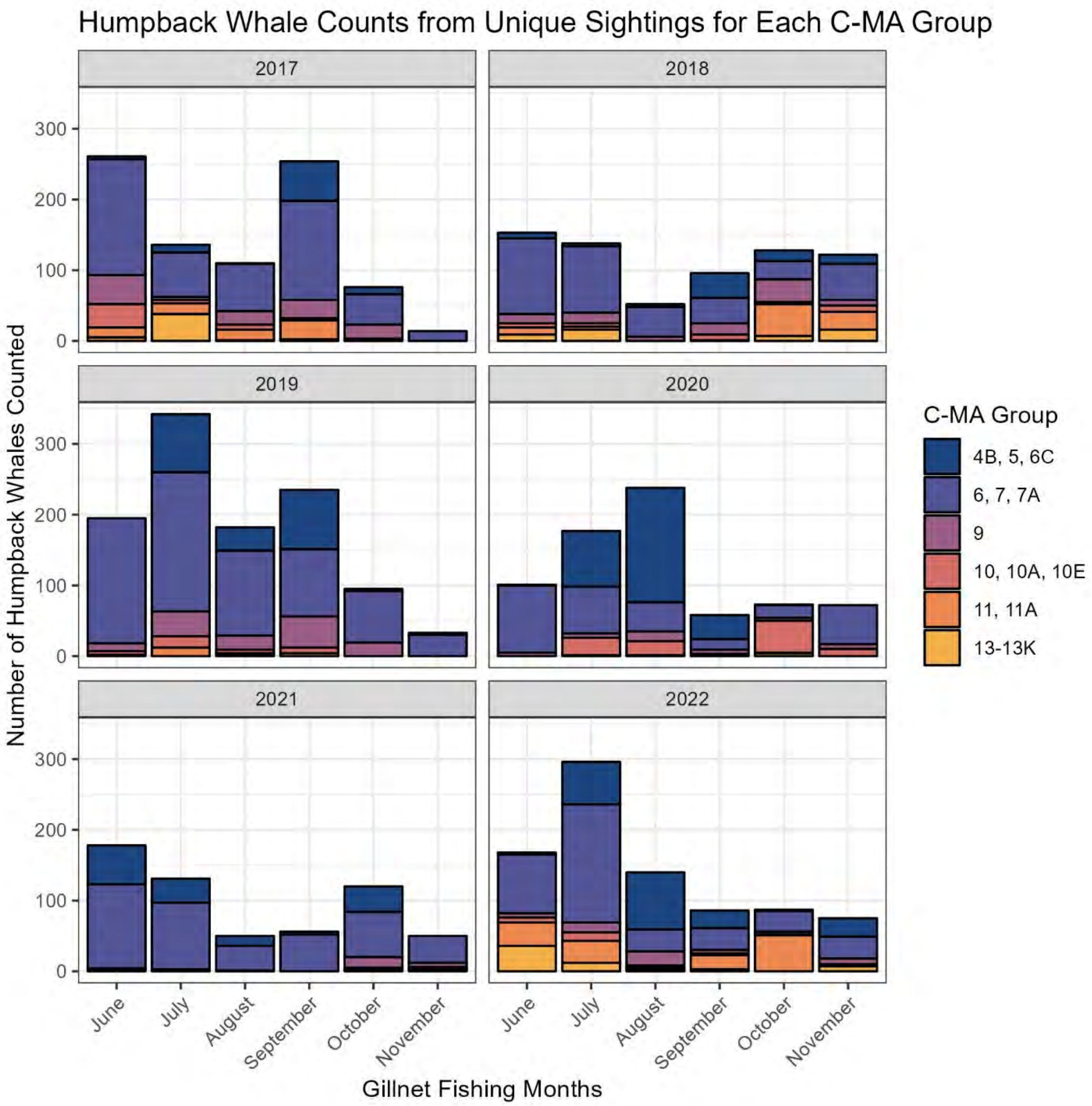

Figure 57. Humpback whale counts from opportunistic unique sightings within commercial marine area (C-MA) groups by month for each recent year (2017 to 2022). Only months with gillnet effort are shown for each year whether or not there is gillnet activity during that month

The Puget Sound salmon gillnet fisheries are generally open for a period of time between June and December, depending on the C-MA. Of the 3,782 unique sightings across the six years, approximately 2,880 (76 percent) unique sightings, representing 5,044 (80 percent) humpback counts, occurred during the months with active gillnet fishing. This indicates that the fisheries overlap with the periods of highest humpback whale sightings depending on the C-MA in each month. Additionally, the observations in bold in Table 42 show that the fisheries often, but not always, overlap with the highest humpback whale use months in each C-MA.

While many of the C-MAs showed overlap, the largest degree of overlap between open gillnet fisheries in U.S. waters and the number of humpback whale unique sightings and counts in U.S. waters occurred near the San Juan Islands (C-MAs 6, 7, 7A) followed by the Strait of Juan de Fuca pre-terminal areas (C-MAs 4B, 5, and 6C). This is likely partially due to a sightings bias with large numbers of people present and whale watching from the San Juan Islands. Other studies have shown the largest congregations of humpback whale sightings and counts in the Strait of Juan de Fuca, including within Canadian waters (NMFS 2019j; Miller 2020). The western portion of the Strait of Juan de Fuca is further away from population centers and humpback whale occurrence in this area is likely underrepresented by public opportunistic sightings. Because the overlaps focused only on humpback whales within U.S. waters, the larger number of sightings in the Canadian portion of the Strait is not reflected, likely underrepresenting the number of whales in the waters of the Strait. The buffering around each sighting attempted to mitigate this issue, but likely still underrepresents the use of the area by humpback whales. The Strait of Juan de Fuca was also the location of the three humpback whale entanglements in gillnet gear that occurred in 2018.

The pre-season estimate of Fraser River sockeye run size for 2024 is the lowest forecast on record (Cunningham 2024). Therefore, we expect more limited drift gill and purse seine fishing effort in these northern C-MAs in the upcoming summer season, which potentially reduces the likelihood of entanglements in gillnet gear. In Table 42 we provide the average number of unique humpback whale sightings and counts for 2017 through 2022 in each C-MA with the anticipated gillnet fishing effort locations for the 2024-2025 season based on the 2024-2025 LOAF. Except for in C-MA group 6, 7, 7A, gillnet fishing by one or both of the co-managers is anticipated to occur during the month with the historically highest number of reports and/or number of whales sighted (these months are indicated in bold). Fishing in C-MA group 6, 7, 7A is proposed for the month with the second most humpback whale reports and number of whales sighted. The degree of overlap in some of the C-MAs may be less than reflected here since they were open for a small portion of a month.

Changing ocean conditions and prey distribution could possibly lead to increased co-occurrence between humpbacks and fisheries in the action area. For example, the potential for overlap between fisheries and humpback whales seen along the West Coast likely increases during periods of ‘habitat compression’. When sea surface temperatures increase, upwelling may become compressed to nearshore areas, causing humpback whales to switch to prey species closer to shore or to inland waters, where the fisheries take place (Santora et al. 2020). Pacific herring and euphausiids are especially important food sources in the Salish Sea (Reidy et al. 2022). Warmer ocean conditions from 2014 to 2019 have been hypothesized to be causing an atypical community of zooplankton (such as krill), a humpback prey species, in the North Pacific (DFO Canada 2018), which may be impacting the distributions of humpback whales. Environmental changes could be impacting the distribution of humpback whale prey, but research into the implications of recent changes in oceanographic conditions is still ongoing. It is not clear yet what the oceanographic conditions will be like in the Salish Sea during the 2024-2025 fishing season.

Humpback whales are expected to overlap with gillnet fishing activities in C-MAs again in 2024 (e.g., C-MAs in the Strait of Juan de Fuca and surrounding the San Juan Islands) based on their return to the Salish Sea in increasing numbers in recent years (Calambokidis et al. 2017; Miller 2020)(Figure 57). Fishing effort in the Strait of Juan de Fuca was relatively high in 2018, when the three humpback whale entanglements attributed to salmon fisheries occurred, due to the large abundance of Fraser sockeye salmon in that year. Because the Fraser River sockeye returns are forecasted to be so low in 2024, we anticipate fishing effort to be much less than the level in 2018, which was open for four intensive days of fishing (Cunningham 2024). However, because humpback whale use of the area is still increasing, WDFW is proposing to conduct entanglement risk minimization measures for the State’s drift gillnet fishery. WDFW will include information on large whale entanglements in the 2024-2025 Salmon Regulations pamphlet and in the “fish friendly” training that is required for new commercial fishing operators (Cunningham 2024). They will also communicate the Be Whale Wise Guidelines with the gillnetters, with an emphasis on slowing to 7 knots or less when a whale is spotted, to help reduce the possibility of vessel strikes.

In addition to these education measures, WDFW has a fish observer program for purse seine and gillnet fishing in C-MAs 7 and 7A that, while not a marine mammal observer program, ensures the gillnet fishery is observed to some degree and would document any entanglements that would occur during the periods of observer coverage (Baltzell 2022). Observers board vessels to examine the catch composition and set characteristics. When not aboard fishing vessels, they are stationed on their own research vessels in an area that allows them to view a net in the water and watch for direct marine mammal interactions with the gear. The observer coverage is prioritized for the purse seine fishery given requirements with release of non-target species like Chinook salmon. The observer coverage for the State’s drift gillnet fishery is only for approximately 5-10 percent of the gillnet effort in C-MAs 7 and 7A (Baltzell 2022).

WDFW also has regulations in place that would help to minimize the risk of entanglement such as a 45 minute soak maximum time and the requirement for gillnets to be attended while they are soaking (Baltzell 2022). Gillnets in the State fishery are only allowed to operate during daylight hours (starting 1.5 hours before sunrise), which limits the risk of vessel strike and the potential of dropping a net on an unseen whale. Gillnets must be marked with two A-3 sized buoys on either end of the cork line and with a single A-1 sized buoy every 50 fathoms of net. One of the two A-3 sized end marker buoys must be legibly marked with the name and gillnet license number of the fisher (WAC 220-354-140). The gear marking requirement may help to identify the fishery if a whale was to become entangled in a gillnet. State commercial fishers are required to report lost nets to WDFW within 24 hours of the loss, which may further help to understand which gear may be entangling a humpback whale. There is an active derelict gear removal program and a toll-free hotline to report lost gear. This may help to narrow down entanglement possibilities if a humpback whale is reported as entangled in a net.

While we cannot quantify the reduction in risk with these minimization measures, we find it is reasonable to conclude that the level of interactions may be less than the number that occurred in 2018 (Cunningham 2024). We therefore estimate that no more than one interaction with these fisheries (i.e., including entanglements and vessel strikes) would be expected in the 2024-2025 fishing season. Based on the past range in severity of entanglements, the one entanglement could result in a non-serious injury, serious injury, or mortality.

Humpback Whale Population-Level Effects

For any individual entanglement, it is likely that the humpback whale would be from either the unlisted Hawaii DPS or the threatened Mexico DPS. A single interaction would most likely be with a whale from the unlisted Hawaii DPS, as they likely have the highest abundance in Washington waters, followed by the threatened Mexico DPS and a very small chance of interactions for Central America DPS whales. As described in the humpback whale Status Section (2.2.1.5), when assessing humpback whale interactions, NMFS will use proportions estimated for humpback whales found off the coast of Washington and South British Columbia for inland waters as well: 6 percent estimated from the Central America DPS and 25% to be from the Mexico DPS. The remaining 69 percent are considered to be from the unlisted Hawaii DPS, consistent with the proportions from Wade (2021). The one interaction estimated for the 2024-2025 fishing season would likely involve one individual from the Hawaii DPS and may include no more than one interaction with individuals from the threatened Mexico DPS. The likelihood of an interaction with individuals from the endangered Central America DPS is very low.

The 18 humpback whale gillnet entanglements that have occurred along the U.S. West Coast from 2007 to 2021 have an average annually assessed M/SI of 0.75 (Carretta et al. 2023a). This means that if a gillnet interaction were to occur, it has a greater than 50 percent chance of resulting in a serious injury/mortality.

In total, it appears that the Mexico and Central America DPSs may have been experiencing relatively high rates of documented M/SI in some portions of their range, however, available data indicate a small number of total fishery interactions or ship strikes are detected or reported in inland waters of Washington compared to other portions of the range. Using the average M/SI per gillnet incident calculated above, the estimated one interaction with Puget Sound salmon gillnet fisheries would account for approximately 9.25 percent of estimated M/SI related to all fisheries interactions for the Central America/Southern Mexico - CA/OR/WA stock (8.1 M/SI per year)[78] and 6.58 percent of the estimated M/SI related to all fisheries interactions for the Mainland Mexico-CA/OR/WA stock (11.4 M/SI per year). The one interaction estimated for the 2024-2025 fishing season would likely involve one individual from the Hawaii DPS and may include no more than one interaction with individuals from the threatened Mexico DPS. The likelihood of an interaction with individuals from the endangered Central America DPS is very low. If there was one M/SI with an individual from the Mexico DPS or the Central America DPS that resulted in M/SI, this impacted individual would represent less than 1 percent of either DPS and would not put the larger population at risk, even conservatively assuming the minimum population estimates from Wade (2021), that likely underestimate the current abundances of these two ESA-listed DPSs to some degree.

In summary, NMFS finds impacts from prey reduction, noise and vessel collisions to be very minor or discountable. The proposed action may result in one interaction between fishing gear and humpback whales within the action area and this could potentially result in a serious injury or mortality, but we have a reasonable expectation that the whale involved would not be from a listed DPS and. The continually increasing presence of humpback whales in inland WA waters, especially during periods of overlap with Puget Sound fisheries, may cause similar levels of interactions to those in previous years. However, the minimization measures described above and the lower anticipated fishing effort due to the low forecast for the Fraser sockeye run would reduce the risk of interactions between fishing gear and humpback whales. Based on the proportions of the DPSs in the inland waters, the expected interaction would most likely impact either the unlisted Hawaii DPS or the threatened Mexico DPS, and any impacts to the Central America, which are very unlikely, or Mexico DPS would be extremely small when compared to the population of the DPS. We acknowledge uncertainty around which DPSs are found within the action area, however, the likelihood of the single interaction involving a Central America DPS whale is very low even accounting for this uncertainty.

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

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[78] While the DPS designations do not fully match the associated stocks, they are similar and the M/SI estimates for the associated stocks are the best available information we have to estimate impacts to the DPSs.

the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described earlier in the discussion of environmental baseline (Section 2.4).

Some types of human activities that contribute to cumulative effects are expected to have adverse impacts on populations and PBFs, many of which are activities that 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. Within the freshwater portion of the action area, non-Federal actions are likely to include human population growth, water withdrawals (i.e., those pursuant to senior state water rights), and land use practices, the effects of which are described in the environmental baseline. In marine waters within the action area, state, tribal, and local government actions are likely to be in the form of legislation, administrative rules, or policy initiatives, shoreline growth management, and resource permitting. Private activities include continued resource extraction, vessel traffic, development, and other activities which contribute to poor water quality and continued vessel and construction noise in the freshwater and marine environments of Puget Sound. Although these factors are ongoing to some extent and likely to continue in the future, past occurrence is not a guarantee of a continuing level of activity. That will depend on whether there are economic, administrative, and legal impediments (or in the case of contaminants, safeguards). Therefore, NMFS finds it likely that the cumulative effects of these activities will have adverse effects commensurate to those of similar past activities, as described in the Environmental Baseline. These effects may occur at somewhat higher or lower levels than those described in the Baseline.

Activities occurring in the Puget Sound area were considered in the discussion of cumulative effects in the opinion on the Puget Sound Harvest Resource Management Plan (NMFS 2021f) 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 2008d), Washington State Department of Transportation Preservation, Improvement, and Maintenance Activities (NMFS 2013a), the National Flood Insurance Program (NMFS 2008f), the Elwha River Fish Restoration Plan (Ward et al. 2008), and the Howard Hansen Dam Operations and Maintenance (NMFS 2019f; 2020d; 2022b); see actions discussed in the Environmental Baseline for Puget Sound Chinook salmon (Section 2.4.1). 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.

Multiple non-federal activities are reasonably certain to occur that impact SRKW interactions with vessels in the Salish Sea. These additional actions by Washington State, Canada, and other partners are designed to further reduce impacts from vessels on SRKW by limiting the potential for interactions and also address other threats to SRKW.

On March 14, 2018, Washington Governor's Executive Order 18-02 was signed ordering state agencies to take immediate actions to benefit Southern Resident killer whales and established a Task Force to identify, prioritize, and support the implementation of a longer-term action plan need for SRKW recovery. The Task Force provided recommendations in a final Year 1 report in November 2018[79] 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) and 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. 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.

On November 8, 2019, the task force released its Year 2 report[80] 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, which is discussed in the environmental baseline.

The state 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. These measures won't improve prey availability in the near term, but they are designed to improve conditions in the long term. Progress towards implementation of recommendations from the task force can be found here: https://orca.wa.gov/, documenting ongoing work and funding in relation to all major threats to improve conditions over the long-term.

As part of implementation of actions recommended by the task force, WDFW has taken a number of actions in recent years and will continue to implement ongoing efforts, including (from Cunningham (2024)):

1. Beginning in 2021, WDFW implemented its new commercial whale watching license program. The associated rules around the watching of SRKW are designed to increase the number of foraging hours without commercial whale-watching presence. In 2023, WDFW continued efforts to promote and enforce state vessel regulations, including restrictions for general vessels and those associated with the commercial whale watching license program. Thirty-five businesses (U.S. and Canadian) were licensed for commercial whale watching in 2023, with 198 vessels between them. In total, 58 motorized vessel operators or kayak guides were licensed. License fees were waived for 2021 and 2022 to alleviate some of the burden

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[79] Available here: https://www.governor.wa.gov/sites/default/files/OrcaTaskForce_reportandrecommendations_11.16.18.pdf

[80] Available here: https://www.governor.wa.gov/sites/default/files/OrcaTaskForce_FinalReportandRecommendations_11.07.19.pdf

caused by COVID-19. In 2023, license fees were no longer waived and returned to legislatively directed pricing.

   a. Commercial vessels are now permitted to approach SRKW at less than a half nautical mile during two, two-hour windows each day from July through September. Only three commercial vessels can approach within a half-mile from SRKW at one time, with an exclusion from approaching a group with a calf under one year old or an otherwise vulnerable, e.g., pregnant or malnourished, individual. Thirteen SRKWs were exempt from commercial viewing in 2023, including two calves, ten deemed vulnerable due to body condition and one due to late-stage pregnancy. Since the exemption includes those individuals and any whales within a mile of them, commercial viewing of SRKW was greatly reduced. Finally, state regulations formalized the no-go zone on the west side of San Juan Island for commercial whale-watching vessels, except for a one hundred-yard corridor for commercial kayak tours to operate.
   b. Additionally, 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 science and results from public survey and focus group engagement. The analysis of all input resulted in WDFW's recommending an expansion of the buffer distance for all vessels to 1,000 yards from SRKWs. That recommendation became Senate Bill 5371, which has now been signed into law by Governor Jay Inslee. The law will be in effect as of January 2025, during this consultation period. In addition to requiring a 1,000-yard buffer, the bill directs WDFW to amplify communications and outreach to enhance public awareness and compliance with the regulations. To satisfy that requirement, WDFW convened the Orca Regulations Communications Advisory (ORCA) Group, which consists of thirteen representatives from various stakeholder groups including recreational boaters, non-governmental organizations, tribes, agency partners, and the commercial whale watching industry. The first meeting of the ORCA Group took place on March 13, 2024, with subsequent meetings taking place bi-monthly through September 2024. The existing laws (commercial whale watch license, daily whale watching time windows, exemption for vulnerable whales, speed and buffer distance, etc.) will be in effect for the interim year.

2. Continued implementation and enforcement of the 2019 restrictions on speed and buffer distance around SRKW for all vessels. WDFW enforcement conducts coordinated patrols with the U.S. Coast Guard, NOAA Office of Law Enforcement, San Juan County Sheriff's Office, Sound Watch, and other partners year-round. These patrols include monitoring and enforcement of fisheries regulations and the MMPA related to vessel operation in the presence of marine mammals throughout Puget Sound. Patrols in the marine areas of southern, central and northern Puget Sound, with particular emphasis in MA7 are specifically targeted to enforce regulations related to SRKW. These patrols are increased in intensity and intervals at times calves and/or sick or distressed individual orcas are present. In 2023, WDFW continued efforts to promote and enforce state vessel regulations, including restrictions for general vessels and those associated with the

commercial whale watching license program. Their Enforcement team covered six days/week of whale patrol, while NOAA OLE and USGC covered the remaining day. There were 59 dedicated SRKW protection patrols, comprised of 478 Enforcement vessel hours, 580 officer hours, 110 recreational vessel contacts, and 40 commercial whale watching vessel contacts. In 2023, WDFW Police conducted 59 SRKW Protection patrols. These patrols yielded 316 contacts resulting in 28 warnings and 1 citation issued for distance regulation violations in the presence of SRKWs and similar levels of enforcement activities are anticipated in 2024 (6 days per week during the summer).

WDFW is able to provide an increased enforcement and monitoring presence throughout the year via a combination of funds granted through a Joint Enforcement Agreement (JEA) with NOAA Fisheries, ESA Section 6 grant funding from NOAA, as well as additional State general funds. Maintaining the JEA is critical to funding WDFW enforcement efforts that align with NOAA Fisheries priorities.

3. WDFW has increased communications efforts to promote messaging about Be Whale Wise guidelines and regulations and Southern Resident killer whale recovery. The Department is continuing to share Be Whale Wise messaging with boaters in the greater Puget Sound area through targeted and organic social media, traditional online and print advertising, video slots on streaming services, and earned media coverage. Other ongoing communications tactics include print materials including the Whale Wise promotional decal, on-the-ground signs and continued collaboration with Be Whale Wise partners in Washington and Canada. The Department has also developed lesson plan materials and provided live “career connection” style events.

4. Promotion of the Whale Report Alert System (WRAS) in Puget Sound, developed by the Ocean Wise Research Institute, which uses on-the-water reporting to alert large ships when whales are nearby. Reporting SRKW to WRAS is required for commercial whale watching license holders, and WDFW has trained on-the-water staff like enforcement personnel to contribute sightings as well.

5. Washington State Department of Commerce, Washington State Ferries, and the Puget Sound Partnership are working with the Ports, NOAA, and many others to pilot Quiet Sound through the Governor’s Maritime Blue alliance. Funding for Quiet Sound was secured in the 2021 state legislative session, and the program launched and had the first meeting of its Leadership Committee in January of 2022. Beyond its Leadership Committee, Quiet Sound includes five topic-area working groups to lead projects and programs on vessel operations, incentives, innovations, notification, monitoring, evaluation, and adaptive management. In 2022 and 2023, it created a voluntary slowdown trial and continued its work to *“improve and support the Whale Report Alert System.”* WDFW has representation on Quiet Sound’s Evaluation and Adaptive Management Work Group and plans for any 2024 trials will be informed by the monitoring and evaluation data.

6. Continued promotion of the voluntary “No-Go” Whale Protection Zone along the southwest side of San Juan Island in R-MA and C-MA7 for all recreational vessels (Figure 58). The geographic extent of this area stretches from Eagle Point in the southeast to Mitchell Point in the north and extend offshore ¼ mile between these locations and ½ mile centered on Lime Kiln Lighthouse. This area is consistent with that already promoted by San Juan County, proposed by NOAA Fisheries as *Alternative 4* in the 2009 Environmental Assessment on New Regulations to Protect SRKWs from Vessel Effects in Inland Waters of Washington, and represents the area most frequently utilized for foraging and socialization in the San Juan Islands. As mentioned, the area is closed to commercial whale watching activities, save a hundred-yard corridor along the shoreline for commercial sea kayak tours. The new 1,000 yard vessel distance requirement would span the distance of the voluntary no-go zone when the whales are present, beginning in January 2025.

Figure 58. An approximation of the Voluntary “No-Go” Whale Protection Zone, from Mitchell Bay to Cattle Point (Shaw 2018a). See https://wdfw.wa.gov/fishing/locations/marine-areas/san-juan-islands

Canada has an active recovery program for SRKW and coordinates with NOAA Fisheries. A joint DFO-NOAA Prey Availability Workshop was held in November 2017 that focused on identifying short-term management actions that might be taken to immediately increase the abundance and accessibility of Chinook salmon. Priority management actions identified in the workshop that should be considered included 1) targeted, area-based fishery management measures designed to improve Chinook salmon availability, and 2) reducing acoustic and vessel disturbance in key Southern Resident foraging areas. There was little support for broad scale coast-wide reductions in fishing to increase the prey available to the whales, which was consistent with the findings of the previous transboundary panel (i.e. Hilborn et al. 2012). In 2019-2023 Canada implemented conservation actions, including area-based fishery closures, interim sanctuary zones, and both voluntary initiatives and mandatory vessel regulations[81] as part of interim orders to protect the whales and for the 2021, 2022 and 2023 closures, certain specific area fishery closures were triggered by the first sighting of whales in the area (in the Southern Gulf Islands)[82]. For 2024, similar actions (fishery closures including closures triggered by SRKW presence, sanctuary zones, vessel regulations) will be implemented with modifications to the specific areas being closed.

There are several state and industry lead efforts underway to reduce impacts from entanglements and vessel activities. While many of these efforts are focused on SRKW, they also have benefits for other marine mammals, including ESA-listed humpback whales. 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. The Be Whale Wise guidelines set viewing distance recommendations for all marine mammals, including large whales, and are promoted broadly to reduce harmful interactions with marine mammals within the Salish Sea, including humpback whales, as discussed in Section 2.5.5.

The changes in whale watching practices associated with SRKW may result in increased viewing of humpback whales in the Salish Sea. While there is Be Whale Wise guidance for viewing humpback whales, these are recommendations and not regulations. Increased viewing of whales may result in increased traffic around individuals.

The Quiet Sound 2022-2023 trial slowdown involved a commercial slowdown trial in Admiralty Inlet and North Puget Sound from October 24, 2022 to January 12, 2023. A report on the success of the trial indicated that 70% of vessel transits through the voluntary slowdown area decreased their speed, and 53% of the transits achieved the proposed speed targets. During the slowdown median broadband sound levels decreased by 2.8 decibels, which is equivalent to a 45% reduction in sound intensity, and underwater noise levels were reduced in the frequencies that SRKW use to communicate and hunt. Of the 80 days the slowdown was in place, SRKW were present in the region for 36 days, or 45% of the time. A similar voluntary vessel slowdown occurred from October 12, 2023 to January 12, 2024. The results of this slowdown are forthcoming. While this trial was intended to reduce impacts from commercial shipping to SRKW, it may have also resulted in decreased acoustic and physical impacts to humpback whales. Quiet Sound may also pursue other projects that are intended to reduce the disturbance and vessel strike risk to humpback whales in other portions of the Salish Sea in the future. At this

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[81] https://www.pac.dfo-mpo.gc.ca/fm-gp/mammals-mammiferes/whales-baleines/srkw-measures-mesures-ers-eng.html

[82] https://www.canada.ca/en/transport-canada/news/2022/04/the-government-of-canada-outlines-2022-measures-to-protect-southern-resident-killer-whales.html

point it is unclear if such projects will occur in the time frame of the fisheries analyzed in this opinion.

The U.S. Coast Guard recently launched the Cetacean Desk within the Vessel Traffic Service in Sector Puget Sound. The Cetacean Desk will collect sighting reports from professional mariners and putting those reports into Ocean Wise's WRAS database. The Cetacean Desk is also promoting WRAS and for professional mariners to sign up for text alerts of whale sightings in areas that they are transiting through. These efforts will help to reduce vessel impacts on both SRKWs and humpback whales while within the Salish Sea.

In 2023, Kitsap Transit identified Pier 48 as their preferred location to expand their passenger-only ferry operations in downtown Seattle. These ferries operate as speeds of up to 38 knots and current routes travel through areas that humpback whales also utilize (Kitsap Transit 2023). An increase in the number of trips by these fast-moving ferries may result in an increased risk of a vessel strike. This type of ferry has already struck a gray whale in Puget Sound in 2021 (NMFS Stranding Database 2022).

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in assessing the risk that the proposed action poses 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 designated or proposed critical habitat as a whole for the conservation of the species.

2.7.1 Puget Sound Chinook

NMFS describes its approach to the analysis of the effects of the proposed actions to Puget Sound Chinook salmon in broad terms in Section 2.1, and in more detail as NMFS focuses on the effects of the action in Section 2.4.1. The approach incorporates information discussed in the Status (Section 2.2.1.1), Environmental Baseline (Section 2.4.1), and Cumulative Effects (Section 2.6) sections. In the Effects analysis, NMFS first analyzes the effects of the proposed actions on individual salmon populations within the ESU using quantitative analyses where possible and more qualitative considerations where necessary. The analyses take into account the impacts of past harvest, hatchery and habitat actions discussed in the Environmental Baseline as well as larger-scale marine survival conditions and fishery management imprecision. The analyses also takes into account the effects of the actions discussed in the Cumulative Effects such as Puget Sound environmental conditions affected by continuing human impacts. Here, in this Integration and Synthesis, risk to the survival and recovery of the ESU from the proposed action is determined by assessing the distribution of risk across the populations within each major geographic region and then accounting for the relative role of each population to the viability of the ESU. In addition, to evaluate the effects of the proposed actions on the ESU, we consider the effects of the actions combined with the effects of the activities in the Environmental Baseline and Cumulative Effects Sections of the opinion, as well the status of the species and broader environmental conditions.

The analysis in this section, leading to our conclusion regarding jeopardy, is presented in two stages. In the first stage, potential areas of concern or risk are identified by population, within each region, based on the effects of the actions to the populations, relative to their critical and rebuilding escapement thresholds and RERs. We then evaluate the likelihood of that concern or risk occurring and consider the practical influence Puget Sound harvest (proposed action) may have on the potential concern or risk (i.e., what would be the implication of the action not taking place for the population?). The second stage of the analysis considers the results of the population-level analyses (first stage) at the region and ESU level, as described in Section 2.5.1, above). It analyzes all of the populations in each region, with particular attention to those identified to be at higher risk in stage one. NMFS considers the factors and circumstances that mitigate the risks identified in the first stage leading to conclusions regarding the effects of the action for each region and the ESU as a whole.

The results of our assessment of the risks to individual populations in the Effects analysis highlight the importance of habitat actions and hatchery conservation programs for the preservation and recovery of individual populations specifically. The importance of these actions carries forward to our consideration of the risks from the proposed action to the ESU in general. The status of many of the populations in the ESU is largely the result of reduced productivity in the wild from habitat loss and degradation and from other sources of human induced mortality. Our analysis suggests that it is unrealistic to expect to achieve substantive increases in Chinook population abundance and productivity and population viability through harvest reductions alone. Without substantive progress on actions in other areas most affecting the survival and productivity of these populations. Recovery of the Puget Sound Chinook ESU depends on implementation of a broad-based program that addresses the identified major limiting factors of decline.

The analysis of the effects of the proposed action on the Puget Sound salmon ESU is unavoidably complex. It involves 22 populations spread across five geographic regions. NMFS uses a variety of quantitative metrics (e.g., RERs, critical and rebuilding thresholds, measures of growth rate and productivity) and qualitative considerations (e.g., PRA designation, whether a population is essential to a recovery scenario, the need for and status of a long-term transitional adaptation and recovery plan where the indigenous population has been extirpated, the difference the proposed fisheries would make in terms of returning spawners, and the mitigating impacts of hatchery production and harvest changes) in its assessment of the proposed actions. The analyses take into account the impacts of past harvest, hatchery and habitat actions discussed in the Environmental Baseline as well as larger-scale marine survival conditions and fishery management imprecision. The analysis also makes assumptions about the effects of the actions discussed in the Cumulative Effects such as Puget Sound environmental conditions affected by continuing human impacts. None of these factors in isolation are dispositive or dictate a particular conclusion. They are all factors that inform NMFS' conclusions with respect to the ESU and are considered comprehensively. These are discussed in Sections 2.4.1 (Environmental Baseline) and 2.5.1 (Effects of the Action).

The Integration and Synthesis Section summarizes and explains the considerations that lead to NMFS' opinion on the proposed actions. In the following Section, NMFS summarizes the considerations taken into account for each population in a discussion that is organized by Region. This regional summarization is synthesized so that NMFS can determine whether the proposed action poses jeopardy at the ESU level as the statute requires.

For 2024, with the proposed Puget Sound fisheries, the Chinook populations in the Georgia Basin Region are forecasted to have natural-origin escapements below their critical escapement threshold, for the North Fork Nooksack Chinook population, and above the critical threshold for the South Fork Nooksack Chinook population. The long-term average natural-origin escapements have been near (NF) and below (SF) critical escapement thresholds (Table 5) which is cause for concern given their role in recovery of the ESU (both populations must reach viability for recovery). Productivity estimates for the North Fork continue below replacement, while the South Fork population has risen above replacement in recent years (Table 5). The majority of harvest affecting these populations occurs outside of Puget Sound in fisheries in Canada and Alaska (Table 24). Impacts from the proposed actions in Puget Sound fisheries are low (<8%), and our analysis indicates that further harvest reductions in 2024 Puget Sound fisheries would not measurably affect the risks to viability for either Nooksack population. This result is consistent with information that indicates system productivity is low and that past harvest constraints have had limited effect on increasing escapement of returning natural-origin fish. There are conservation hatchery programs in place for each Nooksack population and when the programs supplementation is taken into account, total (natural origin and hatchery) escapement trends are increasing for both the North Fork Nooksack and stable for the South Fork Nooksack populations (Table 6). Growth rates for natural-origin recruitment are stable and negative for the North Fork and South Fork populations, respectively. Growth rates for natural-origin escapement are stable and negative for the North Fork and South Fork populations, respectively (Table 6). The South Fork long-term growth rates (Table 6) do not yet fully account for the abundance and overall productivity increases seen in the recent years, based on the positive effects of the South Fork conservation hatchery program. A similar situation exists for the North Fork Nooksack population which has experience declines in natural-origin abundance in recent years. The two conservation hatchery programs are designed to buffer demographic risks and conserve genetic diversity in the populations, and are key components in restoring viability of the Nooksack early Chinook populations. As described in Section 2.4.1, Environmental Baseline, the two Nooksack conservation hatchery programs are part of the Critical Stocks Program, with ongoing funding associated with the PST, as a measure to bolster the status of populations that are impacted in PST fisheries and critical to recovery of the Puget Sound Chinook ESU. Measures to minimize fishery impacts to Nooksack early Chinook are part of the proposed actions. The proposed Puget Sound fisheries will not have negative implications for the long-term viability and recovery potential of the Georgia Basin Region's Chinook populations while measures being implemented to address the long-term habitat capacity and productivity of the Region's watersheds, necessary to achieve recovery, are being implemented.

For the Whidbey/Main Basin Region, the effects of the proposed Puget Sound fishery actions in 2024 are consistent with the recovery plan guidance of not impeding achievement of viability for two to four population representing the range of life histories displayed in this Region including those specifically identified as needed for recovery of the Puget Sound Chinook ESU. The Whidbey/Main Basin Region is a stronghold of natural-origin Chinook production in the ESU. Most populations in the Region are doing well relative to their rebuilding escapement thresholds and the effects of the action on seven of ten of the populations is below their RERs with three exceeding their RER (Lower Skagit, Upper Sauk, and South Fork Stillaguamish) by 1.3, 1.0, and 9.7%, respectively. NMFS considers the proposed fisheries to present a low risk to populations where their estimated impacts are less than or equal to the RERs. Collectively, the populations in this Region represent a diversity of healthy populations in the region as a whole. The overall stable or increasing total escapement trends, generally stable growth rates in natural-origin escapement, and, in particular, the relatively robust status of most of the Region's populations compared with their rebuilding escapement thresholds (Table 5) should mitigate any risk that results from exceeding the RERs in 2024 for the three populations. Five of the 10 populations will exceed their rebuilding escapement thresholds for natural-origin adults in 2024 including the Upper Sauk. Although the South Fork Stillaguamish population is forecast to be below the critical escapement thresholds for 2024, the population is PRA Tier 2 and its life history type is represented by other healthier populations in the region for which fishery rates are expected to be below their RERs (Table 24). The majority of harvest affecting the populations in this region occurs outside of Puget Sound in fisheries in Canada and Alaska (Table 24). Exploitation rates in 2024 Puget Sound fisheries are expected to be relatively low across the four management units in this Region (6.0%-14.8%) (Table 23). If the proposed actions were not to occur in 2024, we estimate that an additional 4 natural-origin spawners would return to the South Fork Stillaguamish River, which would not provide sufficient additional spawners to change the status or trends of this population from what would occur without the Puget Sound fisheries. Growth rates for natural-origin escapement are higher than growth rates for natural-origin recruitment for most populations within the Region, including the South Fork Stillaguamish population (Table 6). Meaning that the constraints in fisheries are likely contributing to stabilizing escapement, dampening the declining trends in overall abundance, thereby reducing demographic risks associated with low population size. The proposed fisheries will not have negative implications for the long-term viability and recovery potential of the Whidbey/Main Basin Region's Chinook populations while measures to address the long-term habitat capacity and productivity of the Region's watersheds, necessary to achieve recovery, are being implemented.

For the Central/South Sound Region, implementation of the proposed 2024 fisheries is consistent with the recovery plan guidance of not impeding achievement of viability for two to four populations representing the range of life histories displayed by the populations in that Region including those specifically identified as needed for recovery of the Puget Sound Chinook ESU (White River and Nisqually). Most populations in the Region are well above their critical escapement thresholds and doing relatively well compared to rebuilding escapement thresholds. However, harvest impacts on all but one population (White River) are anticipated to exceed their

RERs in 2024, and the proposed Puget Sound fisheries contribute substantially to the overall exploitation rates for the populations in this region.

The risks associated with exceeding the RER in the 2024 fishing year should not impede achievement of viability, over the long term, by the Nisqually, Puyallup, Green, Sammamish, and Cedar River populations. The White and Nisqually populations are in Tier 1 watersheds and essential to recovery of the ESU. While the proposed 2024 actions present a low risk to the White River, as they will be below the population's RER, they could present a risk to the Nisqually. For the Nisqually population, the risk presented by the proposed fisheries on the viability of the population is balanced by four additional considerations: (1) the extirpated status of the indigenous Chinook population, (2) the increasing trend in total escapement and stable growth rate for natural-origin escapement, (3) the natural-origin escapement anticipated in 2024 exceeds the critical threshold, substantially, reducing short-term risk, and (4) the implementation of the long-term transitional strategy for the population, which began in 2018 and will continue in 2024 (Mercier 2024). The additional actions being taken by the co-managers, described in Section 2.5.1.2, will also help improve the status of the Nisqually Chinook population. Natural-origin returns for the Green River have substantially increased in recent years and while the fisheries in 2024 will again result in natural-origin spawner escapement well above the critical escapement threshold, the predicted natural-origin spawners will be lower than the recent year levels and below the rebuilding escapement threshold (1,047 vs 1,700). Growth rates for natural-origin escapement are consistently higher than growth rates for natural-origin recruitment in the Green River. This indicates that on average sufficient natural-origin fish are escaping the fisheries to maintain or increase the number of natural-origin spawners from the parent generation, providing some stabilizing influence for natural-origin escapement and reducing risks to the viability of the population. Average natural-origin escapement for the Cedar River population is above its rebuilding escapement threshold and natural-origin escapement in 2024 is again expected to be above its rebuilding escapement threshold and trends for escapement (total) and natural-origin growth rates are increasing and stable, respectively. Average natural origin escapement for the Puyallup population is well above the critical threshold and near to its rebuilding escapement threshold and total escapement in 2024 is expected to be well above the rebuilding escapement threshold. As with the Green River above, the trends for total natural escapement are stable and the Puyallup growth rates for natural-origin escapement are higher than growth rates for natural-origin recruitment indicating that fisheries are providing a stabilizing influence to natural-origin abundance and productivity thereby reducing demographic risks.

The Sammamish River population may experience some increased risks to the pace of adaptation of the existing local stock as a result of fisheries impacts exceeding the applicable RERs. However, the increasing trends in total escapement and stable growth rate for natural-origin recruitment in the Sammamish should mitigate the increased risk that could result from fisheries exceeding the RER. For the Sammamish population, the additional 50 natural-origin spawners if Puget Sound fisheries were eliminated in 2024 might increase the abundance over the critical abundance threshold, but this would not would not substantively change the overall status or trends of the population given the very low productivity of the system. The Sammamish population is a PRA Tier 3 and its life history and Green River genetic legacy are represented by other populations in the Central/South Sound Region. The indigenous Chinook population has been extirpated, and potential improvement in natural-origin production is limited by the existing habitat.

In summary, given the information and context presented above, the fishing regime represented by the proposed actions for 2024 should not impede achievement of viability for the six populations in the Region in 2024; including the two populations that are essential to the recovery of the Puget Sound Chinook ESU (White River and Nisqually). Therefore, implementation of the proposed 2024 fisheries is consistent with the recovery plan guidance that two[83] to four populations representing the range of life histories displayed by the populations in that Region reach viability and, as such, the proposed fisheries will not have negative implications for the long-term viability and recovery potential of the Central/South Sound Region's Chinook populations, while measures are being implemented to address the long-term habitat capacity and productivity of the Region's watersheds, necessary to achieve recovery.

The poor status of the populations in the Hood Canal Region, given their role in recovery of the ESU, is cause for concern. The combination of declining growth rates, low productivity, and low levels of natural-origin escapement, relative to critical and rebuilding thresholds, suggest these populations are at high risk for survival and recovery. However, the indigenous populations no longer exist and the focus for recovery of Chinook salmon in the Skokomish River is on a long-term transitional strategy to rebuild one or more locally adapted Chinook populations that are more representative (run-timing life history) of the historical population in that watershed. The co-managers' actions, inclusive of the proposed 2024 fisheries, are consistent with this longer term, transitional strategy for recovery of the Skokomish Chinook salmon population. The trend in total-natural escapements is stable, and the forecasted total, natural escapement in 2024 is well above the rebuilding threshold, which should mitigate near term demographic risk to the population, i.e., not increasing risks to the extant, non-indigenous population. The co-managers have implemented additional, long-term hatchery-related actions to bolster recovery of the population (Skokomish Indian Tribe and WDFW 2010; Redhorse 2014a; Grayum and Unsworth 2015a; Unsworth and Grayum 2016; Skokomish Indian Tribe and WDFW 2017; Unsworth and Parker 2017; Shaw 2018a; Norton 2019a; Mercier 2020; 2021a; 2022; 2023; 2024). Conservation hatchery programs for spring Chinook and late-time fall Chinook were initiated in the Skokomish River in 2014 with further actions taken in 2015 and 2016 to refine the implementation plan for the late-timed program. Preliminary estimates of the performance of the late-timed fall Chinook program, through return-year 2021 show that the program's releases, from 2015-2019 release years are producing adult recruits back to the Skokomish River, with over 6,500, total CWT recoveries in the system at the George Adams Hatchery on the NF Skokomish and Vance Creek spawning grounds (Skokomish Indian Tribe and WDFW 2023). The 2017 update of the Skokomish Recovery Plan described a myriad of on-going habitat restoration and protection activities designed to contribute to recovery of the population. The fact that growth rates in natural-origin escapement exceed those for recruitment indicates (Table 6)

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[83] The Central/South Sound Region contains two life history patters—spring run and fall run timing. There is only one spring run population, the White River.

that the current fisheries management provides a stabilizing influence to trends in abundance and productivity thereby reducing demographic risks, even to the extant, non-indigenous population.

The Skokomish population has been managed subject to a 50% exploitation rate ceiling since 2010. The ceiling was exceeded several times during the first five years of implementation (Table 23). Substantial changes in management were made in 2015-2017 to address the exceedances. More recent assessments through 2020 show that, since the review and adjustments were made, there has been only one exceedance since 2015 (Table 23). The fisheries proposed by the co-managers for 2024 are expected to result in a total exploitation rate of 49.7% (Table 24). The critical status of the Skokomish Chinook population underscores the importance of meeting the exploitation rate objective such that fisheries do not represent more of a risk than is consistent with the transitional strategy to recovery. Progress of the long-term transitional strategies in the Skokomish basin will continue to be closely watched. Continued adaptive management and implementation of the strategies in the watershed, including the additional management measures described in the proposed actions—spring and late-fall hatchery programs and reduction of harvest during the late-timed fall Chinook period, will be key to recovery of the populations in the Skokomish River. With the actions being taken to ensure the actual exploitation rate does not exceed the objective, and the other factors discussed above, exceeding the RER in 2024 should not impede the long-term persistence of the extant Skokomish Chinook population, while enabling establishment of spring and late-fall Chinook populations to contribute to recovery.

The Mid-Hood Canal Rivers Chinook population is considered essential for recovery of the Puget Sound Chinook ESU. The total escapement for 2024 is expected to be well below the critical abundance threshold. However, the available information indicates further constraints on 2024 Puget Sound fisheries would not measurably affect the risks to viability for the population, amounting to at most one additional spawner that would return to the Mid-Hood Canal rivers population. In addition, to the extent an indigenous population existed in the Mid-Hood Canal watersheds, it has been extirpated (see Section 2.5.1.2 *Hood Canal Region*), and the general characteristics of the current Mid-Hood Canal Rivers population, including genetic lineage, life history, and run timing, are also found in the extant Skokomish River Chinook salmon population. In this context, the proposed 2024 Puget Sound fisheries will not change the status of the Mid-Hood Canal Rivers population in 2024 and would not meaningfully change the trend of the Mid Hood Canal population, if not implemented. Taken together, the proposed 2024 fisheries will not impede the long-term survival and viability of the Hood Canal Region’s Chinook populations, while measures being implemented to address the long-term habitat capacity and productivity of the Region’s watersheds, necessary to achieve recovery, are being implemented.

In the Strait of Juan de Fuca Region, the Dungeness population is expected to be above the critical threshold for natural-origin spawners in 2024. The Elwha population is not expected to be above its critical threshold. Total fishery impacts on both are expected to exceed their RERs in 2024. However, impacts from the proposed actions in Puget Sound fisheries are very low (<3.5%) and analysis suggests further harvest reductions in 2023 Puget Sound fisheries would not measurably affect the risks to viability for either population, only returning two additional natural-origin spawner to each of the Elwha and Dungeness rivers. When hatchery-origin spawners from the two conservation programs are taken into account, total escapement in the Dungeness is anticipated to be well above its rebuilding threshold and the total escapement in the Elwha is expected to greatly exceed the (more than 2x) rebuilding threshold. The trend in total escapement is increasing for the Dungeness, indicating that the conservation program is increasing overall abundance. However, the growth rate for natural-origin recruitment is negative for the Dungeness (Table 6). The growth rate for natural-origin escapement and recruitment are both strongly negative for the Elwha, which is not surprising given the historically poor conditions in the watershed. However, the total natural escapement trend is positive for the Elwha, indicating that the conservation hatchery program is increasing the overall abundance of spawners in the watershed (Table 6). For both populations, the growth rates for escapement are higher than the growth rates for recruitment, which may indicate that recent fishery rates are having a stabilizing impact on the population abundance, lowering demographic risk. The conservation hatchery programs operating in the Dungeness and Elwha Rivers are key components for recovery of these populations and buffer demographic risks and preserve the indigenous genetic legacies of the salmon populations as degraded habitat is recovered. Projects have been implemented to improve flow conditions and to contribute to restoration of the flood plain for the Dungeness River population. Dam removal on the Elwha River was completed in 2014 and a full-scale restoration and recovery program is now underway for 70+ miles of habitat which is expected to substantially improve the long-term status for that population. However, the work in both of these watersheds will likely take years to decades to affect the long-term recovery trajectory for these populations. Management of harvest and hatchery programs that stabilizes and conserves these populations and maximizes the current available habitat is key to conserving the populations to take advantage of the recent access to expanded habitat (Elwha) and future restoration of existing habitat (both basins). The proposed fisheries in Puget Sound will not have negative implications for the long-term viability and recovery potential of the Strait of Juan de Fuca Region’s Chinook populations, while measures to address the long-term habitat capacity and productivity of the Region’s watersheds, necessary to achieve recovery, are being implemented.

In addition to Puget Sound harvest activities in the Proposed Action, we have evaluated fishery-related research effects to Puget Sound Chinook in Section 2.5.6, describing and assessing the anticipated levels of take associated with each of these studies. This assessment found that the research-related effects will not increase risk to the status of any of the individual populations affected by these projects. These effects are quite small, particularly to adult Chinook, and will not meaningfully add to the effects of the fisheries.

In summary, under the proposed action, the combined ocean and Puget Sound exploitation rates for the 2024 fishing year, 8 of 22 total populations (Lower Sauk, , Upper Cascade, Suiattle, Upper Skagit, NF Stillaguamish, Skykomish, Snoqualmie, and White) are expected to be under their RER or RER surrogates (Table 24). NMFS considers the proposed action to present a low risk to populations where fisheries do not exceed their respective RERs (NMFS 2004c). For the remaining populations where fishery effects are expected to exceed their RERs or RER surrogates:

> (1) current and anticipated population status in 2024, relative to critical and rebuilding escapement thresholds, and stable or positive trends in escapement alleviate concerns about additional risk (Upper Sauk, Lower Skagit, Cedar, Puyallup, and Green);
>
> (2) anticipated impacts from the proposed 2023 Puget Sound fisheries are low and the effect on the population is negligible (North Fork Nooksack, South Fork Nooksack, Mid-Hood Canal Rivers, Dungeness, Elwha);
>
> (3) indigenous populations in the watershed have been extirpated and the proposed fisheries and additional actions proposed by the co-managers are consistent with long-term strategies for local adaptation and rebuilding of the remaining populations (Nisqually, Skokomish); and,
>
> (4) populations were in lower PRA tiers (tiers 2 and 3) and life histories are represented by other healthier populations in the Region (Sammamish, South Fork Stillaguamish, and Puyallup).

Sixteen of the 22 populations in the ESU are expected to exceed their critical escapement thresholds for natural-origin spawners and eight of those are expected to exceed their rebuilding escapement thresholds for natural-origin spawners, with two additional populations near their rebuilding escapement threshold for natural-origin spawners (Snoqualmie and Lower Sauk; Table 24). Six populations are expected to be below their critical escapement thresholds for natural-origin spawners (North Fork Nooksack, South Fork Stillaguamish, Sammamish, Mid-Hood Canal, Skokomish, and Elwha). For the latter populations, the fisheries resulting from implementing the proposed actions in 2024 would not meaningfully affect the persistence of the populations under the recovery strategies in place or the indigenous population has been extirpated and a long-term transition strategy is in place, and the proposed actions are consistent with that long-term strategy.

As described in Section 2.5.1.1, Assessment Approach, the co-managers may propose to open fisheries directed at spring Chinook in the April-May 14, 2025 timeframe. They propose to manage these fisheries under the same conservation objectives applied to the spring run MUs, as utilized for the 2024 fisheries (Table 25). NMFS has determined that fisheries managed consistent with these objectives in recent years have not posed jeopardy to the Puget Sound Chinook ESU. In addition, fisheries have had impacts well below the objectives during most of previous seven years. Given the relatively consistent patterns in exploitation rates across these years, we anticipate that the impacts to the Nooksack, Skagit and White River populations will continue to be well below their management objectives and that the anticipated impacts would not change the status or trends of the populations. Additionally, as the fisheries may be proposed to take place for a short period in 2025 (April-May 14, 2025), they would only act on a portion of the returns, which would limit the scale of overall impact to the management units and individual populations. The managers would adjust the fishery, in-season, if needed to ensure that impacts remain below the applicable exploitation rate ceiling once abundance forecasts for 2025 are available.

In considering the likely effects of the proposed action on the Puget Sound Chinook salmon

ESU, NMFS reviewed the current status of the 22 populations, relative to their critical and rebuilding escapement thresholds, their individual roles in the recovery of their Regions and of the ESU, including the historical lineage of each extant population, the role of and contribution of hatchery production to natural spawning, the ability of the current habitat to sustain and recover each population, the recovery strategy in place for each population, the impacts that harvest, in particular, Puget Sound harvest, has on the current populations' status, the likely change in the status and persistence of each population in the absence of the proposed action, and the implications that the proposed actions have on each populations' viability and recovery potential.

For each population where the planned fisheries are expected to have exploitation rates that exceed the RERs, and thus present the potential for risk to the populations, this risk is mitigated by factors described above. For the Nisqually and Skokomish populations in Puget Sound, population-specific transitional strategies are being employed to move management from hatchery-focused to, eventually, natural-origin-focused objectives, coordinated with habitat restoration to improve watershed productivity. These transitional strategies are designed to shape or replace the current non-indigenous, hatchery dominated populations, which did not evolve in these watersheds, to populations more adapted to the current watershed conditions, better able to take advantage of improvements and increased productivity as habitat is restored. They are necessary to allow for the establishment of populations in these watersheds that can reach viability thus contributing to recovery of the ESU. The impact of the Puget Sound fisheries is consistent with the implementation of these strategies, and over time, should not hinder their progress. Efforts described in the environmental baseline and cumulative effects, in addition to actions proposed by the co-managers as part of transition strategies related to the planned fisheries—harvest closure windows to reduce harvest impact on late-times portions of the run, in-river mark-selective net gear development, alternative hatchery stock development, in-basin habitat restoration activities, etc.—are expected to maintain population persistence and improve habitat conditions in the foreseeable future. Other populations, such as the Lower Skagit, Cedar and Green, have average spawner abundances at levels associated with rebuilding, even at exploitation rates higher than their individual RERs. This gives NMFS confidence that the effect of the proposed harvest on these populations, even though it is expected to result in exploitation rates higher than the RERs, are sufficiently low to allow these populations to maintain escapements that are maximizing production given the current condition of the available habitat, and thereby conserving the populations' ability to respond to restoration of that habitat over time, as habitat improvements take effect. Still, other populations (North Fork Nooksack, South Fork Nooksack, Mid-Hood Canal Rivers, Dungeness, Elwha) experience very low exploitation rates in the Puget Sound fisheries. However, while the majority of the harvest that affects these populations happens outside the Puget Sound region, the low amount of harvest in Puget Sound still contributes to overall exploitation rates higher than the RERs. In these cases, the small numbers of additional fish that would return to the spawning grounds without the planned fisheries would not affect the status of the annual or long-term abundance trends and allow fisheries the ability to access abundant, harvestable hatchery-origin and naturally-produced salmon species. Additionally, for most of these populations there are conservation hatchery programs, which augment the natural-origin spawning numbers, such that the resulting total escapement of fish into these watersheds is sufficient to fully utilize the available habitat in its current condition. This ensures that, as habitat improves over time, the population of fish can respond positively. Finally, there are some of the 22 Puget Sound Chinook populations (Sammamish and Puyallup) that have been identified for lesser roles in recovery of the ESU. These are populations whose life history and population characteristics are represented by other populations in their Region and in the ESU, and consistent with the NMFS' recovery plan criteria, have not been identified as needing to reach high viability for recovery of the ESU. The level of risk posed to these populations from the planned fisheries would not impede the survival or recovery of the ESU. For 2024-25, and for the longer-term, we expect all of these factors to mitigate the risk from Puget Sound harvest to specific populations, while other populations in the ESU will experience exploitation rates that pose risk appropriate to their roles in recovery of the ESU.

To roll this analysis up to the ESU level, for the reasons explained above, we conclude that the proposed actions considered in this opinion are consistent with NMFS' recovery guidance for each of the five regions within the Puget Sound ESU. For the Strait of Juan de Fuca and Georgia Basin Regions, the Puget Sound fisheries are expected to have small effects on the populations, with most fishery impacts occurring in Canadian and Alaskan fisheries, such that eliminating the Puget Sound fisheries would not change the status of these populations. In both regions, habitat conditions in the rivers are very poor, and productivity can only improve with time and/or significant restoration efforts. In both regions, conservation hatchery programs are supporting the populations while habitat improves. Our analysis indicates that the fishery impacts in 2024, from the proposed actions, are not expected to reduce the likelihood of persistence and potential for improvement of these populations, all of which are considered essential for recovery of the ESU, while habitat improves. The Whidbey/Main Basin Region includes a majority of populations for which total ERs in 2024 are below RERs, and for the remaining three populations, the contributions to the total ERs of Puget Sound fisheries are relatively low. This Region is a stronghold within the ESU, with the largest number of populations progressing towards viability, and the proposed 2024 Puget Sound fisheries are not expected to change that trajectory. Thus, the effects of the proposed action are consistent with the recovery framework for that region. In the Central/South Sound Region, habitat is generally in poor condition due to urbanization and other human activities, and historic hatchery practices resulted in replacement of indigenous Chinook salmon populations with out-of-basin hatchery fish in several rivers. Although total fishery exploitation rates for 2024 exceed RERs for most populations in this Region (the White River is an exception) and with Puget Sound fisheries significantly contributing to the totals, several populations have reached or are close to reaching their rebuilding escapement thresholds. The Nisqually population, which is essential to recovery and of greatest concern in this Region, is one where the indigenous population has been extirpated and the co-managers are implementing a strategy to establish a well-adapted, self-sustaining population. Escapement after considering the effects of the 2024 fisheries is expected to exceed the critical escapement threshold, by fourfold, and the indicators we considered above suggest the fisheries will not hinder the ability of this population to persist while the transitional strategy and other actions to improve habitat conditions are implemented. Thus, the proposed action is consistent with the recovery framework and is not likely to reduce the chance of persistence of most of the populations in the Region or to hinder their role in recovery. Finally, in the Hood Canal Region, both populations are essential to recovery, and are in poor status. The proposed Puget Sound fisheries have a very low effect on the Mid Hood Canal population, making a minimal difference in terms of the number of returning spawners. The Skokomish population, which returns to spawn in a river whose hydrology has been fundamentally changed by the existence of dams and other human activities, is descended from hatchery fish originally sourced from a different Puget Sound watershed. While the 2024 Puget Sound fisheries will contribute substantially to the total ER for this population, for reasons explained above we do not expect them to reduce the likelihood of persistence of the existing population while strategies are implemented to establish populations that are more likely to become viable given the flow regimes in the river. Thus, while the status of these two populations is poor, we do not expect the 2024 fisheries to further reduce that status or to prevent these populations from achieving viability. Because we conclude the proposed action is not likely to reduce the likelihood of survival or to hinder the role in recovery of the populations important to recovery in each region, we conclude that the proposed action, when added to the Environmental Baseline and cumulative effects, and considering the status of the ESU, is not likely to appreciably reduce the likelihood of survival and recovery of the ESU.

As described in the previous Sections, NMFS, in reaching its determination of effects on the Puget Sound Chinook ESU, based on the available scientific evidence, also weighs its responsibility with respect to the Tribe’s treaty rights in evaluating the proposed actions and recognizes the importance of providing tribal fishery opportunity, as long as it does not pose a risk to the species that rises to the level of jeopardy. This approach recognizes that the treaty tribes have a right and priority to conduct their fisheries within the limits of conservation constraints.

NMFS also assessed the effects of the action on Puget Sound Chinook critical habitat in the context of the status of critical habitat, the environmental baseline, and cumulative effects, to evaluate whether the effects of the proposed fishing are likely to reduce the value of designated critical habitat for the conservation of listed Puget Sound Chinook salmon. The PBFs most likely to be affected by the proposed actions are (1) water quality, and forage to support spawning, rearing, individual growth, and maturation; and, (2) the type and amount of structure and rugosity that supports juvenile growth and mobility. Derelict fishing gear can affect habitat in a number of ways including barrier to passage, physical harm to eelgrass beds or other estuarine benthic habitats, or occupying space that would otherwise be available to salmon. These impacts have been minimized through changes in state law and active reporting and retrieval of lost gear as described in the Effects analysis. Also, fishermen in general actively avoid contact of gear with the substrate because of the resultant interference with fishing and potential loss of gear so would not disrupt juvenile habitat. Any impact to water quality from vessels transiting critical habitat areas on their way to the fishing grounds or while fishing would be short term and transitory in nature and minimal compared to the number of other vessels in the area participating in activities un-related to the proposed actions. Also, these effects would occur to some degree through implementation of fisheries or activities other than the Puget Sound salmon fisheries. Fisheries under the proposed actions will occur within many areas designated as critical habitat for Chinook salmon in Puget Sound. However, fishing activities will take place over relatively short time periods in any particular area. As discussed in Section 2.2, Rangewide Status of the Species and Critical Habitat, and Section 2.4, Environmental Baseline, of this opinion, critical habitat features in the action area (i.e., forage, water quality, and rearing and spawning habitat) have been and 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. For the reasons described, we would expect the proposed actions to result in minimal additional impacts to these features although we cannot quantify those impacts because of their transitory nature. The effects of the proposed action certainly would not rise to the level of adversely modifying critical habitat for Puget Sound Chinook.

2.7.2 Puget Sound Steelhead

ESA-listed steelhead are caught in tribal and non-tribal marine and freshwater fisheries in the proposed actions that target other species of salmon and hatchery-origin steelhead.

NMFS determined that the harvest management strategy that eliminated the direct harvest of natural origin steelhead in the 1990’s, prior to listing, largely addressed the threat of harvest to the listed DPS (72 Fed. Reg. 26722, May 11, 2007). In the recent status review, NMFS concluded that the status of Puget Sound steelhead has not changed significantly since the time of listing (Ford 2022) and reaffirmed the observation that harvest rates on natural-origin steelhead have remained stable and are unlikely to substantially affect the abundance of Puget Sound steelhead (NWFSC 2015b; NMFS 2019i). A key consideration in recent opinions was therefore whether catches and harvest rates had continued to remain very low since listing which would reinforce the conclusion that the threat of harvest to the DPS continued to be low.

The expected impact on Puget Sound steelhead in marine fisheries from implementation of the proposed fisheries during the 2024-2025 season is well below the level noted in the listing determination. We reached this conclusion based on the similarity of expected catch patterns and fishing regulations for 2024-25 to fishery regulations and catch patterns for years since the listing, which resulted in a 51% decline in marine area catches in recent years as described in Section 2.4.1 and summarized in Table 14.

Under the proposed actions, the harvest rate in freshwater fisheries is expected to be below that observed at the time of listing. NMFS compared the average harvest rates for a set of index populations at the time of listing (4.2%) and more recent years (0.87%) and concluded that the average harvest rate had declined by 79% (Table 17).

We anticipate low impacts to steelhead from research test fisheries discussed in this opinion because of the timing, gear and area of the studies relative to the timing and area of steelhead migration in the study areas. However, to be conservative we estimated 4 potential adult mortalities (Section 2.5.2.2). When the research related impacts are added to those resulting from the proposed fisheries, they do not change the conclusion that take associated with the proposed actions continues to be low and well below the levels reported at the time of listing.

Critical habitat for steelhead is located in many of the areas where Puget Sound recreational and commercial salmon fisheries occur. However, fishing activities will take place over relatively short time periods and thus have a very limited opportunity to impact critical habitat. The PBFs most likely to be affected by the proposed actions are (1) water quality, and forage to support spawning, rearing, individual growth, and maturation; and, (2) the type and amount of structure and rugosity (NWFSC 2015b; NMFS 2019i) that supports juvenile growth and mobility. Fishermen endeavor to keep gear from being in contact or entangled with substrate and habitat features because of the resultant interference with fishing and potential loss of gear. This would result in a negligible effect on the PBFs. Any impact to water quality from vessels transiting critical habitat areas on their way to the fishing grounds or while fishing would be short term and transitory in nature (NMFS 2004d; NMFS and BIA 2015).

The environmental baseline for listed steelhead in Puget Sound and their critical habitat includes the ongoing effects of past and current development activities and hatchery management practices. Development activities continue to contribute to the loss and degradation of steelhead habitat in Puget Sound such as barriers to fish passage, adverse effects on water quality and quantity associated with dams, loss of wetland and riparian habitats, and agricultural and urban development activities. Continued propagation of out-of-basin stocks (e.g., Chambers Creek and Skamania hatchery stocks) throughout the Puget Sound DPS and increased predation by marine mammals are also sources of concern. Development activities and the ongoing effects of existing structures are expected to continue to have adverse effects similar to those in the baseline. Hatchery production has been modified to some extent to reduce the impacts to ESA-listed steelhead, but is expected to continue at lower levels with lesser impacts. NMFS expects that both Federal and State steelhead recovery and management efforts will provide new tools, data and technical analyses, refine Puget Sound steelhead population structure and viability, and better define the role of individual populations in the DPS. The recovery plan, which was completed in 2019 identifies measures necessary to protect and restore degraded habitats, manage hatcheries and fisheries consistent with recovery, and prioritize research on data gaps regarding population parameters. The ongoing activities detailed above are expected to continue to affect steelhead and their critical habitat. However, as described above the impacts of the proposed action on Puget Sound steelhead DPS are expected to be minimal, and below the level identified as limiting improvements in status. When added to the baseline, and cumulative effects, these impacts are not expected to reduce the likelihood of survival and recovery of the DPS, or to adversely modify their critical habitat.

2.7.3 Puget Sound/Georgia Basin Rockfish

Status of Rockfish

Detailed assessments of yelloweye rockfish and bocaccio can be found in the recovery plan (NMFS 2017g) and the 5-year status reviews (NMFS 2016a; Lowry et al. 2024). The Puget Sound/Georgia Basin DPS of yelloweye rockfish is listed under the ESA as threatened, and bocaccio are listed as endangered (75 FR 22276, April 28, 2010). The DPSs include all yelloweye rockfish and bocaccio found in waters of Puget Sound, the Strait of Georgia, and the Strait of Juan de Fuca east of Victoria Sill. There is no single reliable historical or contemporary population estimate for the yelloweye rockfish or bocaccio within the full range of the Puget Sound/Georgia Basin DPSs (Drake et al. 2010). Despite this limitation, there is clear evidence each species' abundance and productivity has declined dramatically; spatial structure, connectivity, and diversity have been adversely impacted, largely due to recreational and commercial fisheries that peaked in the early 1980s (Drake et al. 2010; Williams, Levin and Palsson 2010); and there continues to be an exposure risk to mortality from commercial and recreational fisheries bycatch, new derelict gear, and habitat degradation.

Critical habitat was designated for ESA-listed rockfish in 2014 under Section 4(a)(3)(A) of the ESA (79 FR 68041, November 13, 2014). The specific areas designated for bocaccio include approximately 1,083.11 square miles (1,743.10 sq. km) of deepwater (< 98.4 feet [30 meters(m)]) and nearshore (> 98.4 feet [30 m]) marine habitat in Puget Sound. The specific areas designated for yelloweye rockfish include 438.45 square miles (705.62 sq. km) of deepwater marine habitat in Puget Sound, all of which overlap with areas designated for bocaccio. Critical habitat is not designated in areas outside of U.S. jurisdiction; therefore, although waters in Canada are part of the DPSs' ranges for each species, critical habitat was not designated in that area.

The physical or biological features essential to the conservation of yelloweye rockfish and bocaccio fall into major categories reflecting key life history phases; including adult, juvenile, and early settlement from the larval stage. Overall, the status of critical habitat in the nearshore is impacted in many areas by the degradation from coastal development and pollution. The status of deep-water critical habitat is impacted by remaining derelict fishing gear and degraded water quality among other factors. The input of pollutants affects water quality, sediment quality, and food resources in the nearshore and deep-water areas of critical habitat.

We cannot quantify the effects of degraded habitat on the listed rockfish because these effects are poorly understood. However, there is sufficient evidence to indicate that ESA-listed rockfish productivity may be negatively impacted by habitat structure and water quality stressors. We include in the current analysis cumulative impacts from other previous ESA Section 7(a)(2) consultations; including programmatic consultation for salmon and steelhead hatchery production (NMFS 2020a), bycatch from the halibut and other bottom fish fisheries (NMFS 2018e), the impacts from derelict fishing gear, and the annual take allotments for scientific research (Clapp 2024).

To evaluate the effects of proposed fisheries on individual yelloweye rockfish and bocaccio we analyzed direct effects on listed rockfish in two steps. First, we estimated the number of listed rockfish likely to be caught in the salmon fishery and assessed both the sublethal and lethal effects on individuals. Second, we considered the consequences of those sublethal and lethal effects at the population/DPS level. Impacts from bycatch within the hook and line fishery and net fishery were each analyzed, and we analyzed indirect effects by considering the potential effects of fishing activities on benthic habitats.

Throughout, we identified data gaps and uncertainties, and explained how the assumptions in the analysis are based on the best available science. Mortality estimates are highly variable, thus we used the highest available catch estimates for bocaccio and yelloweye rockfish to form a precautionary analysis.

Effects of Puget Sound Fisheries on Rockfish

Historic fishery removals were a primary reason for depleted listed rockfish populations, yet the impact of current fisheries and associated bycatch is more uncertain. As detailed in Section 2.3, Environmental Baseline, yelloweye rockfish and bocaccio are caught by anglers targeting halibut and bottom fish, by researchers, and larval rockfish by hatchery released salmon. To assess if the effects from the salmon fisheries within the area of the listed rockfish DPSs threatens the viability of each species, in combination with all sources of bycatch identified in the environmental baseline, we reviewed the population-level impact from all fisheries, hatcheries, and research combined. In order to conduct this analysis, we must assess numbers of fish harmed or killed relative to the overall population of the rockfish DPS of each species.

To assess the effect of the mortalities expected to result from the proposed actions on population viability, we adopted methodologies used by the PFMC for rockfish species as described in the Effects Section (2.5.3.1). Given the similar life histories of yelloweye rockfish and bocaccio to coastal rockfish managed by the PFMC, we concluded that these methods represent the best available scientific information for assessing the effects of fisheries-related mortality on the viability of the ESA-listed rockfish.

To assess the population-level effects to yelloweye rockfish and bocaccio from the proposed salmon fisheries, and identical to our analysis in Section 2.5.3, we calculated the range of anticipated annual percent mortalities based on the range of estimate take and abundance scenarios (Table 43).

Table 43. Estimated total annual lethal take for the salmon fisheries and percentages of the listed-rockfish.

Species	Range of Estimated Lethal Take	Abundance Scenario	Range of Percent of DPS Killed
Bocaccio	1 to 77	4,606	0.02 to 1.67
Yelloweye rockfish	2 to 66	143,086	0.001 to 0.05

For yelloweye rockfish and bocaccio, mortalities from the proposed salmon fisheries in the range of the DPSs would be well below the precautionary level (0.5 (or less) of natural mortality) and risk-neutral level (0.75 or less) used in the PFMC methodology (Section 2.5.3.1).

Annual natural mortality rate for bocaccio is approximately 8 percent (as detailed in Section 2.4.2) (Palsson et al. 2009); thus, the precautionary level of fishing would be 4 percent and risk-neutral would be up to 6 percent. Lethal takes from the proposed salmon fisheries would be well below the precautionary and risk-neutral levels for each of the abundance scenarios.

Annual natural mortality rates for yelloweye rockfish range from 2 to 4.6 percent (as detailed in Section 2.4.2) (Yamanaka and Kronlund 1997b; Wallace 2007); thus, the precautionary range of fishing and research mortality would be 1 to 2.4 percent and risk-neutral would be 1.5 to 3.45 percent. Lethal takes from the salmon fisheries in the DPS would be below the precautionary and risk-neutral level for each of the abundance scenarios.

To assess the population-level effects to yelloweye rockfish and bocaccio from activities associated with the research permits within the environmental baseline, fishery take within the environmental baseline, hatchery salmon take within the environmental baseline, and fishery take associated with the proposed actions, we calculated the total mortalities for all sources (Table 44).

Table 44. Estimated total takes for the salmon fishery and percentages of the listed-rockfish covered in this Opinion in addition to takes within the environmental baseline.

Species	Total Take in Baseline (plus salmon fishery high estimate)	Total Lethal Take in Baseline (plus salmon fishery high estimate)	Abundance Scenario	Levels of Acceptable Mortality	Percent of DPS Killed (total lethal takes)
Bocaccio	95(+77)	77[a](+77)= 154	4,606	4 - 6%	3.34
Yelloweye rockfish	389(+66)	357[b](+66)= 423	143,086	1 - 3.45%	0.30

[a] This includes the following estimated bocaccio mortalities: 40 from the halibut fishery, 13 during research, 17 in other fisheries, and 7 from larval consumption by hatchery salmon.

[b] This includes the following estimated yelloweye rockfish mortalities: 270 from the halibut fisheries, 18 during research, 65 in other fisheries, and 4 from larval consumption by hatchery salmon.

Lethal takes are most relevant for viability analysis. For yelloweye rockfish and bocaccio, the takes from the salmon fishery, in addition to previously assessed lethal scientific research, predation by hatchery salmon, and fishery bycatch (fishermen targeting bottom fish and halibut) (detailed in Section 2.4, Environmental Baseline), would be within or below the risk-neutral and/or precautionary level for each of the abundance scenarios. Our analysis of potential mortality for each species uses precautionary assumptions and thus the actual level would likely be lower than estimated. These precautionary assumptions include that, of the previously analyzed research projects, all of the take permitted will actually occur, when in fact the actual take of yelloweye rockfish and bocaccio is well below the permitted take. As an example, since bocaccio were listed in 2010, only 3 fish have been taken in research projects (compared to the permitted take of 38 fish, and 21 mortalities in 2020 alone) within the U.S. portion of the DPS area (Lowry et al. 2024). An additional precautionary factor for bocaccio is that the population estimates only include the San Juan Island area, which is less than half of their habitat area within U.S. waters of the DPS (Marine Catch Area 7). Recent ROV surveys and genetic research projects have documented bocaccio in Central Sound.

In addition to fishery mortality, rockfish are killed by derelict fishing gear (Good et al. 2010), though we are unable to quantify the number of yelloweye rockfish and bocaccio killed by pre-existing derelict gear or new gear that would occur as part of commercial fisheries within the proposed actions. Despite these data limitations, it is unlikely that mortality associated with derelict gear associated with the action would cause mortality levels of yelloweye rockfish and bocaccio to exceed the precautionary or risk-adverse levels. This is because: (1) the removal of thousands of nets has restored over 650 acres of the benthic habitat of Puget Sound and likely reduced mortality levels for each species; (2) most new derelict gear would become entangled in habitats less than 100 feet deep (and thus avoid most adults); (3) new derelict gear from the proposed action would degrade a relatively small area (up to 0.8 acres of habitat per year), and thus would be unlikely to result in significant additional mortality to listed-rockfish; and (4) the recent and ongoing programs to provide outreach to fishermen to prevent net loss.

We also assessed the effects of the action on yelloweye rockfish and bocaccio critical habitat in the context of the status of critical habitat, the environmental baseline, and cumulative effects to evaluate whether the effects of the proposed fishing are likely to reduce the value of proposed critical habitat for the conservation of each species. The main potential effect of the proposed fishing on listed rockfish critical habitat would be derelict fishing nets. As discussed in Section 2.2, Rangewide Status of the Species and Critical Habitat and Section 2.4, Environmental Baseline, of this opinion, critical habitat features in the action area (i.e., prey resources, water quality, and complex bottom habitats) may be affected by non-point source and point source discharges, hypoxia, oil spills, dredging projects and dredged material disposal activities, nearshore construction projects, renewable ocean energy installations, and climate change. We would expect the proposed fishing to result in minimal additional impacts by the loss of some gill nets to a subset of these features. Thus, the proposed fishing is not likely to reduce the value of critical habitat for the conservation of yelloweye rockfish and bocaccio of the Puget Sound/Georgia Basin DPSs.

In summary, the listed DPSs are at risk with regard to the each of the four VSP criteria, and habitats utilized by listed-rockfish are impacted by nearshore development, derelict fishing gear, contaminants within the food-web and regions of poor water quality, among other stressors. Benefits to habitat within the DPSs have come through the removal of thousands of derelict fishing nets, though nets deeper than 100 feet remain a threat. Degraded habitat and its consequences to ESA-listed rockfish can only be described qualitatively because the precise spatial and temporal impacts to populations of yelloweye rockfish and bocaccio are poorly understood. However, there is sufficient evidence to indicate that listed-rockfish productivity may be reduced because of alterations to habitat structure and function.

Most adult yelloweye rockfish and bocaccio occupy waters much deeper than surface waters fished by commercial nets, therefore the bycatch of adults in commercial salmon fisheries is likely extremely low to non-existent. The recreational bycatch levels from the 2024/25 salmon fishery season, and beyond, are expected to be quite low, within the risk-neutral or precautionary mortality rates identified for overfished rockfish of the Pacific Coast. New derelict gear from the proposed action is a source of potential incidental mortality, but for reasons described above such mortality is expected to be quite low. Concerns remain about fishery-mortality effects to spatial structure, connectivity, and diversity for each species. These concerns are partially alleviated because of the low bycatch rates for each species, and considering that the abundance of each species is likely higher than assessed within our analysis. The structure of our analysis provides conservative population scenarios for the total population of each DPS, and likely overestimates the total mortalities of caught and released fish. Thus, taken together the effects of the proposed actions on ESA-listed rockfish in Puget Sound, in combination with anticipated bycatch from other fisheries, hatcheries, and research, their current status, the condition of the environmental baseline, and cumulative effects are not likely to reduce appreciably the likelihood of survival and recovery of yelloweye rockfish and bocaccio.

2.7.4 Southern Resident Killer Whales and Critical Habitat

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 the Southern Residents or adversely modify or destroy Southern Residents' designated critical habitat.

Current Status of SRKWs

The SRKW DPS, composed of J, K, and L pods, was listed as endangered under the ESA on November 18, 2005 (70 FR 69903). The limiting factors affecting this population include reduced prey availability and quality, high levels of contaminants from pollution, and disturbances from vessels and sound (NMFS 2008k). 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 (67 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 14). At the time of the summer 2023 census, the Center for Whale Research reported 75 whales in the population (Center for Whale Research 2022). Since the 2023 census, one adult male is presumed dead, bringing the population size to 74.

The NWFSC continues to evaluate changes in demographic rates (fecundity and survival), and has recently updated the previous population viability analyses for the 5-year status review (NMFS 2021j). 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 (the sex ratio at birth was estimated at 55% male and 45% female following current trends), but also related to the relatively low fecundity rate observed over the period from 2017 to 2021 (see NMFS (2021j) and Figure 17). 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 is 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 status of the whales is important because SRKWs are already stressed due to the cumulative effects of multiple stressors, that can interact additively or synergistically, and because of inbreeding depression. 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., (NAS 2017)). We have also identified periods of low Chinook salmon abundance as higher risk conditions for SRKW when effects are more likely to impact the health of the whales.

SRKWs occur throughout the coastal waters off Washington, Oregon, and Vancouver Island and are known to travel as far south as central California and as far north as Southeast Alaska (Figure 18). During the spring, summer, and fall months, SRKWs have typically spent a substantial amount of time in the action area, 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 (especially for K and L pods), potentially connected to Fraser Chinook salmon stock abundance (see Stewart et al. (2023)). There is also variability in occurrence across the three pods with J pod more consistently encountered in inland waters year round (Hanson and Emmons (2010); The Whale Museum unpubl. Data, Figure 19. Over more than a decade of scale, tissue and more recent fecal sampling give us high confidence that the whales' diet consists of a high percentage of Chinook salmon, especially in the summer months in the action area. NOAA Fisheries and WDFW released a priority stock report identifying the Chinook salmon stocks believed to be of most importance to the health of the Southern Resident populations along the West Coast, and multiple Puget Sound Chinook stocks were ranked in the top 10 priority stocks (NOAA and WDFW 2018).

The proposed action is set within a backdrop of the current condition of SRKW, their main prey Chinook, and their critical habitat in the action area and other past and present Federal, State, or private actions and other human activities that impact SRKWs, their Chinook salmon prey, and their designated critical habitat in the action area (Environmental Baseline).

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 status 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. 2020)). 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.

Harvest outside and inside of the action area affect prey availability in the action area (e.g. Southeast Alaska, British Columbia, PFMC coastal salmon fisheries, and the proposed action). PFMC and Southeast Alaska fisheries impacts to abundance of Chinook salmon in the Salish Sea that are SRKW prey is minimal (~1.5% reduction on average), and B.C. fisheries can take ~8.5% on average. All of these fisheries are managed under the PST. The 2019 - 2028 PST Agreement includes provisions limiting harvest impacts in all Chinook salmon fisheries within its scope (including fisheries that will impact salmon abundance in the action area; PFMC, Southeast Alaska, Canada, and Puget Sound salmon fisheries). These reductions result in larger proportions of annual salmon abundance returning to the southerly U.S. Pacific Coast Region than under previous PST Agreements, including Puget Sound. Also, the adoption of Amendment 21 to the salmon fishery management plan for Council-area (PFMC) fisheries may further limit the reductions in prey availability by PFMC fisheries on Salish Sea (action area) prey in years with low salmon abundance (below the threshold established in Amendment 21) when additional fishery management measures will be implemented (but noting that NOF abundance was above the threshold for 2024 so measures were not implemented this year). In sum, fishery impacts on Chinook have been reduced coastwide over the past decade due to changes in PST and changes to other fishery management frameworks, including areas where SRKWs are more likely to occur. The fishery management frameworks used to manage all of these fisheries reduce to some degree allowable catch levels in years of low Chinook abundance.

The funding initiative associated with the implementation of the new PST agreement is designed to produce hatchery fish to conserve Puget Sound Chinook critical populations, increase hatchery production of Chinook to provide additional prey for SRKWs, and restore habitat for Puget Sound Chinook populations. The funding initiative (consulted on in (NMFS 2019g)) is expected to result in an increase in available SRKW Chinook prey throughout inland waters in the summer and coastal waters in the winter that are frequented by SRKW's and affected by fisheries managed under the PST, with increased abundance continuing into the future 3-5 years after implementation of each year of funding and production. As a result of the PST appropriation funding for hatchery production to support SRKW, there has been the release of an additional 21.9 million Chinook smolts from 2020-2023. WDFW is also contributing toward the goal of producing additional Chinook as prey for SRKWs.

In addition to increased hatchery production, the PST-related funding initiative has funded projects to improve habitat conditions for specified populations of Puget Sound Chinook salmon, which we anticipate would increase Puget Sound Chinook abundance, also benefiting SRKWs. The FY20, FY21, and FY22 appropriated funds for implementation of U.S. domestic actions associated with the new PST Agreement included $10.4 million per year directed at habitat restoration projects within the northern boundary watersheds of Nooksack, Skagit, Stillaguamish, Snohomish, Dungeness, and Mid-Hood Canal. Furthermore, Washington State passed House Bill 1579 that included addressing habitat protection of shorelines and waterways, included funding for salmon habitat restoration programs and to increase technical assistance and enforcement of state water quality, water quantity, and habitat protection laws, along with other actions. Finally, funding to BIA through the Inflation Reduction Act will also likely contribute to habitat restoration, climate resilience, and hatchery improvements. By improving conditions for these populations, we anticipate salmon abundance in these watersheds, including Chinook salmon, would increase, also potentially benefiting SRKWs. The benefits of habitat actions will occur over the long-term, but hatchery production from the SRKW prey program should continue benefiting SRKW in 2023, thus we expect them to contribute to mitigation of the short-term effects of the 2024-2025 salmon fisheries in Puget Sound which will have the highest reductions in the summer of 2024.

Vessel disturbance is part of the environmental baseline, which includes the near-constant presence of the whale watching fleet and other private vessels in inland waters in summer months, although there are likely reductions in whale watching through new Washington State programs. Vessels used for a variety of purposes occur in the action area and several studies in inland waters of Washington State and British Columbia have linked interactions of vessels and SRKWs with short-term behavioral changes (see review in Ferrara, Mongillo and Barre (2017)). According to these studies, vessel activities may affect foraging efficiency (thus prey and energy acquisition), communication (which also may impact energy acquisition due to prey sharing), and/or energy expenditure through the physical presence of the vessels, underwater sound created by the vessels, or both. Multiple actions have been implemented that have targeted management actions identified in the recovery plan (NMFS 2008a) to reduce impacts of threats including vessel and noise impacts. For example, in addition to the 2011 federal vessel regulations, Washington State regulations were updated in 2019 to increase vessel SRKW viewing distances (see RCW 77.15.740). In 2020 Washington State law (Senate Bill 5577) established a commercial whale watching license program and charged WDFW with administering the licensing program (see RCW 77.65.615 and RCW 77.65.620), which WDFW put into effect in 2021 (all commercial whale watching rules and regulations can be found WAC Chapter 220-460 at https://apps.leg.wa.gov/waC/default.aspx, title 220). The increased viewing distance and licensing program will reduce the impacts of vessel noise and disturbance on the whales' ability to forage, rest, and socialize in the Salish Sea. A Washington state bill was passed in 2023 that restricts viewing SRKW within 1,000 yards (SB 5371) effective January 2025,part way through the consultation period of this opinion.

Effects of Puget Sound Fisheries on SRKWs

Puget Sound salmon fisheries will affect SRKWs and their designated critical habitat through direct effects of vessel activities, and through indirect effects from reduction in prey availability. Fishing vessels and effort mainly overlap with SRKW occurrence in MA 7 off the west coast of San Juan island because killer whales typically spend the majority of their time foraging in this area in summer months and fishing vessels are active in the area particularly in summer. There is overlap in other areas and times of year to a lesser extent as outlined above. The overlap of fisheries and whales informs our analysis of the potential for direct impacts of fishing vessels on SRKW and indirect effects of reduction of prey in the vicinity of SRKW. We have analyzed the potential overlap between SRKWs and fishing vessels for 2024-2025 and the potential for direct interaction between vessels or fishing gear and SRKWs, and impacts of vessel disturbance on SRKWs, which also forms the basis for our analysis of impacts to the passage feature and water quality of critical habitat. Also, we have analyzed the effects of the 2024-2025 Puget Sound salmon fisheries on prey of SRKWs and this analysis also forms the basis for the analysis of the effects to SRKW critical habitat through reduction in available prey.

Vessel Interactions

We expect the total impact of all vessel disturbances from the environmental baseline, proposed action, and cumulative effects is likely to continue to affect the whales' energetic needs and impair foraging efficiency, particularly during the height of the summer season in the core summer feeding area (including off the west coast of San Juan Island), which is specifically designated as critical habitat. The combined impact on the whales when vessel disturbance and prey reduction occur simultaneously in the whale's primary foraging areas is a cause for concern due to potential increased energy expenditure and reduced energy acquisition through multiple pathways (lower prey availability and reduction in foraging due to a disturbance). While some trends in vessel activities that could disturb the whales have declined in recent years (Ferrara, Mongillo and Barre 2017) vessels continue to operate in ways that are inconsistent with guidelines and out of compliance with regulations (Frayne 2021; The Whale Museum 2022; Frayne 2023). There are a number of mitigation efforts in place to reduce vessel disturbance from all vessel sources, including the state and federal regulations discussed earlier in this opinion, education efforts on and off the water to increase awareness and compliance, voluntary measures related to echosounder use, and voluntary areas with limited or no vessel traffic adopted by San Juan County and the whale watch industry. State regulations described in the Effects and Cumulative Effects Sections of this opinion, will continue protections for the whales in 2024 similar to recent years and enforcement presence is expected to improve compliance by vessel operators and reduce overall vessel impacts that may impact foraging or passage.

Based on monitoring data, interactions between SRKWs and fishing vessels could occur and fishing vessels likely contribute to the total effects of direct disturbance from all vessels (including effects on critical habitat passage conditions) due to overlap between fishing vessels and SRKWs. At the same time, it is difficult to assess cumulative impacts and population level consequences, and difficult to quantify loss to energy acquisition, of vessel disturbance. There is some potential for direct interaction between SRKWs and salmon fishing vessels and gear in the action area, particularly in R-MA and C-MA 7 in the summer months, because of the potential spatial and temporal overlap between the whales' distribution and the distribution of the Puget Sound salmon fisheries. However, vessel strikes or reports of entanglement in general are rare, none have been observed in association with Puget Sound salmon fisheries, and fishing vessels operate at low speeds while fishing, therefore strikes and entanglements are considered unlikely. The proposed action (compared to no fishing) will likely result in an increase in vessel activity across the whales' range in inland waters (including their critical habitat), and likely some level of exposure of individual whales to the physical presence and sound generated by commercial and recreational vessels associated with the proposed fisheries. Again, this may be of particular concern where fisheries overlap with the highest number of sightings and foraging observations of SRKWs along the west side of San Juan Island in MA 7. We do not know how many recreational vessels would still engage in recreational boating near the whales if the proposed fishery were not authorized, so we do not know the exact level of vessel effects caused by the action. Overall, some of the exposure to fishing vessels may result in less efficient foraging by the whales compared to conditions without fishing vessels, but decreasing the number of repeated disruptions from vessels would likely reduce the impact on foraging and, in turn, reduce the potential for nutritional stress.

We compared the direct impacts from fishing vessels from the proposed action analyzed in this opinion to such impacts in previous years. Impacts in 2024 are expected to be similar to other recent years (and lower than previous years, especially prior to 2019) based on the expected reduced presence of fishing vessels in the key foraging areas. This reduction in fishing vessel impacts is expected because of the closure of recreational fishing in MAs 6, 7, 8, 9, and 12 in winter/spring months, closure of 10 and 11 in the second half of November through February, and continued restrictions in summer months, such as mark-selective fisheries in the second half of July with a 3-day openers in MA 7 and possible limited additional openers prior to August 16th, and non-retention management measures for Chinook in half of August and all September (specifically in the Southern Resident killer whale foraging hot spot along the west side of San Juan Island, MA 7). Though the number of recreational fishing boats in MA 7 in the summer has increased over time since 2016 to 2022 (see Figure 43), the number of days open for retention (mark-selective) has decreased, the number of anglers per day of retention has increased and total annual angler trips have declined (Table 33). In recent years, SRKW have been sighted in MA 7 approximately half of the days that MA 7 was open to Chinook retention. Additionally, the number of Be Whale Wise incidents per day in MA 7 has declined in recent years (after 2016; Figure 52) and the percentage of incidents attributed to fishing vessels (recreational and commercial) has not exceeded 7% since 2017. Due to limited Fraser sockeye abundance in 2024, WDFW states that non-tribal commercial fisheries targeted at sockeye are unlikely in 2024 (Cunningham 2024). There are commercial fisheries targeting coho in summer in C-MA 7 but these are primarily in 7A and using reef nets (not moving vessels). Tribal fisheries are also not expected to be higher in 2024-2025 compared to the previous decade and are expected to have a small number of vessels in summer months near the San Juan Islands (>1-2.5 boats per day), no more than 2.5 boats per day in other areas of SRKW occurrence in summer (areas of >10 sightings a month), and even fewer in areas of high SRKW occurrence in other times of year. In general, exposure to tribal fishing vessels and associated noise is expected to be low because the majority of tribal fisheries occur in terminal areas or in times/areas where SRKWs are more rare, and sonar/depth-finder use is not standard practice.

In addition, WDFW will continue to promote the Be Whale Wise guidelines and voluntary No-Go zone (now mandatory for commercial whale watch vessels), and continue conservation efforts including education to fishing vessels to maintain slow transit speeds (restricted to 7 knots or less near whales) at a minimum and potentially reduce transit speeds in areas frequently utilized by Southern Residents in the summer season (specifically off the west coast of San Juan Island). Also, WDFW will continue to encourage fishers to silence vessel sonar in the presence of Southern Residents and when fishing gear is deployed (and to encourage the use of 200 kHz echo sounders which is outside the hearing range of killer whales (Branstetter et al. 2017)). Ongoing monitoring of vessel activities near the whales by the Soundwatch Boater Education Program and WDFW vessel patrols are a part of the proposed action. Both are likely to reduce vessel impacts and allow for tracking reductions in fishing vessel activity when whales are in key foraging areas. In summary, vessel and acoustic disturbances may cause short-term behavioral changes, avoidance, or a decrease in foraging (if interactions occur). However, based on the operation of fishing vessels, that are not targeting the whales, the limited number of tribal vessels, the implementation of area restrictions, and existing mitigation efforts, we expect that any transitory or small amount of disturbance caused by the fishing vessels is not likely to disrupt normal behavioral patterns or distribution, or cause harm to the whales.

Reduction of Prey Availability

As described in the Effects Section, to analyze indirect impacts on SRKWs from the action due to effects to prey, we focused our analysis on SRKW’s primary prey, Chinook salmon, and impacts in inland waters mainly in summer months where the fisheries overlap with foraging areas and reduction of prey by fisheries is highest. While there are several challenges to quantitatively characterize the relationship between Chinook abundance and SRKW health and status, available science supports a relationship, and intuitively, at some low Chinook 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). Based on the biological information described in the Effects Section, our effects analysis focused on the likely reduction in Chinook prey available to the whales as a result of the proposed fishing. To put that reduction in context, we evaluated a range of metrics and information, including comparing the 2024-2025 proposed fisheries and Chinook abundance to the recent 10-year average. Using an updated version of FRAM (version 7.1.1), updated Chinook salmon distribution model from Shelton et al. (2021), and modifications to ad-hoc Workgroup methods for use in Puget Sound (modifications used in NMFS (2022c)), the pre-season estimates for abundance of age 3-5 Chinook in inland waters will be approximately 1,181,819 which is higher than the recent 10-year post-season average of 998,091. The proposed fishing is expected to reduce the annual abundance of prey in inland waters by approximately 4.0%, which is similar to the average reductions over the recent 10 years of validated data (4.5%, 2011-2020) and less than average reductions over the entire retrospective time period (5.1%, 1992-2020). Note that these values cannot be compared to values presented in most previous opinions for Puget Sound fisheries, except for the 2023 opinion given updates in methodology used here.

Also, the Puget Sound fisheries respond to changes in salmon abundance over time and are sustainable by accounting for the available information on the productivity, abundance and status of individual salmon stocks. The fisheries are designed to ensure salmon stocks (ESA-listed and non-listed) impacted in the fishery meet the applicable conservation objectives. We concluded that the proposed actions are not likely to jeopardize the continued existence of the Puget Sound Chinook salmon ESU, part of a priority prey population for SRKW, or adversely modify its designated critical habitat.

Modeling limitations add a level of uncertainty to the percent reduction estimate. However, similar to last year, we used updated methods that address one source of modeling uncertainty. The PFMC Workgroup methods may bias estimates in percent reductions from fisheries because methods assume that the effects on Chinook salmon abundance from fishery removals are distributed across space in proportion to Chinook salmon abundance, rather than based on where fishery removals actually occur and how quickly fish redistribute themselves across space. Updated methods used here address this where, for local stocks (originating from the region in which the fishery occurs), we assign mortalities to the region in which the fishery occurs (e.g., mortalities of Puget Sound stocks in Puget Sound fisheries would all be assigned to the Salish region) because Chinook salmon that are not caught are not likely to return to marine areas outside Salish Sea. At the same time, reduction by the fisheries may be an overestimate of reduction in availability to SRKWs because it is unlikely the whales would consume all the fish caught by the fisheries if the fisheries were closed. Reductions of prey from fishing are expected to be highest in summer in the inland waters, but apply to a broad area (that includes all Puget Sound fishing areas included in the analysis) with varying overlap with SRKWs. Therefore, it is also difficult to assess how reductions in prey abundance may vary throughout inland waters and we have less confidence in our understanding of how reductions could result in localized depletions (for example we can’t assess percent reduction in specifically MA 7 because we don’t know abundance in that specific area). Seasonal prey reductions throughout the action area may not accurately predict reductions in prey available in known foraging hot spots (such as MA 7 especially off the west side of San Juan Island), however recreational fishery restrictions (closures, non-retention limitations) should limit the removal of potential prey in important foraging areas of SRKWs and commercial fisheries occur across the larger region of C-MA 7/7A. Also, expected recreational fishery removals in R-MA 7 are set at 2,181, lower than average harvest in the most recent validated decade (approximately 4,620 on average across 2011-2020).

We also estimate that Chinook prey available in 2024-2025 will be at levels where prey energy available is greater than that required by the whales (based on our analysis and NWIFC analysis of energy requirements of the current SRKW population). However, there are significant limitations and uncertainties in this analysis. Here and in past years, NMFS and the NWIFC estimated the Chinook food energy available to the whales and compared available kilocalories to needs including after reductions from fishing in the past and proposed fishing this year. We have low confidence in forage ratios (prey available compared to needs of the whales), though under both the NWFIC and our analysis for 2024-2025, the estimated kcal based on the projected abundance of Chinook salmon for this year are expected to exceed the metabolic needs of the whales. However, we are unable to quantify how a reduction in the ratio of prey available compared to the whales' needs could affect the foraging efficiency of the whales and therefore apply a low weight to this part of the analysis. Finally, though 32% of J pod, 40% of L pod, and 6% of K pod (K pod percentage from census in summer 2022) are in the poorest category for body condition, Chinook cohort-level populations that were linked to potential declines in body condition by Stewart et al. (2021) (Fraser cohort for J pod and Puget Sound for L pod) are at levels that are above values where recent studies (Stewart et al.) highlighted the highest risk for further body condition decline.

In summary, although there is uncertainty in exact reductions of prey availability to the whales, the proposed actions will reduce prey compared to no fishing, and some amount of the prey reduction occurs in an area known for its high use and considered a foraging hot spot (e.g. MA 7). In response to reduced prey, the whales may increase their searching effort and move to other potential foraging areas within their geographic range. We would expect increased energy expenditure or reduced foraging to have more significant impacts on the health and reproduction of the whales in times of low Chinook salmon abundance, but 2024 is expected to be at a slightly above average level. The expected reduction of Chinook by the fishery is relatively low compared to historic levels, is expected to be similar to the average of this last decade (2011-2020), and Chinook abundance is expected to be above the average of the last decade. WDFW and the NWIFC have provided information on how the salmon fisheries were set for 2024-2025. They identified how the fisheries are managed in ways that account for the distribution of SRKW and important foraging areas, described aspects of the fishery that limit potential effects on the whales, and also outlined specific measures to limit potential impacts from vessels. Though there is incidental mortality of Chinook in the non-tribal Fraser sockeye and chum salmon fishery, these fisheries are likely to not occur, and additional recreational fishery restrictions in the summer (mark selective and non-retention) and winter (closure), and minimal tribal fishing (approximately <1-2.5 boats per day and primarily terminal), will likely limit the impacts to SRKW in foraging hot spots. Efforts to reduce vessel interactions and fishing in the primary foraging area along the west side of San Juan Island (especially non-retention restrictions for Chinook in MA 7 in September when all pods are consistently in inland waters) will reduce the potential for prey reductions to result in significant localized depletions or prey depletions at levels that would cause injury or impair reproduction. Therefore, though a reduction in prey will occur, it is expected to be relatively small, and during a year with slightly above average Chinook salmon abundance.

Effects on Critical Habitat

In addition to the effects to SRKWs discussed above, the proposed action affects critical habitat designated for SRKWs in inland waters of Washington.

Critical habitat includes approximately 2,560 square miles of inland waters of Washington and includes three physical or biological features essential to the conservation of SRKWs: (1) water quality, (2) prey quantity, quality, and availability, and (3) passage conditions (see Section 2.2.2.4). The Section on Effects on Southern Resident Killer Whales considers pathways of effects related to prey as well as vessel effects that could affect movements and foraging and therefore, this analysis draws heavily on the previous assessment of impacts to the whales when considering effects on the habitat features, which are summarized here.

Fisheries actions outlined in this opinion have the potential to affect all 3 habitat features, in designated critical habitat, and these features are also impacted by a variety of other threats to Chinook salmon and from vessel activity. As described above, the abundance of prey is projected to be above average for 2024-2025 and the reduction in quantity and availability of prey from fishery removals and disturbance from fishing vessels is expected to be slightly less than average and mitigated by several conservation efforts and therefore, is not expected to appreciably diminish the value of critical habitat. While vessels could result in the whales moving to areas with higher levels of prey or less disturbance, a number of activities to decrease effects from all vessels are ongoing, fishing restrictions are in place in summer in the killer whale core critical habitat area (including around the San Juan islands), and the action includes specific outreach to fishing vessels to reduce their impacts and vessel presence and sound is not expected to block passage of the whales. Similar to our assessment of the impacts to the whales, reductions in prey by fisheries is expected to be relatively low (compared to historic levels) and we expect that any transitory or small amount of disturbance caused by the fishing vessels is not likely to disrupt normal behavioral patterns or distribution, and therefore the proposed action is not likely to impair the prey (i.e., availability and access to prey) and passage features of SRKW critical habitat. For water quality, though oil spills may occur (and have) the likelihood is small, fishing vessels do not carry large amounts of oil, and response protocols are in place reducing the potential risk from minor spills.

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 status of the whales. The whales' status has continued to decline over the last decade—likely due to a combination of the three top limiting factors: prey availability, vessel noise and disturbance, and toxic contaminants. Chinook salmon are the predominant prey species and there is intuitively a linkage between Chinook abundance and the whales' status although certain available analyses have not been able to identify a quantitative relationship. There is likely a spectrum of risk and at some low level of Chinook abundance there is higher risk that fishery removals would adversely affect the whales' status or reduce the conservation value of the prey habitat feature. Prey reductions, particularly during periods of low Chinook abundance, could affect the foraging behavior of the whales, their energy balance, and subsequently their health, reproduction and survival. Therefore, there is more concern for effects to the whales in years when abundance is relatively low and yet fisheries reduction is high. The environmental baseline and cumulative effects show a continuation of effects of human activities in the action area that contribute to the top three limiting factors for the whales' status, but there are improvements in recent years that are expected to continue, such as reductions in fishery impacts under the new PST Agreement, additional hatchery production to provide increased prey for the whales, increased restrictions on vessel traffic near the whales, and efforts to improve salmon habitat conditions in Washington.

The effects of the proposed action in this opinion add a measurable but small adverse effect in addition to the existing conditions compared to no action. The most significant impacts of the action will occur where the fisheries overlap with key foraging areas for the whales. The action in 2024-2025 will add some vessel disturbance and reduce available prey for the one year fishing period, and any reduction in prey or interference with foraging is a concern for the SRKWs because of their status. However, we anticipate above average Chinook salmon abundance in inland waters, and average percent reduction by the fisheries relative to the most recent 10 years for which FRAM model validated data is available (2011-2020). Specifically, changes in the fisheries and efforts to reduce fishing in the primary foraging area along the west side of San Juan Island (e.g. non-retention regulations) compared to average conditions in the last decade (2011-2020) will reduce the potential for prey reductions to result in significant localized depletions or prey depletions at levels that would cause injury or impair reproduction, especially in September when all three pods are consistently in inland waters. In addition, a number of conservation measures, identified by WDFW as part of the action, and limited pre-terminal tribal fishing as described by the NWIFC, are expected to limit the impact of the prey reduction and limit the effects from fishing vessels, including in key foraging areas. It will be important to monitor and evaluate the effectiveness of protective measures, particularly voluntary measures including those related to acoustic impacts and sonar use, to ensure they are effective in reducing impacts to the whales. In addition, the action will also not jeopardize the listed salmon that the whales depend on over the long term.

In conclusion, this proposed action adds one year of average, limited fisheries to this backdrop. It is possible that there is a measurable effect on the whales’ behavior in terms of possible additional foraging effort given that relatively limited prey reductions will occur in a year with above average Chinook abundance. For purposes of this opinion, we assume there is a measurable effect on the whales in the form of additional foraging effort. However, we do not expect these changes to persist or be so large that they result in more than a minor change to the overall health of any individual whale, or that they change the status of the population. Thus, even with a measurable effect, we find that the proposed action will not likely appreciably reduce the likelihood of survival of SRKWs, and is not likely to appreciably diminish the conservation value of designated critical habitat. 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 and mitigation, along with other recovery actions, in improving conditions for listed Chinook salmon and SRKWs compared to recent years.

Similarly, we do not expect the 2024-2025 fisheries to appreciably reduce the likelihood of the whales’ recovery. First, the action will also not jeopardize the listed salmon that the whales depend on over the long term. Also, efforts are underway to produce additional hatchery fish to increase prey availability for the whales and improve salmon habitat. In recent years, Canada and Washington State have increased vessel measures to reduce sound and disturbance to the whales and NMFS initiated scoping in 2019 to evaluate the need to revise existing federal regulations. These efforts along with voluntary measures are underway to improve vessel regulations and reduce impacts of vessels on foraging. In light of these ongoing efforts addressing the three primary limiting factors and projecting into the future beyond 2024-2025 season with reasonably certain assumptions, we do not expect that the 2024-2025 fisheries will impede the recovery of the whales. With these efforts to ensure that recovery progresses, we find that the 2024-2025 fisheries are not likely to appreciably reduce the likelihood of survival and recovery of SRKWs or adversely modify SRKW designated habitat over the long run.

2.7.5 Central America and Mexico DPSs of Humpback Whales

Humpback whales were historically abundant in the Salish Sea, but were effectively removed from the region by the early 1900s due to overharvesting. Following the end of commercial whaling in the U.S. and the placement of environmental protections, such as the ESA, the species has been recovering and returning to its historic range. In 2016, NMFS divided humpback whales into 14 DPSs. As described in Section 2.2.1.5, there are three humpback whale DPSs found off the U.S. West Coast. These DPSs include the Central America DPS, which is listed as endangered under the ESA and is found predominately off the coasts of California and Oregon; the Mexico DPS, which is listed as threatened and is found along the entirety of the U.S. West Coast; and the Hawaii DPS, which is not listed under the ESA and is found predominately along the coast from northern Washington and southern British Columbia to Southeast Alaska. Humpback whales found in the action area may be from any of these three DPSs.

NMFS takes a proportional approach to assign estimates of each DPS that are applied off the West Coast. Approximately 6% of humpback whales found off of Washington and British Columbia are considered to be from the endangered Central America DPS, while 25% are considered to be from the threatened Mexico DPS, with the majority 69% from the unlisted Hawaii DPS (Wade 2021). That proportional approach is applied to the anticipated interactions with the fishery and to estimate the number of each DPS encountered and potential take of ESA listed species. It is currently unknown which DPSs spend time in the inland waters, so NMFS uses the same estimates when assessing potential impacts to each DPS within the action area.

Humpback whales face many anthropogenic threats including vessel strikes and disturbance, fishery interactions, and pollution. The main threats to humpback whales from the proposed action include entanglement in fishing gear, vessel strike, and prey reduction. As described in Section 2.5.5 Effects Analysis, NMFS considers the threat of prey reduction and disturbance from vessels and noise to be insignificant, since the proposed fishing does not target species that are prey for humpback whales. Similarly, NMFS considers the risk of collision with a fishing vessel to be discountable because of no previously confirmed collisions between humpback whales and fishing vessels within the action area and the slow speeds at which fishing vessels operate.

Entanglement in fishing gear presents a serious source of mortality and serious injury to humpback whales on the U.S. West Coast, and there is a risk of humpback whale interactions with fishing gear within the action area. Analysis of public sighting reports of humpback whales from 2017 to 2022 showed a relatively large degree of overlap of whales in the more northern C-MAs (e.g., in the Strait of Juan de Fuca and the San Juan Islands) with active gillnet fisheries.

There have been 18 gillnet entanglements reported on the U.S. West Coast with only 7 confirmed to a fishery (Table 41). In the action area, there were three tribal salmon gillnet entanglements in 2018, and one additional gillnet interaction with an unknown fishery. These were the first fishery interactions reported for this fishery and the specific DPS interacting with the fishery is unknown. There were three entanglements in unknown gear in 2019 and one entanglement in unknown gear in both 2020 and in 2021 reported in the action area. Ongoing efforts to better understand the proportion of different humpback whale DPSs in Puget Sound and identifying mortalities and fishery interactions to DPS will improve our ability to assess impacts from longer-term fishery management actions in the future.

Humpback whales have been returning to the Salish Sea in increasing numbers in recent years (Calambokidis et al. 2017; Miller 2020), meaning we expect continued overlap between individuals and the fishery. Gillnet fishing effort is anticipated to be at a much lower level than the effort in 2018, the year with the highest reported number of interactions between the fishery and humpbacks. Like during the previous two seasons, WDFW is implementing minimization measures in the fisheries it manages to limit the number of interactions that may occur with active gillnet gear. These include educational measures and existing regulatory measures such as an observer program, soak time limits, and lost gear reporting, which are described further in the Effects Section. Taking these and the minimal gillnet fishing effort expected based on the Fraser River sockeye forecasts into account, we anticipate that the proposed action may result in one interaction within the action area, which may range from minor (not serious injury) to mortality with an expectation that this individual would most likely be from the Hawaii DPS. Whales from the Hawaii DPS, which is not listed under the ESA, are likely the most common humpbacks in the area, however there is roughly a 30 percent chance of an interaction involving an ESA listed individual, which would most likely be from the Mexico DPS. To be conservative, we assume that this one interaction may involve a Mexico DPS individual. One interaction represents a very small proportion of the entire populations of either listed DPS and further only a portion of those interactions would be expected to result in serious injury or mortality, the risk to both populations are very low. For the Mexico DPS which has been showing signs of improvement in recent decades, as indicated by the recent listing as threatened as opposed to the formal global listing as endangered, this level of interaction would likely be undetectable. While the Central America DPS is smaller and has an estimated growth rate of only 1.6 percent per year (Curtis et al. 2022), the risk of an interaction is extremely low and would also likely be undetectable at a population level.

After reviewing and analyzing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed action, and cumulative effects, it is NMFS's opinion that the proposed action is unlikely to reduce the likelihood of either survival or recovery of the Central America or Mexico DPSs of humpback whales.

2.8 Conclusion

2.8.1 Puget Sound Chinook

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 Puget Sound Chinook salmon ESU or destroy or adversely modify its designated critical habitat.

2.8.2 Puget Sound Steelhead

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 Puget Sound Steelhead DPS or destroy or adversely modify its designated critical habitat.

2.8.3 Puget Sound/Georgia Basin Rockfish

After reviewing the current status of yelloweye rockfish and bocaccio within the Puget Sound/Georgia Basin DPSs, the environmental baseline for the action area, the effects of the proposed actions, the effects of other activities caused by the proposed action, and the cumulative effects, we conclude that the proposed actions are not likely to jeopardize the continued existence of each species of listed-rockfish or destroy or adversely modify designated critical habitat for each species.

2.8.4 Southern Resident Killer Whales

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 Southern Resident killer whales or destroy or adversely modify their designated critical habitat.

2.8.5 Central America and Mexico DPSs of Humpback Whales

After reviewing and analyzing the current status of the listed species, 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 endangered or threatened humpback whale DPSs.

2.9 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. “Take” is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. “Harm” is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). “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.

2.9.1 Amount or Extent of Take

In the biological opinion, NMFS determined that incidental take is reasonably certain to occur as follows:

2.9.1.1 *Puget Sound Chinook*

NMFS anticipates incidental take of listed Puget Sound Chinook adults (fishing activities) and juveniles and sub-adult (research activities) to occur in the proposed Puget Sound salmon and steelhead fisheries from May 15, 2024 through May 14, 2025 (2024 fishing year) through contact with fishing gear. This includes mortality associated with these fish being caught (landed mortality), and in some cases, released (a proportion of fish that are caught and released are assumed to die – this is non-landed mortality). NMFS anticipates Puget Sound salmon fisheries occurring during the 2024 fishing year will be limited to exploitation rates which, when combined with the exploitation rates in ocean fisheries that are not part of the fisheries of the proposed action, will not exceed the exploitation rates summarized in (Table 24) in the column titled Ocean + Puget Sound. These exploitation rates account for landed and non-landed mortality of listed Puget Sound Chinook encountered in the proposed fisheries. Test, research, update and evaluation fisheries that inform fishery management decisions are included as part of the fishery-related mortality reflected in Table 24.

The Ocean + Puget Sound exploitation rates are the best surrogate for actual mortality of listed Puget Sound Chinook because these rates are directly connected to the number of fish killed – they express a proportion of the total abundance of each population that are expected to be killed. We cannot provide a precise number of fish that we anticipate to be killed or injured by the fisheries, because this can vary based on the actual numbers of fish returning to Puget Sound relative to the pre-season forecasts, and because the fisheries are managed to stay within exploitation rates and/or to result in escapement levels—they are not managed to overall catch limits. For these reasons, we use a surrogate for the extent of take, described below. They therefore account for the fact that the actual returning abundance of each population may differ from the pre-season forecast. Additionally, we use exploitation rates to analyze the effects of the proposed action, above. The proposed fisheries are designed by the co-managers to avoid exceeding these exploitation rates by structuring the fisheries using timing, duration, gear, quotas, and other limitations. The co-managers track, assess, and report the resulting exploitation rates; therefore, we can compare the actual exploitation rates to the rates in Table 24.

Therefore, the extent of take is exceeded if the reported exploitation rates in the Puget Sound salmon fisheries, when combined with those from all other salmon fisheries, exceed those expressed in the column titled Ocean + Puget Sound in Table 24 of this document.

For the relatively small fishery related research studies whose impacts are not included in the exploitation rates described above, the documentation provided with the proposed action enumerates the number of expected mortalities (MIT and WDFW Lake Washington predator removal and research studies). Based on this information, NMFS anticipates that no more than 9 adult, 69 immature, and 11 juvenile natural-origin Chinook incidental mortalities may occur in the research studies discussed in this opinion from May 15, 2024 through May 14, 2025.

2.9.1.2 *Puget Sound Steelhead*

NMFS anticipates incidental take of Puget Sound Steelhead adults (fishing activities) and juvenile/immature fish (research) to occur in Puget Sound marine and freshwater commercial, recreational and ceremonial and subsistence, from May 15, 2024 through May 14, 2025 through contact with fishing gear.

NMFS anticipates that a maximum of 325 steelhead will be incidentally caught in Puget Sound marine area fisheries. This estimate includes an unknown proportion of ESA listed steelhead, unlisted hatchery steelhead, non-listed Olympic Peninsula fish, and hatchery and natural-origin fish from Canada.

NMFS also anticipates that the harvest rate on natural-origin steelhead in terminal tribal and non-tribal fisheries will be no more than 4.2% (Table 17) (James 2018d; Shaw 2018a; WDFW and PSIT 2018; Norton 2019a; WDFW and PSTIT 2019; Mercier 2023; 2024). This 4.2% will be calculated as an average across the four Puget Sound winter steelhead reference populations (Snohomish, Green, Puyallup and Nisqually). This rate is not a population-specific terminal harvest rate. NMFS does not have similar estimates of freshwater harvest for other Puget Sound steelhead populations. However, NMFS anticipates that the harvest rates for other populations will be within the range for the reference populations discussed above based on the similarity of expected fishing effort, catch patterns and fishing regulations.

Harvest rates are used to define the extent of take for several reasons: (1) they are a direct measure of the take of the listed species that incorporates both the landed and release mortality resulting from implementation of the proposed actions; (2) they are a key parameter used to analyze the effects of the proposed actions; (3) fisheries are generally designed and managed based on harvest rates rather than the mortality of individual fish; (4) they can be monitored and assessed; and, (5) they are responsive to changes in abundance over time and therefore a better measure of the effect on the listed species than just enumeration of individual fish.

NMFS anticipates that no more than 4 adult and 7 juvenile/immature steelhead mortalities will occur in the research studies discussed in this opinion (MIT and WDFW Lake Washington predator removal and research studies), from May 1, 2024 through May 14, 2025.

Therefore, the extent of take is exceeded if the reported, average terminal harvest rate, of the four reference populations (Table 17) exceeds 4.2% in the Puget Sound salmon fisheries, or if the incidental take of steelhead in the Puget Sound marine salmon fisheries exceeds 325.

2.9.1.3 *Puget Sound/Georgia Basin Rockfish*

We anticipate that incidental take of ESA listed rockfish adults would occur by two separate pathways: (1) bycatch of listed-rockfish by anglers targeting salmon, and (2) the indirect effects of lost (derelict) nets.

A number of devices have been invented and are used to return rockfish to the depth of their capture as a means to mitigate barotrauma and decrease mortality from bycatch. Bycatch fish would be released, and using the PFMC methodology we estimate that 56% would likely perish from barotrauma, related hooking injuries, and/or predation induced by injury. Based on the estimated catch rates from previous years, and the percent mortality applied (see Section 2.5.3.1), we anticipate that up to 66 yelloweye rockfish, and 77 bocaccio would be killed annually as bycatch by recreational and commercial anglers during the 2024/25 Puget Sound salmon fishing season.

We also anticipate that some minimal take of ESA-listed rockfish would occur as a result of the indirect effects of lost nets in the Puget Sound/Georgia Basin. We estimate that up to 20 gill nets from salmon fisheries may become lost, and of those up to five nets would not be retrieved. If those five nets are lost within rockfish habitat, they would degrade benthic areas potentially used by ESA-listed rockfish. Estimating the specific number of ESA-listed rockfish that may be killed from a new derelict net is difficult to quantify because of several factors, including the location of its loss, the habitat which it eventually catches on, and the occurrence of fish within or near that habitat, therefore we are using the number of nets lost and not retrieved (5) as a surrogate for the number of rockfish taken. However, it is unlikely that mortality resulting from derelict nets associated with the action would cause mortality levels of yelloweye rockfish and bocaccio to exceed the precautionary or risk-adverse levels, as described in Section 2.7.3.

2.9.1.4 *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 in the action area (inland waters of their range). There are no data available to help NMFS quantify impacts to foraging behavior or any changes to health of individual killer whales in the population from a specific amount of removal of potential prey resulting from the Puget Sound fisheries, as quantitative regression analyses have limitations (see Section 2.5.4.1). Therefore, NMFS is using the level of Chinook salmon catch in the Puget Sound fisheries, which we can quantify, as a surrogate for incidental take of SRKW. Chinook salmon catch in Puget Sound relates directly to the extent of effects on prey availability from the proposed action related to the Puget Sound fisheries, as we would expect catch to be proportional to the reduction in prey in a given year.

As described above, NMFS anticipates Puget Sound salmon fisheries occurring in 2024-2025 will be limited to exploitation rates which, when combined with the exploitation rates in ocean fisheries that are not part of the fisheries of the proposed action, will not exceed the exploitation rates summarized in Table 24 in the column titled Ocean + Puget Sound. The estimated effect for killer whales for a reduction in Chinook salmon prey and impacts from vessels and noise would be highest in inland waters from July through September and represents an approximate 4.9% annual reduction in the abundance of large (age 3-5) Chinook salmon in the action area as estimated by FRAM-Shelton et al. (2021) methods with modifications for use in Puget Sound compared to previous opinions. This approximate 4.0% reduction in prey availability is what we expect to occur as a result of the proposed fisheries at the total exploitation rates within the levels described in Table 24. We believe these exploitation rates are the best surrogate for take of Southern Resident killer whales because these rates are used to manage the fisheries, are the best measure of fishing effort that results in prey reduction, and are monitored. Therefore, the extent of take for killer whales will be exceeded if the amount of take for Puget Sound Chinook salmon is exceeded.

2.9.1.5 *Central America and Mexico DPSs of Humpback Whales*

In the opinion, NMFS determined that the incidental take of Central America and Mexico DPSs of humpback whales may occur as a result of interactions with net fisheries, most likely to occur in Northern Puget Sound. Humpback whale interactions with Puget Sound fisheries, considered as take in the opinion, include entanglement in a net or other components of fishing gear. In the Effects Section, we estimated one interaction of a humpback whale with the Puget Sound fisheries for 2024-2025, ranging from minor (not serious injury) to mortality, with potential for this to be a take from a listed DPS. This interaction would most likely be with a whale from the unlisted Hawaii DPS, as they likely have the highest abundance in Washington waters, but it could be from the Mexico DPS and is unlikely to be from the Central America DPS. There is uncertainty around which DPSs are found within the action area, and therefore we used a conservative approach when assessing the number of possible interactions with whales from these DPSs.

While we are able to describe an amount of take that we expect to occur, monitoring of ESA-listed humpback whale interactions in the Puget Sound fisheries does not occur at a level that allows us to directly and effectively monitor those interactions. The State gillnet fishery has fish observer requirements that may observe and report on interactions between humpback whales and the fishery, but the observers are primarily focused on the purse seine fishery and are not marine mammal observers. Furthermore, ESA-listed and non-listed humpbacks co-occur in the action area and are not readily distinguishable, and not likely identified in opportunistic reports. Because we cannot directly monitor take of the two ESA-listed DPSs, we use a surrogate (humpback whales from any DPS) for the extent of take, which is capable of being monitored for purposes of determining when the surrogate has been exceeded. Entanglements of marine mammals in fishing gear must be reported in accordance with the MMPA. MMPA Section 118 established the 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. Reports from NMFS' entanglement database, which also includes stranded animals, were used to assess risk of entanglement. We will use these in-season mandatory reports and stranding information, identified at the species level as a surrogate for the amount of take that occurs in the Puget Sound salmon fisheries under the proposed action. Therefore, the incidental take limit for Central America and Mexico DPSs of humpback whales is one humpback whale (likely of unknown DPS origin) interaction (i.e. any contact with fishing gear or a vessel that results in any injury or potential injury to a whale) reported as part of the Puget Sound salmon fishery during the 2024-2025 fishing season.

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 thos actions the Director considers necessary or appropriate to minimize the impact of the incidental take on the species (50 CFR 402.02).

The following reasonable and prudent measures are included in this incidental take statement for the *Puget Sound Chinook salmon ESU and Puget Sound steelhead DPS* considered in this opinion. Although the federal agencies are responsible for carrying out this reasonable and prudent measure, in practical terms, it is the states and tribes that monitor catch impacts and regulate fisheries:

(1) In-season management actions taken during the course of the fisheries shall be consistent with the level of incidental take established preseason that were analyzed in the opinion (see Section 2.5.1.2 and 2.5.2.2) and defined in Section 2.9.1.1 and 2.9.1.2.

(2) Catch and the implementation of management measures used to control fisheries shall

be monitored using best available measures

(3) The fisheries shall be sampled for stock composition and other biological information.

(4) Post season reports shall be provided describing the take of listed salmon and steelhead in the proposed fisheries, resulting catch and escapement estimates from the 2024-25 fisheries, results of biological sampling, and related research studies. Managers shall use results to improve management of Puget Sound Chinook and steelhead to ensure management objectives are met.

The following reasonable and prudent measures are included in this incidental take statement for *Southern Resident killer whales*:

(5) NMFS, in consultation with the co-managers, will estimate the abundance of Chinook before and after fishery removals, using postseason information as it becomes available.

(6) NMFS, in consultation with the co-managers, will monitor and review the predicted percent reductions and realized catch of Southern Resident killer whale Chinook prey by fisheries using the best available measures.

(7) NMFS will coordinate across multiple partners including with the co-managers, the State, and DFO to promote and coordinate conservation efforts for Southern Resident killer whales

The following reasonable and prudent measures are included in this incidental take statement for *Central America and Mexico DPSs of Humpback Whales*:

(8) Monitor and report the extent of fishery interactions with ESA-listed marine mammals, including individuals that are likely, but not confirmed as part of an ESA-listed humpback DPS.

(9) Minimize incidental take of ESA-listed humpback whales through implementing entanglement minimization measures for gillnet fishing to reduce the risk of entanglement and reduce the risk of an entanglement resulting in a serious injury/mortality.

(10) Minimize incidental take of ESA-listed humpback whales through implementing best practices to avoid overlap of fishing gear and transiting vessels with humpback whales.

NMFS also concludes that the following reasonable and prudent measures are necessary to minimize the impacts to ESA listed *Puget Sound/Georgia Basin rockfish:*

(11) Derelict gear impacts on listed rockfish shall be reported using best available measures.

(12) Bycatch of ESA-listed rockfish shall be estimated and reported using 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, BIA, and USFWS or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

The following terms and conditions implement reasonable and prudent measures for *Puget Sound Chinook salmon and Steelhead*:

1a. The action agencies will work with the Puget Sound tribes and WDFW to ensure that in-season management actions taken during the course of the fisheries are consistent with the levels of anticipated take.

1b. The affected treaty tribes and WDFW, when conducting harvest research studies involving electrofishing, will follow NMFS' *Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act* (NMFS 2000a).

1c. The co-managers and NMFS will meet by phone to discuss the initial results of the Green River in-season run size update (weeks 29-31). NMFS will be informed of any subsequent management actions taken by the state and tribal co-managers that deviate from the pre-season fishery structure in the 2024-2025 List of Agreed to Fisheries.

1d. The co-managers shall provide to NMFS supplemental harvest plans regarding the spring fisheries for the April-May 14, 2025 period, relative to the management objectives described in Table 25 (described in Section 2.5.1.2, under *Spring Chinook Fisheries*). These plans should be submitted at the conclusion of the 2025 pre-season PFMC process.

2. The action agencies will work with the Puget Sound treaty tribes and WDFW to ensure that the catch and implementation of management measures associated with fisheries that are the subject of this opinion are monitored at levels that are comparable to those used in recent years or using suitable alternatives if sampling access is limited. The effectiveness of the management measures will be assessed in the postseason report.

3. The action agencies will work with the Puget Sound treaty tribes and WDFW to ensure that the fisheries that are the subject of this opinion are sampled for stock composition to the extent access to the fish for sampling is possible, including the collection of coded-wire tags and other biological information (age, sex, size) to allow for a thorough post-season analysis of fishery impacts on listed species and to improve preseason forecasts of abundance. This includes:

    i. ensuring that the fisheries included in this opinion are sampled for contribution of hatchery and natural-origin fish and the collection of biological information (age, sex, and size) to allow for a thorough post-season analysis of fishery impacts on listed Chinook and steelhead species.

ii. evaluating the potential selective effects of fishing on the size, sex composition, or age composition of listed Chinook and steelhead populations as data become available.

iii. using the information, as appropriate, together with estimates of total and natural-origin Chinook and wild steelhead encounters and mortalities (summer and winter-run) to report fishery impacts by population.

4a. The action agencies will work with the Puget Sound treaty tribes and WDFW to provide two post season reports for the 2024-2025 fishery that include:

i. the first report will include preliminary estimates of Chinook salmon catch and encounters in the fisheries that are the subject of this opinion, including reference to pre-season expectations, as well as preliminary spawning escapement estimates for the Chinook salmon populations affected by these fisheries, where data are available. This preliminary report shall be provided by March 15, 2025.

ii. The second report shall be a final report detailing the results of the 2024-25 season for the fisheries that are the subject of this opinion. These results shall include: Chinook salmon management unit objectives for the 2024-2025 season; projected and actual landed Chinook salmon catch in Puget Sound Commercial fisheries; projected and actual landed Chinook salmon catch in Puget Sound recreational fisheries in 2024, where creel surveys were conducted, as well as estimates of 2023 Puget Sound recreational Chinook salmon catch; Estimates of total encounters for the 2024 summer mark-selective fisheries and non-landed mortality in commercial fisheries with Chinook non-retention in place; the final estimates will include catch and encounters in the research studies discussion in Section 2.5.2.2; projected and actual 2024 spawning escapement estimates for all Puget Sound Chinook salmon populations, where data is available; and coded-wire tag sampling rates for commercial and recreational fisheries for calendar year 2024. This final report on the 2024-25 Puget Sound fisheries shall be provided by October 31, 2025. The information will be used to assess consistency with the extent of take specified in the Incidental Take Statement (Section 2.9.1.1).

4b. The action agencies will work with the affected treaty tribes and WDFW, to provide postseason reports for the 2024 steelhead fishery season summarizing effects on all steelhead DIPs affected by the proposed fisheries as identified in this opinion, where data are available, no later than February 18, 2025. The postseason report will include:

i. identification of compliance with the fishery regimes (including test fisheries) and incidental harvest rate of steelhead mortalities in the tribal and WDFW salmon and steelhead fisheries described in this opinion;

ii. a description of the method used to estimate postseason harvest and a description of any changes to the estimation methodologies used for assessing escapement and/or harvest rates.

4c. The action agencies will work with the Puget Sound treaty tribes and WDFW to implement or improve escapement monitoring for all Puget Sound Chinook and steelhead populations that are affected by the proposed actions to improve escapement estimation and to determine and/or augment exploitation rate and harvest rate estimates on natural-origin Chinook and steelhead stocks.

4d. The co-managers shall monitor salmon catch using measures and procedures that provide reliable accounting of the catch of Chinook.

<u>The following terms and conditions implement reasonable and prudent measures for *Southern Resident Killer Whales*</u>:

5. NMFS, in consultation with the co-managers, will estimate, using the best available science, the observed abundance of age 3+ Chinook before and after fishery removals when post-season data becomes available.

6. NMFS will continue to explore improvements to the PFMC ad-hoc Workgroup methods, including analytic assessment of the amount of Chinook removals by fisheries, assessing fishery effects to SRKW through prey removal, and providing a method for managing these effects as necessary. This work should:
    - assess annual post-season fishery abundance reductions (in percent reduction) using PFMC Workgroup or appropriate updated methodology for application to Puget Sound Chinook salmon
    - be responsive to the status of SRKWs and Chinook salmon, and
    - identify the need for thresholds for Chinook salmon abundance in the Salish Sea and prey reductions from fisheries or other mitigation measures to inform fishery adjustments in order to increase prey availability.

7a. NMFS, in cooperation with the affected co-managers, shall ensure that any commercial vessel owner or operator participating in the fishery complies with 50 CFR 229.6 and reports all incidental injuries or mortalities of Southern Resident killer whales that occur during commercial fishing operations to NMFS (or in the case of tribes, voluntary reports). "Injury" is defined in 50 CFR 229.2 as a wound or other physical harm. In addition, any animal that ingests fishing gear, or any animal that is released with fishing gear entangling, trailing, or perforating any part of the body is considered injured and must be reported.

7b. NMFS will engage in ongoing coordination and communication with Canada’s Department of Fish and Oceans with the goal of ensuring that complementary actions are taken in Canadian fisheries that affect the abundance of Chinook prey available to Southern Resident killer whales

7c. Monitoring – NMFS and the co-managers will discuss methods for acoustic monitoring to assess the noise level increases from recreational fishing practices off the west side of San Juan Island during July-September fisheries. NMFS and the co-managers will also consider and discuss methods for assessing area-specific abundance of Chinook, specifically to quantify prey availability in SRKW foraging hotspots during summer

(July-September) and measures to assess stock composition of Chinook off the west side of San Juan Island.

The following terms and conditions implement reasonable and prudent measures for *Humpback Whales*:

8a. The co-managers shall ensure that any commercial vessel owner or operator participating in the fishery complies with 50 CFR 229.6 and reports all incidental injuries or mortalities of humpback whales that occur during commercial fishing operations to NMFS (or in the case of tribes, voluntary reports). "Injury" is defined in 50 CFR 229.2 as a wound or other physical harm. In addition, any animal that ingests fishing gear, or any animal that is released with fishing gear entangling, trailing, or perforating any part of the body is considered injured and must be reported. The co-managers shall report humpback whale entanglements to NMFS as close to real time as possible.

8b. The co-managers shall report to NMFS if the Fraser River sockeye run size is greater than the pre-season estimate and will involve more fishing effort than described in the LOAF and the anticipated effort described in Section 2.5.5. of this consultation.

8c. WDFW shall provide NMFS with an end of season summary report discussing the number of humpback whales observed within 100 yards of the actively fishing and transiting vessels. The report shall discuss the amount of the gillnetting activity observed, by location, such as the number of vessels per day and the percentage of gillnet fishing effort that was observed during the year.

9a. WDFW require non-tribal gillnet observers to undergo a training by NOAA, or a NOAA selected organization, on humpback whale entanglement response prior to the opening of the non-tribal gillnet fishery in any C-MAs.

9b. WDFW shall provide information on large whale entanglements, the whale entanglement hotline, and Be Whale Wise guidelines for large whales in its “fish friendly” training for new participants in the C-MA 7 and 7A commercial salmon fishery. WDFWshall work with NMFS on appropriate language and information to include in the training.

9c. WDFW shall include information on large whale entanglements, the whale entanglement hotline, and Be Whale Wise guidelines for large whales in the 2024-2025 commercial salmon regulations pamphlet. WDFW shall work with NMFS on appropriate language and information to include in the pamphlet.

10. WDFW shall require the gillnet fishers to conduct a scan for humpback whales within 100 yards of their vessel before dropping their nets.

The following terms and conditions implement reasonable and prudent measures for *Puget*

Sound/Georgia Basin rockfish:

11. NMFS, in cooperation with BIA, the USFWS, WDFW and the Puget Sound tribes, shall minimize take and monitor the number of derelict fishing nets that occur on an annual basis by:
    - Derelict Gear Reporting. Requiring all derelict gear to be reported to appropriate authorities within 24 hours of its loss.
    - Derelict Gear Accounting and Location. Recording the total number and approximate locations of nets lost (and subsequently recovered) on an annual basis.
    - Derelict Gear Prevention. The BIA, USFWS and NMFS in collaboration with the state and tribes, shall continue to conduct outreach and evaluate technologies and practices to prevent the loss of commercial fishing nets, and systems to track nets upon their loss, to better aid their retrieval and other measure necessary to prevent and track lost gear.
12. NMFS in cooperation with BIA, the USFWS, WDFW and the Puget Sound Treaty tribes, shall minimize take and monitor the number of yelloweye rockfish and bocaccio incidentally caught by fishermen targeting salmon, on an annual basis by:
    - Monitoring fisheries through fishermen interviews, fish tickets, and phone surveys, as applicable, at levels comparable to recent years.

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 the BIA, USFWS and NMFS in cooperation with the Puget Sound treaty tribes.

(1) As discussed in Section 2.5.1.2, preseason abundance expectations still present challenges for terminal area management for the Puyallup and Skokomish populations in maximizing harvest and achieving management objectives. Improvements in inseason management tools including inseason abundance updates would be useful in addressing these issues and have value for fisheries beyond those in the terminal area. The Action Agencies in collaboration WDFW and the affected Puget Sound treaty tribes should explore and identify methods to update abundance inseason that would be useful for managing fisheries for these populations, particularly in terminal areas, to better achieve management objectives.

(2) The Action Agencies in collaboration with WDFW and the Puget Sound treaty tribes

should continue to improve on the monitoring of the salmon and steelhead populations that are affected by the proposed action using available resources.

(3) The Action Agencies in collaboration with WDFW and the Puget Sound treaty tribes should continue to evaluate improvement in gear technologies and fishing techniques in treaty tribal and U.S. Fraser Panel fisheries to reduce impacts on listed species without compromising data quality used to manage fisheries.

(4) The Action Agencies in collaboration with the WDFW and the Puget Sound treaty Tribes, should continue to collect data on steelhead populations where insufficient data exist and improve upon catch accounting for all steelhead populations as resources become available.

(5) The Action Agencies in collaboration with the WDFW, and the Puget Sound treaty tribes, should implement the recommendations for the prevention, retrieval and investigation of gear modifications of gill nets used in Puget Sound treaty tribal and U.S. Fraser Panel salmon fisheries reported in Gibson (2013).

(6) The Action Agencies in collaboration with the WDFW, and the Puget Sound treaty tribes should explore inclusion of environmental variables into preseason forecasts and use of in-season management to improve their performance and utility in management.

(7) The Action Agencies in collaboration with the WDFW, and the Puget Sound treaty tribes should work to require the use of descending devices to release incidentally encountered rockfish in salmon fisheries with barotrauma.

(8) NMFS should pursue research into the co-occurrence between humpback whales and fisheries within the action area, particularly as it relates to the composition and distribution of humpback whale prey and predictive models for whale concentrations and foraging conditions.

(9) NMFS should continue to support humpback whale photo-identification research in order to understand which DPSs are found within the action area.

(10) The Action Agencies in collaboration with the WDFW, and the Puget Sound treaty tribes should work to train commercial fishermen on how to respond if they encounter an entangled humpback whale or other marine mammal as part of participation in the fishery.

(11) The co-managers and NMFS should examine best practices for gear marking of gillnets to assist in identifying the fishery responsible for the entanglement and discuss implementation of gear marking measures in future fishery seasons, including considerations for a regional management plan for the fishery.

(12) NMFS and the co-managers should work together to determine a reporting mechanism for humpback whale sightings and the co-occurrence with transiting and active fishing vessels for all gear types included in the salmon fishery. Until and unless a different platform is selected, the co-managers should encourage fishers to report humpback whale sightings to the Whale Museum Museum or WRAS.

(13) In addition to the scans discussed in Term and Condition 10a above, the State should encourage gillnet fishers, if they see a humpback whale within approximately 100 yards of their vessel, to wait to drop their nets until the whale is spotted again outside of the 100-yard buffer or 10 minutes has passed since the last sighting.

(14) Continue and expand education and outreach for fishing communities through promoting

Be Whale Wise guidelines and regulations, online training for professional mariners, and encouraging reports of killer whale sightings.

(15) NMFS should continue to review and monitor the SRKW status, which includes diet, spatial and temporal geographic distribution, and SRKW body condition and health when new data are available.

(16) NMFS, will improve understanding of links between prey availability and SRKW body condition and any links to reproduction or survival, and continue to explore relationships between body condition of SRKWs and specific Chinook abundance indicators (similar to Stewart et al. (2021)) for potential use in management as an indication of high risk conditions for SRKWs.

(17) NMFS will update (SRKWs metabolic needs compared to prey available) to reflect current population estimates and utilize current salmon modeling methodologies. NMFS will also improve understanding of foraging efficiency to validate estimates of metabolic needs and inform evaluation of levels of abundance and distribution of prey needed to support growth and reproduction.

2.11 Reinitiation of Consultation

This concludes formal consultation for the impacts of the Role of the BIA Under its Authority to Assist with the Development of the 2024-2025 Puget Sound Chinook Harvest Plan, the Role of the U.S. Fish and Wildlife Service in Activities Carried out under the Hood Canal Salmon Management Plan and the Office of Conservation funding to the Washington Department of Fish and Wildlife under the Sport Fish Restoration Act in 2024-2025, and the Role of the National Marine Fisheries Service in authorizing fisheries consistent with management by the Fraser Panel and Funding Provided to the Washington Department of Fish and Wildlife for Activities Related to Puget Sound Salmon Fishing in 2024-2025.

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 on 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

We do not anticipate the proposed actions will take sunflower sea star, southern DPS green sturgeon, or southern DPS eulachon which occur in the action area, or adversely affect their critical habitat. Additionally, we do not anticipate adverse impacts on designated critical habitat for Central America and Mexico humpback whale DPSs.

Sunflower Sea Star

The sunflower sea star (*Pycnopodia helianthoides*) is a voracious marine mesopredator that occurs along the west coast of North America from Baja California Sur, Mexico, to the Bering Sea, Alaska (Gravem et al. 2021; Lowry et al. 2022b). It is a habitat generalist known to occur to at least 425 m deep, but plays a crucial role in regulating kelp forest ecosystems through its top-down control of urchins and other kelp consumers (Traiger 2017; McPherson et al. 2021; Galloway et al. 2023; Tolimieri et al. 2023). On March 16, 2023, NMFS proposed to list the sunflower sea star as a threatened species under the ESA (88 FR 16212) (NMFS 2023e). A final listing decision is anticipated in summer of 2024.

Sunflower sea stars are highly unlikely to be caught in Puget Sound salmon fisheries for two major reasons. First, the prevalence of sunflower sea star bycatch by halibut longlining gear, crab pots, and derelict fishing gear demonstrates that interactions are heightened when bait/carrion is in contact with the benthos for extended duration (Gilardi et al. 2010; Antonelis et al. 2011; NMFS 2023d), which is not the case during salmon fishing with hook-and-line or nets. Net gear used in terminal and nearshore areas throughout the action area is fished at the surface and is generally not left unattended. Post-larval sunflower sea stars are strictly benthic, putting them out of reach of these nets. NMFS is not aware of any records or reports of sunflower sea stars being caught in Puget Sound salmon fisheries. Any contact of the gear with the bottom during fishing would be rare and inadvertent. NMFS would not expect sunflower sea stars to be caught in, or otherwise affected by, the proposed fisheries, given this separation in space. Second, sunflower sea stars are now rare in Puget Sound, and the Salish Sea at large, after experiencing an estimate 91.9 percent population decline from 2013-17 as a result of Sea Star Wasting Syndrome (Gravem et al. 2021; Lowry et al. 2022b). While batches of newly settled individuals have been reported several times since, recruits generally waste prior to reaching a size where they might interact with hook-and-line gear used to target salmon feeding off the bottom when it incidentally makes bottom contact. Based on this analysis, NMFS finds that the potential for the proposed action to affect sunflower sea stars is discountable and determines that the proposed action may affect but is not likely to adversely affect the species.

The sunflower sea star is a habitat generalist that has been recorded on a wide diversity of substrate types, of varying complexity, with and without vegetative cover (Gravem et al. 2021; Lowry et al. 2022b; Galloway et al. 2023; Tolimieri et al. 2023; Smith, Malone and Carr 2024). Furthermore, evaluations of habitat associations for this species are characterized by a substantial bias toward both depths that can be accessed using scuba gear and complex habitat, such as rock piles and kelp forests (Lowry et al. 2022b). As a result, NMFS determined in the proposed listing that critical habitat was not determinable for the sunflower sea star (88 FR 16212). Only if/when critical habitat is designated for the sunflower sea star will an analysis of impacts to this habitat be possible.

Green Sturgeon

Green sturgeon (*Acipenser medirostris*) are long-lived, anadromous fish that occur along the west coast of North America from Mexico to the Bering Sea. Green sturgeon consists of two

DPSs that co-occur throughout much of their range, but use different river systems for spawning. The Southern DPS consists of all naturally-spawned populations of green sturgeon originating from coastal watersheds south of the Eel River (Humboldt County), California, whereas the Northern DPS consists of populations originating from coastal watersheds north of and including the Eel River. On April 7, 2006, NMFS listed the Southern DPS green sturgeon as a threatened species and maintained the Northern DPS as a NMFS Species of Concern (71 FR 17757). On October 9, 2009, NMFS designated critical habitat for Southern DPS green sturgeon (74 FR 52300).

Individuals of the Southern DPS green sturgeon are unlikely to be caught in Puget Sound salmon fisheries. First, green sturgeon do not appear to use Puget Sound very extensively. Observations of green sturgeon in Puget Sound are much less common compared to the other estuaries in Washington, and monitoring data for tagged green sturgeon show few detections in Puget Sound (NMFS 2009). In addition, most marine area fisheries use hook-and-line gear to target pelagic feeding salmon near the surface and in mid-water areas. Net gear that is used in terminal and nearshore areas throughout the action area is fished at the surface. Green sturgeon are bottom oriented, benthic feeders. NMFS is not aware of any records or reports of green sturgeon being caught in Puget Sound salmon fisheries. Any contact of the gear with the bottom would be rare and inadvertent. NMFS would not expect green sturgeon to be caught in or otherwise affected by the proposed fisheries, given the separation in space and differences in feeding habitats between green sturgeon and salmonids as well as the nature and location of the salmon fisheries. Based on this analysis, NMFS finds that the potential for the proposed action to affect this species is discountable and determines that the proposed action may affect but is not likely to adversely affect Southern DPS green sturgeon.

Designated critical habitat for Southern DPS green sturgeon does not include Puget Sound, but does include the Strait of Juan de Fuca (74 FR 52300). The designated critical habitat within the Strait of Juan de Fuca contains all three essential habitat features for green sturgeon: food resources, water quality, and a migratory corridor. We do not expect the proposed Puget Sound salmon fisheries to have a measurable effect on these essential features. First, the proposed fisheries are not expected to catch or affect prey species for green sturgeon (i.e., benthic invertebrates and fish such as shrimp, clams, crabs, anchovies, sand lances) (Moyle et al. 1995; Erickson et al. 2002; Moser and Lindley 2007; Dumbauld, Holden and Langness 2008). Second, the proposed fisheries are not expected to affect dissolved oxygen or contaminant levels in the designated critical habitat areas. Finally, the proposed fisheries are not likely to reduce the quality of the migratory corridor for green sturgeon, because the proposed salmon fisheries use hook-and-line gear that is fished near the surface or mid-water, or net gear that is fished at the surface, with limited contact with bottom habitat. Given the nature and location of the proposed salmon fisheries, NMFS would not expect measurable effects on the essential features of designated critical habitat. Based on this analysis, NMFS finds that the potential for the proposed action to affect this critical habitat is discountable and determines that the proposed action may affect but is not likely to adversely affect designated critical habitat for Southern DPS green sturgeon.

Eulachon

Eulachon (*Thaleichthys pacificus*) are endemic to the northeastern Pacific Ocean ranging from northern California to southwest and south-central Alaska and into the southeastern Bering Sea (Gustafson et al. 2010). Eulachon are anadromous, spawning in the lower reaches of rivers, followed by a movement to the ocean as small pelagic larvae. Although they spawn in fresh water rivers and streams, eulachon are mainly a marine fish, spending 95% of their lives in marine waters (Hay and McCarter 2000). Eulachon are a short-lived smelt (3-5 years), that averages 40g in weight and 10-30cm in length (Gustafson et al. 2010). Puget Sound lies between two of the larger eulachon spawning rivers (the Columbia and Fraser rivers) but lacks a large eulachon run of its own (Gustafson et al. 2010). Since 2011, eulachon have been found in small numbers throughout Puget Sound and in several watersheds including the Deschutes River, Dungeness River, Elwha River, Goldsborough Creek (Mason Co.), Nisqually River, and Salmon Creek (Jefferson Co.) (NMFS APPS database; https://apps.nmfs.noaa.gov/). Historically, major aboriginal subsistence fisheries for eulachon occurred from northern California into Alaska where the eulachon were eaten fresh, smoked, dried, and salted, and rendered as oil or grease (Gustafson et al. 2010). Since 1888, the states of Washington and Oregon have maintained commercial and recreational eulachon fisheries using small-mesh gillnets (i.e., ≤2 inches) and dipnets (Gustafson et al. 2010). Following the 2010 ESA-listing of the southern DPS of eulachon, the states of Washington and Oregon closed the commercial and recreational eulachon fisheries. In 2014, a reduced Level-I eulachon fishery in the Columbia River and select tributaries began which limits eulachon fisheries to 1% of its spawning stock biomass (Gustafson et al. 2016). Eulachon are also taken as bycatch in the pink shrimp and groundfish fisheries off of the Oregon, Washington, and California coasts (Al-Humaidhi et al. 2012). Salmon fisheries in the northern Puget Sound areas, however, use nets with larger mesh sizes (i.e., >4 inches) and hook and line gear designed to catch the much larger salmon species. The deployed gear targets pelagic feeding salmon near the surface and in mid-water areas. Thus, eulachon bycatch in salmon fisheries is extremely unlikely given these general differences in spatial distribution and gear characteristics. In fact, NMFS is unaware of any records of eulachon caught in either commercial or recreational Puget Sound salmon fisheries. Therefore, NMFS would not expect eulachon to be caught or otherwise affected by the proposed fisheries, making any such effects discountable. The proposed salmon fisheries, therefore, are not likely to adversely affect eulachon or its designated critical habitat.

Humpback Whale Critical Habitat

NMFS designated critical habitat for humpback whales on April 21, 2021 (86 Federal Regulation (FR) 21082). The area proposed stretches across the majority of the west coast of the United States and includes 59,411 square nautical miles (nmi)^2 for the Western North Pacific DPS, 48,521 nmi^2 for the Central American DPS, and 116,098 nmi^2 for the Mexico DPS. The nearshore critical habitat boundary in Washington is defined by the 50-m isobath, and the offshore boundary is defined by the 1,200-m isobath relative to MLLW. Critical habitat also includes waters within the U.S. portion of the Strait of Juan de Fuca to an eastern boundary line at Angeles Point at 123°33′ W. Of the designated critical habitat areas, only 3,441 nmi^2 of critical habitat for the Central America and Mexico DPSs is designated along the Washington coast and into the Strait of Juan de Fuca. The action area includes the portion of the critical habitat within the Strait of Juan de Fuca and near Cape Flattery on the outer coast. No critical habitat for the Western North Pacific DPS is designated within the action area.

The Critical Habitat Review Team (CHRT) identified a prey biological feature that is essential to the conservation of the two humpback whale DPSs. Prey species for the Central America DPS are defined in the designation as “primarily euphausiids (*Thysanoessa, Euphausia*, *Nyctiphanes*, and *Nematoscelis*) and small pelagic schooling fishes, such as Pacific sardine (*Sardinops sagax*), northern anchovy (*Engraulis mordax*), and Pacific herring (*Clupea pallasii*) of sufficient quality, abundance, and accessibility within humpback whale feeding areas to support feeding and population growth.” Prey species for the Mexico DPS are defined in the designation as “primarily euphausiids (*Thysanoessa*, *Euphausia*, *Nyctiphanes*, and *Nematoscelis*) and small pelagic schooling fishes, such as Pacific sardine (*Sardinops sagax*), northern anchovy (*Engraulis mordax*), Pacific herring (*Clupea pallasii*), capelin (*Mallotus villosus*), juvenile walleye pollock (*Gadus chalcogrammus*), and Pacific sand lance (*Ammodytes personatus*) of sufficient quality, abundance, and accessibility within humpback whale feeding areas to support feeding and population growth.”

The proposed action would have minimal overlap with the designated critical habitat. The type of fishing gear used by the co-managers is not likely to result in bycatch of humpback whale prey species. Because the designated humpback whale critical habitat has limited overlap with the action area and the action is not likely to result in meaningful bycatch of humpback whale prey, the essential biological feature identified in the designation, any impacts of the action on humpback whale critical habitat are considered to be insignificant and discountable. As such, the proposed salmon fisheries are not likely to adversely affect humpback whale designated critical habitat.

3.0 MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT CONSULTATION AND ESSENTIAL FISH HABITAT RESPONSES

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, biological, and chemical 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 site-specific or EFH-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 [CFR 600.905(b)].

This analysis is based, in part, on the EFH assessment provided by the NMFS and descriptions of EFH for Pacific Coast groundfish (Pacific Fishery Management Council (PFMC 2005), coastal pelagic species (CPS) (PFMC 1998), and Pacific Coast salmon (PFMC 2014) 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 action area is described in Section 2.3. It includes areas that are designated EFH for various life stages of Pacific Coast salmon, Pacific Coast groundfish, and coastal pelagic species managed by the PFMC.

Marine EFH for Chinook, coho and Puget Sound pink salmon in Washington, Oregon, and California includes all estuarine, nearshore and marine waters within the western boundary of the EEZ, 200 miles offshore. Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds, wetlands, and other water bodies currently, or historically accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable man-made barriers, and longstanding, naturally-impassable barriers (i.e., natural waterfalls in existence for several hundred years). Designated EFH within the action area includes the major rivers and tributaries, and marine waters to the east of Cape Flattery in the hydrologic units identified for Chinook, coho salmon and Puget Sound pink salmon. In those waters, it includes the areas used by Chinook, coho and pink adults (migration, holding, spawning), eggs and alevins (rearing) and juveniles (rearing, migration). A more detailed description and identification of EFH for salmon is found in Appendix A to Amendment 18 to the Pacific Coast

Salmon Plan (PFMC 2014c).

Essential fish habitat for groundfish includes all waters, substrates and associated biological communities from the mean higher high water line, or the upriver extent of saltwater intrusion in river mouths, seaward to the 3500 m depth contour plus specified areas of interest such as seamounts. A more detailed description and identification of EFH for groundfish is found in the Appendix B of Amendment 19 to the Pacific Coast Groundfish Management Plan (PFMC 2014b).

Essential fish habitat for CPS is defined based on the temperature range where they are found, and on the geographic area where they occur at any life stage. This range varies widely according to ocean temperatures. The east-west boundary of CPS EFH includes all marine and estuary waters from the coasts of California, Oregon, and Washington to the limits of the EEZ (the 200-mile limit) and above the thermocline where sea surface temperatures range between 10° and 26° centigrade. The southern boundary is the U.S./Mexico maritime boundary. The northern boundary is more changeable and is defined as the position of the 10° C isotherm, which varies seasonally and annually. In years with cold winter sea surface temperatures, the 10° C isotherm during February is around 43° N latitude offshore, and slightly further south along the coast. In August, this northern boundary moves up to Canada or Alaska. Assessment of potential adverse effects on these species EFH from the proposed actions is based, in part, on this information. A more detailed description and identification of EFH for coastal pelagic species is found in Amendment 8 to the Coastal Pelagic Species Fishery Management Plan (PFMC 2016).

3.2 Adverse Effects on Essential Fish Habitat

3.2.1 Salmon

The PFMC assessed the effects of fishing on salmon EFH and provided recommended conservation measures in Appendix A to Amendment 18 of the Pacific Coast Salmon Plan (PFMC 2014c). The PFMC identified five fishing-related activities that may adversely affect EFH including: (1) fishing activities; (2) derelict gear effects; (3) harvest of prey species; (4) vessel operations; and (5) removal of salmon carcasses and their nutrients from streams. Of the five types of impact on EFH identified by the PFMC for fisheries, the concerns regarding gear-substrate interactions, removal of salmon carcasses, redd or juvenile fish disturbance and fishing vessel operation on habitat are also potential concerns for the salmon fisheries in Puget Sound. However, the PFMC recommendations for addressing these effects are already included in the proposed actions.

Fishing Activities

Most of the harvest related activities in Puget Sound 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 and set gillnets, beach seines, and to a limited extent, purse seines. The types of salmon fishing gear that are used in Puget Sound 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 fishery implementation plan includes 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 Puget Sound salmon fisheries (i.e., recreational boating and marine species fisheries). Therefore, the proposed fisheries would have a negligible additional impact on the physical environment.

Derelict Gear

When gear associated with commercial or recreational fishing breaks free, is abandoned, or becomes otherwise lost in the aquatic environment, it becomes derelict gear. In commercial fisheries, trawl nets, gillnets, long lines, purse seines, crab and lobster pots, and other material, are occasionally lost to the aquatic environment. The gear used in the proposed actions are gillnets, purse seines, beach 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.

Due to additional outreach and assessment efforts (i.e. Gibson (2013)), and recent lost net inventories (Beattie and Adicks 2012; Beattie 2013; James 2018a) it is likely that fewer nets will become derelict in the upcoming 2024/25 fishing season, and beyond, compared to several years and decades ago (previous estimates of derelict nets were 16 to 42 annually (NRC 2010)). In 2022, an estimated 12 nets became derelict, and seven of them were recovered (James and Low 2023). In 2021, an estimated seven nets became derelict, and six of them were recovered (James and Low 2022). In 2020, an estimated three nets became derelict, and all three of them were recovered (James and Low 2021). In 2019, an estimated seven nets became derelict, and five of them were recovered (James 2020). In 2018, an estimated eight nets became derelict, and six of them were recovered (James 2019). In 2017, an estimated 11 nets became derelict (though not all of them may have been associated with a salmon fishery) and 10 were recovered (James 2018a). In 2016, an estimated 14 nets became derelict, nine of which were recovered (James 2017). In

2014, an estimated 13 nets became derelict, and 12 of them where recovered (James 2015), in 2013 an estimated 15 nets became derelict, 12 of which were recovered (Beattie 2013), and in 2012 eight nets were lost, and six were recovered (Beattie and Adicks 2012). A separate analysis from June 2012 to February 2016 a total of 77 newly lost nets were reported, and only 6 of these were reported by commercial fishermen (Drinkwin 2016). We do not yet have estimates of the number of nets lost in the 2023/24 salmon fisheries. Based on this new information we estimate that a range of three to 20 gill nets may be lost in the 2024/25 fishing season, and beyond, but up to 75-80% of these nets would be removed within days of their loss and have little potential to damage EFH.

Harvest of Prey Species

Prey species can be considered a component of EFH (PFMC 2014c). For Pacific salmon, commercial and recreational fisheries for many types of prey species potentially decrease the amount of prey available to Pacific salmon. Herring, sardine, anchovy, squid, smelt, groundfish, shrimp, crab, burrowing shrimp, and other species of finfish and shellfish are potential salmon prey species that are directly fished, either commercially or recreationally. The proposed actions does not include harvest of prey species and will have no adverse effect on prey species.

Vessel Operation

A variety of fishing and other vessels on the Pacific Coast can be found in freshwater streams, estuaries, and the marine environment within the action area. Vessels that operate under the proposed actions range in size from small single-person vessels used in streams and estuaries to mid-size commercial or recreational vessels. Section 4.2.2.29 of Appendix A to Amendment 18 of the Pacific Coast Salmon Plan (PFMC 2014c) regarding Vessel Operations provides a more detailed description of the effects of vessel activity on EFH. Any impact to water quality from vessels transiting critical habitat areas on their way to the fishing grounds or while fishing would be short term and transitory in nature and minimal compared to the number of other vessels in the area. Also, these activities would occur to some degree through implementation of fisheries or activities other than the Puget Sound salmon fisheries, i.e., recreational boating and marine species fisheries.

Removal of Salmon Carcasses

Salmon carcasses provide nutrients to stream and lake ecosystems. Spawning salmon reduce the amount of fine sediment in the gravel in the process of digging redds. Salmon fishing removes a portion of the fish whose carcasses would otherwise have contributed to providing those habitat functions.

The PFMC conservation recommendation to address the concern regarding removal of salmon carcasses was to manage for spawner escapement levels associated with MSY, implementation of management measures to prevent over-fishing and compliance with requirements of the ESA for ESA listed species. These conservation measures are basic principles of the harvest objectives used to manage salmon fisheries. Therefore, management measures to minimize the effects of salmon carcass removal on EFH are an integral component of the management of the proposed fisheries.

3.2.2 Groundfish

As described in Section 2.5.3.4 of this opinion, we believe that the proposed actions would have the following adverse effects on the EFH of groundfish.

Habitat Alteration

Lost commercial fishing nets would adversely affect groundfish EFH. As described in Section 2.5.3.4, most nets hang on bottom structure that is also used by rockfish and other groundfish. This structure consists of high-relief rocky substrates or boulders located on sand, mud or gravel bottoms (Good et al. 2010). Derelict nets alter habitat suitability by trapping fine sediments out of the water column. This makes a layer of soft sediment over rocky areas, changing habitat quality and suitability for benthic organisms (Good et al. 2010). Nets can also cover habitats used by groundfish for shelter and pursuit of food, rendering the habitat unavailable. Using the most common derelict net size reported by Good et al. (2010), if up to 20 nets were initially lost and five were not retrieved they would degrade approximately damage up to 35,000 square feet (0.8 acre) of habitat (assuming an average of 7,000 square feet per net) of benthic habitat.

Reduction in Groundfish Prey and Entanglement

Most nets hang on bottom structure that is also attractive to rockfish and other groundfish species. This structure consists of high-relief rocky substrates or boulders located on sand, mud or gravel bottoms (Good et al. 2010). The combination of complex structure and currents tend to stretch derelict nets open and suspend them within the water column, in turn making them more deadly for marine biota (Akiyama, Saito and Watanabe 2007; Good et al. 2010) and thus result in a decrease of groundfish prey and entanglement of various species of groundfish.

3.3 Essential Fish Habitat Conservation Recommendations

Pursuant to Section 305(b)(4)(A) of the MSA, NMFS is required to provide EFH conservation recommendations to Federal agencies regarding actions which may adversely affect EFH.

However, NMFS is not providing any EFH conservation recommendations for salmon EFH because the proposed actions includes adequate measures to mitigate for the potential adverse effects from salmon fishing. We provide the following conservation recommendations to minimize the adverse effects to groundfish EFH; consistent with the terms and conditions described for rockfish in Section 2.9.2.2 of the opinion:

Derelict Gear Reporting

The BIA, USFWS and NMFS, in collaboration with the WDFW and Puget Sound treaty tribes, should encourage commercial fishers to report derelict gear lost in marine areas within the Action Area to appropriate authorities within 24 hours of its loss.

Derelict Gear Accounting & Locations

The BIA, USFWS and NMFS, in collaboration with the WDFW and Puget Sound treaty tribes, should track the total number and approximate locations of nets lost (and subsequently recovered) in marine areas within the Action Area and account for them on an annual basis.

Derelict Gear Prevention

The BIA, USFWS and NMFS, in collaboration with WDFW, and Puget Sound treaty tribes, should implement the recommendations for the prevention, retrieval and investigation of gear modifications of gill nets used in Puget Sound salmon fisheries reported in Gibson (2013).

Fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in Section 3.2 above, approximately 0.8 acre of designated EFH for Pacific coast groundfish species.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, BIA, USFWS and NMFS must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of the measures proposed by the agency for avoiding, minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects [50 CFR 600.920(k)(1)].

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

The BIA, NMFS and USFWS 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)].

4.0 DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these

DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the BIA, NMFS, USFWS. Other interested users could include recreational and commercial fishers, the general public, and conservation organizations (NGO, agencies). 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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APPENDIX A

Table 1. Puget Sound salmon and steelhead hatchery programs (ongoing and proposed). Shaded programs raise ESA-listed fish.

Chinook Salmon Hatchery Program	Program operator
Minter Creek Fall Chinook	Washington Dept. of Fish and Wildlife (WDFW)
Tumwater Falls Chinook	WDFW
Chambers Creek Fall Chinook	WDFW
Squaxin/South Sound Net-Pens Chinook	Sqauxin Island Tribe/WDFW
Dungeness River Hatchery Spring Chinook	WDFW
Grovers Creek Hatchery Fall Chinook	Suquamish Tribe
Elwha Channel Hatchery Chinook	WDFW
Soos Creek Hatchery Fall Chinook	WDFW
FRF Fall Chinook	Muckleshoot Indian Tribe (MIT)
Hoodsport Fall Chinook	WDFW
Hamma Hamma Chinook Salmon	WDFW
Issaquah Hatchery Fall Chinook	WDFW
UW Chinook	MIT
Nisqually FH Clear Creek/Kalama Creek Fall Chinook	Nisqually Indian Tribe
Skookum Creek Hatchery SF Nooksack Chinook Salmon	Lummi Nation
Kendall Creek North/Middle Fork Nooksack Native Spring Chinook Salmon Restoration Hatchery	WDFW
Lummi Bay Hatchery Chinook Salmon	Lummi Nation
Samish Fall Chinook Salmon Hatchery	WDFW
Whatcom Creek Hatchery Fall Chinook Salmon	WDFW/Bellingham Technical College

Chinook Salmon Hatchery Program	Program operator
Glenwood Springs Hatchery Fall Chinook Salmon	Long Live the Kings
Clarks Creek Fall Chinook	Puyallup Tribe of Indians (PTI)
Voights Creek Fall Chinook	WDFW
White River Spring Chinook	MIT/PTI
Minter/Hupp White River Spring Chinook	WDFW
Skagit River Spring Chinook	WDFW
Skagit River Fall Chinook	WDFW
Skagit River Summer Chinook	Skagit River System Cooperative/WDFW
George Adams Fall Chinook	WDFW
NF Skokomish Hatchery Steelhead	Skokomish Tribe (ST)/WDFW/Tacoma Power (TP)
NF Skokomish Hatchery Spring Chinook	ST/WDFW/TP
Wallace River Hatchery Summer Chinook	WDFW
Stillaguamish Fall Chinook Natural Stock Restoration	Stillaguamish Tribe
Stillaguamish Summer Chinook Natural Stock Restoration	WDFW/Stillaguamish Tribe

Table 2. Current and proposed Hatchery Steelhead programs operating in Puget Sound. Shaded programs raise ESA-listed fish.

Steelhead Hatchery Program	Program operator
Lower Elwha Hatchery Native Steelhead	Lower Elwha Klallam Tribe (LEKT)
FRF Steelhead	MIT
Green River Native Late Winter Steelhead	WDFW
Soos Creek Hatchery Summer Steelhead	WDFW
Hood Canal Steelhead Supplementation	WDFW
White River Winter Steelhead	MIT
Kendall Creek Winter Steelhead	WDFW

Steelhead Hatchery Program	Program operator
Dungeness River Early Winter Steelhead	WDFW
Whitehorse Ponds Winter Steelhead	WDFW
Snohomish/Skykomish Winter Steelhead	WDFW
Snohomish/Tokul Creek Winter Steelhead	WDFW
South Fork Skykomish Summer Steelhead	WDFW

APPENDIX B

Viable Risk Assessment Procedure

Viability Risk Assessment Procedure

NMFS analyzes the effects of harvest actions on populations using quantitative analyses where possible and more qualitative considerations where necessary. The Viable Risk Assessment Procedure (VRAP) is an example of a quantitative risk assessment method that was developed by NMFS and applied primarily for analyzing harvest impacts on Puget Sound and Lower Columbia River tule Chinook. VRAP provides estimates of population-specific exploitation rates (called Rebuilding Exploitation Rates or RERs) that are designed to be consistent with ESA-related survival and recovery requirements. Proposed fisheries are then evaluated, in part, by comparing the RERs to rates that can be anticipated as a result of the proposed harvest plan. Where impacts of the proposed plan are less than or equal to the RERs, NMFS considers the harvest plan to present a low risk to that population (the context and basis of NMFS' conclusions related to RERs is discussed in more detail below). The results of this comparison, together with more qualitative considerations for populations where RERs cannot be calculated, are then used in making the jeopardy determination for the ESU as a whole. A brief summary of VRAP and how it is used to estimate an RER is provided below. For a more detailed explanation see NMFS (2000) and NMFS (2004).

The Viable Risk Assessment Procedure:

- quantifies the risk to survival and recovery of individual populations compared with a zero harvest scenario;
- accounts for total fishing mortality throughout the migratory range of the ESU;
- explicitly incorporates management, data, and environmental uncertainty; and
- isolates the effect of harvest from mortality that occurs in the habitat and hatchery sectors.

The result of applying the VRAP to an individual population is an RER which is the highest allowable ("ceiling") exploitation rate that satisfies specified risk criteria related to survival and recovery. Calculation of RERs depend on the selection of two abundance-related reference points (referred to as critical and rebuilding escapement thresholds (CET and RET[84]4)), and two risk criteria that define the probability that a population will fall below the CET and exceed the RET. Considerations for selecting the risk criteria and thresholds are discussed briefly here and in more detail in NMFS 2000.

The selection of risk criteria for analytical purposes is essentially a policy decision. For jeopardy determinations, the standard is to not "…reduce appreciably the likelihood of survival and recovery …" (50 CFR 402.2). In this context, NMFS used guidance from earlier biological opinions to guide the selection of risk criteria for VRAP. NMFS' 1995 biological opinion on the operation of the Columbia River hydropower system (NMFS 1995) considered the biological

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[84]4 Also referred to in previous opinions as the Upper Escapement Threshold.

requirements for Snake River spring/summer Chinook to be met if there was a high likelihood, relative to the historic likelihood, that a majority of populations were above lower threshold levels[85]5 and a moderate to high likelihood that a majority of populations would achieve their recovery levels in a specified amount of time. High likelihood was considered to be a 70% or greater probability, and a moderate-to-high likelihood was considered to be a 50% or greater probability (NMFS 1995). The Cumulative Risk Initiative (CRI) has used a standard of 5% probability of absolute extinction in evaluating the risks of management actions to Columbia River ESUs. The different standards of risk, i.e., 50% vs. 5%, were based primarily on the thresholds that the standard was measured against. The CRI threshold is one of absolute extinction, i.e., 1 spawning adult in a brood cycle. The Biological Requirements Work Group (BRWG 1994) threshold is based on a point of potential population destabilization, i.e., 150-300 adult spawners, but well above what would be considered extinction. In fact, several of the populations considered by the BRWG had fallen below their thresholds at some point and rebounded, or persisted at lower levels. Since the consequences to a species of the CRI threshold are much greater than the consequences of the BRWG thresholds, the CRI standard of risk should be much higher (5%). Scientists commonly define high likelihood to be ≥95%. For example, tests of significance typically set the acceptable probability of making a Type I error at 5%. The basis of the VRAP critical threshold is more similar to the BRWG lower threshold in that it represents a point of potential population destabilization. However, given the uncertainties in the data, especially when projected over a long period of time, and the different risk to populations represented by the two thresholds, we chose a conservative approach both for falling below the critical threshold, i.e., 5%, and exceeding the recovery threshold, i.e., 80%.

The risk criteria were chosen within the context of the jeopardy standard. They measure the effect of the proposed actions against the baseline condition, and require that the proposed actions not result in a significant negative effect on the status of the species over the conditions that already exist. We determined that the risk criteria consistent with the jeopardy standard would be that: (1) the percentage of escapements below the critical threshold differs no more than 5% from that under baseline conditions; *and* (2) the viable threshold must be met 80% of the time, *or* the percentage of escapements less than the viable threshold differs no more than 10% from that under baseline conditions. Said another way, these criteria seek to identify an exploitation rate that will not appreciably increase the number of times a population will fall below the critical threshold and also not appreciably reduce the prospects of achieving recovery. For example, if under baseline conditions, the population never fell below the critical threshold, escapements must meet or exceed the critical threshold 95% of the time under the proposed harvest regime.

As described above, VRAP uses critical escapement and rebuilding escapement thresholds as benchmarks for calculating the RERs. Both thresholds represent natural-origin spawners. The CET represents a boundary below which uncertainties about population dynamics increase

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[85]5 The Biological Requirements Work Group defined these as levels below which uncertainties about processes or population enumerations are likely to become significant, and below which qualitative changes in processes are likely to occur (BRWG 1994). They accounted for genetic risk, and some sources of demographic and environmental risk.

substantially. In cases where sufficient stock-specific information is available, we can use the population dynamics relationship to define this point. Otherwise, we use alternative population-specific data, or general literature-based guidance. NMFS has provided some guidance on the range of critical thresholds in its document, *Viable Salmonid Populations* (McElhany et al. 2000). The VSP guidance suggests that effective population sizes of less than 500 to 5,000 per generation, or 125 to 1,250 per annual escapement, are at increased risk. For the Lower Columbia River tule analyses, we generally used CETs corresponding to the Willamette/Lower Columbia River TRT's quasi-extinction thresholds (QET): 50/year for four years for 'small' populations, 150/year for four years for medium populations, and 250/year for four years for large populations (McElhany et al. 2000).

The RET may represent a higher abundance level that would generally indicate recovery or a point beyond which ESA type protections are no longer required. The RET could also be an estimate of the spawners needed to achieve maximum sustainable yield or for maximum recruits, or some other designation. It is important to recognize, though, that the RET is not an escapement goal but rather a threshold level that is expected to be exceeded most of the time (≥ 80%). It should also be noted that, should the productivity and/or capacity conditions for the population improve, the RET should be changed to reflect the change in conditions.
There is often some confusion about the relationship between rebuilding escapement thresholds used in the VRAP analysis, and abundance related recovery goals. The RET are generally significantly less than recovery goals that are specified in recovery plans. VRAP seeks to analyze a population in its existing habitat given current conditions. As the productivity and capacity of the habitat improves, the VRAP analysis will be adjusted to reflect those changes. Thus the RET serves as a step in the progression to recovery, which will occur as the contributions from recovery action across all sectors are realized.

There are two phases to the VRAP process for determining an RER for a population. The first, or model fitting phase, involves using data from the target population itself, or a representative indicator population, to fit a spawner-recruit relationship representing the performance of the population over the time period analyzed. Population performance is modeled as:

$$\mathrm{R} = f(\mathrm{S}, \mathbf{e}),$$

> where S is the number of fish spawning in a single return year, R is the number of adult equivalent recruits,[86]6 and **e** is a vector of environmental, density-independent indicators of annual survival.

Several data sets are necessary for this: a time series of natural spawning escapement, a time series of total recruitment by cohort, and time series for the environmental correlates of survival. In addition, one must assume a functional form for f, the spawner-recruit relationship. Given the data, one can numerically estimate the parameters of the assumed spawner-recruit

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[86]6 Equivalently, this could be termed "potential spawners" because it represents the number of fish that would return to spawn absent harvest-related mortality.

relationship to complete the model fitting phase.

The data are fitted using three different models for the spawner recruit relationship: the Ricker (Ricker 1975), Beverton-Holt (Ricker 1975), and Hockey stick (Barrowman and Myers 2000). The simple forms of these models can be augmented by the inclusion of environmental variables correlated with brood year survival. The VRAP is therefore flexible in that it facilitates comparison of results depending on assumptions between production functions and any of a wide range of possible environmental co-variates. Equations for the three models are as follows:

$$R = (aS\mathrm{e}^{-bS})(M^{c}\mathrm{e}^{dF}) \quad \text{[Ricker]}$$

$$R = (S/[bS + a])(M^{c}\mathrm{e}^{dF}) \quad \text{[Beverton-Holt]}$$

$$R = (\min[aS, b])(M^{c}\mathrm{e}^{dF}) \quad \text{[hockey stick]}$$

In the above, M is the index of marine survival and F is the freshwater correlate.

The second, or projection phase, of the analysis involves using the fitted model in a Monte Carlo simulation to project the probability distribution of the near-term future performance of the population assuming that current conditions of productivity continue. Besides the fitted values of the parameters of the spawner-recruit relationships, one needs estimates of the probability distributions of the variables driving the population dynamics, including the process error (including first order autocorrelation) of the spawner-recruit relationship itself and each of the environmental correlates.[87]7 Also, since fishing-related mortality is modeled in the projection phase, one must estimate the distribution of the deviation of actual fishing-related mortality from the intended ceiling. This is termed “management error” and its distribution, as well as the others, is estimated from available recent data.

For each of a stepped series of exploitation rates the population is repeatedly projected for 25 years. From the simulation results we computed the fraction of years in all runs where the escapement is less than the critical escapement threshold and the fraction of runs for which the final year’s escapement is greater than the rebuilding escapement threshold. Exploitation rates for which the first fraction is less than 5% and the second fraction is greater than 80% (or 10% from baseline) satisfies the identified risk criteria are thus used to define the population specific ceiling exploitation rates for harvest management.

Finally, the population-specific RERs must be made compatible with the exploitation rates generated from the FRAM model for use in fishery management planning. The VRAP and the FRAM model were developed for different purposes and are therefore based on different data

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[87]7 Actual environmental conditions may vary from the modeled 25-year projections due to such things as climate change, restoration actions, development, etc. However, it is difficult to anticipate exactly how conditions might be different for a specific population which is the focus of the VRAP analysis. Incorporation of the observed uncertainty in each of the key parameters in the VRAP analysis, the use of high probabilities related to abundance thresholds and periodic revision of the RERs on a shorter time frame (e.g., 5-10 years) in the event that conditions have changes serve to mitigate this concern.

sources and use different approaches to estimate exploitation rates. The VRAP uses long-term population intensive data to derive a RER for a single population. The FRAM uses fishery intensive data to estimate the effects of southern U.S. West Coast fishing regimes across the management units (populations or groups of populations) present in those fisheries. Because the FRAM model is used for preseason planning and to manage fisheries, it is necessary to ensure that the RERs derived from VRAP are consistent with the management unit exploitation rates that we estimated by the FRAM model. To make them compatible, the RERs derived from VRAP are converted to FRAM-based RERs using linear or log-transform regressions between the exploitation rate estimates from the population specific data and post season exploitation rate estimates derived from FRAM.

APPENDIX C

Table B.1. List of Chinook salmon stocks in Fishery Regulation Assessment Model (FRAM).

1. UnMarked Nooksack/Samish Fall
2. Marked Nooksack/Samish Fall
3. UnMarked North Fork Nooksack Spr
4. Marked North Fork Nooksack Spr
5. UnMarked South Fork Nooksack Spr
6. Marked South Fork Nooksack Spr
7. UnMarked Skagit Summer/Fall Fing
8. Marked Skagit Summer/Fall Fing
9. UnMarked Skagit Summer/Fall Year
10. Marked Skagit Summer/Fall Year
11. UnMarked Skagit Spring Year
12. Marked Skagit Spring Year
13. UnMarked Snohomish Fall Fing
14. Marked Snohomish Fall Fing
15. UnMarked Snohomish Fall Year
16. Marked Snohomish Fall Year
17. UnMarked Stillaguamish Fall Fing
18. Marked Stillaguamish Fall Fing
19. UnMarked Tulalip Fall Fing
20. Marked Tulalip Fall Fing
21. UnMarked Mid Puget Sound Fall Fing
22. Marked Mid Puget Sound Fall Fing
23. UnMarked UW Accelerated
24. Marked UW Accelerated
25. UnMarked South Puget Sound Fall Fing
26. Marked South Puget Sound Fall Fing
27. UnMarked South Puget Sound Fall Year
28. Marked South Puget Sound Fall Year
29. UnMarked White River Spring Fing

30. Marked White River Spring Fing
31. UnMarked Hood Canal Fall Fing
32. Marked Hood Canal Fall Fing
33. UnMarked Hood Canal Fall Year
34. Marked Hood Canal Fall Year
35. UnMarked Juan de Fuca Tribs. Fall
36. Marked Juan de Fuca Tribs. Fall
37. UnMarked Columbia River Oregon Hatchery Tule
38. Marked Columbia River Oregon Hatchery Tule
39. UnMarked Columbia River Washington Hatchery Tule
40. Marked Columbia River Washington Hatchery Tule
41. UnMarked Lower Columbia River Wild
42. Marked Lower Columbia River Wild
43. UnMarked Columbia River Bonneville Pool Hatchery
44. Marked Columbia River Bonneville Pool Hatchery
45. UnMarked Columbia River Upriver Summer
46. Marked Columbia River Upriver Summer
47. UnMarked Columbia River Upriver Bright
48. Marked Columbia River Upriver Bright
49. UnMarked Cowlitz River Spring
50. Marked Cowlitz River Spring
51. UnMarked Willamette River Spring
52. Marked Willamette River Spring
53. UnMarked Snake River Fall
54. Marked Snake River Fall
55. UnMarked Oregon North Coast Fall
56. Marked Oregon North Coast Fall
57. UnMarked West Coast Vancouver Island Total Fall
58. Marked West Coast Vancouver Island Total Fall
59. UnMarked Fraser River Late
60. Marked Fraser River Late

61. UnMarked Fraser River Early
62. Marked Fraser River Early
63. UnMarked Lower Georgia Strait
64. Marked Lower Georgia Strait
65. UnMarked White River Spring Year
66. Marked White River Spring Year
67. UnMarked Lower Columbia Naturals
68. Marked Lower Columbia Naturals
69. UnMarked Central Valley Fall
70. Marked Central Valley Fall
71. UnMarked WA North Coast Fall
72. Marked WA North Coast Fall
73. UnMarked Willapa Bay
74. Marked Willapa Bay
75. UnMarked Hoko River
76. Marked Hoko River
77. UnMarked Mid Oregon Coast Fall
78. Marked Mid Oregon Coast Fall

APPENDIX D

Table 1. Habitat Restoration Projects Funded with FY 2020 Pacific Salmon Treaty Implementation Funds

Project Name	Watershed	Project Sponsor
Dungeness Floodplain Restoration	Dungeness	Jamestown S'Klallam Tribe
Dosewallips Powerlines Acquisition & Design	Mid-Hood Canal	Mason County
Farmhouse Phase 4 Restoration	Nooksack	Nooksack Tribe
Middle Fork Nooksack Diversion Dam	Nooksack	American Rivers
Barnaby Reach Restoration	Skagit	Skagit System Cooperative
Hansen Creek Restoration	Skagit	Skagit System Cooperative
Reiner Acquisition	Snohomish	Tulalip Tribes
Gold Basin Habitat Restoration	Stillaguamish	Stillaguamish Tribe

Source: REPORT TO CONGRESS - 2018 RECERTIFICATION OF THE PACIFIC SALMON TREATY – SECOND BIANNUAL STATUS REPORT

Table 2. Habitat Restoration Projects Funded with FY 2021 PST Implementation Funds.

Project Sponsor	Project Name
Stillaguamish Tribe	Trafton Nursery Site Restoration
Stillaguamish Tribe	Anderson Family Farm (Cicero) Restoration and Design
Stillaguamish Tribe	Gold Basin Restoration
Nooksack Tribe	South Fork Nooksack Fish Camp Planning Area Design
Lummi Nation	South Fork Nooksack River Upper and Lower Fobes Reach Phase 2 Restoration
Skagit River System Cooperative	McGlinn Island Fish Passage Conceptual Design
Skagit River System Cooperative	Smokehouse Tidal Marsh Restoration (Final Design)
Tulalip Tribes	Snohomish Floodplain Acquisitions Phase I
Jamestown S'Klallam Tribe	Upper Dungeness Large Wood Restoration Phase 3

Source: REPORT TO CONGRESS - 2018 RECERTIFICATION OF THE PACIFIC SALMON TREATY – Consolidated Appropriation Act, 2021

Table 3. Habitat Restoration Projects Funded with FY 2022 PST Implementation Funds.

Project Sponsor	Project Name
Stillaguamish Tribe	“zis a ba” – Phase II (248 acres) of tribal wetland project stretching from Hatt Slough to “zis a ba” Phase I
Nooksack Tribe	South Fork Nooksack River Homesteader Reach Phase 2 Restoration
Lummi Nation	Middle Fork Nooksack River Porter Creek Reach Phase 2 Restoration
Swinomish Indian Tribal Community	Similk Beach Restoration Final Design
Swinomish Indian Tribal Community	Dunlap Tidal Restoration Construction
Tulalip Tribes	Holy Cross Levee Removal and Enhancement

Source: FY 2022 Spend Plan for Pacific Salmon Treaty Implementation.