UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OR 97232-1274

Refer to NMFS No.:
WCRO-2020-02558

September 10, 2024

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Re: Endangered Species Act Section 7(a)(2) Biological Opinion, Conference Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Washington State Ferries Maintenance and Preservation Work Programmatic, Washington (Puget Sound, HUC4 17110019; San Juan Islands, HUC4 17110003; Strait of Georgia, HUC4 17110002)

Dear Sirs and Madam:

Thank you for your letter of September 15, 2020, 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 the Federal Highway Administration's (FHWA), Federal Transit Administration's (FTA), and U.S. Army Corps of Engineers' (USACE) proposed Washington State Ferries Maintenance and Preservation Work Programmatic in Pierce, Kitsap, Jefferson, San Juan, Island, King, Snohomish, and Skagit counties, Washington. Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1855(b)) for this action.

The enclosed document contains a Biological Opinion prepared by the NMFS pursuant to section 7 of the ESA on the effects of the proposed action. In this Opinion, the NMFS concludes that the proposed action would adversely affect but is not likely to jeopardize the continued existence of Puget Sound (PS) Chinook salmon, Hood Canal summer- run chum salmon, PS steelhead, PS/Georgia Basin (GB) bocaccio, and PS/GB yelloweye rockfish.

The NMFS also concluded the action is likely to adversely affect, but not likely to adversely modify designated critical habitat for PS Chinook salmon, Hood Canal summer-run chum salmon, PS/GB bocaccio, and Southern Resident killer whale (SRKW).

This document also presents our conclusion that the proposed action is not likely to adversely affect southern DPS Pacific eulachon, southern distinct population segment American green sturgeon, humpback whale, and designated critical habitat for PS/GB yelloweye rockfish. Designated critical habitat does not occur within the action area for PS steelhead, Pacific eulachon, southern distinct population segment American green sturgeon, or humpback whale.

This Opinion includes an incidental take statement that describes reasonable and prudent measures the NMFS considers necessary or appropriate to minimize the incidental take associated with this action and sets terms and conditions that the FHWA and/or the applicant must comply with to meet those measures.

This Opinion also includes a conference opinion evaluating the effects of the proposed program of activities on sunflower sea stars (*Pycnopodia helianthoides*).

Thank you also for your request for essential fish habitat (EFH) consultation. NMFS reviewed the proposed action for potential effects on EFH pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), implementing regulations at 50 CFR 600.920, and agency guidance for use of the ESA consultation process to complete EFH consultation. We have concluded that the action would adversely affect EFH designated under the Pacific Salmon, Coastal Pelagic Species, and Groundfish Fishery Management Plans (FMPs).

Section 3 of this document includes our draft analysis of the action's likely effects on EFH pursuant to Section 305(b) of the MSA. Based on that draft analysis, the NMFS concludes that the action would adversely affect designated EFH for Pacific Coast Salmon, Pacific Coast Groundfish, and Coastal Pelagic Species. Therefore, we have provided two conservation recommendations that can be taken by the FHWA to avoid, minimize, or otherwise offset potential adverse effects on EFH.

Please contact Bonnie Shorin in the Central Puget Sound Branch of the Oregon Washington Coastal Office at (360) 995-2750, or by electronic mail at bonnie.shorin@noaa.gov if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

Kim W. Kratz. Ph.D
Assistant Regional Administrator
Oregon Washington Coastal Office

cc: Cindy Callahan, FHWA
Matt Bennet, USACE Seattle District

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

Washington State Ferries Maintenance and Preservation Work Programmatic

Pierce, Kitsap, Jefferson, San Juan, Island, King, Snohomish, and Skagit Counties, Washington (Puget Sound, HUC_4 17110019; San Juan Islands, HUC_4 17110003; Strait of Georgia, HUC_4 17110002)

NMFS Consultation Number: WCRO-2020-02558

Action Agencies: Federal Highway Administration
Federal Transit Administration
U.S. Army Corps of Engineers

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 ESU Chinook (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	Yes	No
Hood Canal Summer-run ESU Chum Salmon (*O. keta*)	Threatened	Yes	No	Yes	No
Puget Sound DPS Steelhead (*O. mykiss*)	Threatened	Yes	No	N/A	N/A
Puget Sound/Georgia Basin DPS Bocaccio Rockfish (*Sebastes paucispinis*)	Endangered	Yes	No	Yes	No
Puget Sound/Georgia Basin DPS Yelloweye Rockfish (*Sebastes ruberrimus*)	Threatened	Yes	No	No	No
Southern DPS Pacific eulachon (*Thaleichthys pacificus*)	Threatened	No	No	N/A	N/A
Southern Resident DPS killer whale (*Orcinus orca*)	Endangered	Yes	No	Yes	No
Southern DPS North American green sturgeon (*Acipenser medirostris*)	Threatened	No	No	N/A	N/A
Mexico DPS humpback whale; *(Megaptera novaeangliae)*	Threatened	No	No	N/A	N/A
Central America DPS humpback whale	Endangered	No	No	N/A	N/A
Sunflower Sea Star *(Pycnopodia helianthoides)*	Proposed	Yes	No	N/A	N/A

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 Salmon	Yes	Yes
Pacific Coast Groundfish	Yes	Yes
Coastal Pelagic Species	Yes	Yes

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

Issued By:

Kim W. Kratz, Ph.D
Assistant Regional Administrator
Oregon Washington Coastal Office

Date: September 10, 2024

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LIST OF ABBREVIATIONS AND ACRONYMS

ACZA	ammoniacal copper zinc arsenate
BA	Biological Assessment
BAR	Biological Assessment Reference document
BIA	Bureau of Indian Affairs
BMP(s)	best management practice(s)
CFR	Code of Federal Regulations
CHARTs	Critical Habitat Analytical Review Teams
CO_2	Carbon dioxide
CRS	Columbia River System
cSEL	cumulative SEL
CWTs	coded wire tags
dB	decibel
DIP	demographically independent population
DO	dissolved oxygen
DPS	Distinct Population Segment
DQA	Data Quality Act
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FAHP	Federal Aid Highway Program
FERC	Federal Energy Regulatory Commission
FHWA	Federal Highway Administration
FHWG	Fisheries Hydroacoustic Working Group
FR	Federal Register
ft	feet
ft^2	square feet
FTA	Federal Transit Administration
FY20	Fiscal Year 2020
GAM	Generalized additive model
GB	Georgia Basin
HAPC	Habitat Areas of Particular Concern
HEA	Habitat Equivalency Analysis
HPA	Hydraulic Project Approval
Hz	hertz
ITS	Incidental Take Statement
kHz	kilohertz
km	kilometer
km^2	square kilometer
m	meter
MARAD	United States Department of Transportation Maritime Administration
mi	mile
mi^2	square mile
mm	millimeter
MLLW	Mean Lower Low Water
MMPA	Marine Mammal Protection Act
MPG	Major Population Group
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSY	Maximum Sustainable Yield
NF	north fork
NHVM	Nearshore Habitat Values Model
NMFS	National Marine Fisheries Service

NOAA	National Oceanic and Atmospheric Administration
NOF	North of Falcon
NRKW	Northern resident killer whale
NTU	nephelometric turbidity unit
NWFSC	Northwest Fisheries Science Center
NWTRC	United States Navy's Northwest Training Range Complex
OHWL	Ordinary High Water Line
PAH	polycyclic aromatic hydrocarbons
PALs	passive aquatic listeners
PBDE	polybrominated diphenyl ethers
PCB	polychlorinated biphenyl
PBF	physical or biological features
PCT	Pacific Salmon Treaty
PCE	primary constituent element
PFMC	Pacific Fishery Management Council
PFMP	Pacific Salmon Fishery Management Plan
PGIS	pollution generating impervious surface
PPB	parts per billion
PS	Puget Sound
PSP	Puget Sound Partnership
PST	Pacific Salmon Treaty
PSTRT	Puget Sound Technical Recovery Team
PSSTRT	Puget Sound Steelhead Technical Recovery Team
PVAs	population viability analyses
RCW	Revised Code of Washington
rms	root mean square
ROV	remotely operated vehicle
RPM	Reasonable and Prudent Measure
SAV	submerged aquatic vegetation
SEAK	Southeast Alaska
SEL	sound exposure level
SF	south fork
SPCC	Spill Prevention, Control and Countermeasures
SPL	sound pressure levels
SRKW	Southern resident killer whale
SSDP	Shoreline Substantial Development Permit
SWFSC	Southwest Fisheries Science Center
TRT	Technical Recovery Team
TTS	temporary threshold shift
USACE	U.S. Army Corps of Engineers
USC	United States Code
USFWS	United States Fish and Wildlife Service
VSP	viable salmonid population
WAC	Washington Administrative Code
WCRO	West Coast Regional Office
WDFW	Washington State Department of Fish and Wildlife
WDOE	Washington State Department of Ecology
WSDOT	Washington State Department of Transportation
WSF	Washington State Ferries
WRAS	Whale Report Alert System
°C	degree Celsius

°F	degree Fahrenheit
μg/l	micrograms per liter
μPa	microPascal
μPa^2-s	microPascal squared second

1. INTRODUCTION

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

1.1 Background

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

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

The Washington State Ferries (WSF) is a Division of the Washington State Department of Transportation (WSDOT) that operates ferries from 19 terminals and 1 maintenance facility (collectively referred to as terminals in this document) as part of the Washington State highway system (Figure 1). For many years, the U.S. Army Corps of Engineers (USACE), the Federal Highway Administration (FHWA), and the Federal Transit Administration (FTA) have requested individual section 7(a)(2) ESA and EFH consultations to address maintenance and repair of these facilities that may affect federally listed species and their designated critical habitats. These activities are typically minor, repetitive, and routine repairs and maintenance of existing infrastructure. In an effort to increase efficiency, and more thoroughly analyze the collective effects of these actions, the federal agencies, WSF, and NMFS agreed to programmatically consult on routine maintenance and repairs of WSF terminals.

The maintenance and repair activities considered in this consultation have a federal nexus with the Seattle District of the USACE based on its regulatory authority to issue permits under section 404 of the Clean Water Act (33 U.S.C. 1344) and section 10 of the Rivers and Harbors Act (33 U.S.C. 403). In addition to having a federal ESA nexus with the USACE, the repair and maintenance projects considered in this consultation may have federal funding provided under the Federal Aid Highway Program (FAHP) or FTA authorities. The FAHP consists of Federal money apportioned to states by legislative formulas or grants, at the discretion of the FHWA. The program is governed by Title 23 of the U.S.C. Funding for FTA programs is through legislation that amends Chapter 53 of Title 49 of the U.S.C.

Figure 1. Washington State Ferry Terminals and ferry routes. The Eagle Harbor Maintenance facility (not shown) is on the east side of Bainbridge Island.

Annual meetings between NMFS, FHWA, USACE, FTA and WSF (applicant) will determine the need for adjustments or reinitiation of the consultation.

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 at the National Oceanic and Atmospheric Administration (NOAA) Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at the Oregon Washington Coastal Office in Lacey, Washington.

1.2 Consultation History

- March 28, 2018, programmatic consultation kick-off meeting with NMFS, United States Fish and Wildlife Service (USFWS), FHWA, FTA, USACE, WSDOT, and WSF. Introduction to State ferry system and environmental program by WSF. Discussion of programmatic BA information needs and activities to include within the proposed action.

- May 10, 2018, follow-up meeting with NMFS, USFWS, FHWA, FTA, USACE, WSDOT, and WSF with continued conversation regarding the programmatic and potential 7(a)(1) conservation measures for consultation. WSF' sustainability matrix provided to Services.

- August 7, 2018, first working group meeting for programmatic consultation with NMFS, USFWS, FHWA, WSDOT and WSF. Discussed types of projects that would be covered, check-in points, use of WSF' Biological Assessment Reference (BAR) document, and how to address pile driving noise. Discussed soft shore armoring projects planned at Vashon and Tahlequah terminals.

- August 28, 2018, second working group meeting with NMFS, FHWA, WSDOT, and WSF. Cindy Callahan (FHWA) informed us she would represent FTA and USACE at working group meetings. Discussed programmatic reviewers at the Services for the programmatic opinion, overwater structures guidance, pile driving noise, MMPA application, BAR updates, and activities to be covered under the consultation and deconstruction matrix.

- September 4, 2018, FHWA reported on action item from August 28, 2018, that per conversation with NMFS, Office of Protected Resources that they were willing to assign a single point-of-contact from their office and would consider streamlining options per the MMPA.

- September 21, 2018, WSF provides NMFS comments on WSF' 7(a)(1) program and draft of program for review to working group.

- October 2, 2018, third working group meeting with NMFS, USFWS, FHWA, WSDOT, and WSF. Discussed WSF' 7(a)(1) program, overwater structures guidance, and BA review by managers at the Services, analyses, and draft project description.

- October 31, 2018, meeting with NMFS, USFWS, FHWA, FTA, USACE, WSDOT, and WSF. WSF' provided update on 7(a)(1) program. Discussed where to put 7(a)(1). NMFS wanted it included as a chapter in the BA to link to consultation. Other Discussion on updates, how programmatic project review at the Services would work, annual reporting, and multiple consultation topics. NMFS wanted the BA and biological opinion written in concert. Agreement to have quarterly management meetings, consider 7(a)(1), use BAR document, use underwater noise spectral data once reviewed by NOAA's Protected Resources Division, Silver Spring, Maryland.

- January 28, 2019, fourth working group meeting with NMFS, FHWA, WSDOT. Discussed project description.

- April 2, 2019, fifth working group meeting with NMFS, USFWS, FHWA, WSDOT, and WSF. Draft project description provided to Services, discussed MMPA Letter of Authorization, and status of effects section of BA.

- June 12, 2019, sixth working group meeting with NMFS, USFWS, FHWA, WSDOT, and WSF. Discussed Navy programmatic maintenance and repair biological opinion and how it would affect consultation. Discussed overwater coverage at all WSF terminals, and tribal involvement to date. Direction for how to use NMFS' structures guidance was not resolved.

- October 31, 2019, meeting with NMFS, USFWS, FHWA, FTA, USACE, WSDOT, and WSF. Overview of WSF programmatic consultation and 7(a)(1) program. Agreement forage fish would be analyzed as in WSF's HPA.

- October through August 2020. WSDOT and WSF drafted BA and coordinated at technical level with NMFS to the extent possible including review of parts of the BA. NMFS requested quantification of stressors provided in the BA.

- September 14, 2020, NMFS received request for formal consultation. The FHWA determined the proposed action would adversely affect PS Chinook salmon, HCSR chum salmon, PS steelhead, bocaccio rockfish, yelloweye rockfish and designated critical habitat for PS Chinook salmon, HCSR chum salmon, and SRKW. The FHWA determined the proposed action is not likely to adversely affect, Southern DPS green sturgeon, Pacific DPS eulachon, Central American and Mexico DPSs of humpback whale, and designated critical habitats for PS/GB bocaccio and yelloweye rockfish.

- April 6, 2021 meeting with NMFS, FHWA, FTA, WSDOT, and WSF to create clarity as to the status and path forward for consultation, review of consultation history (FHWA), and update provided for WSF 7(a)(1) program (WSF).

- July, 2021, meeting with NMFS, FHWA, FTA, WSDOT, and WSF. NMFS provided example calculator outputs for multiple programmatic activities and WSF' projects currently in consultation. Discussed calculator use in the consultation, stormwater effects from existing structures. No agreement reached for calculator use or stormwater analysis.

- December 16, 2021, meeting with NMFS, FHWA, FTA, USACE, and WSF regarding status of Opinion. NMFS requested confirmation on quantities and numbers of some activities, and status of BAR updates for Mukilteo and Seattle terminals. Updated information was received December 20, 2021. Consultation was initiated December 20, 2021.

- January 6, 2022, meeting with NMFS, FHWA, FTA, USACE, and WSF to discuss WSF' 7(a)(1) program with new acting CPS Branch Chief at NMFS.

- January 18, 2022, meeting with NMFS, FHWA, FTA, WSF discussed status of consultation and consistency with Salish Sea Nearshore programmatic. Discussion of where to incorporate 7(a)(1) in consultation. Underwater noise study provided as an example.

- February 7, 2022, meeting at staff level with WSF to clarify outstanding items. NMFS requested FHWA request formal consultation for PS/GB bocaccio critical habitat based on the presence of nearshore critical habitat that would be exposed to project stressors. Discussed eulachon based on Fraser River larval outmigrants in the San Juan Islands.

- February 10, 2022, FHWA declined to change effect determinations.

- June 23, 2022, a meeting between NMFS, FHWA, FTA, and USACE took place to discuss process steps necessary to complete the consultation.

- During 2023, FHWA, WSF, in consultation with NMFS, developed changes to the proposed action to expand the scope of activities covered and further conserve listed resources.

- In late 2023 the Action Agencies requested the consultation to include a conference on sunflower sea stars.

- During the spring of 2024, the WSF and NMFS determined that it was desirable to describe the details and purposes of the advance mitigation component of the proposed action (i.e. the "Credit Savings Scheme") in a stand-alone Instrument.

- On July 24, 2024, the several action agencies approved the Credit Savings Instrument, and provided it to be included with the proposed action.

- On September 6, 2024, upon review of a courtesy draft, the action agencies noted an error in the description of the proposed action derived from the biological assessment. The WSF provided an email to the consultation updates inbox that simplified and corrected the error, which had overstated when state and local permits were required.

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 (50 CFR 402.02). Under MSA, Federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910).

WSF proposes to maintain existing State ferry terminal structures (the structures that are commonly found at the facilities are displayed in Figure 2). For most maintenance actions, the USACE may provide a permit to authorize certain activities under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act and the FHWA or FTA may provide funding to WSF as described in Section 1.1. Structures at some terminals may require repair or replacement of component pieces (e.g. individual piles).

Figure 2. Structures commonly found at a ferry terminal

Because this Opinion and conference opinion provides a programmatic analysis covering a suite of activities, this section provides information on typical activities proposed for programmatic coverage. Each activity is described in greater detail with accompanying photographs in the BAR document at

https://wsdot.wa.gov/sites/default/files/2022-07/BA-WSF_BAR.pdf, which we incorporate here by reference. We provide a summary of that information below.

1.3.1 Deck and Drain Cleaning

This work includes sweeping and/or vacuuming the deck, sidewalks, gutters, and drains. Dry cleaning (scraping, sweeping, vacuuming) is done first and then washing may follow. The only wash water that may enter marine waters is direct drain flushing water after dry cleaning methods have been used in the drains. This work can occur at any time of year and does not involve work below the ordinary high-water line (OHWL).

1.3.2 Deck Overlay Replacement

This work includes removal and replacement of existing asphalt overlay of the deck road surface and sidewalks, to occur only where a structurally sound subsurface exists that will prevent existing or new overlay material from entering state waters. This work does not allow debris, materials, or substances entering state waters. It does not include new construction activities, or replacement of stringers and/or other structural supports. During removal of the existing surface, all debris and substances must be fully contained to prevent them from entering state waters.
This work can occur at any time of year and does not involve work below the OHWL. Deck Overlay Replacement will not include the addition of new pollution generating impervious surface (PGIS).

1.3.3 Painting Including Preparatory Cleaning, Washing, Abrasive Blasting, and Marine Growth Removal

Painting work includes dry cleaning, washing and marine growth removal. A debris and paint collection containment and water filter structure is required. Debris and other substances from dry cleaning cannot be released to state waters. After dry cleaning, washing of the superstructure is done with high pressure equipment followed by abrasive blasting. Wet method work wash water and debris resulting from high pressure washing, including but not restricted to dirt and old paint chips, must be filtered through a filter tarp with a minimum # 100 sieve. Washing is only done at the time of maximum daily tidal flows, which occur from one hour after high or low slack tide to one hour prior to the next high or low slack tide. The filtered wash water may enter state waters. Painting above OHWL is applied with a brush or sprayer; spraying is only done when inside a structure or where the area can be enclosed. Painting may be conducted below the OHWL, provided the paint preparation is done with containment and paint prep wash water is filtered through a # 100 sieve. Painting underwater is done by divers, and is applied with a trowel, as this paint is a thick mastic. The work may include use of a temporary floating work platform for marine growth removal; these activities are conducted below the OHWL and may be conducted at night with temporary artificial lighting shielded and directed away from surface waters.

1.3.4 General Maintenance

Terminals: General maintenance at the terminals will be done at their existing locations and will retain existing configurations. This work occurs at the following locations: over water, at the shoreline, or the intertidal area. Included is work on terminal buildings, trestles, bridge seats, transfer spans, towers, wingwalls, fender piles, bulkheads, and dolphins. Some work, such as marine growth removal, may require diving.,

General maintenance work will not include any new structures, or expansion of any structure on the seabed by excavation, boring, or pile driving fender piles. Replacement of fender piles is also not considered a new structure because these are understood to be sacrificial structures, intended to take blows from approaching vessels and frequent replacement is expected as a routine matter. None of the activities will require pile repair or driving, except for replacement of fender piles. Some activities may be conducted at night with temporary artificial lighting shielded and directed away from surface waters.

General maintenance can include repairing and replacing cap beams, structural bracing replacement, or use of a temporary floating work platform. Transfer spans may need to be repaired or replaced. Timber dolphins and timber fender piles have lashing that needs periodic repair and replacement. Counterweights, cables and hangar bars associated with the trestle and transfer span need repair and replacement. Panels on wingwalls and dolphins (timber, rubber or polyethylene elements that absorb blows from the ferry) need regular replacement. Cross-bracing (angled timbers under the trestle) need periodic replacement. A containment structure is required if any polluting debris, material, or substance could fall into state waters.

Bulkheads: WSF reviewed bulkhead repair projects over the last 20 years and reported that a total of three bulkhead repairs were conducted and all were located at the Coupeville terminal in 2009, 2015, and 2019. We base our proposed action on typical bulkhead repairs which have consisted of replacing rock where it had been displaced by storm or extreme wave action, or repairs to sinkholes (e.g., Mukilteo Terminal in 2002 prior to it being rebuilt in a new location) and replacement of rocks protecting bulkheads. Based on this review, we estimate that no more than two bulkheads will be repaired during each year and all repairs will be minor rock replacement in, or in front of, a bulkhead ("minor" to mean consisting of less than 10 percent of an individual bulkhead). More substantial repairs that replace more than 10 percent of bulkhead are not proposed as part of this action.

<u>1.3.5</u> Removal of Man-Made Debris from Seabed

Debris may be removed from structures, the shoreline, or in the near shore environment. This could include removal of loose logs (surface or subsurface), loose piles, floating debris snagged on structures, underwater fishing nets, concrete and/or asphalt chunks, and old tires. Debris may be removed using hand tools, or by mechanized equipment stationed on the shoreline, overwater structures, or on barges. Work may be aided by divers, depending on tidal conditions.

<u>1.3.6</u> Marine Sediment Test Borings

Geotechnical exploratory drilling and investigative sampling is used to determine the sub-surface composition for the purpose of structure design, hazardous materials detection and other exploratory activities. Geotechnical sampling may include Wet Rotary Sample Boring, and Vibracore or Mudmole Sediment Sampling. The work consists of drilling a hole (maximum diameter about 6 inches) and removing a soil or sediment plug(s). Hammering of casings for borings is not typically used for these methods.

The type of equipment used depends on topography and access to the location of the required boring. A truck-mounted drill will access marine boring locations by cutting through the trestle deck. Each drill will have a support truck for water, tooling, and other required supplies. The track-mounted drill is a low ground pressure (2.5 pounds per square inch) rubber and steel track vehicle. A portable barge can be used when the boring location is away from the trestle. It consists of hauling transportable pontoons to the vicinity by trailer and setting them into the water with a boom truck for assembly into a barge. Drills and support equipment are placed on the barge and moved into position for the drilling operation. The barge is held in place by four anchors. For operations in deep water, a truck-mounted drill is placed on a large barge. Tugboats are used to maneuver the barge. No geared mechanisms (tires, tracks) may enter the wetted work perimeter. Truck mounted and tracked drilling equipment must work from a location outside of the wetted perimeter or from a temporary floating work platform. Drilling water recycle systems must be self-contained, operated, and maintained such that recycled water or lubricating fluids (such as bentonite) do not enter waters of the state. All waste material such as drill spoils and cuttings, construction debris, silt, excess dirt, excess gravel, or overburden resulting from the project are properly disposed of in an upland area above the limits of extreme high tidal water.

Approximately three to five projects with approximately five borings each (25 maximum) are anticipated per year. Each boring is anticipated to take 15-30 minutes. This activity type is not restricted by in-water work windows.

1.3.7 Repair and Replace Floating Dolphins

Floating dolphins serve a number of functions: as protection of adjacent properties (e.g., marinas and breakwaters), as approach and berthing aids, as a means to remain stationary during loading and unloading operations, and as mooring points for overnight tie-up. Floating dolphins do not contribute to the structural integrity of ferry terminals. Floating dolphins are used primarily at terminals with deep water (typically deeper than 45 feet) or where the presence of bedrock makes pile-supported fixed dolphins impractical. A typical floating dolphin is illustrated in Figure 3.

Figure 3. Typical floating dolphin. Photos from WSF Terminal Design Manual, M3082.5, April 2016.

Floating dolphins float on steel or polyethylene tanks or on concrete pontoons. Concrete pontoons have rubber or polyethylene rub faces that are erected on steel frames bolted to the pontoons. Anchor chains are attached at the corners of the floating dolphin, and in some cases, on the sides of the platform. They run out at an angle to the seabed and are connected to concrete or steel anchors that position the dolphin to absorb the energy of berthing vessels, and to prevent it from moving. Steel anchors are installed by lowering them to the seafloor, from a workboat or tug, and dragging them until the anchor fluke penetrates the seafloor and develops the required holding capacity. The drag distance is a function of the soil type, factors of safety, and the length of the anchor fluke, and it may take one or two attempts to set each anchor. Occasionally piles are driven to anchor chains to the seabed when other anchoring options do not work.

Some components of floating dolphins, such as dolphin anchors, pontoons, and chains occasionally need to be replaced, as these materials will wear out or need to be repositioned. There will be no increase in the number of anchors, pontoons or chains and no increase in overwater coverage (OWC) or benthic footprint from this activity. Work, except for pile driving, may be conducted at night with temporary artificial lighting shielded and directed away from surface waters. The following terminals have concrete floating dolphins:

- Point Defiance - 1
- Seattle – 2
- Lopez – 1
- Orcas – 2
- Mukilteo – 1

No replacements of floating dolphins are immediately planned, however, the action agencies anticipate up to one dolphin replacement (sized approximately 3,200 square feet (sq ft) annually (see also Section 1.3.12 for discussion of baseline and enduring effects).

1.3.8 Replacement of Timber Dolphins and Wingwalls with Steel Dolphins and Wingwalls

Wingwalls serve as the primary structure used to stop and hold vessels in place for loading and unloading, and overnight tie-up. Fixed dolphins serve a number of functions: as protection of adjacent properties (e.g., marinas and breakwaters) or other WSF structures (e.g., wingwalls and overhead loading facilities); as approach and berthing aids; as means to remain stationary during loading and unloading operations; and as mooring points for overnight tie-up. Typical wingwalls and fixed dolphins are illustrated in Figures 4 and 5, respectively.

Figure 4. Typical wingwalls. Photos from WSF Terminal Design Manual, M3082.5, April 2016.

Figure 5. Typical fixed dolphins. Photos from WSF Terminal Design Manual, M3082.5, April 2016

There are timber dolphins and wingwalls at the 5 locations listed below.

- Bremerton – 2 dolphins
- Coupeville – 2 dolphins
- Eagle Harbor – 13 dolphins/4 wingwalls
- Kingston – 1 dolphin
- Port Townsend – 2 dolphins

These timber dolphins and wingwalls will be replaced with steel structures over time. Timber dolphins have 35-80 tightly clustered piles; replaced dolphins will have 5-13, more openly spaced steel piles. Work, except for pile driving, may be conducted at night with temporary artificial lighting shielded and directed away from the surface of the water.

Up to 3 structures may be replaced each year (see also Section 1.3.12 for discussion of baseline and enduring effects). The current average overwater coverage for these structures is 82 sq ft. The future average for all completed replacement structures is 179 sq ft. Based on these averages, the replacement of 3 of the 24 structures per year of this programmatic consultation, would result in an expected increase averaging 97 sq ft per structure, with an expected total overwater coverage of 291 sq ft. The structure diaphragms will be situated higher above the water surface than the existing structures (approximately +25-26 ft Mean Lower Low Water (MLLW)).

1.3.9 Seismic Upgrades

There is no standard design for seismic upgrades at WSF terminals – it depends on the terminal and the type of upgrade needed. However, the current project at Vashon Island includes the installation of 8 steel piles (36-inch diameter) and with an increase in benthic impact of 56.5 square feet and increase in overwater coverage of 404 sq ft. Based on the uncertainty of future designs and the known information from the Vashon terminal upgrade, WSF anticipates up to two seismic upgrades per year, estimating a total of 16 steel piles, total of 900 sq ft of overwater coverage and 115 sq ft of benthic impact.

1.3.10 Pile Replacement (Removal, Installation) and Repair

Most ferry structural components are pile-supported, including dolphins, wingwalls, towers, bridge seats, and trestles. Damaged piles are either removed and replaced, or repaired in place.

Pile removal and installation can occur at any of the terminals but is usually focused at one to two terminals per year, with 10 to15 piles installed at each. A few more terminals will replace one or two piles in any given year, but the majority of terminals will not have pile installation or removal in any given year. The proposed action will provide for a maximum of 60 steel/concrete piles removed and 60 steel/concrete/timber piles installed per year, up to 100 timber piles removed per year, and two drilled shafts installed per year. Up to 5 piles per year to be repaired or re-installed may be of treated wood.

Pile sizes will range from 8- to 36-inches diameter and drilled shafts will be up to 120-inches in diameter or possibly larger if needed. A maximum of four piles per day will be installed per site. Construction methods for pile removal, installation, and repair are summarized below.

Pile Removal Methods

Pile removal may be needed for several reasons: 1) replacing an outdated structure supported by piles, 2) replacing individual piles that are damaged, 3) removing piles from temporary construction platforms, and 4) removing derelict piles. Any type of pile may be removed (steel, concrete, timber), but timber creosote piles are the most commonly removed. Structures that are timber pile-supported and are being replaced will have fewer piles per structure, but the replacement piles are typically larger steel piles in the replaced structure (see Appendix D in WSDOT 2020a). The typical scenario would be a creosote timber supported structure being replaced by a steel pile supported structure. The potential methods for pile removal are listed below.

<u>Removal with a Vibratory Driver:</u> The vibratory hammer is supported from a crane, and a barge is typically used to transport the discarded pile for off-site disposal. This is the most commonly employed method suitable for all pile types.

<u>Direct Pull with Chain/cable:</u> Removal of timber piles usually require use of a vibratory hammer to begin removing piles, but once a few piles are removed, the remaining piles may be loose enough to remove by wrapping a chain or cable around them and pulling with a crane.

<u>Clamshell Removal:</u> If a weak timber pile breaks off below the waterline during vibratory or direct pull removal, the remaining portion of the pile may be pulled by clamshell bucket with grasping jaws that is supported by a crane.

<u>Cut Below Mudline:</u> In some cases, piles are cut off below the mudline by special equipment and the hole is backfilled. Concrete piles are always removed in this fashion.

Piles Installation Methods

The method used for installing piles is dependent on the characteristics of the substrate, requirements for ensuring load capacities are met, and work-site constraints at each location. Any of the following methods, or combination of methods, may be chosen as site-suitable:

<u>Vibratory Driver</u>: Vibratory installation of steel piles is done by using a crane-supported vibratory hammer placed on the pile, aligned vertically, and then the hammer vibrates the pile into the sediment. Timber and concrete piles cannot be installed with a vibratory hammer and must be impact driven. Vibratory driving is the preferred method for steel pile driving because peak underwater noise levels are less than with an impact hammer. However, if the installed pile is part of a load bearing structure, the final driving is done with an impact hammer to reach load bearing design criteria (called “proofing”). Vibratory driving may not be the suitable method when installation is needed in dense or unstable sediments; in these cases, impact driving is used.

Impact Hammer: Impact hammers can be used to install any pile type or size pile. They are typically needed where the pile must penetrate denser sediments and are also used to proof piles that are installed with a vibratory hammer, as stated above. The impact hammer is supported by a crane and is positioned over the pile to be driven. The length of time to install a single pile varies depending on sediment conditions (typically 15 minutes, but up to an hour on rare occasions), and the number of strikes by the hammer varies accordingly. Once the pile is installed the crane supporting the impact hammer is repositioned to install the next pile. Modifications for impact hammer installation of concrete piles may be needed in particularly dense sediments, such as attaching an H-pile to the tip of a concrete pile to break dense sediments (a stinger). A maximum of four piles per day will be impact driven at any single terminal.

Piles in Rock Anchors: Some of the terminals have very shallow sediments over bedrock, so rock anchors are used in these situations. Rock anchors are piles that are anchored to bedrock by steel dowels or strand clusters that are fixed within the pile and are cemented into a hole that is drilled into bedrock. A small pipe is cemented within the pile, and the drill is lowered through the pipe and excavates a hole into the bedrock, followed by inserting the steel dowels/strand into the hole and grouting into place. Rock anchors are currently in place only at the Lopez and Friday Harbor terminals.

Small Piles: Small piles are used in situations that are similar for rock anchors. They are not as strong as rock anchors and are used for structures that have lower load bearing capacity requirements, such as dolphins. These piles have a serrated edge and are drilled directly into rock for 2 to 3 ft and backfilled with grout after the cuttings have been removed.

H-Piles: H-piles (12 to 14-inch) are structurally square piles that form an “H” in cross-section and are used in situations that have spatial requirements that round steel piles cannot fill. In some cases where a timber pile is failing, it may be very difficult to remove and directly replace (e.g., under a trestle with many piles close together). In this case, repair will occur by driving an H-pile through the deck of the trestle, in the approximate location of the failing timber pile. The pile is usually driven with a vibratory hammer, but an impact hammer may be needed if the load- bearing capacity of the structure needs to be confirmed. If an impact hammer is used, it is often infeasible to use a bubble curtain because of the limited work area under the trestle. After installation, a cap is placed over the H-pile to connect it to the trestle and support the load.

Drilled Shafts: A drilled shaft is a large steel pile (usually 6 to 10 ft in diameter) that is installed to support hydraulic cylinders used in overhead loading and transfer spans, and to support structures installed in deep water and/or thick layers of soft sediment. The shaft is typically installed with a vibratory driver but may also be oscillated in. After the shaft is installed, an auger excavates sediment within the casing to a desired depth. Then steel rebar is lowered into the casing and filled with concrete to support the hydraulic cylinder. All sediment and water removed from within the shaft are contained and properly disposed of offsite.

Pile Resets

All WSF facilities have dolphin and wingwall structures, which act as landing aids for the vessels. Occasionally a berthing vessel will have a ‘hard landing’, during rough weather or high- flow current conditions. If a WSF inspector determines that a hard landing has pushed a dolphin or wingwall steel fender pile out of alignment, the fenders and other hardware will be removed so that the pile can be adjusted. A vibratory hammer is used to partially remove the pile, then vibrate it back down in the proper alignment. The maximum size of these piles is 36 inches. The contractor will reset piles on an as-need basis.

Pile resets usually include no more than three in a day. The time to partially remove and drive a pile depends on the density of the substrate but is not expected to exceed 60 minutes per reset.

Pile Repair Methods

Piles can be damaged or deteriorated by marine conditions. Depending on the extent of damage, piles are replaced or repaired. Piles that are repaired are usually made of timber, but steel piles can also be repaired, and the repair techniques differ between these types. Up to 15 steel, concrete, or 5 treated timber piles will be repaired each year.

Timber Pile Stubbing with Concrete Collar: This repair is done by replacing a damaged section of the pile with a timber ammoniacal copper zinc arsenate (ACZA)-treated pile section of the same length. After cutting out the damaged section, a connecting pin is inserted into the bottom pile section. If necessary, the sediment area around the bottom part of the pile is excavated, the new pile section is inserted on the pin and a form is built around the bottom pile stub. The form is filled with concrete to create a collar between the new pile section and the bottom pile stub. This is often done at low tide and the lower section of the pile is not removed, so there is no pile removal or pile driving. Piles that are located in deep water can also be repaired by stubbing, but divers are used who employ additional steps to minimize turbidity and prevent concrete contact with marine waters.

Timber Pile Stubbing with Steel Collar: This is similar to the repair described above, but instead of a concrete collar, a steel collar (jacket) is bolted to the new pile section, extending beyond the joints of the old and new pile sections. This method does not form as tight a connection between the old and new sections as the pile stubbing method.

Timber Pile Encapsulation: This is similar to the two repairs above, but rather than removing and replacing a damaged pile section, the original pile is left in place and enclosed (encapsulated) in concrete. A steel or fiberglass form is built around the pile and then filled with grout and epoxy. This can be done in the dry at low tide, or by divers.

Steel Pile Repair: If steel pile repair is needed, an above-water damaged section may be cut off and a new pile section welded on. Repair below-water is more difficult, and the pile may be cut at the base or mudline and abandoned, then another pile driven to replace the damaged one. Steel piles can also be repaired by encapsulating in concrete, as with timber piles. Steel piles have coatings that resist erosion. If these coatings are damaged, the coatings can be reapplied. Divers reapply coatings below the water.

<u>1.3.11</u> Beneficial Activities

Mitigating Impacts on Nearshore Habitat

As NMFS Policy on Mitigating Impacts to Trust Resources provides, NMFS general order of preference is that project impacts are avoided, particularly in high value habitats, such as critical habitat, and minimized. However, a number of activities included in the proposed action are likely to result in the unavoidable loss of nearshore habitat functions and values to ESA listed species and their designated critical habitat. The proposed action evaluated in this programmatic Opinion and conference opinion ensures that the loss of habitat functions and values, resulting from individual projects, is appropriately compensated, and does not meaningfully aggregate over space and time. To achieve this, the proposed action requires project modification or conservation offsets for those proposed activities that, when implemented, result in loss of nearshore habitat functions and values for ESA-listed species and critical habitat. Specifically, under the proposed action, unavoidable adverse effects on nearshore habitat, from the proposed activities will be offset with a proportionate (or greater) amount of conservation offsets/credits (compared to project effects/debits), using one or more of the options described below.

Project effects and offsets will be evaluated as debits and credits using the NMFS' Puget Sound Nearshore Calculator ("Calculator") or other equivalent analytical tool.[1] Analysis of each project using the Calculator or equivalent tool will initially be done by the Federal lead agency and then reviewed and verified by NMFS during the programmatic administration process described in Section 1.4, below.

<u>Option 1. Conservation credits generated by WSF programmatic activities</u>

Some projects undertaken by WSF under the proposed action will generate conservation credits. Specifically, conservation credits can be generated by WSF through the implementation of habitat improvements projects such as creosote removal, habitat enhancement activities, and removal of existing bulkheads (see below for details).

Conservation credits generated by habitat improvement projects must be from one of three identified service areas. A seascape approach was used to identify these three areas, or basins: North Puget Sound (Anacortes, Lopez, Orcas, Shaw, and Friday Harbor terminals), Hood Canal (Port Townsend and Coupeville terminals), and South Central Puget Sound (Mukilteo, Clinton, Edmonds, Kingston, Bainbridge, Eagle Harbor, Bremerton, Seattle,

[1] An alternative analytical tool to NMFS's Calculator can be used if it is: (1) based on the best available science; (2) based on an assessment of nearshore physical and biological features supporting the conservation of ESA listed species affected by the proposed project; and (3) be able to demonstrate equivalency between habitat impacts of the proposed project and conservation offsets offered to compensate for those habitat impacts. NMFS will evaluate any proposed alternative analytical tool and determine if it meets these criteria, thereby ensuring no net loss of long-term habitat function. If NMFS determines that the proposed alternative analytical tool does not meet these criteria, NMFS will use a tool that it determines does meet the criteria.

Southworth, Vashon, Fauntleroy, Point Defiance, and Tahlequah terminals).[2] Impacts that occur within a particular service area are to be offset by conservation credits within the same service area, in order to retain habitat values to populations and MPGs that are expected to rely more heavily on those service areas.

Conservation credits will be evaluated and verified using the Calculator or equivalent tool and reported and tracked consistent with the administration process described in Section 1.4, below.

In general, conservation credits generated by programmatic activities can be applied to offset conservation debits incurred by the proposed action *within the same (or prior) fiscal years*. In addition, if, at the end of any fiscal year, there are more credits available than are necessary to offset debits, provided the "surplus" credits comply with the substantive and procedural requirements of the Credit Savings Instrument attached as Appendix A, these "advance conservation credits" can be carried over and applied to offset conservation debits incurred in *subsequent fiscal years.*

Option 2. Purchase of conservation credits

WSF can purchase conservation credits from:

a. a NMFS-approved conservation bank with a service area that provides conservation credits that are ecologically appropriate for the project impacts, when considering the seascape context of the project; or,
b. An in-lieu fee program with a service area that provides conservation credits that are ecologically appropriate for the project impacts, when considering the landscape or seascape context of the project.

In choosing Option 2 to meet required conservation offsets in whole or in part, WSF will, and:

- Submit, as part of the project verification process described in Section 1.4, below, documentation of an agreement between credit provider and WSF that identifies the number of credits/offsets the permittee intends to purchase
- Provide documentation of credits purchased as part of annual reporting.

Option 3. In-Lieu Fee transactions

WSF can enter into an In-Lieu Fee (ILF) transaction wherein it provides funding to a third party habitat restoration "sponsor" (e.g., a state agency, Regional Organization, designated

[2] As NMFS Policy on Mitigating Impacts to Trust Resources provides, "mitigation recommendations and decisions should be made using a holistic landscape and/or seascape approach, with a goal of selecting the option that best achieves the conservation objectives for the affected resources." For purposes of this Programmatic Biological Opinion and conference opinion, we have applied a seascape approach to defining three service areas for compensatory mitigation. Seascape is defined as a marine, estuarine, tidal freshwater, or Great Lakes area encompassing an interacting mosaic of ecosystems and human systems that is characterized by common management concerns. Relative to this Policy, such management concerns relate to conserving NOAA trust resources. Seascape is not defined by the size of the area, but rather the interacting elements that are meaningful to the conservation objectives for the resources under consideration.

Lead Entity, Conservation District or Regional Fisheries Enhancement Group) for restoration project(s) that will improve nearshore or estuarine habitat within the relevant service area or basin as described above for option 2 . NMFS will analyze the conservation credits generated by the restoration project using the Calculator or equivalent tool. Responsibility for implementing the compensatory mitigation explicitly transfers from WSF to the third party.

In choosing Option 3 to meet required conservation offsets in whole or in part, WSF will provide the following details to NMFS prior to the start of the project:

a. Quantitative description of habitat improvements that will be funded by the ILF transaction (e.g., sq ft of overwater structure removed, if shoreline armoring removed, cubic yards of gravel placement);
b. Where the improvements would occur;
c. How the improvements would occur (e.g., any construction type actions); and
d. When the improvements would occur
e. Documentation of a funding arrangement or agreement between the restoration project sponsor and WSF;
f. Written assurances from the restoration project sponsor that the identified restoration project will occur within three years of funding being received.
g. Documentation that funds have been paid by WSF to the habitat restoration partner prior to construction of the impacting project's construction start date.

Mitigation Timing

Credits and debits are considered accrued within the State of Washington's fiscal year (July 1 to June 30) in which the project generating the credits or debits was verified.

At the end of each fiscal year, there will be an accounting of debits and credits generated from projects that year in order to determine any debit deficits and credit surpluses (see Ledgering process in Section 1.4.4. below). If additional credits are necessary to offset any remaining program debits, the following timeframes apply:

- If Option 1 (Credits generated by programmatic activities) is being used, the credits must be generated by the end of the following biennium (e.g., debits accrued in the 2024-2025 fiscal year, which is year two of the biennium, would need to be offset by June 30, 2027, the end of the following biennium), and documentation that demonstrates the site restoration, such as before and after photos, must be provided to the Corps and to NMFS.

- If Option 2 (conservation credit purchase) or 3 (ILF transaction) is being used, the purchase agreement from a conservation bank or in lieu fee provider must be provided during the project verification process, *and* documentation of the purchase of such credit or payment of ILF funds must be during annual reporting within 2 years of the impacting project's construction start date.

Creosote Removal

WSF has catalogued the remaining creosote at all terminals in the system and separated them into structures whose removal would fall within this program, and those that would fall outside of it. WSF estimates that there are approximately 10,000 tons of creosote to be removed under this program, all of which would be removed within the next 10 years. Such removal is expected to be a source of credits for the duration of this program.

Other Habitat Enhancement Activities

WSF is currently working to systematically identify terminal locations where bulkhead removal, beach nourishment or other habitat enhancement activities might be possible. This will provide a prioritized list of possible offsets that could be implemented. Projects covered under this category may be standalone projects or may be undertaken in conjunction with other projects. These could include:

1. Wetland, shoreline, tidal stream, and floodplain restoration. This conservation action category includes projects focused on restoring degraded wetlands; disconnected floodplains, and shorelines. In all cases, restoration of the resource function and habitat quality is the primary purpose of the action. This category includes:
    a. Enhancement or restoration of wetland, shoreline or floodplain functions and values.
    b. Re-establishment of historic floodplain extent through removal of fill from within the historic 100-year floodplain.
    c. Enhancement of floodplain habitat quality through removal of anthropogenic structures, infrastructure, debris, or water control features (weirs, dams, etc.) located wholly or partially within the floodplain.
2. In-water or over-water structure, rubble, or derelict vessel removal. Restore impaired in- water and riparian habitat through the removal of untreated and chemically treated wood pilings, piers, vessels, floats, derelict fishing gear, as well as similar structures or rubble comprised of plastic, concrete, and other materials.

Removal of Existing Bulkheads

The purpose of this category is to enhance nearshore habitat for ESA listed species and their designated critical habitat. Projects covered under this category may be standalone projects or may be undertaken in conjunction with other projects. No limit is proposed on the level of this activity as the impacts are almost entirely beneficial.

Beach Nourishment

The purpose of this category is to enhance nearshore habitat for ESA listed species and their designated critical habitat, however the value of beach nourishment is site and circumstance specific and will require preliminary evaluation to ascertain if intended benefits will accrue. Projects covered under this category may be standalone projects or may be undertaken in conjunction with other projects.

Activities should meet the following criteria:

a. The material should be similar in size to undisturbed neighboring locations with similar beach morphologies. Sediment may be placed in the high tide zone of the beach, where it is likely to be subsequently reworked and redistributed by wave action.

b. Conduct topographic and bathymetric profile surveys of the beach and offshore within the project and control areas. Pre- and post-construction surveys shall be conducted no more than 90 days before construction commences and no more than 60 days after construction ends. Surveys should be submitted to NMFS at WSF-WA.wcr@noaa.gov with a copy sent to the Corps Project Manager and nws.compliance@usace.army.mil.

c. Placement of beach nourishment will follow WDFW Marine Shoreline Design Guidelines (MSDG), 2014.

1.3.12 General Minimization Measures

The following minimization measures (MMs) will be employed during all construction at WSF facilities. MMs are organized by general MMs used for all construction practices and specific MMs for individual activities. Some of these MMs apply to several different activities and are listed multiple times in this section. These MMs have been developed and are routinely used by WSF during repair, replacement, and maintenance activities at WSF terminals. The MMs are intended to avoid and minimize potential effects to ESA-listed species and designated critical habitats. The language in each MM is included in the Contract Plans and Specifications for specific projects and must be agreed upon by the contractor prior to any construction activities. Upon signing the contract, it becomes a legal agreement between the contractor and WSF. Failure to follow the prescribed MMs is a contract violation.

- WSF policy and construction administration practice is to have a WSF inspector on site during construction. The role of the inspector is to ensure contract compliance. The inspector and the contractor each have a copy of the Contract Plans and Specifications on-site and are aware of all requirements. The inspector is also trained in environmental provisions and compliance. In addition, depending on the specific project, environmental staff may be present for monitoring and compliance.

- All WSF construction projects are performed in accordance with the current WSDOT Standard Specifications for Road, Bridge, and Municipal Construction. Special Provisions contained in preservation and repair contracts are used in conjunction with, and supersede, any conflicting provisions of the Standard Specifications. WSF activities are subject to federal, state, and local permit conditions. WSF uses the best guidance available (e.g., best management practices (BMPs) and MMs) to accomplish the necessary work while avoiding and minimizing environmental effects to the greatest extent possible.

- WSF will comply with water quality restrictions imposed by WDOE (Chapter 173-201A Washington Administrative Code (WAC)), which specify a mixing zone beyond which water quality standards cannot be exceeded. Compliance with WDOE's standards is intended to ensure that fish and aquatic life are being protected to the extent feasible and practicable. General and specific conditions to protect water quality that apply to a project shall be reviewed with all contractors prior to the start of a project and kept on the job site at all times during construction.

- Timing restrictions are used to avoid in-water work when ESA-listed species are most likely to be present. Work windows are imposed by Washington Department of Fish and Wildlife (WDFW) in the Hydraulic Project Approval (HPA) and have additional limitations if forage fish spawning is documented near the terminals.

- The contractor will be advised that eelgrass (*Zostera marina* L.) beds are protected under local, state, and federal law. When work will occur near eelgrass beds, WSF will provide plan sheets showing eelgrass boundaries to the contractor. WSF will require its contractor to exercise extreme caution when working in the area indicated on the plans as "Eelgrass Beds." "Eelgrass beds" are defined as areas dense eelgrass mapped by WSF or Washington State Department of Natural Resources (WADNR). Data may come from WSF or WADNR records and will be provided to the contractor.

  WSF will require its contractor to the following restrictions during the life of the contract:

  The contractor shall not:
  - Place derrick spuds or anchors in the area designated as "Eelgrass."
  - Shade the eelgrass beds for a period of time greater than 3 consecutive days during the growing season (generally March through September).
  - Allow debris or any type of fuel, solvent, or lubricant in the water.
  - Perform activities that could cause significant levels of sediment to cover the eelgrass beds.
  - Conduct activities that may cause scouring of sediments within the eelgrass beds or other types of sediment transfer out of or into the eelgrass beds. Any damage to eelgrass beds or substrates supporting eelgrass beds that results from a contractor's operations will be repaired at the contractor's expense. WSF will comply with all applicable federal, state, and local regulations and the contractor will follow the conditions of any permits and/or approvals. Specific requirements of permits and/or approvals will be included in the contract specifications for the contractor.

  The contractor shall:
  - Clearly mark the edge of the seagrass and/or kelp habitat adjacent to the project during construction activities. Remove markers upon project completion.
  - Operate vessels with minimal propulsion power and in adequate water depth to prevent impacts from grounding and propeller wash to seagrass, kelp, and forage fish spawning beds.

- Restrict vessel operation to tidal elevations adequate to prevent propeller related damage to seagrass and kelp.
- Not deploy anchors or spuds in seagrass or kelp.
- Maintain anchor cable tension, set and retrieve anchors vertically, and prevent mooring cables from dragging to avoid impacts to seagrass and kelp.

- The contractor shall be responsible for the preparation of a Spill Prevention, Control, and Countermeasures (SPCC) Plan to be used for the duration of the project. The plan shall be submitted to the project engineer prior to the commencement of any construction activities. A copy of the SPCC Plan with any updates will be maintained at the work site by the contractor. The SPCC Plan shall identify construction planning elements and recognize potential spill sources at the site. The SPCC shall outline BMPs, responsive actions in the event of a spill or release, and notification and reporting procedures. The SPCC shall also outline contractor management elements such as personnel responsibilities, project site security, site inspections, and training. The SPCC will outline what measures shall be taken by the contractor to prevent the release or spread of hazardous materials, either found on site and encountered during construction but not identified in contract documents, or any hazardous materials that the contractor stores, uses, or generates on the construction site during construction activities. These items include, but are not limited to, gasoline, oils, and chemicals. Hazardous materials are defined in Revised Code of Washington (RCW) 70.105.010 under "hazardous substance." The contractor shall maintain, at the job site, the applicable spill response equipment and material designated in the SPCC Plan.

- No petroleum products, fresh cement, lime, concrete, chemicals, or other toxic or deleterious materials shall be allowed to enter surface waters.

- If beach access is required, use of equipment on the beach area shall be held to a minimum and confined to designated access corridors that minimize foot traffic on the upper beach.

- Up to two barges at each terminal may be brought to support maintenance and repair work. Barge operations shall be restricted to tide elevations adequate to prevent grounding of the barge.

- Wash water resulting from washdown of equipment or work areas shall be contained for proper disposal and shall not be discharged into state waters unless authorized through a state discharge permit.

- Equipment that enters the surface water shall be maintained to prevent any visible sheen from petroleum products appearing on the water. There shall be no discharge of oil, fuels, or chemicals to surface waters, or onto land where there is a potential for reentry into surface waters.
- No cleaning solvents or chemicals used for tools or equipment cleaning shall be discharged to ground or surface waters.

- The contractor shall regularly check fuel hoses, oil drums, oil or fuel transfer valves, fittings, etc. for leaks, and shall maintain and store materials properly to prevent spills.

- Projects and associated construction activities will be designed so potential effects to species and habitat are avoided and minimized.

Measures Specific to Pile Removal and Demolition of Structures

A containment boom surrounding the work area will be used during creosote-treated pile removal to contain and collect any floating debris and sheen, provided that the boom does not interfere with vessel operations. The boom will remain in place until all oily material and floating debris have been collected and all sheens have dissipated. The contractor will also retrieve any debris generated during construction, which will be properly disposed of at an approved upland location.

- The contractor will have oil-absorbent materials on site to be used in the event of a spill if any oil product is observed in the water.

- All creosote-treated material, pile stubs, and associated sediments will be disposed of by the contractor in a landfill that meets the liner and leachate standards of the Minimum Functional Standards, Chapter 173-304 WAC. The contractor will provide receipts of disposal to the WSF project engineer.

- Removed piles, stubs, and associated sediments (if any) shall be contained on a barge. If piles are placed directly on the barge and not in a container, the storage area shall consist of a row of hay or straw bales, filter fabric, or similar BMP placed around the perimeter of the barge

- Excess or waste materials will not be disposed of or abandoned waterward of Ordinary High Water (OHW) or allowed to enter waters of the state, as per WAC 220-110-070. Waste materials will be disposed of in a landfill. Hazardous waste and treated wood waste will be disposed of by the contractor in a landfill that meets the liner and leachate standards of the Minimum Functional Standards, Chapter 173-304 WAC.

- Piling that break or are already broken below the waterline will be removed with a clamshell bucket. To minimize disturbance to bottom sediments and splintering of piling, the contractor will use the minimum size bucket required to pull out piling based on pile depth and substrate. The clamshell bucket will be emptied of piling and debris on a contained barge before it is lowered into the water. If the bucket contains only sediment, the bucket will remain closed, be lowered to the mudline, and opened to redeposit the sediment.

- Demolition and construction materials shall not be stored where high tides, wave action, or upland runoff can cause materials to enter surface waters.

Measures Specific to Pile Installation, Pile Repair, and Installation of Structures

- All steel piles will be installed with a vibratory driver; piles used for non-load bearing structures will not be proofed with an impact driver, but load bearing piles will be impact proofed.

- A bubble curtain will be used for impact driving of steel piles in waters greater than 3 ft deep; a bubble curtain will not be used on concrete piles, timber piles, or small piles.

- WSDOT will monitor underwater noise as described in the most recent NMFS approved Underwater Noise Monitoring Plan template (WSD OT 2012), except when 2 or less piles are being impact driven. If 2 or fewer piles are being impact driven, no underwater noise monitoring will be required.

- There will be at least a 12-hour rest period between impact pile driving events at the same location.

- Piles will be driven during slack tides if feasible.

- Marine mammal monitoring will occur during both impact and vibratory pile driving with shut-down of pile driving if SRKWs or humpback whales are within the behavioral harassment zone modeled for individual projects submitted under this consultation. The most conservative monitoring zones will be for driving 30-inch or 36-inch steel piles. Smaller pile sizes will have reduced monitoring zones as appropriate.

- WSF will comply with water quality restrictions imposed by WDOE (Chapter 173-201A WAC), which specifies a mixing zone beyond which water quality standards cannot be exceeded. Compliance with WDOE's standards is intended to ensure that fish and aquatic life are protected to the extent feasible and practical.

- Creosote-treated timber piling shall be replaced with non-creosote-treated piling.

- The contractor will be required to ensure that wet concrete does not come in contact with marine waters. Forms for any concrete structure will be constructed to prevent leaching of wet concrete. Forms will remain in place until concrete is cured.

- The tube used to fill steel pilings with concrete or to grout rock anchors will be placed toward the bottom of the piling to prevent splashing and concrete overflow. During grouting of rock anchors, the bottom of the pile will be sealed by the sediment it has been driven into or, if the sediment layer is too thin, by plastic and sandbags to ensure no concrete escapes from the base of the pile.

- For installation of drilled shafts, sediments and slurry will be completely contained within the casing during construction. The sediments removed will be contained for upland disposal, as will the drilling slurry.

- The contractor will be required to retrieve any floating debris generated during construction. Any debris in the containment boom will be removed by the end of the workday or when the boom is removed, whichever occurs first. Retrieved debris will be disposed of at an upland disposal site.

- Whenever activities that generate sawdust, drill tailings, or wood chips from treated timbers are conducted, tarps or other containment material shall be used to prevent debris from entering the water. If tarps cannot be used (because of the location or type of structure), a containment boom will be placed around the work area to capture debris and cuttings.

- Excess or waste materials will not be disposed of or abandoned waterward of OHW or allowed to enter waters of the state.

- Water inside the form used for pile repairs will be drained to the water elevation outside the form before concrete is poured.

- Steel, plastic/steel, concrete, or ACZA-treated wood piling will be used. No creosote-treated timber piling will be used.

- ACZA-treated wood for 5 piles/year and for up to 30,000 board feet of non-pile structural members per year, will be treated using the April 3, 2012 version of the BMPs for the Use of Treated Wood in Aquatic and Wetland Environments, Western Wood Preservers Institute.

- All piling, lumber, and other materials treated with preservatives shall be sufficiently cured to minimize leaching into the water or sediment.

- Hand tools or a siphon dredge will be used to excavate around piles to be replaced.

Measures Specific to Temporary Structures

- Temporary structures associated with facility closures during construction will be removed before the contractor demobilizes from the site.

Measures Specific to Drilling and Boring

- If drilling, boring, or tunneling are used, isolate drilling operations in wetted areas using a steel casing or other appropriate isolation method to prevent drilling fluids from contacting water.

- If drilling through decking is necessary, use containment measures to prevent drilling debris from entering the water.

- Sampling and directional drill recovery/recycling pits, and any associated waste or spoils will be completely isolated from surface waters and wetlands.

- All waste or spoils will be covered if precipitation is falling or imminent.

- All drilling fluids and waste will be recovered and recycled or disposed of to prevent entry into the water.

- If a drill boring case breaks and drilling fluid or waste is visible in water or a wetland, make all possible efforts to contain the waste.
- All drilling equipment, drill recovery and recycling pits, and any waste or spoil produced, will be contained, and then completely recovered and recycled or disposed of as necessary to prevent entry into any waterway. Use a tank to recycle drilling fluids.

- When drilling is completed, remove as much of the remaining drilling fluid as possible from the casing (e.g., by pumping) to reduce turbidity when the casing is removed.

1.3.13 Other Activities Caused by the Proposed Action

We considered, under the ESA, whether or not the proposed action would cause any other activities and determined that, with the exception that work may require temporary structures and construction barges (up to 20 barges annually) to complete proposed actions, it would not. The proposed action for this consultation is primarily for maintenance, no part of the proposed action meaningfully extends the life of the larger, operationally critical structures such as the terminals, the loading wharfs, or terminal parking lots.

The proposed action does allow for replacement of non-critical structures, for example dolphins, that result in a loss of nearshore habitat quality but those are not critical for the operation of the terminals and ferry vessels. These structures are primarily to stop and hold vessels in place for loading and unloading, and overnight tie-up; or protect nearby infrastructure from being struck by vessels. The proposed action also includes some repair or replacement of piles and other elements at ferry terminals. The proposed action may extend the life of those individual piles or other structural elements to be replaced. Therefore, we evaluate effects and offsets based on the part of the structure being repaired or replaced. The proposed level of activity, considered annually or cumulatively, is not sufficient to extend the life of the loading wharfs or other operationally critical structures. Since the proposed action does not meaningfully extend the life of any of the operationally critical structures, the effects of the action for this consultation does not include the enduring effects of operationally critical structures or the operation of the ferry vessels.

The proposed action includes a commitment to no net loss using the Calculator or equivalent tool. The proposed action will avoid the loss of nearshore habitat quality caused by the repair or replacement of dolphins, wingwalls, or individual piles.

1.4 Programmatic Administration

1.4.1 Project Review

The WSF or federal action agency will review individual proposed projects (and analyze them using the Calculator to ascertain any project debits or credits), to determine whether the proposed work meets the following criteria and is therefore appropriate for coverage under the programmatic opinion.

1. The proposed project falls within the description of an activity in the proposed action and meets all applicable minimization measures listed in Section 1.3.12.
2. If the proposed project generates debits under the Calculator analysis, the debits will be offset using one of the methods described in the proposed action. The verification request will include a description of which methods for offsetting impacts will be utilized (e.g. existing/available credits generated by programmatic activities, purchase from accredited bank or purchase from in lieu fee provider).
3. Work is not part of a larger project that has been split into smaller interdependent parts to facilitate or sequence consultation. All proposed work must be evaluated under this programmatic consultation (e.g., work cannot be partitioned and submitted under multiple programmatic or other consultations).
4. The proposed work conforms to all applicable Terms and Conditions in the ITS of this programmatic consultation.
5. The proposed work does not include or cause actions (that would not occur but for the proposed action and are reasonably certain to occur) that are specifically excluded from the proposed action.

1.4.2 Electronic Submission

After an initial review of a project determines it will meet the specification in 1.4.1, WSF will send a project notification form to NMFS with the Federal action agency cc'd, as detailed below:

1. Submit information to WSF-WA.wcr@noaa.gov.
2. Email subject line should read: WSF Maintenance and Preservation Work Programmatic Verification, **or**, WSF Maintenance and Preservation Work Programmatic Notification Only, as further described below.
3. The email submission will include, at a minimum, the following information:
    a. Project name
    b. Federal nexus and Federal Aid or USACE reference number, if applicable
    c. Brief project description
    d. Applicable project categories (see Sections 1.3.1 through 1.3.10 for category names)
    e. Project drawings
    f. Information to demonstrate project meets the programmatic and conference Opinion's requirements

    g. Output from Calculator (or equivalent tool) to document conservation credits and/or debits.

4. Within 5 business days of receipt, NMFS will provide WSF an email stating the request has been received. If WSF has not received this email within 5 business days, WSF will seek to confirm whether NMFS has received the submitted materials.

1.4.3 NMFS Review and Verification

NMFS' verification that the proposed project is covered under this programmatic consultation is required for the following activities:

1. Repairs to bulkheads (Section 1.3.4)
2. Replacement of Floating Dolphins (Section 1.3.6)
3. Replacement of Timber Dolphins and Wingwalls with Steel Dolphins and Wingwalls (Section 1.3.7)
4. Structures added for the purpose of seismic upgrades (Section 1.3.9)
5. Repair and replacement of individual piles in any structure (Section 1.3.10)

NMFS will provide a response regarding programmatic coverage verification to the Federal action agency and WSF within 30 days from the date of the email submittal. WSF must receive an affirmative decision from NMFS before verification is complete. If the project does not meet the requirements in the Opinion and Conference Opinion, the email will identify which aspects of the project do not meet the requirements. The federal lead agency and WSF may evaluate the project and resubmit it with additional explanation if they disagree; however, NMFS will make the final determination as to whether a project meets the Opinion's and Conference Opinion's requirements.

NMFS verification is not required (i.e. notification only) for the following activities:

1. Deck and drain cleaning (Section 1.3.1)
2. Deck overlay replacement (Section 1.3.2)
3. Painting including preparatory cleaning, washing, abrasive blasting, and marine growth removal (Section 1.3.3)
4. General maintenance (Section 1.3.4)
5. Removal of man-made debris (Section 1.3.5)
6. Marine sediment test boring (Section 1.3.6)
7. Maintenance of floating dolphins (Section 1.3.7)
8. Repair or replacement of component pieces at wingwalls and pile-supported structures (Section 1.3.8)
9. Pile resets (Section 1.3.10)

1.4.4 Ledgering

WSF will maintain a ledger of conservation credits accrued and debits generated as identified via the NMFS verification process (which occurs per project) of this Opinion and Conference Opinion. This ledger will be included as part of annual reporting and discussed at the Annual Meeting. The offsets will be evaluated in terms of the previous fiscal year as well as the projected year and five-year lookahead for projects to ensure consistency with this proposed action. Debits accrued during any one fiscal year that are not offset by credits carried over from prior year(s), or generated during that fiscal year, would need to be resolved by the end of the following biennium (e.g., debits accrued in the 2024-2025 fiscal year would need to be offset by June 30, 2027).

As described above, Advance Conservation Credits (compliant with the Credit Savings Instrument at Appendix A) can be carried over and applied in subsequent fiscal years. If, at the end of the fiscal year, there are purchased conservation or ILF credits that have not been applied to offset debits, they will continue to remain on the ledger and can be used to offset debits as needed. There is no expiration date on credits.

1.4.5 Options for Projects that Do Not Meet Programmatic Requirements

If on review of a project implementation request, NMFS determines the project does not meet the Opinions' requirements, the WSF may choose to modify their project to meet the design requirements of the programmatic proposed action. If the project cannot be modified to meet the design requirements of the programmatic, NMFS will close the verification request and advise the appropriate federal lead agency to submit a biological assessment and request individual ESA consultation.

1.4.6 Monitoring and Reporting

Verifications allow NMFS to confirm throughout the execution of this program that impacts remain consistent with the program, by documenting that the long term harm from habitat modification is avoided by offsets. A second method for monitoring compliance is, as described above, an annual accounting of debits and credits generated from projects that year in order to determine any debit deficits and credit surpluses (see Ledgering process in Section 1.4.4.).

If the annual meeting/accounting reveals that additional credits are necessary to offset any remaining program debits, the following timeframes apply:

- If Option 1 (Credits generated by programmatic activities) is being used, the credits must be generated by the end of the following biennium (e.g., debits accrued in the 2024-2025 fiscal year, which is year one of the biennium, would need to be offset by June 30, 2027, the end of the following biennium), and documentation that demonstrates the site restoration, such as before and after photos, must be provided to the Corps and to NMFS.

- If Option 2 (conservation credit purchase) or 3 (ILF transaction) is being used, the purchase agreement from a conservation bank or in lieu fee provider must be signed and provided to NMFS within the 1 year of the review *and* documentation of the purchase of such credit or payment of ILF funds must be completed within 2 years of the review.

WSF, in coordination with the FHWA, USACE, and FTA must provide the information listed in Section 2.8.4 to NMFS in an annual programmatic report submitted to WSF-WA.wcr@noaa.gov by March 15 each year.

1.4.7 Annual Coordination Meetings

The USACE, FHWA, FTA, NMFS, and WSF will meet annually by May 15 each year to discuss the Annual Report and any actions that can improve conservation, efficiency, or comprehensiveness under the programmatic consultation.

1.4.8 Programmatic Revisions and Reinitiation

The agencies will discuss any revisions and need for reinitiation during annual coordination meetings described in Section 1.4.6.

1.5 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02).

For the proposed action, there are both short-term construction-related effects and long-term, or enduring, effects caused by the replacement of non-critical structures such as dolphins. The most far-reaching effect of the proposed action is the extent of underwater noise from impact pile driving. Therefore, the action area is defined by the geographic extent of elevated underwater noise from impact pile driving at each WSF terminal location.

Effects from noise over ambient levels are calculated to extend until they are blocked upon reaching topographic barriers. All other effects of the proposed action (except those caused by conservation offset activities) are contained within this geographic area.

As further explained in our analysis below, enduring effects caused by replacement wingwalls and dolphins and replacement of piles or other structure components required for seismic upgrades would result in a reduction in nearshore habitat quality that will be compensated for with habitat offsets to result in no net loss of habitat functions.

The action area is discontiguous, incorporating the 20 terminal locations in Puget Sound and the San Juan Islands and adjacent waterward areas extending in a line-of-site direction to the nearest land mass at each terminal. The action also includes project sites in the Puget Sound and the San Juan Islands where beneficial activities (i.e., projects carried out to achieve conservation offsets) will occur, inclusive of actions that occur within conservation banks and in lieu fee providers that are the source of credits which may be purchased for the purpose of offsetting debits created in this program.

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION, CONFERENCE 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.

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 of critical habitat for PS Chinook salmon, PS steelhead, and Hood Canal Summer Run chum 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 activities covered in this Opinion and Conference Opinion must comply with the criteria described in Section 1.3 of this document. Our jeopardy and adverse modification analyses considers the effects from the maintenance and repair of the WSF's facilities (temporary exposure to water quality reductions, contaminants, noise, benthic disturbance, and lighting), on-going and delayed consequences of maintaining replaced wingwalls and dolphins and seismic upgrades in the marine nearshore (e.g., habitat alteration and loss resulting in increased predation, reduced forage, and migration delays) during their extended life period, and the short and long term effects of habitat benefitting projects that may be undertaken to create credits which are intended to balance impacts. The proposed action does not include construction, reconstruction, or significant expansion of over-water structures. As explained earlier, the proposed action does not extend the life of any operationally-critical structures such as wharfs or parking lots. Effects of the proposed action does not include ferry vessel operations or the enduring effects of the operationally-critical structures.

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.

As with many previous consultations (NMFS 2016; NMFS 2020; NMFS 2021; NMFS 2022a) this Opinion takes the approach that the Nearshore Calculator (Calculator) or equivalent tool can be used to assess credits and debits for nearshore development and restoration projects in Puget Sound with the goal of no-net-loss of critical habitat functions. Under the proposed action (including the Credit Savings Instrument attached as Appendix A), some projects will generate conservation credits that are not needed for offsets in the same fiscal year and, provided these credits comply with the substantive and procedural requirements of the Credit Savings Instrument, these "advance conservation credits" can be carried over and applied to offset conservation debits incurred in subsequent fiscal years. The very purpose of, and motivation for, the advance conservation credits (and their associated projects) is to offset future conservation debits. In addition, the proposed action is a program expressly designed such that conservation credits will offset conservation debits to achieve an overall no-net loss outcome. The advance conservation credits are also subject to multiple limitations and conditions (as described in the attached Conservation Savings Instrument), which provide assurances as to the integrity and reliability of the advance credit scheme. For these reasons, the benefits of conservation credits generated under the proposed action are not considered to accrue to the environmental baseline when the associated project is completed.[3] Accordingly, when this Opinion analyzes the effects of projects that will generate conservation debits, it takes into account the benefits/credits of advance (i.e. previously generated) conservation credits that have been 'saved' in order to offset future debits.

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

- Evaluate the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their habitat using an exposure-response approach.
- Evaluate cumulative effects.

[3] Similarly, due to the unique circumstances and purposes of conservation/ILF, the beneficial effects are considered to accrue incrementally at the time of purchase, not at the time of bank establishment or at the time of restoratio because banks are established based on the expectation of future credit purchases and the purchases as part of a proposed action are themselves the subject of a future section 7 consultation (as here).

- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species, or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.
- If necessary, suggest a reasonable and prudent alternative to the proposed action.
- Use of the NMFS' Nearshore Habitat Conservation Calculator to quantify impacts from repair of structures, and benefits from offsetting activities.

The conference opinion evaluates anticipated adverse effects on sunflower sea stars in order to determine the risk of jeopardy to this species caused by the proposed action.

2.2 Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that is likely to be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' "reproduction, numbers, or distribution" for the jeopardy analysis. The opinion also examines the condition of designated critical habitat, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated critical habitat, and discusses the function of the PBFs that are essential for the species' conservation.

One factor affecting the status of ESA-listed species considered in this opinion and conference opinion, and aquatic habitat at large, is climate change. Climate change is likely to play an increasingly important role in determining the abundance and distribution of ESA-listed species, and the conservation value of designated critical habitats, in the Pacific Northwest. These changes will not be spatially homogeneous across the Pacific Northwest. Major ecological realignments are already occurring in response to climate change (IPCC WGII, 2022). Long-term trends in warming have continued at global, national and regional scales. Global surface temperatures in the last decade (2010s) were estimated to be 1.09 °C higher than the 1850-1900 baseline period, with larger increases over land ~1.6 °C compared to oceans ~0.88 (IPCC WGI, 2021). The vast majority of this warming has been attributed to anthropogenic releases of greenhouse gases (IPCC WGI, 2021). Globally, 2014-2018 were the 5 warmest years on record both on land and in the ocean (2018 was the 4th warmest) (NOAA NCEI 2022). Events such as the 2013-2016 marine heatwave (Jacox et al. 2018) have been attributed directly to anthropogenic warming in the annual special issue of Bulletin of the American Meteorological Society on extreme events (Herring et al. 2018). Global warming and anthropogenic loss of biodiversity represent profound threats to ecosystem functionality (IPCC WGII 2022). These two factors are often examined in isolation, but likely have interacting effects on ecosystem function.

Updated projections of climate change are similar to or greater than previous projections (IPCC WGI, 2021). NMFS is increasingly confident in our projections of changes to freshwater and marine systems because every year brings stronger validation of previous predictions in both physical and biological realms. Retaining and restoring habitat complexity, access to climate refuges (both flow and temperature) and improving growth opportunity in both freshwater and marine environments are strongly advocated in the recent literature (Siegel and Crozier 2020). Climate change is systemic, influencing freshwater, estuarine, and marine conditions. Other systems are also being influenced by changing climatic conditions. Literature reviews on the impacts of climate change on Pacific salmon (Crozier 2015, 2016, 2017, Crozier and Siegel 2018, Siegel and Crozier 2019, 2020) have collected hundreds of papers documenting the major themes relevant for salmon. Here we describe habitat changes relevant to Pacific salmon and steelhead, prior to describing how these changes result in the varied specific mechanisms impacting these species in subsequent sections.

Forests

Climate change will impact forests of the western U.S., which dominate the landscape of many watersheds in the region. Forests are already showing evidence of increased drought severity, forest fire, and insect outbreak (Halofsky et al. 2020). Additionally, climate change will affect tree reproduction, growth, and phenology, which will lead to spatial shifts in vegetation.

Halofsky et al. (2018) projected that the largest changes will occur at low- and high-elevation forests, with expansion of low-elevation dry forests and diminishing high-elevation cold forests and subalpine habitats.

Forest fires affect salmon streams by altering sediment load, channel structure, and stream temperature through the removal of canopy. Holden et al. (2018) examined environmental factors contributing to observed increases in the extent of forest fires throughout the western U.S. They found strong correlations between the number of dry-season rainy days and the annual extent of forest fires, as well as a significant decline in the number of dry-season rainy days over the study period (1984-2015). Consequently, predicted decreases in dry-season precipitation, combined with increases in air temperature, will likely contribute to the existing trend toward more extensive and severe forest fires and the continued expansion of fires into higher elevation and wetter forests (Alizedeh 2021).

Agne et al. (2018) reviewed literature on insect outbreaks and other pathogens affecting coastal Douglas-fir forests in the Pacific Northwest and examined how future climate change may influence disturbance ecology. They suggest that Douglas-fir beetle and black stain root disease could become more prevalent with climate change, while other pathogens will be more affected by management practices. Agne et al. (2018) also suggested that due to complex interacting effects of disturbance and disease, climate impacts will differ by region and forest type.

Freshwater Environments

The following is excerpted from Siegel and Crozier (2019), who present a review of recent scientific literature evaluating effects of climate change, describing the projected impacts of climate change on instream flows:

Cooper et al. (2018) examined whether the magnitude of low river flows in the western U.S., which generally occur in September or October, are driven more by summer conditions or the prior winter's precipitation. They found that while low flows were more sensitive to summer evaporative demand than to winter precipitation, interannual variability in winter precipitation was greater. Malek et al. (2018), predicted that summer evapotranspiration is likely to increase in conjunction with declines in snowpack and increased variability in winter precipitation. Their results suggest that low summer flows are likely to become lower, more variable, and less predictable.

The effect of climate change on ground water availability is likely to be uneven. Sridhar et al. (2018) coupled a surface-flow model with a ground-flow model to improve predictions of surface water availability with climate change in the Snake River Basin. Projections using RCP
4.5 and 8.5 emission scenarios suggested an increase in water table heights in downstream areas of the basin and a decrease in upstream areas.

As cited in Siegel and Crozier (2019), Isaak et al. (2018), examined recent trends in stream temperature across the Western U.S. using a large regional dataset. Stream warming trends paralleled changes in air temperature and were pervasive during the low-water warm seasons of 1996-2015 (0.18-0.35°C/decade) and 1976-2015 (0.14-0.27°C/decade). Their results show how continued warming will likely affect the cumulative temperature exposure of migrating sockeye salmon *O. nerka* and the availability of suitable habitat for brown trout *Salmo trutta* and rainbow trout *O. mykiss*. Isaak et al. (2018) concluded that most stream habitats will likely remain suitable for salmonids in the near future, with some becoming too warm. However, in cases where habitat access is currently restricted by dams and other barriers salmon and steelhead will be confined to downstream reaches typically most at risk of rising temperatures unless passage is restored (FitzGerald et al. 2020, Myers et al. 2018).

Streams with intact riparian corridors and that lie in mountainous terrain are likely to be more resilient to changes in air temperature. These areas may provide refuge from climate change for a number of species, including Pacific salmon. Krosby et al. (2018), identified potential stream refugia throughout the Pacific Northwest based on a suite of features thought to reflect the ability of streams to serve as such refuges. Analyzed features include large temperature gradients, high canopy cover, large relative stream width, low exposure to solar radiation, and low levels of human modification. They created an index of refuge potential for all streams in the region, with mountain area streams scoring highest. Flat lowland areas, which commonly contain migration corridors, were generally scored lowest, and thus were prioritized for conservation and restoration. However, forest fires can increase stream temperatures dramatically in short time- spans by removing riparian cover (Koontz et al. 2018), and 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.

Marine and Estuarine Environments

Along with warming stream temperatures and concerns about sufficient groundwater to recharge streams, a recent study projects nearly complete loss of existing tidal wetlands along the U.S. West Coast, due to sea level rise (Thorne et al. 2018). California and Oregon showed the greatest threat to tidal wetlands (100%), while 68% of Washington tidal wetlands are expected to be submerged. Coastal development and steep topography prevent horizontal migration of most wetlands, causing the net contraction of this crucial habitat.

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. In particular, there will be dramatic changes in both predators and prey of Pacific salmon, salmon life history traits and relative abundance. Siegel and Crozier (2019) observe that changes in marine temperature are likely to have a number of physiological consequences on fishes themselves. For example, in a study of small planktivorous fish, Gliwicz et al. (2018) found that higher ambient temperatures increased the distance at which fish reacted to prey.

Numerous fish species (including many tuna and sharks) demonstrate regional endothermy, which in many cases augments eyesight by warming the retinas. However, Gliwicz et al. (2018) suggest that ambient temperatures can have a similar effect on fish that do not demonstrate this trait. Climate change is likely to reduce the availability of biologically essential omega-3 fatty acids produced by phytoplankton in marine ecosystems. Loss of these lipids may induce cascading trophic effects, with distinct impacts on different species depending on compensatory mechanisms (Gourtay et al. 2018). Reproduction rates of many marine fish species are also likely to be altered with temperature (Veilleux et al. 2018). The ecological consequences of these effects and their interactions add complexity to predictions of climate change impacts in marine ecosystems.

Perhaps the most dramatic change in physical ocean conditions will occur through ocean acidification and deoxygenation. It is unclear how sensitive salmon and steelhead might be to the direct effects of ocean acidification because of their tolerance of a wide pH range in freshwater (although see Ou et al. 2015 and Williams et al. 2019), however, impacts of ocean acidification and hypoxia on sensitive species (e.g., plankton, crabs, rockfish, groundfish) will likely affect salmon indirectly through their interactions as predators and prey. Similarly, increasing frequency and duration of harmful algal blooms may affect salmon directly, depending on the toxin (e.g., saxitoxin vs domoic acid), but will also affect their predators (seabirds and mammals). The full effects of these ecosystem dynamics are not known but will be complex.

Within the historical range of climate variability, less suitable conditions for salmonids (e.g., warmer temperatures, lower streamflows) have been associated with detectable declines in many of these listed units, highlighting how sensitive they are to climate drivers (Ford 2022, Lindley et al. 2009, Williams et al. 2016, Ward et al. 2015). In some cases, the combined and potentially additive effects of poorer climate conditions for fish and intense anthropogenic impacts caused the population declines that led to these population groups being listed under the ESA (Crozier et al. 2019).

Climate change effects on salmon and steelhead

In freshwater, year-round increases in stream temperature and changes in flow will affect physiological, behavioral, and demographic processes in salmon, and change the species with which they interact. For example, as stream temperatures increase, many native salmonids face increased competition with more warm-water tolerant invasive species. Changing freshwater temperatures are likely to affect incubation and emergence timing for eggs, and in locations where the greatest warming occurs may affect egg survival, although several factors impact intergravel temperature and oxygen (e.g., groundwater influence) as well as sensitivity of eggs to thermal stress (Crozier et al. 2020). Changes in temperature and flow regimes may alter the amount of habitat and food available for juvenile rearing, and this in turn could lead to a restriction in the distribution of juveniles, further decreasing productivity through density dependence. For migrating adults, predicted changes in freshwater flows and temperatures will likely increase exposure to stressful temperatures for many salmon and steelhead populations, and alter migration travel times and increase thermal stress accumulation for ESUs or DPSs with early-returning (i.e. spring- and summer-run) phenotypes associated with longer freshwater holding times (Crozier et al. 2020, FitzGerald et al. 2020). Rising river temperatures increase the energetic cost of migration and the risk of *en route* or pre-spawning mortality of adults with long freshwater migrations, although populations of some ESA-listed salmon and steelhead may be able to make use of cool-water refuges and run-timing plasticity to reduce thermal exposure (Keefer et al. 2018, Barnett et al. 2020).

Marine survival of salmonids is affected by a complex array of factors including prey abundance, predator interactions, the physical condition of salmon within the marine environment, and carryover effects from the freshwater experience (Holsman et al. 2012, Burke et al. 2013). It is generally accepted that salmon marine survival is size-dependent, and thus larger and faster growing fish are more likely to survive (Gosselin et al. 2021). Furthermore, early arrival timing in the marine environment is generally considered advantageous for populations migrating through the Columbia River. However, the optimal day of arrival varies across years, depending on the seasonal development of productivity in the California Current, which affects prey available to salmon and the risk of predation (Chasco et al. 2021). Siegel and Crozier (2019) point out the concern that for some salmon populations, climate change may drive mismatches between juvenile arrival timing and prey availability in the marine environment. However, phenological diversity can contribute to metapopulation-level resilience by reducing the risk of a complete mismatch. Carr-Harris et al. (2018), explored phenological diversity of marine migration timing in relation to zooplankton prey for sockeye salmon *O. nerka* from the Skeena River of Canada. They found that sockeye migrated over a period of more than 50 days, and populations from higher elevation and further inland streams arrived in the estuary later, with different populations encountering distinct prey fields. Carr-Harris et al. (2018) recommended that managers maintain and augment such life-history diversity.

Synchrony between terrestrial and marine environmental conditions (e.g., coastal upwelling, precipitation and river discharge) has increased in spatial scale causing the highest levels of synchrony in the last 250 years (Black et al. 2018). A more synchronized climate combined with simplified habitats and reduced genetic diversity may be leading to more synchrony in the productivity of populations across the range of salmon (Braun et al. 2016). For example, salmon productivity (recruits/spawner) has also become more synchronized across Chinook populations from Oregon to the Yukon (Dorner et al. 2018, Kilduff et al. 2014). In addition, Chinook salmon have become smaller and younger at maturation across their range (Ohlberger 2018). Other Pacific salmon species (Stachura el al. 2014) and Atlantic salmon (Olmos et al. 2020) also have demonstrated synchrony in productivity across a broad latitudinal range.

At the individual scale, climate impacts on salmon in one life stage generally affect body size or timing in the next life stage and negative impacts can accumulate across multiple life stages (Healey 2011; Wainwright and Weitkamp 2013, Gosselin et al. 2021). Changes in winter precipitation will likely affect incubation and/or rearing stages of most populations. Changes in the intensity of cool season precipitation, snow accumulation, and runoff could influence migration cues for fall, winter and spring adult migrants, such as coho and steelhead. Egg survival rates may suffer from more intense flooding that scours or buries redds. Changes in hydrological regime, such as a shift from mostly snow to more rain, could drive changes in life history, potentially threatening diversity within an ESU (Beechie et al. 2006). Changes in summer temperature and flow will affect both juvenile and adult stages in some populations, especially those with yearling life histories and summer migration patterns (Crozier and Zabel 2006; Crozier et al. 2010, Crozier et al. 2019).

At the population level, the ability of organisms to genetically adapt to climate change depends on how much genetic variation currently exists within salmon populations, as well as how selection on multiple traits interact, and whether those traits are linked genetically. While genetic diversity may help populations respond to climate change, the remaining genetic diversity of many populations is highly reduced compared to historic levels. For example, Johnson et al. (2018), compared genetic variation in Chinook salmon from the Columbia River Basin between contemporary and ancient samples. A total of 84 samples determined to be Chinook salmon were collected from vertebrae found in ancient middens and compared to 379 contemporary samples. Results suggest a decline in genetic diversity, as demonstrated by a loss of mitochondrial haplotypes as well as reductions in haplotype and nucleotide diversity. Genetic losses in this comparison appeared larger for Chinook from the mid-Columbia than those from the Snake River Basin. In addition to other stressors, modified habitats and flow regimes may create unnatural selection pressures that reduce the diversity of functional behaviors (Sturrock et al.

2020). Managing to conserve and augment existing genetic diversity may be increasingly important with more extreme environmental change (Anderson et al. 2015), though the low levels of remaining diversity present challenges to this effort (Freshwater 2019). Salmon historically maintained relatively consistent returns across variation in annual weather through the portfolio effect (Schindler et al. 2015), in which different populations are sensitive to different climate drivers. Applying this concept to climate change, Anderson et al (2015) emphasized the additional need for populations with different physiological tolerances. Loss of the portfolio increases volatility in fisheries, as well as ecological systems, as demonstrated for Fraser River and Sacramento River stock complexes (Freshwater et al. 2019, Munsch et al. 2022).

2.2.5 Status of the Species

For Pacific salmon, steelhead, and certain other species, we commonly use the four "viable salmonid population" criteria (McElhany et al. 2000) to assess the viability of the populations that, together, constitute the species. These four criteria (spatial structure, diversity, abundance, and productivity) 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.

"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 on habitat quality and spatial configuration, and the dynamics and dispersal characteristics of individuals in the population.

"Diversity" refers to the distribution of traits within and among populations. These range in scale from DNA sequence variation in 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 (i.e., the number of 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, we assess the status of the entire species using criteria for groups of populations, as described in recovery plans and guidance documents from technical recovery teams. Considerations for species viability include having multiple populations that are viable, ensuring that populations with unique life histories and phenotypes are viable, and that some viable populations are both widespread to avoid concurrent extinctions from mass catastrophes and spatially close to allow functioning as metapopulations (McElhany et al. 2000).

The summaries that follow describe the status of the ESA-listed species, and their designated critical habitats, that occur within the geographic area of this proposed action and are considered in this Opinion and Conference Opinion. More detailed information on the status and trends of these listed resources, and their biology and ecology, are in the listing regulations and critical habitat designations published in the Federal Register, and these are incorporated by reference. See Table 1.

Table 1. ESA-listed species, listing status, and relevant Federal Register (FR) decision notices for listing status and critical habitat designation.

Species	Status	Federal Register Notices Listing/Critical Habitat Designation
Chinook salmon (*Oncorhynchustshawytscha*) Puget Sound ESU	Threatened	06/28/05 (70 FR 37160)/ 09/02/05 (70 FR 52630)
chum salmon (*O. keta*) Hood Canal summer-run ESU	Threatened	06/28/05 (70 FR 37160)/ 09/02/05 (70 FR 52630)
steelhead (*O. mykiss*) Puget Sound DPS	Threatened	05/11/07 (70 FR 26722)/ 02/24/16 (81 FR 9252)
yelloweye rockfish *(Sebastes ruberrimus*) Puget Sound/Georgia Basin DPS	Threatened	04/28/10 (75 FR 22276)/ 02/11/15 (79 FR 68041)
bocaccio rockfish (*S. paucispinis*) Puget Sound/Georgia Basin DPS	Endangered	04/28/10 (75 FR 22276)/ 02/11/15 (79 FR 68041)
killer whales (*Orcinus orca*) Southern Resident DPS	Endangered	11/18/05 (70 FR 69903)/ 11/29/06 (79 FR 69054), 08/02/21 (86 FR 41688)

Notes: ESU = evolutionarily significant unit, DPS = distinct population segment, FR =Federal Register.

Status of PS Chinook Salmon

The Puget Sound Chinook salmon evolutionarily significant unit (ESU) was listed as threatened on June 28, 2005 (70 FR 37160). In 2016, we completed a 5-year status review of Chinook salmon (NMFS 2017c). We adopted the recovery plan for this ESU in January 2007. The recovery plan consists of two documents: the Puget Sound salmon recovery plan (SSPS 2007) and a supplement by NMFS (2006). The recovery plan adopts ESU and population level viability criteria recommended by the Puget Sound Technical Recovery Team (PSTRT) (Ruckelshaus et al. 2002). The PSTRT's biological recovery criteria will be met when all of the following conditions are achieved:

- The viability status of all populations in the ESU is improved from current conditions, and when considered in the aggregate, persistence of the ESU is assured;
- Two to four Chinook salmon populations in each of the five biogeographical regions of the ESU (Table 2) achieve viability, depending on the historical biological characteristics and acceptable risk levels for populations within each region;
- At least one population from each major genetic and life history group historically present within each of the five biogeographical regions is viable;
- 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;

- 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; and
- Populations that do not meet the viability criteria for all VSP parameters are sustained to provide ecological functions and preserve options for ESU recovery.

Spatial Structure and Diversity. The PS Chinook salmon ESU includes all naturally spawning populations of Chinook salmon from rivers and streams flowing into Puget Sound including the Straits of Juan De Fuca from the Elwha River, eastward, including rivers and streams flowing into Hood Canal, South Sound, North Sound and the Strait of Georgia in Washington. The PSTRT identified 22 extant populations, grouped 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. The PSTRT distributed the 22 populations among five major biogeographical regions, or major population groups (MPG), that are based on similarities in hydrographic, biogeographic, and geologic characteristics (Figure 6).

Biogeographic Region	Population (Watershed)	2010-2014	2015-2019	Population trend (% change)
Strait of Georgia	**North Fork Nooksack River**	136 (1205)	137 (1553)	Positive 1% (29)
	South Fork Nooksack River	13 (35)	42 (106)	Positive 223% (203)
Strait of Juan de Fuca	**Elwha River**	71 (1349)	134 (2810)	Positive 89% (108)
	Dungeness River	66 (279)	114 (476)	Positive 73% (71)
Hood Canal	**Skokomish River**	136 (1485)	265 (2074)	Positive 95% (40)
	Mid Hood Canal River	80 (295)	196 (222)	Positive 145% (-25)
Whidbey Basin	Skykomish River	1698 (2462)	1736 (2806)	Positive 3% (14)
	Snoqualmie River	839 (1082)	856 (1146)	Positive 2% (6)
	North Fork Stillaguamish River	417 (996)	302 (762)	Negative 28% (-23)
	South Fork Stillaguamish River	34 (68)	37 (96)	Positive 9% (41)
	Lower Skagit River	1416 (1541)	2130 (2640)	Positive 50% (71)
	Upper Sauk River	854 (880)	1318 (1330)	Positive 54% (51)
	Lower Sauk River	376 (416)	635 (649)	Positive 69% (56)
	Suiattle River	376 (378)	640 (657)	Positive 70% (74)
	Upper Cascade River	298 (317)	185 (223)	Negative 38% (-30)
Central/South Puget Sound Basin	North Lake Washington/ Sammamish River	82 (1289)	126 (879)	Positive 54% (-32)
	Green/Duwamish River	785 (2109)	1822 (6373)	Positive 132% (202)
	Puyallup River	450 (1134)	577 (1942)	Positive 28% (71)
	White River	652 (2161)	895 (6244)	Positive 37% (189)
	Cedar River	699 (914)	889 (1253)	Positive 27% (37)
	Nisqually River	481 (1823)	766 (1841)	Positive 59% (1)

Figure 6. Extant PS Chinook salmon populations in each biogeographic region and percent change between the most recent two 5-year periods (2010-2014 and 2015-2019)

Five-year geometric mean of raw natural-origin spawner counts 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).

NOTE: NMFS has determined that the bolded populations, in particular, are essential to recovery of the Puget Sound Chinook 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).

The table presented in the figure above shows 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 (NWFSC 2020).

Since 1999, most PS Chinook populations have mean natural-origin spawner escapement levels well below levels identified as required for recovery to low extinction risk. Long-term, natural-origin mean escapements for eight populations are at or below their critical thresholds[4]. 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. When hatchery spawners are included, aggregate average escapement is over 1,000 for one of the two populations in each of these three regions, reducing the demographic risk to the populations in these regions. Additionally, hatchery spawners help two of the remaining three of these populations achieve total spawner abundances above their critical threshold, reducing demographic risk. Nine populations are above their rebuilding thresholds,[5] 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 Maximum Sustained Yield estimate of spawners based on available habitat. The new spawner-recruit analyses for several populations indicated a significant reduction in the number of spawners that can be supported by the available habitat when compared to analyses conducted 10 to 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[6] spawners. So, although

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

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

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

several populations are above the updated rebuilding thresholds, indicating that escapement is sufficient for the available habitat in many cases, the overall abundance has declined.

The ESU also includes Chinook salmon from certain artificial propagation programs. Artificial propagation (hatchery) programs (26) were added to the listed 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 (fall-run); Harvey Creek Hatchery Program (summer-run); Whitehorse Springs Hatchery Program (summer-run); Wallace River Hatchery Program (yearlings and subyearlings); Issaquah Creek Hatchery Program; White River Hatchery Program; White River Acclimation Pond Program; Voights Creek Hatchery Program; Clarks Creek Hatchery Program; Clear Creek Hatchery Program; Kalama Creek Hatchery Program; George Adams Hatchery Program; Hamma Hamma Hatchery Program; Dungeness/Hurd Creek Hatchery Program; Elwha Channel Hatchery Program; Skookum Creek Hatchery Spring-run Program; Bernie Kai-Kai Gobin (Tulalip) Hatchery-Cascade Program; North Fork Skokomish River Spring-run Program; Soos Creek Hatchery Program (subyearlings and yearlings); Fish Restoration Facility Program; Bernie Kai-Kai Gobin (Tulalip) Hatchery-Skykomish Program; and Hupp Springs Hatchery-Adult Returns to Minter Creek Program.

Three of the five regions (Strait of Juan de Fuca, Georgia Basin, and Hood Canal) contain only two populations, both of which must be recovered to viability to recover the ESU (NMFS 2006b). Under the Puget Sound Salmon Recovery Plan, the Suiattle and one each of the early, moderately early, and late run-timing populations in the Whidbey Basin Region, as well as the White and Nisqually (or other late-timed) populations in the Central/South Sound Region must also achieve viability (NMFS 2006b).

The Technical Recovery Team (TRT) did not define the relative roles of the remaining populations in the Whidbey and Central/South Sound Basins for ESU viability. Therefore, NMFS developed additional guidance which considers distinctions in genetic legacy and watershed condition, among other factors, in assessing the risks to survival and recovery of the listed species by the proposed actions across all populations within the PS Chinook ESU. In doing so, it is important to take into account whether the genetic legacy of the population is intact or if it is no longer distinct 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. If these populations still retain their historic genetic legacy, then the appropriate course, to ensure their survival and recovery, is to preserve that genetic legacy and rebuild those populations. Preserving that legacy requires both a sense of urgency and the actions necessary and appropriate to preserve the legacy that remains. However, if the genetic legacy is gone, then the appropriate course is to recover the populations using the individuals that best approximate the genetic legacy of the original population, reduce the effects of the factors that have limited their production, and provide the opportunity for them to readapt to the existing conditions.

In keeping with this approach, NMFS further classified PS Chinook populations into three tiers based on a systematic framework that considers the population's life history and production and watershed characteristics (NMFS 2010b) (Figure 6). This framework, termed the Population Recovery Approach, carries forward the biological viability and delisting criteria described in the Supplement to the Puget Sound Salmon Recovery Plan (Ruckelshaus et al. 2002; NMFS 2006b). The assigned tier indicates the relative role of each of the 22 populations comprising the ESU to the viability of the ESU and its recovery. Tier 1 populations are most important for preservation, restoration, and ESU recovery. Tier 2 populations play a less important role in recovery of the ESU. Tier 3 populations play the least important role. When we analyze proposed actions, we evaluate impacts at the individual population scale for their effects on the viability of the ESU. We expect that impacts to Tier 1 populations would be more likely to affect the viability of the ESU, as a whole, than similar impacts to Tier 2 or 3 populations, because of the relatively greater importance of Tier 1 populations to overall ESU viability and recovery. NMFS has incorporated this and similar approaches in previous ESA section 4(d) determinations and Opinions on Puget Sound salmon fisheries and regional recovery planning (NMFS 2005b; 2005d; 2008f; 2008e; 2010a; 2011a; 2013b; 2014b; 2015c; 2016b; 2017b; 2018c; 2019b; 2021e).

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

Over the long-term trend (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. 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, Mid-Hood Canal, Dungeness, and the Elwha. These conservation programs are in place to maintain or increase the overall abundance of these populations, helping to conserve the diversity and increase the spatial distribution of these populations in the absence of properly functioning habitat. With the exception of the Mid-Hood Canal program, these conservation hatchery programs culture the extant, native Chinook stock in these basins. With the exception of the NF and SF Stillaguamish, the remainder of the populations included in these conservation programs are identified in NMFS (2006b) as essential for the recovery of the Puget Sound Chinook ESU (Table 2).

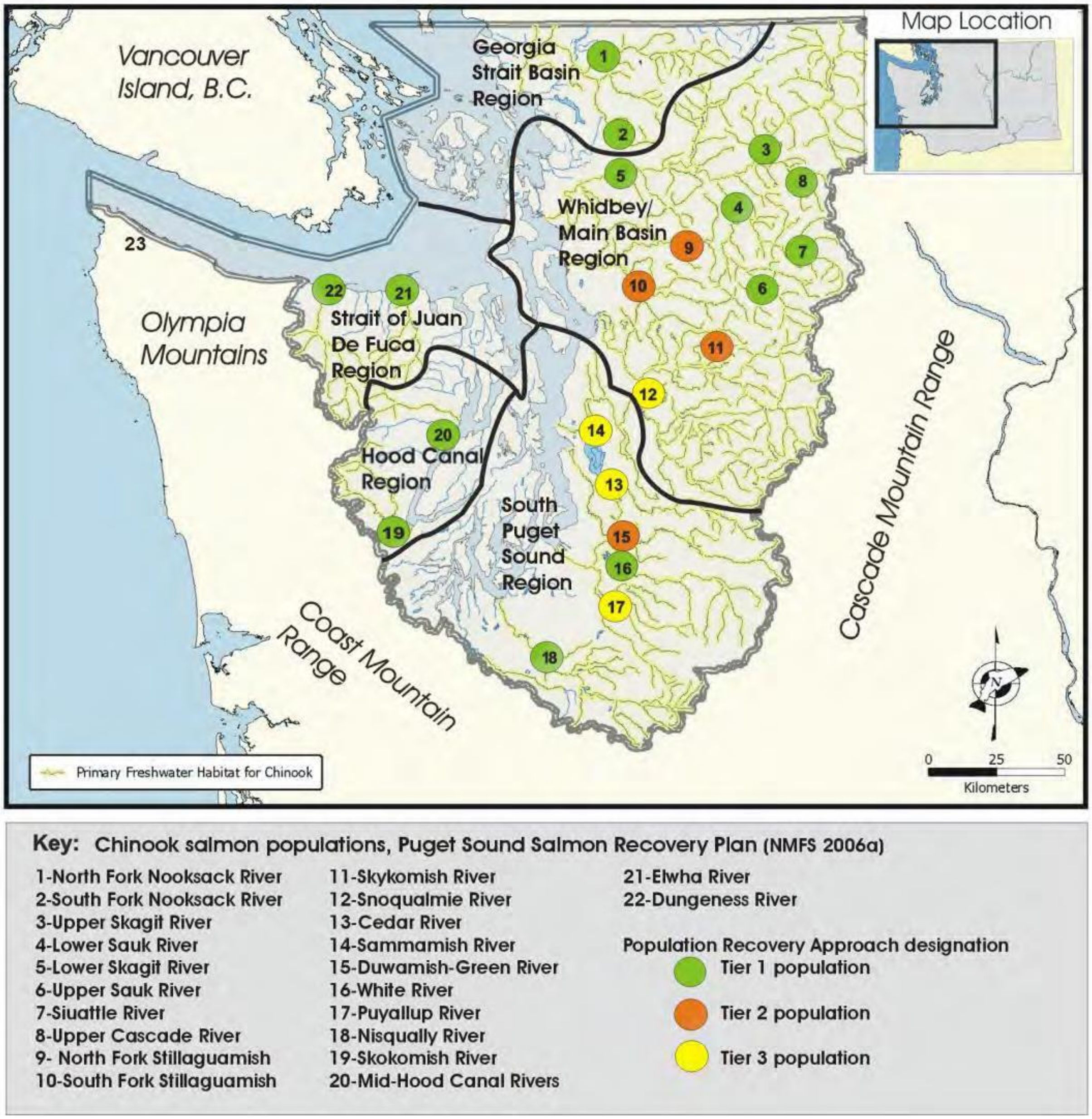

Figure 7. Puget Sound Chinook populations

In addition, spatial structure, or geographic distribution, of the White, Skagit, Elwha[7], and Skokomish populations has been substantially reduced or impeded by the loss of access to the upper portions of those tributary basins due to flood control activities and hydropower development. Habitat conditions conducive to salmon survival in most other watersheds have been reduced significantly by the effects of land use, including urbanization, forestry, agriculture, and development (NMFS 2005a; SSPS 2005; NMFS 2008c; 2008d; 2008b). It is likely that genetic and life history diversity has been significantly adversely affected by this habitat loss.

[7] Removal of the two Elwha River dams and restoration of the natural habitat in the watershed began in 2011

Table 2. Five-year mean of fraction of natural-origin spawners (sum of all estimates divided by the number of estimates) (Ford 2022).

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

Abundance and Productivity. The abundance of the PS Chinook salmon over time shows that individual populations have varied with increasing or decreasing abundance. 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 available for the current status review, 2017-2018 (Figure 7). 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 and South Fork Stillaguamish) showing a negative percent change in the 5-year geometric mean natural- origin spawner abundances since the prior status review. However, 15 of 20 populations with positive percent change in the 5-year geometric mean natural-origin spawner abundances since the prior status review have relatively low population abundances of <1000 fish, so some of these increases represent small changes in total abundance (Ford 2022). Also, given lack of high confidence in survey techniques, particularly with small populations, there is substantial uncertainty in quantifying fish and detecting trends in small populations (Gallagher et al. 2010).

Trends in abundance over longer time periods are generally slightly negative. Fifteen-year trends in log natural-origin spawner abundance were computed over two time periods (1990- 2005 and 2004- 2019) for each Puget Sound Chinook population. Trends were negative in the latter period for 16 of the 22 populations and for four of the 22 populations (SF Nooksack, SF Stillaguamish, Green and Puyallup) in the earlier period. Thus, there is a general decline in natural-origin spawner abundance across all MPGs in the recent fifteen years. Upper Sauk and Suiattle (Whidbey Basin MPG), Nisqually (Central/South MPG) and Mid-Hood Canal (Hood Canal MPG) are the only populations with positive trends, though Mid-Hood Canal has an extremely low population size. Further, no change in trend between the two time periods was detected in SF Nooksack (Strait of Georgia MPG), Green and Nisqually (Central/South MPG). The average trend across the ESU for the 1990-2005 15-year time period was 0.03. The average trend across the ESU for the later 15-year time period (2004-2019) was -0.02. The previous status review in 2015 (NWFSC 2015) concluded there were widespread negative trends for the total ESU despite that escapements and trends for individual populations were variable. The addition of the data to 2018 now also shows even more substantially either flat or negative trends for the entire ESU in natural-origin Chinook salmon spawner population abundances (Ford 2002).

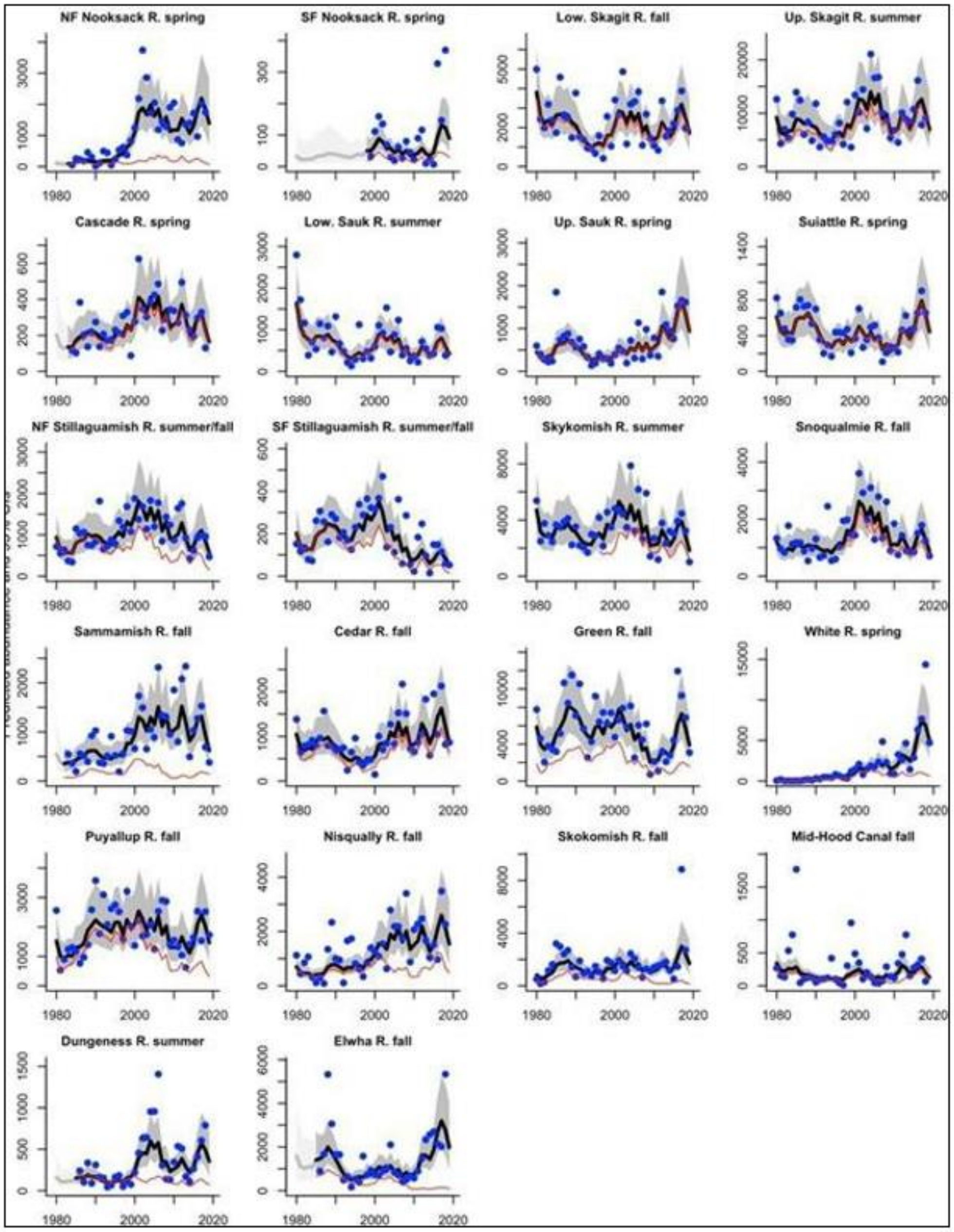

Figure 8. Graphs by population indicating abundance trends over time

Smoothed trend in estimated total (thick black line, with 95 percent confidence internal in gray) and natural (thin red line) PS Chinook salmon population spawning abundance. In portions of a time series where a population has no annual estimate, but s 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 (Ford 2022).

Across the Puget Sound ESU, 10 of 22 Puget Sound populations show natural productivity below replacement in nearly all years since the mid-1980s (Figure 7). These include the

North and South Forks Nooksack in the Strait of Georgia MPG, North and South Forks Stillaguamish and Skykomish in Whidbey Basin MPG, Sammamish, Green and Puyallup in the Central/South MPG, the Skokomish in the Hood Canal MPG, and Elwha in the Strait of Juan de Fuca MPG. Productivity in the Whidbey Basin MPG populations was above zero the mid-late 1990's, with the exception of Skykomish and North and South Forks Stillaguamish populations. White River population in the Central/South MPG was above replacement from the early 1980's to 2001, but has dropped in productivity consistently since the late 1980's. In recent years, only 5 populations have had productivities above zero. These are Lower Skagit, Upper Skagit, Lower Sauk, Upper Sauk, and Suiattle, all Skagit River populations in the Whidbey Basin MPG. This is consistent with, and continues the decline reported in the latest NWFSC biological viability update (Ford 2022).

All Puget Sound Chinook salmon populations continue to remain well below recovery levels (Ford 2022). Most populations also remain consistently below the spawner-recruit levels identified by the TRT as necessary for recovery. Across the ESU, most native-origin populations have slightly increased in abundance since the last status review in 2016 but have small negative trends over the past 15 years (Figure 8). Productivity remains low in most populations. Hatchery- origin spawners are present in high fractions in most populations outside the Skagit watershed, and in many watersheds the fraction of spawner abundances that are natural-origin have declined over time. Habitat protection, restoration and rebuilding programs in all watersheds have improved stream and estuary conditions despite record numbers of humans moving into the Puget Sound region in the past two decades. Bi-annual four-year work plans document the many completed habitat actions that were initially identified in the Puget Sound Chinook salmon recovery plan. However, the expected benefits from restoration actions are likely to take years or decades to produce significant improvement in natural population viability parameters (see Roni et al. 2010).

Development of a monitoring and adaptive management program was required by NMFS in the 2007 Supplement to the Shared Strategy Recovery Plan (NMFS 2006b), and since the last review the Puget Sound Partnership has completed this, but this program is still not fully functional for providing an assessment of watershed habitat restoration/recovery programs, nor does it fully integrate the essentially discrete habitat, harvest, and hatchery programs. A recent white paper produced by the Salmon Science Advisory Group, of the Puget Sound Partnership (PSP) concludes there has been "a general inability of monitoring to link restoration, changes in habitat conditions, and fish response at large-scales" (PSP 2021). A number of watershed groups are in the process of updating their Recovery Plan Chapters and this includes prioritizing and updating recovery strategies and actions, as well as assessing prior accomplishments. Overall, recent information on PS Chinook salmon abundance and productivity since the 2016 status review indicates a slight increase in abundance but does not indicate a change in biological risk to the ESU despite moderate inter-annual variability among populations and a general decline in abundance over the last 15 years (Ford 2022).

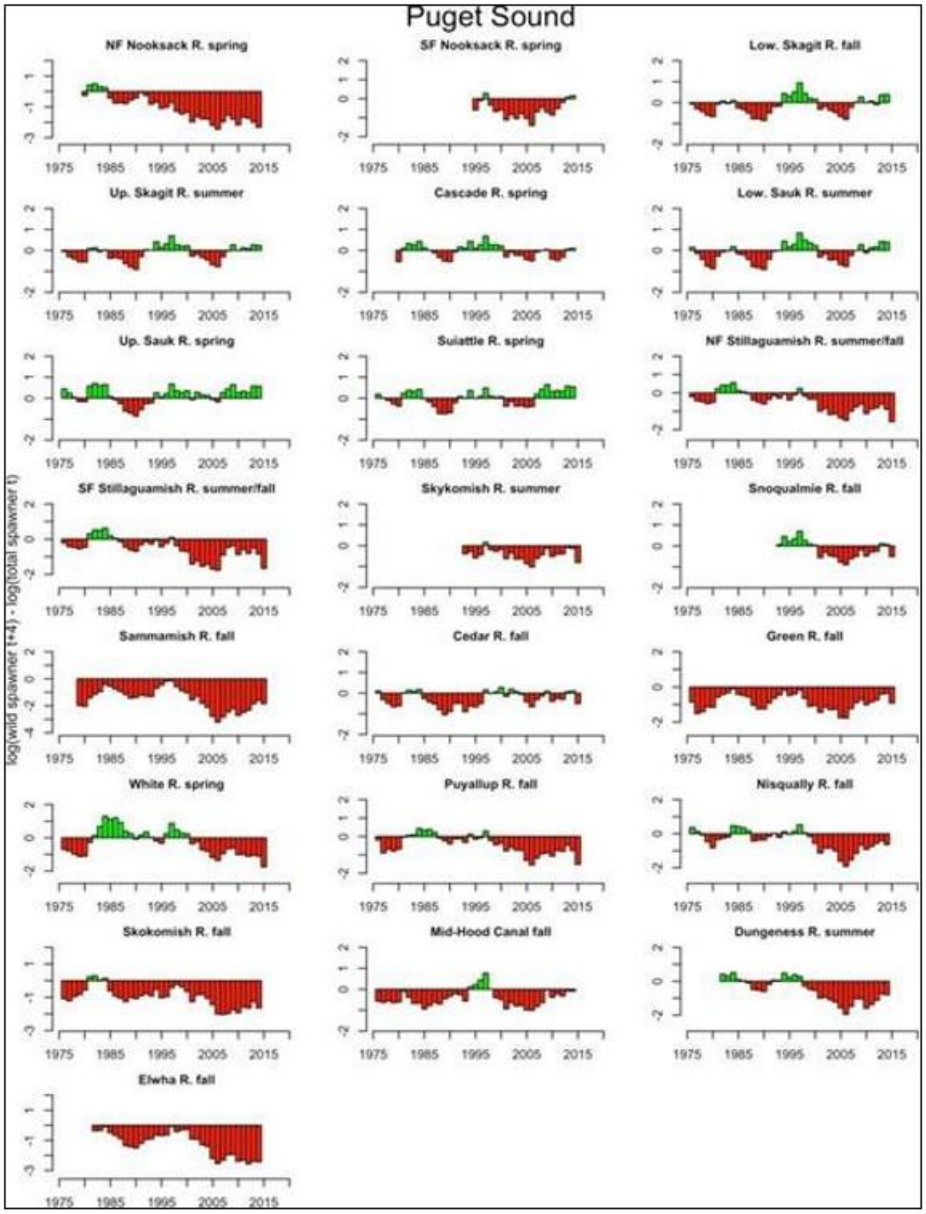

Figure 9. Trends in population productivity[8]

[8] Trends are estimated as the log of the smoothed natural- origin spawning abundance in year t – smoothed natural-origin spawning abundance in year (t – 4) (Ford 2022).

Limiting Factors. Limiting factors for this species include:

- Degraded floodplain and in-river channel structure
- Degraded estuarine conditions and loss of estuarine habitat

Riparian area degradation and loss of in-river large woody debris

- Excessive fine-grained sediment in spawning gravel
- Degraded water quality and temperature
- Degraded nearshore conditions
- Impaired passage for migrating fish
- Altered flow regime

PS Chinook Salmon Recovery Plan. Nearshore areas serve as the nursery for juvenile PS Chinook salmon. Riparian vegetation, shade and insect production, and forage fish eggs along marine shorelines and river deltas help to provide food, cover and thermoregulation in shallow water habitats. Forage fish spawn in large aggregations along shorelines with suitable habitat, which produce prey for juvenile PS Chinook salmon. Juvenile salmon commonly occupy "pocket estuaries" where freshwater inputs provide salinity gradients that make adjusting to the marine environment less physiologically demanding. Pocket estuaries also provide refugia from predators. As the juvenile salmon grow and adjust, they move out to more exposed shorelines such as eelgrass, kelp beds and rocky shorelines where they continue to grow and migrate into the ocean environment. Productive shoreline habitats of Puget Sound are necessary for the recovery of Puget Sound salmon (SSPS 2007).

The Puget Sound Recovery Plan (Volumes 1 and 2) includes specific recovery actions for each of the 22 extant populations of PS Chinook salmon. General protection and restoration actions summarized from the plan include:

- Aggressively protect functioning drift cells and feeder bluffs that support eelgrass bands and depositional features.
- Counties should pass strong regulations and policies limiting increased armoring of these shorelines and offering incentives for protection.
- Aggressively protect areas, especially shallow water/low gradient habitats and pocket estuaries, within 5 miles of river deltas.
- Protect the forage fish spawning areas.
- Conduct limited beach nourishment on a periodic basis to mimic the natural sediment transport processes in select sections where corridor functions may be impaired by extensive armoring.
- Maintain the functioning of shallow, fine substrate features in and near 11 natal estuaries for Chinook salmon (to support rearing of fry).
- Maintain migratory corridors along the shores of Puget Sound.
- Maintain the production of food resources for salmon.

- Maintain functioning nearshore ecosystem processes (i.e., sediment delivery and transport; tidal circulation) that create and support the above habitat features and function.
- Increase the function and capacity of nearshore and marine habitats to support key needs of salmon.
- Protect and restore shallow, low velocity, fine substrate habitats along marine shorelines, including eelgrass beds and pocket estuaries, especially adjacent to major river deltas.
- Protect and restore riparian areas.
- Protect and restore estuarine habitats of major river mouths.

- Protect and restore spawning areas and critical rearing and migration habitats for forage fish.
- Protect and restore drift cell processes (including sediment supply, e.g., from feeder bluffs, transport, and deposition) that create and maintain nearshore habitat features such as spits, lagoons, bays, beaches.

Development of shoreline and estuary areas of Puget Sound is expected to continue to adversely impact the quality of marine habitat for PS Chinook salmon. 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.[9]

Status of Hood Canal Summer-run Chum Salmon

The Hood Canal summer-run (HCSR) chum salmon was listed as threatened on June 28, 2005 (70 FR 37160). In 2016, we completed a 5-year status review of HCSR chum salmon (NMFS 2017c). We adopted a recovery plan for HCSR chum salmon in May of 2007. The recovery plan consists of two documents: Hood Canal and Eastern Strait of Juan de Fuca Summer Chum Salmon Recovery Plan (Hood Canal Coordinating Council 2005) and a supplemental plan by NMFS (2007a). The recovery plan adopts ESU and population level viability criteria recommended by the PSTRT (Sands et al. 2009). The PSTRT's biological recovery criteria will be met when the following conditions are achieved:

- Spatial Structure: (1) Spawning aggregations are distributed across the historical range of the population. (2) Most spawning aggregations are within 20 km of adjacent aggregations. (3) Major spawning aggregations are distributed across the historical range of the population and are not more than approximately 40 km apart. Further, a viable population has spawning, rearing, and migratory habitats that function in a manner that is consistent with population persistence
- Diversity: Depending on the geographic extent and ecological context of the population, a viable population includes one or more persistent spawning

[9] 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).

aggregations from each of the two to four major ecological diversity groups historically present within the two populations (see also McElhany et al. 2000).

- Abundance and Productivity: Achievement of minimum abundance levels associated with persistence of HCSR Chum ESU populations that are based on two assumptions about productivity and environmental response (Table 3).

Despite substantive gains towards meeting viability criteria in the Hood Canal and Strait of Juan de Fuca HCSR salmon populations, the ESU still does not meet all of the recovery criteria for population viability at this time (NWFSC 2015, NMFS 2017c).

Table 3. Hood Canal summer-run chum ESU abundance and productivity recovery goals (Sands et al. 2009).

Population	Low Productivity Planning Target for Abundance (productivity in parentheses)	High Productivity Planning Target for Abundance (productivity in parentheses)
Strait of Juan de Fuca	12,500 (1.0)	4,500 (5.0)
Hood Canal	24,700 (1.0)	18,300 (5.0)

Spatial Structure and Diversity. The ESU includes all naturally spawning populations of summer- run chum salmon in Hood Canal tributaries as well as populations in Olympic Peninsula rivers between Hood Canal and Dungeness Bay, Washington, as well as several artificial propagation programs. The Puget Sound Technical Recovery Team (PSTRT) identified two independent populations for the HCSR chum, one which includes the spawning aggregations from rivers and creeks draining into the Strait of Juan de Fuca, and one which includes spawning aggregations within Hood Canal proper (Sands et al. 2009).

Spatial structure and diversity measures for the HCSR chum recovery program have included the reintroduction and sustaining of natural-origin spawning in multiple small streams where summer chum spawning aggregates had been extirpated. Supplementation programs have been very successful in both increasing natural spawning abundance in 6 of 8 extant streams (Salmon, Big Quilcene, Lilliwaup, Hamma Hamma, Jimmycomelately, and Union) and increasing spatial structure due to reintroducing spawning aggregations to three streams (Big Beef, Tahuya, and Chimacum). Spawning aggregations are present and persistent within five of the six major ecological diversity groups identified by the PSTRT (Table 4). As supplementation program goals have been met in most locations, they have been terminated except in Lilliwaup/Tahuya, where supplementation is ongoing (NWFSC 2015). Spatial structure and diversity viability parameters for each population have increased and nearly meet the viability criteria.

Table 4. Seven ecological diversity groups as proposed by the PSTRT for the HCSR chum ESU by geographic region and associated spawning aggregation.

Geographic Region(population)	Proposed Ecological Diversity Groups	Spawning Aggregations: Extant* and Extinct**
Eastern Strait of Juan de Fuca	Dungeness	Dungeness R (unknown status)
	Sequim-Admiralty	Jimmycomelately Cr* Salmon Cr* Snow Cr* Chimacum Cr**
Hood Canal	Toandos	Unknown
	Quilcene	Big Quilcene R* Little Quilcene R*
	Mid-West Hood Canal	Dosewallips R* Duckabush R*
	West Kitsap	Big Beef Cr** Seabeck Cr** Stavis Cr** Anderson Cr** Dewatto R** Tahuya R** Mission Cr** Union R*
	Lower West Hood Canal	Hamma Hamma R* Lilliwaup Cr* Skokomish R*

Abundance and Productivity. Smoothed trends in estimated total and natural population spawning abundances for both Hood Canal and Strait of Juan de Fuca populations have generally increased over the 1980 to 2014 time period. The Hood Canal population has had a 25 percent increase in abundance of natural-origin spawners in the most recent 5-year time period over the 2005-2009 time period. The Strait of Juan de Fuca has had a 53 percent increase in abundance of natural-origin spawners in the most recent 5-year time period.

Trends in population productivity, estimated as the log of the smoothed natural spawning abundance in year t minus the smoothed natural spawning abundance in year (t-4), have increased over the past five years, and were above replacement rates in 2012 and 2013. However, productivity rates have varied above and below replacement rates over the entire time period up to 2014. The Point No Point Treaty Tribes and the Washington State Department of Fish and Wildlife (PNPTT and WDFW 2014) provide a detailed analysis of productivity for the ESU, each population, and by individual spawning aggregation, and report that 3 of the 11 stocks exceeded the co-manager's interim productivity goal of an average of 1.6 Recruit/Spawner over 8 years. They also report that natural-origin Recruit/Spawner rates have been highly variable in recent brood years, particularly in the Strait of Juan de Fuca population. Only one spawning aggregation (Chimacum) meets the co-manager's interim recovery goal of 1.2 recruits per spawner in 6 of the most recent 8 years. Productivity of individual spawning aggregates shows only two of eight aggregates have viable performance. (NWFSC 2015, NMFS 2017).

Limiting factors. Limiting factors for this species include (HCCC 2005):

- Reduced floodplain connectivity and function
- Poor riparian condition
- Loss of channel complexity (reduced large wood and channel condition, loss of side channels, channel instability)
- Sediment accumulation
- Altered flows and water quality

Mantua et al. (2010) suggested that the unique life history of HCSR chum salmon makes this ESU especially vulnerable to the climate change impacts because they spawn in small shallow streams in late summer, eggs incubate in the fall and early winter, and fry migrate to sea in late winter. Sensitivity during the adult freshwater stage and the early life history was ranked moderate. Predicted climate change effects for the low-elevation Hood Canal streams historically used by summer chum salmon include multiple negative impacts stemming from warmer water temperatures and reduced streamflow in summer, and the potential for increased redd-scouring from peak flow magnitudes in fall and winter. Exposure for stream temperature and summer water deficit were both ranked high, largely due to effects on returning adults and hatched fry.

Likewise, sensitivity to cumulative life-cycle effects was ranked high.

Hood Canal Summer-run Chum Salmon Recovery Plan. The 2005 recovery plan for HCSR Salmon currently guides habitat protection and restoration activities for chum Salmon recovery (HCCC 2005, NMFS 2007a). Human-caused degradation of HCSR chum salmon habitat has diminished the natural resiliency of Hood Canal/Strait of Juan de Fuca river deltas and estuarine habitats (HCCC 2005). Despite some improvement in habitat protection and restoration actions and mechanisms, concerns remain that given the pressures of population growth, existing land use management measures through local governments (i.e., shoreline management plans, critical area ordinances, and comprehensive plans) may be compromised or not enforced (SSPS 2007). "The widespread loss of estuary and lower floodplain habitat was noted by the Biological Review Team (BRT) as a continuing threat to ESU spatial structure and connectivity" (NMFS 2003; 69 FR 33134).

The HCSR chum salmon recovery plan includes specific recovery actions for each stream (HCCC 2005). General protection and restoration actions summarized from those streams include:

- Incorporate channel migration zones within the protected areas of the Shoreline Master Plans of local governments.
- Acquire high priority spawning habitat
- Set back or remove levees in the lower rivers and in river deltas

- Restore upstream ecosystem processes to facilitate delivery of natural sediment and large wood features to lower river habitats
- Remove armoring along the Hood Canal shoreline, including private bulkheads, roadways, and railroad grades
- Restore large wood to river deltas and estuarine habitats
- Restore salt marsh habitats

Status of PS Steelhead

The PS 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 PS steelhead regarding risk of extinction has not changed substantially (Ford et al. 2011a; NMFS 2016a) (81 FR 33468, May 26, 2016) (NWFSC 2020). As mentioned above in the PS Chinook status review section, 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 and the NMFS' WCRO are currently preparing the final five-year status review documents, with anticipated completion in late 2021.

At the time of listing the Puget Sound steelhead BRT considered the major risk factors associated with spatial structure and diversity of PS 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-ESU hatchery fish from Skamania-derived summer run and Chambers Creek-derived winter run stocks (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 PS 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 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).

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 MPGs within the DPS that are summarized in the final draft viability criteria reports (Puget Sound Steelhead Technical Recovery Team 2013; PSSTRT 2013; NWFSC 2015). 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 PS steelhead DPS.

The populations within the PS 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). 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 10 illustrates the DPS, MPGs, and DIPs for PS steelhead.

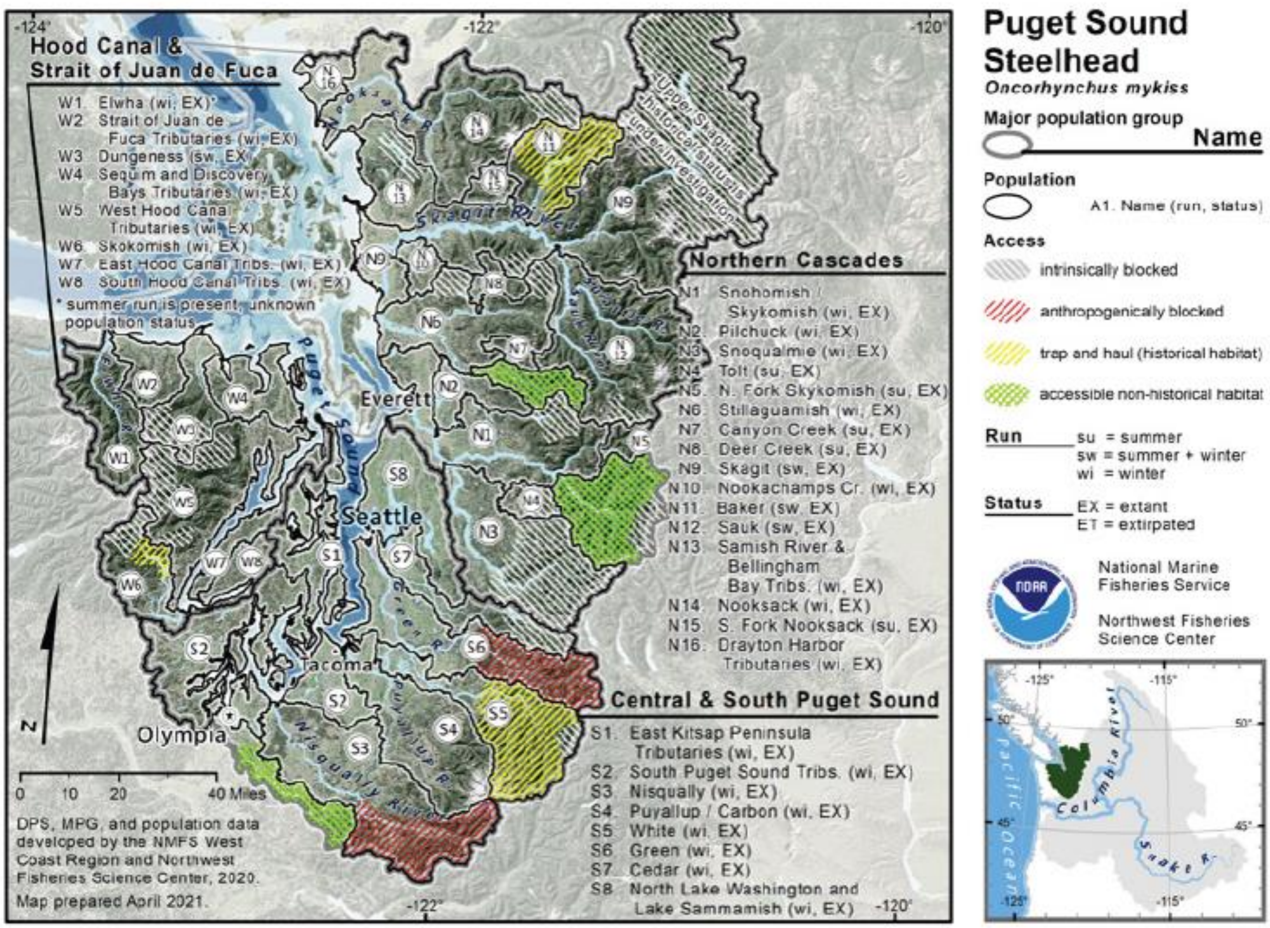

Figure 10. The PS steelhead DPS showing MPGs and DIPs. The steelhead MPGs include the Northern Cascades, Central & Sound Puget Sound, and the Hood Canal & Strait of Juan de Fuca.

NMFS adopted a recovery plan for PS 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 PS steelhead, as described below:

- All three MPGs (North Cascade, Central-South Puget Sound, and Hood Canal-Strait of Juan de Fuca) (Figure 10) 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 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 percent) 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 PSSTRT 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 PS steelhead population structure and viability, if needed, and better define the role of individual populations at the watershed level and in the DPS. Future consultations will incorporate information from the Plan (NMFS 2019h).

<u>Spatial Structure and Diversity</u>. The PS 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 PS 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 the hatchery programs included 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 PS 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[10]. 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 PS 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 2013). 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 2015). Most PS 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 2015). The 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 (2015-2019) that are anticipated to improve status populations within several of the MPGs within the DPS.

Since the PSSTRT completed its 2013 review, the only additional spatial structure and diversity data that have become available have been estimates of the fraction of hatchery fish on the spawning grounds (NWFSC 2015). Since publication of the NWFSC report in 2015, and the 2022 NWFSC biological viability update (Ford 2022), reductions in hatchery programs founded from non-listed and out of DPS stocks (i.e., Skamania) have occurred. In addition, the fraction of out of DPS hatchery steelhead spawning naturally are low for many rivers (NWFSC 2015; NMFS 2016i; 2016h). 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, but the Snoqualmie and Stillaguamish Rivers. 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 2015). However, the fraction of natural-origin steelhead spawners could not be estimated for a substantial number of DIPs

[10] 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).

during the 2010 to 2014 period, or for the most recent 2015 – 2019 timeframe (NWFSC 2015; Ford 2022). In some river systems, such as the Green River, Snohomish/Skykomish Rivers, and the Stillaguamish Rivers these estimates were higher than some guidelines recommend (e.g., no more than 5percent 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 update (Ford 2022) states that a third of the 32 PS steelhead populations continue to lack monitoring and abundance data, and in most cases it is likely that abundances are very low.

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.[11] 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 update (Ford 2022) states that risks to natural-origin PS 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 2019c; 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 2016a; 2019c; 2019g; 2019h).

More information on PS 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 2015; Ford 2022).

Abundance and Productivity. The viability of the PS steelhead DPS has improved somewhat since the Puget Sound Steelhead TRT concluded that the DPS was at very low viability, as were all three of its constituent MPGs, and many of its 32 DIPs (Hard et al. 2015). Increases in spawner abundance have been observed in a number of populations over the last five years; however, these improvements were disproportionately found within the South and Central Puget Sound and Strait of Juan de Fuca and Hood Canal MPGs, and primarily among smaller populations. The recent positive trends among winter-run populations in the White, Nisqually, and Skokomish rivers improve the demographic risks facing those populations. The abundance, productivity, spatial structure, and diversity of Elwha River steelhead winter and summer-runs has dramatically improved following the removal of the Elwha River dams improved.

Improvements in abundance have not been as widely observed in the Northern Puget Sound MPG. The declines of summer and winter-run populations in the Snohomish Basin are

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

especially concerning. These populations figure prominently as sources of abundance for the MPG and DPS (NMFS 2019a). Additionally, the decline in the Tolt River summer-run steelhead population was especially alarming given that it is the only summer-run population for which we have abundance estimates. The demographic and diversity risks to the Tolt River summer-run DIP are very high. In fact, all summer-run steelhead populations in the North Cascades MPG are likely at a very high demographic risk. In spite of improvements in some areas, most populations are still at relatively low abundance levels, with about a third of the DIPs unmonitored and presumably at very low levels (Ford 2022).

The PSSTRT was established by NOAA Fisheries and convened in March 2014 to develop a Recovery Plan for the PS steelhead DPS. This Recovery Plan was finalized in December 2019 (NMFS 2019a). Recovery targets were calculated using a two-tiered approach adjusting for years of low and high productivity. Abundance information is unavailable for approximately one-third of the DIPs, disproportionately so for summer-run populations. In most cases where no information is available it is assumed that abundances are very low. Some population abundance estimates are only representative of part of the population (index reaches, etc.). Where recent five-year abundance information is available, 30 percent (6 of 20 populations) are less than 10 percent of their high productivity recovery targets (lower abundance target), 65 percent (13 of 20) are between 10 and 50 percent, and 5 percent (1 of 20) are greater than 50 percent of their low abundance targets (Figure 11). A key element to achieving recovery is recovering a representative number of both winter- and summer-run steelhead populations, and the restoration of viable summer-run DIPs is a long-term endeavor (NMFS 2019a). Fortunately, the relatively rapid reestablishment of summer-run steelhead in the Elwha River does provide a model for potentially re-anadromizing summer-run steelhead sequestered behind impassable dams.

Major Population Group	Demographically Independent Population	Recent Abundance (2015-2019)	Recovery Target	
			High Productivity	Low Productivity
Northern Cascades	Drayton Harbor Tributaries	N/A	1,100	3,700
	Nooksack River	1,906	6,500	21,700
	South Fork Nooksack River (SR)	N/A	400	1,300
	Samish River & Independent Tributaries	1,305	1,800	6,100
	Skagit River	7,181	15,000 *	
	Sauk River	N/A		
	Nookachamps River	N/A		
	Baker River	N/A		
	Stillaguamish River	487	7,000	23,400
	Canyon Creek (SR)	N/A	100	400
	Deer Creek (SR)	N/A	700	2,300
	Snohomish/Skykomish River	690	6,100	20,600
	Pilchuck River	638	2,500	8,200
	Snoqualmie River	500	3,400	11,400
	Tolt River (SR)	40	300	1,200
	North Fork Skykomish River (SR)	N/A	200	500
Central and South Sound	Cedar River	N/A	1,200	4,000
	North Lake Washington Tributaries	N/A	4,800	16,000
	Green River	1,282	5,600	18,700

Figure 11. Recent (2015-2019) 5-year geometric mean of raw wild spawner counts for PS steelhead populations and populations groups compared with Puget Sound Steelhead Recovery Plan high and low productivity recovery targets (NMFS 2019a). (SR) – Summer-run.

Major Population Group	Demographically Independent Population	Recent Abundance (2015-2019)	Recovery Target	
			High Productivity	Low Productivity
	Puyallup/Carbon River	136	4,500	15,100
	White River	130	3,600	12,000
	Nisqually River	1,368	6,100	20,500
	East Kitsap Tributaries	N/A	2,600	8,700
	South Sound Tributaries	N/A	6,300	21,200
Strait of Juan de Fuca	Elwha River	1,241	2,619	
	Dungeness River	408	1,200	4,100
	Strait of Juan de Fuca Independent Tributaries	95	1,000	3,300
	Sequim and Discovery Bay Tributaries	N/A	500	1,700
	Skokomish River	958	2,200	7,300
	West Hood Canal Tributaries	150	2,500	8,400
	East Hood Canal Tributaries	93	1,800	6,200
	South Hook Canal Tributaries	91	2,100	7,100

Figure 12. Abundance is compared to the high productivity individual DOP targets. Colors indicate the relative proportion of the recovery target currently obtained: red (<10%), orange (10>x<50%), yellow (50%>x<100%). "*" denotes an interim recovery target.

There are a number of planned, ongoing, and completed actions that will likely benefit steelhead populations in the near term, but have not yet influenced adult abundance. Among these, the removal of the diversion dam on the Middle Fork Nooksack River, the Pilchuck Dam removal, passage improvements at Mud Mountain Dam, the ongoing passage program in the North Fork Skokomish River, and the planned passage program at Howard Hansen Dam. Dam removal in the Elwha River, and the resurgence of the endemic winter and summer-run steelhead populations have underscored the benefits of restoring fish passage. The Elwha River scenario is somewhat unique in that upstream habitat is in pristine condition and smolts emigrate into the Strait of Juan de Fuca and not Puget Sound or Hood Canal.

Improvements in spatial structure can only be effective if done in concert with necessary improvements in habitat. Habitat restoration efforts are ongoing, but land development and habitat degradation concurrent with increasing human population in the Puget Sound corridor.

may results in a continuing net loss of habitat. Recovery efforts in conjunction with improved ocean and climatic conditions have resulted in improved viability 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 of extinction.

However, since 2015, fifteen of the 21 populations indicate small to substantive increases in abundance.[12] However, most steelhead populations remain small. From 2015 to 2019, nine of the 21 steelhead populations had fewer than 250 natural spawners annually, and 12 of the 21 steelhead populations had 500 or fewer natural spawners. However, most steelhead populations remain small and the 15-year trend is still negative (Ford 2022).

Limiting factors. In our 2013 proposed rule designating critical habitat for this species (USDC 2013, 78 FR 2725), we noted that the following factors for decline for PS steelhead persist as limiting factors:

- The continued destruction and modification of steelhead habitat.
- Widespread declines in adult abundance (total run size), despite significant reductions in harvest in recent years.
- Threats to diversity posed by use of progeny from two hatchery steelhead stocks (Chambers Creek and Skamania).
- Declining diversity in the DPS, including the uncertain but weak status of summer run fish.
- A reduction in spatial structure.
- Reduced habitat quality through changes in river hydrology, temperature profile, downstream gravel recruitment, and reduced movement of large woody debris.
- In the lower reaches of many rivers and their tributaries in Puget Sound where urban development has occurred, increased flood frequency and peak flows during storms and reduced groundwater-driven summer flows, with resultant gravel scour, bank erosion, and sediment deposition.
- Dikes, hardening of banks with riprap, and channelization, which have reduced river braiding and sinuosity, increasing the likelihood of gravel scour and dislocation of rearing juveniles.

PS steelhead Recovery Plan. Juvenile PS steelhead are less dependent on nearshore habitats for early marine rearing than Chinook or Chum Salmon; nevertheless, nearshore, estuarine, and shoreline habitats provide important features necessary for the recovery of steelhead. PS steelhead spend only a few days to a few weeks migrating through the large fjord, but mortality rates during this life stage are critically high (Moore et al. 2010; Moore and Berejikian 2017).

[12] Nooksack River, Samish River/Bellingham Bays Tributaries, Skagit River, Stillaguamish River, Pilchuck River, Cedar River, Green River, Puyallup River, Nisqually River, White River, S. Hood Canal, Eastside Hood Canal Tributaries, Westside Hood Canal Tributaries, , Skokomish River and Elwha River winter-run populations. The Skagit River and Elwha River summer-run steelhead are also showing increasing trends (NWFSC 2020)

Early marine mortality of PS steelhead is recognized as a primary limitation to the species' survival and recovery (NMFS 2019a). Factors in the marine environment influencing steelhead survival include predation, access to prey (primarily forage fish), contaminants (toxics), disease and parasites, migration obstructions (e.g., the Hood Canal bridge), and degraded habitat conditions which exacerbate these factors.

The PS steelhead recovery plan identifies ten ecological concerns that directly impact salmon and steelhead:

- Habitat quantity (anthropogenic barriers, natural barriers, competition);
- Injury and mortality (predation, pathogens, mechanical injury, contaminated food);
- Food (altered primary productivity, food-competition, altered prey species composition and diversity);
- Riparian condition (riparian condition, large wood recruitment);
- Peripheral and transitional habitats (side channel and wetland condition, estuary conditions, nearshore conditions);
- Channel structure and form (bed and channel form, instream structural complexity);
- Sediment conditions (decreased sediment quantity, increased sediment quantity);
- Water quality (temperature, oxygen, gas saturation, turbidity, pH, salinity, toxic contaminants);
- Water quantity (increased water quality, decreased water quality, altered flow timing); and
- Population-level effects (reduced genetic adaptiveness, small population effects, demographic changes, life history changes).

The Puget Sound steelhead recovery plan and its associated Appendix 3 includes specific recovery actions for the marine environment. General protection and restoration actions summarized from the plan include:

- Continue to improve the assessments of harbor seal predation rates on juvenile steelhead;
- Remove docks and floats which act as artificial haul-out sites for seals and sea lions;
- Consistent with the MMPA, test acoustic deterrents and other hazing techniques to reduce steelhead predation from harbor seals;
- Develop non-lethal actions for "problem animals and locations" to deter predation;
- Increase forage fish habitat to increase abundance of steelhead prey;
- Remove bulkheads and other shoreline armoring to increase forage fish;
- Acquire important forage fish habitat to protect high forage fish production areas;
- Add beach wrack to increase forage fish egg survival;
- Protect and restore aquatic vegetation (e.g., eelgrass and kelp);
- Remove creosote pilings to reduce mortality of herring eggs;
- Increase the assessment of migratory blockages, especially the Hood Canal bridge, where differential mortality has been documented;
- Identify and remedy sources of watershed chemical contaminants (e.g., PBDEs and PCBs).

Status of Rockfishes

NMFS adopted a recovery plan for both PS/GB bocaccio and yelloweye rockfish in 2017. There are no published estimates of historic or present-day abundance of yelloweye or bocaccio rockfish across the full range of DPSs. In 2013, the WDFW published abundance estimates from a remotely operated vehicle (ROV) survey conducted in 2008 in the San Juan Island area (Pacunski et al. 2013). This survey was conducted exclusively within rocky habitats and represents the best available abundance estimates to date for one basin of the DPS. The survey produced estimates of 47,407 (25 percent variance) yelloweye rockfish, and 4,606 (100 percent variance) PS/GB bocaccio in the San Juan area (Tonnes et al. 2016). Though the WDFW has produced other ROV-based estimates of rockfish biomass in Washington waters of the DPSs, none have both covered the entirety of the DPSs and had sufficient sample size to accurately estimate population sizes for such rare species.

Using several available, but spatiotemporally patchy, data series on rockfish occurrence and abundance in Puget Sound, Tolimieri et al. (2017) determined that total rockfish declined at a rate of 3.1 to 3.8 percent per year from 1977 to 2014, or a 69 to 76 percent total decline over that period. The two listed DPSs declined in higher proportions compared to the total rockfish assemblage. Therefore, long-term population growth rate for the listed species was likely even lower (more negative) than that for total rockfish. While there is little to no evidence of recent recovery of total groundfish abundance in response to protective measures enacted over the last 25 years (Essington et al. 2013; 2021; van Duivenbode 2018), increases in the prevalence of several life stages of more common rockfish species have been observed (Pacunski et al. 2020; LeClair et al. 2018). Given the slow maturation rate, episodic recruitment success, and rarity of yelloweye and bocaccio, combined with targeted fisheries being closed for over a decade, insufficient data exist to assess the recent recovery trajectory of these species.

Mature females of each listed species produce from several thousand to over a million eggs annually (Love et al. 2002). In rockfish, the number of embryos produced by the female increases exponentially with size (Haldorson and Love 1991). For example, female copper rockfish that are 20 cm in length produce 5,000 eggs while a female 50 cm in length may produce 700,000 eggs (Palsson et al. 2009). These specific observations come from other species of rockfish, not bocaccio or yelloweye. However, the generality of maternal effects in *Sebastes* suggests that some level of age or size influence on reproduction is likely for all species (Haldorson and Love 1991).

Larval and newly settled rockfishes commonly rockfish rely on nearshore habitat. The nearshore is generally defined as habitats contiguous with the shoreline from extreme high water out to a depth no greater than 98 feet (30 m) relative to mean lower low water. This area generally coincides with the maximum depth of the photic zone of West Coast waters and can contains physical or biological features essential to the conservation of many fish and invertebrate species, including PS/GB bocaccio. Approximately 27 percent of Puget Sound’s shoreline has been modified by armoring, altering sediment budget, wrack accumulation, and other biophysical processes, and in south-central Puget Sound over 60 percent of the shoreline is armored (Simenstad et al. 2011; Whitman 2011; Dethier et al. 2016). Nearshore habitats throughout the greater Puget Sound region have been affected by a variety of human activities, including agriculture, heavy industry, timber harvest, and the development of sea ports and residential property (Drake et al. 2010).

Juvenile yelloweye rockfish are not typically found in intertidal waters (Love et al. 1991; Studebaker et al. 2009). A few juveniles have been documented in shallow nearshore waters (Love et al. 2002; Palsson et al. 2009), but most settle in habitats along the shallow range of adult habitats in areas of complex bathymetry including rocky/boulder habitats and cloud sponges in waters greater than 98 feet (30 m) (Richards 1986; Love et al. 2002; Yamanaka et al. 2006). In British Columbia, juvenile yelloweye rockfish have been observed at a mean depth of 239 feet (73 m), with a minimum depth of 98 feet (30 m) (Yamanaka et al. 2006). In greater Puget Sound, juvenile yelloweye rockfish occur in similar habitats as adults, though in areas with smaller crevices, including cloud sponge formations, crinoid aggregations on top of rocky ridges, and over cobble substrates (Weispfenning 2006; Yamanaka et al. 2006; Banks 2007).

Young-of-year bocaccio occur on shallow rocky reefs and nearshore areas, often associated with macroalgae, especially kelps (Laminariales), and sandy areas that support seagrasses (Moser 1967; Anderson 1983; Kendall and Lenarz 1986; Carr 1991; Love et al. 1991; Love 1996; Murphy et al. 2000; Love et al. 2002). They form aggregations near the bottom in association with drift algae and throughout the water column in association with canopy-forming kelps. It is likely that nearshore habitats used by juvenile bocaccio and other juveniles rockfish offer a beneficial mix of warmer temperatures, food, and refuge from predators (Love et al. 1991). Habitat formed by kelp provides structure for feeding, refuge from predators, and reduced currents that enable energy conservation for juvenile bocaccio. Juvenile bocaccio are exceptionally rare in greater Puget Sound, casting some doubt on whether the current population is capable of reproducing at a rate sufficient to support recovery (Palsson et al. 2009; Drake et al. 2010; NMFS 2017a).

The alteration of Puget Sound shorelines has been found to impact a variety of marine life, ranging from invertebrate fauna (Sobocinski 2003) to surf smelt egg viability (Rice 2006), but consequences of the alteration of Puget Sound shorelines on rockfish habitat such as kelp are less well understood. Some areas around Puget Sound have shown a large decrease in kelp (Berry et al. 2021). Areas with floating and submerged kelp (families Chordaceae, Alariaceae, Lessoniacea, Costariaceae, and Laminaricea) support the highest densities of most juvenile rockfish species (Matthews 1989; Halderson and Richards 1987; Carr 1983; Hayden-Spear 2006). Kelp habitat provides structure for feeding, predation refuge, and reduced currents that enable energy conservation for juveniles (Love et al. 1991). Loss of nearshore habitat quality is a threat to rockfish, but the factors driving this loss vary throughout the DPSs. As such, the recovery plan lists the severity of this threat as very low in Canada, low in the San Juan Islands, moderate in Hood Canal, and high in the Main Basin and South Sound (NMFS 2017a).

A study of rockfish in Puget Sound found that larval rockfish appeared to occur in two peaks (early spring, late summer) that coincide with the main primary production peaks in Puget Sound (Greene and Godersky 2012). Both measures indicated that rockfish ichthyoplankton essentially disappeared from the surface waters by the beginning of November. Densities also tended to be lower in the more northerly basins (Whidbey and Rosario), compared to the Central and South Sound (Greene and Godersky 2012).

The U.S. portion of the Puget Sound/Georgia Basin that is occupied by yelloweye rockfish and PS/GB bocaccio can be divided into five areas, or Basins, based on the distribution of each species, geographic conditions, and habitat features. These five interconnected Basins are: (1) The San Juan/Strait of Juan de Fuca Basin, (2) Main Basin, (3) Whidbey Basin, (4) South Puget Sound, and (5) Hood Canal. See 79 FR 68041, Nov. 13, 2014 (Puget Sound/Georgia Basin Distinct Population Segments of Yelloweye Rockfish, Canary Rockfish and Bocaccio; Designation of Critical Habitat).

Status of PS/GB Bocaccio

PS/GB bocaccio distribution within the DPS may have been historically spatially limited to a few key basins. Historical data indicate they were most abundant in the Central and South Sound with no documented occurrences in the San Juan Basin until 2008 (Pacunski et al. 2013). The apparent decrease in PS/GB bocaccio population size in the Main Basin and South Sound could result in further reduction in the historically limited distribution of PS/GB bocaccio and adds significant risk to long-term viability of the DPS.

The VSP criteria described by McElhaney et al. (2000), and summarized at the beginning of Section 2.2, identified spatial structure, diversity, abundance, and productivity as criteria to assess the viability of salmonid species because these criteria encompass a species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. These viability criteria reflect concepts that are well founded in conservation biology and are generally applicable to a wide variety of species because they describe demographic factors that individually and collectively provide strong indicators of extinction risk for a given species (Drake et al. 2010) and are therefore applied here for PS/GB bocaccio.

<u>General Life History:</u> The life history of PS/GB bocaccio includes a pelagic larval stage followed by a juvenile stage, and occupation of progressively deeper benthic habitats during subadult and adult stages. As with other rockfish, PS/GB bocaccio fertilize their eggs internally and the young are extruded as larvae that are about 4 to 5 millimeter (mm) in length. Females produce from several thousand to over a million offspring per spawning (Love et al. 2002). The timing of larval parturition in PS/GB bocaccio is uncertain, but likely occurs within a five- to six-month window that is centered near March (Greene and Godersky 2012; NMFS 2017a; Palsson et al. 2009). Larvae are distributed by prevailing currents until they are large enough to actively swim toward preferred habitats, but they can pursue food within short distances immediately after birth (Tagal et al. 2002). Larvae are distributed throughout the water column (Weis 2004), but are also observed under free-floating algae, seagrass, and detached kelp (Love et al. 2002; Shaffer et al. 1995). Unique oceanographic conditions within Puget Sound, such as shallow sills and ample freshwater inputs, likely result in most larvae staying within the basin where they are released rather than being broadly dispersed (Drake et al. 2010). Recent modeling of passive particles serving as larval rockfish analogs, however, has demonstrated that this assumption can be substantially violated under certain conditions, resulting in larval transport among basins - both into and out of the DPS (Andrews et al. 2020).

At about 3 to 6 months old and 1.2 to 3.6 inches (3 to 9 cm) long, juvenile PS/GB bocaccio gravitate to shallow nearshore waters where they settle and grow. Rocky or cobble substrates with kelp is most typical, but sandy areas with eelgrass are also utilized for rearing (Carr 1983; Halderson and Richards 1987; Hayden-Spear 2006; Love et al. 1991 and 2002; Matthews 1989; NMFS 2017a; Palsson et al. 2009). Young of the year rockfish may spend months or more in shallow nearshore rearing habitats before transitioning toward deeper water habitats (Palsson et al. 2009). As PS/GB bocaccio grow, their habitat preference shifts toward deeper waters with high relief and complex bathymetry, including rock and boulder-cobble complexes (Love et al. 2002), but they also utilize non-rocky substrates such as sand, mud, and other unconsolidated sediments (Miller and Borton 1980; Washington 1977). Adults are most commonly found between 131 to 820 feet (40 to 250 m) (Love et al. 2002; Orr et al. 2000). The maximum age of PS/GB bocaccio is unknown, but may exceed 50 years, and they reach reproductive maturity near age six.

Spatial Structure and Diversity: Although most individuals of the PS/GB bocaccio DPS are believed to remain within the basin of their origin, including larvae and pelagic juveniles, some movement between basins occurs, and the DPS is currently considered a single population. Research intended to assess this assumption using genetic techniques was unable to collect sufficient samples for analysis (Andrews et al. 2018) but is ongoing.

Abundance and Productivity: The PS/GB bocaccio DPS exists at very low abundance and observations are relatively rare. No reliable range-wide historical or contemporary population estimates are available for the PS/GB bocaccio DPS. It is believed that prior to contemporary fishery removals, each of the major PS/GB basins likely hosted relatively large, though unevenly distributed, populations of PS/GB bocaccio. They were likely most common within the South Sound and Main Basin but were never a predominant segment of the total rockfish abundance within the region (Drake et al. 2010). Bocaccio were not documented in any fishery or research record in the San Juan basin until 2008 (Pacunski et al. 2013). The best available information indicates that between 1965 and 2007, total rockfish populations have declined by about 70 percent in the Puget Sound region, and that PS/GB bocaccio have declined by an even greater extent (Drake et al. 2010; Tonnes et al. 2016; NMFS 2017a).

Limiting Factors: Factors limiting recovery for PS/GB bocaccio include:

- Fishery mortality (commercial and recreational bycatch)
- Derelict fishing gear in nearshore and deep-water environments
- Degraded water quality (chemical contamination, hypoxia, nutrients)
- Climate change
- Habitat disruption, degradation, and destruction

Status of PS/GB Yelloweye Rockfish

The PS/GB yelloweye DPS was listed as endangered on April 28, 2010 (75 FR 22276). In April 2016, we completed a 5-year status review that recommended the DPS retain its endangered classification (Tonnes et al. 2016), and we released a recovery plan in October 2017 (NMFS 2017a).

Spatial Structure. Yelloweye rockfish occupy the waters of the Pacific coast from California to Alaska. Yelloweye rockfish in the waters of the Puget Sound/Georgia Basin were determined to

be a DPS and this water later confirmed using genetic techniques (Andrews et al. 2018). The PS/GB DPS of yelloweye rockfish was listed as "threatened" under the ESA on April 28, 2010 (75 FR 22276). The DPS includes all yelloweye rockfish found in waters of Puget Sound, the Strait of Juan de Fuca east of Victoria Sill, the Strait of Georgia, and Johnstone Strait.

Diversity. Recent collection and analysis of PS/GB yelloweye rockfish tissue samples revealed significant genetic differentiation between the inland (DPS) and coastal samples (Andrews et al. 2018). These new data are consistent with and further support the existence of a population of PS/GB yelloweye rockfish that is discrete from coastal populations, an assumption that was made at the time of listing based on proxy species including quillback and copper rockfish (Ford 2015; Tonnes et al. 2016). In addition, yelloweye rockfish from Hood Canal were genetically differentiated from other PS/GB yelloweye, indicating a previously unknown degree of population differentiation within the DPS (Ford 2015; Tonnes et al. 2016; Andrews et al. 2018). Other genetic analysis has found that yelloweye rockfish in the Georgia Basin had the lowest molecular genetic diversity of a collection of samples along the coast (Siegle et al. 2013).

Although the adaptive significance of such microsatellite diversity is unclear, it may suggest low effective population size, increased drift, and thus lower genetic diversity in the PS/GB DPS.

Abundance. Yelloweye rockfish within U.S. waters of the PS/GB are very likely the most abundant within the San Juan and Hood Canal Basins. Yelloweye rockfish spatial structure and connectivity is threatened by the apparent reduction of fish within each of the basins of the DPS, as they were once prized fishery targets. This reduction is probably most acute within the basins of Puget Sound proper. The severe reduction of fish in these basins may eventually result in a contraction of the DPS' range. Recent research has found evidence for two populations of yelloweye rockfish within the DPS—one in Hood Canal and one within the rest of the PS/GB (Andrews et al. 2018).

In Puget Sound, catches of PS/GB yelloweye rockfish have declined as a proportion of the overall rockfish catch (Figure 2 and Figure 3 from Drake et al. 2010). 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).

Productivity. Life history traits of yelloweye rockfish and PS/GB bocaccio suggest generally low levels of inherent productivity because they are long-lived, mature slowly, and have sporadic episodes of successful reproduction (Musick 1999; Tolimieri and Levin 2005). Yelloweye rockfish productivity may also be impacted by an Allee effect. This situation arises when reproductive adults are removed from the population and remaining individuals are eventually unable to encounter mates. This process then further reduces population density and can lead to extinction. Adult PS/GB yelloweye rockfish typically occupy relatively small ranges (Love et al. 2002), and the extent to which they may move to find suitable mates is unknown. However, there is insufficient information to determine that this is currently occurring for yelloweye rockfish and further research is needed (Hutchings and Reynolds 2004).

Status of Southern Resident Killer Whales (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).

NMFS considers SRKWs to be currently among nine of the most at-risk species as part of the Species in the Spotlight initiative[13] because of their endangered status, declining population trend, and because they are high priority for recovery based on conflict with human activities and recovery programs in place to address threats. The population has relatively high mortality and low reproduction unlike other resident killer whale populations that have generally been increasing since the 1970s (Carretta et al. 2021).

The limiting factors described in the final recovery plan included reduced prey availability and quality, high levels of contaminants from pollution, and disturbances from vessels and sound (NMFS 2008a). This section summarizes the status of SRKWs throughout their range and summarizes information taken largely from the recovery plan (NMFS 2008a), most recent 5-year review[14], the Pacific Fisheries Management Council (PFMC) SRKW Ad Hoc Workgroup's report (PFMC 2020a), as well as newly available data.

Abundance, Productivity, and Trends. Killer whales—including SRKWs—are a long-lived species and sexual maturity can occur at age ten (NMFS 2008a). Females produce a low number of surviving calves (n < 10, but generally fewer) over the course of their reproductive life span (Bain 1990; Olesiuk et al. 1990). Compared to Northern Resident killer whales (NRKWs), which are a resident killer whale population with a sympatric geographic distribution ranging from coastal waters of Washington State and British Columbia north to Southeast Alaska, 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 in the Salish Sea using photo-identification techniques have occurred (Bigg et al. 1990; Center for Whale Research 2019). The

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

[14] Available at (accessed July 2023): https://media.fisheries.noaa.gov/2022-01/srkw-5-year-review-2021.pdf

population of SRKW was at its lowest known abundance in the early 1970s following live-captures for aquaria display (n = 68). The highest recorded abundance since the 1970s was in 1995 (98 animals), though the population declined from 1995-2001 (from 98 whales in 1995 to 81 whales in 2001). The population experienced a growth between 2001 and 2006 and has been generally declining since then. However, in 2014 and 2015, the SRKW population increased from 78 to 81 as a result of multiple successful pregnancies (n = 9) that occurred in 2013 and 2014. At present, the SRKW population has declined to near historically low levels (Figure 13). As of July 2021, the population is 73 whales (one whale is missing and presumed dead since the 2019 summer census), including 25 whales in J pod, 16 whales in K pod, and 32 whales in L pod. Two new calves were born to J pod in September 2020 and one new calf to the L pod in February 2021. As of December 2023, there were 74 members of the SRKW DPS.

The previously published historical estimated abundance of SRKW is 140 animals (NMFS 2008a). This estimate (~140) was generated as the number of whales killed or removed for public display in the 1960s and 1970s (summed over all years) added to the remaining population at the time the captures ended.

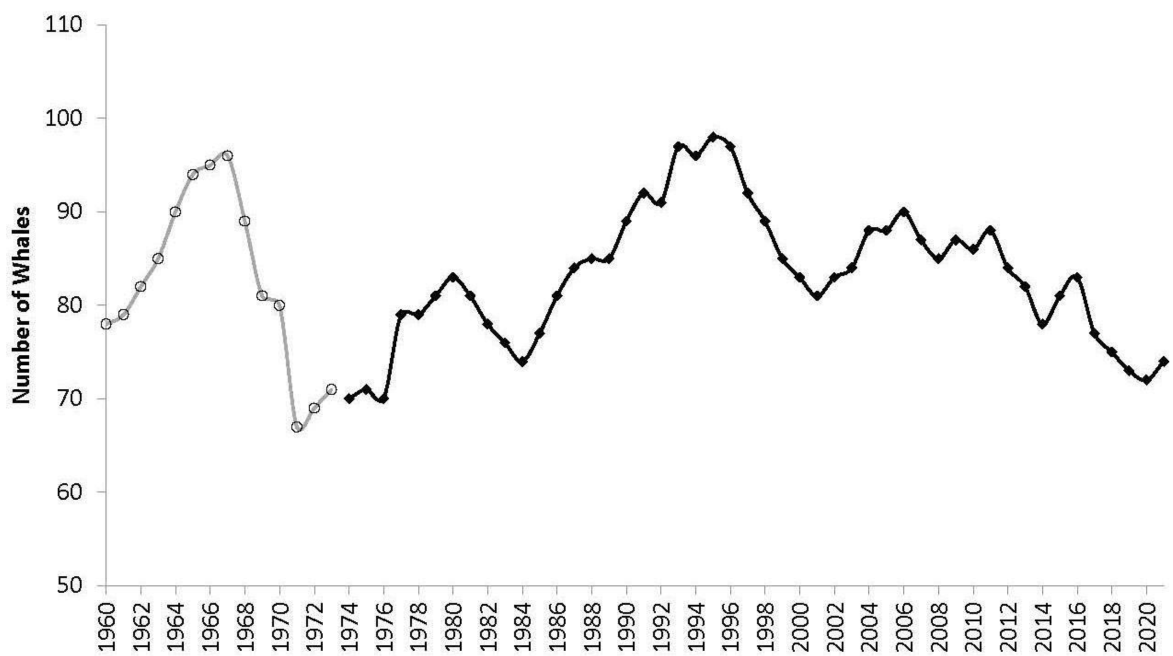

Figure 13. Population size and trend of Southern Resident killer whales, 1960-2021

Numbers from 1960-1973 is shown in open circles, with a gray line.) are number projections from the matrix model of Olesiuk et al. (1990). Data from 1974-2021 (diamonds, black line) were obtained through photo-identification surveys of the three pods (J, K, and L) in this community and were provided by the Center for Whale Research (unpublished data) and NMFS (2008a). 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 (NMFS 2021).

Based on an updated pedigree from new genetic data, 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. Because a small number of males were identified as the fathers of many offspring, a smaller number may be sufficient to support population growth than was previously thought (Ford et al. 2011b; Ford et al. 2018). However, the consequence of this means inbreeding may be common amongst this small population, with a recent study by Ford et al. (2018) finding several offspring resulting from matings between parents and their own offspring. The fitness effects of this inbreeding remain unclear and are an effort of ongoing research (Ford et al. 2018).

Seasonal mortality rates among Southern and Northern Resident whales may be highest during the winter and early spring, based on the numbers of animals missing from pods returning to inland waters each spring and strandings data. Olesiuk et al. (2005) identified high neonatal mortality that occurred outside of the summer season, and multiple new calves have been documented in winter months that have not survived the following summer season (Center for Whale Research, 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 mortality rates and has updated the population viability analyses conducted for the 2004 Status Review for SRKWs and the 2011 science panel review of the effects of salmon fisheries (Krahn et al. 2004; Hilborn et al. 2012; Ward et al. 2013), and the current 5-year review (NMFS 2021). The updated analysis[15] described the recent changes in population size and age structure, change in demographic rates over time, and updated projections of population viability (Ward 2019). According to Ward (2019), the model results indicate that fecundity rates have declined and have changed more than male or female survival since 2010. Ward (2019) performed a series of projections: (1) projections using fecundity and survival rates estimated over the long-term data series (1985 to 2019); (2) projections using fecundity and survival rates from the most recent 5-year period (2014 to 2019); and (3) projections using the highest fecundity and survival rates estimated (in the period 1985 to 1989). The most optimistic scenario, using demographic rates calculated from the 1985 to1989 period, has a trajectory that increases and eventually declines after 2030, while the scenario with long-term demographic data, or the scenario only including the most recent years' demographic data, project declines. Additional runs for this scenario (1985 to1989 data) indicated a similar trajectory with a 50:50 sex ratio. Thus, the downward trends are likely driven by the current age and sex structure of young animals in the population (from 2011-2016 new births were skewed slightly toward males with 64 percent male), as well as the number of older animals (Ward 2019). As the model projects out over a longer time frame (50 years) there is increased uncertainty around the estimates. The current population estimates, which include data from

[15] There are several methodological changes from the projections done previously (Hilborn et al. 2012; Ward et al. 2013). First, because indices of salmon abundance available to whales is not included in the model (and none of the existing metrics of salmon abundance have been found to correlate with killer whale demography; (PFMC 2020)), the estimation model was switched to a generalized additive model (GAM), which allows for smoother over year effects (Ward 2019).

2017 – 2021, project a downward trend over the next 25 years as shown in Figure 14 (NMFS 2021). The downward trend is in part due to the changing age and sex structure of the population, but also related to the relatively low fecundity rate observed over the period from 2017 – 2021. There are several demographic factors of the SRKW population that are cause for concern, namely (1) reduced fecundity observed from 2017 – 2021; (2) a skewed sex ratio toward male births in recent years; (3) a lack of calf production from certain components of the population (e.g., K pod); (4) a small number of adult males acting as sires (Ford et al. 2018); and (5) an overall small number of individuals in the population (NMFS 2021).

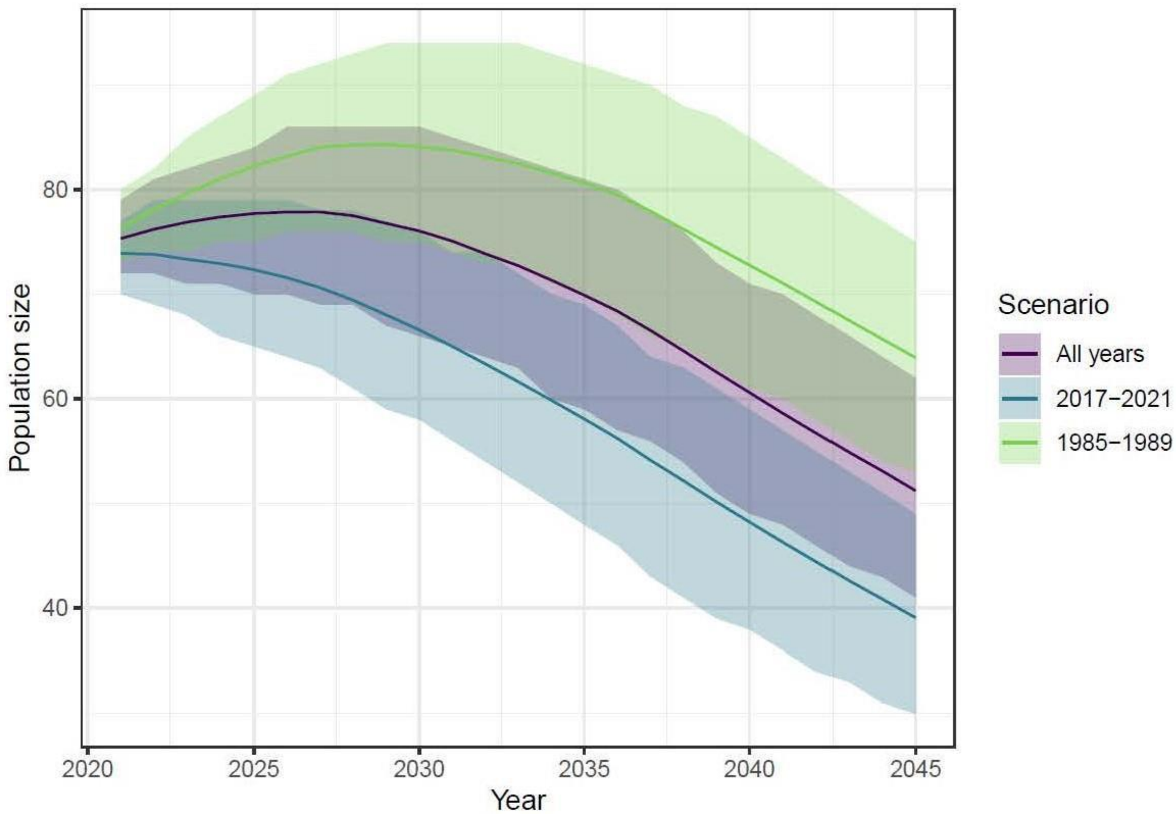

Figure 14. Projected SRKW Population under Three Scenarios

Southern Resident killer whale population size projections from 2020 to 2045 are depicted above 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 (NMFS 2021).

Because of the whales' small population size, the population is also susceptible to increased risks of demographic stochasticity—randomness in the pattern of births and deaths among individuals in a population. Several sources of demographic variance (e.g., differences between individuals 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, known as the extinction vortex (Gilpin and Soulé 1986; Fagan and Holmes 2006; Melbourne and Hastings 2008). The larger the population size, the greater the buffer against stochastic events and genetic risks.

Population-wide distribution of lifetime reproductive success of SRKWs can be highly variable, such that some individuals produce more offspring than others to subsequent generations, and male variance in reproductive success can be greater than that of females (e.g., Clutton-Brock 1998; Hochachka 2006). For long-lived vertebrates such as killer whales, some females in the population might contribute less than the number of offspring required to maintain a constant population size (n = 2), while others might produce more offspring. The smaller the population, the more weight an individual's reproductive success has on the population's growth or decline (Coulson et al. 2006). For example, the overall number of reproductive females has been fluctuating between 25 and 35 for most of the last 40 years, and there have been contrasting changes by pod, with declines in L pod females and increases in J pod (Ward 2019). At the start of the survey in 1976, the distribution of females was skewed toward younger ages with few older, post-reproductive females. The distribution in recent years is more uniform across female ages (in other words, more females in their 30s (Ward 2019)). However, from 2014 through July 2019, only 7 calves were born and survived (3 in J pod and 4 in L pod) (Ward 2019). In a novel study, researchers collected SRKW feces to measure pregnancy hormones (progesterone and testosterone) (Wasser et al. 2017). The fecal hormone data showed that up to 69 percent of the 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 unpubl. data). The congruence between the rate of loss estimates from fecal hormones and aerial photogrammetry suggests the majority of the loss is in the latter half of pregnancy when photogrammetry can detect anomalous shape after several months of gestation (Durban et al. 2016). Although the rates of successful pregnancies in wild killer whale populations is generally unknown, a relatively high level of reproductive failure late in pregnancy is uncommon in mammalian species and suggests there may be cause for concern.

Geographic Range and Distribution. 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 (NMFS 2008a; Carretta et al. 2021; Ford et al. 2017) (Figure 15). SRKW are highly mobile and can travel up to approximately 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, SRKWs have typically spent a substantial amount of time in the inland waterways of the Strait of Georgia, Strait of Juan de Fuca, and Puget Sound (Bigg 1982; Ford et al. 2000; Krahn et al. 2002; Hauser et al. 2007). 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). 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, with late arrivals and fewer days present in recent years (Hanson and Emmons 2010; The Whale Museum unpubl. data).

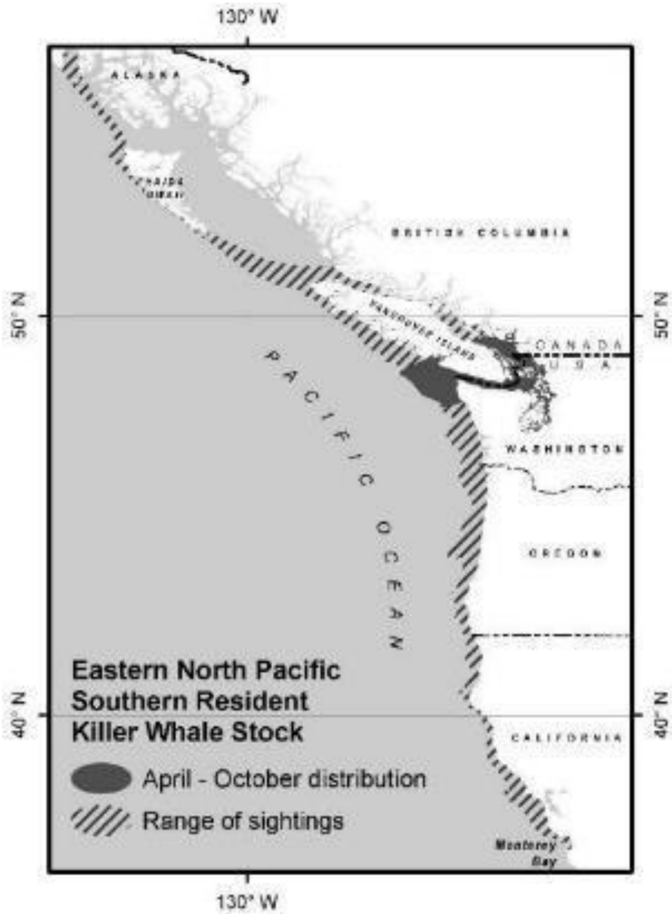

Figure 15. Approximate April–October distribution of SRKW (shaded area) and range of sightings (diagonal lines) (reprinted from Carretta et al. 2021).

Land- and vessel-based opportunistic and survey-based visual sightings, satellite tracking, and passive acoustic research conducted have provided an updated estimate of the whales' coastal range that extends from the Monterey Bay area in California, north to Chatham Strait in southeast Alaska. 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, southeast Alaska and as far south as Monterey Bay, California (NMFS 2019b).

As part of a collaborative effort between NWFSC, Cascadia Research Collective and the University of Alaska, satellite-linked tags were deployed on eight male SRKW (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 4). 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 4). 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 (defined as 1 to 3 standard deviations) in the northern Strait of Georgia and the west entrance to the Strait of Juan de Fuca where they spent approximately 30 percent of their time there (Figure 16), but they spent relatively little time in other coastal areas. K/L pods occurred almost exclusively on the continental shelf during December to mid-May, primarily on the Washington coast, with a continuous high use area between Grays Harbor and the Columbia River and off Westport and spending approximately 53 percent of their time there (Figure 17) (Hanson et al. 2017, 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 square kilometers (km^2), which comprised only 0.5 percent of the three pods' ranges.

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

Whale ID	Pod association	Date of tagging	Duration of signal contact (days)
J26	J	20 Feb. 2012	3
L87	J	26 Dec. 2013	31
J27	J	28 Dec. 2014	49
K25	K	29 Dec. 2012	96
L88	L	8 Mar. 2013	8
L84	L	17 Feb. 2015	93
K33	K	31 Dec. 2015	48
L95	L	23 Feb. 2016	3

Figure 16. Image of a table showing satellite-linked tags deployed on SRKW 2012-2016 (Hanson et al. 2018)[16].

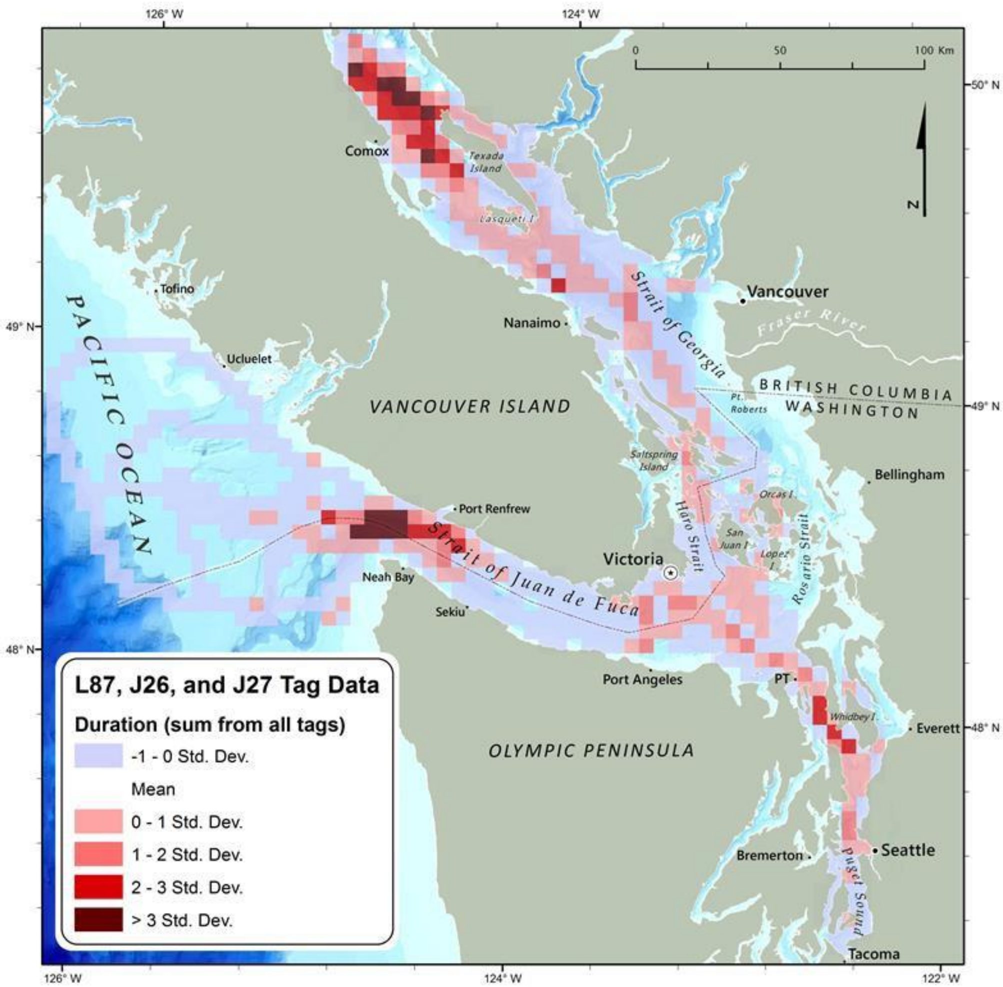

Figure 17. Duration of occurrence model output for J pod tag deployments (Hanson et al. 2017)[17].

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[16] This data was collected as part of a collaborative effort between NWFSC, Cascadia Research Collective, and the University of Alaska.

[17] "High use areas" are illustrated by the 0 to > 3 standard deviation pixels. Duration of occurrence model for all unique K and L pod tag deployments (Hanson et al. 2017). "High use areas" 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 their seasonal uses of these areas via the recording of stereotypic calls of the SRKW (Hanson et al. 2013; Emmons et al. 2019). Passive aquatic listeners (PALs) were originally deployed from 2006–2008. Since 2008, four to seventeen Ecological Acoustic Recorders have been deployed. From 2006–2011, passive acoustic listeners and recorders were deployed in areas thought to be of frequent use by SRKWs based on previous sightings, where enhanced productivity was expected to be concentrated, and in areas with a reduced likelihood of fisheries interactions (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 were selected based on “high use areas” identified in the duration of an occurrence model (Figure 18), and sites within the U.S. Navy’s Northwest Training Range Complex (NWTRC) in order to determine if SRKWs used these areas in other seasons when satellite-linked tags were not deployed (Hanson et al. 2017; Emmons et al. 2019).

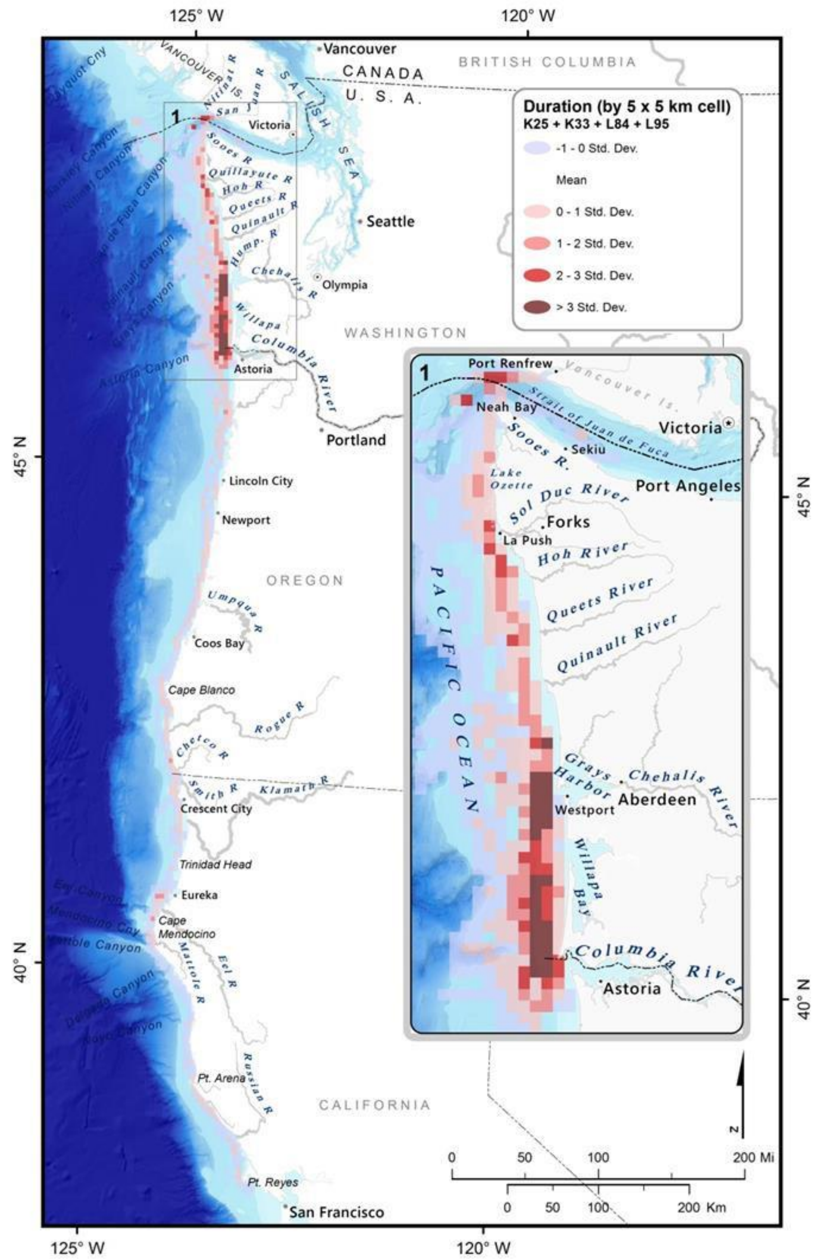

Figure 18. Duration of occurrence model for all unique K and L pod tag deployments (Hanson et al. 2017).[18]

"High use areas" for the SRKW in winter were determined to be primarily located in three areas: (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 the Washington

[18] "High use areas" are illustrated by the 0 to > 3 standard deviation pixels.

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.

There were acoustic detections off the Washington coast in all months of the year (Figures 19-21, 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, and in other coastal waters more often than previously believed (Hanson et al. 2017). Acoustic recorders were deployed off Newport, Fort Bragg, and Port Reyes between 2008 through 2013 and SRKW were detected 28 times (Emmons et al. 2019).

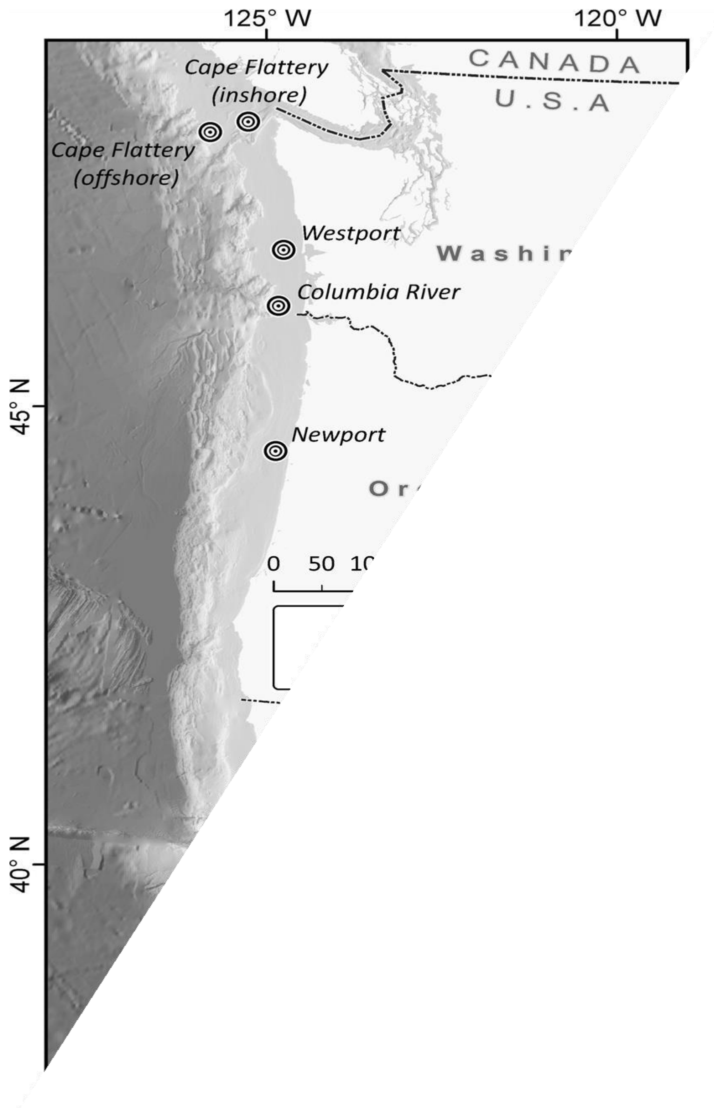

Figure 19. Deployment locations of acoustic recorders on the U.S. west coast from 2006 to 2011 (Hanson et al. 2013).

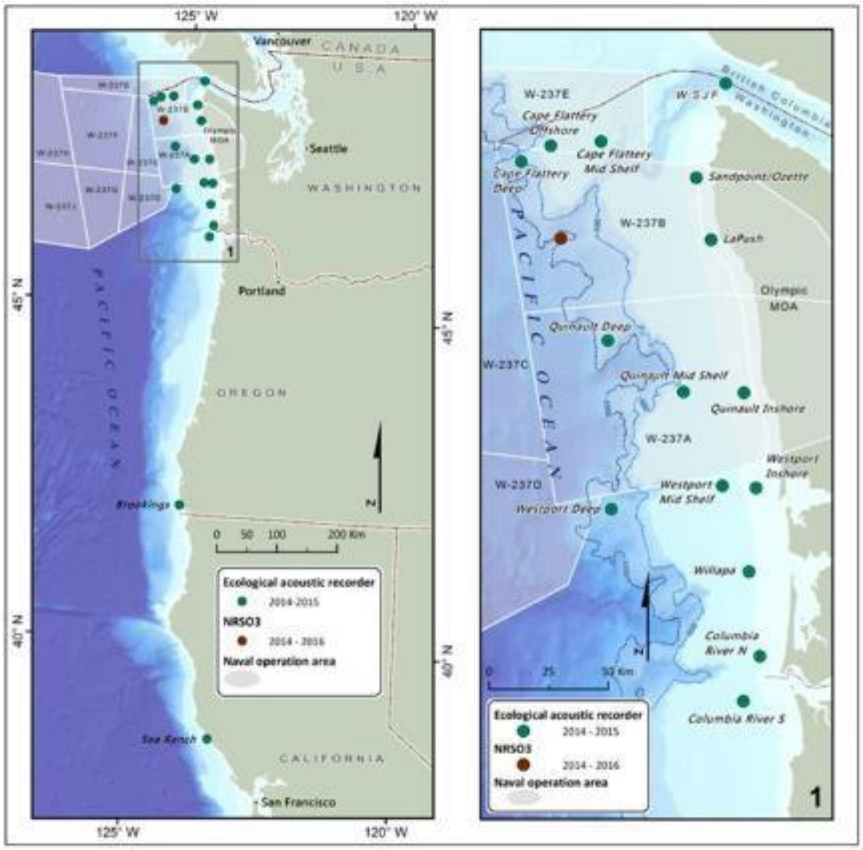

Figure 20. Locations of passive acoustic recorders deployed beginning in the fall of 2014 (Hanson et al. 2017).

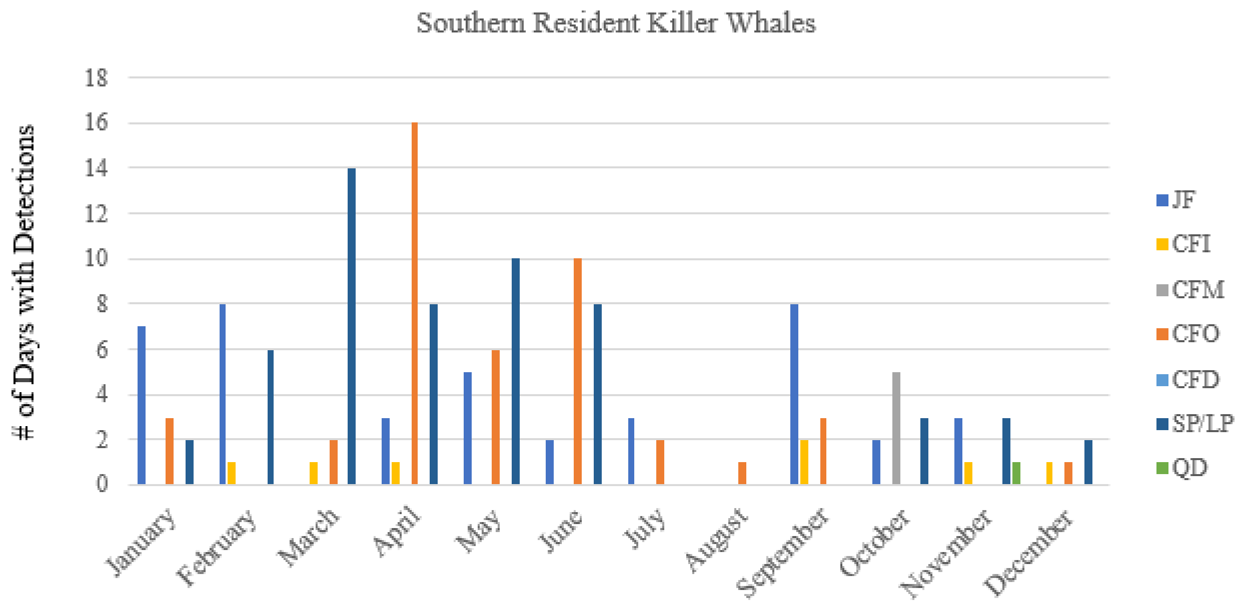

Figure 21. Counts of detections at each northern recorder site by month from 2014-2017 (Emmons et al. 2019)[19]

Additionally, researchers collected data using an autonomous acoustic recorder deployed at Swiftsure Bank from August 2009 to July 2011 to assess how this area is used by Northern Resident and Southern Residents as shown in Figure 22 (Riera et al. 2019). SRKW were detected on 163 days with 175 encounters (see Figure 23 for number of days of acoustic detections for each 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 percent of calls and 89 percent 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 percent of encounters longer than 2 hours occurring between June and September. L pod had the longest encounters in May, with 79 percent of encounters longer than two hours occurring during the summer (May through September). The longest J pod encounters were during winter, with 72 percent of encounters longer than 2 hours occurring between December and May (Riera et al. 2019).

[19] 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).

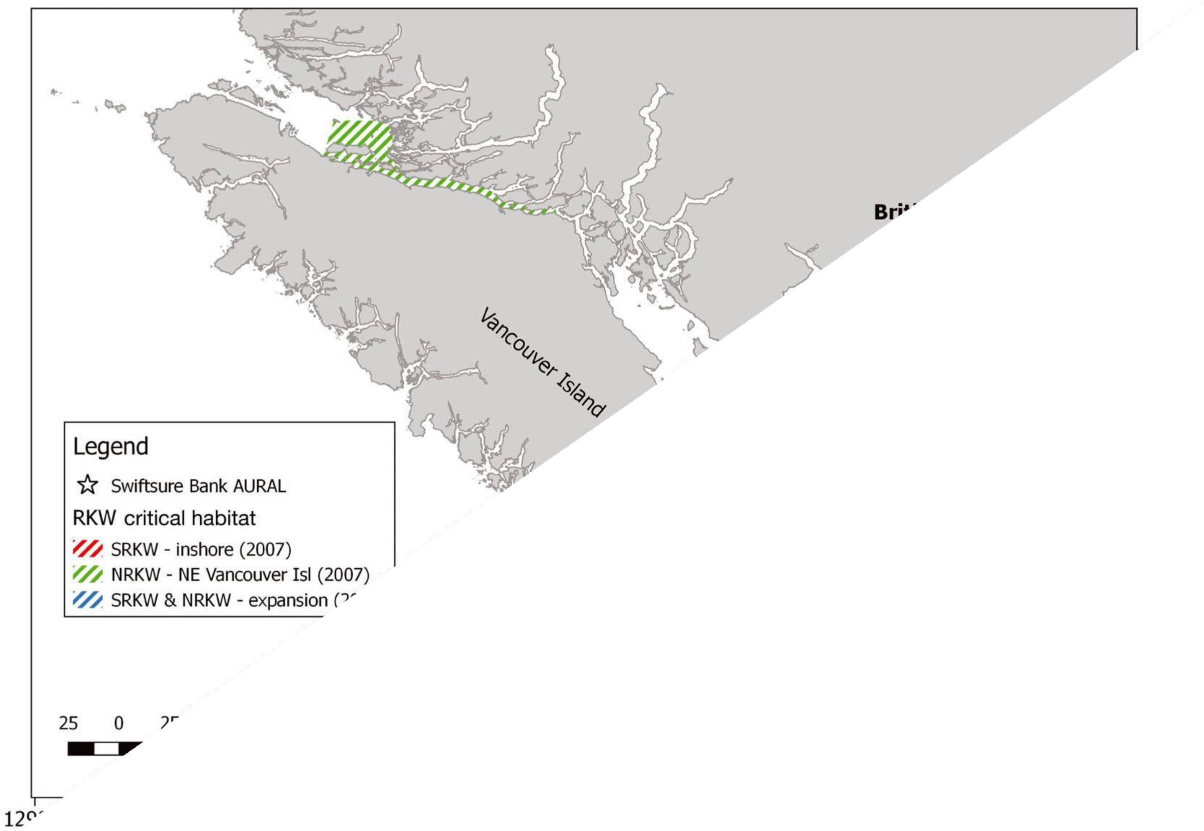

Figure 22. Swiftsure Bank study site off the coast of British Columbia, Canada

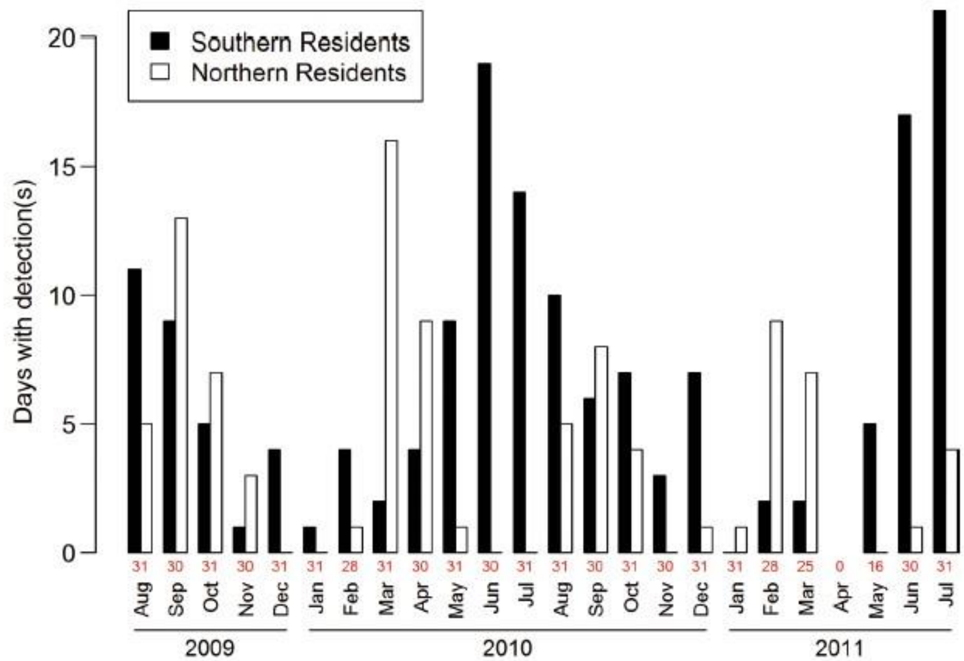

Figure 23. Number of days with acoustic detections of SRKWs at Swiftsure Bank from August 2009–July 2011. Red numbers indicate days of effort. (Riera et al. 2019).

A recent study found SRKWs and NRKWs competition for prey resources among ecologically similar populations that occur in sympatry can be reduced by spatiotemporal resource partitioning and SRKWs were found to prefer the nearshore areas (Emmons et al. 2021).

Understanding patterns of habitat use of cetaceans can be difficult since they are highly mobile and can have large home ranges. Passive acoustic monitoring was used at 15 sites along the coast of Washington, to assess habitat use patterns of two sympatric populations, the NRKW and the SRKW. This area is part of the ocean distributions of a number of important runs of Chinook, the preferred prey of both populations, and is proposed critical habitat for SRKW. Monthly occurrences were compared for both populations at recorder locations grouped by their proximity to the Strait of Juan de Fuca to the north and the Columbia River to the south in one analysis and by their distance from shore in a second analysis. NRKW and SRKW were detected throughout the year with spring and fall peaks in occurrence. The northernmost sites accounted for 93 percent of NRKW detections, while less than half of SRKW detections were at these sites.

SRKW were most frequently detected at nearshore sites (83 percent of detections), while the majority of NRKW detections were at mid-shelf and deep sites (94 percent of detections) (Figure 24). This study provides further information about the habitat use of these resident killer whale populations with implications for their management and conservation.

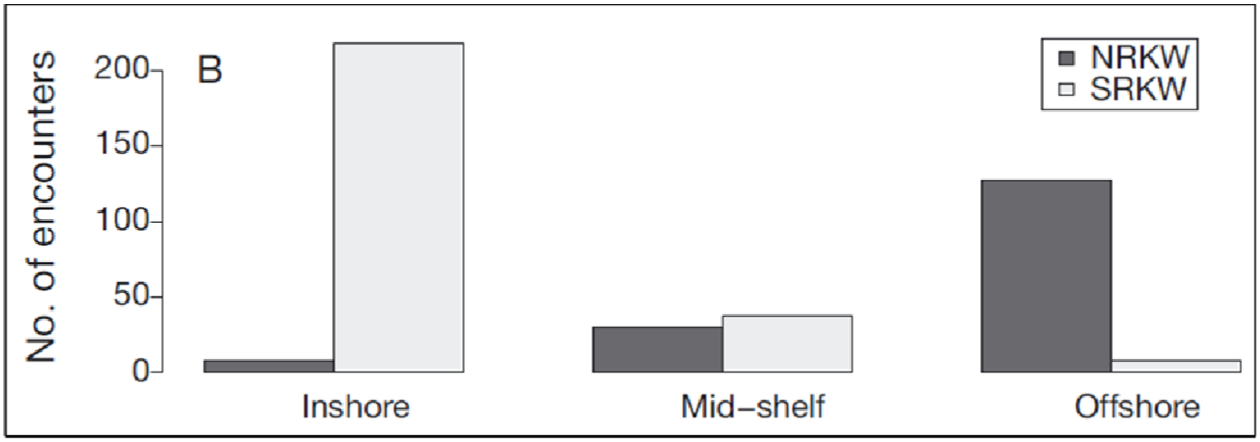

Figure 24. Total number of encounters at inshore, mid-shelf, and offshore sites (Emmons et al. 2021)

Limiting Factors and Threats. Several factors identified in the recovery plan for SRKW may be limiting recovery. The recovery plan identified three major threats including (1) the quantity and quality of prey; (2) toxic chemicals that accumulate in top predators; and (3) impacts from sound and vessels. Oil spills and disease as well as the small population size are also risk factors. It is likely that multiple threats are acting together to impact SRKWs. Modeling exercises have attempted to identify which threats are most significant to survival and recovery (e.g., Lacy et al. 2017) and available data suggest that all the threats are potential limiting factors (NMFS 2008a).

Quantity and Quality of Prey. SRKWs have been documented to consume a variety of fish species (22 species) and one species of squid (Ford et al. 1998; Ford et al. 2000; Ford and Ellis 2006; Hanson et al. 2010; Ford et al. 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 (*O. keta*), coho (*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 (Ford and Ellis 2006). Chinook salmon is their primary prey despite the much lower abundance in comparison to other salmonids in some areas and during certain time periods (Ford and Ellis 2006). Factors of potential importance include the species' large size, high fat and energy content, and year-round occurrence in the SRKW's 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/kilogram [kcal/kg]) (O'Neill et al. 2014). For example, in order for a SRKW to obtain the total energy value of one adult Chinook salmon, they would need to consume approximately 2.7 coho, 3.1 chum, 3.1 sockeye, or 6.4 pink salmon (O'Neill et al. 2014). Research suggests that SRKWs are capable of detecting, localizing, and recognizing Chinook salmon through their ability to distinguish Chinook echo structure as different from other salmon (Au et al. 2010). 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. It has also been difficult to establish a strong relationship between SRKW nutritional stress and Chinook salmon prey availability or any other single factor (NMFS 2021).

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, see below), but highlight temporal variability in isotopic values. Warlick et al. (2020) continued to find that Chinook 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 consumption between months and/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 was the primary prey across years, there was inter-annual variability in nitrogen signature in samples, which could indicate variation in Chinook nitrogen content from year to year or greater Chinook 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. 2017). In particular, southern Chinook salmon stocks ranging south from the Columbia River have been subject to the largest increases in predation, and Chasco et al. (2017) suggested that SRKWs may be the most disadvantaged compared to other more NRKW populations given the northern migrations of Chinook salmon stocks in the ocean and this competition may be limiting the growth of the SRKW population.

May–September

Scale and tissue sampling from May to September in inland waters of Washington and British Columbia, Canada indicate that the SRKW's diet consists of a high percentage of Chinook salmon (monthly proportions as high as >90 percent) (Hanson et al. 2010; Ford et al. 2016).

Genetic analysis of the Hanson et al. (2010) samples from 2006-2010 indicate that when SRKW are in inland waters from May to September, they primarily consume Chinook 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) and Central British Columbia Coast and West and East Vancouver Island. 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.

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

October–December

Prey remains and fecal samples collected in U.S. inland waters during October through December indicate Chinook and chum salmon are primary contributors of the whale's diet during this time (NWFSC unpublished data). Diet data for the Strait of Georgia and coastal waters is limited.

January–April

Observations of SRKWs overlapping with salmon runs (Wiles 2004; Zamon et al. 2007) and collection of prey and fecal samples have also occurred in coastal waters in the winter and spring months. Although fewer predation events have been observed and fewer fecal samples collected in coastal 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 2021). From 2013 to 2016, satellite tags were used to locate and follow the whales to obtain predation and fecal samples. A total of 57 samples were collected from northern California to northern Washington (Figure 21). Results of the 57 available prey samples indicate that, as is the case in inland waters, Chinook are the primary species detected in diet samples on the outer coast, although steelhead, chum, lingcod, and halibut were also detected in samples.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 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 2021). Columbia River, Central Valley, Puget Sound, and Fraser River Chinook salmon collectively comprised over 90 percent of the 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 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 25). However, the Chinook stocks included fish from as far north as the Taku River (Alaska and British Columbia stocks) and as far south as the Central Valley California (Hanson et al. 2021).

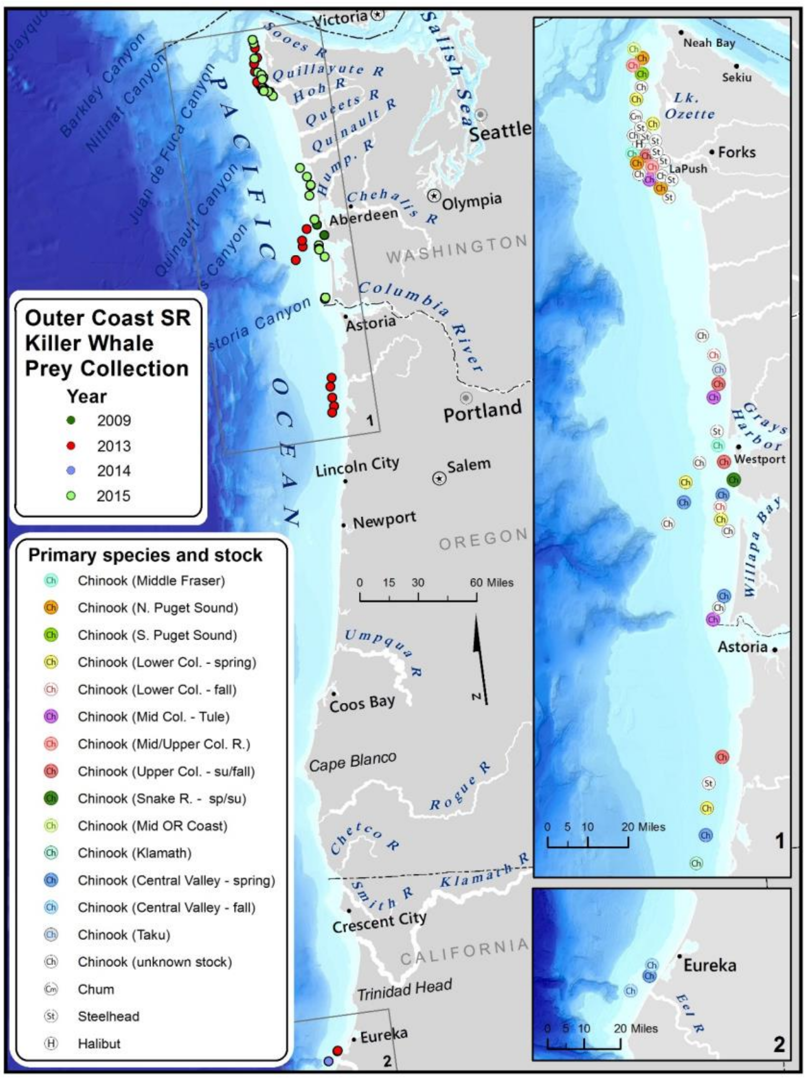

Figure 25. Location and species for scale/tissue samples collected from SRKW predation events in outer coastal waters (NMFS 2019b).

In an effort to prioritize recovery efforts such as habitat restoration and help inform efforts to use fish hatcheries to increase the whales' prey base, NMFS and WDFW developed a report identifying Chinook salmon stocks thought to be of high importance to SRKW along the West Coast (NOAA and WDFW 2018).[20] Scientists and managers from the U.S. and Canada reviewed the model at a workshop sponsored by the National Fish and Wildlife Foundation (NFWF), where the focus was on assisting NFWF in prioritizing funding for salmon related projects. The priority stock report was created using observations of Chinook salmon stocks found in scat and prey scale/tissue samples, and by estimating the spatial and temporal overlap with Chinook salmon stocks ranging from SEAK to California (CA). Puget Sound Chinook salmon are considered a top priority prey stock. Extra weight was given to the salmon runs that support the Southern Residents during times of the year when the whales' body condition is more likely reduced and when Chinook salmon may be less available, such as in winter months. However, it important to note, this priority stock report will continue to get updated over time as new data become available. Given this was designed to prioritize recovery actions and there are no abundance estimates for each stock that are factored in, it is currently not designed to assess fisheries actions or prey availability by area.

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 2008a). 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 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, Hanson et al. 2021). 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 some offset of the historical declines in the abundance of natural-origin salmon within the range of the whales, hatcheries also pose risks to natural-origin salmon populations (Nickelson et al. 1986; Ford 2002; Levin and Williams 2002; Naish et al. 2007). Healthy natural-origin salmon populations are important to the long-term maintenance of prey populations available to Southern Residents because it is uncertain whether a hatchery dominated mix of stocks is sustainable indefinitely and because hatchery fish can differ, relative to natural-origin Chinook salmon, for example, in size and hence caloric value and in availability/migration location and timing.

Nutritional Limitation and Body Condition. When prey is scarce or in low density, SRKWs likely spend more time foraging than when prey is plentiful or in high density. Increased energy expenditure and prey limitation can cause poor body condition and nutritional stress. Nutritional stress is the condition of being unable to acquire adequate energy and nutrients from prey resources and as a chronic condition, can lead to reduced body size of individuals and to lower reproductive or 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

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[20] https://www.westcoast.fisheries.noaa.gov/publications/protected_species/marine_mammals/killer_whales/recovery/srkw_priority_chinook_stocks_conceptual_model_report____list_22june2018.pdf

were observed from boats to have a pronounced "peanut-head"; and all but two subsequently died (Durban et al. 2009; Center for Whale Research unpublished data). None of the whales that died were subsequently recovered, and therefore definitive cause of death could not be identified. Both females and males across a range of ages were found in poor body condition.

Since 2008, NOAA's Southwest Fishery 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. Aerial photogrammetry studies have provided finer resolution for detecting poor condition, even before it manifests in "peanut-head" that is 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 Durban et al. 2017), including five of the six most recent mortalities (Trites and Rosen 2018). These data have provided evidence of a general decline in SRKW body condition since 2008, and documented members of J pod being in poorer body condition in May compared to September of the previous year (at least in 2016 and 2017) (Trites and Rosen 2018). Other pods could not be reliably photographed in both seasonal periods.

Data collected from three SRKW strandings in recent years have also contributed to our knowledge of the health of the population and the impact of the threats to which they are exposed. Transboundary partnerships have supported thorough necropsies of L112 in 2012, J32 in 2014, and L95 in 2016, which included testing for contaminant load, disease and pathogens, organ condition, and diet composition.[21] In fall 2016 another young adult male, J34, was found dead in the northern Georgia Strait (Carretta et al. 2021). The necropsy indicated that the whale died of blunt force trauma consistent with vessel strike.

Previous 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). Body condition in whales can be influenced by a number of factors, including prey availability or limitation, increased energy demands, disease, physiological or life history status, and variability over seasons or across years. Body condition data collected to date has documented declines in condition for some animals in some pods and these occurrences have been scattered across demographic and social groups (Fearnbach et al. 2018).

It is possible that poor nutrition could contribute to mortality through a variety of mechanisms. To exhibit how this is possible, we reference studies that have demonstrated the effects of energetic stress (caused by incremental increases in energy expenditures or incremental reductions in available energy) on adult females and juveniles, which have been studied extensively (e.g., adult females: Gamel et al. 2005, Schaefer 1996, Daan et al. 1996, juveniles: Trites and Donnelly 2003). Small, incremental increases in energy demands

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

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, and lymphoid depletion (Mongillo et al. 2016; Neale et al. 2005; Maggini et al. 2018). Ford and Ellis (2006) report that SRKWs engage in prey sharing about 76 percent of the time. Prey sharing presumably would distribute more evenly the effects of prey limitation across individuals of the population than would otherwise be the case (i.e., if the most successful foragers did not share with other individuals).

Evidence of reduced growth and poor survival in SRKW and NRKW populations at a time when Chinook salmon abundance was low suggests that low abundance may have contributed to nutritional deficiency with serious effects on individual whales. Reduced body condition and body size has been observed in SRKW and NRKW populations. For example, Groskreutz et al. (2019) used aerial photogrammetry to measure growth and length in adult NRKW, which prey on similar runs of Chinook salmon, from 2014 to 2017. 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 adult whales that were 20 – 40 years old have significantly shorter body lengths than those older than 40 years of age, suggesting the younger mature adults had experienced inhibited growth. Similarly, adult Southern Residents under 30 years of age that were measured in 2008 by the same photogrammetric technique were also shorter on average than older individuals also suggesting reduced growth (Fearnbach et al. 2011).

What appears to be constrained growth in both resident killer whale populations occurred in the 1990s during a time when range-wide abundance of Chinook salmon in multiple subsequent years fell below the 1979–2003 average (Ford et al. 2011b. The low Chinook salmon abundance and smaller growth in body size in whales coincided with an almost 20 percent decline from 1995 to 2001 (from 98 whales to 81 whales) in the SRKW population (NMFS 2008g). During this period of decline, multiple deaths occurred in all three pods of the SRKW population and relatively poor survival occurred in nearly all age classes and in both males and females. The 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).

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. Foster et al. (2012) similarly found a significant correlation between SRKW social network connectivity and Chinook prey abundance for the years 1984-2007, where in years with higher Chinook abundance, SRKW social network was more interconnected. The authors discuss that because of this result, years with higher Chinook abundance may lead to more opportunities for mating and information transfer between individuals.

Although both intrinsic and extrinsic factors can affect social cohesion, it has been generally recognized the most important extrinsic factors for medium and larger terrestrial carnivores are the distribution and abundance of prey (refer to Parsons et al. 2009). In social animals, once optimal group size occurs (that is based on intrinsic and extrinsic factors), the response to reduced prey abundance for example could include "group fissioning". However, this may not always be the case, especially if the benefit of "cooperative care" or food sharing outweighs 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. Good fitness and body condition coupled with stable group cohesion and reproductive opportunities are important for reproductive success.

Toxic Chemicals. Various adverse health effects in humans, laboratory animals, and wildlife have been associated with exposures to persistent pollutants. These pollutants have the ability to cause endocrine disruption, reproductive disruption or failure, immunotoxicity, neurotoxicity, neurobehavioral disruption, and cancer (Reijnders 1986; Subramanian et al. 1987; de Swart et al. 1996; Bonefeld-Jørgensen et al. 2001; Reddy et al. 2001; Schwacke et al. 2002; Darnerud 2003; Legler and Brouwer 2003; Viberg et al. 2003; Ylitalo et al. 2005; Fonnum et al. 2006; 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), and more recently, these pollutants were measured in fecal samples collected from SRKWs providing another potential opportunity to evaluate exposure to these pollutants (Lundin et al. 2016a; Lundin et al. 2016b).

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

In 2018, researchers quantified the concentration of polycyclic aromatic hydrocarbons (PAHs) found in killer whale fecal samples in an effort to establish baseline levels of the hazardous compound that is found in oil and vessel exhaust (Lundin et al. 2018). Whales can become exposed to PAHs through aerosol inhalation and contact or ingestion within the water column, with the greatest risk being after an oil spill or in close proximity to vessels (Lachmuth et al 2011). Over the four-year study, PAH levels were relatively low except for four outliers sampled in 2010 (Lundin et al. 2018), before the U.S. vessel distance regulations. However, the extent to which these individuals were exposed to vessels before sampling is unknown. Future work validating these results, and addressing field contamination issues, will support an established baseline understanding of PAH exposure and provide critical information on potential future oil spill cleanup efforts.

Microplastics (microplastic and microfiber particles) are increasingly recognized as a source of contamination in all marine organisms. For marine mammals, the potential exposure pathways include occasional direct incidental ingestion and, more commonly, indirect consumption of contaminated prey. Very little data exist on microplastics levels in SRKWs, though it is the subject of ongoing research in a collaboration among scientists at the NWFSC and the University of Washington. Preliminary data indicate detectable levels of microplastic particles and fibers in every examined killer whale fecal sample from both SRKWs (n = 18) and Alaska resident killer whales (n = 15) (K. Parsons, pers. comm.). The microparticle burden (particles/g dry fecal matter) varied considerably among samples. While a recent paper modeling bioaccumulation and biomagnification using resident killer whales and Chinook salmon as a model predator-prey system suggested that the biomagnification of microplastics particles is low among fish-eating cetaceans (Alava 2020), the physiological and biological effects of microplastic ingestion and potential transfer of biotic and abiotic contaminants to higher trophic marine organisms is unknown.

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

<u>Disturbance from Vessels and Sound.</u> 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 (which can result in injury or mortality (Gaydos and Raverty 2007), the masking of echolocation and communication signals by anthropogenic sound, and behavioral changes (NMFS 2008a). There is a growing body of evidence documenting effects from vessels on small cetaceans and other marine mammals. 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, and that noise from motoring vessels up to 400 meters away has the potential to affect the echolocation abilities of foraging whales (Holt 2008; Lusseau et al. 2009; Noren et al. 2009; Williams et al. 2010). Individual energy balance may be impacted when vessels are present because of the combined increase in energetic costs resulting from changes in whale activity with the decrease in prey consumption resulting from reduced foraging opportunities (Williams et al. 2006; Lusseau et al. 2009; Noren et al. 2009; Noren et al. 2012). Ayres et al. (2012)

examined glucocorticoid and thyroid hormone levels in fecal samples collected from SRKWs in inland waters and their results suggest that the impacts from vessel traffic on hormone levels are lower than the impacts from reduced prey availability. In another study, suction-cup sound and movement tags were attached to SRKWs in their summer habitat while collecting geo-referenced proximate vessel data. Prey capture dives were identified by using whale kinematic signatures and it was found that the probability of capturing prey increased as salmon abundance increased but decreased as vessel speed increased (Holt et al. 2021). When vessels emitted navigational sonar, whales made longer dives to capture prey and descended more slowly when they initiated these dives (Holt et al. 2021). Finally, whales descended more quickly when noise levels were higher and vessel approaches were closer (Holt 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 SRKWs. NMFS concluded it was necessary and advisable to adopt regulations to protect SRKWs from disturbance and sound associated with vessels, to support recovery of SRKWs. Federal vessel regulations were established in 2011 to prohibit vessels from approaching SRKWs within 200 yards (182.9m) and from parking in the path of SRKWs within 400 yards (365.8m). 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 2019, the Washington Legislature passed Senate Bill 5577: a bill concerning the protection of SRKWs from vessels, which developed a license for commercial whale watching and directed the WDFW to administer the licensing program and develop rules for commercial viewing of SRKW (*See* RCW 77.65.615 and RCW 77.65.620). Bill 5577 went into effect in 2021. It established licensing processes and rules for license holders' viewing of SRKW in order to reduce daily and cumulative impacts of whale watching on SRKW. Bill 5577 makes it unlawful "for a person to cause a vessel to approach or fail to disengage the transmission of a vessel within 300 yards of a southern resident orca. It is unlawful to position a vessel behind a southern resident orca within 400 yards. Additionally, it is unlawful for a person to cause a vessel to exceed a speed of seven knots at any point located within one-half of a nautical mile of a southern resident orca. Commercial fishing vessels in transit are not exempt from the approach and speed restrictions." (2SSB 5577). The approach buffer will increase in January 2025 to 1,000 yards (SB 5371).

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

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; National Research Council 2003). Impacts from these sources can range from serious injury and mortality to changes in behavior. In other cetaceans, hormonal changes indicative of stress have been recorded in response to intense sound exposure (Romano et al. 2003). Chronic stress is known to induce harmful physiological conditions including lowered immune function, in terrestrial mammals and likely does so in cetaceans (Gordon and Moscrop. 1996).

Oil Spills. In the Northwest, SRKWs are the most vulnerable marine mammal population to the risks imposed by an oil spill due to their small population size, strong site fidelity to areas with high oil spill risk, large group size, late reproductive maturity, low reproductive rate, and specialized diet, among other attributes (Jarvela-Rosenberger et al. 2017). Oil spills have occurred in the range of SRKWs in the past, and there is potential for spills in the future. Oil can be discharged into the marine environment in any number of ways, including shipping accidents, refineries and associated production facilities, and pipelines. Despite many improvements in spill prevention since the late 1980s, much of the region inhabited by SRKWs remains at risk from serious spills because of the heavy volume of shipping traffic and proximity to petroleum refining centers.

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

Climate Change and Other Ecosystem Effects. In Section 2.2, above, we briefly discussed climate change and the stress it can bring to the ESA-listed species and habitats considered in this Opinion and Conference Opinion. In a broader view, overwhelming data indicate the planet is warming (IPCC 2014), which poses a threat to many species. Climate change has the potential to impact species abundance, geographic distribution, migration patterns, timing of seasonal activities (IPCC 2014), and species viability into the future. 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.

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

Pacific Northwest anadromous fish inhabit as many as three marine ecosystems during their ocean residence period: the Salish Sea, the California Current, and the Gulf of Alaska (Brodeur et al. 1992; Weitkamp and Neely 2002; Morris et al. 2007). The response of these ecosystems to climate change is expected to differ, although there is considerable uncertainty in all predictions. Columbia River and Puget Sound anadromous fish also use coastal areas of British Columbia and Alaska, and mid-ocean habitats in the Gulf of Alaska, although their fine-scale distribution and marine ecology during this period are poorly understood (Morris et al. 2007; Pearcy and McKinnell 2007). Increases in temperature in Alaskan marine waters have generally been associated with increases in productivity and salmon survival (Mantua et al. 1997; Martins et al. 2012).

Warmer streams, loss of coastal habitat due to sea level rise, ocean acidification, lower summer stream flows, higher winter stream flows, and changes in water quality and freshwater inputs are projected to negatively affect salmon (e.g., Mauger et al. 2015). The persistence of cold water "refugia" within rivers and the diversity among salmon populations will be critical in helping salmon populations adapt to future climate conditions. More detailed discussions about the likely effects from climate change in freshwater systems on salmonids can be found in biological opinions such as the implementation of the Mitchell Act (NMFS 2017b).

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

The potential impacts of climate and oceanographic change on whales and other marine mammals will likely involve effects on habitat availability and food availability. For species that depend on salmon for prey, such as SRKWs, the fluctuations in salmon survival that occur with these changes in climate conditions can have negative effects. Site selection for migration, feeding, and breeding may be influenced by factors such as ocean currents and water temperature. For example, there is some evidence from Pacific equatorial waters that sperm whale feeding success, and, in turn, calf production rates are negatively affected by increases in sea surface temperature (Smith and Whitehead 1993; Whitehead 1997). Different species of marine mammals will likely react to these changes differently. MacLeod (2009) estimated, based on expected shifts in water temperature, 88 percent of cetaceans would be affected by climate change, with 47 percent likely to be negatively affected. Range size, location, and whether or not specific range areas are used for different life history activities (e.g., feeding, breeding) are likely to affect how each species responds to climate change (Learmonth et al. 2007).

Although few predictions of impacts on the Southern Residents 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.

Recent analysis ranked the vulnerability of West Coast salmon stocks to climate change and, of the top priority stocks for Southern Residents (NMFS 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, and this stemmed from exposure to higher ocean and river temperatures as well as exposure to changes in flow regimes (including in relation to snowpack, upwelling, sea level rise, and flooding). However, certain Chinook salmon runs do have higher ability to adapt and/or cope with climate change due to high life history diversity in juveniles and adults (including both subyearling and yearling smolts, multiple migration timings), but diversity may be lost with future climate change. Overall, chum and pink salmon were less vulnerable to climate change because they spend less time in fresh water than other salmonids, and certain steelhead runs had more moderate vulnerability than many Chinook and coho runs because of higher resilience (Crozier et al. 2019).

Status of Sunflower Sea Stars

The sunflower sea star *Pycnopodia helianthoides* is proposed for ESA-listing. This species occupies nearshore intertidal and subtidal marine waters shallower than 450 m (~1400 ft) deep from Adak Island, AK, to Bahia Asunción, Baja California Sur, MX. They are occasionally found in the deep parts of tide pools. The species is a habitat generalist, occurring over sand, mud, and rock bottoms both with and without appreciable vegetation. Prey include a variety of epibenthic and infaunal invertebrates, and the species also digs in soft substrate to excavate clams. It is a well-known urchin predator and plays a key ecological role in control of these kelp consumers. More information about sea star biology, ecology, and their life history cycle is found in the proposed listing (88 FR 16212, Mar. 16, 2023).

From 2013 to 2017, the sunflower sea star experienced a range-wide epidemic of sea star wasting syndrome (SSWS) (Gravem et al. 2021; Hamilton et al. 2021; Lowry et al. 2022). While the cause of this disease remains unknown, prevalence of the outbreak has been linked to a variety of environmental factors, including temperature change, sustained elevated temperature, low dissolved oxygen, and decreased pH (Hewson et al. 2018; Aquino et al. 2021; Heady et al. 2022; Oulhen et al. 2022). As noted above, changes in physiochemical attributes of nearshore waters are expected to change in coming decades as a consequence of anthropogenic climate change, but the specific consequences of such changes on SSWS prevalence and severity are currently impossible to accurately predict.

2.2.6 Status of the Critical Habitats

This section examines the status of designated critical habitat affected by the proposed action by examining the condition and trends of essential physical and biological features throughout the designated areas. 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).

Salmon Critical Habitat

For salmon and steelhead, NMFS ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC_5) in terms of the conservation value they provide to each listed species they support.[22] 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 (NOAA Fisheries 2005). Thus, even a location that has poor quality of habitat could be ranked with a high conservation value if it were essential due to factors such as limited availability (e.g., one of a very few spawning areas), a unique contribution of the population it served (e.g., a population at the extreme end of geographic distribution), or if it serves another important role (e.g., obligate area for migration to upstream spawning areas).

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

The physical or biological features of freshwater spawning and incubation sites include water flow, quality and temperature conditions and suitable substrate for spawning and incubation, as well as migratory access for adults and juveniles (Table 5). These features are essential to conservation because without them the species cannot successfully spawn and produce offspring. The physical or biological features of freshwater migration corridors associated with spawning and incubation sites include water flow, quality and temperature conditions supporting larval and adult mobility, abundant prey items supporting larval feeding after yolk sac depletion, and free passage (no obstructions) for adults and juveniles. These features are essential to conservation because they allow adult fish to swim upstream to reach spawning areas and they allow larval fish to proceed downstream and reach the ocean.

Table 5. PCEs of critical habitats designated for ESA-listed salmon species considered in this Opinion and corresponding species life history events.

Primary Constituent Elements Site Type	Primary Constituent Elements Site Attribute	Species Life History Event
Freshwater spawning	Substrate Water quality Water quantity	Adult spawning Embryo incubation Alevin growth and development
Freshwater rearing	Floodplain connectivity Forage Natural cover Water quality Water quantity	Fry emergence from gravel Fry/parr/smolt growth and development
Freshwater migration	Free of artificial obstruction Natural cover Water quality Water quantity	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Estuarine areas	Forage Free of artificial obstruction Natural cover Salinity Water quality Water quantity	Adult sexual maturation and "reverse smoltification" Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Nearshore marine areas	Forage Free of artificial obstruction Natural cover Water quantity Water quality	Adult growth and sexual maturation Adult spawning migration Nearshore juvenile rearing

<u>CHART Salmon and Steelhead Critical Habitat Assessments</u>. The CHART for each recovery domain assessed biological information pertaining to occupied habitat by listed salmon and steelhead, determine whether those areas contained PCEs essential for the conservation of those species and whether unoccupied areas existed within the historical range of the listed salmon and steelhead that are also essential for conservation. The CHARTs assigned a 0 to 3 point score for the PCEs in each HUC_5 watershed for:

Factor 1. Quantity,
Factor 2. Quality—Current Condition,
Factor 3. Quality—Potential Condition,
Factor 4. Support of Rarity Importance,
Factor 5. Support of Abundant Populations,
Factor 6. Support of Spawning/Rearing.

Thus, the quality of habitat in a given watershed was characterized by the scores for Factor 2 (quality—current condition), which considers the existing condition of the quality of PCEs in the HUC_5 watershed and Factor 3 (quality—potential condition[23]) which considers the likelihood of achieving PCE potential in the HUC_5 watershed, either naturally or through active conservation/restoration, given known limiting factors, likely biophysical responses, and feasibility.

Puget Sound Recovery Domain. Critical habitat has been designated in Puget Sound for PS Chinook salmon, PS steelhead, and HCSR chum salmon. Major tributary river basins in the Puget Sound basin include the Nooksack, Samish, Skagit, Sauk, Stillaguamish, Snohomish, Lake Washington, Cedar, Sammamish, Green, Duwamish, Puyallup, White, Carbon, Nisqually, Deschutes, Skokomish, Duckabush, Dosewallips, Big Quilcene, Elwha, and Dungeness rivers and Soos Creek.

Critical habitat for PS steelhead was designated on February 24, 2016 (81 FR 9252). Nearshore and offshore marine waters were not designated for this species. Designated critical habitat for PS steelhead therefore does not occur within the action area for the proposed action.

Critical habitat for PS Chinook salmon was designated on September 2, 2005 (70 FR 52630). Critical habitat includes 1,683 miles of streams, 41 square miles (mi^2) of lakes, and 2,182 miles of nearshore marine habitat in Puget Sound. 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.

Critical habitat for HCSRC was designated on September 2, 2005 (70 FR 52630). Critical habitat includes 79 miles of rivers and 377 miles of nearshore marine habitat in Hood Canal and the Strait of Juan de Fuca (to Dungeness Bay). Most freshwater rivers in HCSRC designated critical habitat are in fair to poor condition (Table 6). Many nearshore areas are degraded, but some areas, including Port Gamble Bay, Port Ludlow, and Kilisut Harbor, remain in good condition (Daubenberger et al 2017, Garono and Robinson. 2002).

Critical habitat is designated for PS Chinook salmon and HCSR chum in estuarine and nearshore areas.

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[23] Definition of “Potential Condition”: Considers the likelihood of achieving PCE potential in the HUC5, either naturally or through active conservation/restoration, given known limiting factors, likely biophysical responses, and feasibility

Landslides can occur naturally in steep, forested lands, but inappropriate land use practices likely have accelerated their frequency and 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 (SSPS 2007).

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; SSPS 2007).

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 (SSPS 2007).

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 (SSPS 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 et al. 1996)., Recent studies have shown that coho salmon show high rates of pre-spawning mortality when exposed to chemicals that leach from tires

(McIntyre et al. 2015). Researchers have recently identified a tire rubber antioxidant as the cause (Tian et al. 2020). Although Chinook did not experience the same level of mortality, tire leachate is still a concern for all salmonids. Traffic residue also contains many unregulated toxic chemicals such as pharmaceuticals, 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).

Dams constructed for hydropower generation, irrigation, or flood control have substantially affected PS salmon and steelhead populations in a number of river systems. The construction and operation of dams have blocked access to spawning and rearing habitat (e.g., Elwha River dams block anadromous fish access to 70 miles of potential 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 (SSPS 2007). These actions 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).

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 (WDFW 2009). 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 (SSPS 2007).

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 (SSPS 2007).

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; SSPS 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 2008d), the Washington State Department of Transportation Preservation, Improvement and Maintenance Activities (NMFS 2013a), and the Elwha River Fish Restoration Plan (Ward et al. 2008; NMFS 2014f; 2019f; 2020g).

In 2012, the Puget Sound Action Plan was developed with several federal agencies (e.g., Environmental Protection Agency [EPA], NOAA Fisheries, the Corps of Engineers, Natural Resources Conservation Service, United States Geological Survey, Federal Emergency Management Agency, and USFWS). They collaborated on an enhanced approach to implement the Puget Sound Action Plan. On January 18, 2017, the National Puget Sound Task Force reviewed and accepted the Interim Draft of the Puget Sound Federal Task Force Action Plan FY 2017-202129. 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.

As discussed in the Status of the species section, the abundance of Chinook salmon in recent years is significantly less than historic abundance due to a number of human activities. The most notable human activities that cause adverse effects on ESA-listed and non-ESA-listed salmon include: land use activities that result in habitat loss and degradation, hatchery practices, harvest and hydropower systems.

As mentioned previously, numerous factors have led to the decline of PS Chinook salmon including overharvest, freshwater and marine habitat loss, hydropower development, and hatchery practices, as mentioned in Section 2.2.1, above. Adjustments can and have been made in the short term to ameliorate some of the factors for decline. Harvest can be adjusted on yearly or even in-season basis. Since PS Chinook salmon were listed, harvest in state and federal fisheries has been reduced in an effort to increase the number of adults returning to spawning grounds.

Likewise, hatchery management can, and has been adjusted relatively quickly when practices are detrimental to listed species. To address needed improvements in hydropower, NMFS has issued biological opinions with reasonable and prudent alternatives to improve fish passage at existing hydropower facilities. Unlike the other factors, however, loss of critical habitat quality is much more difficult to address in the short term. Once human development causes loss of critical habitat quality, that loss tends to persist for decades or longer. The condition of critical habitat will improve only through active restoration or natural recovery following the removal of human infrastructure. As noted throughout this Opinion and the Conference Opinion, future effects of climate change on habitat quality throughout Puget Sound are expected to be negative.

Habitat utilization by Chinook 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 2015a). 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. The response of fish populations to this action is still being evaluated. It is clear; however, that Chinook 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, although juvenile collection efficiency is still relatively low, and 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 2014f). 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 (NWFSC 2020).

As of 2019 approximately 8,000 culverts that block steelhead habitat have been identified in Puget Sound (NMFS 2019g), 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 (NWFSC 2020).

In summary, even with restoration success, like dam removal and blocked culverts being addressed, critical habitat for salmon 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.[24]

[24] 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).

The PS recovery domain CHART for PS Chinook salmon and HCSR chum salmon (NOAA Fisheries 2005) determined that only a few watersheds with PCEs for Chinook salmon in the Whidbey Basin (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. 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 6).

Table 6. Puget Sound Recovery Domain: Current and potential quality of HUC5 watersheds identified as supporting historically independent populations of ESA- listed Chinook salmon (CK) and Hood Canal summer- run chum salmon (CM) (NOAA Fisheries 2005). Watersheds

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 HUC5 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 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
HammaHamma 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

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
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

Puget Sound Bocaccio Rockfish Critical Habitat

NMFS designated critical habitat for PS/GB yelloweye and PS/GB bocaccio rockfish on November 13, 2014 (79 FR 68042). Critical habitat is not designated in areas outside of U.S. jurisdiction; therefore, although waters in Canada are part of the DPSs' ranges for both species, critical habitat was not designated in that area. The U.S. portion of the Puget Sound/Georgia Basin that is occupied by PS/GB yelloweye rockfish and PS/GB bocaccio can be divided into five areas, or Basins, based on the distribution of each species, geographic conditions, and habitat features. These five interconnected Basins are: (1) The San Juan/Strait of Juan de Fuca Basin, (2) Main Basin, (3) Whidbey Basin, (4) South Puget Sound, and (5) Hood Canal.

Based on the natural history of PS/GB bocaccio and their habitat needs, NMFS identified two physical or biological features, essential for their conservation: (1) Deepwater sites (>30 meters) that support growth, survival, reproduction, and feeding opportunities; and (2) Nearshore juvenile rearing sites with sand, rock and/or cobbles to support forage and refuge. Habitat threats include degradation of rocky habitat, loss of eelgrass and kelp, introduction of non-native species that modify habitat, and degradation of water quality.

We have determined that approximately 644.7 mi^2 (1,669.8 km^2) of nearshore habitat for juvenile PS/GB bocaccio and 438.5 mi^2 (1,135.7 km^2) of deep-water habitat for PS/GB yelloweye rockfish and PS/GB bocaccio meet the definition of critical habitat. Critical habitat for adult PS/GB bocaccio includes 590.4 mi^2 of nearshore habitat and 414.1 mi^2 of deep-water habitat.

Nearshore critical habitat for PS/GB bocaccio at juvenile life stages is defined as areas that are contiguous with the shoreline from the line of extreme high water out to a depth no greater than 98 feet (30 m) relative to mean lower low water. The PBFs of nearshore critical habitat include settlement habitats with sand, rock, and/or cobble substrates that also support kelp. Important site 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 (DO) to support growth, survival, reproduction, and feeding opportunities.

Deep water critical habitat includes marine waters and substrates of the U.S. in Puget Sound east of Green Point in the Strait of Juan de Fuca, and serves adult PS/GB bocaccio. Deepwater critical habitat is defined as areas at depths greater than 98 feet (30 m) that support feeding opportunities and predator avoidance.

The Federal Register notice for the designation of rockfish critical habitat in Puget Sound notes that many forms of human activities have the potential to affect the essential features of listed rockfish species, and specifically calls out, among others, (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 (79 FR 68041;11/13/14) (Figure 23). Water quality throughout Puget Sound is degraded by anthropogenic sources within the Sound (e.g., pollutants from vessels) as well as upstream sources (municipal, industrial, and nonpoint sources).

Nearshore habitat degradation exists throughout the Puget Sound from fill and dredge to create both fast land and navigational areas for commerce, from shore hardening to protect both residential and commercial waterfront properties, and from overwater structures that enable commercial and recreational boating.

NMFS’s 2016 status update identifies recommended future actions including protection and restoration of nearshore habitat through removal of shoreline armoring and protecting and increasing kelp coverage.

DPS Basin	Nearshore sq. mi. (for juvenile bocaccio only)	Deepwater sq. mi. (for adult and juvenile yelloweye rockfish and adult bocaccio)	Physical or Biological Features		Activities
San Juan/ Strait of Juan de Fuca	349.4	203.6	Deepwater sites <30 meters) that support growth, survival, reproduction and feeding opportunities	Nearshore juvenile rearing sites with sand, rock and/or cobbles to support forage and refuge	1, 2, 3, 6, 9, 10, 11
Whidbey Basin	52.2	32.2			1, 2, 3, 4, 6, 9, 10, 11
Main Basin	147.4	129.2			1, 2, 3, 4, 6,7, 9, 10, 11
South Puget Sound	75.3	27.1			1, 2, 3, 4, 6,7, 9, 10, 11
Hood Canal	20.4	46.4			1, 2, 3, 6,7, 9, 10, 11

Figure 26. Image of a table indicating Physical or Biological Features of Rockfish Critical Habitat[25]

SRKW Critical Habitat

Critical habitat for the SRKW DPS was designated on November 29, 2006 (71 FR 69054). Critical habitat includes approximately 2,560 mi^2 of inland waters of Washington in three specific areas: (1) the Summer Core Area in Haro Strait and waters around the San Juan Islands; (2) Puget Sound; and (3) the Strait of Juan de Fuca. Based on the natural history of SRKWs and their habitat needs, NMFS identified the following physical or biological features essential to conservation: (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.

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[25] Management Considerations Codes: (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 habitats; (9) research; (10) aquaculture; and (11) activities that lead to global climate change and ocean acidification. Commercial kelp harvest does not occur presently but would probably be concentrated in the San Juan/Georgia Basin. Artificial habitats could be proposed to be placed in each of the Basins. Non-indigenous species introduction and management could occur in each Basin

In 2006, few data were available on SRKWs distribution and habitat use in coastal waters of the Pacific Ocean. Since the 2006 designation, additional effort has been made to better understand the geographic range and movements of SRKWs. For example, opportunistic visual sightings, satellite tracking, and passive acoustic research conducted since 2006 have provided an updated estimate of the whales' coastal range that extends from the Monterey Bay area in California, north to Chatham Strait in southeast Alaska (NMFS 2019b).

On August 2nd, 2021, NMFS revised the critical habitat designation for the SRKW DPS under the ESA by designating six new areas along the U.S. West Coast (86 FR 41668). Specific new areas proposed along the U.S. West Coast include approximately 15,910 mi^2 (41,207 km^2) of marine waters between the 6.1-meter (m) depth contour and the 200-m depth contour from the U.S. international border with Canada south to Point Sur, California). In the final rule (86 FR 41668), NMFS states that the "designated areas are occupied and contain physical or biological features that are essential to the conservation of the species and that may require special management considerations or protection." The three physical or biological features essential to conservation in the 2006 designated critical habitat were also identified for the six new areas along the U.S. West Coast.

Water Quality

Water quality supports SRKW's ability to forage, grow, and reproduce free from disease and impairment. Water quality is essential to the whales' conservation, given the whales' present contamination levels, small population numbers, increased extinction risk caused by any additional mortalities, and geographic range (and range of their primary prey) that 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. The absence of contaminants or other agents of a type and/or amount that would inhibit reproduction, impair immune function, result in mortalities, or otherwise impede the growth and recovery of the SRKW population is a habitat feature essential for the species' recovery. Water quality in Puget Sound, in general, is degraded as described in the Puget Sound Partnership 2018-2022 Action Agenda and Comprehensive (Puget Sound Partnership 2018). 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. Water quality varies in coastal waters from Washington to California. For example, as described in NMFS (2019b), high levels of DDTs have been found in SRKWs, especially in K and L pods, which spend more time in California in the winter where DDTs still persist in the marine ecosystem (Sericano et al.
2014).

Exposure to oil spills also poses additional direct threats as well as longer term population level impacts; therefore, the absence of these chemicals is of the utmost importance to SRKW conservation and survival. Oil spills can also have long-lasting impacts on other habitat features. Oil spill risk exists throughout the SRKW's coastal and inland range. From 2002-2016, the highest-volume crude oil spill occurred in 2008 off the California coast, releasing 463,848 gallons (Stephens 2017). In 2015 and 2016, crude oil spilled into the marine environment off the California coast totaled 141,680 gallons and 44,755, respectively; no crude oil spills were reported off the coasts of Oregon or Washington in these years (Stephens 2015, Stephens 2017). Non-crude oil spills into the marine environment also occurred off California, Oregon, and Washington in 2015 and 2016 (Stephens 2015, Stephens 2017). The EPA and U.S. Coast Guard oversee the Oil Pollution Prevention regulations promulgated under the authority of the Federal Water Pollution Control Act. There is a Northwest Area Contingency Plan, developed by the Northwest Area Committee, which serves as the primary guidance document for oil spill response in Washington and Oregon. In 2017, the WDOE published a new Spill Prevention, Preparedness, and Response Program Annual Report describing the Spills Program as well as the performance measures from 2007–17 (WDOE 2017).

Prey Quantity, Quality, and Availability

SRKW are top predators that show a strong preference for salmonids in inland waters, particularly larger, older age class Chinook (age class of 3 years or older) (Ford and Ellis 2006, Hanson et al. 2010). Samples collected during observed feeding activities, as well as the timing and locations of killer whales' high use areas that coincide with Chinook salmon runs, suggest the whales' preference for Chinook extends to outer coastal habitat use as well (Hanson et al. 2017, Hanson et al. 2021). Quantitative analyses of diet from fecal samples indicate a high proportion of Chinook in the diet of whales feeding in waters off the coast but a greater diversity of species, which included substantial contributions of other salmon and also lingcod, halibut, and steelhead (Hanson et al. 2021). Habitat conditions should support the successful growth, recruitment, and sustainability of abundant prey to support the individual growth, reproduction, and development of Southern Residents.

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

In addition to sufficient quantity of prey, those fish need to be accessible and available to the whales. Depending on pod migratory behavior, availability of Chinook along the outer coast is likely limited at particular times of year (e.g. winter months) due to run timing of various Chinook stocks. Prey availability may also be low when the distribution of preferred adult Chinook is relatively less dense (spread out) prior to their aggregation when returning to their natal rivers. Prey availability may also be affected by competition from other predators including other resident killer whales, pinnipeds, and fisheries (Chasco et al. 2017).

Contaminants and pollution also affect the quality of SRKW prey in Puget Sound and in coastal waters of Washington, Oregon, and California. Contaminants enter marine waters and sediment from numerous sources but are typically concentrated near areas of high human population and industrialization. Once in the environment these substances proceed up the food chain, accumulating in long-lived top predators like SRKWs. Chemical contamination of prey is a potential threat to SRKW critical habitat, despite the enactment of modern pollution controls in recent decades, which were successful in reducing, but not eliminating, the presence of many contaminants in the environment. The size of Chinook salmon is also an important aspect of prey quality (i.e., SRKWs primarily consume large Chinook) so changes in Chinook size (for instance as shown by Ohlberger et al. (2018) may affect the quality of this component critical habitat.

Availability of prey to the whales may also be impacted by anthropogenic sound if it raises average background noise to a level that is expected to chronically or regularly reduce the effective zone of echolocation space for SRKW (Holt 2008, Veirs et al. 2016, Joy et al. 2019), and therefore could limit a whale's ability to find/access the prey critical habitat feature. For example, ship noise was identified as a concern because of its potential to interfere with SRKW communication, foraging, and navigation (Veirs et al. 2016). In-water anthropogenic sound is generated by other sources beside vessels, including construction activities, and military operations, and may affect availability of prey to Southern Residents by interfering with hearing, echolocation, or communication depending on the intensity, persistence, timing, and location of certain sounds in the vicinity of the whales (see review in NMFS 2008a). Therefore, anthropogenic noise may affect the availability of prey to SRKWs by reducing echolocation space used for foraging and communication between whales (including communication for prey sharing).

SRKW might shift their distribution in response to climate-related changes in their salmon prey, as discussed above in Section "Climate change and other ecosystem effects" and climate change may have impacts on the prey feature of critical habitat.

Passage

Southern Residents are highly mobile and use a variety of areas for foraging and other activities, as well as for traveling between these areas. Human activities can interfere with movements of the whales and impact their passage. Southern Residents 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 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 (2010), Ferrara et al. (2017).

2.3 Environmental Baseline

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultations, and the impact of State or private actions which are contemporaneous with the consultation in process. The impacts to listed species or designated critical habitat from federal agency activities or existing federal agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

2.3.1 Current Status of Marine Habitat in the Action Area

NMFS has identified several marine physical or biological features essential to conservation for salmon, rockfish and SRKW in Section 2.2.2. In this section, we describe the overall status of the marine habitat in the Action Area, which includes much of Puget Sound, and the San Juan Islands/Strait of Juan de Fuca. Detailed information on the structures present, armoring, physical processes, water and sediment quality, riparian and marine vegetation, and forage fish spawning habitat present at each terminal is provided in Chapter 4 of the WSF' BAR and is incorporated here by reference.

WSF and FHWA currently or are in in the process of conducting several actions that will have broad conservation benefits to listed species. These include noise reduction from vessels, notification of marine mammal locations to the greater shipping community, and a reduction in greenhouse gasses.

The most recent report of the PSP (2018) concluded the overall decline in habitat conditions and native species abundance in the Puget Sound has been caused by development and climate change pressures. They described the following issues within Washington inland marine waters:

- Chinook salmon, steelhead and SRKW: ongoing decline.
- Herring stocks: declining
- Loss of non-federal forested land cover to developed land cover: continuing. Loss of 1,196 acres of non-federal forested land per year between 2006 and 2011.
- Shoreline armoring: Stable between 2011 and 2014. No recent net increase, restoration actions balance out increase from private shoreline armoring. However, this could be related to poor economic conditions. More years of data are needed to determine trends.
- Accelerated conversion/loss of vegetation cover on ecologically important lands: 1.116 percent loss for 2006-2011. This is even more loss than the cautious 2020 Target: Basin- wide loss of vegetation cover on ecologically important lands under high pressure from development does not exceed 0.15 percent of the total 2011 baseline land area over a 5- year period.
- Marine water quality: Overall, trends have been getting worse with closures of beaches and shellfish harvest in some bays. While there has been some increase between 2011 and 2014 in the amount of shellfish beds open to harvest, about 19 percent are still closed. Polychlorinated biphenyl (PCB) levels in fish[7] are still high.
- Native Eelgrass (*Z. marina*) abundance seems stable comparing 2011 to 2013 data to baseline from 2000 to 2008. This does not account for losses that occurred prior to 2000.
- Over-Water Structure: not assessed by PSP. Current percent of nearshore coverage is 0.63 percent for all of Puget Sound, as detailed below.

Nearshore Physical Habitat Changes

Over the last 150 plus years, 4.5 million people have settled in the Puget Sound region. With the level of infrastructure development associated with this population growth, the Puget Sound nearshore has been altered significantly. Major physical changes documented include the simplification of river deltas, the elimination of small coastal bays, the reduction in sediment supplies to the foreshore due to beach armoring, and the loss of tidally influenced wetlands and salt marsh (Fresh et al. 2011).

The duration of impairment of habitat condition and function derived from decades of persistent anthropogenic changes in the amount of and character of estuarine habitat, is made more detrimental because: (1) regulatory and permitting measures do not avoid all impacts and largely fail to include methods to rectify unavoidable impacts, (2) development pressure continues to impact habitat in the marine and freshwater portion of the range; (3) improvements in human use patterns to minimize resource impacts are slow at best; and (4) few of the 2020 improvement targets identified by the PSP[26] have been reached (PSP 2018).

The nearshore is the zone where marine water, fresh water, and terrestrial landscapes interact in a complex mosaic of habitats and processes. The nearshore encompasses the shoreline from the top of the upland bank or bluff on the landward side down to the depth of water that light can penetrate and where plants can photosynthesize, called the photic zone. The upper extent of the nearshore covers the terrestrial upland that contributes sediment, shade, organic material like leaf litter, and insects that fish eat. The lower range of the photic zone depends on water clarity; in Puget Sound, underwater vegetation can be found to depths of 30 to 100 ft below MLLW (Williams and Thom 2001). The nearshore includes a variety of environments: marine shallows, eelgrass meadows, kelp forests, mudflats, beaches, salt marshes, rocky shores, river deltas, estuaries, barrier islands, spits, marine riparian zones, and bluffs. This wide range of habitats supports many species. The nearshore forms the basis for the biologic productivity of the Puget Sound basin.

Throughout the Action Area, the nearshore areas have been modified by human activity, disrupting the physical, biological, and chemical interactions that are vital for creating and sustaining the diverse ecosystems within the Action Area. There are approximately 503,106 acres of overwater structure in the nearshore of Puget Sound (Schlenger et al. 2011). Currently, a third of Puget Sound's shorelines are armored (Simenstad el al. 2011). The shoreline modifications are usually intended for erosion control, flood protection, sediment management, or for commercial, navigational, and recreational uses. Seventy-four percent of shoreline modification in Puget Sound consists of shoreline armoring (Simenstad et al. 2011), which usually refers to bulkheads, seawalls, or groins made of rock, concrete, or wood. Other modifications include jetties and breakwaters designed to dissipate wave energy, and structures such as tide gates, dikes, and marinas, overwater structures, including bridges for railways, roads, causeways, and artificial fill.

[26] The PSP Action Agenda is an EPA-approved recovery plan under the National Estuary Program.

An analysis conducted in 2011 though the Puget Sound Nearshore Ecosystem Restoration Project (Fresh et al, 2011; Simenstad et al 2011) found that since 1850, of the approximately 2,470 miles of Puget Sound shoreline:

- Shoreline armoring has been installed on 27 percent of Puget Sound shores (Table 7).
- One-third of bluff-backed beaches are armored along half their length. Roads and nearshore fill have each affected about 10 percent of the length of bluff-backed beaches.
- Forty percent of Puget Sound shorelines have some type of structure that impacts habitat quality.
- Conversion of natural shorelines to artificial shoreforms occurred in 10 percent of Puget Sound (Table 8).
- There has been a 93 percent loss of freshwater tidal and brackish marshes. The Duwamish and Puyallup rivers have lost nearly all of this type of habitat.
- A net decline in shoreline length of 15 percent as the naturally convoluted and complex shorelines were straightened and simplified. This represents a loss of 1,062 km or 660 miles of overall shoreline length.
- Elimination of small coastal embayments has led to a decline of 46 percent in shoreline length in these areas.
- A 27 percent decline in shoreline length in the deltas of the 16 largest rivers and a 56 percent loss of tidal wetlands in the deltas of these rivers.

Table 7. Total area of over water structures by sub-basin observed in aerial photo review between 2013 and 2016 (Beechie et al. 2017).

Marine Basin	Acres
Hood Canal	233
North Puget Sound	281
South Central Puget Sound	817
Strait of Juan de Fuca	65
Whidbey Basin	186
Total	**1581**

The distribution and sizes of over water structures in the nearshore[27] are detailed further in Schlenger et al. (2011) and (Simenstad et al. 2011).

[27] The nearshore area includes the area from the deepest part of the photic zone (approximately 10 meters below MLLW) landward to the top of shoreline bluffs, or in estuaries upstream to the head of tidal influence (Clancy et al. 2009).

Table 8. Length of shoreline armored as a percent of total shoreline length (Simenstad et al. 2011) by Marine Basin (Beechie et al. 2017).

Marine Basin	Armoring (miles)	Shoreline Length (miles)	Percent Armored
Hood Canal	63.9	359.7	17.7%
North Puget Sound	103.3	720.4	14.3%
South Central Puget Sound	397.0	832.6	47.7%
Strait of Juan de Fuca	33.0	210.3	15.7%
Whidbey Basin	68.3	343.4	19.9%
Grand Total	**665.3**	**2466.3**	**27.0%**

Existing shoreline armoring on nearshore and intertidal habitat function has diminished sediment supply, diminished organic material (e.g. woody debris and beach wrack) deposition, diminished overwater (riparian) and nearshore in-water vegetation (SAV), diminished prey availability, diminished aquatic habitat availability, diminished invertebrate colonization, and diminished forage fish populations (see Toft et al. 2007; Shipman et al. 2010; Sobocinski et al. 2010; Morley et al. 2012; Toft et al. 2013; Munsch et al. 2014; Dethier et al. 2016). In some locations shoreline armoring has caused increased beach erosion waterward of the armoring, which, in turn, has created beach lowering, coarsening of substrates, increases in sediment temperature, and reductions in invertebrate density (Fresh et al. 2011; Morley et al. 2012; Dethier et al. 2016).

Shoreline armoring has reduced suitable habitat for forage species (Pacific sand lance [*Ammodytes personatus*] and surf smelt [*Hypomesus pretiosus*]) spawning and likely has reduced their abundance and productivity. Bulkheads alter habitat conditions for the duration that they are present and simultaneously diminish or eliminate intertidal habitat for forage species including sand lance, an obligate upper intertidal spawner (Whitman et al. 2014). As stated in Fresh et al. (2011) "we can only surmise how much forage fish spawning habitat we have lost because we lack comprehensive historical data on spawning areas." Considering that these forage fish are an essential food source for salmon, beach armoring has multiple negative effects on salmon including reductions in prey and reductions in access to shallow water rearing habitat and refuge.

Puget Sound nearshore and deep marine waters are fundamental to many life histories of salmon and steelhead and particularly crucial for PS Chinook salmon juvenile (parr, fry, sub-yearling), and sub adult life stages. Juvenile salmon use nearshore habitat extensively during the early marine period (Duffy et al. 2005), a critical time for salmon growth, as larger, faster-growing fish have an increased probability of surviving to adulthood (Beamish et al. 2003; Duffy and Beauchamp 2011). As mentioned in Section 2.2.1 above, the loss of nearshore habitat is considered a factor in the loss of Puget Sound salmon abundance and productivity. Reduction in nearshore habitat quality has reduced survival at multiple life stages. Marine survival rates of PS Chinook salmon in Puget Sound have declined drastically since 1980 (Ruggerone and Goetz 2004, Sharma et al. 2012). Smolt-to-adult survival rates for hatchery-reared sub-yearling Chinook salmon within Puget Sound have averaged less than 1% over the past three decades (Kilduff et al. 2014).

There is also evidence that loss of nearshore habitat quality may be eliminating PS Chinook salmon life history strategies that make use of nearshore areas during the early life stages. Campbell et al. (2017) found less than 3 percent of adults returning to the Green, and Puyallup rivers had exhibited the fry migrant life history while approximately 95 percent of their estuary habitat has been eliminated. The converse was true from the Skagit and Nooksack estuaries where approximately 50 percent of the estuary remained in a natural state (Beechie et al. 2017) and 36 and 24 percent of the adult population examined returned from fry sized fish, respectively.

Anthropogenic Noise and Disturbance

There is growing concern about the effect of increasing ocean noise levels due to anthropogenic sources on marine organisms, particularly marine mammals. A primary source of anthropogenic noise in Washington inland marine waters is vessel traffic. Within the Action Area there is ferry traffic from WSF terminals, as well as commercial, recreational, and military vessel traffic.

Vessels range in size from massive commercial shipping container ships to kayaks. In addition to ferry vessels associated with WSF terminals, other vessel access Puget Sound through the Strait of San Juan de Fuca, the Strait of Georgia, ports, public and private marinas, naval bases, single- family piers, public boat ramps, and freshwater piers and marinas.

Effects of noise exposure on marine organisms can be characterized by the following range of physical and behavioral responses (Richardson et al. 1995):

1. Behavioral reactions—Range from brief startle responses, to changes or interruptions in feeding, diving, or respiratory patterns, to cessation of vocalizations, to temporary or permanent displacement from habitat.
2. Masking—Reduction in ability to detect communication or other relevant sound signals due to elevated levels of background noise.
3. Temporary threshold shift (TTS) —Temporary, fully recoverable reduction in hearing sensitivity caused by exposure to sound.
4. Permanent threshold shift—Permanent, irreversible reduction in hearing sensitivity due to damage or injury to ear structures caused by prolonged exposure to sound or temporary exposure to very intense sound.
5. Non-auditory physiological effects—Effects of sound exposure on tissues in non-auditory systems either through direct exposure or as a consequence of changes in behavior, (e.g., resonance of respiratory cavities or growth of gas bubbles in body fluids).

Several studies have shown fish to respond physiologically and biologically to increased noise (Mueller 1980; Scholik and Yan 2002; Picciulin et al. 2010). Xie et al. (2008) report that adult migrating salmon avoid vessels by swimming away. Graham and Cooke (2008) studied the effects of three boat noise disturbances (canoe paddling, trolling motor, and combustion engine (9.9 horsepower) on the cardiac physiology of largemouth bass (*Micropterus salmoides*).

Exposure to each of the treatments resulted in an increase in cardiac output in all fish, associated with a dramatic increase in heart rate and a slight decrease in stroke volume, with the most extreme response being to that of the combustion engine treatment (Graham and Cooke 2008). Recovery times were the least with canoe paddling (15 minutes) and the longest with the power engine (40 minutes). They postulate that this demonstrates that fish experienced sublethal physiological disturbances in response to the noise propagated from recreational boating activities. The existing levels of vessel traffic likely cause sublethal physiological stress to listed fish species.

Veirs et al. (2016), found that noise from large ships extends into frequencies used by SRKWs for echolocation. Killer whale hearing is one of the most sensitive of any odontocete, with a hearing range of 600 Hertz (Hz) to 114 kilohertz (kHz), with the most sensitive range being between 5 and 81 kilohertz (Branstetter et al. 2017). Veirs et al. (2016) measured underwater sound pressure levels for 1,582 unique ships that transited the core critical habitat of the SRKWs in Haro Strait during 28 months between March 2011, and October 2013. Median received spectrum levels of noise from 2,809 isolated transits were found to be elevated relative to median background levels not only at low frequencies (20–30 dB re 1 $\mu Pa^2/Hz$ from 100 to 1,000 Hz), but also at high frequencies (5–13 dB from 10 to 96 kHz). Thus, noise received from ships at ranges less than 3 km extended to frequencies used by SRKW. The researchers found that most ship classes show a linear relationship between source level and vessel speed with a slope near +2 dB per m/s (+1 dB/knot). Mean ship speeds during measurements were 7.3 ± 2.0 m/s (14.1 ± 3.9 knots).

Underwater-radiated noise from WSF vessels was collected while they made their regularly scheduled runs for eight days near the Seattle, Anacortes and Port Townsend terminals (NCE 2020). The measurement data was also used to identify causes of noise ranging from propeller cavitation to specific machinery items. Overall, the analysis found that underwater-radiated noise from WSF vessels is dominated by bubbles formed by propeller motion and blade rate harmonics. A unique noise signature was identified for WSF’s diesel electric vessels, which use both the forward and aft propellers for thrust, and thus produce additional propeller noise projecting from the bow of the vessel. In general, the study provided evidence that reduction in speed provided for a reduction in noise with the reduction being slightly less for diesel electric vessels than for diesel-geared vessels. Noise reduction vessel designs, and quiet propeller designs are currently incentivized for new WSF ferry vessels.

Recent evidence indicates vessel disturbance imposes an energetic cost on surface active behaviors and vocal effort for killer whales (Williams et al. 2006; Noren et al. 2012; Noren et al. 2013; Holt et al. 2015). For example, Williams et al. (2006) estimated that changes in activity budgets in Northern Resident killer whales in inland waters in the presence of vessels result in an approximate 3percent increase in energy expenditure compared to when vessels are not present. However, this increased energy expenditure may be less important than the reduced time spent feeding and the resulting potential reduction in prey consumption (Ferrara et al. 2017). Southern Resident killer whales spent 17 to 21percent less time foraging in inland waters in the presence of vessels for 12 hours, depending on vessel distance (see Ferrara et al. 2017). In Haro Strait, Holt et al. (2021) found that SRKW descended more quickly when noise levels were higher from vessels and when vessel approaches were closer. They also found that when vessel navigational sonar was used SRKWs made longer dives to capture prey and descended more slowly when they initiated these dives. Thus, vessel-related noise has the potential to result in behavioral disturbance or harassment, including displacement, site abandonment (Gard 1974, Reeves 1977, Bryant et al.1984), masking (Richardson et al. 1995), alteration of diving or breathing patterns, and less responsiveness when feeding. Because SRKWs are exposed to vessels the majority of daylight hours they are in inland waters, there may be biologically relevant effects at the population level (Ferrara et al. 2017).

Another concern for vessel noise is the potential to cause acoustically induced stress (Miksis et al. 2001) which can cause changes in heart rate, blood pressure, and gastrointestinal activity. Stress can also involve activation of the pituitary-adrenal axis, which stimulates the release of more adrenal corticoid hormones. Stress-induced changes in the secretion of pituitary hormones have been implicated in failed reproduction (Moberg 1987, Rivest and Rivier 1995) and altered metabolism (Elasser et al. 2000), immune competence (Blecha 2000) and behavior.

Larger tanker-type vessel traffic in the Action Area generally stay in shipping lanes and ferry vessels stay on established routes. Barges and tugs while transiting to and from work sites are not expected to travel at high speeds. These types of vessels are not targeting or following whales and as the vessels are moving while making noise means that the noise can be transitory depending on location and traffic volumes. As such co-occurrence with these types of vessels is expected to be short-term and transitory when whale presence overlaps with vessel presence. This means vessels not targeting the whales can still cause disturbance and impair the whales' ability to find food and interact with each other. Given this information, these vessel types can cause disturbance of SRKW in the action area.

From a study of the Haro Strait Region of Washington and British Columbia (the boundary waters of the Canadian Gulf and San Juan Islands), the majority of vessels in close proximity to SRKW are commercial whale watching vessels and recreational whale watching vessels (Frayne 2021, Seely 2017). The average number of boats accompanying whales can be high during the summer months (i.e., from 2013 to 2020 an average of 9 to 18 boats [Frayne 2021]). In 2020, 92 percent of all incidents (inconsistent with Be Whale Wise guidelines and non-compliant with federal regulations, see [Frayne 2021]) of vessel activities were committed by private/recreational motor vessels, 4 percent private sailing vessels, 3 percent U.S. commercial vessels, less than one percent commercial kayaks, less than one percent Canadian commercial vessels (possibly related to closures due to COVID-19 orders) and less than one percent by commercial fishing vessels (Frayne 2021). Fishing vessels are also found in close proximity to the whales and vessels that were actively fishing were responsible for 7 percent of the incidents inconsistent with the Be Whale Wise Guidelines and federal regulations in 2020 (Frayne 2021). These activities included entering a voluntary no-go zone and fishing within 200 yards of the whales. A number of recommendations to improve compliance with guidelines and regulations are being implemented in inland waters by a variety of partners to further reduce vessel disturbance (Ferrara et al. 2017).

Vessels are subject to existing federal regulations prohibiting approach closer than 200 yards or positioning in the path of the whales within 400 yards (with exemptions for vessels lawfully engaged in commercial or treaty Indian fishing that are actively setting, retrieving, or closely tending fishing gear). State regulations also mandate protections for SRKWs (see RCW 77.15.740, mandating 300–400-yard approach limits, 7 knots or less speed within ½ nautical mile of the whales. The approach will increase to 1,000 yards effective January 2025). In addition to following State and federal regulations, WSF has measures in place including reducing speed when cetaceans are present, training for crew to watch for marine mammals, reporting real-time marine mammal sightings to the WRAS and monitoring WRAS for the presence of marine mammals near WSF vessels (see Appendix D, WSF Underwater Noise Mitigation and Management Plan for the Protection of Marine Mammals). The WRAS is available only to commercial mariners. WSF's goal is to get the primary commercial operators in Puget Sound (i.e., the American Waterways Operators [who represent the tug and tow industry], Puget Sound Pilots, and Kitsap Fast Ferries) to use the system. Along with the WSF, these operators make up 85 percent of the transits tracked in Puget Sound[28]. NMFS and other partners, including WSF, have outreach programs in place to educate vessel operators on how to avoid impacts to whales. The average number of vessels with the whales in the Haro Strait Region decreased in 2018, 2019 and 2020 likely due to decreased viewing effort on SRKWs by commercial whale watching vessels, with an average of 10, 9, and 10.5 vessels with the whales at any given time, respectively (Frayne 2021). NMFS initiated scoping in 2019 to evaluate the need to revise existing federal regulations.

Water Quality

Mackenzie and McIntyre (2018) found that stormwater is the most important pathway to Puget Sound for most toxic contaminants, transporting more than half of Puget Sound's total known toxic load (Ecology & King County 2011). During a robust Puget Sound monitoring study, toxic chemicals were detected more frequently and at higher concentrations during storm events compared with baseflow for diverse land covers, pointing to stormwater pollution (Ecology 2011). The Puget Sound basin has over 4,500 unnatural surface water and stormwater outfalls, 2,121 of which discharge directly into the Sound (WDNR 2015).

In general, the pollutants in the existing stormwater discharge are diverse. The discharge itself comes from rainfall or snowmelt moving over and through the ground, also referred to here as "runoff." As the runoff travels along its path, it picks up and carries away natural and anthropogenic pollutants (U.S. EPA 2016b). Pollutants in stormwater discharge typically include:

[28] Washington State Governor's Office. October 24, 2019. How protecting orcas starts with tech. https://medium.com/wagovernor/how-protecting-orcas-starts-with-tech-80218a4ed127.

- Excess fertilizers, herbicides, insecticides, and sediment from landscaping areas.
- Chemicals and salts from de-icing agents applied on sidewalks, driveways, and parking areas.
- Oil, grease, polycyclic aromatic hydrocarbons (PAHs) and other toxic chemicals from roads and parking areas used by motor vehicles.
- Bacteria and nutrients from pet wastes and faulty septic systems.
- Metals (arsenic, copper, chromium, lead, mercury, and nickel) and other pollutants from pesticide use in landscaping, roof runoff (WDOE 2014), decay of building and other infrastructure, and airborne particles from street and tire wear.
- Atmospheric deposition from surrounding land uses.
- Metals, PAHs, polybrominated diphenyl ethers (PBDEs), and phthalates from roof runoff.
- Erosion of sediment and attached pollutants due to hydromodification.

(Buckler and Granato 1999; Colman et al. 2001; Driscoll et al. 1990; Kayhanian et al. 2003; Van Metre et al. 2006).

Recent studies have shown that coho salmon show high rates of pre-spawning mortality when exposed to chemicals that leach from tires (McIntyre et al. 2015). Researchers have recently identified a tire rubber antioxidant as the cause (Tian et al. 2020). Although Chinook did not experience the same level of mortality, tire leachate is still a concern for all salmonids. Traffic residue also contains many unregulated toxic chemicals such as pharmaceuticals, 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).

Pollutants travel long distances when in solution, adsorbed to suspended particles, or else they are retained in sediments, particularly clay and silt, which can only be deposited in areas of reduced water velocity until they are mobilized and transported by future sediment moving flows (Alpers et al. 2000a; Alpers et al. 2000b; Anderson et al. 1996). Santore et al. (2001) indicates that the presence of natural organic matter and changes in pH and hardness affect the potential for toxicity (both increase and decrease). Additionally, organics (living and dead) can adsorb and absorb other pollutants such as PAHs. The variables of organic decay further complicate the path and cycle of pollutants.

Climate Change

While the general effects of climate change are described above in the section on Status of Species and Critical Habitat, this section describes more specifically the effects that have occurred in the action area. The environmental baseline also includes the projected effects of climate change for the time period commensurate with the effects of the proposed action. Mauger et al. (2015) predict that circulation in Puget Sound is projected to be affected by declining summer precipitation, increasing sea surface temperatures, shifting streamflow timing, increasing heavy precipitation, and declining snowpack. While these changes are expected to affect mixing between surface and deep waters within Puget Sound, it is unknown how these changes will affect upwelling. Changes in precipitation and streamflow could shift salinity levels in Puget Sound by altering the balance between freshwater inflows and water entering from the North Pacific Ocean. In many areas of Puget Sound, variations in salinity are also the main control on mixing between surface and deep waters. Reduced mixing, due to increased freshwater input at the surface, can reduce phytoplankton growth, impede the supply of nutrients to surface waters, and limit the delivery of DO to deeper waters. Patterns of natural climate variability (e.g., El Niño/La Niña) can also influence Puget Sound circulation via changes in local surface winds, air temperatures, and precipitation.

The world's oceans are becoming more acidic as increased atmospheric carbon dioxide is absorbed by water. The North Pacific Ocean is already acidic compared to other oceans, making it particularly susceptible to further increases in acidification (Lemmen et al. 2016). Laboratory and field studies of ocean acidification show it has the greatest effects on invertebrates with calcium-carbonate shells, and relatively little direct influence on finfish; see reviews by Haigh et al. (2015) and Mathis et al. (2015). The largest impact of ocean acidification on salmon is likely to be its influence on marine food webs, especially its effects on lower trophic levels, which are largely composed of invertebrates such as pteropods, larval crabs, and krill, which play a significant role in some salmon diets (Haigh et al. 2015, Mathis et al. 2015, Wells et al. 2012). Marine invertebrates fill a critical gap between freshwater prey and larval and juvenile marine fishes, supporting juvenile salmon growth during the important early-ocean residence period (Daly et al. 2009, 2014).

The direct effects of ocean acidification on salmon are uncertain (Crozier et al. 2019). Physiological effects of acidification may impair olfaction, which could hinder homing ability (Munday et al. 2009), along with other developmental effects (Ou et al. 2015). Using the criteria of Morrison et al. (2015) for scoring, PS Chinook salmon, HCSR Chum salmon, and PS steelhead had low-to-moderate sensitivity to ocean acidification (Crozier et al. 2019).

2.3.2 Prior Section 7 Consultations in the Action Area

NMFS's management strategy for conservation and recovery of listed salmonids in the West Coast has been premised on reducing adverse effects among the "4 Hs." which are Habitat, Hatcheries, Harvest, and Hydropower. Each has had a role in the decline of west coast salmonids, each has been the subject of section 7 consultations, and each has been found to have continuing negative influence on species' viability. In the following subsections, prior section 7 consultations that overlap with the action area are described within the appropriate "H."

Habitat Actions

Activities that affect salmon habitat such as agriculture, forestry, marine construction, levy maintenance, shoreline armoring, dredging, hydropower operations and new development continue to limit the ability of the habitat to produce salmon, and thus limit prey available to SRKWs in the action area. Many of these activities have a federal nexus and have undergone section 7 consultation. Those actions have nearly all met the standard of not jeopardizing the continued existence of the listed salmonids or adversely modifying their critical habitat, and when they did not meet that standard, NMFS identified Reasonable and Prudent Alternatives (RPAs) that described modifications and methods for the proposed actions to proceed without jeopardizing. In addition, the environmental baseline is influenced by many actions that pre-date the salmonid listings and that have substantially degraded salmon habitat and lowered natural production of PS Chinook salmon. In fact, Chinook salmon currently available to SRKW are still below their pre-ESA listing levels, largely due to past activities that pre-date the salmon listings. Since the SRKWs were listed, federal agencies have consulted on impacts to SRKW from actions affecting salmon by way of habitat modification.

Activities that NMFS has consulted on that affect salmon habitat and therefore also likely limit prey available to SRKWs include hydropower projects (Mud Mountain Dam [NMFS 2014d], Howard Hanson Dam, Operation, and Maintenance [NMFS 2019d]), the National Flood Insurance program (NMFS 2008g), and habitat modifying projects in the nearshore marine areas of Puget Sound (NMFS 2022a). When actions did not meet the standard of not jeopardizing the continued existence of the listed salmonids or SRKWs or not adversely modifying their critical habitat, NMFS identified RPAs.

A funding initiative for U.S. domestic actions associated with the new Pacific Salmon Treaty (PST) Agreement (NMFS 2019e) includes funding for habitat restoration projects to improve habitat conditions for specified populations of PS Chinook salmon. By improving conditions for these populations, we anticipate PS Chinook abundance would increase and thereby benefit SRKWs.

On November 9, 2020, September 30, 2021, and May 11, 2022, NMFS issued biological opinions for multiple habitat modifying projects in the nearshore marine areas of Puget Sound. The biological opinions concluded that the proposed action was not likely to jeopardize the continued existence of, nor adversely modify the critical habitat of PS steelhead, HCSR chum salmon, PS/GB yelloweye rockfish, or PS/GB bocaccio. The opinions concluded that the proposed action was likely to jeopardize the continued existence of, and adversely modify critical habitat for PS Chinook salmon and SRKWs. The biological opinions provided RPAs to the proposed actions. The RPAs 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 RPAs were designed to achieve, a reduction of these debits to zero, which the opinions concluded was required to avoid jeopardizing the continued existence of, and adversely modifying critical habitat for PS Chinook salmon and SRKW. On June 29, 2022, NMS issued a programmatic biological opinion for habitat modifying projects in the nearshore marine area of the Washington portion of the Salish Sea habitat and concluded the proposed action was not likely to jeopardize the continued existence of, nor adversely modify the critical habitat of any listed species and designated critical habitat covered by the opinion.

The Eagle Harbor Opinion issued on April 22, 2022, which evaluated four WSF actions in a “batched” consultation, included multiple repairs, replacements and relocations of in and over-water features of ferry facilities, which, when evaluated at the nearshore calculator, which created some long-term adverse habitat effects, and which also had some elements that created positive results, primarily due to removal of creosote. When taken together, the impacts were considerably fewer than the benefits.

Hatcheries

Hatcheries can provide benefits to the status of PS Chinook 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. Hatchery-origin fish may also pose risk to listed species through genetic, ecological, or harvest effects. Seven factors may pose positive, negligible, or negative effects to population viability of naturally produced salmon and steelhead. These factors are:

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

Beginning in the 1990s, state and tribal co-managers took steps to reduce risks identified for Puget Sound hatchery programs as better information 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 (SSPS 2005). The intent of hatchery reform is to reduce negative effects of artificial propagation on natural populations while retaining proven production and potential conservation benefits. The goals of conservation programs are to restore and maintain natural populations. Hatchery programs in the Pacific Northwest are phasing out use of 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. The reforms proposed are to ensure that existing natural salmonid populations are preserved, and that hatchery-induced genetic and ecological effects on natural populations are minimized.

Nearly half of the hatchery programs in Puget Sound incorporate natural-origin Chinook salmon as broodstock for supportive breeding (conservation) or harvest augmentation purposes. Use of natural-origin fish as broodstock for conservation programs is intended to impart viability benefits to the total, aggregate population by bolstering total and naturally spawning fish abundance, preserving remaining diversity, or improving population spatial structure by extending natural spawning into unused areas. Integration of natural-origin fish for harvest augmentation programs is intended to reduce genetic diversity reduction risks by producing fish that are no more than moderately diverged from the associated, donor natural population.

Incorporating natural-origin fish as broodstock for harvest programs produces hatchery fish that are genetically similar to natural-origin fish, reducing risks to the natural population that may result from unintended straying and spawning by unharvested hatchery-origin adults in natural spawning areas. To 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.

Chinook salmon stocks are artificially propagated through 30 programs in Puget Sound. Currently, the majority of Chinook salmon hatchery programs produce fall-run (also called summer/fall) stocks for fisheries harvest augmentation purposes. Supplementation programs 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). Supplementation or reintroduction programs are in operation for early Chinook in the South Fork Nooksack River, fall Chinook in the South Fork Stillaguamish River (Tynan 2010) and spring and late-fall Chinook in the Skokomish River (Redhorse 2014; Speaks 2017).

Conservation hatchery programs, under the PST critical stock program, are currently operating in the Nooksack, Dungeness, and Stillaguamish rivers. A new program is being developed for Mid- Hood Canal. Funding for these programs was included in the PST funding initiative, which NMFS addressed in the consultation on domestic actions associated with implementation of the 2019-2028 PST Agreement (NMFS 2019e). Federal funding appropriated in 2020 and 2021 for the PST funding initiative provides a level of certainty these programs will continue. NMFS previously reviewed both the Dungeness and Stillaguamish programs through a section 7 consultation and approved them under the 4(d) rule for threatened Chinook salmon (NMFS 2016j; 2019a). Review and development of a renewed approach to the Mid-Hood Canal hatchery program is currently ongoing.

In addition to the PST critical stock programs, there are new initiatives to increase hatchery production to further enhance the SRKW's prey base. For example, in response to recommendations from the Washington State Southern Resident Killer Whale Task Force (2018), the Washington State Legislature provided approximately $13 million of funding "prioritized to increase prey abundance for southern resident orcas" (Engrossed Substitute House Bill 1109) for the 2019-2021 biennium (July 2019 through June 2021). Further, NMFS allocated $5.6 million of the PST federal appropriation for Fiscal Year (FY) 2020 to increase prey availability for SRKW through regional hatchery production. As a result of the additional funding for hatchery production to support SRKW (FY 2020 PST funding and 2019-2021 Washington State Legislature funding), over 11.6 million additional hatchery-origin Chinook salmon were released in 2020, just over 6.0 million from Puget Sound, and over 18.3 million additional hatchery-origin Chinook salmon are expected to be released in 2021 relative to the base period considered in NMFS' 2019 biological opinion on domestic actions associated with implementation of the new PST Agreement (NMFS 2021a). For FY 2021, Congress has appropriated $39.5 million for activities in support of these activities. (166 Cong. Rec. 12/21/2020). In that assessment of the PST funding initiative (NMFS 2019f), we described our expectations for increased prey abundance for SRKWs through increases in the abundance of age 3-5 Chinook salmon in the times and areas most important to SRKWs. The expectations included increased abundance in inside areas (Puget Sound) in the summer and outside areas (coast) during the winter (Dygert 2018) resulting in a minimum increase of adult fish abundance by 4-5 percent in both inside areas in the summer and coastal areas in the winter.

The beneficial effects of these activities (i.e., increases in the abundance of Chinook salmon available as prey to SRKW, hatchery conservation programs to support critical Puget Sound Chinook populations, and improved habitat conditions for those populations) are expected to begin in the next 3-5 years. Subsequent specific actions (i.e., hatchery production programs) would undergo separate consultations, tiered from the programmatic consultations (NMFS 2019d) to assess effects for site-specific actions. The harvest management provisions of the new Agreement and the appropriations to initiate the conservation activities are in place. However, under current production (hatchery and wild) there is evidence of density dependence in Puget Sound estuaries. Therefore, any additional habitat loss could exacerbate potential density dependent impacts especially with increased hatchery production (Greene et al. 2021)

Harvest

Washington State salmon fisheries for Chinook, coho, chum, and Fraser River sockeye and pink salmon are managed by the State of Washington and the Indian tribes with treaty rights to fish. These fisheries are managed consistent with the provisions of the, an international agreement between the U.S. and Canada, which also governs fisheries in South East Alaska (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 coast of Washington and Oregon and in inland waters, such as the Puget Sound, harvest salmon originating in U.S. West Coast and Canadian river systems. The PST provides a framework for the management of salmon fisheries in these U.S. and Canada waters that fall within the PST's geographical scope. The overall purpose of the fishing regimens is to 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.

Because PS Chinook salmon are listed under the ESA and are subject to management under the PST, objectives for PS Chinook salmon fisheries are designed to be consistent with both of these laws. Generally, objectives for PS Chinook populations are agreed by the State and tribes, in coordination with NMFS. In recent years, NMFS has consulted with the BIA on their assistance to the tribes in managing Puget Sound fisheries. In the resulting biological opinions, NMFS considered the effects of the proposed state and tribal fisheries on PS Chinook and SRKW. The most recent opinion, issued May 2023, concluded the fisheries were not likely to jeopardize PS Chinook or SRKW, and not likely to adversely modify their critical habitat.

The 2019-2028 PST agreement includes reductions in harvest impacts for all Chinook fisheries within its scope and refines the management of sockeye, pink, chum and coho salmon caught in these areas. The 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 agreement (2008-2019). The level of reduction depends on the 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 under the jurisdiction of the Pacific Fishery Management Council (PFMC) are reduced by up to 15% from the previous agreement (2009 through 2018). Beginning in January 2020 this will result in an increased proportion of abundances of Chinook salmon migrating to waters more southerly in the U.S. Pacific Coast Region portion of the EEZ than under prior PST agreements. Although provisions of the updated agreement are complex, they were specifically designed to reduce fishery impacts in all fisheries to respond to conservation concerns for several U.S. and Canadian stocks.

In 2021, NMFS consulted on the authorization of the West Coast Ocean salmon fisheries through approval of the Pacific Salmon Fishery Management Plan (PFMP) including Amendment 21 and implementation of the Plan through regulations. The PFMC, in November 2020, adopted proposed Amendment 21 to address effects of Council-area ocean salmon fisheries on the Chinook salmon prey base of SRKWs. 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 would implement specific management measures (NMFS 2021a). The NOF abundance threshold is equal to the arithmetic mean of the seven lowest years of time step 1 (TS1, October through April, see (PFMC 2020b) for details) starting abundance from the FRAM model (1994 – 1996, 1998 – 2000 and 2007, updated for validated run size abundance estimates). Each year, the preseason estimate of Chinook salmon abundance for TS1 for the upcoming fishing year would be 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) will be implemented through annual regulations within the NOF area, with the goal of limiting effects of the fishery on SRKWs. NMFS' 2021 biological opinion concluded that the Fisheries Management Plan (FMP) including Amendment 21 is responsive to the abundance of Chinook salmon by requiring that fisheries be designed to meet FMP conservation objectives and addresses the needs of the whales by limiting prey removal from the fisheries in NOF areas during years with low Chinook salmon abundance. Amendment

21 will also reduce the potential for competition between fisheries and SRKW in times and areas where/when the fisheries and whales overlap, and when Chinook salmon abundance is low. NMFS completed a biological opinion under section 7 of the ESA on the implementation of the Salmon FMP, including Amendment 23, and determined that this action is not likely to jeopardize the continued existence of any endangered or threatened species under the jurisdiction of NMFS (NMFS Consultation Number: WCRO-2021-03260; biological opinion signed April 28, 2022).

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 or proposed critical habitat (NMFS 2021a). This action may limit the reductions in prey availability by PFMC fisheries on Puget Sound (action area) prey in years with low salmon abundance, compared to the FMP without Amendment 21, but the extent of the impacts of the amendment on inland prey availability specifically is unknown. In years when Chinook salmon abundance is above the threshold, we anticipate similar reductions in prey availability attributed to the PFMC fisheries as that observed in the most recent 10-yr period into the foreseeable future (similar to the approximate 1-3 percent reduction in Chinook salmon abundance in Salish Sea).

Hydropower

Three dams, the White River Dam, previously operated by Puget Sound Energy, Mud Mountain Dam (NMFS 2014) operated by the USACE for the purpose of flood control operations, and as needed to facilitate maintenance activities at the downstream White River diversion dam, and Howard Hanson Dam (NMFS 2019c) operated by the USACE for downstream flood damage reduction, have each been found to jeopardize ESA listed fish, and in the case of Mud Mountain and Howard Hanson, jeopardy to PS Chinook salmon posed a secondary threat of jeopardy to SRKW.

The outcomes of those jeopardy opinions include the surrender of the White River FERC license. Puget Sound Energy retired the hydropower project in 2004. Cascade Water Alliance purchased it in 2009 and intends to complete a habitat conservation plan for its operation. Passage improvements at Mud Mountain Dam have already reduced fish mortality, and while new passage is being designed for Howard Hanson Dam, the USACE is evaluating modifications to its retention and release schedule of water to benefit eggs in spawning areas downstream of the dam. In each case, modifications to avoid jeopardizing listed species are being undertaken.

A proportion of Chinook salmon from coastal Washington/Oregon and Columbia River likely move into the action area and could be available to SRKW as prey. In 2020, NMFS consulted on the operation and maintenance of 14 dams and also reservoir projects within the Columbia River System (CRS). Actions analyzed in the biological opinion included both operational (hydropower generation, flood risk management, navigation, and fish passage) and non- operational (habitat improvements, predator management, and hatchery programs) actions and the effects on eight salmon ESUs, five steelhead DPSs, and one DPS of Pacific Eulachon and associated critical habitat (NMFS 2020e). The consultation concluded that the action is not likely to jeopardize the continued existence of the species/populations or destroy or adversely modify critical habitat. The CRS opinion also included NMFS concurrence with the action agencies determination of not likely to adversely affect for the Southern DPS of North American green sturgeon and for SRKW and SRKW designated critical habitat. The determination for SRKW considered the potential to affect prey availability through negative effects on the direct survival of juvenile and adult salmonids, including Chinook salmon, through the hydropower system and concluded that any effects to SRKW prey base are undetectable or extremely unlikely because the CRS-funded hatchery production more than offsets any adverse effects of CRS operations and maintenance (NMFS 2020e).

2.3.3 Summary of Environmental Baseline

When considered at the landscape scale, the baseline condition of the Action Area is degraded overall, with reduced water quality, reduced forage and prey availability, reduced quality of forage and prey communities, reduced amount of estuarine habitat, reduced quality of nearshore and estuarine habitat, and reduced condition of migration habitat due to structures, noise, and vessel perturbations. Each of these baseline conditions exerts stress on all cohorts of all populations of each listed species considered in this Opinion for the duration of their time in the action area. Loss of production of Chinook salmon, as well as coho and chum salmon, from habitat degradation reduces available forage for SRKWs. The baseline conditions currently constrain the carrying capacity of the action area and limits its potential for serving recovery of these species. Overall, baseline conditions are impacted in many areas by degradation from coastal development and pollution including derelict fishing gear, degraded water quality, and vessel noise and disturbance. The input of pollutants, including noise, affects water quality, sediment quality, and food resources in the nearshore and deep-water areas of critical habitat. Baseline conditions in estuarine and marine environments for salmonids and SRKW are also valid for sunflower sea stars, including poor water quality, anthropogenic habitat modifications, climate change influences, as well as the presence of the virus or bacteria that causes the sea star wasting disease.

2.4 Effects of the Action

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

Conservation Offsets

The requirement to offset long-term impacts on the quality of nearshore habitat in the Salish Sea is a key feature of the proposed action. By requiring offsets, the proposed action ensures no net- loss of nearshore habitat quality over time. The ecological relevance of the conservation offsets is assured by the design of and the mechanisms built into the

Calculator (or any other tool deemed equivalent) which operates to determine the relative value both of habitat impacting and habitat improving actions, with the intention that the conservation function of the habitat remains undiminished overall.

As described in more detail below, activities carried out to achieve conservation offsets are themselves likely to have some short-term impacts, but none of those impacts are expected to have long-term adverse effects on listed species nor will they be severe enough to impair the ability of habitat to support recovery. We also expect that the frequency of disturbance caused by these actions will usually be limited to a single event or, at most, a few projects within the same area.

All of the activities intended to achieve offsets are designed to have long-term beneficial effects to species and critical habitat. These activities are reasonably certain to lead to some degree of ecological recovery, including the establishment or restoration of environmental conditions associated with functional nearshore habitat. The effects of these activities on listed fish and their habitat are discussed in detail below. The removal of over-water structures reduces shade and decreases predation on juvenile salmonids. Removal of in-water structures such as treated-wood piles also removes habitat for piscine predators and eliminates persistent sources of contaminants. The purchases of conservation bank credits will lead to improved habitat quality, but in some cases, the improvement may be off-site or out-of-kind. Similarly, contributions to in-lieu fee programs generally result in habitat improvements but the improvement can be delayed and is typically off-site. The Calculator takes factors such as off-site/out-of-kind into account in determining applicable credits.

NMFS will work with the federal action agencies and WSF on each project requiring conservation offsets in accordance with the detailed mechanisms and processes set out in the proposed action and the attached Credit Savings Instrument. In particular WSF will utilize the Calculator to evaluate project impacts and generate a result presented as debits which will be verified by NMFS and recorded on the WSF ledger. This informs the amount of offset that is required per project, and as described in Section 1.3.11, those offsets may be met via credits generated by WSF (which can be saved per the Credit Savings Instrument (Attachment A)), or by the purchase of an offsetting amount from an approved bank or in lieu fee provider. Credits generated or purchased in surplus of the immediate amount of debits may be saved for future use within this program and the WSF shall ledger all credits and debits to ensure on annual review that a debits do not carry longer than a biennium.

Some habitat improving activities may occur before impacting work and provide value to listed species life stages until such time as the credits are applied to offset debits, consistent with the Credit Savings Instrument. The proposed action also allows that habitat impacting work may not be fully offset until the biennium after the debits are incurred. Therefore, for the purpose of this analysis, NMFS assumes that many projects will have a delay in addressing the calculated habitat impacts. Listed species' exposure and response to enduring effects are presented in Section 2.4.3, below.

2.4.1 Temporary Effects

Temporary effects are typically associated with construction or maintenance activities. These effects are described in detail in NMFS' programmatic biological opinion on nearshore action in the Salish Sea[29] (SSNP)(WCRO-2019-04086). Stressors to species from the proposed activities will vary depending on their location relative to a listed individual and their duration, frequency, and intensity. Because BMPs will be implemented to limit effects to water quality, aquatic vegetation and benthic habitat, and, for pile driving, associated noise, the analysis is for those effects that occur despite the implementation of BMPs. The following stressors (habitat reductions) were analyzed for their effects to individuals of listed species, and in a later section for their influence on critical habitat:

(a) increased suspended sediments and turbidity,
(b) contaminant input/resuspension of contaminants in sediments,
(c) reduction of prey (benthic invertebrate, fish prey, SAV),
(d) obstructions in migration pathways (including from temporary in- and overwater structures),
(e) noise in aquatic habitats, and
(f) overwater lighting.

The temporary stressors identified with each activity are listed in Table 9. We analyze each stressor in this section based on its extent, the risk of potential exposure to individuals of each species, and their anticipated responses. For each stressor and for each species, where exposure will occur, we evaluate the response of species to that exposure.

[29] Available at: https://media.fisheries.noaa.gov/2022-06/2022-06-29-ssnp-wcro-2019-04086.pdf (accessed 5/2023)

Table 9. Activity types causing temporary stressors (habitat reductions) (denoted by X), by activity.

Activity	Total Number of Activities	Suspended Sediment and Turbidity	Contaminant Release/ Resuspension	Reduction in Prey	Obstruction in Migration Areas	Underwater Noise	Artificial Overwater Lighting**
Terminal deck and drain cleaning	unlimited	X	X				
Deck overlay replacement	4/year						
Terminal painting: cleaning, washing, abrasive blasting, and marine growth removal	unlimited	X	X				X
Overwater/shoreline maintenance or repair work (See Section 1.3.4)	unlimited						X
In-water maintenance work including bulkheads, marine growth removal *	unlimited, except bulkheads 2/year	X	X	X			X
Remove man-made debris from seabed*	unlimited	X		X			
Marine sediment test boring	25/year	X		X		X	
Pile repair*	15/year	X	X	X			X
Pile removal and pile installation*	60/year concrete and steel install, 60/year concrete and steel remove, 100/year timber remove, 2 drilled shafts/year	X	X	X		X	
Temporary work platforms*	2/year			X	X		
Construction vessels	For barges 20 during IWW and 2/terminals outside IWWW	X	X	X	X	X	
Beach nourishment	unlimited	X		X			
Bulkhead removal	unlimited	X					

*Activities that occur within the in-water work window (IWWW), from July 15-February 15. All other activities can occur year- round
**Overwater lighting estimated to occur 10 nights/year at each terminal.

Suspended Sediment and Turbidity, Corollary Decreases in DO

In-water sediment-disturbing activities can cause short-term and localized increases in total suspended solids resulting in increased turbidity. Suspension of anoxic sediment compounds during in water work can result in reduced DO in the water column as the sediments oxidize or when removed marine growth is decaying on the seabed. In-water activities that may temporarily increase suspended sediment or reduce DO are listed in Table 10 and below:

- Terminal deck and drain cleaning
- Terminal painting preparatory cleaning, washing, abrasive blasting, and marine growth removal
- Bulkhead maintenance
- Removal of man-made debris from the seabed
- Marine sediment test boring
- Pile repair
- Pile removal/installation
- Construction vessels
- Beach nourishment
- Bulkhead removal

<u>Extent of Suspended Sediment and Turbidity:</u> Turbidity is a measurement of water clarity and is a surrogate for the concentration of suspended sediment in a water sample. A nephelometric turbidity unit (NTU) is a measurement of turbidity. A number of site-specific conditions will influence the spatial extent and magnitude of turbidity and suspended sediment exposure. The size and shape of the temporary plume, and therefore the spatial extent of potential exposure, will be influenced by the following: the quantity and composition of resuspended sediment, the quantity and composition of released interstitial pore water, the rate or degree of desorption to the surrounding water column, particle size and resettling rate, discharge volume, current, tidal flux, degree of turbulence, height of release to the water column, water temperature, salinity, and operational considerations (Bridges et al. 2008, pp. 5, 7-9, 13, 20, 42).

For in-water project activities, turbidity levels will not exceed five NTUs over background at 150-ft radius from an in-water activity. This is the Washington State water quality standard that WSF’s projects meet through on-site monitoring of the mixing zone (WAC 173- 201A-210).

Because of the number of variables discussed above including maximum current velocities, particle size and resettling rate, etc. the extent of suspended sediment and turbidity levels will vary at each facility but are not anticipated to extend more than 150 ft from project work. Where possible, WSF conducts maintenance and repairs at tidal elevations that allow work to occur in the dry. At location where work occurs in the dry, we expect an increase in suspended sediment and associated turbidity during the following tidal inundation, but effects would not be expected to be extensive.

Additionally, we expect minimal suspended sediment and turbidity from several activities. Wash water when following deck and drain cleaning or terminal painting preparatory activities could contain small amounts of sediment that will cause turbidity when washed through drains to surface waters. With implementation of BMPs that require dry sweeping to preceded flushing into drains and collection of dirty wash water, so it is not discharged to state waters, we anticipate very minor result suspended sediment and turbidity from this activity that will disperse quickly with little effect to surface waters. Construction vessel operation includes BMPs that are requirements of the WSF's HPA (see Appendix B in WSDOT 2020a,). BMPs limit any sediment disturbance to minimal levels by requiring operation of vessels with minimal propulsion power to avoid propeller scour damage to the seabed and marine vegetation habitats, restriction of vessel operation to tidal elevations adequate to prevent propeller related damage to seagrass and kelp, restriction of anchor or spud deployment in seagrass or kelp, and maintenance of anchor cable tension, vertical set and retrieve of anchors, and prevention of mooring cables from dragging to avoid impacts to seagrass and kelp.

In summary, elevated suspended sediment and turbidity levels will be intermittent during construction, and for work conducted at low tide (bulkhead maintenance, some pile work, and some marine debris removal) will be limited to the tidal cycle following project work. For the analysis in this Opinion and Conference Opinion, we conservatively assume temporary increases in suspended sediment and associated turbidity levels will be at levels that could result in effects to listed species from the following activities:

- Bulkhead maintenance or removal
- Removal of man-made debris from the seabed
- Marine sediment test boring
- Pile repair
- Pile removal/installation
- Beach nourishment

Each of these activities will occur during the in-water work window. The numbers of these activities are presented in Table 10. Although, we are unable to quantify the number of debris items that will be removed from the seabed, we calculated a maximum extent of suspended sediment and turbidity from all other activities would result in a maximum of 422 acres[30] per year for all 20 terminals. Because not all activities will occur every year, and some activities will occur in the dry, we believe even without the debris removal events, this area would be an overestimate of the maximum area affected. Additionally, areas of effects would overlap in many instances. For example, multiple piles from a single timber dolphin would have overlapping areas of effect and result in a much smaller area affected than calculated here.

[30] Each activity with an affect area radius of 150 ft may disturb 1.6 acres (area = $\pi r^2 = \pi 150^2$ ft = 1.6 acres). If all activities occurred (264 activities) and resulted in the maximum extent of turbidity, 422 acres may be affected total per year of this opinion and conference. Projects can have overlapping pile areas of effect so the maximum area would be less than this. Note: number of activities = 2 bulkhead repairs + 25 sediment borings + 15 pile repairs + 220 pile installations and removals + 2 drilled shafts = 264

Extent of Reduced Dissolved Oxygen: Suspension of anoxic sediment compounds during in water work can result in reduced DO in the water column as the sediments oxidize. Based on a review of six studies on the effects of suspended sediment on DO levels from dredging, LaSalle (1988) concluded that when relatively low levels of suspended material are generated and counterbalancing factors such as flushing exist, anticipated DO depletion around in-water work activities will be minimal. Because in-water sediment disturbing activities would be much less disturbing than dredging, they are expected to have only a minor, temporary, and localized effect on DO concentrations associated with resuspension of bottom sediments.

Terminal painting preparatory activities could result in decay of biofouling organisms on the seabed, which would consume DO. However, work will occur under an HPA that requires WSF to only release marine growth to surface waters provided it does not accumulate or spoil on the seabed (see Appendix B in WSDOT 2020a). Therefore, with implementation of BMPs required under the HPA, we do not expect the removal of biofouling organisms will result in a measurable decrease in DO.

In summary, with implementation of BMPs, we expect any temporary decreases in DO concentrations would be much less than those for dredging, limited to the immediate area surrounding in-water work, and extremely limited in duration.

Contaminant Release and Resuspension

Where contaminants are present in sediment, in-water work that suspends sediment (see above section) could potentially include resuspension of contaminated sediments. In addition to the 6 activities described above, these additional activities may release or resuspend contaminants:

- Terminal deck and drain cleaning
- Construction vessels

Direct releases of contaminants are not anticipated because they would constitute an unlawful discharge. BMPs are employed to prevent accidental losses or spills of construction debris or hazardous materials into surface waters (see Section 1.3.10 above and Appendix B in WSDOT 2020a). As a result, release of PAHs from creosote-treated timber removal, construction-related stormwater, including epoxy grout wastewater for encapsulations, discharge of hydraulic fluid, oils, or fuels from construction equipment are unlikely to violate applicable state or federal water quality standards. These types of releases constitute unlawful discharges, are not expected, and are therefore not evaluated in this Opinion or Conference Opinion.

We specifically note here, that three terminals are within Superfund sites (Eagle Harbor, Bainbridge, and Point Defiance). The Seattle terminal is a WDOE listed contaminated sediment site. Additional BMPs are typically required for in-water work at these terminals, as well as coordination with the Environmental Protection Agency and we assume for this analysis those BMPs will be in place to ensure safeguards to limit exposure of species and features of critical habitat.

Extent of Contaminant Release and Resuspension:

Terminal Cleaning - Pollutants from terminal cleaning activities are expected to be present in very low concentrations because BMPs are implemented to dry clean and then filter, contain, and remove pollutants for these activities. The residual amounts that are not captured by BMPs will dilute to immeasurable levels when they enter marine waters. However, persistent pollutants can bioaccumulate in the food web even at immeasurable levels. Because cleaning activities are ongoing at all terminals, residual pollutants that bind to sediment particles could concentrate in sediments over the lifespan of terminal structures.

Sediment Disturbing Activities - For the analysis in this Opinion and Conference Opinion, we consider the sediment generating work identified in Section 2.4.1(a) to potentially resuspend existing contaminated sediments. Creosote-treated pile removal is the only sediment disturbing activity that has contaminants directly associated with it. Not all of the piles removed will be creosote-treated piles. However, removal of hollow steel piles can result in contaminants being brought to the surface as the sediments within the pile cores are resuspended in the water column. Pile repair typically requires minor amounts of hand excavation near a pile. Bulkhead maintenance, removal of debris, and marine sediment test boring could disturb existing contaminants, if present.

Creosote has PAHs that can entering the water column or sediments. The environmental fate of each type of PAH depends on its molecular weight. In surface water, PAHs can volatilize, photolyze, oxidize, biodegrade, bind to suspended particles or sediments, or accumulate in aquatic organisms, with bioconcentration factors often in the 10-10,000 range. In sediments, PAHs can biodegrade or accumulate in aquatic organisms or non-living organic matter. Most do not easily dissolve in water. Some evaporate into the air from surface waters, but most stick to solid particles and settle into sediments. Changes in pH and hardness may increase or decrease the toxicity of PAHs, and the variables of organic decay further complicate their environmental pathway (Santore et al. 2001).

The concentration of PAHs released into surface water rapidly dilutes. Smith et al. (2008) reported concentrations of total PAHs of 101.8 micrograms per liter (μg/l) 30 seconds after creosote-pile removal and 22.7 μg/l 60 seconds after removal. Creosote-treated piles contaminate the surrounding sediment up to 6.6 ft (2 meters) away with PAHs (Evans et al. 2009). PAH levels in the sediment after pile removal can remain high for six months or more (Smith et al. 2008). Romberg (2005) found a major reduction in sediment PAH levels three years after pile removal contaminated an adjacent sediment cap. In the long-term removal of creosote timber piles will reduce leaching of chemical compounds into nearshore waters and marine sediments (WDNR 2014).

Suspended contaminants would be directly related with the number of creosote piles removed. A maximum of 100 creosote piles would be removed each year. Also, the area of debris or sediment test borings, in a known area of impact with contaminated sediment (i.e. a superfund site) is directly related to suspended contaminants.

Construction Vessel Exhaust - Operation of construction vessels and potentially some equipment will introduce some exhaust into the water. The number of construction vessels operating during the life of this Opinion and Conference Opinion is dependent on the types and number of activities that will occur under this consultation. We expect PAHs and other contaminants to be introduced into the water column during construction when vessels are moving, which would occur only intermittently at each terminal. Because these materials can disperse quickly, they can become quite widespread at very low concentrations. As stated above, in surface water, PAHs can volatilize, photolyze, oxidize, biodegrade, bind to suspended particles or sediments, or accumulate in aquatic organisms. While it is difficult to determine the fate, extent and duration of these PAHs, for the analysis in this Opinion and Conference Opinion, we assume they will occur throughout the Action Area, though at levels difficult to discern because of the general presence and volatilization of PAHs from seawater to the air (Zheng et al. 2021)]. Most PAHs are hydrophobic, which leads to high absorption and consequent persistency in soils and sediments (Kumar et al. 2021) and are considered to remain at high levels for years (Fan et al. 2010) though some PAHs associated with organic carbon (OC) in suspended sediment (SPS) desorb with the release of OC and become DOC-associated PAHs in the overlying water, then the PAHs desorb from the DOC and become freely dissolved (Dong et al. 2016) .

Reduction in Prey from Effects to Benthic Communities and Forage Species

Reduction of light levels and sediment disturbing activities can adversely affect benthic communities and SAV, where it is present. Shafer (1999; 2002) provides background information on the light requirements of seagrasses and documents the effects of reduced light availability on seagrass biomass and density, growth, and morphology. Decreased ambient light typically results in lower overall productivity, which is ultimately reflected in lower shoot density and biomass (Shafer 1999, 2002). Disturbance of sediment can result in disruption of benthic prey communities and forage fish spawning areas, suppressing these forage sources for ESA-listed fish.

In-water activities that may temporarily decrease light levels or disturb benthic habitats are listed below and in Table 10:

- Bulkhead maintenance
- Remove man-made debris from seabed
- Marine sediment test boring
- Pile repair
- Pile removal/installation
- Temporary work platforms
- Construction vessels

<u>Extent of Reduction in Forage:</u>

Seabed Disturbance - We do not expect any in-water activities to disturb sediments further than a 150-ft radius (the area where potential suspended sediment effects could occur). Bulkhead maintenance are limited to replacing rocks that have been dislodged in or adjacent to an existing bulkhead and some work will be conducted in the dry if practicable. Marine sediment borings use a tube 6-inches in diameter. Based on the small diameter of the tube, and BMPs to retain all cored sediments, we expect very little sediment disturbance outside the 6-inch diameter tube footprint. Pile repairs use BMPs to limit sediment disturbance and pile repairs are conducted in the dry when possible. Pile removal and installation will disturb sediment within the footprint of each pile (maximum diameter of 36-inches per pile) and for a limited radius around the piles. Up to eight piles may be worked on in a single day affecting a substrate area of approximately 1.6 to 13 acres per day[31] (assuming a maximum 150 ft area of effect around each pile).

Benthic habitat loss is expected where piles are encapsulated for repairs because the pile diameters are increased with the encapsulation material. Based on prior pile encapsulations at the Point Defiance, Tahlequah, and Vashon terminals, pile diameters increased approximately 41 square inches for 14-inch diameter piles to 116 square inches for 36-inch piles. If all 15 piles per year were repaired by encapsulation, approximately of 12sq ft of benthic habitat would be permanently lost annually. Removal of creosote piles and man-made debris from the seabed will result in permanent addition of benthic habit in the footprint of each structure removed. Additionally, when timber pile supported dolphins and wingwalls are replaced with steel pile supported structures, the in-water benthic footprint of the structures will decrease. However, seismic retrofits will result in an increased benthic footprint. Long-term effects to benthos and substrate are discussed in Section 2.4.3.

Benthic prey communities will be disturbed and potentially diminished in areas where sediment is disturbed by the activities described above. Eelgrass is not present in the footprint of any of the structures and limited macroalgae is expected to occur where sediments will be disturbed, so we expect extremely limited effects to SAV. Smothering of benthic organisms can occur in areas where suspended sediment settles on the bottom. Several factors affect the recovery of benthic communities, including the intensity of the disturbance and distance of adjacent benthic communities to reseed the affected area. The greater the disturbance to benthic communities, the longer the duration of their recovery (Dernie et al. 2003). Additionally, the ability of a disturbed site to recolonize is affected by whether or not adjacent benthic communities are nearby that can re-seed the affected area. Thus, recovery can range from several weeks to many months. For projects covered under this Opinion and Conference Opinion, the area where benthic forage base is temporarily diminished by disturbed substrate is very small, and because benthic prey can recruit from adjacent areas via tides and currents, the prey base can re-establish in a week to months.

Construction Vessel Disturbance - Construction vessels can adversely affect benthic habitats and SAV, by churning water and sediment in the shallow water environment. Turbidity from construction vessel propeller wash decreases light levels (Eriksson et al. 2004). The WSF will implement a number of BMPs to reduce SAV impacts and scour from construction vessel propellers (Section 1.3.10) that are requirements of their HPA (see Appendix B in WSDOT 2020a). Based on implementation of the BMPs described above, we expect limited turbidity and benthic disturbance from the churning of water and sediments from construction vessel propellers. Any changes to light levels from increased turbidity would be

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[31] One pile with an affect area radius of 150 ft may disturb 1.6 acres (area = $\pi r^2 = \pi 150^2$ ft = 1.6 acres). If 8 piles per day are disturbed 12.98 acres may be affected. Most projects have overlapping pile areas of effect so the maximum area would likely be less than this.

limited to brief, intermittent disturbances and are unlikely to result in a measurable change to overall seagrass or macroalgae productivity.

Shading from Temporary Work Platforms and Barges - Some projects will require the construction of temporary work platforms and barges that will result in light attenuation in their shadows. Information provided by WSF indicates the maximum overwater coverage resulting from temporary work platforms and barges is 90,000 square feet per year. Shading effects from permanent ferry infrastructure are reviewed by Haas et al. (2002) and include reduced eelgrass density, reduced macrofauna diversity, and reduced density and species richness of epibenthic organisms (which serve as prey for juvenile salmonids). These effects have been observed based on permanent structures and the effects from temporary structures would be expected to vary depending on their duration in water, time of placement, width, and height. Temporary work platforms may be elevated a few feet to several feet above the water surface. The higher the structure the less the effect of the shadow, with floats on the water-surface having the greatest effect. Because eelgrass does not occur at ferry terminal structures, and barges are not allowed to moor over eelgrass during the growing season for more than four days, we do not expect measurable effects to eelgrass.

Temporary work platforms may be in place for up to several weeks during a single in-water windows. The maximum size of a temporary work structure is about 44 ft x 40 ft (1,760 ft^2). Two temporary work structures will be used during each year of this Opinion/Conference Opinion. Barges may be in use from days to weeks, and they typically do not anchor in a single location for the entire work period, but periodically move to access new work zones. Barges are not allowed to anchor over eelgrass or kelp beds. A typical barge is estimated to be 45 ft by 100 ft (4,500 ft^2).

Based on the duration of work platforms and barges, some effects to benthic fauna and SAV may occur. However, with implementation of the BMPs and the lack of eelgrass at terminal locations, we do not expect any effect to eelgrass or kelp from work platforms or barges. With only two work platforms built per year within the in-water work window, we expect only a spatially limited effect to the benthic communities and SAV (3,520 ft^2 total for two platforms per year).
Because barges typically do not remain in the same location for multiple weeks, we do not expect a measurable effect to benthic communities or SAV from moored barges.

Temporary Obstructions in Migration Areas

Anchored barges and the presence of temporary work platforms shades nearshore habitats, which can affect movement of fish. In-water activities that may temporarily obstruct migration areas are listed below and in Table 10:

- Temporary work platforms
- Moored barges

Temporary Obstructions: As described above, some projects will require the construction of temporary work platforms and barges that will result in shading. Maximum overwater coverage from work platforms and barges would be 90,000 square feet. Effects of overwater coverage have been observed based on large overwater permanent structures and the effects from temporary structures would be expected to vary depending on their duration in water, time of placement, width, and height. The higher the structure the less the effect of the shadow, with structures directly on the water- surface having the greatest effect.

Temporary work platforms may be in place for up to several weeks during a single in-water windows. Temporary work platforms may be elevated a few feet to several feet above the water surface. The maximum size of a temporary work structure is about 44 ft x 40 ft (1,760 ft^2). A maximum of two temporary work structures will be used per year for all terminals (total of 3,520 ft^2). Barges may be in use from days to weeks, and they typically do not anchor in a single location for the entire work period, but periodically move to access new work zones. Barges are not allowed to anchor over eelgrass or kelp beds. A typical barge is estimated to be 45 ft by 100 ft (4,500 ft^2) (one construction barge per ferry terminal per year= 90,000 total ft^2.) Barges can be used for terminal maintenance and repair work year-round. During the in-water work window typically one barge, but sometimes two barges, travel to multiple terminals. We do not expect more than two barges at any terminal outside the in-water work window.

Construction Noise in Aquatic Habitats

The following construction activities generate underwater noise:

- Marine sediment test borings
- Pile removal/installation
- Construction vessels

Minimization measures for pile driving are listed in Section 1.3.10 and include:

- All steel piles will be installed with a vibratory driver; piles used for non-load bearing structures will not be proofed with an impact driver, but load bearing piles will be impact proofed.
- A bubble curtain will be used for impact driving steel piles in waters greater than 3 ft deep; a bubble curtain will not be used on concrete piles, timber piles, or small piles.
- WSDOT will monitor underwater noise as described in the most recent NMFS approved Underwater Noise Monitoring Plan template (WSDOT 2012), except when 2 or less piles are being impact driven. If 2 or less piles are being impact driven, no underwater noise monitoring will be required.
- There will be at least a 12-hour rest period between impact pile driving events at the same location.
- Piles will be driven during slack tides if feasible.
- Monitoring zones for marine mammals will be implemented as appropriate and will include both impact and vibratory driving monitoring zones. The most conservative monitoring zones will be for driving 30-inch or 36-inch steel piles. Smaller pile sizes will have reduced monitoring zones as appropriate.

Extent of Construction Noise:

Pile Installation/Removal Noise - The methods of pile installation and removal, pile type, size, and duration of pile work are presented in Table 10.

Table 10. Driving Method, Pile Type, Size, and Duration of Pile Installation and Removal

Driving Method	Pile Type	Pile Diameter (inches)	Minutes/day	Maximum Duration (days)**
Vibratory Install	Steel Pipe	24	80	
Vibratory Install	Steel Pipe	36	160	15
Impact	Steel Pipe/concrete	36	80	15
Vibratory (drilled shaft)	Steel Pipe	120	240	1
Vibratory Install	Steel H-Pile	14	80	
Driving Method	**Pile Type**	**Pile Diameter (inches)**	**Minutes/day**	**Maximum Duration (days)****
Vibratory Remove	Timber	14	60	
Vibratory Remove	Steel Pipe	12-24	80	
Vibratory Remove	Steel Pipe	36	160	15

**Duration in days is only shown for 36-inch diameter piles and drilled shafts, which take longer than other piles covered in this consultation; smaller diameter piles are expected to be installed or removed in less time. Duration in days assumes uninterrupted installation or removal at a single site for all 60 piles per year or 2 drilled shafts. A more likely scenario would be several projects that install or remove piles of various sizes at multiple sites.

Although we anticipate 60 or fewer piles will be installed at the multiple terminals each year, a worst-case scenario is all 60 are installed at one location. In the worst-case, underwater sound pressure levels (SPLs) from impact pile-driving would be temporary and intermittent, lasting up to 80 minutes per workday for a maximum duration of 15 days (Table 10). The worst-case underwater SPLs from vibratory driving will occur for a maximum of 160 minutes per day (~2.5 hours per workday for drilled shafts) and 160 minutes per day for removing piles for a maximum duration of 15 days (1 day for drilled shafts) (Table 10).

We analyzed the level and extent of noise from pile driving based on current conservative thresholds used by NMFS for fish and marine mammals (FHWG 2008, NMFS2023). In our analysis, SPLs are presented in decibels (dB) measured as root mean square (rms) or peak with one microPascal (1 μPa) as the reference unit. The thresholds use SPLs when analyzing sounds of relatively long duration, such as the noise of a vibratory pile driver. These sounds are referred to as nonimpulsive or continuous sources. Shorter duration sound sources (milliseconds) are referred to as impulsive sounds and have thresholds denoted in SPLs and Sound Exposure Level (SEL). SEL is a measure of the energy of the emitted sound over a specified duration and is referenced to 1 microPascal squared second [$\mu Pa^2 \cdot s$]). For impact pile driving, the duration is a single strike. Multiple strikes from an impact pile driver are assessed by integrating the sound energy across all pile strikes, which is denoted as cumulative SEL (cSEL)[27].

For fish, NMFS uses conservative dual broadband interim criteria using the following peak SPL and cSEL for impulsive noise to identify the onset of injury:

- Peak SPL: 206 dB and
- cSEL: > 187 dB for fish $\geq$ 2 grams or 183 dB for fish < 2 grams.

Cumulative SEL is calculated from all pile strikes within a continuous work period, where a work period is defined as all pile driving between 12-hour breaks. It is important to note that these criteria represent the onset of injury and that higher sound levels are required to cause serious injury or death (PFMC 2014). We also applied a conservative threshold of 150 dB rms to assess potential behavioral responses of fishes from acoustic stimuli (PFMC 2014).[32]

For marine mammals, NMFS uses conservative dual broadband peak SPL and frequency-weighted cSEL thresholds for impulsive noise and frequency-weighted cSEL thresholds for non- impulsive noise to identify the onset of PTS for generalized hearing groups of cetaceans (NMFS 2018, Southall et al. 2019). Killer whales are categorized in the mid-frequency cetacean group with a generalized hearing range from 150 Hz to 160 kHz. The impulsive noise thresholds for mid-frequency cetaceans are:

- 230 dB peak unweighted[33] and
- 185 dB cSEL weighted

And the non-impulsive noise thresholds is:

- 198 dB weighted cSEL.

Broadband behavioral harassment thresholds are identified for all cetaceans as 160 dB rms for impulsive noise sources and 120 dB rms for non-impulsive noise sources.

[32] $SEL_{single\ strike} + 10 \log_{10}(N)$, where N is the number of pulses.
[33] Unweighted (flat-weighted) within the generalized hearing range of marine mammals from 7 Hz to 160 kHz

To assess the greatest potential for exposure to listed species and their habitat, worst-case pile driving scenarios were modeled using the practical spreading loss model to determine the distance where pile driving noise attenuates to threshold values. Source levels were provided by data from WSF terminals for pile sizes and types that have resulted in the highest measured noise levels. An attenuation of 8 dB was subtracted from the source values for impact driving to account for implementation of a bubble curtain. Results of the modeling are provided in Table 11 for distances to fish thresholds and Table 12 for distances to marine mammal thresholds. Of note is the extent of the very large distances to the behavior thresholds are truncated by land depending on site-specific topography surrounding each terminal (see Figures 3-22 in the BA, WSDOT 2020a).

Table 11. Distance (meters) to Fish Injury Thresholds and Behavior Guidance Criteria for Pile Driving

Method	Pile Type and Size	Onset of Physical Injury dB_{PEAK}	Onset of Physical Injury cSEL dB Fish ≥ 2 grams	Onset of Physical Injury cSEL dB Fish < 2 grams	Behavior dB rms in
Impact	30-inch steel[1]	19	638	1,177	4,686
Vibratory	36-inch steel[2]	n/a	n/a	n/a	1,848

Notes: cSEL = cumulative SEL measured as single Strike SEL + 10 * log (# strikes), rms=root mean square, n/a= not applicable. Distance calculated as TL =15 log R. Distances to the cSEL thresholds is limited to the maximum affected distance to a point ("effective quiet") at which the acoustic energy from a single strike attenuates to 150 dB SEL. No physical injury is expected beyond this distance. Peak and rms levels are relative to 1 μPa and cSELs are relative to 1 μPa2·s.

[1]Based on WSF's worst-case SPLs measured at the Vashon Terminal (Laughlin 2010, WSDOT 2020b) with 8 dB subtracted for bubble curtain attenuation, measured at 16 meters. cSEL based on a maximum of 2,000 strikes/day. [2]Based on WSF's worst-case SPL of 184 dB rms at 10 m (Laughlin 2017, WSDOT 2020b).

Behavioral Disturbance Acoustic Thresholds for Fishes[2]

Source Type	Threshold
All Sources	L_{RMS} 150 dB

Table 12. Distance to Killer Whale Injury and Behavior Thresholds for Pile Driving

Method	**Pile Type and Size**	**Injury (onset of PTS) 230 dB_{PEAK} (unweighted)**	**Injury (onset of PTS) cSEL (weighted) 185 dB**	**Injury (onset of PTS) cSEL (weighted) 198 dB**	**Behavior (unweighted) 160 dB_{rms}**	**Behavior (unweighted) 120 dB_{rms}**
Impact	30-inch steel[1]	< threshold[2]	n/a	29 meters	1010 meters	n/a
Vibratory	H-pile[3]	n/a	1 meter	n/a	n/a	1 mile
Vibratory	36-inch steel[4]	n/a	63 meters	n/a	n/a	115 miles[5]

Notes: cSEL = cumulative SEL measured as single Strike SEL + 10 * log (# strikes), rms=root mean square, n/a= not applicable. Distance calculated as TL =15 log R. Weighted vibratory thresholds calculated using NMFS weighting factor adjustment of 2.5kHz and user spreadsheet available at https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal- acoustic-technical-guidance. Peak and rms levels are relative to 1 μPa and cSELs are relative to 1 μPa2·s.
[1]Based on WSF's worst-case SPLs measured at the Vashon Terminal (Laughlin 2010, WSDOT 2020b) with 8 dB subtracted for bubble curtain attenuation, measured at 16 meters. cSEL based on a maximum of 2,000 strikes/day.
[2]Because the 230 dB peak injury threshold for mid-frequency cetaceans, which includes killer whale, far exceeds the attenuated peak SPL during pile driving, there is no associated injury zone.
[3]Laughlin 2019, WSDOT 2020b.
[4]Based on WSF's worst-case SPL of 184 dB rms at 10 m (Laughlin 2017, WSDOT 2020b).
[5]At all terminals noise will be obstructed by land masses before reaching this distance.

The actual sound levels produced and propagated from pile driving (both sound pressure and particle motion) will vary depending on numerous factors such as pile type (e.g., timber, concrete, steel), pile diameter, driver size, substrate characteristics, etc. (Bellmann et al. 2020; Jimenez-Arranz et al. 2020, WSDOT 2020b). The vibratory removal of timber piles will have a much smaller area of behavioral effect. Shallower water (less than 2 feet deep) does not propagate noise energy effectively, especially at lower frequencies (Urick 1983). Therefore, when piles are installed in very shallow water or in the dry, sound propagation through the water column will be minimal.

Geotechnical Test Boring Noise - Marine geotechnical test borings drill a small solid tube (maximum diameter of six inches) into the sediment and may also hammer the sample tube into the sediment. Hammering is typically not done using the methods described in Section 1.3.2. However, we have provided an analysis for hammering, should contractor employ this method. Little acoustic data is available for in-water geotechnical test boring. Based on a review of geotechnical sampling at the Mukilteo Ferry Terminal and a port in Australia, drilling did not produce SPLs above any noise thresholds for fish (Gilbertson 2007, entire; Erbe and McPherson 2017, p.142-143). Hammering of tubes produced pulsed noise, but the hammering had lower levels of SPLs compared to impact pile driving (Erbe and McPherson, 2017, p. 283-284; WSDOT 2020b, p.7.41-7.43). The number of blows needed for the tube to penetrate a fixed depth relates to the hardness of the ground (Erbe and McPherson 2017, p.142).

Gilbertson (2007, entire) noted that unlike impact driving of larger steel piles, which have most of their sound energy in frequencies below 5,000 Hz, the boring sound energy was consistent across the frequency spectrum. Peak SPLs ranged from 155-181 dB and were below the peak injury threshold for fish (206 dB peak). SEL levels ranged from 128-148 dB and strikes ranged from 13-49. Based on these data, the 183 dB cSEL onset of injury threshold for fish less than 2 grams would be less than 1 meter from a boring and would not be reached for fish greater than are equal to 2 grams. Borings exceeded the 150 dB rms behavioral guidance threshold for fish by up to 8 dB at 10 meters from a boring.

The extent of noise effects for marine mammals was based on our review of geotechnical sampling at the Mukilteo Ferry Terminal (Gilbertson 2007) and a port in Australia (Erbe and McPherson 2017). Drilling produced SPLs of 143 dB rms, which is above the behavioral guidance for marine mammals (120 dB rms), and results in a 341-meter isopleth where noise is above the behavioral guidance. The actual distance would depend on background noise levels at the test site. Geotechnical hammering ranged between 154 and 158 dB rms and was not above the behavioral noise guidance for marine mammals (160 dB rms). Drilling did not produce noise above the PTS threshold for SRKW (mid-frequency cetacean198 dB cSEL). Hammering did not produce noise above the dual PTS and peak thresholds for SRKW (mid-frequency cetacean:185 cSEL and 230 dB peak). A maximum of 25 geotechnical borings are anticipated per year during the life of this Opinion/Conference Opinion. Each boring is anticipated to take 15-30 minutes total.

Construction Vessel Noise - Barges and tugs will be used to construct many of the proposed projects and will increase the amount of noise in an area surrounding each construction site as the arrive and exit terminal construction sites from their transit paths. Based on prior vessel noise studies in Admiralty Inlet (Bassett et al. 2012), we anticipate vessel noise will be detectable within the line of sight of vessel in Puget Sound proper and the San Juan Island waterways until it mixes with other vessel noise to reach ambient conditions. We also anticipate construction vessels will be traveling slow, especially near terminals, resulting in a reduction in their noise levels. Because sound from vessels travels long distances, their noise will be truncated by landforms once they arrive at terminals. Therefore, their noise in the vicinity of each terminal is considered to be coextensive (overlapping the same distance) with the extent of noise from pile driving modeled to attenuate to ambient conditions (see Section 1.4 Action Area and Figures 3-22 in the BA, WSDOT 2020a).

Temporary Overwater Lighting

Visual predators, such as salmon rely on vision to both capture prey and to avoid predation. Natural processes that are a function of lighting, such as diel activity patterns, migration, and predator-prey interactions can be affected by artificial lighting (Zapata et al. 2019, p.309).

<u>Overwater Lighting:</u> Mobile light units that illuminate nearshore surface waters adjacent to work areas are anticipated to occur for several activities at any of the WSF facilities (Table 14). Lighting would be in place for a maximum of 10-nights each year at each terminal. The degree or extent of illumination is unknown; however, projects that use mobile light units will orientate and shield lighting to limit illumination of the water surface. Temporary work lights could be used at any time of year. Temporary light units will not be used for pile

driving activities due to the need for the 12-hour rest period and visibility for protected species monitoring.

2.4.2 Exposure and Response of Listed Species to Temporary Effects

A general description of species presence in the Action Area is provided in Table 13 and below. Species exposure to project effects is a function of work timing and life stage presence.

Juvenile PS Chinook salmon are generally found in PS neritic waters between April and November (Brennan et al. 2004, Rice et al. 2011, Beamer and Fresh 2012). Wild fish have a broader out-migration period that results in continued recruitment at the lower end of the length distribution over the season (Rice et al. 2011). The work window avoids peak juvenile Chinook presence from mid-February through mid-July, but does not fully avoid exposure, especially of natural origin fish. Additionally, a substantial percentage of Chinook salmon rear in Puget Sound without migrating to ocean areas (O'Neill and West 2009).

Juvenile HCSR chum use shallow nearshore habitat extensively during their early outmigration. Tuohy et al. (2018) show widespread use of nearshore habitat by HCSR chum even at sites that are distant from natal streams in Hood Canal. HCSR chum are anticipated in the nearshore at the Port Townsend and Coupeville terminals from January through June (Frierson et al. 2017, Small et al. 2017), which overlaps with the beginning of the in-water work window.

Juvenile PS steelhead primarily emigrate from natal streams in April and May and appear to move directly out into the ocean to rear, spending little time in the nearshore zone (Moore et al. 2015). However, steelhead smolts have been found in low abundances in the marine nearshore, outside of their natal estuary until August (Brennan et al. 2004). Because they enter the Sound after a longer freshwater residency, they are larger and move through inland waters quickly (Moore et al. 2015), they are less dependent on nearshore waters where in-water work will occur.

Table 13. General Timing of Species Presence by Life History Stage in the Action Area

Species	Larval	Juvenile	Subadult/Adult
PS Chinook salmon	N/A	March – November[1]	Year-round
HCSR chum salmon	N/A	January – June[2]	August – October
PS steelhead	N/A	~ Mid-April – August Typically, 2–3-year-olds not dependent on shallow nearshore areas Move from natal streams/rivers to ocean in a few weeks[3]	~May - January[4]
PS/GB bocaccio rockfish	Pelagic larval ~March-October	At 3-9 centimeters, move into shallow nearshore waters with rocky or cobble substrates, preferably with kelp[5]	Year-round Most commonly found between 30-425 meters[5]
PS/GB yelloweye rockfish	Pelagic larval ~March-October	At 3-9 centimeters, typically settle in deeper offshore waters greater than 30 meters[5]	Year-round Most commonly found between 30-425 meters[5]
SRKW	N/A	Potentially present year-round with a higher probability of presence in the San Juan Islands in summer and Puget Sound proper in fall and early winter[6]	Potentially present year-round with a higher probability of presence in the San Juan Islands in summer and Puget Sound proper in fall and early winter[6]

N/A = not applicable.
[1]Brennan et al. 2004, Rice et al. 2011, Beamer and Fresh 2012.
[2]Frierson et al. 2017.
[3]Moore et al. 2015.
[4]NMFS 2019g, based on freshwater entry.
[5]Based on rockfish larvae in general in Puget Sound/San Juan Basin, Greene and Godersky 2012, NMFS 2017.
[6]Olson et al. 2018.

Larval and Juvenile Rockfish. Larval rockfish presence peaks twice in the spawning period, once in spring and once in late summer. Beginning in November, larval rockfish are typically absent from the surface waters (Greene & Godersky, 2012). Juvenile bocaccio settle into nearshore habitats from a pelagic stage, but yelloweye rockfish juveniles typically occur at depths deeper than 40 meters (NMFS 2017). The San Juan Islands portion of the Action Area has rocky benthic habitats and rocky shorelines with extensive SAV and floating kelp beds. Juvenile bocaccio would be expected to occur in nearshore habitats and juvenile yelloweye in waters typically greater than 30 meters (deeper than depths at the terminals).

Adult salmonids. The presence of adult PS Chinook, HCSR chum salmon, and PS steelhead in PS overlaps with the proposed in-water construction window. Adult PS Chinook salmon, HCSR chum salmon, and adult PS steelhead are generally expected to occupy deeper habitat than the location where construction is proposed. Thus, we expect the direct habitat effects from the structures to create little exposure or response among this life stage of these species as they do not rely on the nearshore. Some subyearling and subadult PS Chinook salmon remain in the waters of the Action Area for some period of time before migrating to the ocean or they remain within inland marine waters without going to the ocean.

Subadult and Adult PS/GB bocaccio and yelloweye rockfish prefer depths between 30 and approximately 250 meters, which are deeper than at all the terminal structures. Their presence in the Puget Sound proper portion of the Action Area is extremely low because suitable habitat features with rugosity for this life stage are extremely limited. However, given the ability of this species to move throughout the marine environment, we cannot conclude that they would not ever occur within this portion of the Action Area. Adults of both species would be expected to occur in the San Juan Islands portion of the Action Area in waters greater than 30 meters (deeper than depths at the terminals).

Southern Resident Killer Whales could be present in some portion of the Action Area year-round. Observations since 1976 generally shown that all three pods occur in the San Juan Island portion of the Action Area June through September and tend to occur sporadically in Puget Sound proper in the fall and early winter (Olson et al. 2018). 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. Later arrival times and fewer days present in inland waters have been observed in recent years (Olson et al. 2018).

Suspended Sediment and Turbidity and Corollary Decreases in DO

<u>Fish Response</u>: Depending on the depth of the activity and habitat present, all species of fish in this opinion could be exposed to increases in suspended sediment and turbidity within the 150-ft radius of sediment disturbing activities, except for adult bocaccio and adult and juvenile yelloweye rockfish, which would be expected at depths greater than terminal structures.

Elevated suspended sediment and turbidity levels will be intermittent during construction, and for work conducted at low tide will be limited to the tidal cycle following project work. Acute exposures are usually most intense in the initial mixing zone where sediment resuspension creates a three-dimensional plume that dissipates vertically, horizontally, and longitudinally (Bridges et al. 2008, pp. 6-8, 15, 18).

Increases in suspended sediment affect salmonids in several recognizable ways. The effects of suspended sediment may be characterized as lethal, sublethal or behavioral (Bash et al. 2001, Newcombe and MacDonald 1991, Waters 1995). Lethal effects include gill trauma (physical damage to the respiratory structures), severely reduced respiratory function and performance, and smothering and other effects that can reduce egg-to-fry survival (Bash et al. 2001). Sublethal effects include physiological stress reducing the ability of fish to perform vital functions (Cederholm and Reid 1987), elevated blood sugars and cough rates (Servizi and Martens 1991), increased metabolic oxygen demand and susceptibility to disease and other stressors (Bash et al. 2001), and reduced feeding efficiency (Bash et al. 2001, Berg and

Northcote 1985, Waters 1995). Sublethal effects can act separately or cumulatively to reduce growth rates and increase fish mortality over time. Elevated turbidity levels can reduce the ability of salmonids to detect prey, cause gill damage (Sigler et al. 1984; Lloyd et al. 1987; Bash et al. 2001) and cause juvenile steelhead to leave rearing areas (Sigler et al. 1984). Additionally, short-term pulses of suspended sediment influence territorial, gill-flaring, and feeding behavior of salmon under laboratory conditions (Berg and Northcote 1985). Behavioral effects that result in avoidance and loss of territoriality can have secondary effects to feeding rates and efficiency (Bash et al, 2001, p. 7). Fish that avoid elevated concentrations of suspended sediments may abandon preferred habitats and refugia and may enter less favorable conditions and/or be exposed to additional hazards (including predators).

The severity of effect of suspended sediment increases as a function of the sediment concentration and exposure time, or dose (Newcombe and Jensen 1996, Bash et al. 2001). Adult and larger juvenile salmonids appear to be little affected by the high concentrations of suspended sediments that occur during storm and snowmelt runoff episodes (Bjornn and Reiser 1991). Studies show that salmonids have an ability to detect and distinguish turbidity and other water quality gradients (Quinn 2005), and that larger juvenile salmonids are more tolerant to suspended sediment than smaller juveniles (Servizi and Martens 1991, Newcombe and Jensen 1996). However, research indicates that chronic exposure can cause physiological stress responses that can increase maintenance energy and reduce feeding and growth (Lloyd et al. 1987, Servizi and Martens 1991).

Exposure concentration and duration will strongly influence whether temporary exposures cause lethal or sublethal effects. Information is limited and there are important sources of uncertainty. These sources of uncertainty include grain size, the quantity and composition of resuspended sediment, the quantity and composition of released interstitial pore water, and the rate or degree of contaminant desorption to the surrounding water column. Additional sources of uncertainty include the effect of intermittent, episodic, or transient exposures (Burton et al. 2000, p. ab; Marsalek et al. 1999, p. 34), variations in tolerance among exposed individuals, populations, and/or species (Ellis 2000, p. 89; Hodson 1988, p. ab; Lloyd 1987, p. 502), and the potential for additive or synergistic effects among water quality stressors (Burton et al. 2000, p. ab; Ellis 2000, p. 88; Lloyd 1987, p. 494). Burton et al. (2000, p. ab) have emphasized the importance of "real-world" patterns of exposure.

Based on the information reviewed above, we do not expect the limited turbidity and suspended sediment from drain flushing or vessels to result in measurable effects to any of the fish species. For all other activities, while larger fish may respond behaviorally to avoid areas of increased suspended sediment and turbidity, we do not expect subadult or adult PS Chinook salmon, adult HCSR chum, juvenile and adult PS steelhead to be measurable affected physiologically by suspended sediment and associated increased in turbidity. These larger fish are unlikely to be affected by short-term exposure to elevated turbidity because they can tolerate short term increases in suspended sediment. Furthermore, they are not shoreline-oriented and will not be displaced from their preferred habitat if they avoid areas of higher turbidity. All work is intended to occur in the in-water work window to minimize effects to juvenile salmon, and exceptions are to occur only on a case by case basis with prior evaluation and confirmation by NMFS that additional duration would not exceed the analysis presented here. However, some juvenile PS Chinook salmon, juvenile HCSR chum, juvenile bocaccio and larval stages of both rockfish species could be exposed (Table 17) to spatially limited, intermittent effects of suspended sediment and turbidity, which could result in adverse physiological effects and displacement from preferred habitats.

Lloyd (1987, pp. 492, 501) suggests that water quality stressors can exert a greater effect when DO levels are low. None of the activities covered in this Opinion will produce the magnitude of suspended sediment produced by dredging, therefore, we do not expect a reduction in DO around in-water work areas that will be measurable beyond a limited distance. Any reduction in DO concentration within this area will be limited in duration as sediment settles and mixing occurs. Therefore, we consider the temporary and limited reduction of DO associated with the project activities described previously to be minor or undetectable.

<u>SRKW Response:</u> SRKW are not expected to be exposed to temporary increases in turbidity levels and suspended sediment during in-water maintenance and repairs for several reasons, including the limited extent of the zones (150 ft or less from the activity) and the marine mammal monitoring protocols, which will stop pile removals and installations (activities that suspend sediment) if ESA-listed marine mammals are seen in the much larger behavioral zone of effect. In the unlikely event that SRKWs are exposed to increased turbidity or suspended sediment, the exposure would be extremely limited based on both the small spatial extent of elevated turbidity (150-ft) relative to whale movements, and the extremely short duration as an animal moved through the area. We do not expect this level of potential exposure to result in any measurable change in a whale's behavior or physiology. As discussed above any reduction in DO concentration within the 150 ft zone of increased suspended sediment will be limited in duration as sediment settles and mixing occurs. We do not expect any response of marine mammals as they move through these spatially and temporarily limited zones.

Contaminants

Sediment disturbing activities can disturb and mobilize contaminants. The greatest exposure is expected from the removal of creosote-treated piles, which mobilizes PAHs[34] into surrounding water and sediments (Smith et al. 2008, Parametrix 2011). Therefore, we utilize the exposure of PAHs as a worst-case exposure scenario since they can remain persistently in the marine environment.

<u>Fish Response</u>: There are two pathways for PAH exposure to listed fish species in the action area, direct uptake through the gills and dietary exposure (Lee and Dobbs 1972; Neff et al. 1976; Karrow et al. 1999; Varanasi et al. 1993; Meador et al. 2006; McCain et al. 1990; Roubal et al. 1977). The extent of direct exposure will be limited to several meters from a pile and indirect exposure through prey species. Juvenile salmon prey, including amphipods and copepods, uptake PAHs from contaminated sediments (Landrum and Scavia 1983; Landrum et al. 1984; Neff 1982) and could be exposed through that pathway. Juveniles of PS Chinook salmon, HCSR chum salmon, and juvenile bocaccio could also be exposed to

[34] PAH are a class of chemicals that occur naturally in coal, crude oil, and gasoline. They also are produced when coal, oil, and gas are burned.

PAHs directly in the water column when in nearshore habitats. Adult and subadult PS Chinook salmon, adult HCSR chum, juvenile and adult PS steelhead, and juvenile and adult PS/GB bocaccio rockfish are much less likely to be exposed to PAHs in the water column because they are less likely to be present near sediment producing activities. They could be exposed indirectly through ingestion of prey. Larval stages of both bocaccio and yelloweye rockfish could be exposed to PAHs in the water column or through ingestion of contaminated prey. Creosote contains numerous constituents that are known to be toxic to aquatic organisms (Eisler 1987; Germain et al. 1993; Brooks 1994; Brooks 2000; Johnson et al. 2002). Creosote is composed primarily of PAHs (about 65 to 85 percent), with smaller percentages of phenolic compounds (ten percent), and nitrogen-, sulfur-, or oxygenated heterocyclics (Brooks 1994).

Contaminants in sediments and dissolved in water can have varying levels of toxicity, most often occurring as sub-lethal effects.

PAHs are lipophilic, persistent, interact synergistically with bio-accumulative and redox-active metals and other contaminants, and may disperse long-distances in water (Gauthier et al. 2014, 2015; Arkoosh et al. 2011; WDOE 2021). Metabolites are commonly more toxic than the parent, some are carcinogenic, neurotoxic, and cause genetic damage. Although biotransformation of PAHs causes oxidative stress with subsequent cellular damage and increased energy is required at the cost of growth, many organisms (including salmon) can eliminate at least the lower density PAHs from their bodies as part of metabolism and excretion (Arkoosh et al. 2011). However, plants and some aquatic organisms, such as mussels and lamprey, have limited ability to metabolize or degrade PAHs, which may bioaccumulate over several years (Tian et al. 2019; Nilsen et al. 2015). PAHs and metabolites are acutely toxic to salmonids and may cause narcosis at low levels of exposure, can in some cases bioaccumulate through food webs (water, groundwater, soil, and plants; Bravo et al. 2011; Zhang et al. 2017), and can also cause chronic sub-lethal effects to aquatic organisms at very low levels (Neff 1985; Varanasi et al. 1985; Meador et al. 1995). PAHs can affect DNA within the nucleus of cells, cause genetic damage, and are classified as carcinogens (Collier et al. 2014).

The primary effects of PAHs on salmonids from both uptake through their gills and dietary exposure are immunosuppression and reduced growth. Karrow et al. (1999) characterized the immunotoxicity of creosote to rainbow trout (*Oncorhynchus mykiss*) and reported a lowest observable effect concentration for total PAHs of 17 μg/l. Varanasi et al. (1993) found greater immune dysfunction, reduced growth, and increased mortality compared to control fish. In order to isolate the effects of dietary exposure of PAHs on juvenile Chinook salmon, Meador et al. (2006) fed a mixture of PAHs intended to mimic those found by Varanasi et al. (1993) in the stomach contents of field-collected fish. These fish showed reduced growth compared to the control fish.

Studies of dissolved PAH mixtures in marine habitat from oil spills found developing fish heart as the primary biological target organ for the toxic impacts of the water-soluble impacts derived from petroleum (see review in NOAA 2022). A review of studies on PAH toxicity found that all fish species studied to date are vulnerable to PAH toxicity in the embryonic stage, with thresholds for severe developmental abnormalities often in the low parts-per-billion (µg/L) range (NOAA 2022). Large-scale tagging (mark-and-recapture) studies showed that embryonic exposure to oil-derived chemical mixtures with total PAH levels in the range of 5 - 20 µg/L resulted in cohorts of salmon that survived the exposure (and appeared outwardly normal), but nevertheless displayed reduced growth and reduced survival to reproductive maturity in the marine environment. Follow-up studies at NWFSC have linked this poor survival to reduced individual fitness manifested by reduced swimming performance and subtle changes in cardiac structure (Incardona et al. 2015, 2021; Gardner et al. 2019) that is known to be associated with considerable morbidity and mortality across vertebrate species.

Forage species are also affected by PAHs. Herring embryo studies have observed high mortality, in embryos spawned directly on creosote-treated piles (Vines et al. 2000), sublethal effects in developing herring embryos exposed to creosote-treated wood effluent, and accumulation of PAHs in herring embryos at several locations in Puget Sound (West et al. 2014). West et al. (2019) found herring embryos accumulated higher PAHs near 100-year-old creosote-treated piles than embryos from reference sites indicating that even old weathered creosote-treated piles are a source of toxic contaminants. In other laboratory and field studies, exposure to petrogenic PAHs resulted in detection of cardiac toxicity in herring embryos (Incardona et al. 2012) and cardiac edema and arrhythmia in fish (Incardona et al. 2009, Incardona et al 2004). Because ultraviolet light exacerbates the toxic effects of PAH exposure on fish embryos, fish species, such as herring that spawn in shallow nearshore waters may experience an increased risk of PAH-phototoxicity (West et al. 2019).

NMFS cannot, with any meaningful level of accuracy, estimate the proportion of each species that will enter the impact zones or ingest contaminated prey. Long-term effects from very small amounts of inputs of persistent contaminants from wash water or vehicle exhaust are likely to adversely affect species for a longer, unknown time-period (see eg. Eisler 1987, and Ruifei, et al. 2019). However, as discussed above fish will be able to eliminate some of the low-density PAHs. Some of the listed fish exposed to PAHs and other contaminants from the proposed action will experience immunosuppression and reduced growth which, in some cases will increase the risk of death. Therefore, release and resuspension of contaminants is likely to adversely affect all fish species in this Opinion. Within three years, NMFS expects the PAHs in the surrounding sediments of pile removals will return to background levels. Because creosote-treated timber releases PAHs throughout its life, the removal of the creosote-treated timber will reduce listed- fish and prey exposure to PAHs in the long-term.

In summary, all fish species in this Opinion could be adversely affected through exposure to contaminants from the activities described either through the sediments, water column directly, or through ingested of contaminated prey.

<u>SRKW Response:</u> The direct exposure of SRKWs to PAHs and other released contaminants in the water column is unlikely because of the relatively small size of exposure zones. SRKW would be expected to infrequently come within a few meters of terminal structures, so the likelihood of their being near a structure during an activity is highly unlikely. Additionally, during pile driving, a marine mammal exclusion zone will be monitored.

The exposure of SRKWs to PAHs and other released contaminants in the water column could occur indirectly through food web contaminated prey. Chinook salmon, a main prey source for SRKW, contain higher levels of some persistent pollutants than other salmon species, but only limited information is available for pollutant levels in Chinook salmon (Krahn et al. 2007, O'Neill and West 2009, Veldhoen et al. 2010, Mongillo et al. 2016).

Killer whales store contaminants in their blubber, which can later be released when the blubber is metabolized in response to food shortages, reduced acquisition of food energy, gestation, lactation, or other factors. High levels of pollutants have been measured in blubber biopsy samples from SRKW (Ross et al. 2000, Krahn et al. 2007, Krahn et al. 2009), and more recently, these pollutants were measured in fecal samples collected from SRKW (Lundin et al. 2015, Lundin et al. 2016). When the contaminants are released, they are redistributed to other tissues and into the circulatory system where they have the potential to cause a toxic response. Various adverse health effects in multiple species 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, de Swart et al. 1996, Subramanian et al. 1987, de Boer et al. 2000, Reddy et al. 2001, Schwacke et al. 2002, Darnerud 2003, Legler and Brouwer 2003, Viberg et al. 2003, Ylitalo et al. 2005, Fonnum et al. 2006, Viberg et al. 2006, Darnerud 2008, Legler 2008, Bonefeld-Jørgensen et al. 2011). SRKW are exposed to a mixture of pollutants, some of which may interact synergistically and enhance toxicity, influencing their health. Additionally, nutritional stress from reduced prey may act synergistically with high pollutant levels in SRKW and result in adverse health effects.

The NMFS (2008a) Recovery Plan for SRKWs identifies bioaccumulation of toxins as a high concern for SRKWs. Included in the list of toxins that bio-accumulate are PAHs (NMFS 2008a). As described above for fish, long-term effects from small amounts of continuing inputs of persistent contaminants, like those from creosote piles, are likely to adversely affect fish species, including Chinook salmon that are a primary prey species for SRKW. Although removal will result in contaminant release for up to 3 years following removal, the removal of creosote piles will result in a long-term beneficial effect by removing sources of contaminants in the action area, and their availability for uptake by whale prey species. Therefore, although short-term adverse effects will occur, the effect to the overall forage base for SRKW is beneficial in the long-term. Therefore, we consider the direct effects to SRKW highly unlikely to occur and the indirect effects through their forage base to be minimal.

Reduced Forage

<u>Fish Response</u>: Juvenile Chinook and HCSR chum salmon migrate along nearshore habitats. Juvenile bocaccio rockfish utilize shallow nearshore benthic habitats for settlement and growth. All of these species rely in part on production of forage species produced in benthic habitats. PS steelhead smolts, juvenile yelloweye rockfish and adults and subadults of PS Chinook, HCSR chum, and bocaccio and yelloweye rockfish, and larval stages of rockfish are not expected to be affected by these stressors because they are not reliant on these habitats or forage sources.

Juvenile PS Chinook, juvenile HCSR chum salmon, and juvenile bocaccio could be affected by a temporary diminishment of epibenthic fauna from sediment disturbance and decreased light levels from in water work activities, vessels, and work platforms in the nearshore. Because prey is abundant in close proximity, feeding, growth, development, and fitness of individual PS Chinook, HCSR chum salmon, and bocaccio present during this temporary, short-term habitat disruption would not be affected. Juvenile PS/GB bocaccio feed on the young of other fish in nearshore areas (Love et al. 1991; Leet et al. 1992) and all life stages of copepods and euphausiids (MacCall et al. 1999). Because fish and zooplankton that are generally carried with the flow of water and currents will be available, reductions in benthic prey communities and in SAV from disturbance in work areas, are not likely to measurably affect the forage base in their nearshore settlements. Up to 40 sq ft of benthic habitat would be lost where piles are encapsulated, which is considered immeasurable to their prey base. Benthic habitat changes from propeller disturbance are unlikely to measurably impact benthic forage or forage fish habitat with implementation of BMPs. The limited amount of overwater cover produced by temporarily moored barges that move intermittently during the days to weeks they are in place would result in a minimal amount of reduced benthic productivity for affected fish species.

In summary, we consider the temporary effects to the benthic forage base from sediment disturbance and decreased light levels to be undetectable to juvenile PS Chinook salmon, HCSR chum salmon and juvenile bocaccio rockfish.

SRKW Response: Because effects to the forage base for salmon and steelhead is considered undetectable, we do not expect effects from this stressor to affect the overall forage base for SRKW. Therefore, do not expect a change in foraging behavior, growth, fitness, or fecundity based on prey effects from temporary effects of the proposed action.

Migratory Obstruction

Fish Response: Outmigrating juvenile PS Chinook and HCSR chum in the earliest periods of their marine residency prefer the protection of shallow nearshore water. These species rely in part on production of forage species produced in benthic habitats. PS steelhead smolts, adults and subadults of PS Chinook and HCSR chum are not expected to be affected by these stressors because they do not migrate along the nearshore. We do not expect effects to any life stage of rockfish because they do not migrate along the nearshore.

Fishes rely on visual cues for spatial orientation, prey capture, schooling, predator avoidance, and migration. The sharp light/dark contrast between non-shaded waters and shaded water under structures affects the behavior of smaller juvenile salmon in the nearshore in two ways: 1) migrating juvenile salmon in the nearshore will avoid shaded areas and may mill along the edge, move to deeper waters, or delay migration until the light/dark contrast is reduced, 2) movement into deeper waters may increase susceptibility to predation. Therefore, the physical presence of the structures may result in juvenile salmonid delaying passage or forcing them into deeper water in an attempt to go around the structures, resulting in more vulnerability to predation.

The effect of anchored barges on juvenile Chinook and chum salmon migration would depend on their location and tidal elevation. Barges located further from shore and not contiguous with an existing structure, would not be expected to have a significant effect on juvenile salmon migration. While barges moored inshore, contiguous or adjacent to an existing structure may result in obstruction of the nearshore migration pathway. However, barges will not be in place for extended periods, but can be present year-round. Therefore, shading effects from temporary mooring of barges may adversely affect juveniles of PS Chinook and HCSR chum salmon by impeding migration. We anticipate a maximum of two barges at each terminal outside the in- water work period. Temporary work platforms will only be used in the in-water work window, so we do not expect interference with migration of early nearshore stages of juvenile PS Chinook, but they could interfere with migration of HCSR chum (January-February 15) at the Port Townsend and Coupeville terminals.

SRKW Response: Direct effects to SRKW from the temporary presence of overwater cover from work platforms or barges is extremely unlikely because nearshore overwater structures are not considered to be a significant obstruction to their movements. Within the in-water work window, work platforms or barges, based on their limited presence (two work platforms over 20 terminals per year, and periodic movement of barges) are unlikely to result in a measurable reduction in the salmon forage base for SRKW. A limited number of barges will occur in nearshore areas outside the in-water work window. Because barges at terminal locations outside the work window will be few in number (one or two per terminal per year) and will remain in place at a single location for a limited time, the effect to the overall salmon forage base of SRKW will not be measurable.

Construction Noise in Aquatic Habitats

All fish species in this Opinion could be exposed to construction noise. Fish responses to each type of construction noise are analyzed below.

The effects on fish exposed to noise varies with the hearing characteristics of the fish, the frequency, intensity, and duration of the exposure, and the context under which the exposure occurs. At low noise levels, effects may include the onset of behavioral disturbances such as acoustic masking (Codarin et al. 2009), startle responses and altered swimming (Neo et al. 2014), abandonment or avoidance of the area of acoustic effect (Mueller 1980; Picciulin et al. 2010; Sebastianutto et al. 2011; Xie et al. 2008) and increased vulnerability to predators (Simpson et al. 2016). At higher intensities and/or longer exposure durations, the effects may rise to include temporary hearing damage (a.k.a. temporary threshold shift or TTS, Scholik and Yan 2002) and increased stress (Graham and Cooke 2008). At even higher levels, exposure may lead to physical injury that can range from the onset of permanent hearing damage (a.k.a. permanent threshold shift or PTS) and mortality.

The best available information about the auditory capabilities of the fish considered in this Opinion suggest that their hearing capabilities are limited to frequencies below 1,500 Hz, with peak sensitivity between about 200 and 300 Hz (Hastings and Popper 2005; Picciulin et al. 2010; Scholik and Yan 2002; Xie et al. 2008).

Fish Response to Pile Driving Noise: The intense underwater sound pressure waves from impact pile driving have been observed to injure and kill a number of species of fishes, including Pacific salmon (e.g., Caltrans 2001, Longmuir and Lively 2001, Stotz and Colby 2001, Abbott and Bing- Sawyer 2002, Stadler pers. obs. 2002). Injuries to non-auditory tissues associated directly with impact pile driving (collectively known as barotrauma) include rupture of the swim bladder, bruising of the internal organs, and internal or external hemorrhaging. Impact pile driving sounds have very sharp rise times with most of their energy below 500 Hz, though some energy may extend up to 1 kHz (Dahl et al. 2015). Sharp rise times may affect the response of an animal and result in more injury than slower rise times. Fish with swim bladders are more susceptible to barotrauma, with smaller fish being more susceptible than larger fish (see review by Popper and Hawkins 2019, p.695 and p.703).

No instances of fishes killed or injured have been observed with vibratory pile driving. While no specific studies evaluate the effects of vibratory pile driving on salmonids, NMFS extrapolates from other studies to determine that vibratory pile driving could result in noise level sufficient to alter normal behavior patterns in fish. For example "When exposed to boat noise, wild Pacific herring and juvenile pink and chum salmon schools showed stereotyped responses that are consistent with classic vigilance behaviors associated with anti-predator tactics (Magurran, 1990). During exposure trials (in the presence of boat noise) both fish groups spent more time in behaviors considered to be a response to predators. These composite response findings suggest that salmon and herring respond to boat noise as a non-lethal predator (Beale and Monaghan, 2004; Frid and Dill, 2002). Flight responses to predators, including perceived predators, are adaptive. Once a predator is detected, schooling behavior decreases any one individual's probability of being eaten (Turner and Pitcher, 1986). But repeated responses to predation risk can carry costs. If fish are repeatedly replacing foraging activities with vigilance and anti- predator behavior, this can reduce their energetic intake and fitness. Simply living in a "landscape of fear" of predation risk can carry population-level consequences, even in the absence of actual predation (Lima and Dill, 1990). In fact, fish exposed to boat noise are responding to perceived and actual predation risk. In addition to disrupting normal behaviour in response to anthropogenic disturbance, juvenile salmon and herring in the Salish Sea face a gauntlet of predators (Chasco et al., 2017 as cited in van der Knapp et al 2022.)

The magnitude of the effect on fish that are exposed to the sounds from pile driving will depend on the type of driving, the size and physical condition of exposed fish, depth in the water column, and buoyance state of the fish, ambient noise at the time of driving, as well as the characteristics of the received sound including the shape and energy content of the sound pressure wave.

Injury or death associated with impact pile driving appears to be positively correlated with the size of the pile because driving larger piles requires more energy than smaller piles and produces higher sound levels. However, the geologic conditions are important as WSF has observed higher sound levels from 30-inch diameter steel piles than 36-inch diameter steel piles (WSDOT 2020b). The type of pile seems to influence the severity of impacts to fishes. All of the observed fish-kills have been associated with impact driving of hollow steel piles ranging from 24- to 96- inches in diameter. Wood and concrete piles appear to produce lower sound pressures than hollow steel piles of a similar size, although it is not yet clear if the sounds produced by wood or concrete piles are harmful to fishes.

Several field studies were designed to take advantage of projects with pile driving (e.g., Abbott et al. 2005; Ruggerone et al. 2008; Caltrans 2010a, 2010b). However, such "opportunistic" field studies cannot control the levels of sound to which the fish are exposed. In addition, Halvorsen et al. (2012) noted that these studies lacked appropriate biological control groups because the experimental fishes may not have been neutrally buoyant. All salmonids are physostomous, inflating and deflating their swim bladder by gulping in or burping out air, and may have deflated the swim bladder when handled prior to the experiment. A deflated swim bladder could put the fish at a lower risk of injury from the sounds, leaving the validity of the results open to question.

To address these issues, Halvorsen et al. (2011, 2012) conducted a laboratory study on juvenile Chinook salmon using an apparatus that was specially designed to simulate, and precisely control, the sounds and intensities produced during impact pile driving. It also incorporated a protocol to ensure that the test fish were neutrally buoyant before exposure to the sound. This study attempted to establish thresholds for the sound levels that would cause physical injury to juvenile Chinook salmon. Juvenile Chinook salmon (mean standard length 103 mm, mean weight 11.8 gram) were exposed to between 204 dB and 220 dB cSEL, at single strike SELs of 171 dB to 187 dB. The authors concluded that the onset of injury to Chinook salmon occurred at 210 dB cSEL.

Based on these results, the authors suggested that a minimum cSEL of 210 dB was required to inflict injury on these fish, higher than the 187 dB or 183 dB set by the Fisheries Hydroacoustic Working Group (FHWG) (FHWG 2008) and used in this Opinion. However, the criteria have not been revised because of several concerns. First, the study developed a novel model to reflect the onset of injury from impulsive sounds that used undescribed energetic costs to weight the injuries. Without knowing these costs, it is difficult to evaluate the validity of the model. Second, the study was unable to assess the effects of noise exposure on the inner ear, an important sensory system that can be damaged by exposure to sounds. Finally, although eye hemorrhaging and bruising of the spleen were observed, they were excluded from the analysis because they were inconsistently scored and recorded (Halvorsen, pers. com). Because the studies did not account for these injuries, there remains uncertainty around the proposed 210 dB cSEL threshold. It should be noted here that the interim criteria developed by the FHWG were intended for the protection of salmonids listed under the ESA. Under the ESA, any form of injury, even apparently non-life-threatening injuries such, as eye hemorrhage or bruises to the spleen, are to be avoided when possible. As such, the interim criteria should be viewed as conservative.

Despite the uncertainty regarding the acoustic threshold for onset of injury to Chinook salmon, this study provides important new insights into the effects on Chinook salmon from pile driving. First, no fish died immediately to cSEL as high as 220 dB (Halvorsen et al. 2012). And second, there was 100 percent survival and near full recovery from injuries in fish held for two weeks in the laboratory (Casper et al. 2012). These findings are important because it is a first step in distinguishing acoustic thresholds that inflict mortal injuries from those for the onset of injury. While these studies showed that the observed injuries were not directly fatal to fish held in the safety of the laboratory, the survival of fish with these types of injuries has yet to be tested in the wild, where injured fishes could be more susceptible to predation or disease or be less efficient at foraging or reproducing.

Adverse effects on survival and fitness can occur, however, even in the absence of visible injury. Exposure to elevated noise levels can over-stimulate the auditory system of fishes and may result in TTS (a non-injurious temporary reduction in hearing sensitivity) or physical injury, such as a loss of hair cells of the sensory maculae (Hastings and Popper 2005). TTS can result in decreased sensory capability for periods lasting from hours to days (Turnpenny et al. 1994, Hastings et al. 1996). Popper et al. (2005) found TTS after exposure to cSELs as low as 184 dB. Temporary threshold shifts potentially altering normal behavior patterns and increasing the risk of predation

As described earlier, sounds that result in masking can negatively impact reproduction, predator detection, foraging, orientation, or communication (Slabbekoorn et al. 2010, Hawkins and Picciulin, 2019). Planktonic reef fishes have been found to use sound to settle into reef habitats, so masking can potentially affect this important environmental clue (see review by Putland et al. 2019). Fish hear at low frequencies (the majority of fish hearing from less than 50 Hz to 500 Hz [Popper and Hawkins 2019]) and most of the sound energy of impact pile driving in concentrated at frequencies (100-800 Hz) within their hearing range. However, there is a limited understanding of fish hearing because fish are primarily sensitive to particle motion with a gradient of sensitivity among species to SPL depending on if they have a swim bladder and the degree of anatomical adaptations they have to convert sound pressure into particle motion that is detectable by the inner ear (Putland et al. 2019, p.41). Fish species that lack a swim bladder (such as eulachon and sand lance) have the most limited hearing. Salmon and rockfish have a swim bladder, but little specialization, so they primarily detect particle motion. Pacific herring, an important forage species of salmon, have special anatomical adaptations to their swim bladder and can hear sound pressure up to 5 kHz (Mann et al. 2005). Even at levels far lower than those that might result in mortality, may result in temporary hearing impairment, physiological changes, changes in behavior and the masking of biologically important sounds (Table 1; Popper et al., 2014; Erbe et al., 2016). There may be significant consequences to individuals and populations as a result of changes in behavior, including impairment of spawning (Popper 2019). Therefore, underwater noise, including noise from pile driving could result in masking of communication and environmental signals for salmon and rockfish and their forage species, but to what extent we are unsure. For herring (prey species), we assume pile driving could result in masking or behavioral effects.

High sound levels can also result in behavioral effects to fish. Behavioral effects from anthropogenic sound exposure remains poorly understood for fishes, especially in the wild. The behavioral response of fishes to underwater sound depends on a variety of factors, including the species of fish, the type of sound (impulsive vs continuous), and the intensity of the sound (see reviews by Putland et al. 2019, Popper and Hawkins 2019). The observed behavioral changes include startle responses, changes in swimming activity, and increases in stress hormones.

However, few studies have examined the behavioral response of fishes to the sounds that are comparable to those from pile driving. Under some conditions, with some species, elevated sound may cause an effect, but it is not possible to extrapolate to other conditions and other species (Popper and Hastings 2009). A number of species of fishes, including Chinook salmon and Atlantic salmon (*Salmo salar*), have been shown to avoid continuous sounds (similar to vibratory pile driving) at frequencies below 30 Hz (infrasound), but not impulsive-type sounds (similar to those from impact pile driving) at frequencies above 100 Hz (e.g., Knudsen et al. 1992, Enger et al. 1993, Knudsen et al. 1997, Sand et al. 2001). In contrast, McKinley and Patrick (1988, as cited in PFMC 2014) successfully used impulsive-type sounds to divert downstream migrating sockeye salmon (*O. nerka*) smolts from at a hydroelectric dam. Feist et al. (1992) observed that juvenile pink salmon and chum salmon appeared to be less prone to spooking by an observer on the shore when piles were being driven. This reduced awareness could lead to increased predation. Ruggerone et al. (2008) found no observable changes in the behavior of caged coho salmon in the vicinity of impact pile driving; however, the behavior may have been affected by the cages themselves.

Faced with the paucity of data on the response of salmon to pile driving sounds, NMFS is currently using the conservative level of 150 dB RMS as a trigger for analysis of potential adverse behavioral effects from all types of sounds, including those from impact and vibratory hammers. In this Opinion, the potential for adverse behavioral effects will be most important to juvenile PS Chinook and HCSR chum salmon that are outmigrating and overlap with pile driving, because they face a greater risk of predation than subadult or adult fish in marine waters. Both juvenile and adult bocaccio have calling behaviors which may be related to foraging (pers. Comm David Lowry May 2023) and or reproduction (Kok et al. 2021). Masking due to pile driving sound (including vibratory driving) may produce behavioral effects to juvenile bocaccio could also put them at a greater risk of predation, and interfere with reproduction among adult bocaccio.

Work windows are generally designed to prevent work from occurring during peak presence of salmonids, but do not guarantee that exposure will not occur. During the in-water work window for each terminal, all exposed PS Chinook salmon, and PS steelhead, adult HCSR chum, adult rockfish, and most juvenile rockfish individuals will be at least two grams, which reduces the likelihood of injury. Larval rockfish, younger juvenile PS/GB bocaccio, and younger HCSR chum salmon will be less than two grams, making them more vulnerable to injury. Juvenile PS Chinook salmon will have the most exposure due to their extensive use of nearshore habitats and potential to overlap with the in-water work window (Table 14). Juvenile HCSR chum salmon also depend on estuarine and nearshore habitats and their presence overlaps with in-water work window during the early part of their outmigration (Table 14). Adult PS Chinook, adult and juvenile PS steelhead, and adult HCSR chum make little use of nearshore habitats and would be less likely to be exposed to injurious levels of underwater sound unless they were holding in an area long enough to accumulate harmful received levels of impact pile driving noise. However, based on the distance to the onset of injury, 638 m (Table 13), it is hard to assume some adult salmon and steelhead would not be present. Rockfish at all life stages could be exposed but based on the information above and the potential to be closer to the sound source, juvenile bocaccio and larval stages of bocaccio and yelloweye would be most susceptible to potential injurious effects. However, based on the distance to the onset of injury threshold, 638 m, it is hard to assume rockfish would not be present, even in deepwater habitats at some of the terminals located in the San Juan Islands, where rockfish deepwater habitats with structure are more likely to be present.

We cannot predict the exact number of individual fish that will be exposed because of high variability in species presence at any given time. Furthermore, not all exposed individuals will experience adverse effects. We expect that some individuals of listed fish species exposed to pile driving noise will experience sublethal effects, including disruption of normal behavior patterns.

Fish Response to Geotechnical Test Boring Noise – Geotechnical test borings can produce noise above the behavioral guidance criteria for several meters and, if hammering is used, may exceed the cSEL injury thresholds for fish less than 2 grams within a meter from a boring location.

Hammering will likely also generate sound above 150 dB RMS.[35] Therefore, injury from noise produced from geotechnical sample borings would be limited to rockfish larvae or newly settled juvenile bocaccio rockfish that would be adjacent to a boring as a casing is being hammered in. All other ESA-listed fish in the action area during the in-water work window would be greater than 2 grams in weight and not expected to be exposed to injurious noise levels. However, those fish may experience behavioral disturbance sufficient to disrupt normal behavior patterns and increase the risk of predation.

Fish Response to Construction Vessel Noise – Barges, tugs, and smaller vessels will be used for some of the construction activities covered by this Opinion. We expect all life history stages of PS Chinook salmon, HCSR chum salmon, PS steelhead, and PS/GB bocaccio and yelloweye rockfish could be exposed to temporary construction vessel noise. Because most activities covered under this Opinion will occur during a specified in-water work window, most exposure to vessel noise will be limited to that timeframe and exclude most juvenile outmigrants of salmon and steelhead.

Increased background noise has been shown to increase stress in fish (Mueller 1980; Scholik and Yan 2002; Picciulin et al. 2010). Recreational boat noise diminished the ability of resident red- mouthed goby (*Gobius cruentatus*) to maintain its territory (Sebastianutto et al. 2011). Xie et al. (2008) report that adult migrating salmon avoid vessels by swimming away. Graham and Cooke (2008) studied the effects of three boat noise disturbances (canoe paddling, trolling motor, and combustion engine (9.9 horsepower) on the cardiac physiology of largemouth bass (*Micropterus salmoides*). Exposure to each of the treatments resulted in an increase in cardiac output in all fish, associated with a dramatic increase in heart rate and a slight decrease in stroke volume, with the most extreme response being to that of the combustion engine treatment (Graham and Cooke 2008). Recovery times were the least with canoe paddling (15 minutes) and the longest with the power engine (40 minutes). Graham

[35] Technical memorandum from Paul Wolf (WSDOT) to Shawn Gilbertson (WSDOT) on sound-level measurements for over-water geotechnical test boring activities (available at: https://wsdot.wa.gov/sites/default/files/2021-10/Env-Noise-MonRpt-MukilteoFerryBoringNoise.pdf) (accessed June 2023)

and Cooke (2008) postulate that the fishes' reactions demonstrate that the fish experienced sublethal physiological disturbances in response to the noise propagated from recreational boating activities. There are few published studies that assess mortality from vessel traffic on fishes, but studies thus far indicate that ichthyoplankton, which could include larval rockfish, may be susceptible to mortality because they are unable to swim away from traffic and thus may be harmed by propellers and turbulence. One study found low overall mortality from traffic, but that larvae loss was size dependent and that smaller larvae were more susceptible to mortality (Tonnes et al. 2016).

Engine noise, propeller movement, and the physical presence of vessel hulls will likely disrupt or displace nearby fishes (Mueller 1980). Some fish that encounter vessel noise will likely startle and briefly move away from the area. A study of motorboat noise on damselfish noted an increase in mortality by predation (Simpson et al. 2016). While some fish species have been noted to not respond to outboard engines, others respond with increased stress levels, and sufficient avoidance as to decrease density (Whitfield and Becker, 2014), while others experience reduced forage success (Voellmy et al. 2014) either by reducing foraging behavior, or because of less effective foraging behavior. When fish startle and avoid preferred habitats, both the predator and prey detection may be impaired for a short period of time (minutes up to one hour) following that response.

Construction vessels, primarily tugs and barges, will be slow moving, and only be moving intermittently once at construction sites. Because of the intermittent nature of the disturbance, and the short-term and transitory nature of potential exposure, and the baseline level of vessel noise in the action area, we do not expect construction vessels noise and disturbance will result in new or additional responses that will measurably result in increased predation. In addition, adult fish will be less vulnerable to predation and all fish will be able to recuperate when disturbance ceases. Therefore, the temporary, intermittent, and spatially limited disturbance from vessels to all life history stages of PS Chinook salmon, HCSR chum salmon, PS steelhead, and PS/GB bocaccio and yelloweye rockfish is considered minimal.

<u>SRKW Response to Construction Noise:</u> - Because WSFs will monitor for ESA-listed marine mammals and shut-down pile driving if they occur within the extent of the modeled behavioral noise guidance isopleth, SRKW are not expected to be exposed to pile driving noise that will have any measurable effects on their behavior and no exposure to injurious noise levels will occur. Geotechnical boring noise would be above the behavioral threshold for SRKW, but in spatially limited areas for limited time periods per location. The overlap of SRKW and boring noise would be unlikely to occur and, if it did occur, would be so brief as to not be of a duration to cause a measurable effect to behavior. Effects from temporary underwater construction noise will be to prey species. These effects were described above listed species and forage fish and would be expected to be similar for non-listed salmon species in the action area.

SRKWs could be exposed to temporary vessel noise if they overlap with transiting construction vessels. The overlap of SRKW and construction vessels is expected to be brief as SRKWs only occur near terminals for brief periods of time. Once at the terminals, construction vessel noise will only occur intermittently.

Vessels used for a variety of purposes (commercial shipping, military, recreation, fishing, whale watching and public transportation) occur in inland waters of the SRKWs' range. As described in the Baseline Section 2.3.1, Veirs et al. (2016) found that noise from large ships transiting the Salish Sea extends into frequencies used by killer whales for echolocation. Several studies in inland waters of Washington State and British Columbia have linked interactions of vessels and Northern and Southern Resident killer whales with short-term behavioral changes (see review in Ferrara et al. 2017, Holt et al. 2021). 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. Vessel speed also strongly predicted received sound levels by SRKW (Holt et al. 2017, Houghton et al. 2015, Veirs et al. 2016).

Construction vessel, primarily tugs and barges, will be slow moving, will not target or follow whales and are subject to existing federal regulations prohibiting approach to SRKW closer than 200 yards or positioning in the path of the whales within 400 yards. State regulations also mandate protections for SRKWs (see RCW 77.15.740, mandating a 300–400-yard approach limits, 7 knots or less speed within ½ nautical mile of the whales. This approach restriction will increase to 1,000 yards effective January 2025). Once at a construction site, construction vessels would be stationary or operate at very low speeds to reposition.

Based on the above information on construction vessel operation combined with baseline vessel usage within the action area, and the short-term and transitory nature of potential exposure, we do not expect that construction vessels would cause adverse physiological effects or measurable behavioral changes to SRKW. Vessel strikes are extremely unlikely based on the slow speeds of construction vessels near a work site. Therefore, we expect construction vessel noise to be minimal to SRKW and vessel strikes to be unlikely. Although construction vessels could have adverse effects to fish, the extent of effects is not likely to measurably affect the forage base for SRKW.

In summary, noise produced by construction activities (pile driving, marine sediment test boring, and construction vessels) is not anticipated to have a measurable direct effect to SRKW. Effects to salmon forage would be similar to those described previously for ESA-listed salmon and steelhead. Although construction activities could have adverse effects to fish, the extent of effects is not likely to measurably affect the forage base for SRKW.

Overwater Lighting

Fish Response: Although lighting will be oriented away from the water and shielded, some of the activities that do not have an in-water component could be conducted outside of the in- water work window resulting in a greater likelihood of exposure to outmigrating salmon. Juvenile PS Chinook and HCSR chum salmon could be exposed. Juvenile steelhead smolts are larger and better able to avoid predation, are not nearshore dependent, and outmigrate from the Salish Sea within a couple of weeks of entering marine waters (Table 14). Therefore, individual steelhead smolts could be exposed to artificial light, but the duration of exposure would be limited. Adult Chinook and HCSR chum salmon and adult steelhead are not nearshore dependent, occur deeper in the water column, so they are less likely to be exposed to artificial lighting in the nearshore. However, some adult and subadult Chinook may be attracted to the light. Adult rockfish and yelloweye rockfish juveniles would not be expected to be exposed to artificial lighting, because they occur in deep water that would be beyond the extent of the illumination. However, larval life stages of both species, and some juvenile PS/GB bocaccio rockfish may be exposed.

Modal depths occupied by juvenile salmon are 0-10 meters (Beamish et al. 1998, Duffy et al. 2010). Therefore, we can infer that HCSR chum salmon and PS Chinook in the juvenile and subadult stages could be more susceptible to predation if attracted to a light source. The larger their size the less susceptible they would be to predation by fish and avian predators, but they would still be susceptible to pinniped predation. Juvenile HCSR chum, and juvenile and larger resident subadult PS Chinook would also benefit from an increased ability to detect prey, either small fish that may be attracted to lights or zooplankton that migrate into upper surface waters.

Artificial lighting is known to attract several species of fish resulting in changes to orientation, migration, schooling, which can increase predation risk (Becker et al. 2013, Gaston et al. 2017, Nightingale et al. 2006, Tabor et al. 2017, Tabor et al. 2004). However, the estuarine nightscape is complex (Zapata et al. 2019) and salmonids react differently to light levels based on multiple variables including species, light spectrum, and life history stage (Nightingale et al. 2006, pp. 260-261). In salmonids and other diadromous fish, the retinal visual pigments composition is known to change based on salinity (Toyama et al. 2008, pp. 997-1001). As they move from freshwater to estuarine and marine water, their visual sensitivity changing from red-yellow to blue hues (Nightingale et al. 2006, p. 259). Therefore, our analysis below relies primarily on effects from marine habitats or general effects (e.g., pinniped predation aided by illumination and general changes to reaction distances).

Fish attracted to upper water layers with artificial light sources are more susceptible to visual predators, including piscivorous fish, birds and harbor seals (Olesiuk 1996, Yurk and Trites 2000). Hobson (1966) found increased lighting helped fish or mammals distinguish the dark form of their prey against the illuminated background. In the lower Puntledge River in British Columbia, harbor seals foraged on chum salmon fry and coho salmon smolts at night by using the lights from bridges to silhouette the fish and aid in their capture (Olesiuk 1996). Mazur and Beauchamp (2003) investigated prey detection and reaction distance in piscivorous salmonids in a freshwater lake. Reaction distances for cutthroat and rainbow trout increased as light levels increased. Beauchamp et al. (2021) calculated light-dependent visual predation risk six times higher in urbanized nearshore marine habitat in Puget Sound proper than in non-urbanized habitats. In offshore habitats, increased skyglow extended at least 6 kilometers and resulted in almost twice the risk than offshore habitats in non-urbanized regions.

Most studies of lighting and fish use lights directed at surface waters (Prinslow et al. 1980) or look at the overall effect of artificial light at night (ALAN) from all sources in the night sky (Beauchamp et al. 2020, Bolton et al. 2017), whereas temporary project lighting covered in this Opinion will be shielded and directed away from surface waters. We expect that temporary artificial lighting will have some light scattering that will illuminate surface waters or contribute to ALAN even though lights will be shielded and directed away from surface waters. However, with the BMPs that will be implemented to shield and direct lights away from surface waters, and the complexity of the nightscape at each location, it is highly unlikely light levels will be so much greater than the baseline levels to result in measurable changes to behavior of adult, juvenile or larval fish that will result in increased risk of predation.

SRKW Response: SRKW could be temporarily exposed to overwater lighting at night if they were close to a terminal during nighttime construction. Because of the limited extent of the lighting on the water in the nearshore, the limited number of nights with construction, and the limited likelihood of individuals being present in the nearshore near ferry terminals, individual whale exposure is possible, but likely to be limited.

Nighttime lighting is used at the terminals and vessels year-round, although most of the lighting is not overwater. Other overwater and nearshore structures throughout Puget Sound and in the San Juan Islands have overwater lighting that would be likely to illuminate nearshore surface waters, yet there is no data to suggest that SRKWs are affected by illuminated nearshore surface waters. Therefore, the response to overwater lighting is not expected to adversely affect SRKW.

Therefore, the only effect we would expect from temporary, limited artificial lighting would be to salmon prey species for SRKW. Effect to fish were discussed in the overwater lighting fish response section. Because of the temporary duration and limited area of illumination of overwater lighting during the in-water work window, we do not expect a reduction to the overall forage base for SRKWs.

2.4.3 Enduring Effects of Structures and Offsetting Activities

Because of the long duration expected for replaced piles, wingwalls, and components of other structures, many individuals of the listed species are expected to be exposed to the effects of these structures at any time of year, in each year they are present.

The proposed action includes a replacement of floating dolphins, pile-supported wingwalls and dolphins, and the repair or replacement of piles. All new replaced pile-supported dolphins and wingwalls will replace the existing timber or steel piles with steel piles. Table 14 summarizes the type of replacement, location, number, extent of impacts, and expected duration of the effects (maximum durations are assumed based on the material and type of structure which influence the rate at which they remain serviceable). In-water and overwater structures influence habitat functions and processes for the duration of the time they are present in habitat areas. The effects include:

(a) diminishment of forage species and
(b) disrupted migration
(c) suppression of aquatic vegetation

To offset the enduring loss of nearshore habitat function from the replaced structures WSF will use habitat offsets calculated as explained in Section 2.1. The effects of habitat offsets are described below, along with the enduring effects from replacement of wingwalls and dolphins and components of other structures.

Table 14. Summary of the Type, Locations, Maximum Number, Extent, and Duration of Enduring Effects from Replaced Wingwalls, Dolphins and Seismic Upgrades.

Type and Location of Potential Structures to be Replaced per year	Maximum Number to be Replaced per year	Enduring Overwater Footprint/ Structure	In-water Footprint/structure	Creosote Piles Removed/ Structure	Steel Piles Installed/ Structure	Maximum Duration of Effect
Bulkhead Repairs	2		~150 sq ft each			50
Floating Dolphins (concrete): • Point Defiance - 1 • Seattle – 2 • Lopez – 1 • Orcas - 2 • Mukilteo - 1	Up to 2	~3200 sq ft each	Same as baseline and associated with replaced anchors	Not applicable	Not applicable	50 years[36]
Timber Dolphins: • Bremerton – 2 • Coupeville – 2 • Eagle Harbor – 13 • Kingston – 1 • Port Townsend – 2 Timber Wingwalls: • Eagle Harbor – 4	Up to 5	~1790 sq ft (increase of 97 sq ft)	Decreased from baseline and associated with footprints of 5-13 steel piles	35-80	5-13	50 years
Seismic Upgrades – any terminal	Up to 2	450 sq ft	58 sq ft	Not applicable	~8	75 years
Type and Location of Potential Structures to be Replaced per year	**Maximum Number to be Replaced per year**	**Enduring Overwater Footprint/ Structure**	**In-water Footprint/structure**	**Creosote Piles Removed/ Structure**	**Steel Piles Installed/ Structure**	**Maximum Duration of Effect**
Repair/Replace Piles Location at any of 20 terminals	Up to 60		424 sq ft total (assumes all piles are 36”)	~70		20 years*

* Assumes repaired and replaced piles are part of a larger structure which is on a replacement schedule.

[36] The assumed 50-year life is based on the NMFS’s experience implementing similar programmatic consultations, as well as input from WSF and consultants that regularly work on nearshore marine projects in the Salish Sea.

Diminished Forage Species

In-water structures that are driven into substrate displaces that benthic habitat that would provide prey for listed fishes. When all projects are considered the total displaced habitat from in-water structure is approximately 8,848 sq ft. Also, large overwater structures can reduce suitable habitat for forage fish and epibenthic prey species through shading and direct loss of benthic habitat (Lambert et al. 2021, Munsch et al. 2017, Nightingale and Simenstad 2001). Forage fish are also prey for marine mammals and piscivorous birds and appear to be able to provide a prey buffer for salmonid predation (Moore et al. 2021). Less is known about the effects of small overwater structures[37] and their effects (Lambert et al. 2021). Wingwalls and dolphins do not have the same footprint as a ferry trestle or other large overwater structures, so the effects will differ somewhat and are likely to be more variable (see review in Lambert et al. 2021). Seismic upgrades will expand the footprints of existing structures. Although, they are not as large as commercial structures or ferry trestles, in our analysis below we still considered replaced wingwalls and dolphins and seismic upgrades to be overwater structures that will significantly block ambient light. In addition, wingwalls and dolphins are associated with high levels of ferry use and mooring of ferry vessels that will decrease ambient light levels through turbulence or physical presence of vessels.

Extent of Forage Reduction: Under the proposed action, floating dolphins will have a maximum enduring presence of 6,400 sq ft of overwater cover annually.

Up to 10 timber pile-supported wingwalls and dolphins will be replaced annually, with a maximum enduring presence of 1,790 sq ft, with an increase in over-water cover of up to 970 sq ft. The exact footprint of existing and replaced pile-supported wingwall and dolphins is unknown, but the in-water footprint of each of the replaced structures will be reduced because fewer steel piles will be needed (5-13 steel piles at each replaced structure). Overwater coverage will increase by an average of 97 sq ft per replaced structure. Light levels in the replaced structures will be increase because there will be fewer piles that will be more widely spaced, and the height of the structures overwater will increase to approximately 25-26 ft above MLLW. Where overwater structures are in the "shallow shore zone" shade effects on benthic communities and aquatic vegetation are greater than when structures are in the "deep shore zone" (identified as locations deeper than -10 MLLW and no vegetation attached to substrate) as light penetration typically is estimated at ~30 feet. Floating dolphins are typically located at depths greater -45 feet MLLW. The majority of pile supported dolphins and wingwalls are in deeper areas and lacking vegetation. Where located in the shallow shore zone, shade and structure reduce available forage for the duration of time that the structures are present.

Fish Exposure/Response to Forage Reduction:

Each of these species rely on production of forage species produced in benthic habitats for some portion of their forage. PS steelhead smolts, juvenile yelloweye rockfish and adults and subadults of PS Chinook, HCSR chum, and adult bocaccio and yelloweye rockfish are not

[37] As presented in Lambert et al. 2021, small overwater structures are generally much less than 6,028 sq ft (560 sq meters) (WAC 220-660-380).

expected to be affected by reductions in prey at these locations because they are not dependent on these habitats or forage sources.

However, juvenile Chinook and HCSR chum salmon migrate along nearshore habitats to forage in order to sustain their growth and development. We expect juveniles at this life stage to be relatively strong swimmers that can easily migrate to areas with greater prey availability. Such adaptive behavior, while a normal response, could cause a small increase in energy expenditure that can decrease growth and fitness among some individuals from these two species in each year the structures are present. Juvenile bocaccio rockfish utilize shallow nearshore benthic habitats for settlement and growth, and their use of the site may be affected by shade if they prefer locations with greater prey densities. These effects (reduced forage for juvenile PS Chinook, HCSR chum, and juvenile bocaccio) and reduced growth or fitness among some individual fish that are exposed to this reduction, are expected each year for the 50-year presence of the replaced structures.

SRKW Exposure/Response: SRKW are not expected to have disrupted migration or feeding areas based on the presence of the structures, but rather, would be indirectly affected by the replacement of wingwalls and dolphins and seismic upgrades, through impacts to their forage base (primarily PS Chinook). A slight annual reduction in growth or fitness of a few juvenile PS Chinook each year could result from impacts of the program's activities, due primarily to the temporal delay between impacts and offsetting (beneficial) projects. The expected reduction of adult PS Chinook salmon, when aggregated over the life of the structures, is expected to be low number (tens of fish), which could be influence foraging behavior and foraging success among some members of the SRKW population.

Use of Treated Wood

The proposed action includes the use of structural lumber and wood piles treated with ammoniacal copper zinc arsenate (ACZA), with a maximum number of timber piles (5 per year) and
maximum board feet of AZCA timber (30,000 per year). The proposed action requires that all piling, lumber, and other materials treated with preservatives shall be sufficiently cured to minimize leaching into the water or sediment.

ACZA treated-wood placed in or over water will leach copper and other toxic compounds directly into the waterbody (Hingston et al. 2001; Kelly and Bliven 2003; Poston 2001; Weis and Weis 1996). If shavings, sawdust, or smaller particles of pesticide-treated wood generated during construction, use, or maintenance of a structure are allowed to enter soil or water below, they make a disproportionately large contribution to environmental contamination because the rate of leaching from smaller particles is 30 to 100 times greater than from solid wood (FPL 2001; Lebow 2004; Lebow and Tippie 2001).

Copper and other toxic chemicals, such as zinc, and arsenic, that leach from pesticide- treated wood are likely to adversely affect listed fish, that spawn, rear, or migrate by those structures, and when they ingest contaminated prey (Poston 2001). Sub-lethal concentrations of dissolved copper have been shown to impair olfactory function in salmon in freshwater (Tierney et al., 2010). This copper-induced loss of smell leads to a reduction in predator avoidance (McIntyre et al., 2008). Further, fish have shown avoidance of sub-lethal levels of dissolved copper in freshwater (Giattina et al. 1982). While the avoidance behavior persisted in saltwater, no impairment of olfactory function in salmon has been found in saltwater (Sommers et al., 2016). Thus, we believe that the effects of the proposed action include behavioral responses, such as the avoidance of waters around projects sites where treated wood is used and/or impairment of olfaction where elevated, sub-lethal dissolved copper concentrations occur.

Arsenic contamination can be absorbed by aquatic organisms via ingestion, inhalation, and/or permeation of the skin or mucous membranes, entering cells through active transport (Yang et al., 2012; Hong et al., 2014), and the toxic effects of arsenic vary by chemical form. Arsenic exists in four oxidation states: arsenate (AsV), arsenite (AsIII), arsenic (As), and arsine (As−III) (Sharma and Sohn, 2009). Inorganic arsenic (iAs), AsV and AsIII, are dominant forms in aquatic environments. The speciation of arsenic plays a critical role in toxicity and bioavailability (Akter et al., 2005). In general, trivalent arsenic is more toxic than pentavalent arsenic as it can be more easily absorbed by a biological system compared with the prevalent form of arsenic. In addition, when the juvenile marine rockfish *Sebastes schlegelii* was exposed to different doses of waterborne arsenic over 20 days, arsenic accumulated to high levels in the liver, kidney, spleen, gill, intestines, and muscles in a time- and concentration-dependent manner (Kim and Kang, 2015). Arsenic accumulation, was notable in the liver and gills. However, when the marine fish *Siganus fuscescens* was exposed to AsIII and AsV, no significant variances in total As accumulation in intestine and muscle tissues were observed (Zhang et al., 2016). Thus, the ability of AsIII and AsV to pass through the intestine was species-specific (Zhang et al. 2022). Regardless, of the three metals, arsenic, copper and chromium, aquatic organisms tend to be most sensitive to the copper (Stook et al., 2004, Stook et al., 2005). We therefore consider behavioral changes to be the most prevalaent response to exposure to ACZA leachate, which is highest in the initial period after being installed, although some delayed sublethal responses could also result.

<u>Fish Exposure/Response:</u>

Leaching of preservatives from ACZA-treated piles would cause degradation of water quality around the piles and exposure of fish to copper, zinc, and arsenic. All ACZA-treated piles must be sufficiently cured to minimize leaching into the water. This is expected to reduce, but not eliminate leaching of copper, arsenic, and zinc into the water. Although ferry terminals do not provide ideal habitat for salmonids or rockfish, juvenile members of these species are reasonably certain to come close enough to piles to be exposed to copper, zinc, and arsenic. Salmonids and rockfish exposed to these metals would experience behavioral changes and other physiological damage that are expected to impair normal behavior patterns. Since a maximum of five piles will be replaced each year and these piles will be distributed across the WSF locations, a relatively small number of fish will experience to these negative effects.

Use of dimensional ACZA-treated lumber as structural elements typically causes preservatives to enter the water when those structural elements are exposed to precipitation, abrasion, or submersion. A maximum of 30,000 board feet of treated lumber is proposed for use each year. ACZA-treated lumber must be sufficiently cured to minimize leaching into the water. This is expected to reduce, but not eliminate leaching of copper, arsenic, and zinc into the water. As with piles, copper, zinc, and arsenic will degrade water quality around structures where ACZA-treated lumber is used. Since this lumber is not continually submerged, the total amount of metals leaching into the water, when compared to piles, would significantly less. As is the case with piles, the use of ACZA-treated piles would result in degraded water quality and exposure of salmonids and rockfish to copper, arsenic, and zinc. Salmonids and rockfish exposed to these metals would experience behavioral changes and other physiological damage that are expected to impair normal behavior patterns. The response when fish are exposed to these chemicals in additive or synergistic settings, such as where the receiving water body is already impaired, is expected to include more significant health consequences among individual fish.

Obstructions in Migration Areas

<u>Extent of Effects from Obstruction in Migration Areas:</u> Many projects in the proposed action are in areas that may be used by listed species for migration. Up to four timber wingwalls will be replaced (Table 15). Each of the 4 timber wingwalls will have an increase in surface cover of 97 sq ft (total of 388 sq ft if all four timber wingwalls are replaced) compared to current levels. All of the timber wingwalls to be replaced occur at the Eagle Harbor Maintenance Facility. Wingwalls are located close to the most water-ward end of trestles and transfer spans and would be expected to result in shadows that converge with the adjoining structures that could effectively extend the shadow edge of the larger trestle and transfer span (see figures 2 and 4). The future wingwalls will be above the water surface (approximately +25-26 ft Mean Lower Low Water [MLLW]), so the shadow effect is minimized and allows more light to penetrate in between the piles.

Dolphins are independent standing structures, located further offshore, and therefore are not anticipated to interrupt the nearshore migration of juvenile salmon (see figures 2, 3, and 5).

<u>Fish Exposure/Response:</u> The four timber wingwalls at the Eagle Harbor Maintenance Facility are anticipated to obstruct migration pathways for juvenile PS Chinook. No other fish are anticipated to be affected because 1) HCSR chum are considered highly unlikely to occur in the central portion of Puget Sound proper, 2) PS steelhead outmigrate as larger sized smolts that are not shoreline dependent and 3) rockfish do not migrate along the nearshore. Juvenile bocaccio, which settle in shallower habitat, migrate waterward toward deeper habitat as they mature.

The seismic retrofits would also be expected to obstruct the migration pathway to the same species in a similar manner as the wingwalls, but would also include HCSR chum exposure due to location.

Therefore, the analysis following is for juvenile PS Chinook likely encounter the four replaced wingwalls at the Eagle Harbor Maintenance Facility and for juvenile PS Chinook and HCSR chum salmons encountering seismic retrofits and repaired/replace piles at any terminal, and at Coupeville where PS Chinook and HCSR chum may encounter the repaired bank armor.

No Chinook salmon-bearing streams are located near the Eagle Harbor Maintenance Facility; however, beach seining indicates juvenile Chinook salmon are present in the Central portion of Puget Sound from April through September (Duffy et al. 2005 and 2010, Toft et al. 2007, BAR Chapter 4 Terminal Specific Information) and in general in the Action Area from April through November (Brennan et al. 2004, Rice et al. 2011, Beamer and Fresh 2012). HCSR chum juveniles would be expected to be in the action area from January through June. The duration of effect will be for the life of the replaced structures, estimated at up to 50 years for wingwalls and up to 75 years for transfer spans with seismic retrofits.

Outmigrant juvenile PS Chinook and HCSR chum in the earliest periods of their marine residency prefer the protection of shallow nearshore water and overwater structures can cause delays in migration for outmigrants from disorientation, fish school dispersal (resulting in a loss of refugia) and altered migration routes (Simenstad 1999), all of which can result in increased exposure to predation. Nearshore oriented juvenile Chinook salmon and HCSR in both the marine nearshore and in freshwater, migrate along the edge of shadows rather than through them (Nightingale and Simenstad 2001; Southard et al. 2006; Celedonia et al. 2008a; Celedonia et al. 2008b; Munsch et al. 2014). Juvenile salmon have been observed stopping at the edge of the structures and avoid swimming into their shadow or underneath them (Heiser and Finn 1970, Simenstad 1999, Southard et al. 2006, Toft et al. 2007 and 2013, Ono 2010, Munsch et al. 2014). Southard et al. (2006) snorkeled underneath, conducted surface observations, and acoustically tagged juvenile Chinook and coho salmon at ten Puget Sound ferry terminals and found that juvenile salmon were not underneath the terminals at high tides when the water was closer to the structure, but moved underneath the terminals at low tides when there was more light penetrating the edges or when light impacts of the structure were less pronounced. Nightingale and Simenstad (2001) concluded that cumulative impacts of overwater structures in urban industrialized areas in estuaries (multiple placements of overwater structures) can pose substantive risks to estuarine ecosystems, especially in areas like Elliott Bay where estuarine habitat is extremely limited, and the shoreline is highly modified with piers and bulkheads. Ono et al. (2010) and Ono and Simenstad (2014) extrapolated that migration delays when encountering large overwater structures like the Port Townsend Ferry Terminal could result in several hours of migration delay. In Lake Washington, actively migrating juvenile Chinook salmon swam around structures through deeper water rather than swimming underneath a structure (Celedonia et al. 2008b). Structure width, light conditions, water depth, and presence of macrophytes influenced the degree of avoidance. Juvenile Chinook salmon were less hesitant to pass beneath narrower structures (Celedonia et al. 2008b).

In summary, NMFS anticipates that PS Chinook juveniles and HCSR chum juveniles will be vulnerable to piscivorous predators from aggregating at the replaced wingwalls (PS Chinook only at Eagle Harbor) and seismic upgrades or migrating into deeper water to go around them for the duration of each replaced structure’s lifespan. Therefore, the enduring presence of the replaced wingwalls is considered to adversely affect individual juvenile PS Chinook salmon and the enduring presence of the seismic upgrades is considered to adversely affect juvenile of PS Chinook salmon and HCSR chum.

SRKW Exposure/Response: No direct effect to SRKW is expected from the presence of increased overwater cover at the WSF' terminals because nearshore overwater structures are not considered to be a significant obstruction to their movement.

Habitat Offsetting Activities

As described in Section 2.1, some elements of the proposed action, (e.g., removal of creosote-timber piles and man-made debris) generate beneficial effects on the quality of nearshore habitat. (Short-term effects from these activities are discussed in 2.4.1). The proposed action includes any number of removals of man-made debris and replacements of timber wingwalls and dolphins, with each replacement resulting in 35 to 80 creosote-timber piles removed. If additional offsetting measure are necessary to retain conservation values of critical habitat, WSF intends to apply a combination of restoration activities, purchase of conservation or ILF credits, or additional creosote removal.

The proposed action includes the removal ofman-made debris and wood piles. Construction and water quality impacts of removing piles were analyzed in our assessment of construction impacts earlier in this document.

Piling and other structure removal from waterways will improve water quality by eliminating chronic sources of toxic contamination and associated impacts to nearshore dependent species. Removal will also restore impacted substrates because the presence of the structure prevents recovery of important freshwater, intertidal, and subtidal habitats.

During pile or other debris removal, sediments will be re-suspended because they are inevitably pulled up with, or attached to, the piles, or other man-made debris. If sediment in the vicinity of the removed item is contaminated, or if the pile is creosote treated, those contaminants will be included with the re-suspended sediments, especially if a creosote-treated pile is damaged during removal. Due to the relatively small amount of sediment disturbed during pile removal, re-suspended sediment will be localized and temporary. The long-term effects of structure removal will be beneficial, including substrate recovery and reduction of resting areas for piscivorous birds, hiding habitat for aquatic predators, and, in the case of preservative-treated piles, a chronic source of contamination.

Beach nourishment is an activity designed to provide an ecological uplift through the rehabilitation or restoration of beach substrate through placement of suitable substrate materials. Activities covered under this category could be standalone projects or an action taken to achieve conservation offsets. Placement of substrate material will occur in the high tide zone of the beach or shore. Some short-term suspended events are likely as the materials are naturally redistributed by wave, wind, current, or tidal action. Suitable materials will not be contaminated with toxics or hazardous materials. Existing substrate will be disturbed during materials placement, but redistribution will restore organisms and natural processes in a zone that routinely experiences disturbance in normal tide cycles or seasonal fluctuations in river flows. Placed materials will also closely match the existing substrates. Beach nourishment activities address sediment deficits and allow for wave energy dissipation, which contribute to improved ecological processes. In many areas beach nourishment will provide improved nursery grounds and other habitat for forage fish species. Improved beach and shoreline habitats will also provide shelter from predators and food for young salmonids. Nourishment does not remove the physical forces that cause erosion but it does help to improve and restore habitats affected by erosion.

The proposed action requires that these actions or credits will address the loss of ecosystem functions caused by the impacting activities, with the goal of achieving a no-net-loss of habitat function as a result of this proposed action. A no-net-loss will help ensure that PS Chinook do not continue to drop below the existing 1-2% percent juvenile survival rates (Kilduff et al. 2014, Campbell et al. 2017) and in turn will not further reduce available SRKW prey. With implementation of the Calculator as described in Section 1, we expect no net loss of shoreline habitat function from replacement of wingwalls and dolphins and seismic upgrades covered by this Opinion. Under the proposed action, the federal action agencies and WSF have committed to ensure that all activities that result in enduring effects on nearshore habitat will be offset by beneficial activities that improve the quality of nearshore habitat. The action agencies and WSF have committed to use the Calculator or similar analytical tool to ensure that enduring effects on nearshore habitat are fully offset by the beneficial activities. The proposed also action includes reporting and review steps to ensure the offsetting process works as proposed.

If the WSF elects to satisfy identified debits via an option that allows delay (for example, contributions to in-lieu fee programs, or credits generated during the subsequent biennium), this expected time delay in achieving a conservation offset does not undermine our benefits analysis because significant evidence supports our assumption that ecosystem improvements restoration in nearshore environments will occur rapidly once restoration is complete. For example, Lee et al. (2018) documented strong and positive biotic restoration response within one year of the removal of shoreline armoring. In addition, following significant estuary restoration in the Nisqually River delta, salmon catch data indicated that smolts were using this newly accessible habitat as early as one-year post-restoration (Ellings 2016).

Thus, within a short time frame, we expect ESA listed fish, and SRKW would have only beneficial response to these habitat offsets from the removal of creosote and man-made debris.

2.4.4 Effects of Program Activities on Sunflower Sea Stars

Several of the activities and their consequences have the potential to adversely affect sea stars. While the abundance of sunflower sea stars is fractional relative to its historical numbers, we expect that within the action area sunflower sea stars are likely to be present, in part because the range of their habitat is so extensive (nearshore to 450 m in depth).

However, each individual project area for activities carried out under this programmatic action will affect a tiny portion of the habitat available for sea stars in the Salish Sea. There is no indication that sea stars favor the type of habitat at these project sites, and the density of stars in these areas is likely to be low. As a result, the total number of stars affected by the proposed action is expected to be very low relative to the number of sunflower sea stars in Puget Sound.

The activities with the greatest likelihood of adversely affecting sea stars include removal of structures that sea stars may attach to (piles, bulkheads, some types of in-water debris), modification of the substrate (beach nourishment), exposure to suspended sediment, or facilities washing that may introduce chemical contaminants.

Little is known about specific effects of toxic contaminants on sunflower sea stars, or how stress from exposure to such chemicals affects susceptibility to sea star wasting syndrome. Suspended sediment in stormwater may also be a concern as stars that become covered by sediment may experience greater risk of wasting disease. NMFS anticipates that over the course of this programmatic a very small number of individuals could be harmed, injured, or killed by these activities.

2.4.5 Effects on Critical Habitat

Effects of the proposed action on habitat are described above in order to present effects on species. In this section we evaluate the effects of those habitat changes on the function of features of critical habitat for PS Chinook, HCSR chum, PS/GB bocaccio, and SR killer whales. Critical habitat these species occurs within the action area and, as described above in Sections 2.4.2 and 2.4.3, may be adversely affected either temporarily or by more enduring effects. PS Steelhead do not have critical habitat designated in the Action Area.

NMFS reviews effects on critical habitat by examining how the PBFs of critical habitat will be altered, the duration of such changes, and the influence of these changes on the potential for the habitat to serve the conservation values for which it was designated. We did not find any significant effects to PS/GB yelloweye rockfish designated critical habitat, so it is discussed in Section 2.10, "Not Likely to Adversely Affect" Determinations.

In estuarine and marine areas, the features of designated habitat common to each of these listed species are water quality and forage or prey, and for PS Chinook and HCSR chum salmon safe migration. For juvenile PS/GB bocaccio, and PS Chinook salmon are nearshore habitat with suitable conditions for growth and maturation, including sub-aquatic vegetation.

Water Quality

Designated critical habitat for each species will experience temporary, and episodic declines in water quality (a PBF of PS Chinook, HCSR chum, PS/GB bocaccio, and SRKW habitats).

Temporary water quality reductions from increased turbidity and suspended sediment, corollary decreases in DO: Increased turbidity and suspended sediment effects are expected to be intermittent during in-water repairs, extend no more than 150-ft from in-water work, have little effect on DO and return to baseline within hours (turbidity and suspended sediment) after work ceases. Based on these factors, the temporary turbidity, suspended sediment from construction related impairment of this PBF will not reduce the conservation value of the habitat for salmon, rockfish, or SRKW. Values for species movement, growth, maturation, and fitness are all retained.

Episodic reductions in water quality from contaminants: Increased levels of PAHs and other contaminants re-suspended in the water column will occur with the removal of creosote material and potentially when sediments are disturbed from pile removal and other substrate disturbing activities. These water quality effects are expected to abate as the contaminated materials settle out, at which point they become persistent in the substrate for up to three years. Total surface water concentrations are anticipated to dilute to background levels rapidly but remain persistently in marine waters. Because exposure to such contaminants can have chronic or sublethal effects, and bioaccumulate, this aspect of water quality degradation could temporarily impair the value of critical habitat for salmon, bocaccio rockfish, and SRKW by affecting the growth and maturation of the listed species and their prey species.

Consequently, we consider the temporary and intermittent effects of the proposed action on water quality will create a temporary diminishment of the water quality PBF for all designated critical habitat in the action area. However, with BMPs to minimize effects and the permanent removal of creosote piles, the water quality PBF will be degraded, but we do believe that the effect of the Action will not diminish the overall value of critical habitat for salmon, rockfish, or SRKW.

Temporary water quality reductions from noise occur during construction: Noise from pile driving, geotechnical borings, and construction vessel movement is transmitted through the water and diminishes habitat value for all fish species addressed in this Opinion that are present and detect this disturbance. Habitat value can be diminished by potentially altering fish behaviors, causing TTS, PTS (impact pile driving only), or injury depending on individual received levels and type of sound received (non-impulsive, impulsive) and duration of exposure. This reduction in the aquatic habitat value ceases when the activity stops. Because most activities will only occur during the work window, and even within that timeframe noise is not continuous but is interrupted by breaks in work, the effect of noise will not diminish the overall value of critical habitat for salmon, bocaccio rockfish, or SRKW.

Additional effects of noise to the migration PBF for PS Chinook, HCSR chum and SRKW are discussed below.

Forage and Prey

Designated critical habitat for PS Chinook, HCSR chum, PS/GB bocaccio, and SRKW will experience declines in forage or prey communities (a PBF of Chinook, chum, PS/GB bocaccio, and SRKW).

Prey reductions are both temporary, when sediment is disturbed during work, and more enduring, such as when in-water structures and overwater structures are repaired or replaced, or in the case of seismic retrofit, newly constructed. Where structures are in the deep shore zone, the reduction of prey communities is much less than in the shallow shore zone, as light penetration in shallow areas supports benthic communities and sub aquatic vegetation that hosts other prey species.

Disturbing sediment will disrupt the benthic communities that live within those sediments, reducing prey availability in the footprint of the in-water work and adjacent areas where suspended sediment settles out. Among prey fishes, short-term and intermittent exposure to reduced water quality could result in minor reductions in forage species via gill damage of forage fishes. Suspended sediment will eventually settle in the area adjacent disturbance from bulkhead repairs, debris removal, sediment borings, and pile repair, removal, or placement, which can smother benthic prey species, and if the sediments are contaminated, then sublethal toxicity of benthic prey species could occur within 150 ft of these activities.

Loss of benthic habitat from pile placement will reduce invertebrate production, decreasing the availability of salmon and juvenile rockfish prey. Because the area affected around each pile is relatively small, and where temporary disturbance will occur, benthic recolonization to their former level of abundance and diversity is anticipated to occur relatively quickly, we consider the reduction in benthic habitat, to be small and fully offset through beneficial activities.

Shade from barges during construction activities will not occur in areas of SAV or potential forage fish spawning. Shading from temporary work platforms is restricted to the in-water work window and will be limited to only two platforms at all 20 terminals per year, so shade from this source is not expected to have an appreciable effect on available prey communities.

We anticipate impacts to SAV and epibenthic forage will be diminished or fail to establish due to the shade produced by replaced overwater structures, and in some cases from shade when vessels are moored at the structures for extended periods, and from prop wash from vessels leaving and arriving at these structures. SAV is important in providing cover and a food base for juvenile PS Chinook salmon, HCSR chum salmon, and juvenile PS/GB bocaccio. The reduction in food sources includes epibenthos (Haas et al. 2002) as well as forage fish. Forage fish are important to all fish species in this Opinion. The repeated episodes of disturbance, together with the enduring reduction at replaced dolphin, wingwall, and seismic retrofit locations, will create an incremental systemic decline in the prey PBF for Chinook salmon, HCSR chum salmon, and juvenile PS/GB bocaccio. This effect is adverse, but is expected to be fully offset through beneficial actions.

Migration/Passage

Designated critical habitat will experience temporary and long-term diminishment of safe migration for PS Chinook and HCSR chum salmon. This PBF is not expected to be diminished for SRKW because nearshore structures are not observed to affect migration of SRKWs and because of marine mammal monitoring during pile driving will result in shutdowns if SRKW are present.

The activity with the greatest impact for obstructing migratory is impact pile driving. WSFs will impact drive a maximum of four piles per day with a maximum of 2,000 strikes per day at any one terminal. At any one terminal, the total time of impact driving per day is estimated at a maximum of 80 minutes of actual striking. There will be a 12-hour overnight rest period each day. A bubble curtain or other sound attenuation device that has been designed to meet approved specifications will be used to reduce underwater SPLs during impact driving. Vibratory pile driving for longer durations and larger piles could produce levels of sound that result in TTS, masking or behavioral changes that could disrupt migration or result in increased vulnerability to predation. Geotechnical sediment test borings will produce lower-level intermittent noise of short durations and are not likely to significantly obstruct a migratory corridor. Construction vessels can temporarily increase noise levels and cause physical disturbance by their presence but will only be intermittently operating at a construction site. The effects of temporary construction noise are more fully described in Section 2.4.1, Temporary Noise in Aquatic Habitats. Because passage is obstructed by noise during the work window only, and even within that timeframe is not continuous but is interrupted by breaks in work, the values of critical habitat for all species are only slightly diminished.

Shade from temporary work platforms and barges can cast a sharp light/dark contrast that can impair the migration corridor for juvenile salmon and disrupt other habitat functions. Minimization measures will prevent barges from measurably affecting kelp or eelgrass beds and work platforms will only be present in limited areas (up to two per year at all terminals) during an in-water work window. Therefore, the migration pathways will be adversely affected temporarily, primarily within the in-water work window. Once temporary structures and barges are removed the obstruction will cease. Based on the limited duration and timing of temporary obstructions, we consider the migration value for PS Chinook and HCSR critical habitat to be largely retained.

Artificial lighting that will be temporarily placed during construction (up to 10 nights per year at each terminal at any time of year). As discussed in Section 2.4.2, we expect that temporary artificial lighting will have some light scattering that will illuminate surface waters or contribute to ALAN even though lights will be shielded and directed away from surface waters. However, with the BMPs that will be implemented to shield and direct lights away from surface waters, and the complexity of the nightscape at each location, it is highly unlikely light levels will be high enough over baseline levels to result in measurable changes to the migration behavior of adult, juvenile or larval fish. Therefore, the effects of artificial lighting to the migration PBF are considered minimal. Permanent shading will occur in the migratory corridor from replaced pile-supported wingwalls at the Eagle Harbor terminal and seismic upgrades at other terminals. But, these adverse effects are expected to be fully offset through beneficial activities.

Summary of Effect to Critical Habitats

The proposed action, including full application of the planned conservation measures and BMPs, is likely to adversely affect designated critical habitat for PS Chinook salmon, HCSR chum salmon, PS/GB bocaccio rockfish, and SRKW.

To summarize the effects on critical habitat, PBFs will be temporarily impaired during maintenance and repairs at each terminal with a corresponding reduction in habitat/resource availability while the work occurs. Removal of creosote piles is likely to have detrimental water quality effects for up to three-years. However, the beneficial activities covered by this

Opinion will improve habitat in a manner that fully offsets the adverse effects caused by the repair or replacement activity categories.

2.5 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.

The majority of activities that may affect listed species in the action area will have a federal nexus because they occur waterward of the ordinary high-water mark and require a permit from the USACE (e.g., improvements at ports, replacement of revetments, bulkheads, overwater and in-water structures and stormwater outfalls) or have financial contribution from another federal agency.

Generally, non-federal activities and effects of non-federal activities that we can reasonably expect are: recreational uses of Puget Sound; increasing upland uses that contribute more stormwater inputs to Puget Sound; conversion of riparian areas above mean higher high water adjacent to Puget Sound; and climate effects, as described above at the status of species section, and which we anticipate to become more pronounced over time, including in the action area.

Some nonfederal actions were identified in the action area from a review of pending permits and information from city and county planning departments. From the review, the following action is reasonably certain to occur and would potentially impact the marine environment:

- New upland developments planned near the Anacortes and Clinton terminals that would result in increases in impervious surfaces and potentially additional stormwater runoff into the Action Area.

Other regional actions that will be ongoing include city and county Shoreline Master Programs. These programs include provisions for shoreline mitigation including elimination or softening of existing shoreline armoring, as well as utilization of buffers to reduce discharges to adjacent waters. The actions of these programs should work to improve water quality and habitat for fish and aquatic species. Many of these actions will require federal permitting from the USACE. Another regional action is the Washington State's Derelict Fishing Gear Removal Program that removes derelict gear from marine waters in cooperation with other entities. Gear removal has a beneficial effect on marine species and habitats into the future, including the ESA-listed species and designated critical habitats addressed in this Opinion.

The human population in the Puget Sound region increased from about 1.29 million people in 1950 to about 3.84 million in 2014 and is expected to reach nearly 5 million by 2040 (Puget Sound Regional Council 2020). As of 2019, the human population in the Puget Sound Region is 4.2 million[38], slightly exceeding projections. As the human population continues to grow, demand for agricultural, commercial, and residential development and supporting public infrastructure is also reasonably certain to grow. Thus, future private and public development actions are reasonably certain to continue in and around Puget Sound.

Future development is anticipated to include future residential and commercial development, redevelopment, road and railroad construction and maintenance, agricultural development and shoreline modifications (e.g., repair, replacement, construction and removal of bulkheads above the High Tide Line that may not have a federal nexus through authorization or funding). We believe the majority of environmental effects related to future growth will be linked to these activities, in particular land clearing associated with land-use changes (i.e., from forest to impervious, lawn or pasture), increased impervious surface, and related contributions of contaminants to area waters. Changes to tributary watersheds from timber harvest and land conversions are likely to result in reduced water quality and quantity, changes in sediment transport, and reduction of riparian cover. Though existing regulations minimize future potential adverse effects on salmon habitat, as currently constructed and implemented, development actions are reasonably certain to have effects to listed species from systemic, incremental, and additive degradation. Therefore, land use changes and development of the built environment that are detrimental to fish habitats are reasonably certain to continue under existing regulations.

In addition to growth and associated marine habitat changes, human population growth is expected to result in a higher density of boat traffic (both commercial and residential), which is reasonably certain to include reduced water quality, collisions with marine mammals, and increased underwater noise. The Human Sound Behavior Index indicates that no change in average behavior is expected. Thus, an increase in human population is likely to continue to degrade habitat quality. (The Sound Behavior Index tracks 28 human use practices[39] that likely affect habitat and water quality and quantity).

Some types of human activities that contribute to cumulative effects are expected to have adverse impacts on SRKWs, 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. Tribal, state and local government actions will likely be in the form of legislation, shoreline growth management, administrative rules, or policy initiatives and fishing permits. These actions may include changes in ocean policy and increases and decreases in the types of activities currently seen in the action area, including changes in the types of fishing activities, resource extraction, or designation of marine protected areas, any of which could impact listed species or their habitat. Government actions are subject to political, legislative and fiscal uncertainties. Private activities are primarily associated with other commercial and sport fisheries, construction, dredging and dredge

[38] https://www.psrc.org/whats-happening/blog/region-adding-188-people-day

[39] Human use practices include among others: (a) Number of residents with native vegetation on banks of waterways; (b) number of residents using pump stations for boat wastewater; (c) residents using herbicides and pesticides; and (d) pasture practices for residents with livestock.

material disposal, vessel traffic and sound, alternative energy development, offshore aquaculture/mariculture, and marine pollution.

Although these factors are ongoing to some extent and likely to continue in the future, past occurrence is not a guarantee of continuing level of activity. That will depend on whether there are economic, administrative, and legal impediments (or in the case of contaminants, safeguards). Therefore, it is difficult to assess the cumulative impacts and the relative importance of effects additional to those already identified, but that these effects may occur at somewhat higher or lower levels than those described in the environmental baseline (Section 2.3).

Multiple non-federal activities are reasonably certain to occur that impact SRKW. NMFS, in coordination with its multiple partners, have implemented targeted management actions identified in the SRKW recovery plan and informed by research. Transboundary efforts between the U.S. and Canada have occurred to address all the threats identified in the recovery plan. Actions to reduce impacts from vessels on SRKW by limiting the potential for interactions include:

1. Washington State law (Senate Bill 5577) established a commercial whale watching license program and charged WDFW with administering the licensing program and developing rules for commercial whale watching for inland Washington waters (see RCW 77.65.615 and RCW 77.65.620). The rules were adopted in December 2020, and became effective May 12, 2021, and include limitations on the time, distance, and area that SRKW can be viewed within ½ nautical mile, in an effort to reduce vessel and noise disturbance:
    a. The commercial whale watching season is limited to 3 months/year for viewing SRKW closer than ½ nautical mile and is limited to 4 hours per day in the vicinity of SRKW.
    b. Up to 3 commercial whale watching vessels are allowed within ½ nautical mile of SRKW at a given time, with exclusion from approaching within ½ nautical mile of SRKW groups containing a calf.
    c. Year-round closure of the “no-go” Whale Protection Zone along the western side of San Juan Island to commercial whale watching vessels, excluding a 100-yard corridor along the shoreline for commercial kayak tours.
    d. In July of 2023, Senate Bill 5371 increase d the approach distance for SRKWs to 1,000 yards effective January 2025.

2. Continued implementation and enforcement of Washington State’s 2019 restrictions on speed and buffer distance around SRKW for all vessels (see RCW 77.15.750).

3. Increased effort dedicated to outreach and education programs by Washington State agencies. This includes educational material for boating regulations, Be Whale Wise guidelines, the voluntary no-go zone, and the adjustment or silencing of sonar in the presence of SRKWs. Outreach content was created in the form of video, online (including social media), and print advertising targeting recreational boaters. These materials are distributed as part of WSF’ 7(a)(1) Program (see Appendix B) on ferry

vessels and on-site efforts at pump out and re-fueling stations along Puget Sound, during enforcement orca patrols, and signage at Washington State Parks and WDFW water access sites. Washington State Parks integrated materials on whale watching regulations and guidelines in their boating safety education program to ensure all boaters are aware of current vessel regulations around SRKW. Additionally, when possible, WSF will continue to enlist naturalist onboard on specific routes during the summer high season to educate ferry riders on SRKW and other marine mammals (see WSF's 7(a)(1) program, Appendix B).

4. Promotion by Port of Seattle and Port of Vancouver, and other entities of the WRAS in the Salish Sea, 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 (WAC 220-460-140), and on- the-water staff are also being trained to report their sightings. WSF uses the WRAS system on all ferry crossings.

5. Piloting a new program ("Quiet Sound") that will have topic-area working groups to lead projects and programs on vessel operations, incentives, innovations, notification, monitoring, evaluation, and adaptive management. This effort was developed with partners including Commerce, WSF, and the PSP in collaboration with the Ports, NOAA, and others. Funding was secured in the 2021 state legislative session.

   Currently WDFW enforcement boats conduct 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 that include monitoring and enforcement of fisheries and Marine Mammal Protection Act requirements related to vessel operation in the presence of marine mammals throughout Puget Sound. Patrols in the marine waters surrounding the San Juan Islands, Fidalgo Island, and Bellingham Bay area (WDFW Marine Area 7) are specifically targeted to enforce regulations related to killer whales. These patrols will be increased in intensity at times SRKW calves are present. For comparison, in 2017, WDFW Police conducted 55 patrols; in 2018, they conducted 140 patrols; and in 2019 they conducted 105 patrols specific to Marine Area 7 during the summer (Cunningham 2021). Outreach and enforcement of vessel regulations will reduce the vessel effects (as described in Ferrara et al. [2017)]) of recreational and commercial whale watching vessels in U.S. waters of the action area.

Other actions include:

- On March 14, 2018, WA Governor's Executive Order 18-02 was signed. It ordered state agencies to take immediate actions to benefit SRKW and established a Task Force to identify, prioritize, and support the implementation of a longer-term action plan needed for SRKW recovery. The Task Force provided recommendations in a final Year 1 report in November 2018.[40] In 2019, a new state law was signed that

[40] Available at: https://www.governor.wa.gov/sites/default/files/OrcaTaskForce_reportandrecommendations_11.16.18.pdf, last visited May 26, 2019.

increases vessel viewing distances from 200 to 300 yards to the side of the whales and reduces vessel speed within ½ nautical mile of the whales to seven knots over ground yards (the approach limit will increase to 1,000 yards effective January 2025). SB 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[41] 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. In response to recommendations of the Washington State Southern Resident Killer Whale Task Force, the Washington State Legislature provided approximately $13 million in funding "prioritized to increase prey abundance for southern resident orcas" (Engrossed Substitute House Bill 1109) for the 2019-2021 biennium (July 2019 through June 2021).

- On March 7, 2019, 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. Other actions included providing funding to WSDOT to continue to correct fish barriers. Although these measures won't improve prey availability in the next few years, they are designed to improve conditions in the long-term.

Some continuing non-federal activities are reasonably certain to contribute to climate effects within the action area. Crozier et al. (2019) state that "sea level rise is projected to expand the area of some tidal wetlands in Puget Sound but reduce the area of others, as water depths increase, and new areas become submerged. For example, the area covered by salt marsh is projected to increase, while tidal freshwater marsh area is projected to decrease. Rising seas will also accelerate the eroding effect of waves and surge, causing unprotected beaches and bluffs to recede more rapidly. The rate of sea level rise in Puget Sound depends both on how much global sea level rises and on regionally specific factors such as ocean currents, wind patterns, and the distribution of global and regional glacier melt. These factors can result in higher or lower amounts of regional sea level rise (or even short-term periods of decline) relative to global trends, depending on the rate and direction of change in regional factors affecting sea level" (Mauger et al. 2015).

In summary, we consider human population growth to be the main driver for most future negative effects on salmon and steelhead and their habitats within the action area. Multiple future non-federal actions, in the nearshore as well as in tributary watersheds that flow into and affect the marine habitat in the action area, will cause long-lasting environmental

[41] Available at: https://www.governor.wa.gov/sites/default/files/OrcaTaskForce_FinalReportandRecommendations_11.07.19.pdf, last visited May 26, 2019

degradation. Only improved, low-impact development actions together with increased numbers of restoration actions, watershed planning, and recovery plan implementation will be able to address growth related impacts into the future. To the extent that non-federal recovery actions are implemented and offset ongoing development actions, adverse cumulative effects may be minimized, but will not be completely avoided. However, the cumulative effects associated with continued development are reasonably certain to have ongoing adverse effects on all the listed species and critical habitats addressed in this Opinion. Therefore, NMFS finds it likely that the cumulative effects of these activities will have adverse effects on population abundance and productivity of ESA-listed species and critical habitats within the Action Area.

2.6 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.

The design of the proposed action for the programmatic biological and conference opinions is a critical factor in our assessment. The activity types and associated design criteria were carefully selected to ensure that environmental outcomes of each activity can be readily predicted. As described in the analysis of the effects of the action, the effects of the proposed activities primarily cause short- term, localized, and minor effects. These effects are mostly caused by in- and near-water construction and last, at most, a year or two. General construction measures required by this maintenance and preservation program ensure minimization of short-term effects and recovery of function of aquatic and riparian habitat at disturbed sites. The location of projects covered will be spread across the Salish Sea at fixed ferry terminal locations. Although there is some geographic clumping of projects around urban areas, the geographic extent of short-term adverse effects from projects do not typically overlap. The short-term adverse effects of projects will bear on far too small of an area to meaningfully affect the conservation value of critical habitat for PS Chinook salmon, HCSR chum, bocaccio, and SRKW. Activities involving maintenance of existing structures will often result in a reduction of current impacts and improved habitat quality at project. For example, replacement of overwater structures made of treated wood piles and decking with steel piles will decrease input of contaminants into surrounding water.

Most importantly, the proposed action requires that all enduring or long-term effects of structures on nearshore habitat quality must be compensated through conservation offsets. By including this requirement in the proposed action, we expect no-net loss of nearshore habitat or critical habitat conservation value over time. New and replacement terminals are beyond the scope of analysis. Under the proposed action design criteria, structures require fish-friendly features such as grated decking and use of treated wood piles only when methods are applied to minimize the wood preservative reaching the water (i.e. all piling, lumber, and other materials treated with preservatives must be sufficiently cured to minimize leaching into the water or sediment). In addition, there are maximum limits on the amount of ACZA treated wood that can be used. These limits ensure that only a small number of fish are reasonably certain to be exposed to the negative effects of treated wood preservatives. All long-term impacts of structures on nearshore habitat must be entirely compensated through conservation offsets (habitat enhancement activities or purchased credits or ILF) on a rolling per-year basis resulting in a no long-term net loss of habitat. Habitat enhancement activities implemented by WSF as well as purchased credits and ILF (those not carried out to achieve conservation offsets) will result in long-term beneficial effects on quality of critical habitat such that they would offset detrimental effects.

In summary, most projects carried out under the proposed action will have short-term adverse effects on habitat resulting from construction activities. As stated earlier, these short-term adverse effects will impact far too few individuals to cause any meaningful on population viability for any affected species. Moreover, most of these short-term effects ameliorate over time and habitat will recover. Habitat enhancement projects carried out by WSF will result in a long-term improvement of habitat quality. Some maintenance and repair activities result in an enduring loss of habitat quality. However, these activities require conservation offsets to compensate for the loss of nearshore habitat function. In the long-term, a no-net loss approach to nearshore habitat quality will avoid negative effects on population viability especially for PS Chinook salmon. Even with the expected negative effects of climate change, the proposed action will not appreciably reduce the likelihood of survival and recovery of any the listed species addressed in this biological opinion or conference opinion.

2.6.1 ESA Listed Species

Salmon and Steelhead

The status of all PS salmonids is threatened based on low abundances, low productivity, reduced spatial structure and limited species diversity. These species are listed in part because of system loss or degradation of habitat, throughout their range. Some conditions of degraded habitat are factors for decline and are limiting to productivity, constraining recovery. Some of these limiting factors are found as baseline conditions in the action area (e.g. at each terminal there are structures present, and armoring, and uses, that alter physical processes, water and sediment quality, riparian and marine vegetation, and forage fish spawning habitat).

All Puget Sound Chinook salmon populations continue to remain well below the TRT planning ranges for recovery escapement levels. Most populations also remain consistently below the spawner–recruit levels identified by the TRT as necessary for recovery. Across the ESU, most populations have increased somewhat in abundance since the last status review in 2016, but have small negative trends over the past 15 years. Productivity remains low in most populations (Ford 2022).

Natural-origin spawner abundance of Hood Canal Summer Run Chum has increased since ESA listing, and spawning abundance targets in both populations have been met in some years.

Productivity had increased at the time of the last review (NWFSC 2015), but has been down for the last three years for the Hood Canal population, and for the last four years for the Strait of Juan de Fuca population. Productivity of individual spawning aggregates shows that only two of eight aggregates have viable performance. Spatial structure and diversity viability parameters, as originally determined by the TRT, have improved, and nearly meet the viability criteria for both populations. Despite substantive gains toward meeting viability criteria in the Strait of Juan de Fuca and Hood Canal summer chum salmon populations, the ESU still does not meet all of the recovery criteria for population viability at this time. Overall, the Hood Canal summer-run chum salmon ESU therefore remains at “moderate” risk of extinction (Ford 2022).

The viability of the Puget Sound steelhead DPS has improved somewhat since the PSTRT concluded that the DPS was at very low viability, as were all three of its constituent MPGs, and many of its 32 DIPs (Hard et al. 2015). Increases in spawner abundance were observed in a number of populations over the last five years. These improvements were disproportionately found within the Central & South Puget Sound and the Hood Canal & Strait of Juan de Fuca MPGs, primarily among smaller populations. The apparent reversal of strongly negative trends among winter-run populations in the White, Nisqually, and Skokomish Rivers abated somewhat the demographic risks facing those populations. Certainly, improvement in the status of the Elwha River steelhead (both winter- and summer-run) following the removal of the Elwha dams reduced the demographic and diversity risk for the DIP and the MPG. Improvements in abundance were not as widely observed in the Northern Cascades MPG. Foremost among the declines were summer- and winter-run populations in the Snohomish River basin. [A]ll summer- run steelhead populations in the Northern Cascades MPG are likely at a very high demographic risk. In spite of improvements in some areas, most populations are still at relatively low abundance levels, with about a third of the DIPs unmonitored and presumably at very low levels (Ford 2022).

Cumulative effects in the action area include those related to climate change and to human population growth in the region, and these are likely to increase habitat conditions that further constrain viability parameters. These effects are independent of the effects of the proposed action and cumulative effect are likely to have a continuing negative influence over time on the potential for conservation of species.

With the status in mind, we add the anticipated effects during maintenance, repair and replacement activities to the baseline and with cumulative effects to determine how effects that will occur among rearing and migrating PS Chinook and HCSR chum salmon and migrating PS steelhead will influence the populations that comprise the species.

As described above, some stressors are not considered likely to cause more than limited or infrequent effects to individuals from any species: temporary artificial lighting (which is not expected to appreciably affect migration behaviors), and strikes by construction vessels (as these vessels are slow moving or stationary when deployed for construction). In each year of the proposed action some individuals from each species will be exposed to elevated suspended sediment and turbidity, which create brief response, potential contaminants, which can cause health effects ranging from sublethal to lethal depending on lifestage and intensity of exposure, reduced forage opportunities which can reduce growth or fitness, potential delays in migration which can impair fitness and development, potentially increased predation risk which will reduce survival of a few individuals from any affected population, and elevated underwater noise associated with construction which can injure or kill some individual fish. Responses of exposed fish can vary depending on the age, size, and initial fitness of the species, and the intensity or duration of exposures. Some response will be behavioral responses that abate quickly and are unlikely to result in injury or death for more than a few individuals. As stated, some individuals will experience reduced growth, delayed migration, or displacement from preferred habitats, each of which increases their susceptibility to predation.

To the degree that juvenile PS Chinook, PS steelhead, and HCSR chum salmon are exposed to water quality contamination from creosote, they could have a sublethal or delayed health responses. Conversely, the proposed action includes, in some instances, the permanent removal of creosote that will ensure that habitat conditions and overall carrying capacity are not reduced below baseline conditions. Because the proposed action includes habitat conservation offsets to be carried out, as identified via a calculator, these offsets ensure that habitat conditions and overall carrying capacity are not reduced below baseline conditions by the permanent in- and over-water effects of replaced wingwalls and dolphins and seismic upgrades.

For these reasons, we construe the detrimental effects of the proposed action, when added to the baseline, are temporary construction effects, affecting relatively few individuals with each occurrence, and long-term enduring effects from replacement or new structure in the nearshore. There is likely to be a small reduction in abundance among the salmonid species. However, because the Calculator will be used to ensure sufficient conservation activities occur such that the action as a whole will result in no net loss of habitat function, as described in Section 2, the enduring effects of the replaced or added structure will not result in measurable enduring effects to the juvenile PS Chinook salmon, juvenile PS steelhead, or juvenile HCSR chum at the population level. Therefore, we conclude that the reductions in abundance of PS Chinook, PS steelhead, and HCSR chum will be insufficient to modify productivity, spatial structure, or diversity of specific populations or of the species themselves, thus the proposed action will not appreciably reduce the likelihood of both the survival and recovery of PS Chinook salmon, PS steelhead, or HCSR chum salmon in the wild by reducing their numbers, reproduction, or distribution.

Puget Sound/Georgia Basin Bocaccio and Yelloweye Rockfish

PS/GB bocaccio are listed as endangered, and abundance of this species likely remains low. PS/GB yelloweye rockfish are listed as threatened but likely persist at abundance levels somewhat higher than bocaccio. Historical overfishing has been recognized as the primary cause of the decline of ESA-listed rockfishes in Puget Sound (Drake et al. 2010; Palsson et al. 2009). Lack of specific information on rockfish abundance in Puget Sound makes it difficult to generate accurate abundance estimates and productivity trends for these two DPSs. Available data does suggest that total rockfish declined at a rate of 3.1 to 3.8 percent per year from 1977 to 2014 or a 69 to 76 percent total decline over that period. The two listed DPSs declined over-proportional compared to the total rockfish assemblage.

Bocaccio abundances continue to decline with little to no signs of any effects of recent protective measures. Yelloweye abundance has also declined within Puget Sound proper with little to no signs of any effects of recent protective measures. One of the main factors for their poor status and low abundance and productivity is past practices of overharvesting and a life history that does not allow for fast recovery. Rockfish are long-lived, mature late, and highest fecundity occurs in older and larger fish which largely have been harvested. Changes to nearshore areas in Puget Sound have reduced the ability of this habitat to support juvenile life stages of PS/GB bocaccio. Loss of submerged aquatic vegetation has reduced cover available for juvenile bocaccio rockfish. Changes in physical characteristics of nearshore areas and loss of water quality reduce the amount of prey available for juvenile rockfish. For PS/GB bocaccio, degradation of nearshore habitat quality has likely reduced juvenile survival. However, this is not considered to be a primary threat to either yelloweye or bocaccio.

As indicated above, habitat conditions in the baseline are degraded in the action area by terminal structures and armoring, and uses that, together alter physical processes, water and sediment quality, riparian and marine vegetation, and forage fish spawning habitat). Climate change is likely to exacerbate several of the ongoing issues for bocaccio and their critical habitat, mainly the reduction in available quality nearshore rearing habitat. Cumulative effects in the action area, associated with increasing human population growth and climate change, are likely to have negative effects over time on the potential for conservation of both rockfish species, and these effects occur irrespective of the effects of the proposed action.

We consider the status and baseline, of poor abundance and productivity, and nearshore habitat conditions, when we add the effects resulting from the proposed action are likely to have measurable adverse effects on yelloweye and bocaccio and bocaccio critical habitat: (1)temporary increases in suspended sediment (larvae of both species and juvenile bocaccio), (2) temporary increased contaminants from creosote-treated timber pile extraction and sediment disturbance (all life stages), (3) reduced forage as a result of sediment disturbance and overwater coverage (juvenile bocaccio only), and (4) sound effects from impact driving steel piles (larvae of both species and juvenile bocaccio). The effects are of the same nature and magnitude as described above for salmonids.

Juvenile yelloweye rockfish are not typically found in nearshore habitat and adults are found solely in deep water areas of Puget Sound. Larval yelloweye rockfish are found in nearshore areas and would likely be exposed to the short-term effects of the proposed construction. However, the Action would only result in short-term impacts to larval rockfish and juvenile bocaccio. We cannot estimate the numbers of larval rockfish that will be exposed, as location of spawning can vary and the movement of larvae is largely driven by drift. It is impossible to distinguish the two species at the larval lifestage, but give the low abundance of bocaccio, we expect most effects will occur among yelloweye larvae with few exposures of bocaccio. A small number of juvenile bocaccio could be exposed to the long term effects of the presence of structures.

When all effects are considered together, we expect a very small number of bocaccio and yelloweye to experience measurable adverse effects as the result of the construction and existence of the replaced structures. Even when we consider the current poor status of the populations and degraded environmental baseline, and continuing cumulative effects within the action area, when we evaluate the addition of effects of temporary suspended sediment and turbidity, contaminants, reduced forage, and elevated SPLs, we do not expect reductions in abundance of larvae, juveniles or adults from these construction effects to alter rockfish abundance or productivity, nor to further degrade baseline conditions or limiting factors.

Although loss of nearshore habitat quality is a threat to bocaccio, the recovery plan for this species list the severity of this threat as low (NMFS 2017). Other factors, such as overfishing, are more significant threats to bocaccio rockfish. Moreover, due to the uncertainty associated with current population abundance estimates and the uncertainty of the total number of fish likely to be taken as a result of the action it is difficult to determine the impact on the population viability of San Juan/Georgia Strait, main basin and Whidbey basin rockfish populations. However, because the adverse construction effects are short term, and conservation offsets will be used to ensure sufficient conservation activities occur such that the action as a whole will result in no net loss of habitat function, as described in Section 2.4, the Action will not reduce the viability of bocaccio populations. The effects of the action will be too small in scale and too minor to have a measurable impact on the affected populations. Because the proposed action will not significantly reduce the productivity, spatial structure, or diversity the affected populations, the action, when combined with a degraded environmental baseline and additional pressure from cumulative effects, will not appreciably affect the status of PS/GB bocaccio.

We do not expect the effects of the action to measurably affect juvenile or adult yelloweye rockfish because juveniles are not typically found in nearshore habitat and adults are found solely in deep water areas of the Action Area. Larval yelloweye rockfish could occur in nearshore areas and would likely be exposed to the short-term effects of the proposed construction. However, the proposed actions would only result in short-term impacts to larval rockfish as compared to the much larger area representing the range of this DPS and the small number of in-water activities proposed that would affect this life stage. Larval rockfish have very high natural mortality rates and recruitment success is highly dependent on environmental conditions (NMFS 2017). Poor larval survival in most years is balanced by the long lives of reproductive adults. For a long-lived, late maturing species with high natural mortality in early life stages, the loss of a very small number of individual larvae and juveniles is not anticipated to have a measurable effect on adult population abundance. Given the low overall level of impact, the proposed action will not have any meaningful effect on the numbers, reproduction, or distribution of yelloweye rockfish.

Southern Resident Killer Whale

Southern resident killer whales are listed as endangered, based on an extremely low population size, and low productivity. Their critical habitat, inclusive of the action area, is diminished by water quality degradation, chronic sound, and insufficient prey (both abundance and poor quality of the prey available, inferred from the high body load of contaminants of SRKW which are an apex predator). Baseline conditions, as described in preceding sections, are impaired in the action area by several anthropogenic conditions. And, as described above, cumulative effects driven largely by human population growth, are likely to have a negative influence over time, (however regulatory protections have recently increased, and these are designed to curtail the influence of recreational interactions with SRKW).

We add the effects of the proposed action to this status, baseline, and cumulative effects. Effects from construction are expected to be minor with little exposure to turbidity and re-suspended contaminants, little exposure to construction nose based on monitoring and stop work protocols, vessel noise and potential strikes, low response to artificial lighting, low response to temporary structures (e.g. construction barges) in migration areas, and no reduction in prey availability or forage behaviors from temporary effects. Enduring effects could, over the long term, create a very small reduction in total adult abundance of adult salmon, but the Calculator will be used to ensure sufficient conservation activities occur such that the action as a whole will result in no net loss of habitat function, as described in Section 2.4. Because adverse effects of the proposed action accrue among juvenile salmonids, it is unlikely that the numbers of juvenile injured or killed would reach a level that can detected as a reduction in returning adults, or, in other words we do not expect prey reduction would be at a level that would lead to increased forage behavior and increased energy expenditure among SRKW individuals among the listed unit. Therefore, we do not anticipate any change in SRKW's viability parameters as a result of the proposed action and given the low overall level of impact, the proposed action will not have any meaningful effect on the numbers, reproduction, or distribution of SRKW.

Sunflower Sea Stars

The species is proposed for listing throughout its range, and no data exist to suggest anything other than a single, panmictic population, so, to reach a determination of jeopardy, a proposed action would have to impact range-wide population dynamics. We are not currently aware of any habitat types or locations used by sunflower sea stars for mating or spawning, larvae are planktonic, and newly settled juveniles appear in a variety of habitats. Here, as we evaluate this program of activities, NMFS does not anticipate that the number of individual sea stars that could be adversely affected will be large enough to impair the species' population-level viability or its potential for recovery.

2.6.2 Critical Habitat

Critical Habitat Puget Sound Chinook and Hood Canal Summer-run Chum Salmon

Based on the importance of marine waters for salmonids, the critical habitat has high conservation value for PS Chinook salmon (NOAA Fisheries 2005) despite the current degraded conditions. Nearshore habitat modification has caused broad-scale ecological changes, reducing the ability of critical habitat to support PS Chinook migration and rearing. Once developed, shoreline areas tend to remain developed due to the high residential, commercial, and industrial demand for use of these areas. New development continues and as infrastructure deteriorates, it is rebuilt. Shoreline bulkheads, marinas, residential structures, and port facilities are quickly replaced as they reach the end of their useful life. Although designs of replacement infrastructure are often more environmentally friendly, replacement of these structures ensures their physical presence will causes adverse effects on nearshore habitat into the future. This is evidenced by the continued requests for consultation on these types of actions. As a result, shoreline development causes a "press disturbance" in which habitat perturbations accumulate without periods of ecosystem recovery. This interrupts the natural cycles of habitat disturbance and recovery crucial for maintenance of critical habitat quality over time. Although the occasional restoration project will improve nearshore habitat quality, the area impacted by these projects is tiny compared to the developed area. The general trend of nearshore habitat quality is downward and is unlikely to change given current management of these areas.

Nearshore habitat modification has caused broad-scale ecological changes, reducing the ability of critical habitat to support PS Chinook salmon juvenile migration and rearing. The loss of submerged aquatic vegetation, including eelgrass and kelp, has reduced cover, an important PBF of critical habitat for both species. Degradation of sand lance and herring spawning habitat has reduced the quality of the forage PBF for PS Chinook. Construction of overwater structures throughout Puget Sound has degraded salmon critical habitat by creating artificial obstructions to free passage in the nearshore marine area. Habitat modification reduces juvenile survival, and in some cases, has eliminated PS Chinook salmon life history strategies that rely on rearing in nearshore areas during early life history. Under the current environmental baseline, nearshore habitat is not able to support optimal juvenile survival of PS Chinook salmon such that populations of this ESU can become viable. HCSR chum also extensively rely on rearing in nearshore habitats. Habitat for HCSR chum salmon has been degraded by development but some areas of nearshore habitat remain in good condition. For this Opinion, there is one terminal that occurs in HCSR chum critical habitat, the Port Townsend terminal. Although temporary maintenance and repair activities and permanent replacement activities potential replacement of two creosote-treated timber dolphins with steel supported dolphins) covered under this Opinion will result in loss of nearshore habitat quality, the aggregate impacts of the temporary activities is small and habitat offsets will result in a no net loss of habitat function for long-term impacts. We expect, given the current status of nearshore habitat and the implementation of recovery actions that address habitat limiting factors, this impact is not significant enough to result in any meaningful effect on the abundance, productivity, spatial structure, or diversity of the HCSR chum salmon populations.

Given the rate of expected population growth in the Puget Sound area, cumulative effects are expected to result in mostly negative impacts on critical habitat quality. While habitat restoration and advances in best management practices for activities that affect critical habitat could lead to some improvement of PBFs, adverse impacts created by the intense demand for future development is likely to outpace any improvements. Current state and local regulations do not prevent much of the development that degrades the quality of nearshore critical habitats. There is no indication these regulations are reasonably certain to change in the foreseeable future.

The proposed action would have minor localized effects, both positive and negative, to habitat when added to the baseline and cumulative effects. Additionally, the temporary negative effects on these critical habitats do not occur at an intensity or duration that will further limit the action area's role for growth, maturation, or movement of any of the fishes between important habitats. Although enduring effects will occur to critical habitats, the Calculator will be used to ensure sufficient conservation activities occur such that the action as a whole will result in no net loss of habitat function, as described in Section 2.4.

When long- and short-term effects, along with the conservation offsets, are considered together and added to the baseline, the proposed action does not further reduce the conservation value of the action area for PS Chinook or HCSR chum salmon.

Critical Habitat Puget Sound/Georgia Basin Bocaccio

Adverse effects of the action are only expected for bocaccio critical habitat (see Section 2.11 for analysis of yelloweye critical habitat). For PS/GB bocaccio critical habitat, the proposed actions would degrade the quality of PBFs in the nearshore. This would likely reduce juvenile survival in some areas of affected critical habitat. When reviewing the effects of the action to critical habitat for bocaccio, even though aspects off the baseline are degraded, mainly through nearshore development, and cumulative effects likely will continue to adversely affect the nearshore portion of bocaccio critical habitat, the added adverse effects of the proposed action are too small on a DPS-level to substantially reduce the conditions of critical habitat or preclude re- establishing properly functioning conditions. Overall, when added to the baseline and cumulative effects, the effects of the action on bocaccio critical habitat do not significantly alter the conservation value of critical habitat at the designation scale. The long-term effects on PBFs for bocaccio are neither positive nor negative because the NHVM will be used to ensure sufficient conservation activities occur such that the action as a whole will result in no net loss of habitat function, as described in Section 2.1.

Critical Habitat Southern Resident Killer Whale

Critical habitat for SRKWs is designated in the Action Area. Within the Action Area, the quality of critical habitat for SRKWs has been negatively affected by reduction of prey availability.

Over the past several years, the reduced and declining SRKW status has become a serious concern. PS Chinook salmon, a key part of the prey PBF for SRKW critical habitat, will be adversely affected by activities conducted under this Opinion. Impacts on the survival of juvenile PS Chinook salmon translate to reduction of adult PS Chinook salmon, the prey PBF for SRKW critical habitat. As observed during recent years, the SRKW's population has declined. Toxins 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 continued cleanup efforts.

Once in the environment these substances proceed up the food chain, accumulating in long-lived top predators like SRKWs.

As stated for salmon and bocaccio critical habitat above, with the rate of expected population growth in the Puget Sound area, cumulative effects are expected to result in mostly negative impacts on critical habitat quality and adverse impacts created by the intense demand for future development is likely to outpace any improvements with little change to the decline in the foreseeable future.

Adverse effects of the action will be both temporary and enduring to SRKW prey species. Temporary effects as described above will be short-term and limited in extent, and therefore will not diminish the conservation value of critical habitat at the designation scale. The Action requires that activities that cause enduring effects be evaluated with the Calculator (or equivalent tool) and any debits generated are offset by a commensurate amount of credit-generating activity. In this way, the proposed action ensures sufficient conservation activities occur such that the action as a whole will result in no net loss of long-term habitat function. Therefore, overall, when added to the baseline and cumulative effects, the effects of the action on SRKW critical habitat do not diminish the conservation value of critical habitat at the designation scale.

2.7 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, habitat conservation offsets, and cumulative effects, it is the NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of PS Chinook salmon, HCSR chum salmon, PS steelhead, PS/GB bocaccio rockfish, PS/GB yelloweye rockfish, and SRKW or destroy or adversely modify the critical habitat of PS Chinook salmon, HCSR chum salmon, PS/GB bocaccio, or SRKW.

NMFS's Conference Opinion concludes that adverse effects to Sunflower Sea Stars are not likely to jeopardize this species. If Sunflower Sea Stars become listed under the Endangered Species Act, this Conference Opinion becomes effective as the biological opinion for this species.

2.8 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 interim guidance as to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering." "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

The amount and extent of take in this ITS serves two functions: (1) it identifies the quantity of incidental take exempted for the action agency and applicant. In the case of a species without 4(d) protective regulations, such as the sunflower sea star, the exemption is not needed because incidental take is not prohibited; and (2) it serves as a check on NMFS's jeopardy analysis. The amount or extent of take identifies the anticipated level of take NMFS considered in reaching its conclusion that the proposed action will not jeopardize the continued existence of a listed species. If this level of take is exceeded, reinitiation of consultation is triggered to ensure that NMFS's no-jeopardy conclusion remains valid.

2.8.1 Amount or Extent of Take

The projects carried out under the proposed action will take place beside and within aquatic habitats that are reasonably certain to be occupied by individuals of the ESA-listed species considered in this opinion (and conference opinion). The take of fish, described below, cannot be accurately quantified as a number because NMFS cannot predict, using the best available science, the number of individuals of listed fish that will be exposed to these stressors. When NMFS cannot precisely predict the number of fish that are reasonably certain to be harmed, captured, or killed we rely on surrogate measures for take, called an extent of take. The most appropriate surrogates for take are action-related parameters that directly relate to the magnitude and duration of the expected take. In such circumstances, NMFS uses the causal link established between the activity and the likely extent and duration of changes in habitat conditions to describe the extent of take as a numerical level of habitat disturbance. In many instances, these take surrogates are coextensive with the proposed action. However, they are still the best indicator of the extent of expected take because of the causal relationship between the parameters and expected effects, and because the surrogate is readily observable, easily measured, and therefore suffices to trigger reinitiation of consultation if take is exceeded.

In developing indicators or surrogates to express the extent of incidental take, the values of the metrics used to project levels of activity were round up or down to a relevant whole number. As described below, the proposed action is reasonably certain to cause incidental take of one or more of those species. NMFS considered information from the action agencies' consultation request, and information though communication with WSF to project the future level of activity expected during one year of typical work authorized under the proposed action.

In the Opinion (and Conference Opinion), the NMFS determined that incidental take is reasonably certain to occur as described below. The same surrogates also serve as a valid take surrogate for SRKWs. The harm to SRKWs is caused by the reduction in PS Chinook salmon prey which is in turn caused by the adverse effects resulting from the temporary structures. The adverse effects result in a reduction in the abundance of SRKW's preferred prey, PS Chinook salmon. Therefore, the surrogate for SRKW harm is also the size of the temporary structures:

1. Take in the form of harm of juvenile salmonids and juvenile bocaccio, from construction related disturbance (increased suspended sediment/turbidity, contaminants, temperature, and reduced DO)

   The best available indicator for the extent of take caused due to temporary water quality impacts of construction is an increase in visible suspended sediment in the water column. This variable is proportional to the water quality impairment construction and dredging will cause, including increased sediment, temperature, and contaminants, and reduced dissolved oxygen. NMFS assumes that an increase in turbidity will be visible in the immediate vicinity of project areas and for a distance downstream or down-current, and the distance that increased sediment will be visible is proportional both to the size of the disturbance and therefore the amount of take that will occur. Also, a turbidity flux may be greater at project sites that are subject to tidal or coastal scour. When background/natural turbidity is 50 Nephelometric Turbidity Units (NTUs) or less, the extent of take will be exceeded if the turbidity plume generated by construction activities is both a) visible above background levels, and b) increases more than 5 NTUs. If background turbidity is higher than 50 NTUs, the extent of take will be exceeded if construction activities cause a 10 percent or greater increase in background turbidity.

   The extent of turbidity will be determined by visually monitoring during construction as well as with turbidity meters if suspended sediment visibly exceeds background levels.

2. Take in the form of harassment, injury or death of juvenile salmonids and juvenile rockfish from pile driving

   Installation, removal, or replacement piles will cause underwater sound sufficient to harass, injure, or kill salmon, steelhead, and rockfish. The implementation of marine mammal monitoring pans with stop work provisions will ensure no incidental take of SRKWs from pile driving or removal. NMFS cannot estimate the number of fish harassed, injured, or killed by pile driving or removal because fish presence at project sites will vary depending on time of years, water temperature, forage distribution and many other factors. Additionally, there are limited ways to count or observe the number of fish exposed to the adverse effects of pile driving without causing additional risk of injury or harassment.

The number of piles, up to 36-in diameter, driven annually for projects authorized under this Programmatic Opinion (and Conference Opinion) is the valid indicator of the amount of incidental take caused by pile driving. Piles will be installed with both impact and vibratory driving. Piles removed and reset will use vibratory methods. The number of piles driven is proportional to the amount of take because each pile driven creates sound that could harass, injure, or kill fish. The risk and total number of fish likely to be exposed as more piles are driven. A maximum of 60 piles would be installed, and 160 removed, annually for projects authorized under this programmatic (Table 16 below). A maximum of two drilled shafts are authorized under this programmatic (Table 16 below).

3. Take in the form of harm of juvenile salmonids and juvenile rockfish from in-water and over-water structures

   The physical size (square feet) of replaced in-water structure is the best available surrogate for the extent of take from exposure to the structure itself. This is because the likelihood of avoidance and the distance required to swim around the structure (migration delay) would both increase as the size of a structure and the intensity of its shadow increase, which would increase the number of juveniles that enter deeper water where forage efficiency would be reduced and vulnerability to predators would be increased. The amount of overwater structure directly determines the amount of shaded area, migration obstruction, reduced benthic productivity and submerged aquatic vegetation (SAV) distrusting and limiting feeding opportunities available at the project sites. The extent of these impacts would increase and decrease depending directly on structure size.

   The extent of incidental take was determined by summing proposed actions that will replace in-water structures. The following structures represent maximum long-term overwater-and in-water coverage:

   3,200 square feet – floating dolphins (annually)
   1,790 square feet – pile-supported wingwalls and dolphins
   (annually) 424 square feet (7.06*60) for new and replaced piles
   (annually)

   This totals 5,414 square feet of overwater-and in-water coverage.

4. Take in the form of harm of juvenile salmonids and juvenile bocaccio from temporary overwater structures and barges. The temporary structures and barges and impede juvenile salmonid migration, an essential behavior for this life stage.

   The physical size (square feet) of temporary structures and barges represents the best available surrogate for the extent of take from exposure to the structures proposed to juvenile salmonids because take is proportional to the size of the structures or barges. The larger the barge or structure, the more shade it can produce, and it is this shade which causes impairment of migration for juvenile salmonids. Therefore, the take surrogates for take caused by temporary overwater structures and barges are the physical size of temporary structures and barges.

a. A maximum of 90,000 ft^2 year per year for mooring of up to 20 barges and work platforms per year during construction within in-water work window.
b. A maximum of 12,520 ft^2 for the presence of up to 2 work platforms and barges (each year) from January 15 - February 15 at the Port Townsend and Coupeville terminals.

The extent of over and in-water structures will be determined by monitoring the total area of work platforms or barges as specified. Incidental take will be exceeded if the specified areas are exceeded.

5. Take in the form of harm among juvenile and adult salmonids and rockfish caused by water quality impairment due to the use of ACZA treated wood. Use of ACZA-treated wood will impair water quality by contaminants into water at project sites. Annually, we expect up to 5 ACZA piles to be installed (including repairs) and 30,000 board feet of exposed non-pile ACZA treated lumber to be installed.

Table 15. Incidental take pathways and associated indicators of the amount or extent of incidental take.

Incidental Take Pathway	**Amount or Extent of Incidental Take**
Visible suspended sediment (turbidity) and small amounts of contaminants released during in-water construction	Turbidity levels shall not exceed 5 nephelometric turbidity units (NTUs) more than background turbidity when the background turbidity is 50 NTUs (monitored and reported to NMFS and FHWA)) or less, or there shall not be more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTUs
Pile driving	Annually, no more than 60 steel or concrete piles up to 36" diameter would be installed. No more than 60 piles would be removed or replaced. No more than 100 wood piles removed. Annually, no more than 2 drilled shafts would be installed.
Harm from in-water and over-water structures	Annually, no more than 5,414 square feet[42] of replaced in-water structure.
Harm from temporary overwater structures	Annually, no more than 90,000 square feet of temporary OWS during the IWWW. No more than 12,520 square feet annually outside the IWWW (retained Jan 15- Feb 15) at Port Townsend and Coupeville terminals
Harm caused by water quality impairment due to the use of ACZA treated wood	Annually, no more than 5 ACZA piles installed (including repairs) and 30,000 board feet of exposed non-pile ACZA treated lumber.

[42] The area represents the amount of impact

2.8.2 Effect of the Take

In the biological opinion and conference 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.

2.8.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" (RPMs) are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

The following measure is necessary and appropriate to minimize the impact of incidental take of listed species from the proposed action.

1. WSF, in coordination with the FHWA, USACE, and FTA shall ensure completion of an annual monitoring and reporting program to confirm this Opinion (and Conference Opinion) is minimizing take from permitted activities.
2. The FHWA, the FTA, USACE, and WSF shall ensure that take from the use of ACZA treated wood is minimized.
3. The FHWA, the FTA, USACE and WSF shall ensure that take from pile driving is minimized.

2.8.4 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 FHWA, FTA, or USACE or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following terms and conditions implement reasonable and prudent measure 1:

    a. Reporting: WSF, in coordination with the FHWA, USACE, and/or FTA must report to NMFS and projectreports.wcr@noaa.gov all monitoring items annually, including:
        i. Project identification;
        ii. Project name;
        iii. Project location by 5th field U.S. Geological Survey (USGS) HUC and by latitude and longitude as determined from the appropriate 7- minute USGS quadrangle map;
        iv. Timing and Duration of Project Work:
        v. Starting and ending dates for work completed;
        vi. Number of days of in-water work

b. Evidence of Construction-Related Noise
    i. For Piles Installed, the final report must include all hydroacoustic monitoring reports for each project and identify:
        1. Number days that pile installation activities occurred
        2. Number of Pile(s)
        3. Pile type(s)
        4. Pile size(s)
        5. Method(s) used for installation
        6. Daily records of impact hammer strikes and impact driving time.
        7. Daily record of time that vibratory hammer was used
    ii. For Piles Removed:
        1. Number days that pile removal activities occurred
        2. Number of Piles removed
        3. Pile type(s)
        4. Pile size(s)
        5. Method(s) used for removal
        6. Daily record of time that vibratory hammer was used
        7. Disposal records (tonnage) of creosote piles removed
    iii. If during pile driving or pile removal injury or mortality of fish is observed, stop work, collect killed or moribund specimens to determine species, and report this circumstance to NMFS within 24 hours.

c. Suspended Sediment and Contaminant Monitoring: For the extent of suspended sediments and contaminants, visually monitor the extent of turbidity during bulkhead repair, removal of man-made debris from the seabed, marine sediment test boring, pile repair, pile removal/installation, and deck and drain cleaning.

d. For In-water and Overwater Structures:
    i. Final area of temporary work platforms in place from January 15 - February 15 at the Port Townsend and Coupeville terminals.
    ii. Final number and area of barges moored from January 15- February 15 at the Port Townsend and Coupeville terminals (combined).
    iii. Final number and area of barges moored outside the in-water work window, by terminal.
    iv. Final area of replaced area of wingwalls and dolphins, and new area of seismic upgrades, by terminal.

e. For habitat improvements/offsetting actions (other than pile removal), the location, design, and calculator results, and intended timing of work.

2. The following terms and conditions implement reasonable and prudent measure 2:

a. <u>ACZA Treated Piles.</u> Piles treated with ACZA will be wrapped or coated as follows:
    i. Wrappings are made from a pre-formed plastic such as polyvinyl chloride (PVC), a fiber glass-reinforced plastic or a high-density polyethylene (HDPE) with an epoxy fill or petrolatum saturated tape (PST) inner wrap in the void between the HDPE and the pile.

ii. Wrapping material used for interior pilings must be a minimum of 1/10 of an inch thick, durable enough to maintain integrity for at least 10 years, and have all joints sealed to prevent leakage.

iii. Wrapping material used for exterior pilings that come into direct contact with ocean going vessels or barges must be HDPE pile wrappings with epoxy fill or PST inner wrap.

iv. The tops of all wrapped piles must be capped or sealed to prevent exposure of the treated wood surface to the water column and to prevent preservative from dripping into the water.

v. Polyurea barrier systems must meet these additional criteria:

1. The polyurea barrier must be an impact-resistant, biologically inert coating that lasts or can be maintained for 10 years and in accordance with American Wood Protection Association M 27 standard.
2. The polyurea barrier must be ultraviolet light resistant and a minimum of 250 mm (0.25 inch) thick in the area that is submerged (Morrell 2017).
3. Polyurea barriers must be installed on dry piles that are free of loose wood, splinters, sawdust or mechanical damage.
4. Wrappings or polyurea barriers will extend both above and below the portion of the pile that is in contact with the water. The wrapping or polyurea barrier must extend at least 18 inches below the mudline into the substrate and to the top of the pile.
5. All operations to prepare wrappings or polyurea barriers for installation over piles (cutting, drilling, and placement of epoxy fill) will occur in a staging area away from the waterbody.
6. All piles with wrappings or polyurea barriers must be regularly inspected and maintained to identify unobserved failures of the wrapping or polyurea barrier or anytime a wrapping or polyurea barrier breach is observed.

b. <u>ACZA Treated Wood For Uses Other Than Piles</u>. The following criteria pertains to the repair or maintenance of pre-existing structures at WSF facilities.

i. ACZA-treated wood shall be avoided for non-pile structural elements in locations identified as 303(d) CWA listed for metals.

ii. Where non-ACZA materials satisfy design criteria, the WSF should prioritize their use to reduce incidental leaching of Arsenic, Ammonia, Zinc and Copper into marine waters.

3. The following terms and conditions implement RPM 3.
    a. For the protection of fish species, when piles are located in the “dry” at low tide, drive during periods of low tide to limit sound propagation through the water column.

2.9 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 has identified the following measures to further minimize or avoid adverse effects on listed species:

1. For the protection of HCSR chum outmigrants adopt the in-water work windows in WAC 220-660-330 for Tidal Reference Area 10.

2. To reduce contaminant loads to ESA-listed species, prioritize permanent removal of remaining creosote timber piles at all terminals.

3. Evaluate and prioritize areas for soft shore armoring where existing bulkheads occur.

4. To reduce contaminant loads to ESA-listed species, construct stormwater BMPs to provide runoff treatment for untreated PGIS at WSF terminals.

5. Continue to reduce vessel noise by investing in quiet propeller designs.

6. Continue implementation and reporting on 7(a)(1) activities.

2.10 “Not Likely to Adversely Affect” Determinations

This assessment was prepared pursuant to section 7(a)(2) of the ESA, implementing regulations at 50 CFR 402 and agency guidance for preparation of letters of concurrence.

When evaluating whether the proposed action is not likely to adversely affect listed species or critical habitat, NMFS considers whether the effects are expected to be completely beneficial, insignificant, or discountable. Completely beneficial effects are contemporaneous positive effects without any adverse effects to the species or critical habitat. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Effects are considered discountable if they are extremely unlikely to occur. The effects analysis in this section relies heavily on the descriptions of the proposed action discussed in Section 1.3 and on the effects analyses presented in Section 2.4.

Southern DPS Pacific Eulachon and its Designated Critical Habitat

Eulachon were listed as a threatened species on March 18, 2010 (75 FR 13012). NMFS adopted a final recovery plan for eulachon on September 6, 2017 (NMFS 2017). On April 1, 2016, we announced the results of our 5-year review of eulachon status (Gustafson et al. 2016). After completing the review, we recommended the southern DPS of eulachon remain classified as a threatened species. The major threats to eulachon are impacts of climate change on oceanic and freshwater habitats (species-wide), fishery by-catch (species-wide), dams and water diversions (Klamath and Columbia subpopulations) and predation (species-wide) (NMFS 2017).

The southern DPS of eulachon includes all naturally spawned populations that occur in rivers south of the Nass River in British Columbia to the Mad River in California. Core populations for this species include the Fraser River, Columbia River and (historically) the Klamath River.

Eulachon are an anadromous fish, meaning adults spend most of their life in the ocean but migrate into fresh water to spawn. Eulachon leave saltwater to spawn in their natal streams late winter through early summer, and typically spawn at night in the lower reaches of larger rivers fed by snowmelt. After hatching, larvae are carried downstream and widely dispersed by estuarine and ocean currents. Larvae and young juveniles become widely distributed in coastal waters, where they are typically found near the ocean bottom in waters 20–150 m deep (66-292 ft) (Hay and McCarter 2000) and sometimes as deep as 182 m (597 ft) (Barraclough 1964).

There is currently little information available about eulachon movements in nearshore marine areas and the open ocean.

Eulachon larvae and juveniles eat a variety of prey items, including phytoplankton and copepods, and adults feed on zooplankton (NMFS 2011b). Adults and juveniles commonly forage at moderate depths (20 – 150 m [66 – 292 ft]) in nearshore marine waters (Hay and McCarter 2000). In a trawl survey of the Strait of Juan de Fuca, Haro Strait/Georgia Strait, and area near the Fraser River in 2017-2018 the majority of stomachs sampled were empty (1,764 of 2,245) with 88 percent empty in the Haro Strait/Georgia Strait survey area (Dealy and Hodes 2019).

Eulachon spawning in the Fraser River can occur as early as February with peak spawning occurring in April and May (Hay and McCarter 2000). Larval eulachon typically emigrate from the Fraser River during April to Mid-June, peaking in the last two weeks of May (McCarter and Hay 2003). Eulachon larvae 5-6 mm in size are immediately flushed into receiving coastal inlets beginning in mid-April Larval retention and dispersal occurs in nearshore areas and coastal fjords well into mid-June and July where eulachon post-larvae grow and rear in low salinity, surface waters. Little is known of the distribution of juveniles, but they are thought to disperse to open marine waters within a few months to a year (Hay and McCarter 2000).

We reviewed the occurrence of eulachon within and near the Action Area and determined eulachon from the Elwha River in the Strait of Juan de Fuca and Fraser River, British Columbia, have the potential to occur in the San Juan Island/Georgia Strait portion of the Action Area where five terminals are located (Anacortes, Orcas Island, Lopez, Shaw, and Friday Harbor). In a trawl survey covering the Strait of Juan de Fuca, the Haro Strait/Georgia Strait, and area near the Fraser River in 2017-2018, eulachon were found in the Haro Strait/Georgia Strait from December through the end of sampling in June (Dealy and Hodes 2019). Eulachon were caught between 81 and 227m depth with highest catch per unit effort in depths greater than 117m. Eulachon have been documented in the Elwha River, which drains to the Strait of Juan de Fuca, since 2005 (Shaffer et al. 2007), although anecdotal observations suggest that eulachon "were a regular, predictable feature in the Elwha until the mid-1970s" (Shaffer et al. 2007). The potential for eulachon strays in the San Juan Islands from the Elwha River exists. Other Olympic Peninsula rivers draining into the Strait of Juan de Fuca have been extensively surveyed over many years for salmonid migrations; however, eulachon have not been observed in any of these other systems (Shaffer et al. 2007).

Other studies report few eulachon in the San Juan Island/Georgia Strait portion of the Action Area. DeLacy et al. (1972) gathered available fish collection records for Puget Sound from academic and fisheries agencies sources and indicated that between 10 and 49 reports of eulachon exist in these records for the San Juan Islands. Miller and Borton (1980) reported a total of 20 eulachon specimens collected in the San Juan Islands, southern Strait of Georgia, and Strait of Juan de Fuca and recorded in boat logs and museum collection records. Midwater trawl surveys in the Strait of Juan de Fuca routinely collected longfin smelt juveniles, while eulachon were rarely encountered (Anchor Environmental 2003, as cited in Gustafson et al. 2010). However, eulachon have been incidentally caught by the non-spot shrimp trawl fishery within the inland waters (NMFS 2011b).

Few records of eulachon exist within Puget Sound proper. A WDFW technical report entitled "Marine Forage Fishes in Puget Sound" (Pentilla 2007) presents detailed data on the biology and status and trends of surf smelt and longfin smelt in Puget Sound, but states that "there is virtually no life history information within the Puget Sound Basin" available for eulachon. Similarly, detailed notes provided by WDFW and Oregon Department of Fish and Wildlife as part of their review, do not provide evidence of spawning stocks of eulachon in Puget Sound rivers. The Nooksack River has frequently been listed as supporting a run of eulachon (WDFW and ODFW 2001, Wydoski and Whitney 2003, Willson et al. 2006, Moody 2008); however, there seems to be some confusion as to the exact species encountered. The Nooksack River is known to support a run of longfin smelt (*Spirinchus thaleichthys*), which are sometimes mistaken for eulachon.

The run of longfin smelt into the Nooksack occurs in November, which is outside the normal spawning time for eulachon. Since 2011, eulachon have been found in small numbers throughout Puget Sound and in several watersheds including the Deschutes River, Dungeness River, Goldsborough Creek (Mason County), Nisqually River, and Salmon Creek (Jefferson County) (NMFS APPS database; https://apps.nmfs.noaa.gov/). Small numbers of eulachon in freshwater outside of spawning areas are thought to be strays and NMFS did not include these areas in the critical habitat designation for this species (NMFS 2011b).

None of the WSF terminal locations are near any of the rivers where eulachon have been documented. However, eulachon from the Fraser River, British Columbia, and potentially some from the Elwha River have the potential to occur in the San Juan Islands/Georgia Strait portion of the Action Area where five of the WSF' terminal are located. Adult eulachon could be present toward the end of the in-water work window (December-February 15) as they move from the ocean toward the Fraser River. We would expect them in deep water (greater than 80 m deep). Since they are decreasing foraging as they move toward natal river, we would expect primarily migratory behavior. If present, adult eulachon would only be exposed to noise from construction activities. We do not expect extensive pile driving at the five terminals located in the San Juan Islands/Georgia Strait because no pile-supported wingwalls or dolphins will be replaced at them (see Section 1.3.7). Additionally, eulachon do not have a swim bladder, so they are less susceptible to barotrauma from impact pile driving. Because they are migrating, in deep offshore water, they are much less likely to stay in an area for the duration of pile driving and are highly unlikely to be exposed to levels of underwater noise that are harmful. Lower levels of exposure to underwater noise are considered insignificant based on their life history stage. No other effects to adult eulachon would be expected based on the limited extent of temporary effects of activities in the nearshore and limited area where enduring effects of structures would overlap with the deep water where adult eulachon would be expected to occur.

Larval eulachon could be present near the five terminals in the San Juan Islands/Georgia Strait during the beginning of the in-water work window (July 15) but will be highly dispersed by lower salinity surface waters from the Fraser River. With the limited in-water maintenance and repairs proposed under this Action and no expected reaction of larval stages to the enduring presence of overwater structures, exposure to larval eulachon would be extremely unlikely and is considered discountable.

Based the rarity of this species in Puget Sound proper, exposure to effects from activities under this Opinion are extremely unlikely and considered discountable at the 15 terminals in Puget Sound proper.

Critical habitat was designated for the southern DPS of Pacific eulachon in 2011 (76 FR 65323 October 20, 2011). Within Washington inland waters critical habitat is only designated in the Elwha River, which flows into the Strait of Juan de Fuca. Critical habitat is not designated in the Action Area. Therefore, the effect of the proposed action on eulachon designated critical habitat is not analyzed in this Opinion.

Southern DPS North American Green Sturgeon and its Designated Critical Habitat

The southern DPS of green sturgeon was listed as threatened on April 7, 2006 (71 FR 17757). We completed a 5-year review for this DPS in 2015 and recommended the DPS retain its threatened classification.

The southern DPS of green sturgeon spawn in the Sacramento River and migrate north along the coast as adults and subadults as far as the Bering Sea, Alaska. They occupy coastal waters for most of their life and utilize estuaries in the summer, including those in

Washington State, where habitat is characterized by soft sandy or muddy substrate and relatively shallow water less than 20 meters (Moser et al. 2016). Green sturgeon are long-lived with a relatively low reproductive potential. They reach maturity at 14 to 20 years and only reproduce every one to four years (Moser et al. 2016). Acoustic tagging data has found that adults migrate north from summering grounds in estuaries to important overwintering areas at north end of Vancouver Island in British Columbia and further north (Moser et al. 2016).

Observations of green sturgeon in Puget Sound proper and around the San Juan Islands have been rare. A review of acoustic tagging data of sturgeon detected opportunistically from 350 tagged green sturgeon (67 percent from the southern DPS) on hydrophones in Puget Sound and the Strait of Juan de Fuca from 2002 to 2019 found that both the southern and northern DPSs of green sturgeon commonly occupy waters in the Strait of Juan de Fuca and were found in the Strait of Juan de Fuca in every month. Of the known-origin sturgeon entering the Strait of Juan de Fuca, 71 percent (97 fish) were identified as members of the southern DPS. Of the five sturgeon of known origin detected in Admiralty Inlet, one was from the southern DPS. Of the 16 sturgeon of known origin detected in Puget Sound, four were from the southern DPS. In two years, 2006 and 2009, two southern DPS sturgeon were detected in Puget Sound. Green sturgeon were detected in shallow and deep water, indicating they can occur at all depths (Moser et al. 2021). All southern DPS sturgeon detected in Puget Sound were detected during January through May. Although, Puget Sound was primarily used by the northern DPS, both populations can occur. Moser et al. (2021) noted there was bias in the study sample origins and receiver placement locations that could bias the Puget Sound numbers lower that what actually occurs.

Also, data from acoustic tags should not be interpreted as absolute numbers, since tagged fish only represent a small portion of the southern DPS. Moser et al. (2021) concluded that the detection data suggests green sturgeon use the Strait of Juan de Fuca as a corridor where they reside at receiver sites for relatively short periods before moving northward into the Strait of Georgia. The relatively few detections at Admiralty Inlet, suggested they are moving north to overwintering areas. Because Puget Sound proper does not appear to be part of the coastal migratory corridor used to reach overwintering grounds north of Vancouver Island, we anticipate the southern DPS does not use Puget Sound proper extensively.

Two southern DPS green sturgeon were detected incidentally at a receiver located in Rosario Strait (NMFS 2009) and one green sturgeon of unknown DPS was incidental detected at a receiver off Lime Kiln State Park in Haro Strait on the west side of San Juan Island (outside the Action Area) (Moser et al. 2021). Because green sturgeon likely move northward into the Strait of Georgia after transiting the Strait of Juan de Fuca, some southern DPS sturgeon could be exposed to the effects of the action at the Anacortes, Orcas Island, Lopez, Shaw, and Friday Harbor terminals.

Based on the information above, adult and sub-adult green sturgeon could occur in the action area from at least January through May. We expect them to occur at extremely low levels within Puget Sound proper. Based on receiver data, any migrating green sturgeon are unlikely to spend extended time near any terminal in the San Juan Islands/Georgia Strait as they migrate north.

Therefore, exposure to intermittent and temporary effects of the action as described (e.g., temporary suspended sediment and turbidity, noise from pile driving, and effects to prey sources) during the limited overlap in timing of in-water work and green sturgeon presence is extremely unlikely. Based on the tracking data cited above indicating green sturgeon are not nearshore dependent or dependent on shallow depths during their migration in the Action Area, we do not expect them to have delays in migration or a reduction in prey from the enduring presence of overwater structures. Therefore, we consider exposure of Southern DPS green sturgeon to the stressors associated with activities in this Opinion to be discountable.

Critical habitat was designated for the southern DPS of green sturgeon in 2009 (74 FR 52299; October 9, 2009). In the designation documents, Puget Sound is identified as an occupied area possessing PBFs for the southern DPS of green sturgeon, however Puget Sound is excluded from the designation for economic reasons. The areas in Strait of Juan de Fuca and San Juan Islands that were included in the designation are outside the Action Area. Therefore, critical habitat for the southern DPS of green sturgeon is not analyzed in this Opinion.

Puget Sound/Georgia Basin DPS Yelloweye Rockfish Designated Critical Habitat

Critical habitat was designated for all species of listed rockfish in 2014 (79 Fed. Reg. 68041, November 13, 2014). NMFS identified one physical or biological features, essential for their conservation:

1) Deepwater sites (>30 meters) that support growth, survival, reproduction, and feeding opportunities.

Habitat threats include degradation of rocky habitat, loss of eelgrass and kelp, introduction of non-native species that modify habitat, and degradation of water quality as specific threats to rockfish habitat in the Georgia Basin (NMFS 2017).

Critical habitat for yelloweye rockfish includes 414.1 square miles of deepwater marine habitat in Puget Sound, all of which overlaps with areas designated for bocaccio. No nearshore component was included in the critical habitat listing for juvenile yelloweye rockfish as they, different from bocaccio, typically are not found in intertidal waters (Love et al. 1991).

The only effects of the Action that may extend into these deepwater habitats are temporary noise from construction activities. Temporary noise, primarily continuous noise from vibratory pile driving, that extends into deepwater habitat will not measurably alter the PBF of this habitat, including prey species, water quality, and structure. Therefore, the effects of the Action to designated critical habitat for PS/GB yelloweye rockfish are considered insignificant.

Central America and Mexico DPS of Humpback Whale and their Designated Critical Habitat

Humpback whales were listed as endangered under the Endangered Species Conservation Act in June 1970 (35 FR 18319) and remained listed after the passage of the ESA in 1973 (35 FR 8491). Humpback whales are divided globally by NMFS into 14 DPSs and place four DPSs (Western North Pacific, Arabian Sea, Cape Verde/Northwest Africa, and Central America) as endangered and one (Mexico DPS) as threatened (81 FR 62259). Photo-identification and modeling efforts indicate that a large proportion of humpback whales feeding along the coasts of northern Washington and southern British Columbia are from the Hawaii DPS (63.5 percent), with fewer animals from the Mexico (27.9 percent) and Central America (8.7 percent) DPSs (Wade 2017).

Data has not been collected on the proportion of each DPS within the Salish Sea, but it may be similar to coastal populations. For our analysis, we consider humpback whales migrating or foraging off the coast or in inland waters of Washington to primarily originate from the listed Mexico or non-listed Hawaii DPSs, with a smaller proportion being Central America humpback whales, following Wade (2017 and 2021). However, because of limited data availability for the Salish Sea, we have presented our humpback whale text outside the scope of DPS. With current limited data, any individual humpback in the Salish Sea should be assumed to be part of a listed population, unless proven otherwise.

Numbers of humpback whales have been growing annually at a rate of 6-7.5 percent off the U.S. West Coast (Carretta et al. 2021; Calambokidis and Barlow 2020). Humpback whale sightings in the Salish Sea have also been increasing since the early 2000s (Calambokidis et al. 2018). Humpbacks may be entering the Salish Sea as a foraging or rearing opportunity along their migration from summer feeding grounds to winter breeding grounds. Alternatively, there are indications that some humpbacks may overwinter entirely within the Salish Sea. Existing sighting data in the Salish Sea is not reliable distribution data and may be skewed to warm weather, when more people are likely to be whale watching. Sightings in recent years have most mostly occurred from May through October but occur year-round.

We considered long-term effects to humpbacks in light of the recent designation of critical habitat in the Strait of Juan de Fuca and increased sightings in the Salish Sea. Humpback whales in the North Pacific are vulnerable to entanglement in fishing gear and marine debris, ship strikes, human-generated marine sound, the effects of climate change, and for the Central America DPS, possible issues related to small population size (Sato and Wiles 2021). We have examined possible effects of the action on humpback whales: temporary effects from suspended sediment and associated turbidity, contamination from resuspension of sediments and other pollutants, obstructions, construction noise, temporary lighting, potential for strikes from construction vessels, and decreased forage availability.

Because the proposed action is limited to maintenance and preservation (not replacement, expansion, or new facilities) of the WSF system in the Salish Sea, the operation of ferries was not included in our analysis. Thus, only effects from the resulting structures themselves along with construction-related impacts were considered.

Humpback whales are not expected to be exposed to temporary short-term increases in turbidity levels and suspended sediment and associated contaminated sediments during in-water maintenance and repairs because of the limited extent of the zones (150-ft or less from the activity). In the unlikely event that humpbacks are exposed to increased turbidity or suspended sediment, the area would be extremely limited (150-ft) relative to whale movements and extremely short in duration as an animal moved through the area. We do not expect this level of potential exposure to result in any measurable change in a whale's behavior or physiology.

Pile removal will result in PAHs in a spatially limited area around each pile removal site. Humpback whales can bio-accumulate toxins, including PAHs and other pollutants from contaminated forage species or inhalation in areas of high contaminant concentrations. Although there has been substantial research on the identification and quantification of such contaminants on individual whales, including humpbacks, no detectable effect from contaminants has been identified in baleen whales. There may be chronic, sub-lethal impacts, but these are currently unknown. In the 2015, NMFS status review of humpback whales, contaminants were not considered an important threat to the Central America, Mexico, and Hawaii DPSs (Bettridge et al. 2015). Because no detectable effects of contaminants have been identified in humpback whales, the response is considered insignificant.

Direct effects to humpback whales from the temporary presence of overwater cover from work platforms, barges, permanently replaced wingwalls and dolphins, or seismic upgrades is extremely unlikely because nearshore overwater structures are not considered to be a significant obstruction to their movements. The presence of a limited number of temporary structures or the permanently replaced wingwalls and dolphins and seismic upgrades are unlikely to measurably obstruct the small schooling fish that are part of the prey base for humpback whales.

Humpback whales could be disturbed or injured if exposed to SPLs generated by pile driving. Because WSFs will actively monitor for ESA-listed marine mammals during construction and shut-down pile driving if they occur within the extent of the modeled behavioral noise guidance isopleth, humpback whales are not expected to be exposed to pile driving noise that will have a measurable effect on their behavior and no exposure to injurious noise levels will occur.

We expect no direct effects to humpback whales from limited artificial lighting that is shielded and directed away from surface waters. As described in the Opinion, we consider this activity to have no measurable effects to the fish forage base.

Humpback whales could be exposed to temporary vessel noise if they overlap with transiting construction vessels. The overlap of humpback whales and construction vessels is expected to be brief as humpback whales only occasionally occur near terminals for brief periods of time.

Construction vessels are primarily slow moving, do not follow or target whales, and once at a construction site, construction vessels would be stationary or operating at very low speeds to reposition. The volume of construction vessel traffic caused by the proposed action is relatively small.

There are no state or federal laws that set a minimum distance between vessels and humpback whales in Washington. Federal protections under the MMPA and ESA apply to humpback whales. NOAA whale viewing guidelines suggest all vessels remain at least 100 yards away from large whales. It is against federal law to harass or otherwise "take" marine mammals, including disrupting important behavioral patterns such as resting, nursing, feeding, or breeding. Acts of harassment include pursuing, tormenting, or annoying any marine mammal, or attempting to do so, that disrupt natural behaviors or cause injury. We expect construction vessels associated with the action would follow NOAA guidelines and federal mandates and would not likely disrupt normal behavioral patterns of humpback whales.

Because construction vessels are primarily tug/barges that will operate at low speeds near terminals, follow federal guidelines, will not target or follow whales, and will be short-term and transitory, we expect construction vessels in the vicinity of humpback whales are not likely to measurably disrupt normal behavioral. Vessel strikes are extremely unlikely based on their slow speeds and limited movement once at a construction site. Therefore, we expect construction vessel noise to be insignificant to humpback whales and vessel strikes to be discountable. Humpback whales are generalist feeders and feed on krill and small schooling and forage fish. Krill are planktonic, and do not rely on the nearshore environment in a substantial way for their life cycle, therefore will not be affected by the proposed actions. Surf smelt or sand lance spawning beaches, or herring spawning areas have been identified at or within 1,000 ft of 13 of the 20 terminals. Prior to work in the intertidal, WSF will conduct forage fish spawning surveys following WDFW protocols to determine if herring, surf smelt, or sand lance spawning is occurring or has recently occurred, or appropriate spawning habitat is not present (see Appendix B in WSDOT 2020a). Work must begin within seventy-two hours of negative survey results and must be completed within two weeks of the survey. With the survey protocol to protect spawning forage fish, no measurable loss to the forage base from pile driving or other intertidal work is anticipated. The enduring effects of the replacement of wingwalls and dolphins and seismic upgrades may affect forage fish prey for humpback whales. However, humpbacks forage and switch between target prey depending on what is most abundant or of highest quality in the system (Fleming et al. 2016). Because humpbacks are opportunistic foragers, however, the small decrease in the number of forage fish available in the entire Salish Sea due to the proposed action is not likely to adversely affect their overall food supply, humpback whales are unlikely to result in measurable effects to the overall forage base of humpback whales.

In summary, based on our analysis, we consider each of the effects of the proposed action to be either discountable or insignificant to humpback whales and insignificant to their prey base.

Critical habitat was designated for humpback whales in April 2021 (86 FR 21082). Critical habitat for the Central America DPS and Mexico DPS of the humpback whale extends from the Pacific Ocean into the Strait of Juan de Fuca, to Angeles Point, just west of Port Angeles.

The action area does not overlap with critical habitat for humpback whales. Therefore, critical habitat for humpback whales is not analyzed in this Opinion.

2.11 Reinitiation of Consultation

This concludes ESA consultation for the FHWA's, FTA's, and Corps's WSF Maintenance and Preservation Work programmatic activities.

As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat that was not considered in this opinion (and conference opinion), or (4) a new species is listed or critical habitat designated that may be affected by the action.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT RESPONSE

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. Under the MSA, this consultation is intended to promote the conservation of EFH as necessary to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. For the purposes of the MSA, EFH means "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity", and includes the 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 on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) 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 FHWA and descriptions of EFH for Pacific coast groundfish (PFMC 2005), coastal pelagic species (PFMC 1998), and Pacific Coast Salmon (PFMC 2014) contained in the fishery management plan developed by the Pacific Fishery Management Council (PFMC) and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

The entire action area overlaps with identified EFH for Pacific Coast salmon, Pacific coast groundfish, and coastal pelagic species. Designated EFH for groundfish and coastal pelagic species encompasses all waters along the coasts of Washington, Oregon, and California that are seaward from the mean high water line, including the upriver extent of saltwater intrusion in river mouths to the boundary of the U. S. economic zone, approximately 230 miles (370.4 km) offshore (PFMC 1998a,b). Designated EFH for the Pacific coast salmon fishery within marine water extends from the nearshore and tidal submerged environments within state territorial waters out to the full extent of the exclusive economic zone offshore of Washington, Oregon, and California, north of Point Conception to the Canadian border (PFMC 1999). Species within the management groups that have designated EFH in the action area are listed in Figure 24.

Additionally, Puget Sound is a Habitat Area of Particular Concern (HAPC), based on importance of the ecological function provided by the habitat. Other areas near terminals at Anacortes and in the San Juan Islands are also HAPCs. The environmental effects of the proposed project may adversely affect EFH for Pacific coast groundfish, coastal pelagic species, and Pacific coast salmon in the HAPC for these species.

Groundfish			
Common Name	**Scientific Name**	**Common Name**	**Scientific Name**
arrowtooth flounder	Atheresthes stomias	rosy rockfish	Sebastes rosaceus
big skate	Raja binoculata	rougheye rockfish	Sebastes aleutianus
black rockfish	Sebastes melanops	sablefish	Anoplopoma fimbria
bocaccio	Sebastes paucispinis	sand sole	Psettichthys melanostictus
brown rockfish	Sebastes auriculatus	sharpchin rockfish	Sebastes zacentrus
butter sole	Isopsetta isolepis	English sole	Parophrys vetulus
cabezon	Scorpaenichthys marmoratus	flathead sole	Hippoglossoides elassodon
California skate	Raja inornata	greenstriped rockfish	Sebastes elongatus
canary rockfish	Sebastes pinniger	hake	Merluccius productus
China rockfish	Sebastes nebulosus	kelp greenling	Hexagrammos decagrammus
copper rockfish	Sebastes caurinus	lingcod	Ophiodon elongatus
curlfin sole	Pleuronichthys decurrens	longnose skate	Raja rhina
darkblotch rockfish	Sebastes crameri	Pacific cod	Gadus macrocephalus
Dover sole	Microstomus pacificus	Pacific ocean perch	Sebastes alutus
Pacific sanddab	Ctlharichthys sordidus	shortspine thornyhe	Sebastolobus alascanus
petrale sole	E opsetta jordani	spiny dogfish	Squalus acanthias
quillback rockfish	Sebastes maliger	splitnose rockfish	Sebastes diploproa
ratfish	Hydrolagus colliei	starry flounder	Platichthys stellatus
redbanded rockfish	Sebastes babcocki	stripetail rockfish	Sebastes saxicola
redstripe rockfish	Sebastes proriger	tiger rockfish	Sebastes nigrocinctus
rex sole	Glyptocephalus zachirus	vermilion rockfish	Sebastes miniatus
rock sole	Lepidopsetta bilineata	yelloweye rockfish	Sebastes ruberrimus
rosethorn rockfish	Sebastes helvomaculatus	yellowtail rockfish	Sebastes llavidus
Coastal Pelagic			
Common Name	**Scientific Name**		
market squid	Latigo opalescens		
northern anchovy	Engraulis mordax		
jack mackerel	Trachurus symmetricus		

Groundfish	
Pacific mackerel	Scomber japonicus
Pacific sardine	Sardinops sagax
Salmonid Species	
Common Name	**Scientific Name**
Chinook salmon	Oncorhynchus tshawytscha
coho salmon	Oncorhynchus kisutch
pink salmon	Oncorhynchus gorbuscha

Figure 26. Species within each of the fishery management groups within in the action area

3.2 Adverse Effects on Essential Fish Habitat

The effects of the proposed project on ESA-listed species and habitats are described in Section 2.4 above. The same mechanisms of effect are likely to affect EFH for Pacific coast groundfish, coastal pelagic species, and Pacific coast salmon to varying degrees. These adverse effects include:

1. Water quality – Temporary (during construction). Temporary effects include turbidity and suspended sediments, contaminant release and resuspension, and noise in aquatic habitats. Temporary overwater lighting during construction may affect aquatic habitat resulting in attraction to lights and the potential for increased predation for some species esspecially during susceptible life stages (e.g., planktonic); however, with implementation of BMPs, we did not expect the effects to be adverse.

2. Forage reduction – Sediment disturbance and shading of SAV and resulting reduction in SAV density and abundance, and related primary production. Designated EFH will experience temporary, episodic, and enduring declines in forage or prey communities. Habitat offsets proposed to result in no net loss in nearshore habitat are anticipated to offset enduring effects to forage reduction.

3. Migration and passage - Designated Pacific coast salmon EFH will experience enduring incremental diminishment of safe migration from the proposed replaced wingwalls and seismic upgrades. As mentioned in Section 2.3, in the marine nearshore, there is substantial evidence that overwater structures impede the nearshore movements of juvenile Chinook and pink salmon. Habitat offsets are anticipated to result in no net loss in nearshore habitat and offset enduring effects to migration and passage.

Adverse temporary effects to water quality, forage, and migration will occur to Pacific Coast salmon, Pacific Coast Groundfish, and Coastal Pelagic Species EFH from the temporary effects of this Action. The chronic, episodic, and enduring diminishments of EFH created by maintenance, repair, and replacement of nearshore structures as outlined above will result in no net loss of habitat functions through habitat offset as proposed in this Opinion and Conference Opinion.

3.3 Essential Fish Habitat Conservation Recommendations

NMFS determined that the following conservation recommendations are necessary to avoid, minimize, mitigate, or otherwise offset the impact of the proposed action on EFH.

1. Prioritize removal of remaining creosote timber piles at all terminals to remove contaminants permanently from terminal facilities.
2. Evaluate and prioritize areas for soft shore armoring where existing bulkheads occur.

Fully implementing these EFH Conservation Recommendations would protect, by avoiding or minimizing the adverse effects described in Section 3.2, above.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the FHWA 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 FHWA must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations (50 CFR 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the document addresses these DQA components, documents compliance with the DQA, and certifies that this opinion, conference opinion, and EFH consultation 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 document are the FHWA, as the lead Federal Agency. Other interested users could include the FTA, USACE, WSDOT, WDFW, citizens of affected areas, or others interested in the conservation of the affected ESUs/DPSs. Individual copies of this document were provided to the FHWA, FTA, USACE, and WSDOT. The document will be available at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adheres to conventional standards for style.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion, conference 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 - Credit Savings Instrument

WASHINGTON STATE FERRIES
MAINTENANCE AND PRESERVATION WORK PROGRAMMATIC
CREDIT SAVINGS INSTRUMENT

This Instrument sets forth the details and understandings of Washington State Ferries (WSF) as well as the U.S. Army Corps of Engineers (USACE), the Federal Highway Administration (FHA), and the Federal Transit Administration (FTA) (collectively "the federal action agencies") regarding the establishment and use of a Credit Savings Scheme designed for, and for use solely in connection with, the WSF Maintenance Work Programmatic program in Pierce, Kitsap, Jefferson, San Juan, Island, King, Snohomish, and Skagit Counties, Washington.

I <u>Background and Context</u>

A. The federal action agencies are consulting with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act on the proposed WSF Maintenance and Preservation Work Programmatic program in Pierce, Kitsap, Jefferson, San Juan, Island, King, Snohomish, and Skagit counties, Washington ("the Program"). The NMFS consultation number is WCRO-2020-02558.

B. Under the Program, WSF proposes to maintain existing state ferry terminal structures through maintenance activities, including deck and drain cleaning, deck overlay replacement, painting, dolphin repair and replacement, removal of man-made debris from seabed, marine sediment test borings, seismic upgrades, and pile replacement and repair. The Program also includes stand-alone restoration activities such as creosote removal, and removal of existing bulkheads and piles.

C. Under the Program, any unavoidable adverse long-term effects on nearshore habitat from the proposed activities must be calculated as conservation debits and offset with a proportionate amount of conservation credits. These debits and credits will be measured using NMFS' Puget Sound Nearshore Calculator or equivalent tool. Under the Program, debits accrued during any one fiscal year of the program must be offset by conservation credits during that fiscal year or within the subsequent two fiscal years.

D. The Program includes options for providing conservation offsets. For example, one option is to purchase credits from a NMFS-approved conservation bank or in lieu fee program. Another option is for WSF to implement credit-generating restoration activities included within the Program, e.g., creosote removal, or removal of existing bulkheads and piles. A further option is for WSF to generate offsets from repair/replace activities included within the Program, i.e., where credits from the early removal of a lawful, sound structure (or parts thereof) outweigh the debits generated by the existence of the repaired/replaced structure into the future.

E. Credit-generating activities undertaken by WSF as part of the Program could generate more credits than are necessary to offset project debits occurring in the same fiscal year. It is the action agencies' and WSF's understanding that any such surplus credits can be "saved" and applied to offset debits from Program activities in subsequent fiscal years provided there is compliance with the Credit Savings Scheme set out in II. below.

II. WSF Maintenance and Preservation Work Programmatic Credit Savings Scheme

A. Definition of Program Conservation Credit.

Program Conservation Credits are credits that:

(i) Are generated by WSF under the Program either by:

a. stand-alone habitat restoration activities, e.g. removing creosote, removing bulkheads and derelict piles; or,

b. repair/replace activities (i.e. where credits from the early removal of a lawful, sound structure - or parts thereof - outweigh the debits generated by the existence of the repaired/replaced structure into the future); and,

(ii) Have been computed using the most recent version of NMFS' Puget Sound Nearshore Calculator[43] (or equivalent tool approved by NMFS).

B. Definition of Advance Conservation Credit.

Advance Conservation Credits are Program Conservation Credits that:

(i) Have not already been applied to offset Program debits generated within the same fiscal year; and,

(ii) Are "saved" within the program's administrative regime and can be applied to offset debits generated by program activities in future fiscal years.

C. Exclusions.

The following activities do not generate Program Conservation Credits or Advance Conservation Credits:

(i) Habitat restoration activities mandated by Federal, state, or local law;

(ii) Habitat restoration activities required to resolve unavoidable impacts to tribal treaty rights; and,

[43] The Calculator is updated every February and the most recent version applies going forward.

(iii) Activities funded by public programs expressly to support habitat restoration.

D. Purpose of the Credit Savings Scheme.

The purpose of the Credit Savings Scheme is to provide a reliable, accountable and transparent system for Advance Conservation Credits so that:

(i) WSF has a basis for undertaking large restoration projects early and as consolidated projects (rather than multiple, small projects), thus facilitating immediate and meaningful habitat improvements. The reason and motivation for WFS to undertake such early and consolidated projects would be to generate credits on the understanding they could be used to offset debits from Program activities occurring in the future; and,

(ii) NMFS has a basis for evaluating the benefits of Advance Conservation Credits in the Program's Biological Opinion.

D. Commencement Date

The Credit Savings Scheme will commence operation when NMFS issues its Biological Opinion on the Program.

E. Advance Conservation Credits Not Transferable

Advanced Conservation Credits can only be applied by WSF to offset conservation debits generated under the Program and cannot be transferred to any other entity or applied or sold outside the Program (even for other WSF projects).

F. No Double Counting of Advance Conservation Credits.

Once an Advance Conservation Credit has been applied to offset a debit generated under the Program, it cannot be applied to offset any debit in any context in the future.

G. Verification and Documentation of Program Credits

(i) For each Program activity that generates conservation credits or debits, WSF will use the project verification form to communicate to NMFS (cc'ing the Federal lead agency) the number of conservation credits or debits computed using the Puget Sound Nearshore Calculator (or equivalent tool approved by NMFS).

(ii) NMFS will review the Calculator outputs and indicate confirmation or disagreement in its response to the project verification form, which it provides to the lead agency and WSF within 30 days from the date of verification submittal. The federal lead agency and WSF may resubmit debit and credit computations with additional explanation if they disagree; however, NMFS will make the final determination as to the conservation credits and/or debits generated by a project. If discussions about Calculator outputs exceed 30 days past a February Calculator update, NMFS may use the most recent Calculator for final credit determination.

(iii) WSF will maintain a ledger of all conservation credits and debits that are generated and applied under the Program, including Advance Conservation Credits. To the extent Advance Conservation Credits are not applied to offset debits in the same fiscal year they will remain on the ledger and be carried forward to the following fiscal year. In this way, the ledger will provide a dynamic documentation of the number of Program and Advance Conservation Credits available.

(iv) When Advance Conservation Credits are applied to offset debits, the ledger must clearly show the Advance Conservation Credits that have been applied and are no longer available.

(v) The ledger will be included in the program's Annual Report to NMFS by WSF, in coordination with the action agencies. At the Annual Meeting between NMFS, WSF and the action agencies, the following will be evaluated and confirmed by the attendees (in addition to other elements described in the program):

a. Conservation debits accumulated during the reporting year;
b. Conservation credits accumulated during the reporting year;
c. Conservation credits applied to offset conservation debits during the reporting year;
d. Advance Conservation Credits proposed for carry-over to the subsequent reporting year.