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

Refer to NMFS No.:
WCRO-2021-03047

May 11, 2022

Todd Tillinger
Chief, Regulatory Branch
Seattle District, U.S. Army Corps of Engineers
P.O. Box 3755
Seattle, Washington 98124-3755

Re: Endangered Species Act Section 7(a)(2) Jeopardy Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Issuance of Permits for 15 Projects under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act for Actions Related to Structures in the Nearshore Environment of Puget Sound

Dear Mr. Tillinger

Between June 2, 2020, and July 30, 2020, we received 15 letters from the U.S. Army Corps of Engineers (USACE), Seattle District, requesting initiation of consultation with the National Oceanic and Atmospheric Administration'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 USACEs' permitting replacements of, repairs to, or new construction of in-water, overwater, and nearshore structures. Based on the locations of the proposed projects and their similar impacts on Endangered Species Act (ESA)-listed species and their critical habitat designated under the ESA, specifically in the nearshore of Puget Sound, and in an effort to expedite and streamline the ESA consultation processes, we have batched these actions into a single Biological Opinion. This consultation was conducted in accordance with the 2019 revised regulations that implement section 7 of the ESA (50 CFR 402, 84 FR 45016).

We have determined that the USACEs' proposed action to permit the 15 projects is likely to jeopardize the continued existence of Puget Sound (PS) Chinook salmon and Southern Resident killer whales (SRKW). The proposed action also is likely to adversely modify those species' designated critical habitats. We also determined that the proposed action is likely to adversely affect, though not likely to jeopardize, PS steelhead, PS/Georgia Basin (GB) bocaccio, PS/GB yelloweye rockfish, or Hood Canal summer-run chum salmon. Likewise, the projects are likely to adversely affect, but not adversely modify, designated critical habitat for PS/GB bocaccio, PS/GB yelloweye rockfish, or Hood Canal summer-run chum salmon. PS steelhead critical habitat is not found in the action area.

Our Biological Opinion includes a Reasonable and Prudent Alternative (RPA) to the proposed action that, if implemented, will not jeopardize PS Chinook salmon or SRKW, or adversely modify those species' designated critical habitats. Four of the proposed projects batched in this consultation are not subject to the requirements of the RPA because those projects, as proposed, do not result in a net loss of nearshore habitat quality and quantity.

We also reviewed the likely effects of the proposed action on essential fish habitat (EFH), pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1855(b)). We concluded that the action would adversely affect EFH of Pacific Coast groundfish, coastal pelagic species, and Pacific Coast salmon. Therefore, we have included the results of that review and EFH conservation recommendations in Section 3 of this document.

Please contact North Puget Sound Branch Chief, Elizabeth Babcock, at *Elizabeth.Babcock@noaa.gov* or (206) 526-4505 if you have any questions concerning this consultation or if you would like additional information.

Sincerely,

Scott M. Rumsey, Ph.D.
Acting Regional Administrator

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

Issuance of 15 Permits under Section 404 of the Clean Water Act and/or Section 10 of the Rivers and Harbors Act for New, Replacement, or Repaired Structures in the Nearshore Environment of Puget Sound

NMFS Consultation Number: WCRO-2021-03047

Action Agency: U.S. Army Corps of Engineers, Seattle District

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 Steelhead (*Oncorhynchus mykiss*)	Threatened	Yes	No	NA	NA
Puget Sound Chinook (*Oncorhynchus tshawytscha*)	Threatened	Yes	Yes	Yes	Yes
Hood Canal Summer-run Chum (*Oncorhynchus keta*)	Threatened	Yes	No	Yes	No
Puget Sound/Georgia Basin Yelloweye Rockfish (*Sebastes ruberrimus*)	Threatened	Yes	No	Yes	No
Puget Sound/Georgia Basin Bocaccio (*Sebastes paucispinis*)	Endangered	Yes	No	Yes	No
Southern Resident Killer whale *(Orcinus orca)*	Endangered	Yes	Yes	Yes	Yes
Southern Distinct Population of Sturgeon (*Acipenser medirostris*)	Threatened	No	NA	No	NA
Central America Distinct Population of Humpback Whale (*Megaptera novaengliae*)	Endangered	No	NA	No	NA
Mexico Distinct Population of Humpback Whale (*Megaptera novaengliae*)	Threatened	No	NA	No	NA

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

Issued By:

Scott M. Rumsey, Ph.D.
Acting Regional Administrator

Date: May 11, 2022

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LIST OF ACRONYMS

ACZA	Ammoniacal copper zinc arsenate
BMP	Best Management Practices
BRT	Biological Review Team
CA	California
CFR	Code of Federal Regulations
CH	Critical Habitat
CHART	Critical Habitat Review Team
CRMC	Coastal Resources Management Council
CY	Cubic Yards
CP	Conservation Points
cSEL	Cumulative sound exposure level
dB	Decibel
DDE	Dichlorodiphenyldichloroethylene
DDD	Dichlorodiphenyltrichloroethane
DIP	Demographically independent populations
DO	Dissolved oxygen
DNA	Deoxyribonucleic acid
DPS	Distinct Population Segment
DQA	Data Quality Act
DZ	Deep Shore Zone
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Units
FMP	Fisheries Management Plan
FPRP III	Fish Passage and Restoration Action Programmatic Biological Opinion III
FR	Federal Register
HAPC	Habitat Areas of Particular Concern
HAT	Highest Astronomical Tide
HC	Hood Canal
HCCC	Hood Canal Coordinating Council
HCSR	Hood Canal Summer Run chum
HEA	Habitat Equivalency Analysis
HPA	Hydraulic Project Approval
HSRG	Hatchery Scientific Review Group
HTL	High Tide Line
HUC	Hydrologic Unit Code
ITS	Incidental Take Statement
Km	kilometer
LAA	Likely to Adversely Affect
lf	Linear foot
LSZ	Lower Shore Zone
m	meter

Mg/L	milligrams per liter
MHHW	Mean Higher High Water
Mi	mile
MM	Millimeter
MMPA	Marine Mammal Monitoring Plan
MLLW	Mean Lower Low Water
MPG	Major Population Group
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NHVM	Nearshore Habitat Values Model
NLAA	Not Likely To Adversely Affect
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NRKW	Northern Resident killer whales
NTU	National Turbidity Units
NWFSC	NOAA's Northwest Fisheries Science Center
NWP	Nationwide Permit
NWTRC	U.S. Navy's Northwest Training Range Complex
OHWM	Ordinary High Water Mark
Opinion	Biological Opinion
OWS	Overwater Structure
PA	Proposed Action
PAH	Polycyclic aromatic hydrocarbons
PAL	Passive aquatic listeners
PBDE	Polybrominated dephenyl ethers
PBF	Physical or biological features
PBO	Programmatic Biological Opinion
PCBs	PolyChlorinated Biphenyls
PCE	Primary Constituent Element
PDO	Pacific Decadal Oscillation
PFMC	Pacific Fishery Management Council
pH	Power of Hydrogen
PPB	Parts per billion
PRF	Pier Ramp and Float
PS	Puget Sound
PSDDA	Puget Sound Dredge Disposal Analysis
PS/GB	Puget Sound/Georgia Basin
PSP	Puget Sound Partnership
PSRG	Pacific Scientific Review Group
PST	Pacific Salmon Treaty
PSTRT	Puget Sound Technical Recovery Team
PVA	Population Viability Analyses
PVC	Polyvinyl Chloride
RCW	Revised Code of Washington
ROV	Remote Operated Vehicle
RMS	Root Mean Squared
RPA	Reasonable and Prudent Alternative

RPM	Reasonable and Prudent Measures
SAR	Stock Assessment Report
SAV	Submerged Aquatic Vegetation
SEAK	Southeast Alaska
SEL	Sound Exposure Level
SIMP	Structure in Marine Waters Programmatic
SRKW	Southern Resident Killer Whale
SSNP	Salish Sea Nearshore Programmatic
SPSAA	South Puget Sound Action area
SQ FT	Square foot (feet)
SWFSC	NOAA's Southwest Fisheries Science Center
TACT	Trouble-shooting, Action planning, Course correction, Tracking Monitoring
TRT	Technical Review Team
TS1	Time Step 1, October through April
TSS	Total Suspended Solids
T&C's	Terms and Conditions
μg/L	Micrograms/liter
U.S.C.	United States Code
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
VSP	Viable Salmonid Populations
WCRO	West Coast Regional Office
WDF	Washington Department of Fisheries
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington Department of Natural Resources
WDOE	Washington State Department of Ecology
WQ	Water Quality
WRIA	Water Resource Inventory

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 this Biological Opinion (Opinion) and the incidental take statement (ITS) portion of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 U.S.C. 1531 et seq.), and implementing regulations at 50 CFR 402, as amended.

In 2019, following a 30+ day federal government lapse in appropriations, NMFS informed the U.S. Army Corps of Engineers (USACE or Corps) of a redeployment of NMFS resources, which would result in a delay of completion of individual consultations on a suite of (nearshore) projects, to work with the USACE on development and completion of a programmatic consultation to address that high workload and efficiently accommodate new in- or overwater or nearwater structures or repair or replacement of existing in- or overwater or nearwater structures. This programmatic has a working title of "the Salish Sea Nearshore Programmatic" or SSNP. However, because of delays in achieving a mutually agreeable consultation product, it became unattainable to evaluate dozens of pending projects through SSNP, including the 15 subject projects addressed in this Opinion. SSNP is still under development at this time.

In January 2022, the Department of the Army (Civil Works) and the National Oceanic and Atmospheric Administration (NOAA) signed a Memorandum articulating a mutual understanding of how the agencies evaluate the effects of projects involving existing structures in ESA Section 7 consultations. Consistent with the Memorandum, the agencies have renewed their efforts to develop SSNP and anticipate finalizing that Opinion by summer 2022. However, in order to continue to consult on as many projects as possible during SSNP's development, NMFS provides here a batched review of 15 proposed projects and their effects on listed species and designated critical habitat. In order to preserve project proponent privacy, certain details of each applicant's specific project are identified separately, and project-specific information is provided as separate attachments (when necessary) to this Opinion. NMFS has made every attempt to remove applicant-identifying details and preserve privacy.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available within two weeks of its completion at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file in Lacey, Washington.

1.2 Consultation History

Between June 2, 2020, and July 30, 2020, the USACE requested consultation on its proposed authorization of 15 projects (Table 1). The proposed projects would construct new in- or overwater or nearwater structures or repair or replace existing in- or overwater or nearwater structures. The proposed projects would occur within the designated critical habitat for one or more of the following species: Puget Sound (PS) Chinook salmon, Hood Canal Summer-Run (HCSR) chum salmon, PS/Georgia Basin (GB) bocaccio rockfish, PS/GB yelloweye rockfish, and Southern Resident killer whales (SRKWs). All of the projects are located in the Puget Sound geographic area.

Table 1. Project reference number, NMFS (WCRO or INQ) consultation identification number, USACE identification number (NWS), project structure type, and consultation request date for each project.

NMFS Consultation #	USACE Identification # (NWS #)	Project Structure Type	Consultation Request Date
INQ-2020-00106	NWS-2020-430	Mooring pile	6/2/2020
INQ-2020-00116	NWS-2019-799	Bulkhead	6/15/2020
INQ-2020-00117	NWS-2019-759	Bulkhead	6/15/2020
INQ-2020-00131	NWS-2020-382	Bulkhead	7/1/2020
INQ-2020-00133	NWS-2019-812	Bulkhead	7/6/2020
WCRO-2020-01860	NWS-2020-365	Pier	7/7/2020
INQ-2020-00137	NWS-2020-54-WRD	Pier, ramp, floats	7/9/2020
WCRO-2020-01935	NWS-2020-277	Bulkhead	7/16/2020
WCRO-2020-01934	NWS-2018-1183	Ramp, float	7/16/2020
WCRO-2020-01974	NWS-2018-263	Dredge	7/20/2020
INQ-2020-00149	NWS-2019-962	Pier, ramp, floats	7/29/2020
INQ-2021-00093	NWS-2019-725	Dredge	7/27/2021
INQ-2020-00147	NWS-2019-897	Pier, ramp	7/29/2020
INQ-2020-00151	NWS-2019-1032	Boat ramp, bulkhead, floats	7/30/2020
INQ-2020-00152	NWS-2019-682	Breakwater, floats	7/30/2020

In addition to being located within designated critical habitat for one or more species, the projects are all located within areas of habitat utilized by PS steelhead. However, the majority of project impacts are on nearshore habitat in Puget Sound. Nearshore areas are not designated as critical habitat for PS steelhead.

In April 2020, after protracted discussion with USACE in which no immediate agreement was reached on how to proceed with development of SSNP, NMFS redirected resources to batch projects into single consultations. NMFS and the Corps worked collaboratively to finalize the first batched opinion, WCRO-2020-01361, in November 2020. NMFS took a similar approach to complete a second batched opinion for marine nearshore projects throughout the Puget Sound, WCRO-2021-01620, which was issued in September 2021. NMFS continued this approach with this third batch consultation on these 15 nearshore projects because it was the most efficient and expedient path forward to clear the backlog of projects while discussions regarding SSNP continue.

On December 29, 2021, the NMFS transmitted a draft of this Opinion to the USACE. At that time, the consultation initiation package for one of the projects (NWS-2020-430) listed in Table 1 had provided all of the data necessary to complete a detailed analysis. The remainder of the proposed project initiation packages contained some information gaps. Additionally, on December 29, 2021, for the USACE's administrative ease, NMFS provided 15 project specific letters to the USACE that included the Nearshore Habitat Values Models (NHVM) or "conservation calculators" and depicted draft debit/credit output for each project. The USACE distributed the letters and the December 29, 2021, draft Opinion to the applicants. Starting on January 3, 2022, NMFS offered to schedule individual meetings with project applicants and the USACE to confirm whether NMFS had accurate information with regard to each project.

Between January 13, 2022, and February 23, 2022, NMFS met with, or received response from 13 applicants. As of February 23, 2022, NMFS had received updated project information, and project amendments (additional proposed conservation offsets) from 10 of the 15 applicants. As a result of the applicant meetings, the final debit calculation, which includes offsets that have been proposed by applicants to reduce impacts from the proposed action, decreased overall by 1,277 debits from what was calculated in the draft Batch Opinion. Changes in debits and credits were largely due to project clarification and refinements to the calculator. Eleven of the 15 projects included updates resulting in reduced debit output, and for two projects the updates resulted in increased credits (outlined below). Project clarifications or updates included the following:

- Projects that amended the originally proposed action to provided conservation offsets
- Proposed (but yet-to-be-finalized) additional conservation offsets
- Refinements to the calculator (based on applicant/consultant feedback). Refinements in the calculator did not result in increased debits and did result in some decrease in debits.

This Opinion reflects these updates where the new information informed the take surrogates.

NMFS will transmit to the USACE a second set of "Administrative Ease Letters" and enclosures that the USACE can transmit to project applicants. Those letters describe each project, and include the most up to date NHVM calculator spreadsheet, the updated Reasonable and Prudent Alternative (RPA) for projects subject to the RPA, and reasonable and prudent measures (RPMs) and Terms and Conditions (T&C) as described in this consultation. The updated NHVM calculators transmitted with these letters were used to complete the analysis for this Opinion.

During this batch consultation the USACE requested 2 projects undergo emergency consultation: NWS-2020-430 and NWS-2019-812. NMFS will continue to include those projects within this Opinion as it is the most expeditious way to conclude those consultations.

To complete this consultation, NMFS reviewed all relevant project information provided by the applicant and USACE and made reasonable assumptions that would allow for a complete analysis for this Opinion. All of the projects, as currently described, are expected to have adverse effects on ESA-listed species and their critical habitat (Table 2).

Table 2. Adversely affected-ESA listed species and designated critical habitat (denoted with an "X") by proposed USACE projects.

NWS#	PS Steelhead	PS Chinook salmon	PS Chinook salmon Critical Habitat	HC S-R Chum salmon	HCSR Chum salmon Critical Habitat	PS/GB bocaccio	PS/GB bocaccio Critical habitat	Yelloweye rockfish	Yelloweye rockfish Critical Habitat	SR Killer whale	SR Killer whale Critical Habitat
NWS-2020-430	X	X	X			X		X		X	X
NWS-2019-799	X	X	X			X		X		X	X
NWS-2019-759	X	X	X			X	X	X		X	X
NWS-2020-382	X	X	X			X	X	X		X	X
NWS-2019-812	X	X	X			X	X	X		X	X
NWS-2020-365	X	X	X	X	X	X		X		X	X
NWS-2020-54-WRD	X	X	X			X		X		X	X
NWS-2020-277	X	X	X			X	X	X		X	X
NWS-2018-1183	X	X	X	X	X	X		X		X	X
NWS-2018-263	X	X	X			X	X	X		X	X
NWS-2019-962	X	X	X			X	X	X		X	X
NWS-2019-725	X	X	X			X		X		X	X
NWS-2019-897	X	X	X			X	X	X		X	X
NWS-2019-1032	X	X	X			X		X		X	X
NW-2019-682	X	X	X			X		X		X	X

1.3 Proposed Federal Action

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies (50 CFR 402.02).

For the purposes of this Biological Opinion, the proposed action is the USACE's issuance of 15 permits for the projects listed in Table 1. The USACE permits would authorize the 15 projects, as described in more detail in Table 3, under the Clean Water Act and/or Rivers and Harbors Act. Two of the 15 proposed projects contain a new or expanded structure. These projects, along with 11 other proposed projects, also include repair and replacement of existing structures, or components of existing structures. As described more fully in Section 2.3.2, Distinguishing Baseline from Effects of the Action, the effects of this action are the consequence caused by the Corps' decision to grant a permit that would not occur but for that decision and that are reasonably certain to occur. For permits allowing structures to be repaired or replaced, the proposed action generally results in an extension of the time the existing structures will exist on the landscape. At the same time, the currently existing, to-be-repaired, rebuilt and/or replaced structures are part of the environmental baseline conditions, and in most cases, would persist for some period of time regardless of the current request for a USACE permit. Thus, for purposes of this analysis, we must differentiate between effects that are part of the baseline and effects that are caused by the proposed action. To do so, NMFS assumes the following:

- The proposed repair and replacement structures are in compliance with state and federal requirements and received a USACE permit when they were originally built. Or, the structures were built at a time when USACE authorization was unnecessary (i.e., prior to the enactment of the Clean Water Act in 1972).

- If the USACE has previously issued a permit for the structure, that permit authorized the structure with no end date. However, pursuant to general condition 2 at 33 C.F.R. Part 325, Appendix A, and Nationwide Permit General Condition Number 14, permittees are required to maintain authorized structures (or fill) in "good condition." Thus, for the structure to remain in compliance with the original USACE permit, at some point(s) during the life of the structure it is reasonably certain that the owner will seek a future USACE permit(s) to repair or replace some or all components of the structure.

- If the applicant did not request the permit the USACE is proposing to issue as part of the proposed action for this consultation, the existing structure could remain in a structurally sound and good condition and not need any additional USACE permit for some remaining "useful life period." For this consultation, we assume that the remaining "useful life period" is 10 years.[1] As such, we consider the existing structure (without the proposed repair or replacement) to be part of the environmental baseline and assume that absent the proposed action, the respective projects' current impacts would continue to persist for 10 years.

We discuss these assumptions further in the description of the Environmental Baseline (Section 2.3) below, and provide additional details and graphs explaining these assumptions in Appendix 1.

Carrying this forward to the consequences of the proposed action, and based on our assumption that the existing structure (or part being repaired or replaced) would have remained in its current state for a remaining "useful life period" (that we assume is 10 years), there are two kinds of effects we consider a consequence, or effect, of the proposed action. First, are there any positive effects that result from removing the structure (or part being repaired or replaced) for any

[1] The "10-year" time period is a default assumption for this consultation. NMFS developed this assumption through input from marine industry stakeholders and the Corps while working to implement the mitigation calculator that supported the Structure in Marine Waters Programmatic (SIMP) (NMFS 2016a). In some cases where there is immediate need of replacement or repair (e.g., in the upcoming in-water work window), there might be no remaining "useful life period. In other cases (e.g., where an applicant is upgrading a relatively new structure, say one less than 10 years old) it may be reasonable to assume a remaining "useful life period" greater than 10 years.

remaining "useful life period"? Second, are there future effects of the proposed (replaced/repaired, and often environmentally friendlier) structure for a new "useful life"? At its simplest, the repair and replacement projects will extend the life of part or all of the structures. Here, based on what we know about the life of the structures, we assume these repaired and replaced structures (or parts of structures) will establish a new[2] "useful life period" for the structure, or the part of the structure, being repaired or replaced, as follows:

- Over and in water structures: 40-year useful life period
- Bank stabilization: 50-year useful life period

We discuss this approach in more detail in the Effects of the Action Section 2.4 below, and similarly provide additional details and explanatory graphs in Appendix 1.

Two projects included elements of stormwater management as part of the proposed action. One project (NWS-2019-799) will discharge stormwater from the adjacent road, through an outfall, into the Puget Sound. The revetment and culvert repairs will continue the discharge of approximately 4,810 square feet (ft^2) roadway runoff into Puget Sound. The other project (NWS-2019-812) will discharge stormwater from a parking area and driveway through two outfalls into Puget Sound. The replaced outfalls drain an estimated 2,777 ft^2. Thus, for these projects, stormwater discharged that would not occur "but for" the USACE action has been analyzed in this Opinion as a consequence of the proposed action.

Two projects include maintenance dredging exclusively or as part of the proposed action. Maintenance dredging occurs because the depth of the dredge channel has filled in with sediments. The dredge channel at its existing elevation (filled in with sediment) is considered in the environmental baseline, and the proposed action resulting is a deeper channel (the deeper channel would not occur "but for" the USACE action).

Mechanical dredging typically involves a barge-mounted crane with clamshell bucket, but may also include the use of a barge-mounted excavator or backhoe with a digging bucket at the end of an articulated arm. A crane dredge consists of a large construction crane with a steel bucket with two hinged jaws that is suspended by a winch cable under the crane boom. Typically, a sediment transport barge is positioned alongside the dredge barge during active dredging.

During dredging, the digging bucket is lowered to the bottom where it sinks into channel sediments and is then closed, taking a "bite" of sediment. The crane then raises the bucket and swings it over a sediment transport barge, where the bucket is dumped. When the transport barge is full, a tug takes it to the disposal site.

The dredging material is typically disposed of at designated multi-user open-water disposal sites (open-water disposal sites) that are managed under the Dredge Material Management Program

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[2] NMFS based the assumed duration of the "useful life periods" on SIMP, as referenced in footnote 1, as well as input from consultants that regularly assist applicants through permitting processes. Depending on design, engineering, and materials, these useful life periods could also be shorter or longer. However, for this consultation we applied the 40 or 50-year assumptions for consistency as described above.

(DMMP) https://www.nws.usace.army.mil/Missions/Civil-Works/Dredging/. The effects of sediment disposal at DMMP open-water disposal sites have already been considered in the programmatic formal consultation for their continued use through 2040 (NMFS 2015a). Therefore, the use of DMMP open-water disposal sites for disposal of sediments dredged in accordance with this proposed action and the resulting effects of that disposal have already been consulted on and will be accounted for in the monitoring and reporting of the DMMP Opinion and are considered in the Environmental Baseline Section 2.3 of this Opinion.

Table 3. Abbreviated project description and associated USACE identification number (NWS #).

NWS#	Abbreviated Permit Description
NWS-2020-430	A project that repaired one existing 24-inch steel fender pile at a barge that is used to moor tug vessels that was issued an emergency permit while pending at NMFS. The pile was repaired by inserting a 30-foot long, 12-inch steel pile into the existing 24-inch broken steel pile that is located at the southeast corner of the barge. The void area between the piles was filled with concrete. The proposed repaired and replaced components of the in- and overwater structures are expected to remain in place with a new 40-year "useful life period" (i.e., not in need of another Corps permit for 40 years).
NWS-2019-799	The project would replace a 214 linear foot u-shaped creosote pile bulkhead with a sheet-pile bulkhead in the same location. It would also replace two existing outfalls on the bulkhead. The proposed repaired and replaced components of the bulkhead are expected to remain in place with a new 50-year "useful life period" (i.e., not in need of another Corps permit for 50 years).
NWS-2019-759	The project would replace a 453 linear foot timber bulkhead with a sheet-pile bulkhead in the same footprint as the original as well as replace a 21 linear foot bulkhead behind a boat house. The proposed repaired and replaced components of the bulkhead are expected to remain in place with a new 50-year "useful life period" (i.e., not in need of another Corps permit for 50 years).
NWS-2020-382	The project would replace an existing 70 linear foot creosote bulkhead with a 70 linear foot rock bulkhead and with 8 feet set back as stairs. The proposed repaired and replaced components of the bulkhead are expected to remain in place with a new 50 year "useful life period" (i.e., not in need of another Corps permit for 50 years).
NWS-2019-812	A project that replaced six sections, totaling 290 linear feet, of failed rock bulkhead adjacent to a roadway that was issued an emergency permit while pending at NMFS. One associated 16-inch diameter culvert was replaced and another was extended. The project would also to repair (not complete yet) an additional three sections of bulkhead, totaling 191 linear feet, of existing failed rock bulkhead within the original footprint. The project would also install two T-diffusers waterward of the culvert repairs to minimize erosion from stormwater discharge. The applicant proposes to add 400 cubic yards of beach nourishment. The proposed repaired and replaced components of the bulkhead are expected to remain in place with a new 50 year "useful life period" (i.e., not in need of another Corps permit for 50 years).
NWS-2020-365	The proposed action would repair one existing 12-inch diameter creosote pile with an epoxy grout filled fiberglass jacket and to repair up to 9 sets of creosote cross-bracings with galvanized steel cross-bracings. The proposed repaired and replaced components of the in- and overwater structures are expected to remain in place with a new 40 year "useful life period" (i.e., not in need of another Corps permit for 40 years).

NWS#	Abbreviated Permit Description
NWS-2020-54-WRD	The project would remove an existing public access pier, ramp, float system in the Foss Waterway and replace it with a new, wider dock. Removal: 10 foot by 35 foot, solid-decked, timber pier, (4) 16-inch diameter timber piles, 6 foot by 61-foot gangway, and the 6 foot by 224.5-foot concrete float system. Replace with: new 10 foot by 35-foot, solid-decked timber pier, (4) 16-inch diameter steel piles, a 6 foot by 88-foot grated aluminum gangway, and 8 foot by 224.5-foot concrete float system. The structure expansion is proposed to be compliant with ADA requirements. To offset this project, a municipal concrete pier was removed, as mitigation under USACE. The proposed repaired and replaced components of the in- and overwater structures are expected to remain in place with a new 40 year "useful life period" (i.e., not in need of another Corps permit for 40 years).
NWS-2020-277	The proposed project would replace 24.2 square foot concrete access stairs that are in line with the bulkhead. A skimcoat will be applied to the exisiting wave return. Ten cubic yards of beach nourishment gravel will be placed. The new stairs would be formed using ten cubic yards of concrete, and would be poured from the uplands at low tide. The proposed repaired and replaced components of the bulkhead are expected to remain in place with a new 50-year "useful life period" (i.e., not in need of another Corps permit for 50 years).
NWS-2018-1183	The project would replace elements of a ramp and float system. A solid float (16-foot by 20-foot) would be replaced with a grated float with the same dimensions, a 5-foot by 3-foot float bridge would be removed, and an 80 square foot ramp leading to the float would be installed. The project would replace six piles. The proposed repaired and replaced components of the in- and overwater structures are expected to remain in place with a new 40-year "useful life period" (i.e., not in need of another Corps permit for 40 years).
NWS-2018-263	The project would dredge near a boat ramp and would be approximately 36,000 square feet. The base dredge elevation ranges from 4 feet MLLW to -3.0 feet MLLW at its deepest. Additionally, 1,034 square feet of derelict boats will be removed from the marina and surrounding area.
NWS-2019-962	The project would replace an existing solid surfaced pier, ramp, 3 floats, and 42 creosote piles with a smaller, fully grated pier and ramp, 3 floats of a similar size, and fourteen 10-inch diameter steel piles. The proposed repaired and replaced components of the in- and overwater structures are expected to remain in place with a new 40 year "useful life period" (i.e., not in need of another Corps permit for 40 years).
NWS-2019-725	The project proposes to dredge an existing residential moorage channel system and marina connected to the Skagit Bay. The applicant proposes to dredge a total of 248,422 square feet to a depth of -4 MLLW for the marina and -3 MLLW for the entrance channel in addition to one foot of allowable overdredge, for a maximum depth of -5 MLLW. The cove will be dredged once and the entrance channel will be dredged twice within 5 years (likely years 1 and 5). Eelgrass within the dredge footprint was transplanted as per an eelgrass transplant and monitoring plan. Appropriate dredge materials from the entrance channel is proposed to be used as beach nourishment.
NWS-2019-897	The project would replace a net shed, pier (1,959 square feet) and access ramp with a smaller net shed and pier (1,760.8 square feet). The previous shed was demolished in a snow storm. Twelve 12-inch diameter (average length of 7 foot 6 inches) creosote treated piles would be removed and replaced with twelve 12-inch diameter steel piles. The solid surfaced access ramp that connects the top of the slope to the mezzanine of the net shed (72 square feet overwater coverage) would be replaced with a fully grated ramp with 24 square feet overwater coverage. The proposed repaired and replaced components of the in- and overwater structures are expected to remain in place with a new 40 year "useful life period" (i.e., not in need of another Corps permit for 40 years).

NWS#	Abbreviated Permit Description
NWS-2019-1032	The project would replace a deteriorated boat ramp and associated ramp structures at a port boat launch facility. The existing 14-foot-wide concrete boat ramp would be replaced. At the toe of the ramp where a scour hole has developed, a 14 by 12-foot scour protection pad would be placed using quarry spalls. The existing floats would be replaced with wider floats that meet ADA requirements. The new floats would incorporate 60% open grating decking and plastic flotation tubs. Four 14-inch diameter fiberglass float piles would be replaced with 12-inch diameter steel pile on the east side of the replacement floats. Collapsed and eroded sections of the existing bulkhead, located along the east side of the existing boat ramp, would be replaced as part of the proposed project. Bulkhead repair would include placement of geotextile as well as repair of toe rock and collapsed sections. A total of 105 linear feet of the existing 215-foot bulkhead wall is within the repair section. The proposed repaired and replaced components of the in- and overwater structures are expected to remain in place with a new 40 year "useful life period" (i.e., not in need of another Corps permit for 40 years), and the proposed repaired and replaced components of the bulkhead are expected to remain in place with a new 50 year "useful life period" (i.e., not in need of another Corps permit for 50 years).
NWS-2019-682	The project would replace a deteriorated vertical pile and log boom breakwater at a public marina. The existing fixed breakwater consists of two sections (West and South), with both vertical (plumb) and batter creosote piles. To replace this structure, the applicant would install a re-used solid floating breakwater from another marina. The replacement breakwater would be connected to the Port's existing marina dock by a new 8-foot wide grated walk float. The new breakwater would contain 22 new grated finger floats for moorage. The port would also install a new floating restroom and a FLUPSY on the breakwater. Sediment and creosote treated debris would be excavated from around the base of the existing log-boom after its removal. The proposed repaired and replaced components of the in- and overwater structures are expected to remain in place with a new 40 year "useful life period" (i.e., not in need of another Corps permit for 40 years).

For the proposed permits, the USACE has suggested the following best management practices:

1. All project proponents will comply with the Washington State Department of Fish and Wildlife's Hydraulic Project Approval (HPA) work windows for all projects to reduce the amount of exposure of listed salmonids and forage fish to construction effects.
2. Where vessels are used as staging locations for equipment, no ground-out will be allowed, reducing the effects on benthic communities.
3. Where bulkhead repair, replace, or new construction is proposed, work will occur at low tides/in the dry to limit turbidity and suspended sediment.
4. All projects that include impact or vibratory pile driving which will exceed levels of sound that will likely result in temporary threshold changes in marine mammal hearing sensitivity (120 dB_{rms}, decibels referenced to 1 micro Pascal based off root mean square (rms) levels) will have a Marine Mammal Monitoring Plan (MMMP) in place before any work can commence in waters of the U.S.[3] The MMMP must meet the requirements of NOAA's guidance for MMMPs found on NOAA's website: https://www.fisheries.noaa.gov/alaska/endangered-species-conservation/guidance-developing-marine-mammal-monitoring-plan

[3] As clarified by the USACE as part of the recommended revisions to the description of the proposed action.

a. If the following projects drive or remove any piles via impact or vibratory methods, the applicants must have a MMMP in place before work can commence:
    - NWS-2020-54-WRD
    - NWS-2018-1183
    - NWS-2019-962
    - NWS-2018-897
    - NWS-2019-1032
    - NWS-2019-682
b. The following projects propose to drive or remove piles via impact or vibratory driving methods but plan to conduct the activity in the dry and the MMMP requirement is not needed for these projects:
    - NWS-2019-799
    - NWS-2019-759

Additionally, some of the projects have proposed minimization and conservation measures to offset impacts. They are summarized in Table 4. For the purposes of our analysis, we assumed all proposed measures listed in Table 4 will occur.

Table 4. Minimization and Conservation Measures Proposed by Permit.

	Minimization/Conservation Proposed							
NWS#	**Debris Removal**	**Boat Ramp Removal**	**Pile Removal**	**Bulkhead Removal**	**Beach Nourish**	**Planting**	**Manmade Groin Removal**	**Creosote Removal**
NWS-2020-430								
NWS-2019-799				X				X
NWS-2019-759				X				
NWS-2020-382				X				X
NWS-2019-812	X			X	X			
NWS-2020-365			X					X
NWS-2020-54-WRD			X					X
NWS-2020-277					X			
NWS-2018-1183			X					X
NWS-2018-263	X							
NWS-2019-962			X					X
NWS-2019-725								
NWS-2019-897			X					X
NWS-2019-1032	X	X	X	X				
NW-2019-682	X		X					X

We also considered whether the proposed action would cause any other activities, effects, or consequences and determined that projects involving overwater structures (OWS), such as piers, docks, floats, ramps, ports or marinas, would cause recreational and/or commercial boat use to continue at current levels or increase, commensurate with the amount of the structure being built, repaired, or replaced. Six of the projects included in this Opinion are either residential, commercial, or industrial structures that support motorized boating with the potential to extend boating and its effects throughout Puget Sound (discussed further below, Table 5).

1.4 Action Area

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

The USACE's action is the exercise of its permit authorities for the 15 projects (Table 1). The proposed action would cause a range of effects, as described in Section 2.4. Effects of the Action include:

Temporary effects related to construction:

1. Water Quality
2. Re-suspended Contaminants and Incidental Discharge
3. Noise in aquatic habitat generated during in-water work
4. Benthic Communities and Forage Species Diminishment

Intermittent effects including related to the proposed structures:

1. Water Quality
2. Noise from Commercial and Recreational Boat and Ship Operation
3. Scour of nearshore areas from prop wash

Enduring effects caused by the proposed structures:

1. Predator/Prey Dynamics
2. Obstructions in Migration Areas
3. Disrupted Shore Processes

As further explained in our analysis below, enduring effects caused by the proposed structures would result in a reduction in nearshore habitat quality. This reduction in habitat quality would reduce survival of juvenile PS Chinook salmon. This in turn would reduce the abundance of adult PS Chinook salmon, resulting in less forage for SRKWs. SRKWs forage for Chinook salmon in four regions along the West Coast: (1) The Strait of Georgia, (2) the Strait of Juan de Fuca, (3) Puget Sound, and (4) coastal areas from Vancouver Island south to Northern California (Hanson et al. 2021, Hanson et al. 2010). In the straits of Georgia and Juan de Fuca, SRKWs primarily prey on Chinook salmon from the Fraser River. PS Chinook salmon comprise only a small portion of the Chinook salmon consumed in the straits. (Hanson et al. 2021, Hanson et al. 2010). In coastal areas, SRKWs prey on Chinook salmon from multiple areas including the Columbia River and the California Central Valley. PS Chinook salmon only represent a small portion of the Chinook salmon consumed by SRKWs in coastal areas (Hanson et al. 2021, Hanson et al. 2010). In contrast, in Puget Sound itself, PS Chinook salmon represent a much larger portion of the Chinook salmon consumed by SRKWs. Hanson et al. 2021, found that 67 percent of Chinook salmon found in SRKW diet samples collected in Puget Sound were estimated to have originated from Puget Sound. The reduction in forage for SRKWs that would be caused by the proposed action manifests predominantly within Puget Sound.

Construction of new overwater structures and the repair or replacement of existing overwater structures is included in 7 of the 15 projects. The purpose of many of these structures, such as residential pier, ramp, and floats, and commercial marinas, wharfs or ports, is to provide mooring locations for commercial and recreational vessels. Because the primary purpose of these structures is to provide moorage for vessels, it is reasonably certain that the structures will generate some future vessel operation. As identified earlier, intermittent impacts from these vessels would include noise, propeller wash, and the introduction of a small amount of contaminants (i.e., fuel).

Recreational and commercial vessel use caused by the proposed structures would be most concentrated around the structures themselves. However, the vessels can travel throughout Puget Sound. We expect this to be particularly true for vessels using commercial structures and larger recreational vessels moored at marinas and ports. Given the number of vessels mooring at some of the project sites and the variety of reasons for vessel use including commercial shipping, fishing, site seeing, and wildlife watching, emergency use, and recreational use, we expect the vessel use to be well spread throughout Puget Sound. Notable landmarks or location indicators and expected vessel use, if applicable, are indicated in Table 5. As Table 5 and Figure 1 illustrate, the 15 projects are geographically dispersed throughout a broad portion of Puget Sound.

When all of the areas affected by the proposed action are considered collectively, Puget Sound proper becomes the action area for this consultation. Puget Sound proper is the body of water encompassing South-Central Puget Sound, Whidbey Basin, and Hood Canal.

Table 5. Notable landmark/water body indicator, and vessel use, by USACE number

NWS#	Notable Land Mark Indicator (City, Island, etc.)	Vessel Use
NWS-2020-430	Commencement Bay	NA – Pile Replacement
NWS-2019-799	Oak Harbor/Whidbey Island	NA – Bulkhead
NWS-2019-759	Camano Island	NA – Bulkhead
NWS-2020-382	Stretch Island	NA – Bulkhead
NWS-2019-812	Bainbridge Island	NA – Bulkhead
NWS-2020-365	Hood Canal	NA - Overwater Structure Only
NWS-2020-54-WRD	Thea Foss Waterway	Recreational Vessel Mooring
NWS-2020-277	Alki	NA – Bulkhead
NWS-2018-1183	Belfair	NA – Overwater Structure Only
NWS-2018-263	Silverdale	Recreational and Commercial Vessels
NWS-2019-962	Port Madison	Residential Recreational Vessels
NWS-2019-725	Skagit Bay	Residential Recreational Vessels
NWS-2019-897	Bainbridge Island	NA – Bulkhead
NWS-2019-1032	Poulsbo	Recreational Vessels
NW-2019-682	Poulsbo	Recreational and Commercial Vessels

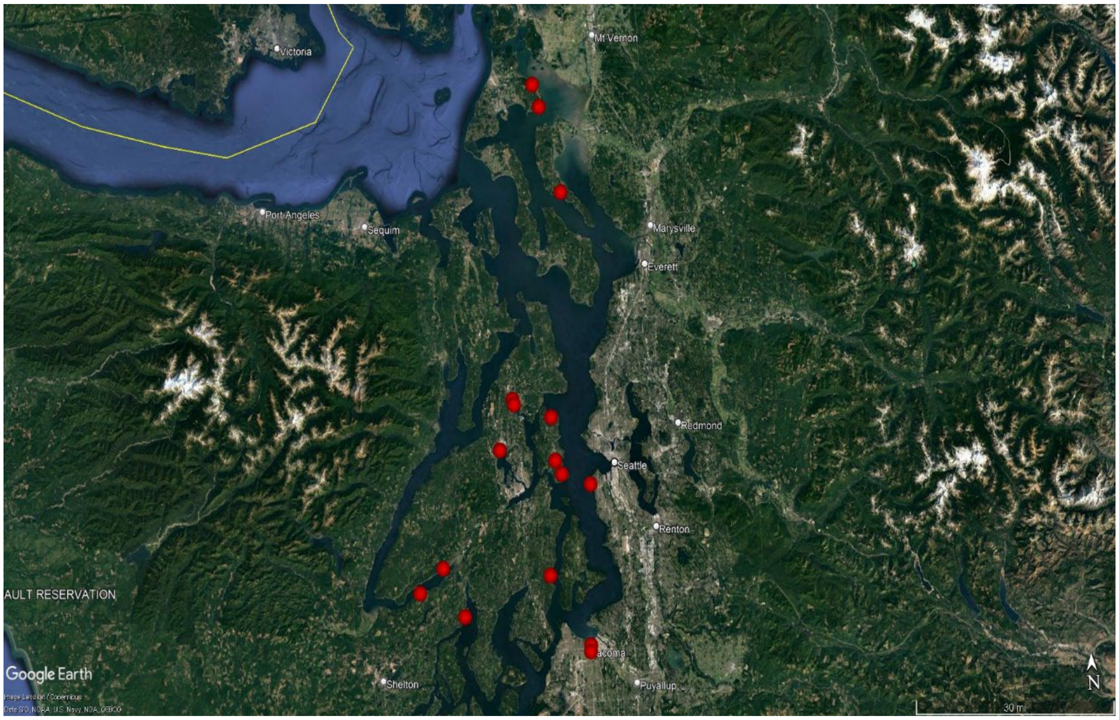

Figure 1. Image of Puget Sound with Approximate Project Locations

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS 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 incidental take statement (ITS) that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions (T&C) 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 relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR 402.02).

The designation(s) of critical habitat for species use(s) the term primary constituent element (PCE) or essential features. The 2016 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 2019 regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the regulations (84 FR 44977), that definition does not change the scope of our analysis and in this Opinion we use the terms "effects" and "consequences" interchangeably.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify designated 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.
- 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.

For this consultation, NMFS evaluated each project that was part of the proposed action in part using a Habitat Equivalency Analysis (HEA)[4] and the Puget Sound Nearshore Habitat Values

[4] A common "habitat currency" to quantify habitat impacts or gains can be calculated using Habitat Equivalency Analysis (HEA) methodology when used with a tool to consistently determine the habitat value of the affected area before and after impact. NMFS selected HEA as a means to identify section 7 project related habitat losses, gains, and quantify appropriate mitigation because of its long use by NOAA in natural resource damage assessment to scale compensatory restoration (Dunford et al. 2004; Thur 2006) and extensive independent literature on the model

Model (NHVM) that we adapted from Ehinger et al. 2015. This model was only used to evaluate the enduring effects of the over or in-water structures and nearshore structures, like bulkheads. In other words, the model does not evaluate construction effects (example: pile driving or turbidity), but only the continued/future existence of the structure on the habitat (example: square footage of overwater structure being repaired or replaced). We developed an input calculator ("conservation calculator") that serves as an interface to simplify model use. Ecological equivalency that forms the basis of HEA is a concept that uses a common currency to express and assign a value to functional habitat loss and gain. Ecological equivalency is traditionally a service-to-service approach where the ecological functions and services for a species or group of species lost from an impacting activity can be fully offset by the services gained from a conservation activity. In this case, we use this approach to calculate the "cost" and "benefit" of certain enduring effects of the proposed action, as well as the impacts of the existing environmental baseline, using the NHVM. NMFS has a webpage with general information, Frequently Asked Questions, and a downloadable calculator and user guide here: https://www.fisheries.noaa.gov/west-coast/habitat-conservation/puget-sound-nearshore-habitat-conservation-calculator.

The NHVM applies a debit/credit factor of two to new structures to account for the fact that impacts on unimpaired habitat have been found to be more detrimental than future impacts to already impaired habitat at sites with existing structures (Roni et al. 2002, Zedler 2004). To clarify, given the current condition of nearshore habitat, impacts from new structures on relatively unimpaired habitat are more harmful than impacts resulting from the repair or replacement of existing structures, and the model accounts for this difference.

NMFS developed the NHVM based specifically on the designated critical habitat of listed salmonids in Puget Sound, scientific literature, and our best professional judgement. The model, run by inputting project specific information into the conservation calculator, produces numerical outputs in the form of conservation credits and debits. Credits (+) indicate positive environmental results to nearshore habitat quality, quantity, and/or function. Debits (-), on the other hand, indicate a loss of nearshore habitat quality, quantity, and/or function. The model can be used to assess credits and debits for nearshore development projects and restoration projects; in the past, we have used this approach in the Structures in Marine Waters Programmatic consultation (NMFS 2016a). As explained above, model outputs for new or expanded projects account for impacts to a "pristine" environment and are calculated at a higher debit rate (2 times greater) than those calculated for replace/repair projects, which assume that some function has already been lost from the existing structure. In sum, outputs from the NHVM account for the following consequences of the action:

- Beneficial aspects of proposed projects, including any positive effects that would result from removing a structure, or piece of a structure, prior to the end of any remaining "useful life period";

(Milon and Dodge 2001; Cacela et al. 2005; Strange et al. 2002). In Washington State, NMFS has also expanded the use of HEA to calculate conservation credits available from fish conservation banks (NMFS 2008, NMFS 2015b)), from which "withdrawals" can be made to address mitigation for adverse impacts to ESA species and their designated critical habitat.

- Minimization incorporated through project design improvements (e.g., credit is given for removal of, or replacement of creosote piles with steel piles as steel piles typically have less impact on water quality);
- Adverse effects that would occur for the duration of a new "useful life period" that would result from the proposed expanded, new, or repaired or replaced structure (or components of an existing structure).

We also describe the nature of these outputs earlier in the Proposed Federal Action (Section 1.3) and in the Effects of the Action (Section 2.4). Additionally, specific project outputs from each proposed project are included with this Opinion as 15 separate attachments designated by Corps identification number. Each attachment contains a summary sheet of overall credits of the proposed project as well as remaining debits. Finally, following the summary sheets is Appendix 1 which contains a detailed model output that describe how the remaining "useful life periods" (i.e., a 10-year credit for removal of an existing structure) and new "useful life periods" (impacts of the proposed project for 40 or 50 years) are determined. Other project effects, such as such as temporary construction effects like underwater sound from pile driving or intermittent effects such as propeller wash, are not quantified in the calculator but are analyzed in Section 2.4 of this Opinion.

The NHVM is also used to assess critical habitat impacts resulting from maintenance dredging. The NHVM quantifies the number of and extent to which PCE's are impacted by the proposed dredging. Maintenance dredging occurs at regular intervals; depending on the location every 2 to 5 years (Krenz 2020). After dredging, the dredged area starts to silt back in and the habitat functions of the migratory corridor gradually increase. The NHVM only assesses the temporal impacts of critical habitat impacts. Short-term effects, like elevated suspended sediments and re-suspended contaminants, are addressed qualitatively in the Effects of the Action in Section 2.4 below.

The model's accounting includes a selection of applicable Submerged Aquatic Vegetation (SAV) conditions prior to dredging and assumes no SAV after dredging. It also includes a 2-year impact to prey base from disrupted sediment and substrate (McCabe et al. 1998) with a restoration to full function expected in 4 years. After dredging, the dredged area starts to silt back in and the habitat functions of the migratory corridor gradually increase.

2.2 Rangewide Status of the Species and Critical Habitat

This Opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The Opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential PBFs that help to form that conservation value.

One factor affecting the status of ESA-listed species considered in this 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. The largest hydrologic responses are expected to occur in basins with significant snow accumulation, where warming decreases snow pack, increases winter flows, and advances the timing of spring melt (Mote et al. 2014; Mote et al. 2016). Rain-dominated watersheds and those with significant contributions from groundwater may be less sensitive to predicted changes in climate (Tague et al. 2013; Mote et al. 2014).

Higher temperatures will reduce the quality of available salmonid habitat for most freshwater life stages (ISAB 2007). Reduced flows will make it more difficult for migrating fish to pass physical and thermal obstructions, limiting their access to available habitat (Mantua et al. 2010; Isaak et al. 2012). Temperature increases shift timing of key life cycle events for salmonids and species forming the base of their aquatic foodwebs (Crozier et al. 2011; Tillmann and Siemann 2011; Winder and Schindler 2004). Higher stream temperatures will also cause decreases in dissolved oxygen and may also cause earlier onset of stratification and reduced mixing between layers in lakes and reservoirs, which can also result in reduced oxygen (Meyer et al. 1999; Winder and Schindler 2004; Raymondi et al. 2013). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier et al. 2008; Wainwright and Weitkamp 2013; Raymondi et al. 2013).

In addition to changes in freshwater conditions, predicted changes for coastal waters in the Pacific Northwest as a result of climate change include increasing surface water temperature, increasing but highly variable acidity, and increasing storm frequency and magnitude (Mote et al. 2014). Elevated ocean temperatures already documented for the Pacific Northwest are highly likely to continue during the next century, with sea surface temperature projected to increase by 1.0-3.7ºC by the end of the century (IPCC 2014). Habitat loss, shifts in species' ranges and abundances, and altered marine food webs could have substantial consequences to anadromous, coastal, and marine species in the Pacific Northwest (Tillmann and Siemann 2011; Reeder et al. 2013).

The adaptive ability of these threatened and endangered species is depressed due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. Without these natural sources of resilience, systematic changes in local and regional climatic conditions due to anthropogenic global climate change will likely reduce long-term viability and sustainability of populations in many of these ESUs (NWFSC 2015). New stressors generated by climate change, or existing stressors with effects that have been amplified by climate change, may also have synergistic impacts on species and ecosystems (Doney et al. 2012). These conditions will possibly intensify the climate change stressors inhibiting recovery of ESA-listed species in the future.

During the last century, average regional air temperatures in the Pacific Northwest increased by 1-1.4°F as an annual average, and up to 2°F in some seasons (based on average linear increase per decade; Abatzoglou et al. 2014; Kunkel et al. 2013). Recent temperatures in all but two years since 1998 ranked above the 20th century average (Mote et al. 2014). Warming is likely to continue during the next century as average temperatures are projected to increase another 3 to 10°F, with the largest increases predicted to occur in the summer (Mote et al. 2014). In fact, most Washington State models predict average temperatures in Washington State to increase 0.1-0.6ºC per decade (Mote and Salathé 2009). Warmer air temperatures will lead to more precipitation falling as rain rather than snow. As the snow pack diminishes, seasonal hydrology will shift to more frequent and severe early large storms, changing stream flow timing and increasing peak riverflows, which may limit salmon survival (Mantua et al. 2009). The largest driver of climate-induced decline in salmon and steelhead populations is projected to be the impact of increased winter peak flows, which scour the streambed and destroy salmonid eggs (Battin et al. 2007; Mantua et al. 2009).

Decreases in summer precipitation of as much as 30 percent by the end of the century are consistently predicted across climate models (Mote et al. 2014). Precipitation is more likely to occur during October through March, less during summer months, and more winter precipitation will be rain than snow (ISAB 2007; Mote et al. 2013). Earlier snowmelt will cause lower stream flows in late spring, summer, and fall, and water temperatures will be warmer (ISAB 2007; Mote et al. 2014). Models consistently predict increases in the frequency of severe winter precipitation events (i.e., 20-year and 50-year events), in the western United States (Dominguez et al. 2012). The largest increases in winter flood frequency and magnitude are predicted in mixed rain-snow watersheds (Mote et al. 2014).

The combined effects of increasing air temperatures and decreasing spring through fall flows are expected to cause increasing stream temperatures. In 2015 this rise resulted in 3.5-5.3ºC increases in Columbia Basin streams and a peak temperature of 26ºC in the Willamette (NWFSC 2015). Overall, about one-third of the current cold-water salmonid habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (Mantua et al. 2009).

The NOAA's Northwest Fisheries Science Center (NWFSC, NWFSC 2015) reported that climate conditions affecting Puget Sound salmonids were not optimistic, and recent and unfavorable environmental trends are expected to continue. A negative pattern in the Pacific Decadal Oscillation[5] has recently emerged, which adds uncertainty to the short-term duration of warming trends. However, the long-term trends of climate change and other environmental indicators suggest the continuation of warming ocean temperatures; fragmented or degraded freshwater spawning and rearing habitat; reduced snowpack; altered hydrographs producing reduced summer river flows and warmer water; and low marine survival for salmonids in the Salish Sea (NWFSC 2015). Overall, the marine heat wave in 2014-2016 had the most drastic impact on marine ecosystems in 2015, with lingering effects into 2016 and 2017. Conditions had somewhat returned to "normal" in 2018, but another marine heat wave in 2019 again set off a series of marine ecosystem changes across the North Pacific. One reason for lingering effects of ecosystem response is due to biological lags. These lags result from species impacts at larval or juvenile stages, which are typically most sensitive to extreme temperatures or changes in food supply. It is only once these species grow to adult size or recruit into fisheries that the impact of the heat wave is apparent (Ford 2022). Any rebound in VSP parameters for PS steelhead are likely to be constrained under these conditions (NWFSC 2015; Ford 2022).

[5] https://www.ncdc.noaa.gov/teleconnections/pdo/.

As more basins become rain-dominated and prone to more severe winter storms, higher winter stream flows may increase the risk that winter or spring floods in sensitive watersheds will damage spawning redds and wash away incubating eggs (Goode et al. 2013). Earlier peak stream flows will also alter migration timing for salmon smolts, and may flush some young salmon and steelhead from rivers to estuaries before they are physically mature, increasing stress and reducing smolt survival (McMahon and Hartman 1989; Lawson et al. 2004).

Mauger et al. (2015) reviewed the expected effects of climate change on the Puget Sound marine ecosystem. They identify warmer water temperatures, loss of coastal habitat due to sea level rise, ocean acidification, changes in water quality and freshwater inputs, more frequent algal blooms, and increased erosion from wave action as likely impacts of future climate change.

Recent modeling research has shown variation in the impacts of marine warming on fall-run Chinook salmon distribution depending on stock, resulting in future regional declines or increases in salmon abundance. Shelton et al. (2020) used a Bayesian state-space model to model ocean distribution of fall-run Chinook salmon stocks in the Northwest Pacific, paired with data on sea surface temperature associated with each stock and future ocean climate predictions to predict future distribution of Chinook salmon related to changing sea surface temperature in 2030-2090. In warm years (compared to cool) Klamath, Columbia River (upriver bright run, lower, middle), and Snake River stocks shifted further North, while California Central Valley stock shifted south. Notably, Columbia River and Snake River fall-run Chinook salmon are in the top 10 priority stocks for SRKWs (NMFS and WDFW 2018). Predicted future shifts in distributions due to warming led to future increases in ocean salmon abundance off northern British Columbia and central California, minimal changes off Oregon, Southern British Columbia, and Alaska, and declines in abundance off Washington and northern California (Shelton et al. 2020).

In a broader view, data overwhelmingly 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.

In marine habitat, scientists are not certain of all the factors impacting salmon and steelhead survival but several ocean-climate events are linked with fluctuations in steelhead health and abundance such as El Niño/La Niña, the Aleutian Low, and coastal upwelling (Pearcy and Mantua 1999). Steelhead, along with Chinook and coho salmon, have experienced tenfold declines in survival during the marine phase of their lifecycle, and their total abundance remains well below what it was 30 years ago[6]. The marine survival of coastal steelhead, as well as Columbia River Chinook and coho salmon, do not exhibit the same declining trend as the Salish Sea populations. Specifically, marine survival rates for steelhead in Washington State have declined in the last 25 years with the PS steelhead populations declining to a greater extent than other regions (i.e., Washington Coast and Lower Columbia River). Abundance of PS steelhead populations is at near historic lows (Moore et al. 2014). Climate changes have included

[6] Long Live the Kings 2015: http://marinesurvivalproject.com/the-project/why/

increasing water temperatures, increasing acidity, more harmful algae, the loss of forage fish and some marine commercial fishes, changes in marine plants, and increased populations of some marine mammals (i.e. seals and porpoises) (LLTK 2015). Preliminary work conducted as part of the Salish Sea Marine Survival Project reported that approximately 50 percent of the steelhead smolts that reach the Hood Canal Bridge did not survive in the 2017 and 2018 outmigration years. Of the steelhead that did not survive, approximately 80 percent were consumed by predators that display deep diving behavior, such as pinnipeds (Moore and Berejikian 2019). Climate change plays a part in steelhead mortality, but more studies are needed to determine the specific causes of this marine survival decline in Puget Sound.

Evidence suggests that marine survival among salmonids fluctuates in response to 20 to 30-year cycles of climatic conditions and ocean productivity. Naturally occurring climatic patterns, such as the Pacific Decadal Oscillation, El Niño and La Niña events, and North Pacific Gyre Oscillation, can cause changes in ocean productivity that can affect productivity and survival, of salmon (Mantua et al. 1997; Francis and Hengeveld 1998; Beamish et al. 1999; Hare et al. 1999; Benson and Trites 2002; Dalton et al. 2013, Kilduff et al. 2014), affecting the prey available to SRKWs. (Though relationships may be weakening, see Litzow et al. 2020). Prey species such as salmon are most likely to be affected through changes in food availability and oceanic survival (Benson and Trites 2002), with biological productivity increasing during cooler periods and decreasing during warmer periods (Hare et al. 1999; NMFS 2008a). Also, range extensions were documented in many species from southern California to Alaska during unusually warm water associated with “The Blob” in 2014 and 2015 (Bond et al. 2015; Di Lorenzo and Mantua 2016), and past strong El Niño events (Pearcy 2002; Fisher et al. 2015).

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

Moreover, as atmospheric carbon emissions increase, increasing levels of carbon are absorbed by the oceans, changing the pH of the water. A 38 to 109 percent increase in acidity is projected by the end of this century in all but the most stringent CO_2 mitigation scenarios, and is essentially irreversible over a time scale of centuries (IPCC 2014). Regional factors appear to be amplifying acidification in Northwest ocean waters, which is occurring earlier and more acutely than in other regions and is already impacting important local marine species (Barton et al. 2012; Feely et al. 2012). Acidification also affects sensitive estuary habitats, where organic matter and nutrient inputs further reduce pH and produce conditions more corrosive than those in offshore waters (Feely et al. 2012; Sunda and Cai 2012).

Global sea levels are expected to continue rising throughout this century, reaching predicted increases of 10-32 inches by 2081-2100 (IPCC 2014). These changes will likely result in increased erosion and more frequent and severe coastal flooding, and shifts in the composition of nearshore habitats (Tillmann and Siemann 2011; Reeder et al. 2013). Estuarine-dependent salmonids, such as chum and Chinook salmon, are predicted to be impacted by significant reductions in rearing habitat in some Pacific Northwest coastal areas (Glick et al. 2007). Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances, and therefore these species are predicted to fare poorly in warming ocean conditions (Scheuerell and Williams 2005; Zabel et al. 2006). This is supported by the recent observation that anomalously warm sea surface temperatures off the coast of Washington from 2013 to 2016 resulted in poor coho and Chinook salmon body condition for juveniles caught in those waters (Ford 2022). Changes to estuarine and coastal conditions, as well as the timing of seasonal shifts in these habitats, have the potential to impact a wide range of listed aquatic species (Tillmann and Siemann 2011; Reeder et al. 2013).

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

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

2.2.1 Status of the Species

For Pacific salmon, steelhead, and certain other species, we commonly use the four "viable salmonid population" (VSP) 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. 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. See Table 6.

Table 6. Listing status, status of critical habitat designations and protective regulations, and relevant Federal Register (FR) decision notices for ESA-listed species considered in this Opinion. Listing status: 'T' means listed as threatened; 'E' means listed as endangered.

Species	Listing Status	Critical Habitat
PS Chinook salmon *(Oncorhynchus tshawytscha)*	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630
Hood Canal Summer Run Chum *(Oncorhynchus keta)*	T 6/28/05; 70 FR 37160	9/02/05; 70 FR 52630
PS Steelhead (*Oncorhynchus mykiss*)	T 5/11/07; 72 FR 26722	2/24/16; 81 FR 9252
PS/GB Yelloweye Rockfish *(Sebastes ruberrimus)*	T 4/28/10; 75 FR 22276	2/11/15; 79 FR 68041
PS/GB Bocaccio (*Sebastes paucispinis)*	E 4/28/10; 75 FR 22276	2/11/15; 79 FR 68041
Southern Resident Killer Whale *(Orcus orcinus)*	E 11/18/2005; 70 FR 69903	11/29/06; 79 FR 69054 08/02/21; 86 FR 41668

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 6) 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.

On October 4, 2019, NMFS published notice of 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 status review (84 FR 53117). On March 24, 2020, NMFS extended the public comment period, from the original March 27, 2020, through May 26, 2020 (85 FR 16619). The NMFS' West coast Regional Office (WCRO) is currently preparing the final status review documents. In this section, we utilize information from the NWFSC's biological viability report update for Pacific salmon and steelhead (Ford 2022) in order to provide the most recent information for our evaluation in this Opinion.

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 (Table 7).

Table 7. 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. This is the raw total spawner estimate times the fraction natural-origin estimate, if available. In parentheses, 5-year geometric mean of raw total spawner estimates (i.e., hatchery and natural) are shown. A value only in parentheses means that a total spawner estimate was available but no (or only one) estimate of natural-origin spawners was available. The geometric mean was computed as the product of estimates raised to the power 1 over the number of counts available (2 to 5). A minimum of 2 values were used to compute the geometric mean. Percent change between the most recent two 5-year periods is shown on the far right (Ford 2022).

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)

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

Since 1999, most PS Chinook salmon 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.[7] 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,[8] 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 spawners[9]. So, although several populations are above the updated rebuilding thresholds, indicating that escapement is sufficient for the available habitat in many cases, the overall abundance has declined.

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;

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

[8] 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.

[9] 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 the Green River Management Unit Profile (PSIT and WDFW 2017).

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 action across all populations within the PS Chinook salmon ESU. In doing so, it is important to consider 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 salmon populations into three tiers based on a systematic framework that considers the population’s life history and production and watershed characteristics (NMFS 2010b) (Figure 2). 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; 2016f; 2017b; 2018c; 2019b; 2021e)

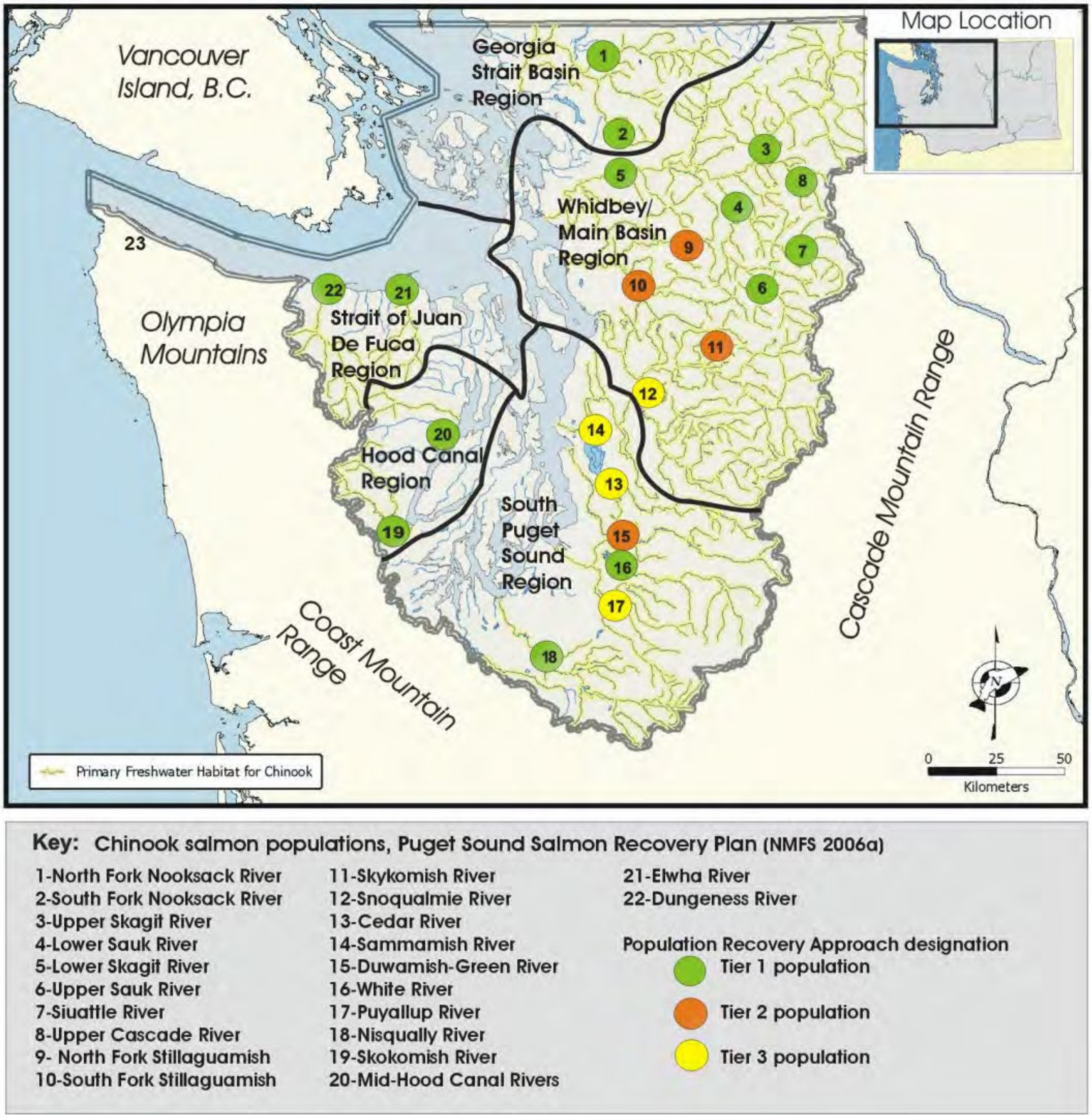

Figure 2. Puget Sound Chinook salmon populations.

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

Over the long-term trend (since 1990), there is a general declining trend in the proportion of natural-origin spawners across the ESU (Table 8). 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 8). 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 salmon 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 salmon ESU (Table 8).

In addition, spatial structure, or geographic distribution, of the White, Skagit, Elwha,[10] 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.

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

Table 8. Five-year mean of fraction of natural-origin spawners[11] (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 3). 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).

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

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 salmon 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 2022).

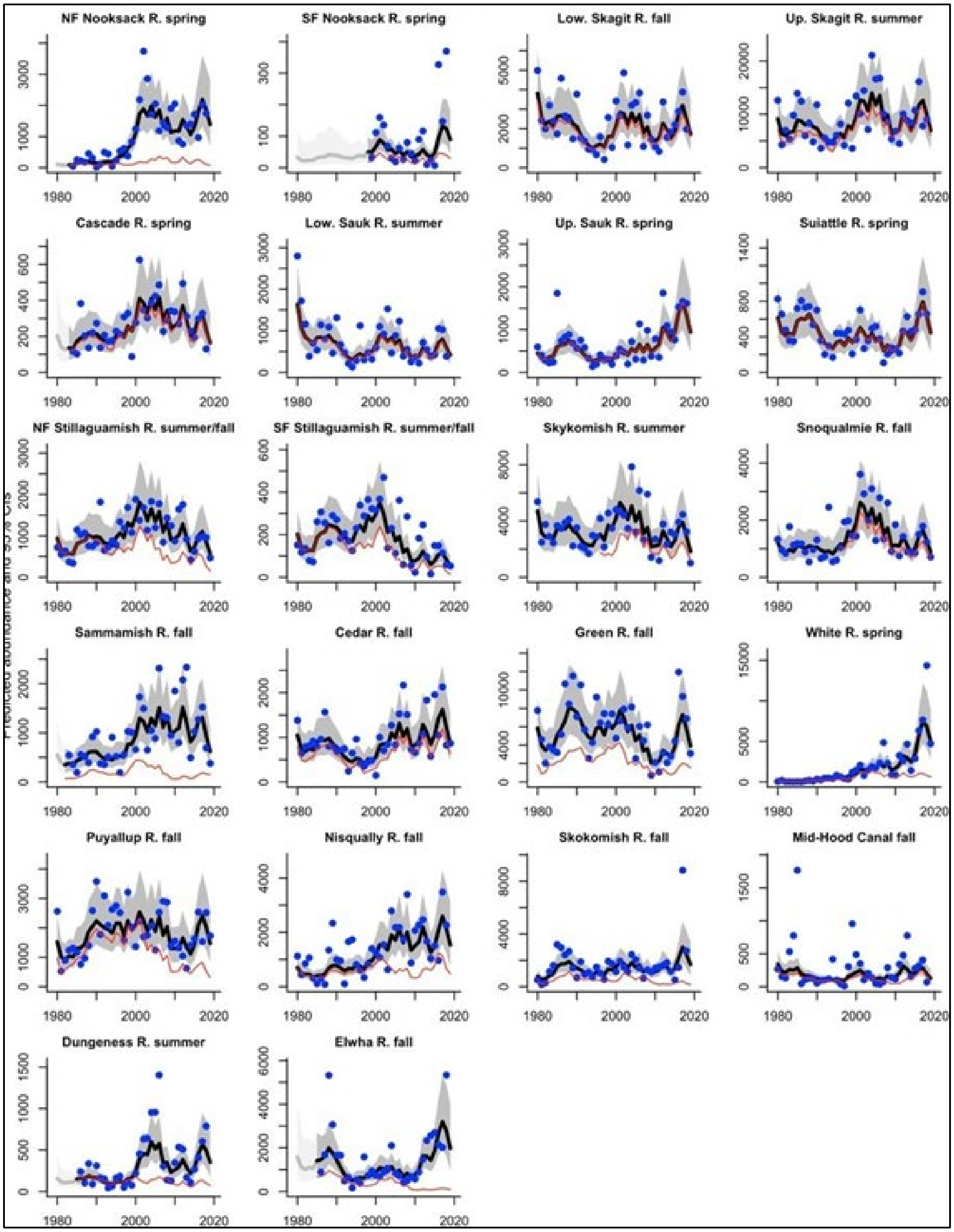

Figure 3. Smoothed trend in estimated total (thick black line, with 95 percent confidence internal in gray) and natural (thin red line) PS Chinook salmon population spawning abundance. In portions of a time series where a population has no annual estimate but smoothed spawning abundance is estimated 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-1980's (Figure 3). 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 4). 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 is 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 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).

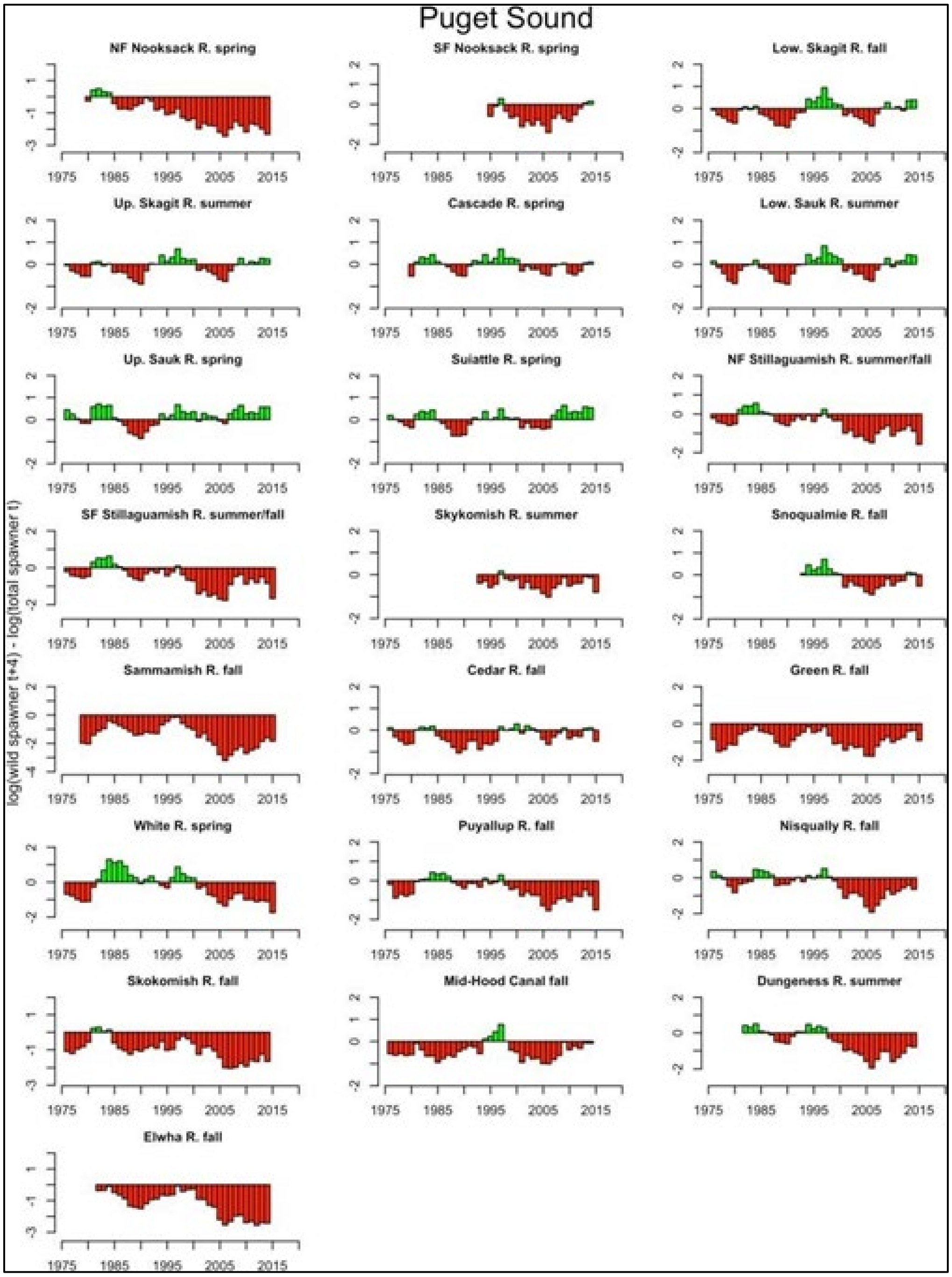

Figure 4. Trends in population productivity, estimated as the log of the smoothed natural-origin spawning abundance in year t – smoothed natural-origin spawning abundance in year (t – 4) (Ford 2022).

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 functions;
- 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.[12]

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, NMFS completed a 5-year status review of HCSR chum salmon (NMFS 2017c) and in 2022, the NWFSC released a biological viability update for Pacific salmon and steelhead (Ford 2022). We adopted a recovery plan for HCSR chum salmon in May of 2007. The recovery plan consists of two documents: the 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 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 salmon ESU populations that are based on two assumptions about productivity and environmental response (Table 9).

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

[12] 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).

Table 9. Hood Canal summer-run chum salmon 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 salmon, 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 salmon recovery program have included the reintroduction and sustaining of natural-origin spawning in multiple small streams where summer chum salmon 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 10). 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 10. Seven ecological diversity groups as proposed by the PSTRT for the HCSR chum salmon 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 Hood Canal summer-run chum 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 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; Ford 2022) (81 FR 33468, May 26, 2016). As mentioned above in the PS Chinook salmon 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' WCR are currently preparing the final five-year status review documents, with anticipated release in 2022. In this Opinion, where possible, the 2015 status review information is supplemented with information and other population specific data available considered during the drafting of the most recent five-year status review for PS Chinook salmon and steelhead.

At the time of listing the Puget Sound steelhead Biological Review Team (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 2011; 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 2019g) 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 5 illustrates the DPS, MPGs, and DIPs for PS steelhead.

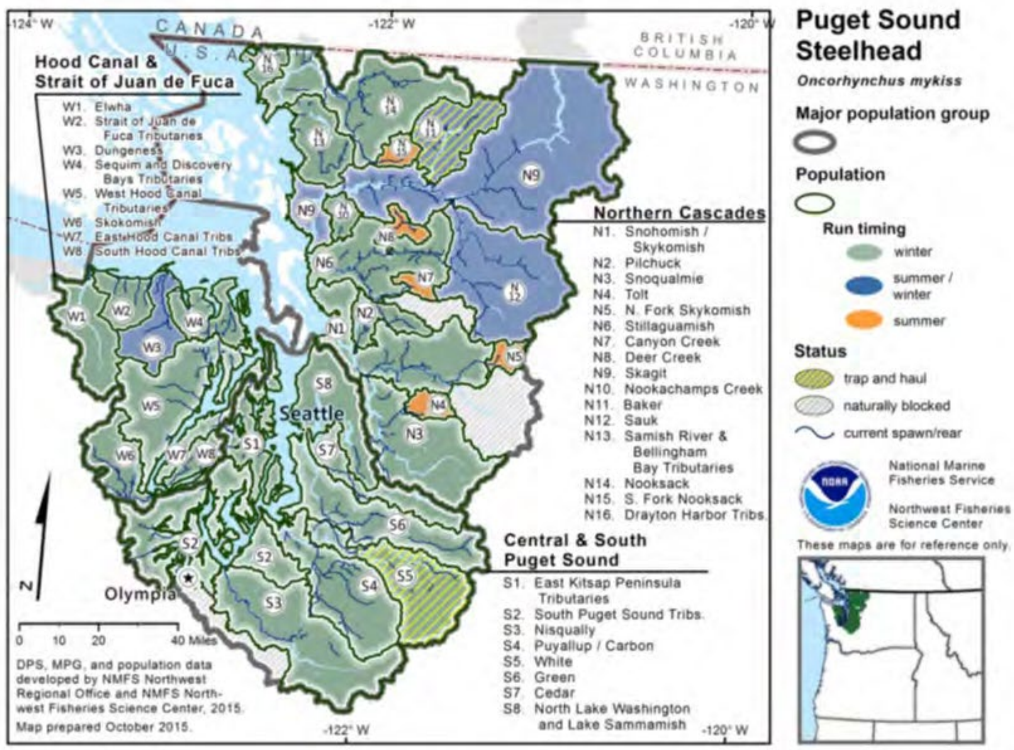

Figure 5. The PS steelhead DPS showing MPGs and DIPs. The steelhead MPGs include the Northern Cascades, Central & Sound Puget Sound, and the Hood Canal & Strait of Juan de Fuca.

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 2019g) 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 2019g).

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 5) 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 2019g) also established MPG-level viability criteria. The following are specific criteria are required for MPG viability:

- At least 50 percent of steelhead populations in the MPG achieve viability.
- Natural production of steelhead from tributaries to Puget Sound that are not identified in any of the 32 identified populations provides sufficient ecological diversity and productivity to support DPS-wide recovery.
- In addition to the minimum number of viable DIPs (50 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 2019g) 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 2019g). 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 2019g).

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 2019g) 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 2019g).

<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[13]. For diversity, these factors included hatchery fish production, contribution of resident fish to anadromous fish production, and run timing of adult steelhead. Quantitative information on spatial structure and connectivity was not available for most 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 2011). Diversity was generally higher for populations within the Northern Cascades MPG, where more variability in viability was expressed and diversity generally higher, compared to populations in both the Central and South Puget Sound and Hood Canal and Strait of Juan de Fuca MPG, where diversity was depressed and viabilities were generally lower (NWFSC 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 assessment 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 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 5 percent 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 case, it is likely that abundances are very low.

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

Early winter-run fish produced in isolated hatchery programs are derived from Chambers Creek stock in southern Puget Sound, which has been selected for early spawn timing, a trait known to be inheritable in salmonids.[14] Summer-run fish produced in isolated hatchery programs were historically derived from the 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 2016b; 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 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

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

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 (Table 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.

Table 11. Recent (2015-2019) 5-year geometric mean of raw wild spawner counts for PS steelhead populations and population groups compared with Puget Sound Steelhead Recovery Plan high and low productivity recovery targets (NMFS 2019a). (SR) – Summer-run. Abundance is compared to the high productivity individual DIP targets. Colors indicate the relative proportion of the recovery target currently obtained: red (<10%), orange (10%>x<50%), yellow (50%>x<100%), green (>100%). "*" denotes an interim recovery target.

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

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

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 Hanson 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.[15]. 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 (Table 12). 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.

[15] 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 (Ford 2022).

Table 12. Five-year geometric mean of raw natural spawner counts for PS steelhead. This is the raw total spawner count times the fraction natural estimate, if available. In parentheses, the 5-year geometric mean of raw total spawner counts is shown. A value only in parentheses means that a total spawner count was available but none or only one estimate of natural spawners was available. The geometric mean was computed as the product of counts raised to the power 1 over the number of counts available (2 to 5). A minimum of 2 values was used to compute the geometric mean. Percent change between the most recent two 5-year periods is shown on the far right. MPG, major population group; NC, Northern Cascades, SCC South and Central Cascades, HCSJF, Hood Canal and Strait of Juan de Fuca, W, winter run; S, summer run (NWFSC 2020).

Biogeographic Region	Population (Watershed)	2010-2014	2015-2019	Population trend (% change)
Hood Canal and Strait of Juan de Fuca	East Hood Canal Tribs	60 (60)	93 (93)	Positive 55% (55)
	Sequim/Discovery Bay Tribs	-	-	-
	Elwha River	680 (680)	1241 (1241)	Positive 82% (82)
	Dungeness River	517 (517)	408 (408)	Negative 21% (-21)
	Skokomish River	533 (533)	958 (958)	Positive 80% (80)
	South Hood Canal Tribs	69 (69)	91 (91)	Positive 32% (32)
	West Hood Canal Tribs	138 (138)	150 (150)	Positive 9% (9)
	Strait of Juan de Fuca Tribs	151 (151)	95 (95)	Negative 37% (-37)
Northern Cascades	Snohomish/Skykomish River	975 (975)	690 (690)	Negative 29% (29)
	Snoqualmie River	706 (706)	500 (500)	Negative 29% (-29)
	Stillaguamish River	386 (386)	487 (487)	Positive 26% (26)
	Nooksack River	1745 (1745)	1906 (1906)	Positive 9% (9)
	Skagit River	6391 (6391)	7181 (7181)	Positive 12% (12)

Biogeographic Region	Population (Watershed)	2010-2014	2015-2019	Population trend (% change)
	Pilchuck River	626 (626)	638 (638)	Positive 2% (2)
	Sammish/Bellingham Bay Tribs	748 (748)	1305 (1305)	Positive 74% (74)
	Tolt River	108 (108)	40 (40)	Negative 63% (-63)
Central/South Puget Sound Basin	Cedar River	4 (4)	6 (6)	Positive 50% (50)
	North Lake Washington/ Sammamish River	-	-	-
	Green River	662 (662)	1282 (1282)	Positive 94% (94)
	Puyallup/Carbon River	85 (85)	201 (210)	Positive 136% (136)
	White River	79 (79)	182 (182)	Positive 130% (130)
	Nisqually River	477 (477)	1368 (1368)	Positive 187% (187)

<u>PS steelhead Recovery Plan.</u> 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). 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 Rockfish

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 rockfish bocaccio across the full DPSs area. In 2013, the Washington Department of Fish and Wildlife (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 size for rare species, such as yelloweye and bocaccio rockfish.

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 over-proportional 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 the 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 rockfish, 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 rockfish, not the two listed species, or for the listed species in areas outside the DPSs. 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 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 juvenile rockfish species offers 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.

General Life History: 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 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 as well out 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: The PS/GB bocaccio DPS includes all bocaccio from inland marine waters east of the central Strait of Juan de Fuca and south of the northern Strait of Georgia, collectively known as the Salish Sea. The waters of Puget Sound and Straits of Georgia can be divided into five interconnected basins that are largely hydrologically isolated from each other by relatively shallow sills (Burns 1985; Drake et al. 2010). The basins within US waters are: (1) San Juan, (2) Main, (3) South Sound, and (4) Hood Canal. The fifth basin consists of Canadian waters east and north of the San Juan Basin into the Straits of Georgia (Tonnes et al. 2016). 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 Juans 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 threatened on April 28, 2010 (75 FR 22276). In April 2016, we completed a 5-year status review that recommended the DPS retain its threatened 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 DPSs include 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). A 5-year review under the ESA completed in 2021 concluded that SRKWs should remain listed as endangered and includes recent information on the population, threats, and new research results and publications (NMFS 2021b).

NMFS considers SRKWs to be currently among nine of the most at-risk species as part of the Species in the Spotlight initiative[16] 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

[16] https://www.fisheries.noaa.gov/resource/document/species-spotlight-priority-actions-2016-2020-southern-resident-killer-whale

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 (NMFS 2016b), the Pacific Fishery Management Council (PFMC) SRKW Ad Hoc Workgroup's report (PFMC 2020), 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 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 6). As of September 2021, the population is 74 whales, including 24 whales in J pod, 17 whales in K pod, and 33 whales in L pod, including two calves born to J pod in September 2020 and one new calf to the L pod in February 2021 (Center for Whale Research 2021). 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.

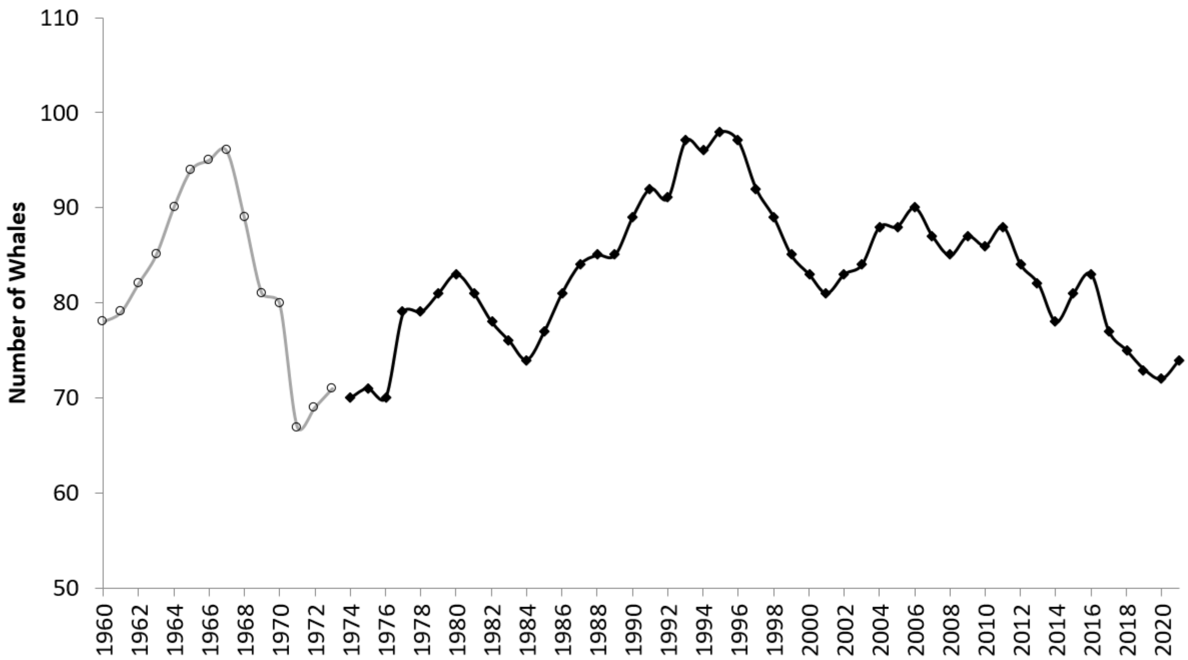

Figure 6. Population size and trend of Southern Resident killer whales, 1960-2021. Data from 1960-1973 (open circles, gray line) are number projections from the matrix model of Olesiuk et al. (1990). Data from 1974-2021 (diamonds, black line) were obtained through photo-identification surveys of the 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.

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. 2011; 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 standings 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 most recent 5-year review (NMFS 2016j). The updated analysis[17] 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 downward trend is in part due to the changing age and sex structure of the population. If the population of SRKW experiences demographic rates (e.g. fecundity and mortality) that are more similar to 2016 than the recent 5-year average (2011to 2016), the population will decline faster as shown in Figure 7 (NMFS 2016b). There are several demographic factors of the SRKW population that are cause for concern, namely (1) reduced fecundity; (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 2016b).

[17] 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).

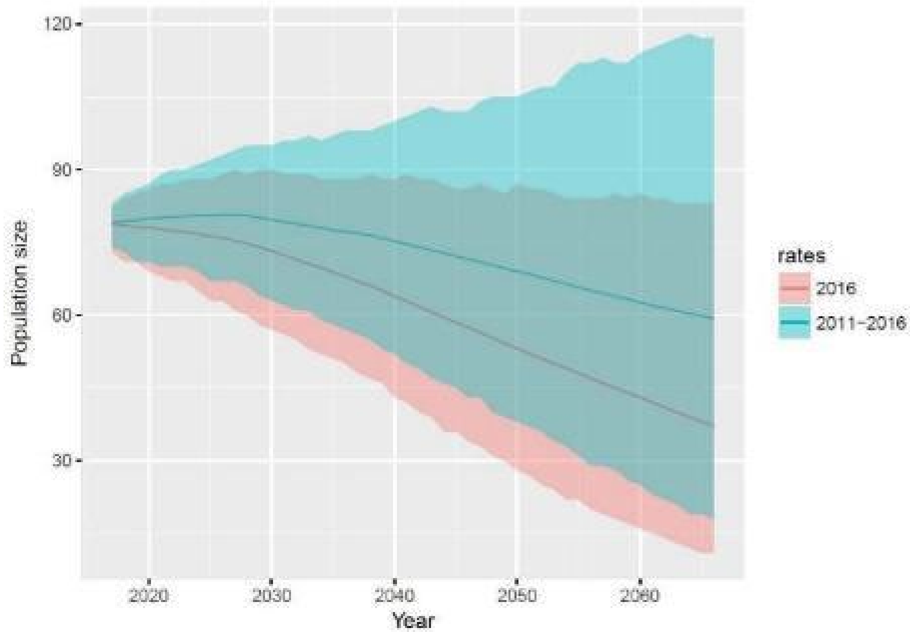

Figure 7. SRKW population size projections from 2016 to 2066 using two scenarios: (1) projections using demographic rates held at 2016 levels, and (2) projections using demographic rates from 2011 to 2016. The pink line represents the projection assuming future rates are similar to those in 2016, whereas the blue represents the scenario with future rates being similar to 2011 to 2016 (NMFS (2016b)).

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 failed pregnancies 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 8). 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).

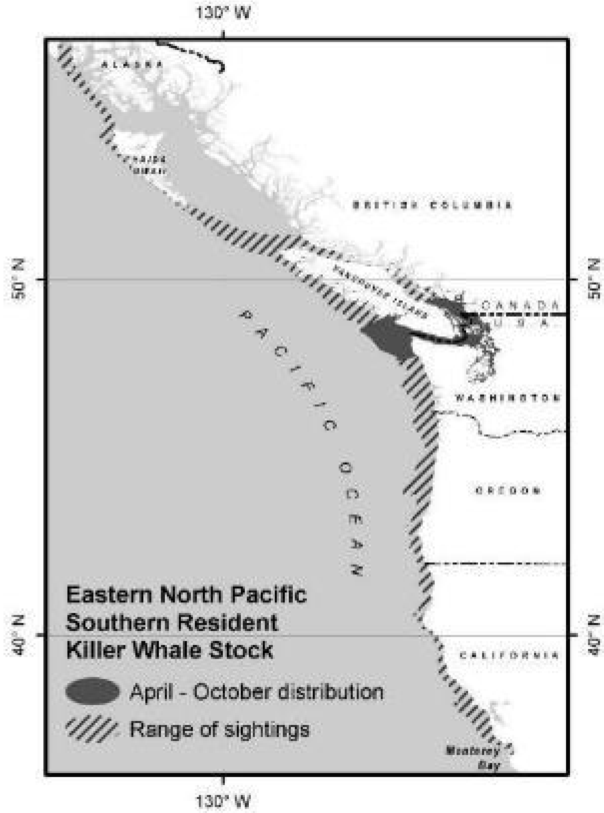

Figure 8. Approximate April–October distribution of SRKW (shaded area) and range of sightings (diagonal lines) (reprinted from Carretta et al. (2021)).

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 11). 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 13). 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 9), 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 10) (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 km2, 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).

Table 13. Satellite-linked tags deployed on SRKW 2012-2016. (Hanson et al. 2018). This was part of a collaborative effort between NWFSC, Cascadia Research Collective, and the University of Alaska.

Whale ID	Pod association	Date of tagging	Duration of signal contact (days)
J26	J	20 Feb. 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

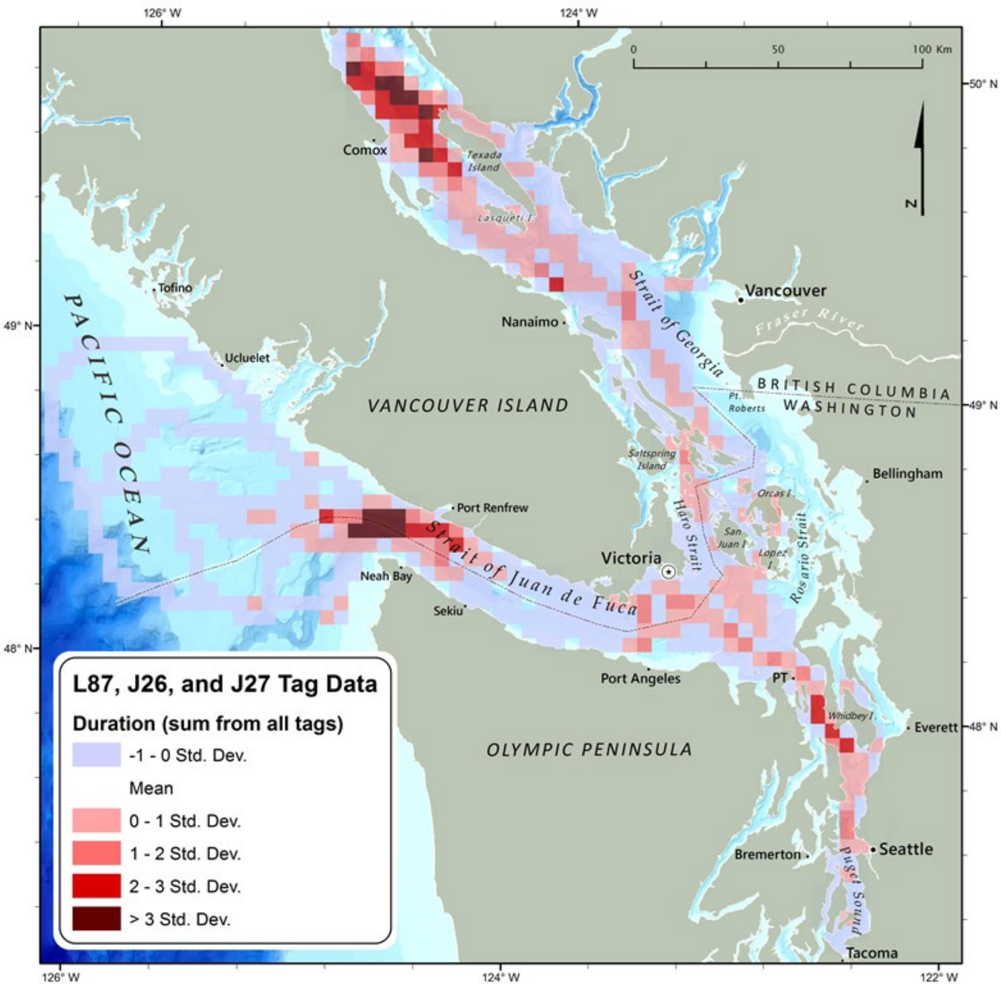

Figure 9. Duration of occurrence model output for J pod tag deployments (Hanson et al. 2017). "High use areas" are illustrated by the 0 to > 3 standard deviation pixel**.** Duration of occurrence model for all unique K and L pod tag deployments (Hanson et al. 2017). "High use areas" are illustrated by 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 11), 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). "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 Washington coast and thus the effort was higher in this area (i.e., the number of recorders increased in this area) compared to off Oregon and California.

There were acoustic detections off Washington coast in all months of the year (Figure 12), 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).

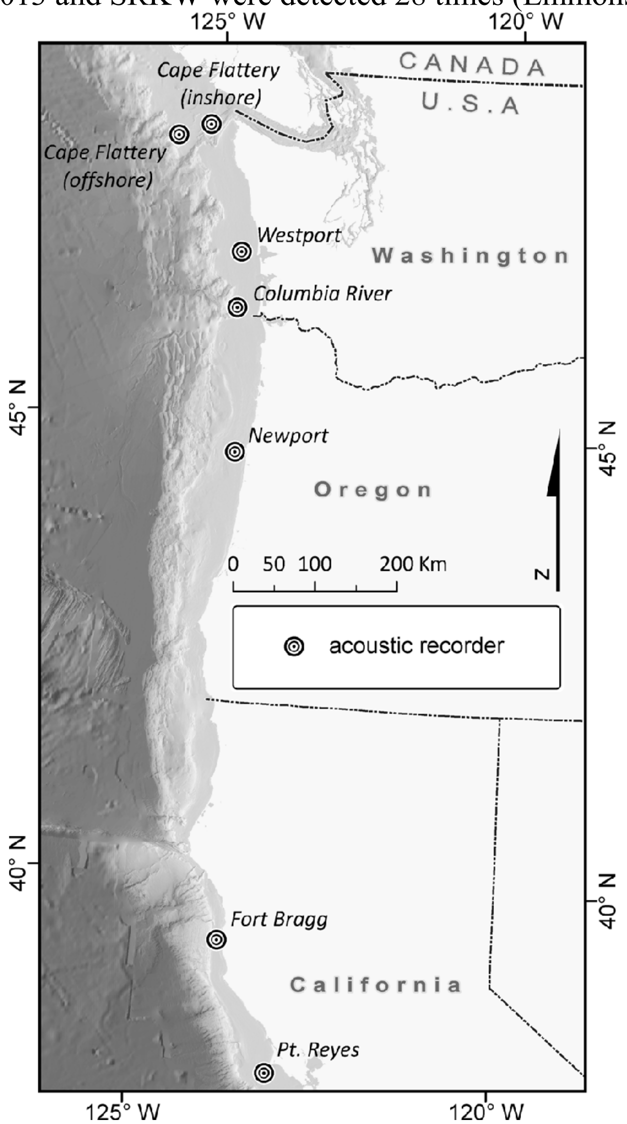

Figure 10. Deployment locations of acoustic recorders on the U.S. west coast from 2006 to 2011 (Hanson et al. 2013).

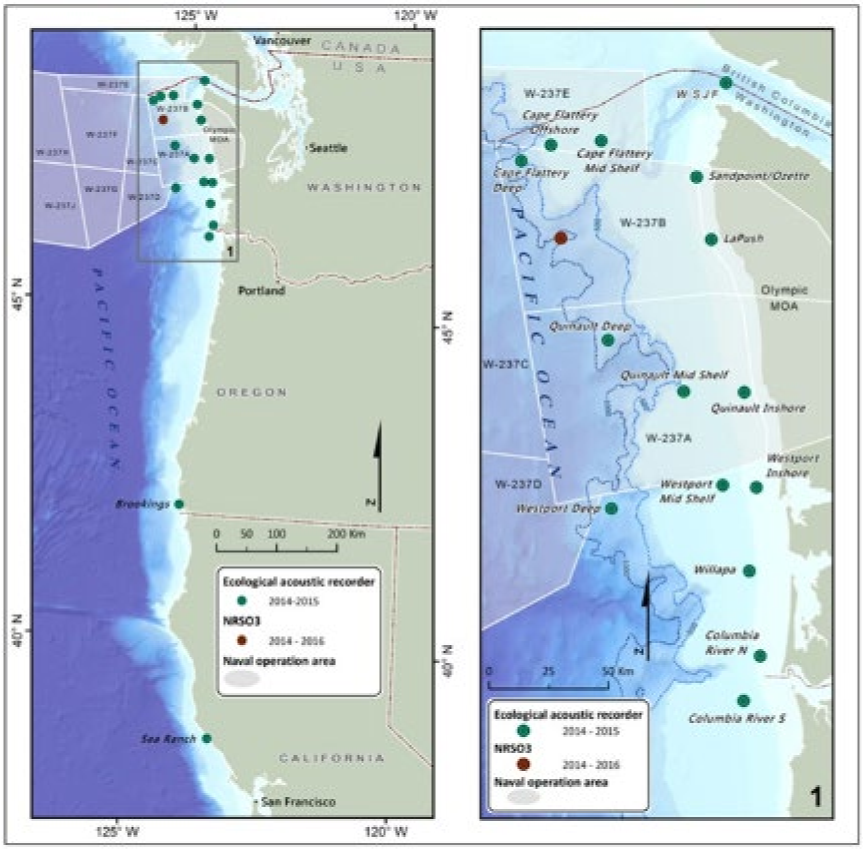

Figure 11. Locations of passive acoustic recorders deployed beginning in the fall of 2014 (Hanson et al. 2017).

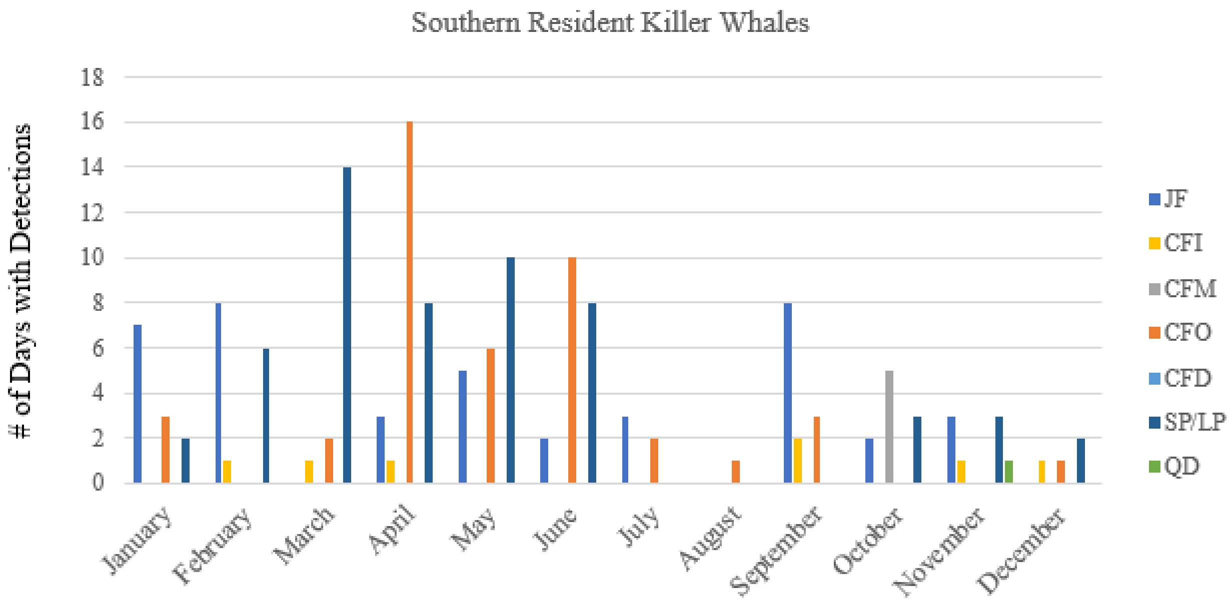

Figure 12. Counts of detections at each northern recorder site by month from 2014-2017 (Emmons et al. 2019). Areas include Juan de Fuca (JF); Cape Flattery Inshore (CFI); Cape Flattery Mid Shelf (CFM); Cape Flattery Offshelf (CFO); Cape Flattery Deep (CFD); Sand Point and La Push (SP/LP); and Quinault Deep (QD).

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 13 (Riera et al. 2019). SRKW were detected on 163 days with 175 encounters (see Figure 14 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).

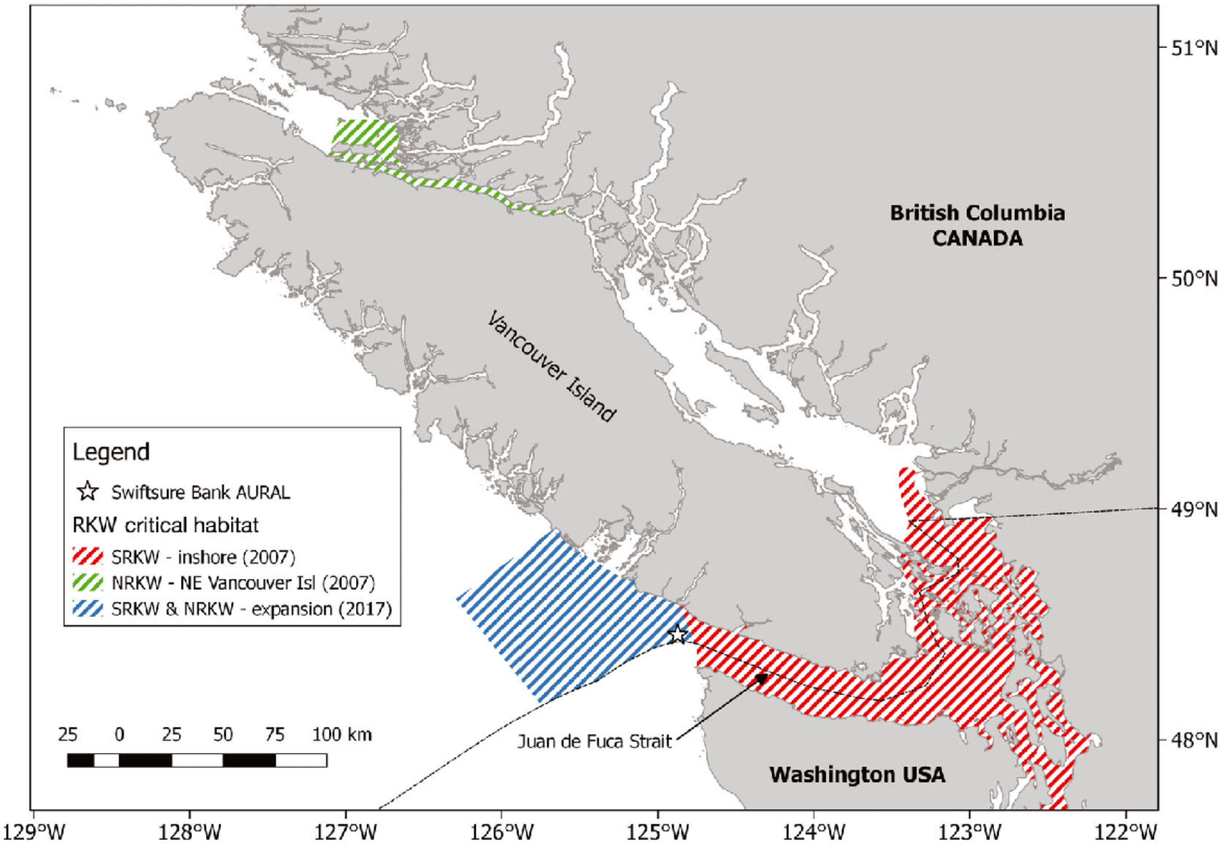

Figure 13. Swiftsure Bank study site off the coast of British Columbia, Canada in relation to the 2007 Northern Resident critical habitat (NE Vancouver Island) and 2007 SRKW critical habitat (inshore waters) and the 2017 Northern Resident and Southern Resident expansion of critical habitat (Riera et al. 2019).

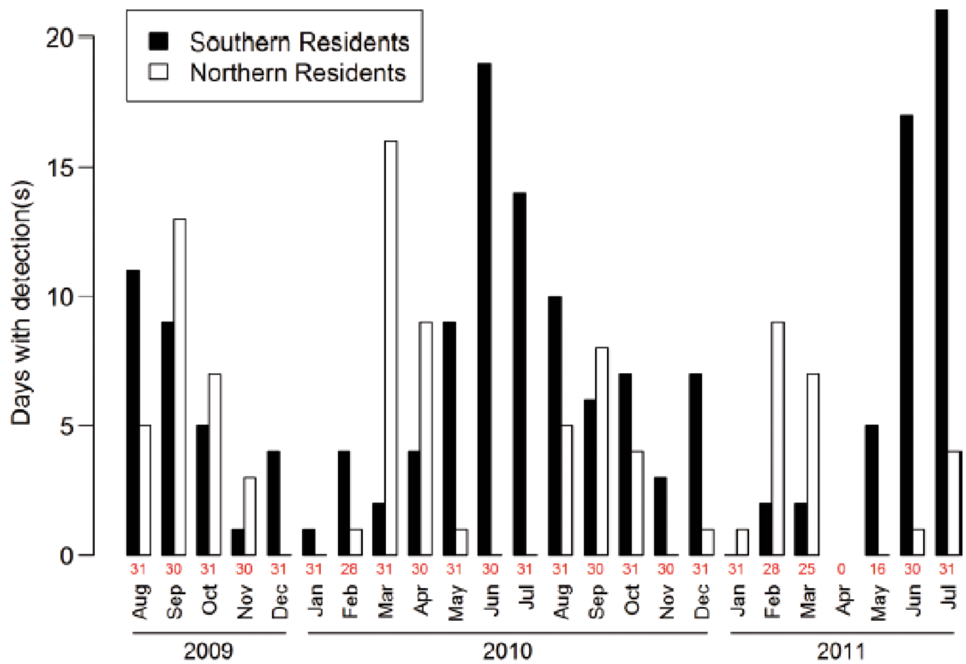

Figure 14. Number of days with acoustic detections of SRKWs at Swiftsure Bank from August 2009–July 2011. Red numbers indicate days of effort. (Riera et al. 2019).

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 salmon, 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 15). This study provides further information about the habitat use of these resident killer whale populations with implications for their management and conservation.

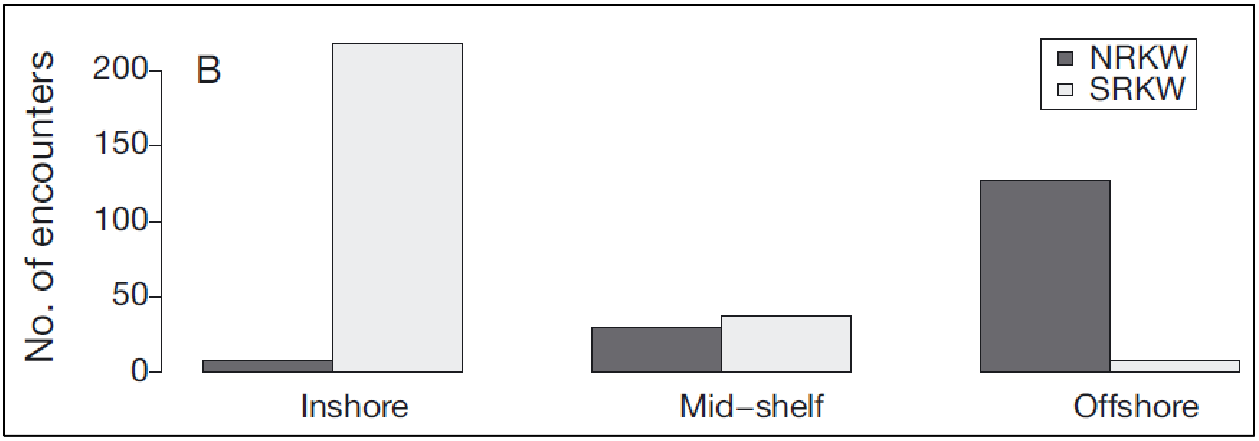

Figure 15. Total number of encounters at inshore, mid-shelf, and offshore sites (Emmons et al. 2021)

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 of 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 (during the summer and fall. Chum salmon, coho salmon, and steelhead) 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 salmon 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.

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 salmon is the primary prey for all pods in summer months followed by coho and then other salmonids. Carbon signatures in samples varied by month, which could indicate variation in Chinook and coho salmon consumption between months 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 salmon was the primary prey across years, there was inter-annual variability in nitrogen signature in samples, which could indicate variation in Chinook salmon nitrogen content from year to year or greater Chinook salmon consumption in certain years versus others and/or nutritional stress in certain years, but this is difficult to determine.

Over the last forty years, predation on Chinook salmon off the West Coast of North America by marine mammals has been estimated to have more than doubled (Chasco et al. 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 salmon stocks that originate from the Fraser River (80–90 percent of the diet in the Strait of Juan de Fuca and San Juan Islands; including Upper Fraser, Mid Fraser, Lower Fraser, North Thompson, South Thompson and Lower Thompson), and to a lesser extent consume stocks from Puget Sound (North and South Puget Sound) 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 16). Results of the 57 available prey samples indicate that, as is the case in inland waters, Chinook salmon are the primary species detected in diet samples on the outer coast, although steelhead, chum salmon, 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 salmon prey samples opportunistically collected in coastal waters were determined to have originated from the Columbia River basin, including Lower Columbia

Spring, Middle Columbia Tule, and Upper Columbia Summer/Fall. In general, we would expect to find these stocks given the diet sample locations (Figure 16). However, the Chinook salmon stocks included fish from as far north as the Taku River (Alaska and British Columbia stocks) and as far south as the Central Valley California (Hanson et al. 2021).

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).[18] 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 salmon abundance, including hatchery fish, benefit this endangered population of whales by enhancing prey availability to SRKWs and hatchery fish often contribute significantly to the salmon stocks consumed (Hanson et al. 2010, Hanson 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.

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

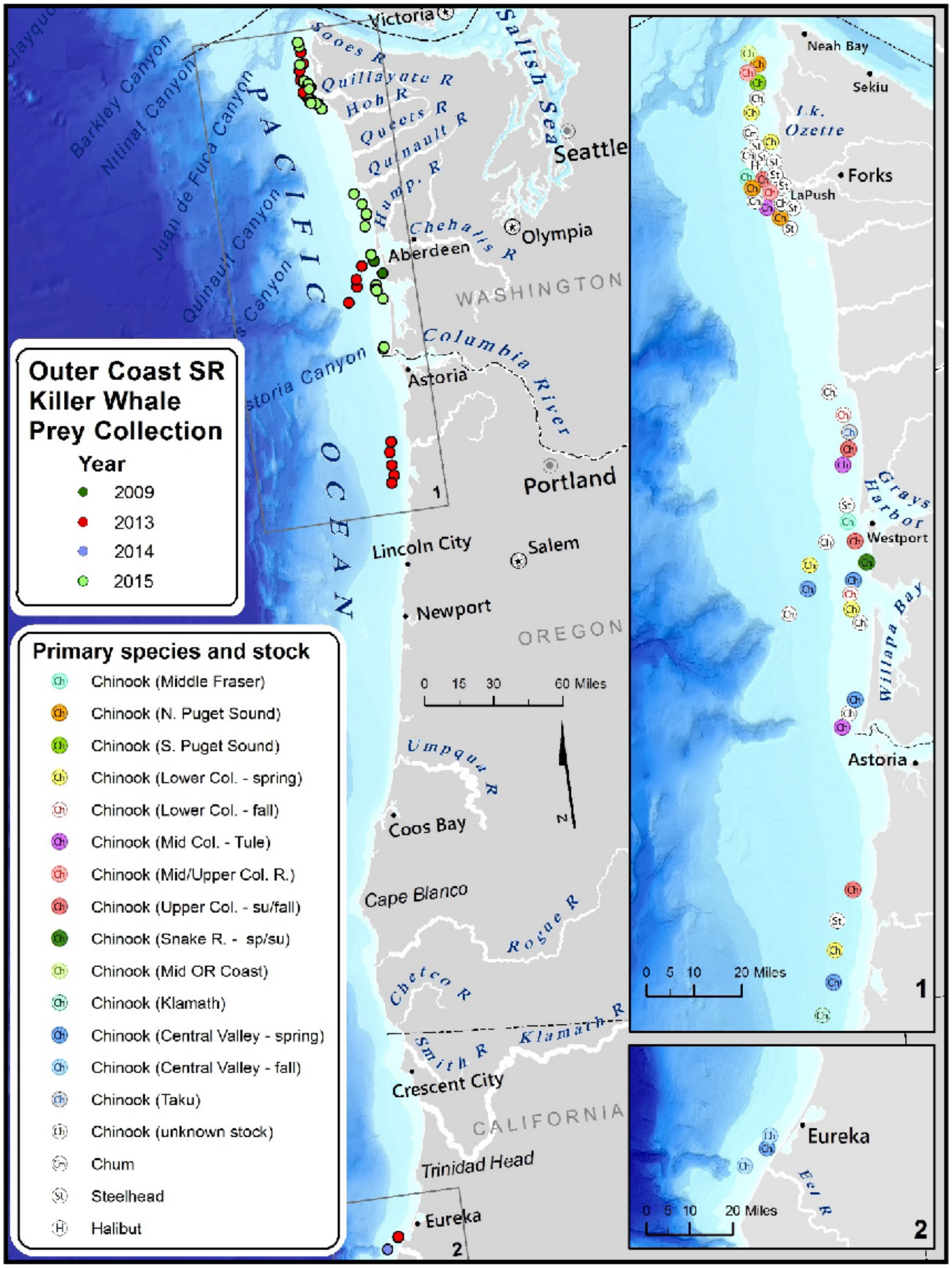

Figure 16. Location and species for scale/tissue samples collected from SRKW predation events in outer coastal waters (NMFS 2019b).

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 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 Fisheries Science Center (SWFSC) has used aerial photogrammetry to assess the body condition and health of SRKWs, initially in collaboration with the Center for Whale Research and the Vancouver Aquarium. 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.[19] 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).

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

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 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. 2010). 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 salmon prey abundance for the years 1984-2007, where in years with higher Chinook salmon abundance, SRKW social network was more interconnected. The authors discuss that because of this result, years with higher Chinook salmon 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.

<u>Toxic Chemicals.</u> 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 when comparing the limited information 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 in to circulation, they have the potential to cause a toxic response. Therefore, nutritional stress from reduced Chinook salmon populations may act synergistically with high pollutant levels in SRKWs and result in adverse health effects.

In April 2015, NMFS hosted a 2-day SRKW health workshop to assess the causes of decreased survival and reproduction in the killer whales. Following the workshop, a list of potential action items to better understand what is causing decreased reproduction and increased mortality in this population was generated and then reviewed and prioritized to produce the Priorities Report (NMFS 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.

Disturbance from Vessels and Sound. Killer whales rely on their highly developed acoustic sensory system for navigating, locating prey, and communicating with other individuals. While in inland waters of Washington and British Columbia, SRKWs are the principal target species for the commercial whale watch industry (Hoyt 2001; O'Connor et al. 2009) and encounter a variety of other vessels in their urban environment (e.g., recreational, fishing, ferries, military, shipping). Several main threats from vessels include direct vessel strikes (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. Holt et al. (2021a) identified prey capture dives by using whale kinematic signatures and it found that the probability of capturing prey increased as salmon abundance increased but decreased as vessel speed increased. When vessels emitted navigational sonar, whales made longer dives to capture prey and descended more slowly when they initiated these dives. Finally, whales descended more quickly when noise levels were higher and vessel approaches were closer.

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. In 2021 the rule went into effect. The rules do not restrict the viewing of other whales or marine mammals, but set a three-month July-September season for viewing of SRKW by motorized commercial whale watching vessels at closer than one-half nautical mile. From July-September, motorized commercial whale watching of SRKWs is permitted daily during two, two-hour periods (10 a.m-12 p.m. and 3-5 p.m.). During these times, there is a limit of three motorized commercial whale watching vessels per group of SRKWs. The rules formally establish the 'no-go' zone on the west side of San Juan Island for motorized commercial whale watching vessels, allowing a 100-yard corridor along the shore for commercial kayak tours. The no-go zone applies year-round regardless of SRKW presence. The no-go zone remains voluntary for vessels not engaging in commercial whale watching operations. The rules establish training, reporting, and compliance monitoring procedures, including real-time reporting of SRKW sightings to the Whale Report Alert System.

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 found 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).

<u>Oil Spills.</u> 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 pod 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. 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 salmon stocks, Snake river fall and spring/summer Chinook salmon, Puget Sound Chinook salmon, and spring-run Chinook salmon stocks in the interior Columbia and Willamette River basins were ranked as "high" or "very high" vulnerability to climate change (Crozier et al. 2019). In general, Chinook, coho, and sockeye salmon 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 salmon runs because of higher resilience (Crozier et al. 2019).

2.2.2 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.[20] 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).

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 14). 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

[20] 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).

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 14. PCEs of critical habitats designated for ESA-listed salmon and steelhead 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, 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 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,[21]
Factor 4. Support of Rarity Importance,
Factor 5. Support of Abundant Populations, and
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) 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 Chinook salmon was designated on September 2, 2005 (70 FR 52630). Critical habitat includes 1,683 miles of streams, 41 square mile of lakes, and 2,182 miles of nearshore marine habitat in Puget Sound. The 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. Most freshwater rivers in HCSRC designated critical habitat are in fair to poor condition (Table 15). 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 for PS steelhead was designated on February 24, 2016 (81 FR 9252). Critical habitat includes 2,031 stream miles. Nearshore and offshore marine waters were not designated for this species. There are 66 watersheds within the range of this DPS. Nine watersheds received a low conservation value rating, 16 received a medium rating, and 41 received a high rating to the DPS. Critical habitat for PS steelhead includes freshwater spawning sites, freshwater rearing sites, and freshwater migration corridors.

Critical habitat is designated for PS Chinook salmon and Hood Canal Summer run chum salmon in estuarine and nearshore areas. Designated critical habitat for PS steelhead does not include

[21] 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

nearshore areas, as this species does not make extensive use of these areas during the juvenile life stage.

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-derived chemical, 6PPD-quinone, as the cause (Tian et al. 2020). Coho salmon are extremely sensitive to 6PPD-quinone, more so than most other known contaminants in stormwater (Scholz 2011; Chow 2019; Tian et al. 2020). Although Chinook salmon 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, polycyclic aromatic hydrocarbons (PAHs), fire retardants, and emissions that have been linked to deformities, injury and/or death of salmonids and other fish (Trudeau 2017; Young et al. 2018).

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 also developed with several federal agencies (e.g., Environmental Protection Agency, NOAA Fisheries, the Corps of Engineers, Natural Resources Conservation Service, United States Geological Survey, Federal Emergency Management

Agency, and US Fish and Wildlife Service) 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 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, future effects of climate change on habitat quality throughout Puget Sound are expected to be negative.

Habitat utilization by Chinook salmon and steelhead in the Puget Sound area has been historically limited by large dams and other manmade barriers in a number of drainages, including the Nooksack, Skagit, White, Nisqually, Skokomish, and Elwha river basins (Appendix B in NMFS (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 salmon and steelhead are accessing much of this newly available habitat (Pess et al. 2020). Passage operations have begun on the North Fork Skokomish River to reintroduce steelhead above Cushman Dam, 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 (Ford 2022).

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 (Ford 2022).

In summary, even with restoration success, like dam removal and blocked culverts being addressed, critical habitat for salmon and steelhead throughout the Puget Sound basin continues to be degraded by numerous management activities, including hydropower development, loss of mature riparian forests, increased sediment inputs, removal of large wood, intense urbanization, agriculture, alteration of floodplain and stream morphology (i.e., channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, dredging, armoring of shorelines, marina and port development, road and railroad construction and maintenance, logging, and mining. Changes in habitat quantity, availability, and diversity, and flow, temperature, sediment load and channel instability are common limiting factors in areas of critical habitat. As mentioned above, development of shoreline and estuary areas of Puget Sound is expected to continue to adversely impact the quality of marine habitat for PS salmonids. Projected changes in nearshore and estuary development based on documented rates of developed land cover change in Bartz et al. (2015) show that between 2008 and 2060, an additional 14.7 hectares of development of shoreline areas and 204 hectares of estuary development can be expected.[22]

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 15).

[22] 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).

Table 15. Puget Sound Recovery Domain: Current and potential quality of HUC_5 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 are ranked primarily by "current quality" and secondly by their "potential for restoration."

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

Watershed Name(s) and HUC_5 Code(s)	Listed Species	Current Quality	Restoration Potential
Strait of Georgia and Whidbey Basin #1711000xxx			
Skagit River/Gorge Lake (504), Cascade (506) & Upper Sauk (601) rivers, Tye & Beckler rivers (901)	CK	3	3
Skykomish River Forks (902)	CK	3	1
Skagit River/Diobsud (505), Illabot (507), & Middle Skagit/Finney Creek (701) creeks; & Sultan River (904)	CK	2	3
Skykomish River/Wallace River (903) & Skykomish River/Woods Creek (905)	CK	2	2
Upper (602) & Lower (603) Suiattle rivers, Lower Sauk (604), & South Fork Stillaguamish (802) rivers	CK	2	1
Samish River (202), Upper North (401), Middle (402), South (403), Lower North (404), Nooksack River; Nooksack River (405), Lower Skagit/Nookachamps Creek (702) & North Fork (801) & Lower (803) Stillaguamish River	CK	1	2
Bellingham (201) & Birch (204) bays & Baker River (508)	CK	1	1
Whidbey Basin and Central/South Basin #1711001xxx			
Lower Snoqualmie River (004), Snohomish (102), Upper 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 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 square miles (1,669.8 sq km) of nearshore habitat for juvenile PS/GB bocaccio and 438.5 square miles (1,135.7 sq km) of deepwater 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 square miles of nearshore habitat and 414.1 square miles 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 both adult PS/GB bocaccio, and both juvenile and adult PS/GB yelloweye rockfish. 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 17). 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 fastland 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 17. Physical or Biological Features of Rockfish Critical Habitat

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.

SRKW Critical Habitat

Critical habitat for the SRKW DPS was designated on November 29, 2006 (71 FR 69054). Critical habitat includes approximately 2,560 square miles of inland waters of Washington in three specific areas: (1) the Summer Core Area in Haro Strait and waters around the San Juan Islands; (2) Puget Sound; and (3) the Strait of Juan de Fuca. 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.

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 square miles (mi^2) (41,207 square kilometers (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 Environmental Protection

Agency and U.S. Coast Guard oversee the Oil Pollution Prevention regulations promulgated under the authority of the Federal Water Pollution Control Act. There is a Northwest Area Contingency Plan, developed by the Northwest Area Committee, which serves as the primary guidance document for oil spill response in Washington and Oregon. In 2017, the Washington State Department of Ecology published a new Spill Prevention, Preparedness, and Response Program Annual Report describing the Spills Program as well as the performance measures from 2007–17 (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 salmon (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 salmon 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 salmon 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 salmon along the outer coast is likely limited at particular times of year (e.g. winter months) due to run timing of various Chinook salmon stocks. Prey availability may also be low when the distribution of preferred adult Chinook salmon 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 salmon) so changes in Chinook salmon 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 Southern Residents 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 consequences to listed species or designated critical habitat from ongoing agency activities or existing 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 Puget Sound

Puget Sound can be generally described as nearshore and deepwater areas. NMFS has identified the several nearshore and deepwater physical or biological features essential to conservation for salmon, rockfish and SRKW in Section 2.2.2.

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 even the 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 feet below Mean Lower Low Water (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.

The most notable past and present human activities that cause adverse effects on salmon include the four H's: land use activities that result in **habitat** loss and degradation, **hatchery** practices, **harvest**, and **hydropower** systems.

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 RPAs. In addition, the environmental baseline is influenced by many actions that pre-date the salmonid listings and that have substantially degraded salmon habitat and lowered natural production of Puget Sound Chinook salmon. In fact, Chinook salmon currently available to the 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 the whales from actions affecting salmon by way of habitat modification.

Landscape Overview

When considered at the landscape scale, the baseline condition of Puget Sound nearshore habitat 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 structure noise and vessel perturbations. Each of these baseline conditions exerts downward pressure on affected cohorts of all populations of listed species considered in the Opinion for the duration of their time in the action area. Loss of production of Chinook salmon from habitat degradation reduces available forage for SRKWs. The baseline currently constrains the carrying capacity of the action area and limits the potential recovery of these species. Overall, the nearshore is degraded from coastal development and pollution. The input of pollutants affects water quality, sediment quality, and food resources in the nearshore and deep-water areas of critical habitat.

Nearshore habitat in Hood Canal has been plagued by an increase in hypoxia, however many inter- and subtidal areas evaluated in a 2002 study were found to be dominated by the dense eelgrass and sand habitat classes, suggesting multiple areas of high habitat quality were present in the Hood Canal nearshore (Garono et al. 2002). Daubenberger et al. (2017) document that Port Gamble Bay, Port Ludlow, and Kilisut Harbor are relatively shallow embayments within the greater Hood Canal system with a highly productive aquatic environment allowing for the presence of eelgrass and attached macroalgae. These three embayments consistently had higher densities of single target detections of juvenile salmonids that may be explained by the presence of abundant zooplankton and larval forage fish. Port Gamble Bay, Port Ludlow, and Kilisut Harbor include productive spawning grounds for Pacific herring, surf smelt, and sand lance, which leads to high densities of larvae that are high energy prey items for juvenile salmonids. Additionally, juvenile chum, pink, and Chinook salmon prey heavily upon crab zoea and megalops, which were found in high densities in these three embayments, likely due to the presence of vegetated habitat (Fernandez et al. 1993).

Shoreline Modifications

Although shoreline modifications occur and are typically evaluated on the site scale, the aggregate of these individual impacts diminish and disrupt entire ecosystems at the landscape scale. Shoreline modification can cause fragmentation of the landscape that disrupts connectivity and reduces the productivity and biological diversity of Puget Sound watersheds. These impacts leave ecosystems less resilient.

Throughout Puget Sound, 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 of Puget Sound. There are approximately 503,106 acres of overwater structure in the nearshore of Puget Sound (Schlenger et al. 2011) and approximately 27 percent of Puget Sound’s shoreline has been modified by armoring (Simenstad et 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. Analyses conducted in 2011 through the Puget Sound Nearshore Ecosystem Restoration Project (Fresh et al. 2011; Simenstad et al. 2011), and supported by Beechie et al. (2017), 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 16).
- 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 17).
- 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 or isolation 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 16. 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 overwater structures in the nearshore[23] are detailed further in Schlenger et al. (2011) and (Simenstad et al. 2011).

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

Table 17. 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%**

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 increased probabilities of surviving to adulthood (Beamish et al. 2004; 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 PS 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, Ruff et al. 2017). Smolt-to-adult survival rates for hatchery-reared sub-yearling Chinook salmon within Puget Sound have averaged less than one percent 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 three percent of adults returning to the Green and Puyallup Rivers to exhibit 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 we examined returned from small fry sized fish, respectively.

From 2005 to 2011, in Puget Sound an average of 1.1 miles per year of new shoreline armoring was permitted in and 2.3 miles per year of replacement armoring was permitted (Johannessen et al 2014). These figures do not include unpermitted structures, which can exceed those constructed with permits. For example, in the Green/Duwamish River Watershed (Water Resources Inventory Area 9), permitted structures comprised only 38 percent of all the armoring physically surveyed in 2012 and 2013 (King County 2014).

Residential parcels make up 57 percent of Puget Sound shorelines and 48 percent of these are armored. In some areas, armoring is even more prevalent: more than 50 percent of the residential parcels are armored in King, Kitsap, Pierce, Snohomish, Mason, and Thurston counties. Overall, 26 percent of residential parcels are in forage fish spawning grounds and 58 percent of those are armored (PSMNGP 2014). In a survey of HPAs issued by WDFW in Puget Sound between January 2005 and December 2010 the data recorded the installation of 6.5 miles of new armor and 14.45 miles of replacement armor. This starkly contrasts with data from that same time period that shows only 0.61 miles of armor were removed (Carman et al. 2011). More recent studies have suggested a less dramatic rate of new armoring, but those studies were limited in their geographic scope and types of shoreline modification.[24] The studies have, however, corroborated that the bulk of permitted shoreline armoring activities continue to be repair and replacement. This demonstrates that the lifecycle of structures that includes the repair or replacement of aging armoring and other in- or over-water structures in Puget Sound extends the duration of degraded baseline conditions and retains limits on habitat features and corresponding carrying capacity.

The duration of impairment of habitat condition and function that derive from decades of persistent anthropogenic changes in the amount of and character of estuarine habitat, is made more detrimental due to the compounding nature of these effects, occurring because: (1) regulatory and permitting measures do not avoid all impacts and largely fail to include methods to rectify unavoided 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 (3) few of the 2020 improvement targets identified by the Puget Sound Partnership (PSP)[25] have been reached (Puget Sound Partnership 2021, https://vitalsigns.pugetsoundinfo.wa.gov/VitalSignIndicator/Detail/42). In more detail, this most recent report points out the following issues:

- 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.
- 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. PCB levels in fish[7] are still high.

[24] Shoreline Permitting through TACT (Spring 2015) (TACT is an acronym for: Trouble-Shooting, Action Planning, Course Correction, and Tracking and Monitoring).
[25] The PSP Action Agenda is an EPA-approved recovery plan under the National Estuary Program.

- 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.
- Human Sound Behavior Index: No change in average behavior. Thus, an increase in human population is likely to continue to degrade habitat quality. (The Sound Behavior Index tracks 28 human use practices[26] that likely affect habitat and water quality and quantity).
- Over Water Structure (OWS): not assessed by PSP. Current percent of nearshore coverage is 0.63 percent for all of Puget Sound, as detailed below.

The PSP concludes the overall decline in habitat conditions and native species abundance in the Puget Sound has been caused by development and climate change pressures. Over the last 150+ 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).

In addition to beach armoring, other shoreline changes including OWS, marinas, roads, and railroads reduce habitat quality. The amount of these changes varies, and their source varies by region, generally correlating with development, but overall is staggering (Simenstad et al. 2011). The simplification of the largest river deltas has caused a 27 percent decline in shoreline length compared to historical conditions. Of 884 historic small embayments, 308 have been eliminated. About 27 percent of PS's shorelines are armored and only 112 of 828 shoreline segments remain in properly functioning condition. The loss of tidal wetlands in the largest deltas averages 26 percent (Fresh et al. 2011). Each of these habitat changes is related to development and overall reduces the quality and quantity of PS Chinook and HC summer-run chum salmon, in the Puget Sound nearshore.

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 and surf smelt) 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

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[26] 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.

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 (Davis et al. 2020).

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 39 habitat modifying projects in the nearshore marine areas of Puget Sound (NMFS 2020g). 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.

On November 9, 2020, NMFS issued a biological opinion for 39 projects proposing in water, overwater and nearwater structures in the nearshore marine habitats of Puget Sound (WCRO-2020-01361) and a second biological opinion on 11 projects on September 30, 2021 (WCRO-2021-01620). In those Opinions, we determined the Corps' proposed action, to permit the projects, was likely to jeopardize the continued existence of listed PS Chinook salmon and SRKW and was likely to adversely modify those species' designated critical habitats. We also determined that the proposed action was not likely to jeopardize listed PS steelhead, PS/GB bocaccio rockfish, PS/GB yelloweye rockfish, or Hood Canal Summer-run chum salmon or adversely modify designated critical habitat for those four species. Our conclusions were based on:

- PS Chinook salmon populations are far from meeting recovery goals and trends in abundance and productivity are mostly negative.
- Nearshore habitat quality is insufficient to support conservation of this ESU. SRKW prey is at a fraction of historical levels. Under the current environmental baseline, nearshore habitat in Puget Sound cannot support the biological requirements of PS Chinook salmon.
- Fewer populations of PS Chinook salmon contributing to SRKW's prey base will reduce the representation of diversity of life histories, resiliency in withstanding stochastic events, and redundancy to ensure there is a margin of safety for the salmon and SRKWs to withstand catastrophic events.
- The condition of the environmental baseline is such that additional impacts on the quality of nearshore habitat is likely to impair the ability of that habitat to support conservation of these species.
- The proposed action would further reduce the quality and quantity of nearshore habitat in Puget Sound.
- The proposed action would also exacerbate habitat limiting factors identified by the PS Chinook salmon and SRKW recovery plans and are inconsistent with recovery action listed in these plans. Due to demand for future human development cumulative effects on nearshore habitat quality are expected to be mostly negative.

The 2020 and 2021 jeopardy opinions included an RPA with five elements, including on site habitat improvements; off site habitat improvements; funding from a habitat restoration sponsor; purchase of credits from a conservation bank in-lieu fee program, or crediting provider; and, project modifications. The RPA utilized a Habitat Equivalency Analysis methodology and the Nearshore Habitat Values Model to establish a credit/debit target of no-net-loss of nearshore habitat quality. The RPA was designed to achieve, a reduction of these debits to zero, which the Opinions concluded were required to avoid jeopardizing the continued existence of, and adversely modifying critical habitat for, PS Chinook salmon and SRKWs.

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

Dredging

The 1988 Environmental Impact Statement (EIS) for the Puget Sound Dredge Disposal Analysis (PSDDA) documented 34 port districts within the Puget Sound region (https://www.nws.usace.army.mil/Missions/Civil-Works/Dredging/Reports/ (this is the most recent information that could be located). This EIS identifies 50 miles of navigation channels, about 50 miles of port terminal ship berths, and more than 200 small boat harbors that must be periodically dredged to maintain the commercial and recreational services provided by these facilities.

Between 1996 and 2014, maintenance dredging resulted in at least 25 million cubic yards of sediment being removed from nearshore environments and disposed of in multi-user disposal by Puget Sound harbors and waterways by various dredgers (Figure 18). These included private developers and public entities (e.g., federal and state agencies, ports, and local governments) responsible for funding and undertaking dredging projects.

These dredging activities are generally limited to nearshore environments. Regular dredging maintenance results in periodic short-term water quality degradation suspending sediments above background levels and re-suspendeing contaminants. This also results in periodic removal of sediments that support invertebrate prey and forage species for salmon and rockfish (Jones and Stokes 1998, McCabe et al. 1998). According to various studies (Boese et al 2009, Dethier and Schoch 2005, McCabe et al. 1998), a dredged area typically recolonizes in approximately 2 years. Maintenance dredging increases depth and maintains increased depth. This results in a reduction of critical shallow habitat and causes a disruption of the migratory corridor for rearing and migrating juvenile salmonids. The dredging material is typically disposed of at designated multi-user open-water disposal sites (open-water disposal sites) that are managed under the Dredge Material Management Program (DMMP) https://www.nws.usace.army.mil/Missions/Civil-Works/Dredging/. The effects of sediment disposal at DMMP open-water disposal sites have already been considered in the programmatic formal consultation for their continued use through 2040 (NMFS 2015a).

Dredging Year[1]	Bellingham Bay	Port Gardner	Elliott Bay	Commencement Bay	Anderson Ketron	Rosario Strait	Port Townsend	Port Angeles	South Jetty	Annual Total
1996	44,800	121,246	95,302	460,684	0	205,500	0	22,344	1,674,267	2,626,139
1997	0	102,531	18,982	0	0	0	0	0	959,249	1,082,759
1998	1,200	0	110,465	693,540	0	53,000	4,000	0	780,181	1,644,384
1999	0	0	414,794	140,319	0	140,761	1,986	0	1,153,621	1,853,480
2000	0	0	360,577	893,776	0	0	0	0	1,282,663	2,539,016
2001	0	248,965	557,340	265,867	0	10,419	0	0	358,873	1,443,465
2002	0	45,919	133,270	0	0	0	0	0	475,199	656,390
2003	0	0		710,675	0	38,223	0	0	824,694	1,575,595
2004	0	0	15,602	1,205,993	5,772	230,747	0	0	1,166,089	2,626,207
2005	0	0	77,838	949,399	8,180	23,847	0	0	740,910	1,802,179
2006	0	722,185	3,801	811,000	0	150,921	0	0	196,893	1,886,806
2007	0	4,400	24,250	1,324,254	10,407	20,970	10,996	0	389,127	1,786,411
2008	0	17,393	172,999	214,858	97,310	0	0	0	0	504,568
2009	0	10,450	20,133	18,803	0	188,580	6,856	0	21,088	267,919
2010	0	371,500	96,046	14,812	0	0	9,048	0	0	493,416
2011	0	44,196	11,486	179,160	0	45,865	0	0	1,012,127	1,294,845
2012	0	34,143	165,700	3,489	10,579	180	0	0	320,985	537,088
2013	0	104,199	15,266	1,673	0	144,206	0	0	0	267,357
2014	0	0	117,593	0	6,093	0	0	0	0	125,700
										25,013,724

Figure 18. Multi-user Disposal Site Volumes by Year (in cubic yards). [1] Dredging Year: 16 June through June 15 (e.g. DY 2014 began on June 16, 2013 and ended June 15, 2014). Data from: USACE Biological Evaluation for the Continued Use of Multiuser Dredge Material Disposal Sites in Puget Sound and Grays Harbor. *Available at*: https://usace.contentdm.oclc.org/utils/getfile/collection/p266001coll1/id/9083, last visited December 2, 2021.

Stormwater

Mackenzie et al. 2018 found that stormwater is the primary pathway to Puget Sound for most toxic contaminants, transporting more than half of the Sound's total known toxic load (Ecology and King County 2011). During an extensive Puget Sound monitoring study, toxic chemicals were detected more frequently and at higher concentrations during storm events compared with base flows, demonstrating the impact of untreated stormwater pollution (Ecology 2011). The Puget Sound basin has over 4,500 surface water and stormwater outfalls, with 2,121 discharging treated and untreated stormwater directly into the Puget Sound (WDNR 2015).

Pollutants in stormwater discharge are diverse. 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:

- 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, PAHs, 6PPD-quinone and other toxic chemicals from roads and parking areas used by motor vehicles.
- Bacteria and nutrients from animal wastes and faulty septic systems.
- Metals (arsenic, copper, chromium, lead, mercury, and nickel) and other pollutants from the pesticide use in landscaping, roof runoff (WDOE 2014), decay of building and other infrastructure, and as airborne particles from street and tire wear.
- Atmospheric deposition from surrounding land uses.
- Metals, PAHs, 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. 2005).

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).

Marine Vessels

Commercial, recreational, military, and public ferry vessel traffic occurs throughout Puget Sound. Vessels range in size from massive commercial shipping container ships to kayaks. Vessels can 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. 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.

Recent evidence indicates there is a higher energetic cost of surface-active behaviors and vocal effort resulting from vessel disturbance in the Salish Sea (Williams 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 NRKW s in British Columbia’s inland waters in the presence of vessels result in an approximate 3 percent increase in energy expenditure compared to when vessels are not present. Other studies measuring metabolic rates in captive dolphins have shown these rates can increase during the more energetically costly surface behaviors (Noren et al. 2012) that are observed in killer whales in the wild, as well as during vocalizations and the increased vocal effort associated with vessels and noise (Noren et al. 2013; Holt et al. 2015). These studies that show an increase in energy expenditure during surface active behaviors and changes in vocal effort may negatively impact the energy budget of an individual, particularly when cumulative impacts of exposure to multiple vessels throughout the day are considered.

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). SRKW spent 17 to 21 percent less time foraging in inland waters in the presence of vessels for 12 hours, depending on vessel distance (see Ferrara et al. 2017). Although the impacts of short-term behavioral changes on population dynamics is unknown, it is likely that because SRKWs are exposed to vessels the majority of daylight hours they are in inland waters, there may be biologically relevant effects at the population level (Ferrara et al. 2017).

Additionally, there is growing concern about the effect of increasing ocean noise levels due to anthropogenic sources on marine organisms, particularly marine mammals. 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—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).

Researchers measured underwater sound pressure levels for 1,582 unique ships that transited the core critical habitat of the SRKWs 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 10,000 to 96,000 Hz). Thus, noise received from ships at ranges less than 3 km extended to frequencies used by odontocetes (toothed whales, including 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).

Although the hearing range of killer whales and other mid-frequency odontocetes (e.g. sperm whales) is believed to extend between 150 and 160,000 Hz, their peak sensitivity is between about 15,000 and 20,000 Hz, and acoustic sensitivity falls off sharply below 600 Hz and above 114,000 Hz (Branstetter et al. 2017). Viers et al., 2016, found that noise from large ships extends into frequencies used by SRKWs for echolocation. Thus, tanker-related noise has the potential to result in some type of behavioral disturbance or harassment, including displacement, site abandonment (Gard 1974; Reeves 1977; Bryant et al.1984), and masking (Richardson et al. 1995). These disturbances could be causing minor, short-term displacement and avoidance, alteration of diving or breathing patterns, and less responsiveness when feeding.

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 Puget Sound generally stay in shipping lanes within the inland waters, they are not targeting or following whales and as the ships are moving while making noise means that the noise is also transitory. As such co-occurrence with large tanker-type traffic is expected to be short-term and transitory when whale presence overlaps with ship 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, tanker-type vessels can cause ongoing low-level disturbance of SRKW periodically in the action area. However, we are not currently able to meaningfully measure responses specific to this noise.

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). 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). 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).

The majority of vessels in close proximity to SRKW in inland waters are commercial whale watching vessels and recreational whale watching vessels and the average number of boats accompanying whales can be high during the summer months (i.e., from 2013 to 2017 an average of 12 to 17 boats (Seely 2020)).

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- to 400-yard approach limits, 7 knots or less speed within ½ nautical mile of the whales). NMFS and other partners have outreach programs in place to educate vessel operators on how to avoid impacts to whales. The average number of vessels with the whales 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.

Hatcheries

The central challenge of operating and managing hatchery programs is finding a balance between the risks and benefits of hatchery production for harvest or conservation. Hatchery production of Chinook salmon and steelhead can be an effective tool to increase fish abundance for conservation and harvest. However, hatcheries can also pose demographic, genetic, and ecological risks to these species. Risks and benefits of hatchery production are best evaluated in the context of the purpose of the hatchery program. Conservation of native populations is one purpose. The primary goal of Chinook salmon and steelhead conservation in Puget Sound is sustainable natural production of locally adapted fish throughout the accessible watersheds (Hard et al. 2015). Thus, to effectively achieve its goals, a conservation hatchery program must increase the abundance, productivity, spatial structure, and/or diversity of a natural-origin steelhead population. In contrast, some hatchery programs have a different goal: to provide harvest opportunities. These hatchery programs may be either integrated or segregated.

Interactions of hatchery- and natural-origin Chinook salmon and steelhead pose different risks to abundance, productivity, genetic diversity, and fitness of fish spawning in the natural environment depending on how hatcheries are operated. A growing body of scientific literature, stemming from improved tools to assess parentage and other close genetic relationships on relative reproductive success of hatchery and natural-origin salmonids, suggests that strong and rapid declines in fitness of natural-produced fish due to interactions with hatchery-produced fish are possible (Araki et al. 2008; Christie et al. 2014). These studies have focused primarily on steelhead, Chinook salmon, coho salmon, and Atlantic salmon. Limited but growing evidence suggests that steelhead may be more susceptible to genetic risk (i.e., domestication) posed by hatchery propagation than other species (Ford et al. 2016). Further, because selective regimes and mortality differ dramatically between natural and cultured populations, some genetic change cannot be avoided (Waples 1999). These changes are difficult to predict quantitatively because there may be considerable variation in relative reproductive success among species, populations, and habitats, as well as temporal variability owing to environmental change.

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, Hatchery Scientific Review Group 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 proposed reforms 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 salmon in the South Fork Nooksack River, fall Chinook salmon in the South Fork Stillaguamish River (Tynan 2010) and spring and late-fall Chinook salmon in the Skokomish River (Redhorse 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.

Conservation programs are designed to preserve the genetic resources of salmon populations and protect against demographic risks while the factors limiting anadromous fish viability are addressed. In this way, hatchery conservation programs reduce the risk of extinction (NMFS 2005; Ford et al. 2011a). However, hatchery programs that conserve vital genetic resources are not without risk to the natural salmonid populations. These programs can affect the genetic structure and evolutionary trajectory of the natural population that the hatchery program aims to conserve by reducing genetic diversity and fitness (HSRG 2014; NMFS 2014a). More details on how hatchery programs can affect ESA-listed salmon and steelhead can be found in Appendix C of NMFS (2018a), incorporated here by reference, and summarized below.

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 ~$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 FY20 to increase prey availability for SRKW through regional hatchery production. As a result of the additional funding for hatchery production to support SRKW (FY20 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 2021d). For Fiscal Year 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.

In 2019, NMFS consulted on impacts to ESA-listed species from several U.S. domestic actions associated with the new PST agreement (NMFS 2019d) including federal funding of a conservation program for critical Puget Sound salmon stocks and SRKW prey enhancement. The 2019 opinion (NMFS 2019d) included a programmatic consultation on the PST funding initiative. In Fiscal Year 2020, Congress appropriated $35.1 million dollars for implementation of U.S. domestic activities associated with implementation of the new PST agreement, of which $5.6 million is being used for increased hatchery production to support prey abundance for SRKW and $13.5 million is being used in support of Puget Sound Critical Stock Conservation and Habitat Restoration and Protection, consistent with the funding initiative. For Fiscal Year 2021, Congress appropriated $39.5 million for activities in support of these activities. (166 Cong. Rec. 12/21/2020). 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 salmon populations, and improved habitat conditions for those populations) are expected to begin within 3-5 years following implementation. Site or project specific ESA and NEPA coverage for these activities is described in the Environmental Baseline (NMFS 2019d).

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 salmon populations, and improved habitat conditions for those populations) have recently begun. 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.

One thing worth noting, is that even under current production (hatchery and wild) there is evidence of density dependence in Puget Sound estuaries. Any additional habitat loss could exacerbate potential density dependent impacts especially with increased hatchery production (Greene et al. 2021)

Harvest

Puget Sound 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 in Puget Sound. These fisheries are managed consistent with the provisions of the Pacific Salmon

Treaty, an international agreement between the U.S. and Canada, which also governs fisheries in Southeast Alaska (SEAK), 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 the 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. In 2018, U.S. and Canadian representatives reached agreement to amend versions of five expiring Chapters of Annex IV (Turner and Reid 2018); both countries have since executed this agreement.

Because the Puget Sound Chinook salmon are listed under the ESA and are subject to management under the PST, objectives for Puget Sound salmon fisheries are designed to be consistent with both of these laws. Generally, objectives for Puget Sound Chinook salmon populations are agreed by the State and tribes, in coordination with NMFS. In recent years, NMFS has consulted with the Bureau of Indian Affairs on that agency's assistance to the tribes in managing Puget Sound fisheries; in the resulting biological opinions NMFS has considered the effects of the proposed state and tribal fisheries for the year on Puget Sound Chinook salmon and SRKW. The most recent opinion was issued in May 2021 concluded the fisheries were not likely to jeopardize Puget Sound Chinook salmon or SRKW, and not likely to adversely modify their critical habitat.

The new 2019-2028 PST Agreement includes reductions in harvest impacts for all Chinook salmon fisheries within its scope and refines the management of sockeye, pink, chum, and coho salmon caught in these areas. The new 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 salmon 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 PFMC are reduced by up to 15 percent 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 Exclusive Economic Zone (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 a number of U.S. and Canadian stocks.

In its 2019 opinion on domestic actions related to the 2019-2028 PST Agreement (NMFS 2019e), NMFS assumed that the State of Alaska would manage its SEAK salmon fisheries consistent with the provisions of the Agreement. Using methodology similar to previous biological opinions completed up to that time (e.g. NMFS 2019b), NMFS estimated that the percent reductions of Chinook salmon in inland waters of WA from the SEAK fisheries were expected to range from 0.1 percent to 2.5 percent with the greatest reductions occurring in July – September. Percent reductions in coastal waters of WA and OR from the SEAK fisheries were expected to range from 0.2% to 12.9 percent and similarly the greatest reductions would occur in July – September. Percent reductions from Canadian salmon fisheries were expected to range up to 13.2 percent in coastal waters and up to 12.9 percent in inland waters, with greatest reductions in July to September, and also greater inland water reductions in May-June than Puget Sound or PFMC fisheries (NMFS 2019e).

In 2021, NMFS consulted on the authorization of the West Coast Ocean salmon fisheries through approval of the Pacific Salmon Fishery Management Plan including Amendment 21 and implementation of the Plan through regulations., In November 2020, the PFMC adopted proposed Amendment 21 to reduce the effects of Council-area ocean salmon fisheries on the Chinook salmon prey base of SRKWs. The proposed Amendment, if approved by NMFS, would establish 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). The threshold based on these years is currently estimated at 966,000 Chinook salmon. 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. 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

NMFS's management strategy for conservation and recovery of listed salmonids in the West Coast has long been premised on reducing adverse effects among all of the "4 Hs" namely, Hatcheries, Hydropower, Harvest, and Habitat. Each has had a role in the factors for 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 and recovery potential.

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 North American green sturgeon DPS and for SRKW and 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 hydrosystem, however, concluded that any effects to SRKW prey base are insignificant or extremely unlikely because the CRS-funded hatchery production more than offsets any adverse effects of CRS operations and maintenance (NMFS 2020e).

In the Puget Sound, there have been multiple section 7 consultations on dams associated with hydropower operations. The Mud Mountain Dam Operation and Maintenance on the White River near Buckley (NMFS 2014) and the Howard Hanson Dam in the Green River watershed (NMFS 2019c) have each been found to jeopardize ESA-listed fish. These dams are associated with operations including water diversion, hydropower, and flood control. In the case of Mud Mountain and Howard Hanson, the jeopardy finding to PS Chinook salmon posed a secondary threat of jeopardy to SRKW. In each case, modifications to avoid jeopardizing ESA- listed species are being undertaken. Passage improvements at Mud Mountain Dam have been implemented and have reduced fish mortality. New fish passage is being designed for Howard Hanson Dam and modifications to its water retention and release schedule is being evaluated to benefit salmonid redds and eggs in spawning areas downstream of the dam. The White River FERC license was surrendered as an outcome of that jeopardy opinion, which resulted in a change of ownership with an intent to complete a habitat conservation plan for its water diversion.

Climate Change

The environmental baseline would also include 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 dissolved oxygen 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.

All three ESA-listed Puget Sound salmonids were classified as highly vulnerable to climate change in a recent climate vulnerability assessment (Crozier et al. 2019). In estuarine environments, the two greatest concerns associated with climate change are rates of sea-level rise and temperature warming (Wainwright and Weitkamp 2013, Limburg et al. 2016). While the effects of climate change-induced ocean acidification on invertebrate species are well known, the direct exposure effects on salmon remains less certain (Crozier et al. 2019).

The world's oceans are becoming more acidic as increased atmospheric CO_2 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). Consequently, 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).

Physiological effects of acidification may also impair olfaction, which could hinder homing ability (Munday et al. 2009), along with other developmental effects (Ou et al. 2015). Although a recent review of ocean acidification studies on fish has called into question many of the behavioral effects of ocean acidification (Clark et al. 2020). 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).

The same document states 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).

<u>2.3.2 Distinguishing Baseline from Effects of the Action</u>

As described in more detail below in Section 2.4, and above in this Section 2.3, the effects of an action are the consequences to listed species or critical habitat that would not occur but for the proposed action and are reasonably certain to occur, whereas the environmental baseline refers to the condition of the listed species or its designated critical habitat in the action area without the consequences caused by the proposed action. 50 CFR 402.02. Distinguishing these for new structures is relatively straightforward. Repair or replacement projects require a bit more explanation. As relative to this consultation, we must distinguish what impacts from existing structures are properly attributed to the baseline compared with what future impacts are consequences of the proposed action. At its most basic, a repair or replacement project at least extends the life of the part of the structure being repaired or replaced. The impacts of part or all of the structure for the duration of that new life would not occur but for the USACE permit approval and so we consider them a consequence of the action. We explain additional nuances below.

As an initial matter, NMFS acknowledges that when the USACE originally permits a structure, or a part of a structure, there is no "end date" on the permit that would require the future removal of that structure, or the piece of the structure. But based on our experience with hundreds of consultations, to facilitate the existence of a permitted and structurally intact structure into perpetuity, regular maintenance will be necessary to keep that structure in good condition.[27] Some future maintenance will require an additional USACE permit, and other future maintenance may occur without any additional authorization. The types of expected maintenance that will not require an additional USACE permit are included as part of the proposed action section above, and the effects of that kind of maintenance are considered below as part of the consequences of the proposed action. Future maintenance that will require an additional USACE permit is not part of this proposed action and thus effects stemming from that kind of maintenance are therefore not covered, nor analyzed by, this consultation. Finally, it is within the Corps' discretionary authority to grant or deny the 15 permits that form the basis of this consultation. *See* Appendix 3 to NMFS 2020g (explaining that if an applicant requests the Corps to make a permit decision based on the findings of the final Opinion and ". . . [if] the applicant is unwilling to meet the RPA requirements, the likely outcome would be a permit denial"); Section 4(b) of 2022 Memorandum between the Department of the Army (Civil Works) and the National Oceanic and Atmospheric Administration articulating a mutual understanding of how the agencies evaluate the effects of projects involving existing structures on listes species and designated critical habitat in Endangered Species Act Section 7 consultations.[28]

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[27] USACE general condition 2 at 33 C.F.R. Part 325, Appendix A, and Nationwide Permit General Condition Number 14, require permittees to maintain authorized structures in good condition.

[28] *Available at* https://www.fisheries.noaa.gov/resource/document/army-and-noaa-joint-resolution-memorandum-evaluating-effects-projects-involving, last visited April 28, 2022.

The expected issuance of future permits to facilitate work on, and maintain the structural integrity of, the structures that are part of this proposed action allows us to make reasonable assumptions about the maximum amount of time certain types of structures will exist before the owner will seek a new USACE permit. The maximum expected number of years before another USACE permit will be needed to perform maintenance (hereafter, useful life period), as explained next, allows NMFS to limit our analysis to those expected time frames.

Two main assumptions form the basis of our analysis. First, we expect existing structures to have a maximum "useful life" for the following number of years before requiring an additional USACE permit to maintain their structural integrity: 40 years for overwater structures (residential pier, ramps and floats, marinas and other commercial structures) and 50 years for shoreline bulkheads. Similarly, we assume that the repairs or replacements being authorized by the USACE will extend, at a minimum, the life of the portion of the structure being worked on by 40 to 50 years, respectively. Second, we assume that an owner will typically request a USACE permit ten years before the existing "useful life" time period elapses. Thus, absent information to the contrary and for structures in average condition, we assume that existing nearshore and overwater structures that are part of this proposed action would have remained on the landscape in their current state, with no change in usage, for ten more years if the applicant had not requested a USACE permit at this time. Our assumptions are based on our experience in previous consultations showing that applicants typically seek USACE authorization to replace or significantly repair a structure when it nears the end of its useful life but before the structure is compromised to the point it is unsafe or not usable.

As introduced above, there is an increment of future impacts stemming from the existing structures that we are considering as part of the environmental baseline. Specifically, we expect that the existing structures that are part of this proposed action could typically persist in the environment and cause the same effects for some additional years left of the structure's *original* useful life. Based on the above assumptions, for this consultation we assume that the remaining useful life period for any of the existing structures (or piece of structure) being repaired or replaced is ten years absent evidence to the contrary. In these instances where useful life remains, we will consider the future impacts of an existing structure for the remaining part of its original useful life period as part of the environmental baseline.

With this in mind, we consider the difference (or "delta") between the expected impacts during any remaining useful life of an existing structure (or piece of a structure) in its current state (the environmental baseline) and the impacts of the part of the structure proposed to be repaired or replaced for that same time period in its repaired or replaced state to be "effects of the action." Since the proposed replacements or repairs considered in this consultation are typically, although not always, more environmentally friendly than the existing structures they replace or repair, the difference between the future impacts of the existing structure during the remaining useful life period and the impacts during that same time-frame are mostly positive. Stated differently, the proposed action would generally result in some reduction of impacts during the remaining useful life that would not occur but for the proposed action. Based on the above assumptions and absent information to the contrary, we assume the temporal extent of the difference in impacts is ten years. We then consider all impacts caused by the replaced or repaired structure that occur *beyond* the remaining, original useful life period, for a total future useful life of 40 or 50 years, respectively—along with any associated short-term and intermittent impacts, such as construction related activities, that are a direct result of the proposed action, vessel, or stormwater impacts that are consequences of the proposed action—to be an "effect of the action" and analyze all of these in the following section.

To be clear, in some instances, the proposed action will authorize the repair or replacement of only a small portion of a structure (e.g., a few piles or the replacement of floats). In all instances where the repair or replacement is something less than the entire structure, unless requested otherwise, we have limited the use of the nearshore calculator in our effects of the action and baseline analysis for this consultation to only those parts being repaired or replaced. In all repair or replacement cases, we assume, absent information to the contrary, that the portion being repaired had ten years of useful life remaining, and that the repair extended at least the life of that part of the structure, from the date of this Biological Opinion, by an additional 40 years for overwater structures (residential pier, ramps and floats, marinas and other commercial structures) and 50 years for shoreline bulkheads, for a total useful life of 40 or 50 years, respectively.

To account for the remaining "useful life period," which we assumed was 10 years for all the proposed actions that contain existing structures being analyzed as part of this consultation with the exceptions noted in the consultation history, the NHVM (introduced in the Analytical Approach (Section 2.1), *see also* Appendix 1) has calculated and ascribed, a 10-year "credit" for projects that are removing and replacing existing structures in part or in whole. This particular credit, along with any credit for improving conditions as a result of a change in project design, is detailed below in Section 2.4.

During the preparation of this and the WCR-2020-01361 opinion, the USACE and some applicants have asserted that NMFS should also consider potential effects associated with the possible future degradation of all existing structures as part of the baseline. They argue that but for the current permit, an existing structure would degrade over an unspecified period of time. We disagree that our analysis needs to consider those kinds of theoretical effects for two reasons. First, NMFS acknowledges that for existing structures there could be multiple scenarios relative to how an existing nearshore, in- or overwater structures would persist and degrade in the marine shoreline environment if the owner ceased to perform any maintenance. This range of potential outcomes is exponential, to the point it is not reasonable to assume them all, nor is there currently enough data or analysis that would support such an analysis. In general, for scenarios where structures are left to degrade beyond a usable point, we acknowledge that such degradation could take more than 10 years. Further, the range of possible scenarios could result in impacts associated with a degrading structure over time would be both negative (e.g., decomposing creosote impacts to water quality) and positive (e.g., overwater cover is no longer obstructing migration). This could also mean that at some point, the structure would fall out of compliance with the USACE original permit, or state or local permits). Failure to maintain nearshore, in- and/or overwater structures is not unheard of (Patterson et al 2014, King County 2019). However, there is also a preponderance of evidence (including the 15 projects evaluated in this Opinion and thousands of redevelopment consultations that have occurred with the USACE since salmon were listed) that demonstrate that owners of nearshore, in- and overwater structures do at some point in time apply for USACE permit before the structure falls into a less-than useful state. As the proposed applicants all have demonstrated a desire to maintain their structures by applying for a USACE permit, and in light of the USACE's own requirements that the structures be maintained in a safe and "good" condition, *see* General Condition 2 at 33 C.F.R. Part 325, Appendix A, and Nationwide Permit General Condition Number 14, NMFS has assumed that is reasonably likely that regular maintenance will occur. In addition, because granting the requested permits is within the Corps' discretionary authority, the consequences of the issuance of these permits—namely, impacts associated with a prolonged life of structures for an additional 40 to 50 years—is properly considered a consequence that would not occur but for the proposed action. For these reasons, we appropriately declined to consider a range of possible outcomes that might occur absent regular maintenance.

Second, even if we were to consider what might happen to a structure absent the proposed repair or replacement for the duration of its existence on the landscape, and such impacts should be attributed to the baseline, those impacts are still part of the calculus, they have just been moved out in time to occur after the new useful life (rather than the existing useful life). The basic consequence of the currently proposed action is to extend the life of the part of the structure being worked on. Any effects of a possible degradation, instead of occurring now, will occur, if at all, after the new useful life expires. In that way, the potential effects that might occur should the applicant cease maintenance are still part of the baseline.

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. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered 50 CFR 402.17(a) and (b).

The effects of the USACE's issuance of permits for the 15 projects for nearshore construction will include effects ranging from temporary (typically related to the impacts of construction activity), to persistent and intermittent (from the use or operation of the permitted structures), to enduring (from effects of the structures on the environment and their impacts on habitat features that might be diminished during the new "useful life" period). Also included in this section, are any positive effects of project design features, designed to reduce the impact of a structure, during any of its remaining useful life (the "credits" described in the Environmental Baseline Section 2.3.2). Figures 19 and 20 illustrate how the calculator incorporates impact to the habit throught time (per HEA) and also depicts the NHVM's differing treatment of already impacted vs. untouched habitat and its assessment of lesser impacts for repaired or replacement projects compared with greater impacts (2x's) expected for expansions to an existing structure or an entirely new structure (Appendix 1 further describes how the model calculates the effects of the action in light of the environmental baseline). Table 18 summarizes the quantitative, project-specific credits and any debits the model generated for the projects as currently proposed.

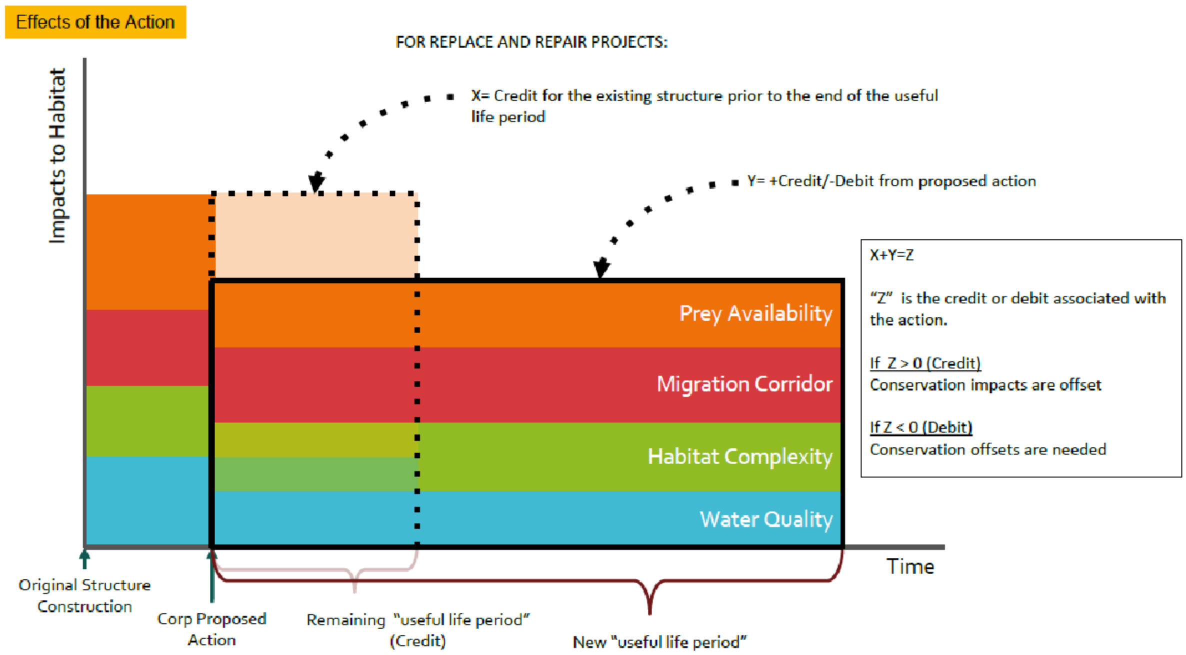

Figure 19. Effects of the Action: Illustration depicts "credit" for early removal of an existing structure plus effects of a proposed replacement structure. Note the scale of time for the original structure is condensed for the sake of readability.

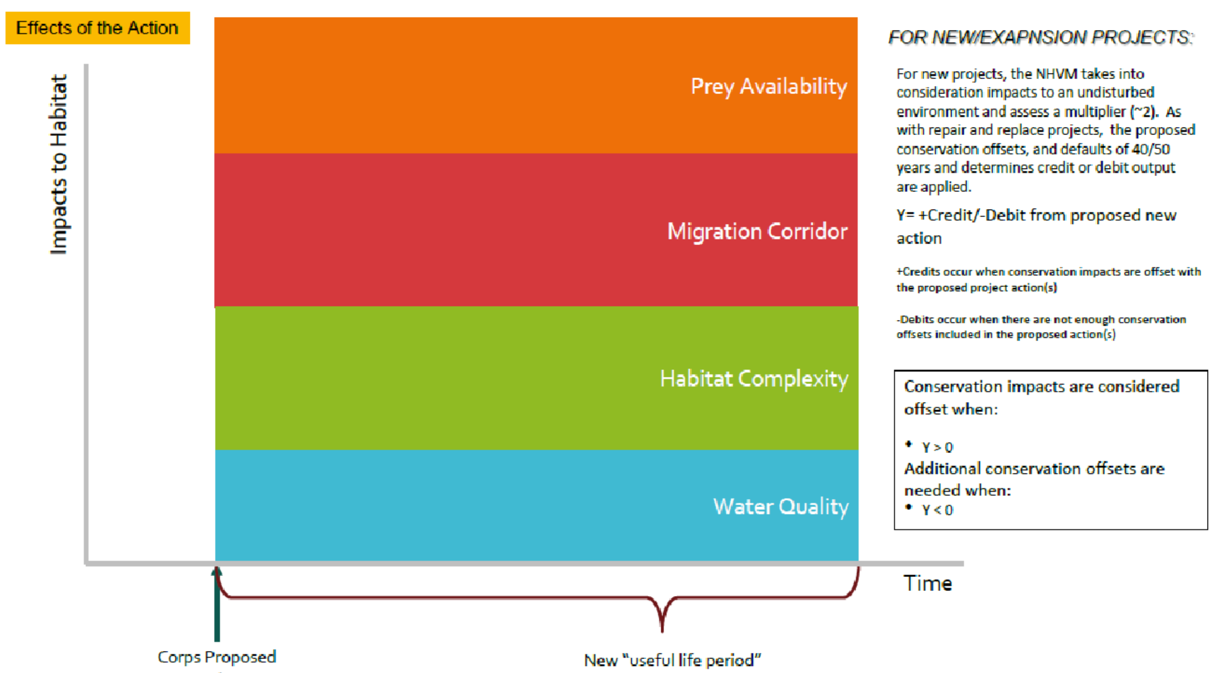

Figure 20. Effects of the Action: Illustration depicts debits for a new or expanded component of a nearshore structure.

Table 18. NWS number, proposed conservation credits for removing existing structure and improved project design, and net conservation credit resulting from the proposed action and proposed offsets as of May 11, 2022, for each project.

NWS#	Proposed Conservation Credits (10-year credit for removing existing structure and any improved project design)	Effects of the Action - Resulting conservation credit (+)/debit(-) from proposed action, impacts resulting from new "useful life period" added to the proposed conservation credits in adjacent column)
NWS-2020-430	0	-3
NWS-2019-799	146	-202
NWS-2019-759	248	-500
NWS-2020-382	12	-13
NWS-2019-812	103	-325
NWS-2020-365	1	0
NWS-2020-54-WRD	363	20
NWS-2020-277	1	0
NWS-2018-1183	19	-11
NWS-2018-263	17	-33
NWS-2019-962	129	-43
NWS-2019-725	0	-359
NWS-2019-897	22	-29
NWS-2019-1032	123	-237
NW-2019-682	1560	840
Total	1039	-1110

All of the proposed projects have similar components that resulted in co-occurrence of listed ESA-species or designated critical habitat and are therefore addressed collectively in this effects analysis section. Table 19 summarizes respective project components.

Table 19. The components of the proposed projects that were relevant to the effects analysis by USACE project.

NWS #	Components of the proposed projects relative to the effect analysis							
	Installed or Repaired Piles	**Removed Piles**	**Installed Jetty/ Breakwater**	**Boat Ramp Installed**	**Dredging**	**OWS, New/ Removed & Replaced/Installed**	**Bulkhead New Removed/ Replaced**	**Stormwater outfall or conveyance**
NWS-2020-430	X							
NWS-2019-799							X	X
NWS-2019-759							X	
NWS-2020-382							X	
NWS-2019-812							X	X
NWS-2020-365	X	X						
NWS-2020-54-WRD	X	X				X		
NWS-2020-277				X				
NWS-2018-1183	X	X				X		
NWS-2018-263					X			
NWS-2019-962	X	X				X		
NWS-2019-725					X			
NWS-2019-897	X	X				X		
NWS-2019-1032	X	X		X		X	X	
NWS-2019-682	X	X				X		

The effects analyses in this section will include both an overarching description of effects caused by the construction and presence of near, over- and in-water structures as well as a specific analysis of the effects we expect as a result of each proposed project. Table 20 provides project-specific summaries of effects and is intended to supplement the general effects descriptions in this Section. This section also analyzes effects resulting from actions intended to offset the impacts of a proposed structure (e.g., removal of creosote piles).

Table 20. Summary of effect by USACE project.

	Effects/Disruptions to listed species and critical habitat								
NWS#	**Noise (Pile driving, construction vessel noise)**	**Water Quality (Suspended Sediments & Contaminant, Stormwater, Vessel Discharge)**	**Nearshore migration corridors (Overwater Structures)**	**Feeder Bluff**	**Natal Estuary Zone or Hood Canal**	**Pocket Estuary**	**Forage Fish Spawning**	**Submerged Aquatic Vegetation (SAV)**	**Drift Cell**
NWS-2020-430	X	X			X			X	
NWS-2019-799	X	X					X	X	X
NWS-2019-759	X	X		X			X	X	X
NWS-2020-382	X	X					X	X	X
NWS-2019-812	X	X						X	X
NWS-2020-365	X	X					X	X	X
NWS-2020-54-WRD	X	X	X			X		X	
NWS-2020-277	X	X			X			X	
NWS-2018-1183	X	X	X				X	X	X
NWS-2018-263	X	X					X	X	X
NWS-2019-962	X	X	X	X		X	X	X	X
NWS-2019-725	X	X					X	X	X
NWS-2019-897	X	X	X	X			X	X	X
NWS-2019-1032	X	X	X					X	
NWS-2019-682	X	X	X					X	

In addition to the positive effects accounted for as credits in Table 18, this effects section takes into account beneficial effects that will occur as a result of the removal of creosote pilings. A total of 8 proposed projects will remove 430.3 tons of creosote (Table 21). While the short-term effects of removing creosote is adverse (resuspension of contaminants), the removal will result in improved benthic conditions in the long run and is discussed further below.

Table 21. USACE projects that propose to remove creosote piles and number of creosote piles removed.

NWS#	Estimated Tons of Creosote Removed
NWS-2019-799	14.3
NWS-2020-382	3.6
NWS-2020-365	0.3
NWS-2020-54-WRD	3.1
NWS-2018-1183	2.6
NWS-2019-962	18.2
NWS-2019-897	1.3
NW-2019-682	387
Total	430.3

2.4.1 Temporary Effects During Construction of Structures

Authorization of construction of new or repairs to, or replacement of structures, or dredging, despite the use of BMPs to reduce suspended sediments and vessel grounding, will include (a) water quality reductions; (b) increases in re-suspended contaminants; (c) increased noise in the aquatic environment; and (d) reduction of prey/forage (benthic prey, forage fish, prey fishes). Additionally, dredging activities can entrain fish.

Water Quality

Water quality is likely to be affected during in-water work associated with, replacement, expansion, or new in- and over-water structures and shoreline armoring. Water quality effects during construction are likely to include turbid conditions, decreased dissolved oxygen, and suspension of contaminated materials.

Turbidity: Turbid conditions can be created during pile installation, pile removal, boat ramp repairs, and excavation to install, replace or repair bulkheads. In estuaries, state water quality regulations (WAC173-201A-210) establish a mixing zone of 200 feet plus the depth of water over the discharge port(s) as measured during mean lower low water. For non-dredging activities it is expected that during the days that construction activities occur in the water, elevated suspended sediment levels could occur within this area.

Dredging activities unavoidably disturb the sediment substrates and where contaminants are present, increase contaminant concentrations by re-suspending particulates, thereby allowing more contaminants to enter into the water column. Consequently, in these cases elevated water column contaminant concentration occurs in the vicinity (upstream or downstream) of the dredging, depending on the tidal stage during the dredging activity. For dredging activities that occur in estuary environments, Washington state water quality regulations (WAC173-201A-210) establish that mixing zones do not extend in a downstream direction for a distance from the discharge port(s) greater than three hundred feet plus the depth of water over the discharge port(s), or extend upstream for a distance greater than one hundred feet. During proposed dredging activities, we anticipate that elevated suspended sediment levels would occur within these threshold distances.

Reduced Dissolved Oxygen (DO): Suspension of anoxic sediment compounds during in water work can result in reduced DO in the water column within the mixing zone area as the sediments oxidize. Based on a review of six studies on the effects of suspended sediment on DO levels, 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. High levels of turbidity would likely have contemporaneous reduction in dissolved oxygen within the same affected area.

Reduced DO is not expected to exceed the established mixing zone of 200 feet (plus the depth of water over discharge ports) for non-dredging activities.

For dredging activities, reduced DO is not expected to exceed the established mixing zone of three hundred feet (plus the depth of water over discharge ports), or extend upstream for a distance of over one hundred feet.

Re-suspended Contaminants and Incidental Discharge

In some of the proposed locations, in water work is likely to include resuspension of contaminated sediments, including the incidental discharge of contaminated materials when creosote treated wood materials are being removed. Creosote-treated piles contaminate the surrounding sediment up to two meters away with PAHs (Evans et al. 2009). The removal of the creosote-treated piles mobilizes these PAHs into the surrounding water and sediments (Smith et al. 2008; Parametrix 2011). Projects can also release PAHs directly from creosote-treated timber during the demolition of overwater timber and if any of the piles break during removal (Parametrix 2011). The concentration of PAHs released into surface water rapidly dilutes. Smith et al. (2008) reported concentrations of total PAHs of 101.8 µg/l 30 seconds after creosote-pile removal and 22.7 µg/l 60 seconds after. However, 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. For the projects proposing creosote pile removal, we anticipate that chemical compounds leaching into nearshore and marine sediments would be reduced after a brief increase in leachate, which would rapidly decrease toxic conditions for organisms that use the water column, and decrease toxicity for benthic organisms within six months to a year (DNR 2014).

Barges and tugs will be used to construct many of the projects as well as some work associated with offsetting habitat conservation measures. Discharge of hydraulic fluid, oils, or fuels from construction equipment would constitute an unlawful discharge and are not considered here.

However, the operation of these vessels at each location is likely to result in small incidental discharges caused by drippage from engines, which will introduce very small amounts of fuels, oils, or lubricants into the water. Incidental discharge of oils or fuels, and polycyclic aromatic hydrocarbons (PAHs)[29] may also result from exhaust from these kinds of construction vessels, or from accidental introduction of oils or fuels from equipment in contact with water. These incidental discharges are likely at any site where such vessels are used to stage construction equipment or materials. We expect these PAHs and other contaminants to be introduced into the water column during and immediately following the proposed activity. Because these materials can disperse quickly, they can become quite widespread at very low concentration. PAHs from the exhaust of these vessels have a similar pattern of dispersal. 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.

Re-suspended contaminants and incidental discharge are not expected to be detectable beyond background levels beyond the established mixing zone of 200 feet plus the depth of water over the discharge port(s).

Puget Sound contains isolated, highly industrialized environments that are known to have hazardous substances in and near the dredge sites. Contaminants in sediments and dissolved in water can have varying levels of toxicity, and most cause sub-lethal effects in fishes. Common chemicals observed in dredge spoils include metals (mercury, arsenic, zinc, and tri-butyl tin (TBT)), polychlorinated biphenyls (PCBs), dioxin, polycyclic aromatic hydrocarbons (PAHs), pesticides, butyl benzyl phthalate, benzyl alcohol, and benzoic acid. Researchers have recently identified a tire rubber-derived chemical, 6PPD-quinone, as the cause of pre-spawn mortality in coho salmon (McIntyre et al. 2015; Tian et al. 2020). Coho salmon are extremely sensitive to 6PPD-quinone (Scholz 2011; Chow 2019; Tian et al. 2020) which is a concern because the chemical is found to readily adsorb to organic matter and thus may be a persistant contaminant in sediments in aquatic ecosystems (OSPAR Commission 2006; CDTSC 2021). Although Chinook salmon did not experience the same level of mortality as coho salmon, tire leachate is a concern for all salmonids because the science is still emerging and there is uncertainty about potential sublethal effects. Re-suspended contaminants and incidental discharge associated with dredging are not expected to be detectable above background levels beyond the established mixing zone of three hundred feet plus the depth of water over the discharge port(s), or extend upstream for a distance of over one hundred feet.

Noise in Aquatic Habitat Generated During In-water Work

Noise is expected as a short-term consequence from construction activities during in-water work to build, repair, and replace structures and from dredging activities.

<u>Pile Driving.</u> Pile driving can cause high levels of underwater sound; the use of a confined or unconfined bubble curtain can result in a reduction of sound level. Ideally, the bubble curtain absorbs and reduces the sound pressure waves generated from driving the pile into the ground

[29] 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.

(Wursig et al. 2000). Many factors can influence the effectiveness of bubble curtains such as water currents, bathymetry, and tide levels. The average attenuation from multiple ring bubble curtain deployment during pile driving at the Friday Harbor ferry terminal ranged between 1 and 3 dB with a maximum reduction of 16 dB (Laughlin 2005). Pile driving can significantly increase sound waves in the aquatic habitat. The sound pressure levels from pile driving and extraction will occur contemporaneous with the work and radiate outward; the effect attenuates with distance. Cumulative sound exposure level (SEL) is a measure of the sound energy integrated across all of the pile strikes. The Equal Energy Hypothesis, described by NMFS (2007b), is used as a basis for calculating cumulative SEL (cSEL). The number of pile strikes is estimated per continuous work period. This approach defines a work period as all the pile driving between 12-hour breaks. NMFS uses the practical spreading model to calculate transmission loss, and define the area affected (NMFS 2020h, https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-acoustic-technical-guidance). Both vibratory noise and impact noise can create sufficient disturbance to affect the suitability of habitat from a behavioral and physiological sense for listed species. If sound attenuation is used for impact pile driving (e.g., a bubble curtain), NMFS allows a 10 dB reduction in sound in the model.

Six of the proposed projects include pile driving activities (Table 22). Some projects proposed multiple pile types and diameter sizes, and proposed either vibratory or impact driving for installation. To accurately assess the greatest potential for harm and exposure to listed species and their habitat we will focus this analysis on the pile type and size that will produce the greatest amount of energy for each installation method (vibratory and impact) for each project. Table 23 provides the assumptions used in the practical spreading model for each project.

Table 22. NWS number, total piles, pile type, largest pile diameter, pile installation method, maximum piles driven per day, minutes per pile, and minutes per day for each project with proposed pile driving.

NWS#	Total Piles	Pile Type	Largest Pile Diameter (Inches)	Pile Installation Method	Bubble Curtain proposed	Maximum Piles/Day	Maximum (Impact) Strikes/Pile	Maximum Pile (Impact) Strikes/Day	Minutes/Pile (Vibratory)	Minutes/Day (Vibratory)
NWS-2020-430	1	Steel	24	Vibratory	No	1	NA	NA	30	30
NWS-2020-365	1	Fiber glass	14	Jacketing	NA	NA	NA	NA	NA	NA
NWS-2020-54-WRD	4	Steel	16	Vibratory, with impact proofing	Yes	4	100	400	60	240
NWS-2018-1183	6	Steel	10	Impact	Yes	4	45	180	NA	NA
NWS-2019-962	14	Steel	10	Impact	Yes	5	45	225	NA	NA
NWS-2019-897	18	Steel	12	Vibratory	No	5	NA	NA	40	200
NWS-2019-1032	4	Steel	12	Vibratory, Impact if Needed	No	4	130	520	30	120
NWS-2019-682	72	Steel	20	Vibratory, Impact if Needed	Yes	10	52	520	30	300

Given the assumptions above, underwater sound from the pile driving could exceed behavioral and injury thresholds. Table 23 details this for each project that will pile drive for each sound threshold.

Table 23. Fish and marine mammal distance to thresholds for behavioral and injury responses to proposed pile driving. Decibels referenced to 1 micro Pascal and SEL referenced to 1 μPa²·s.

NWS#	Impact Pile Driving Response: Behavioral for Fish (150 dB_{RMS}) (meters)	Impact Pile Driving Response: Injury for Fish ≥ 2g (187 dB_{cumSEL}) (meters)	Impact Pile Driving Response: Injury for Fish < 2g (183 dB_{cumSEL}) (meters)	Vibratory Pile Driving Response: Behavioral for SRKW (120 dB_{RMS}) (meters)	Impact Pile Driving Response: Behavioral for SRKW (160 dB_{RMS}) (meters)	Vibratory Pile Driving Injury for SRKW (198 $_{cumSEL}$) (meters)	Impact Pile Driving Injury for SRKW (185 $_{cumSEL}$) (meters)
NWS-2020-430	22	NA	NA	2154	NA	0	NA
NWS-2020-54-WRD	7	3	6	4642	2	1	0
NWS-2018-1183	136	1	3	NA	29	NA	0
NWS-2019-962	136	2	3	NA	29	NA	0
NWS-2019-897	NA	NA	NA	2154	NA	1	NA
NWS-2019-1032	631	14	26	21,544	136	4	1
NWS-2019-682	Travels until it hits land	30	55	Travels until it hits land	Travels until it hits land	3	2

Construction vessels. Barges and tugs will be used to construct many of the proposed projects and would be expected to have adverse effects similar to those articulated for vessel impacts in the Environmental Baseline section of this Opinion. Barges will increase the amount of noise in an area surrounding each construction site and their transit paths.

Benthic Communities and Forage Species Diminishment

Areas where sediment is disturbed by pile driving, pile removal, dredging, or other in-or near water work such as boat ramp or bulkhead construction, repair, or replacement, and from vessels in shallow water areas to facilitate construction, will disturb and diminish benthic prey communities. In areas where suspended sediment settles on the bottom, some smothering can occur which also disrupts the benthic communities. The speed of recovery by benthic communities is affected by several factors, including the intensity of the disturbance, with greater disturbance increasing the time to 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.

Entrainment

Mechanical dredges entrain organisms that are captured within the clamshell bucket. Mechanical dredges commonly entrain slow-moving and sessile benthic epifauna along with burrowing infauna that are removed with the sediments. They also entrain algae and aquatic vegetation.

Fish entrainment is be dependent upon the likelihood of fish occurring within the dredge prism, dredge depth, fish densities, the entrainment zone (water column of the clamshell impact), location of dredging within the estuary, type of equipment operations, time of year, and species life stage. Listed fish could be entrained however, forage fish species, such as sand lance, or demersal fish like sculpins, and pricklebacks are most likely to be entrained as they reside on or in the bottom substrates with life-history strategies of burrowing or hiding in the bottom substrate (Nightingale and Simenstad 2001a). If listed fish are entrained, they are likely to be injured or killed during the entrainment. However, the potential for salmon, steelhead or rockfish entrainment is expected to be very unlikely. The rarity of these occurrences is likely due to a combination of factors. In order to be entrained in a clamshell bucket, a fish must be directly under the bucket when it drops. The relatively small size of the bucket, compared against the scattered and low-density distribution of the fish across the available habitat within the project area strongly suggest that the potential for overlap between fish and bucket presence is very low, and that potential would decrease after the first few bucket cycles because mobile organisms such as salmon are likely to move quickly away from the noise and turbid water. Further, mechanical dredges typically stay within an area limited to the range of the crane/excavator arm for many minutes to several hours before moving to an adjacent area. The risk of entrainment and bucket strike during the planned dredging would be lowered further by conducting the work during a period when very few individuals are likely to be present anywhere within the action area. Therefore, based on the best available information, the NMFS considers it extremely unlikely that any listed fish would be entrained or struck by the bucket during the planned maintenance dredging.

2.4.2 Intermittent Effects From Use and Maintenance

The proposed use and operation and maintenance of the pier, ramp, float, wharf, dock or marina structures authorized by the USACE, as part of this batch of 15 projects, will generate several types of episodic habitat effects, which will occur while the structures are present in the environment: (a) water quality reductions from vessel use and discharge of stormwater from pollution generating impervious surfaces; (b) noise from vessel operation; (c) scour from vessel operation. Each are episodic and persistent effects, coextensive with the respective design lives of the new, expanded, repaired or replaced wharfs, piers, docks, floats, and structures.

Impacts from future maintenance that does not require a USACE permit would also be considered effects of the action. These effects are expected to be relatively minor as they are unlikely to include in-water construction. Future maintenance would likely include activities such as replacing decking, painting, and minor maintenance to shoreline bulkheads. These types of activities are not expected to have any direct impacts on listed species. However, these activities would slightly extend the life of structures, consistent with the USACE' position that their proposed authorization of near- and in-water structures includes minor maintenance that would not require additional USACE permits.

Water Quality

The proposed actions generally cause reduction in water quality stemming from vessels and/or unmanaged stormwater from upland areas as follows. Pollutants in the post-construction stormwater runoff produced at projects that include impervious surface will come from many diffuse sources, but is most likely to occur at large commercial or municipal facilities with larger areas of impervious surface that supports vehicular traffic. The runoff itself comes from rainfall or snowmelt moving over, where it picks up and carries away natural and anthropogenic pollutants, finally depositing them into coastal waters, (Dressing et al. 2016). Pollutants in post-construction stormwater runoff typically include:

- Excess fertilizers, herbicides, insecticides and sediment from landscaping areas;
- Oil, grease, PAHs, 6PPD-quinone, 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 the decay of building and other infrastructure;
- Atmospheric deposition from surrounding land uses; and
- 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. 2005). Pollutants will become more concentrated on impervious surfaces until they either degrade in place or are transported by wind, precipitation, or active site management. Although stormwater discharge from most proposed projects will be small in comparison to the flow of the nearby waterways, it will have an incremental impact on pollutant levels. The adverse effects of stormwater runoff from the projects covered by the USACE will occur primarily at the basin scale due to persistent additions of pollutants or the compounding effects of many environmental processes.

Two projects will result in stormwater runoff, both from the replacement of stormwater outfalls which will discharge stormwater into Puget Sound. Effects caused by this project are considered intermittent as stormwater run off occurs during and after rain events.

The following brief summaries from toxicological profiles (ATSDR 1995; ATSDR 2004a; ATSDR 2004b; ATSDR 2005; ATSDR 2007) show how the environmental fate of each contaminant and the subsequent exposure of listed species and critical habitats varies widely, depending on the transport and partitioning mechanisms affecting that contaminant, and the impossibility of linking a particular discharge to specific water body impairment (NRC 2009):

- DDT and its metabolites, dichlorodiphenyldichloroethylene (DDE) and dichlorodiphenyltrichloroethane (DDD) (all collectively referred to as DDx) may be transported from one medium to another by the processes of solubilization, adsorption, remobilization, bioaccumulation, and volatilization. In addition, DDx can be transported within a medium by currents, wind, and diffusion. These chemicals are only slightly soluble in water, therefore loss of these compounds in runoff is primarily due to transport of particulate matter to which these compounds are bound. For example, DDx have been found to fractionate and concentrate on the organic material that is transported with the clay fraction of the wash load in runoff. Sediment is the sink for DDx released into water where it can remain available for ingestion by organisms, such as bottom feeders, for many years.
- 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. Some evaporate into the air from the surface but 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).
- PCBs are globally transported and present in all media. Atmospheric transport is the most important mechanism for global dispersion of PCBs. PCBs are physically removed from the atmosphere by wet deposition (i.e., rain and snow scavenging of vapors and aerosols); by dry deposition of aerosols; and by vapor adsorption at the air-water, air-soil, and air-plant interfaces. The dominant source of PCBs to surface waters is atmospheric deposition; however, redissolution of sediment-bound PCBs also accounts for water concentrations. PCBs in water are transported by diffusion and currents. PCBs are removed from the water column by sorption to suspended solids and sediments as well as from volatilization from water surfaces. Higher chlorinated congeners are more likely to sorb, while lower chlorinated congeners are more likely to volatilize. PCBs also leave the water column by concentrating in biota. PCBs accumulate more in higher trophic levels through the consumption of contaminated food.

- Due to analytical limitations, investigators rarely identify the form of a metal present in the environment. Nonetheless, much of the copper discharged into waterways is in particulate matter that settles out. In the water column and in sediments, copper adsorbs to organic matter, hydrous iron and manganese oxides, and clay. In the water column, a significant fraction of the copper is adsorbed within the first hour of introduction, and in most cases, equilibrium is obtained within 24 hours.
- For zinc, sorption onto hydrous iron and manganese oxides, clay minerals, and organic material is the dominant reaction, resulting in the enrichment of zinc in suspended and bed sediments. The efficiency of these materials in removing zinc from solution varies according to their concentrations, pH, redox potential, salinity, nature and concentrations of complexing ligands, cation exchange capacity, and the concentration of zinc. Precipitation of soluble zinc compounds appears to be significant only under reducing conditions in highly polluted water.
- A significant fraction of lead carried by river water occurs in an undissolved form, which can consist of colloidal particles or larger undissolved particles of lead carbonate, lead oxide, lead hydroxide, or other lead compounds incorporated in other components of surface particulate matter from runoff. Lead may occur either adsorbed ions or surface coatings on sediment mineral particles, or it may be carried as a part of suspended living or nonliving organic matter in water. The ratio of lead in suspended solids to lead in dissolved form has been found to vary from 4:1 in rural streams to 27:1 in urban streams. Sorption of lead to polar particulate matter in freshwater and estuarine environments is an important process for the removal of lead from these surface waters.

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-derived chemical, 6PPD-quinone, as the cause (Tian et al. 2020). Coho salmon are extremely sensitive to 6PPD-quinone, more so than most other known contaminants in stormwater (Scholz 2011; Chow 2019; Tian et al. 2020). Although Chinook salmon 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, polycyclic aromatic hydrocarbons (PAHs), fire retardants, and emissions that have been linked to deformities, injury and/or death of salmonids and other fish (Trudeau 2017; Young et al. 2018).

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.

Noise from Commercial and Recreational Vessel Operation

During consultation, NMFS identified boat use associated with proposed new, repaired, and replacement piers, wharfs, marinas, docks, and boat ramps as a consequence of the associated use of such structures. NMFS has found that although boat use is already common in the general vicinity of existing structures, a level of boat use that is commensurate with the useful life of the structure attributable to the proposed action will be a consequence of the underlying action of repairing, replacing, or expanding existing docks, piers, wharfs, ramps, floats and marinas. We assume new and continued boat use will occur in association with new, expanded and with the continued existence of these structures.

Similar to what is described in the section on boat noise from construction vessels, above, underwater sound from boat motors and associated propeller cavitation is known to cause physiological stress to fish. Recreational boating activity is another known cause of underwater sound. Boating sound effects are expected intermittently for short periods with each episode of use for recreational vessels, and NMFS anticipates these effects will be primarily during late spring, summer, and early fall when leisure boating typically occurs. For vessels using commercial structures, such episodic noise is expected year-round.

We assume that for each repair and replace project proceeding under this consultation, vessel traffic extending beyond the remaining useful life period would be a consequence of the proposed action, while new and expanded projects will likely incrementally increase the amount of vessel traffic, and the associated noise created by those vessels.

Scour of Nearshore Areas from Prop Wash

Associated commercial and recreational boat use adversely affects submerged aquatic vegetation (SAV) where it is present, and inhibits its recruitment where not present, by frequently churning water and sediment in the shallow water environment. Additionally, the turbidity from boat propeller wash decreases light levels (Eriksson et al. 2004). 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). Areas where sediment is routinely disturbed by prop wash will experience repeated disruption of benthic prey communities, suppressing this forage source. Consistent with our analytical approach in this Opinion, these impacts are considered coextensive with the effects of the repaired, replaced or new OWS themselves (see *Response to Habitat Disruptions from In-Water and Overwater Structures* below).

2.4.3 Enduring Effects of Inwater, Overwater, and Nearshore Structures

All of the projects included in the proposed action will install, expand, repair and replace over-or in water or nearshore structures (Table 19 and Table 24).

Table 24. Summary of installed and replaced in- and overwater and nearshore structures resulting from the proposed action (some projects have both types of structures).

	Enduring Effects—Totals		
	# of projects	Installed	New "useful life"
Bulkheads (Linear Feet)	5	1,323	50 years
In- and Overwater Structures (Square Feet)	9	97,614	40 years

In- and overwater structures and nearshore structures influence habitat functions and processes for the duration of the time they are present in habitat areas. The effects include: (a) altered predator/prey dynamics; (b) disrupted migration; and (c) modified shore processes related to bank armoring. These effects are chronic, persistent, and co-extensive with the design life, or useful life, of the structure.

Predator/Prey Dynamics

OWSs adversely affect SAV, if present, and inhibit the establishment of SAV where absent, by creating enduringly shaded areas. (Kelty and Bliven 2003). Decreased ambient light typically results in lower overall productivity, which is ultimately reflected in lower shoot density and biomass (Shafer 1999; 2002). In contrast to other studies in the Pacific Northwest, Shafer (2002) specifically considers small residential OWS and states, "much of the research conducted in Puget Sound has been focused on the impacts related to the construction and operation of large ferry terminals. Although some of the results of these studies may also be applicable to small, single-family docks, there are issues of size, scale, and frequency of use that may require separate sets of standards or guidelines. Notwithstanding, any overwater structure, however small, is likely to alter the marine environment."

Fresh et al. (2006a) researched the effects of grating in residential floats on eelgrass. They reported a statistically significant decline in eelgrass shoot density underneath six of the eleven studied floats in northern Puget Sound. However, the physiological pathways that result in the reduction in shoot density and biomass from shading applies to all SAV. Thus, it is reasonable to assume that shading from OWS adversely affects all SAV.

In addition to reduced SAV biomass and shoot density, shading also has been shown to be correlated with reduced density of the epibenthic forage under OWS's (Haas et al. 2002, Cordell et al. 2017). While the reduction in light and SAV were likely a cause for the reduction in epibenthos, changes in grain size due to boat action and current alteration also may have contributed (Haas et al. 2002). Eelgrass is a substrate for herring spawning, and herring spawn is Chinook salmon forage species. The likely incremental reduction in epibenthic prey associated with OWS projects will reduce forage for listed fish.

Obstructions in Migration Areas

Juvenile Chinook and juvenile HCSR chum salmon migrate along shallow nearshore habitats, and OWS's will disrupt their migration and increase their predation risk. Most juvenile Chinook and juvenile HCSR chum salmon will encounter some OWSs during their out-migration. We cannot estimate the number of individuals that will experience migration delays and increased predation risk from the proposed OWSs. Adult Chinook salmon, adult and juvenile steelhead, and adult chum salmon, do not explicitly rely on shallow nearshore habitats; OWS are not considered to be a significant obstruction to their movements.

Overwater structures cause delays in migration for PS Chinook salmon from disorientation, fish school dispersal (resulting in a loss of refugia), and altered migration routes (Simenstad 1999). Juvenile salmonids stop at the edge of the structures and avoid swimming into their shadow or underneath them (Heiser and Finn 1970; Able et al. 1998; Simenstad 1988; Southard et al. 2006; Toft et al. 2013; Ono 2010). Swimming around structures lengthens the migration distance and is correlated with increased mortality. Anderson et al. (2005) found migratory travel distance rather than travel time or migration velocity has the greatest influence on the survival of juvenile spring Chinook salmon migrating through the Snake River.

Juvenile salmon, in both the marine nearshore and in freshwater, migrate along the edge of shadows rather than through them (Nightingale and Simenstad 2001b; Southard et al. 2006; Celedonia et al. 2008a; Celedonia et al. 2008b; Moore et al. 2013; Munsch et al. 2014). In freshwater, about three-quarters of migrating Columbia River fall Chinook salmon smolts avoided a covered channel and selected an uncovered channel when presented with a choice in an experimental flume setup (Kemp et al. 2005). 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 the marine nearshore, there is substantial evidence that OWS impede the nearshore movements of juvenile salmonids and reduced feeding rates for those fish that do utilize OWS (Heiser and Finn 1970; Able et al. 1998; Simenstad 1999; Southard et al. 2006; Toft et al. 2007; Moore et al. 2013, Munsch et al. 2014, see ref). In the Puget Sound nearshore, 35-millimeter to 45-millimeter juvenile chum and pink salmon were reluctant to pass under docks (Heiser and Finn 1970). Southard et al. (2006) snorkeled underneath ferry terminals and found that juvenile salmon were not underneath the terminals at high tides when the water was closer to the structure, but only moved underneath the terminals at low tides when there was more light penetrating the edges. Moore et al. (2013) concluded in their study that the Hood Canal Bridge may attract PS steelhead smolts to its shade while also inhibiting passage by disrupting Hood Canal currents. They found this delayed migration, for a species whose juveniles typically migrate rapidly out to the open ocean, likely resulted in steelhead becoming more susceptible to predation by harbor seals and avian predators at the bridge. These findings show that overwater-structures can disrupt juvenile salmonid migration in the Puget Sound nearshore.

An implication of juvenile salmon avoiding OWS is that some of them will swim around the structure (Nightingale and Simenstad 2001b). This behavioral modification will cause them to temporarily utilize deeper habitat, thereby exposing them to increased piscivorous predation. Hesitating upon first encountering the structure, as discussed, also exposes salmonids to avian predators that may use the floating structures as perches. Typical piscivorous juvenile salmonid predators, such as flatfish, sculpin, and larger juvenile salmonids, being larger than their prey, generally avoid the shallowest nearshore waters that outmigrant juvenile salmonids prefer—especially in the earliest periods of their marine residency. When juvenile salmonids temporarily leave the relative safety of the shallow water, their risk to being preyed upon by other fish increases. This has been shown in the marine environment where juvenile salmonid consumption by piscivorous predators increased fivefold when juvenile pink salmon were forced to leave the shallow nearshore (Willette 2001). Elevated pinniped predation rates have been documented at major anthropogenic structures that inhibit movement and cause unnaturally large aggregations of salmonid species (Jeffries and Scordino 1997, Keefer et al. 2012, Moore et al. 2013).

Another study was conducted by Moore et al. 2013 at the Hood Canal Bridge, a floating structure that extends 3.6 meters underwater and forms a partial barrier for steelhead migrating from Hood Canal to the Pacific Ocean. The authors found more steelhead smolt mortality events occurred within the vicinity of the Hood Canal Bridge than at any other site that was monitored from 2006 through 2010. Smolts that passed by the Hood Canal Bridge receiver array behaved differently than those migrating past similarly spaced receiver arrays inside the Hood Canal, in Puget Sound, and in the Strait of Juan de Fuca. The observed changes in behavior was potentially a result of one or several interacting physical, ecological or environmental factors altered by the bridge structure. Mortalities are likely caused by predation by a marine mammal, inferred from movement patterns recorded on Hood Canal Bridge receivers that would be atypical of surviving steelhead smolts or tags consumed by avian predators (Moore et al. 2013).

Further, swimming around OWS lengthens the salmonid migration route, which has been shown to be correlated to increased mortality. Migratory travel distance rather than travel time or migration velocity has been shown to have the greatest influence on survival of juvenile spring Chinook salmon migrating through the Snake River (Anderson et al. 2005). In summary, NMFS anticipates that the increase in migratory path length from swimming around OWS as well as the increased exposure to piscivorous predators in deeper water likely will result in proportionally increased juvenile PS Chinook salmon and HCSR chum salmon mortality. Except for the Hood Canal Bridge example where the pontoons span roughly 95 percent of the width of the Hood Canal at low tide, PS steelhead do not tend to be nearshore dependent and thus the presence of these structures is unlikely to affect their behavior.

Disrupted Shore Processes

A total of 6 projects would result in a new or repaired/replaced 50-year useful life for 1,323 linear feet of bulkhead (Table 19 and Table 24) throughout Puget Sound. The effects that these structures exert on habitat features and functions also would persist for the same duration. The impacts of hard armor along shorelines are well documented.[30] Armoring of the nearshore can reduce or eliminate shallow water habitats through the disruption of sediment sources and sediment transport. In addition, shoreline armoring used as infrastructure support for pollution generating impervious surfaces (PGIS), such as parking lots or roads, will introduce pollutants

[30] Marine Shoreline Design Guidelines at 2-1 (Johannessen et al. 2014).

into the PS and will impact the nearshore habitat through stormwater runoff. Impervious surfaces, such as roads and parking lots, alter the natural infiltration of vegetation and soil, and accumulate many diverse pollutants. During heavy rainfall or snowmelt events, accumulated pollutants are mobilized and transported in runoff from roads and other impervious surfaces.

Bulkheads, whether new, repaired, or replacement are expected to result in a higher rate of beach erosion waterward of the armoring from higher wave energy compared to a natural shoreline. This leads to beach lowering, coarsening of substrates, increases in sediment temperature, and decreased SAV, leading to reductions in primary productivity and invertebrate density within the intertidal and nearshore environment (Bilkovic and Roggero 2008; Fresh et al. 2011; Morley et al. 2012; Dethier et al. 2016). Structures in the intertidal zone change the hydrodynamics of the waves washing up on the beach. Hard structures reflect waves without dissipating their energy the way a natural beach would, especially if vegetation is present. In addition to higher rates of beach erosion and substrate coarsening by increased wave energy, bulkheads would also prevent input of sediment from landward of the bulkhead to the beach, further diminishing the supply of fine sediment. Shoreline armoring generally reduces the sediment available for transport by disconnecting the sediment source, e.g. a feeder bluff, from the drift cell, potentially causing loss of beach width and height as transport of material outpaces supply. This can occur at the site of the structure or down the drift cell.

When the physical processes are altered, there is also a shift in the biological communities. The effects of nearshore modification cascade through the Puget Sound food web. The consequences can be seen in the population declines of a variety of species that depend on these ecosystems, from shellfish, herring, and salmon to orcas, great blue heron, and eelgrass. The number and types of invertebrates, including shellfish, can change; forage fish lose spawning areas; and juvenile salmon and forage fish lose the feeding grounds that they use as they migrate along the shore (Shipman et al. 2010). Native shellfish and eelgrass have specific substrate requirements and altered geomorphic processes can leave shellfish beds and eelgrass meadows with material that is too coarse or with too much clay exposed. Finer material like gravel and sand provide important spawning substrate for sand lance and surf smelt. Therefore, a reduction to this substrate type within the intertidal and nearshore zone as a result of the bulkhead would reduce potential spawning habitat availability and fecundity of both species of forage fish (Rice 2006; Parks et al. 2013), which are important prey species for salmonids.

As a result of deepening of the intertidal zone adjacent to the bulkhead, as well as increased wave energy, the repaired, replaced, or new bulkhead would also be expected to reduce SAV (Patrick et al. 2014). Reduced SAV diminishes habitat for larval rockfish, which in their pelagic stage generally rely on SAV for prey and cover for several months. Both salmonids and juvenile bocaccio are affected by the loss of prey communities. When shoreline development removes vegetation, the loss of shading and organic material inputs can increase forage fish egg mortality (Penttila 2007). Surf smelt, for example, use about 10 percent of Puget Sound shorelines for spawning and many bulkheads are built in forage fish spawning habitat, threatening their reproductive capacity (Penttila 2007). A reduction in eelgrass could cause a reduction in potential spawning habitat for Pacific herring, another forage species for salmonids and juvenile PS/GB bocaccio. Shoreline armoring can also physically bury forage fish spawning beaches when structures are placed in or too close to the intertidal zone. Besides being prey, a sometimesoverlooked benefit of forage fish abundance to salmonids is their use as a prey buffer for predation by marine mammals and piscivorous birds. Moore et al. (2021) found that the high abundance of age-1+ anchovy in the Puget Sound provided an alternative prey source for predators of outmigrating steelhead smolts which resulted in an increase in smolt survival. A total of 9 projects (Table 20) would be expected to impact forage fish spawning areas.

Bulkheads located within the intertidal zone (below HAT) prevent upper intertidal zone and natural upper intertidal shoreline processes such as accumulation of beach wrack (Sobocinski et al. 2010; Dethier et al 2016). This is an additional mechanism that reduces primary productivity within the intertidal zone and diminishes invertebrate populations associated with beach wrack (Sobocinski et al. 2010; Morley et al. 2012; Dethier et al. 2016). Reductions in forage from bulkheads then affect primary productivity and invertebrate abundance in both the intertidal and nearshore environments. Invertebrates are an important food source for juvenile PS/GB bocaccio and PS Chinook salmon and for forage fish, prey species of salmonids.

Along with physical loss of habitat, the impacts of nearshore modification include the loss of functions such as filtration of pollutants, floodwater absorption, shading, sediment sources, and nutrient inputs. The greatest impacts to the nearshore are from shoreline armoring; roads and artificial fill are also significant, and these stressors often occur together or with other modifications (Fresh et al. 2011).

Thus, the loss of material below bulkheads, together with the loss of upland sources of material from above the bulkheads, over time, can affect the migration and growth of juvenile salmonids (primarily PS Chinook salmon) by reducing the amount of available shallow habitat that juveniles rely on for food and cover, and by preventing access to habitat upland of bulkheads at high tides.

2.4.4 Effects on Critical Habitat

Critical habitat for PS Chinook salmon, Hood Canal Summer Run chum salmon, PS/GB Bocaccio and PS/GB Yelloweye Rockfish, and SRKWs all occur within the action area. PS steelhead do not have nearshore or marine habitat areas designated as critical. NMFS reviews effects on critical habitat affected by a proposed action by examining how the PBFs of critical habitat will be altered, and 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.

In estuarine and marine areas, the features of designated habitat common to each of these listed species, with the exception of PS steelhead, are (a) water quality and (b) forage or prey. For Chinook and chum salmon (c) safe migration areas are a feature of critical habitat. For juvenile PS/GB bocaccio, and PS Chinook salmon, (d) nearshore habitat with suitable conditions for growth and maturation, including sub-aquatic vegetation, is a feature of critical habitat. Table 20 summarizes by projects the adverse effects to these functions, or credit factors, while Table 24 quantifies the aerial extent (linear footage and square footage) of impacts by structure.

Water Quality

Designated critical habitat for each species will experience temporary, episodic, and enduring declines in water quality (a PBF of Chinook salmon, chum salmon, PS/GB bocaccio, yelloweye, and SRKW habitats).

The *temporary water quality reductions from incidental discharge, increased turbidity and corollary decrease in dissolved Oxygen (DO), and re-suspended contaminants*—are expected to persist with the in-water work period of each project, and then to return to baseline within hours (turbidity and incidental discharge) to days (DO) after work ceases. Based on these factors, the temporary turbidity, incidental discharge, and DO changes from construction related impairment of this PBF will not reduce the conservation value of the habitat for salmon, salmon prey species or rockfish.

Temporary water quality reductions from sound occur during any period in which pile driving, either vibratory or impact, occurs. Sound pressure waves transmitted through the water diminish this habitat for the species that are present and detect this disturbance, by altering the behaviors, or injuring the species (all species addressed in this Opinion), within the affected zone. This reduction in the aquatic habitat value ceases when pile driving stops. The effects of pile driving sound are more fully described in the effects on species section later in this document.

Episodic reductions in water quality that occur with use or maintenance. Increased levels of PAHs, PCBs, and other contaminants re-suspended in the water column will also occur with the removal of creosote material sites such as marinas or commercial wharfs or piers. However, these water quality effects are expected to abate as the contaminated materials settle out, at which point they become persistent in the substrate, which will be described below. Because exposure to such contaminants can have chronic or sublethal effects, this aspect of water quality degradation could temporarily impair the value of critical habitat for growth and maturation of the listed species. Similarly, the frequent episodes of noise in the aquatic environment from vessel use associated with each of the in- and overwater structures is likely to create a chronic condition that reduces the suitability of the habitat for key behaviors necessary for all listed species considered in this Opinion to thrive.

The *enduring effects on water quality* include the chronic and system-wide introduction and extended existence of pollutants from boating activity associated with both commercial and recreational vessels, and upland stormwater, particularly at larger structures (e.g., marinas or commercial wharfs and piers). Increased levels of PAHs, oils, 6PPD-quinone, and other contaminants will be widely dispersed as a result of stormwater runoff effects, and can have detrimental effects at very low levels of exposure either directly to the individual or indirectly through bioaccumulation of these substances from consuming contaminated prey found in their designated critical habitat. Through these direct and indirect pathways, contamination of water quality will impair the value of critical habitat for growth and maturation of each of the listed species.

Accordingly, we consider the combined effects of temporary, episodic, and enduring effects on water quality will create an incremental but chronic diminishment of the water quality PBF for all of the listed species with designated critical habitat in the action area, throughout the new useful life period (40 to 50 years, depending on the structure).

Forage and Prey

Designated critical habitat for each species will experience temporary, episodic, and enduring declines in forage or prey communities (a PBF of Chinook salmon, chum salmon, PS/GB bocaccio, yelloweye and SRKW).

Forage for Fish. Disturbing sediment will simultaneously 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 pile removal or placement, bulkhead construction, removal, or replacement, or vessel prop wash, which can smother benthic prey species, and if the sediments are contaminated, then sublethal toxicity of benthic prey species could occur within 200 feet of these non-dredging activities.

Designated critical habitat will have enduring diminishment of SAV and benthic communities in rearing areas of juvenile PS/GB bocaccio, and migration areas of juvenile salmonids, underneath OWS. We anticipate impacts to SAV and epibenthic forage will be diminished, or fail to establish due to the shade produced by 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. OWS will reduce this PBF of adult and juvenile Chinook salmon, chum salmon, and juvenile PS/GB bocaccio. SAV is important in providing cover and a food base for juvenile PS Chinook salmon, HCSR chum salmon, and juvenile PS/GB bocaccio. OWSs shade SAV (Kelty and Bliven 2003) which creates a reduction to the primary production of SAV beds, and in turn is likely to incrementally reduce the food sources 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. The repeated episodes of disturbance, together with the enduring reduction at the OWS locations, will create an incremental systemic decline in prey, with the potential to increase competition among every cohort of each population of each listed species, with the exception of yelloweye rockfish, and adult PS/GB bocaccio, based on their reliance on deepwater areas where the effects of nearshore development are unlikely to be discernible.

Dredging activities cause a short-term change in the characteristics of the benthic in-faunal biota, of which the majority are expected to recover within a few months to two years after dredging, based on the results of studies in other areas. For example, Romberg et al. (1995), studying a subtidal sand cap placed to isolate contaminated sediments in Elliott Bay, identified 139 species of invertebrates five months after placement of the cap. The benthic community reached its peak population and biomass approximately two and one-half years after placement of the cap, and then decreased, while the number of species increased to 200 as long-lived species recruited to the population (Wilson and Romberg 1996).

Prey for SRKW. For SRKW, discharge events from stormwater would reduce quality and quantity of prey including juvenile Chinook salmon. As PS Chinook salmon are a PBF of SRKW critical habitat, their repeated/chronic exposure to contaminants in successive cohorts, directly through diminished water quality, and via contaminated prey, both described above, results in a diminishment of the forage PBF of SRKW critical habitat. Both quantity and quality of prey will slightly decline as a result of impacts to water quality, as these effects are likely to cause latent health effects on salmon that slightly reduce adult abundance, and also reduce the quality of adult salmon that do return and serve as SRKW prey, due to bioaccumulated contaminants.

Additionally, the critical habitat feature related to prey includes prey quantity, quality, and availability and this analysis also draws on the analysis of the effects on prey to the whales themselves. The proposed action has the potential to affect quantity and therefore availability of prey, but likely little effect on prey quality. We would not expect any impacts from the proposed action on the quality of prey with respect to levels of harmful contaminants. However, as described in section the Environmental Baseline for SRKWs (Section 2.4.3), size and age structure in Chinook salmon has substantially changed across the Northeast Pacific Ocean since the 1970s. Across most of the region, adult Chinook salmon (ocean ages 4 and 5) are becoming smaller, the size of age 2 fish is generally increasing, and most of the Chinook salmon populations from Oregon to Alaska have shown declines in the proportions of age 4 and 5 year olds and an increase in the proportion of 2 year olds (mean age in populations has declined over time) (Ohlberger et al. 2018). Strength of trends varied by region (see above). The declining trend in the proportion of older ages in Washington stocks was observed but slightly weaker than that in Alaska. In a follow-up paper, authors found that reasons for this shift may be largely due to direct effects from size-selective removal by marine mammals and fisheries (Ohlberger et al. 2019a). As noted above, SRKW mainly consume larger (age 3 and older) salmon, and larger fish typically have higher energy content. Ohlberger et al. (2019a) through simulation modeling did find that harvest, in comparison to predation, had a “weaker effect” on the observed changes in Chinook salmon mean body size, and that in the simulations, harvesting alone could not explain changes in size (without predation also) in the past 50 years. The simulations suggested that harvest impacts on size were likely stronger in the earlier period of the simulation and less so in more recent periods as harvest rates have declined while predation has increased, and that size composition may have at least partly recovered with the decline in harvest over the last decades if predation pressure had not increased. Therefore, we would not expect the current level of harvest would appreciably decrease Chinook size (i.e., quality) thereby reducing the conservation value of the prey feature.

Given the total quantity of prey available to SRKWs throughout their range numbers in the millions, the reduction in prey related to short-term construction effects from the proposed action is extremely small. Therefore, NMFS anticipates that the short-term reduction of Chinook salmon from temporary effects would have little effect on SRKWs. However, episodic and enduring declines of SRKW’s prey as a result of the proposed action is also expected. Sufficient quantity, quality, and availability of prey are an essential feature of the critical habitat designated for Southern Residents. Increasing the risk of a permanent reduction in the quantity and availability of prey, and the likelihood for local depletions in prey populations in multiple locations over time, reduces the conservation value of critical habitat for SRKWs.

Migration/Passage

Designated critical habitat will experience enduring incremental diminishment of safe migration for Chinook and Hood Canal Summer run chum salmon. In the marine nearshore, there is substantial evidence that OWS impede the nearshore movements of juvenile salmonids (Heiser and Finn 1970; Able et al. 1998; Simenstad 1999; Southard et al. 2006; Toft et al. 2007). In the Puget Sound nearshore, 35-millimeter to 45-millimeter juvenile chum and pink salmon were reluctant to pass under docks (Heiser and Finn 1970). Southard et al. (2006) snorkeled underneath ferry terminals and found that juvenile salmon were not underneath the terminals at high tides when the water was closer to the structure, but only moved underneath the terminals at low tides when there was more light penetrating the edges. These findings show that overwater-structures can disrupt juvenile migration in the Puget Sound nearshore, reducing the value of the critical habitat for its designated purpose of juvenile salmonid migration in estuarine and nearshore ocean environments.

Maintenance dredging in the nearshore can result in periodic deepening of shallow water migratory corridors for listed juvenile salmonids. This effect could persist for years, depending on how long it takes for the dredge channel to fill back in.

Migration values are not expected to be impaired for PS/GB yelloweye rockfish, PS/GB bocaccio, as these species do not rely on the nearshore area for migration.

The proposed action has the potential to affect passage conditions in SRKW designated critical habitat. Effects of the proposed action include the potential for exposure to the physical presence and sound generated by vessels associated with the proposed action and noise from construction and pile driving activities. The increase in vessel presence and sound in SRKW critical habitat contribute to total effects on passage conditions. However, vessels associated with the proposed action do not target whales and disturbance would likely be transitory, including small avoidance movements away from vessels. The number and spread of vessels is not expected to result in blocking movements of the whales in their travel corridors. Therefore, it is unlikely that any small transitory disturbance from vessels that might occur would have more than a very minor effect on passage in designated critical habitat. Lastly, given all projects that include impact or vibratory pile driving will include a Marine Mammal Monitoring Plan that is sufficient to ensure pile driving ceases before marine mammals enter the area where sound will exceed 120 dB_{RMS}, effects from these activities on passage in SRKW critical habitat is likely minor.

Shoreline Armoring Projects will Reduce Available Nearshore Habitat

Bank armoring degrades sediment conditions, forage base, and access to shallow water waterward of the structures. Armoring also prevents access to forage and shallow water habitat upland of the structures during high tides. Shoreline armoring is extensive in urban areas worldwide, but the ecological consequences are poorly documented. A study by Morley et al. (2012) mapped shoreline armoring along the Duwamish River estuary and evaluated differences in temperature, invertebrates, and juvenile salmon diet between armored and unarmored intertidal habitats. Epibenthic invertebrate densities were over tenfold greater on unarmored shorelines and taxa richness double that of armored locations. Over 66 percent of the Duwamish shoreline is armored, similar to much of south and central Puget Sound, the impacts from armoring, and denying access to potential food sources, can affect overall fish health, growth, and survival.

Degraded sediment condition. As described above, shoreline armoring coarsens sediments waterward of bulkheads by concentrating marine energy and washing away finer sediments. Because bulkheads will be located within the intertidal zone (below HAT), they would prevent upper intertidal zone and natural upper intertidal shoreline processes such as deposition and accumulation of beach wrack (Sobocinski et al. 2010; Dethier et al 2016).

As a result, this would further reduce primary productivity within the intertidal zone and diminish invertebrate populations associated with beach wrack (Sobocinski et al. 2010; Morley et al. 2012; Dethier et al. 2016). Reductions in forage may result from bulkhead effects on primary productivity and invertebrate abundance in the intertidal and nearshore environments. Invertebrates provide an important food source for juvenile PS/GB bocaccio and PS Chinook salmon and for forage fish prey species of salmonids.

The loss of marine shoreline material, over time, can affect the migration areas of juvenile salmonids by reducing the amount of available shallow habitat that juveniles, both by steepening shore areas waterward of bulkheads, and, particularly during high tides, creating a physical barrier that obstructs water from reaching high shore areas.

Critical Habitat Summary

The chronic, episodic, and enduring diminishments of critical habitat created by nearshore in-water and overwater structures to water quality, migration areas, shallow water habitat, forage base, and SAV has and will continue to incrementally degrade the function of critical habitat, for each fish species considered in this analysis with the exception of PS steelhead, which do not have critical habitat designated in the action area. The effects further constrain the carrying capacity for critical life stages (larval and juvenile) for multiple listed species within the action area, reducing conservation values and/or preventing conservation values from being improved.

SRKW critical habitat PBFs of water quality and prey base will be impaired. The continued decline and reduced potential for recovery of the PS Chinook salmon as a PBF of SRKW critical habitat is likely to alter the abundance and distribution of migrating salmon and increase the likelihood of localized depletions in prey, with adverse effects on the SRKWs' ability to meet their energy needs. SRKWs could abandon depleted areas in search of more abundant prey, and end up expending substantial effort only to find depleted prey resources elsewhere. Increasing the risk of a permanent reduction in the quantity and availability of prey, and the likelihood for local depletions in prey populations in multiple locations over time, reduces the conservation value of critical habitat for SRKWs.

In summary, the proposed action, in the useful life period of the projects, reduces available nearshore feeding, rearing and safe migration for juvenile salmon, thereby impacting juvenile salmon survival rates, limiting their life-histories (fry contribution to returning adults Chinook salmon) (Beechie et al. 2017), and ultimately contribute to lower adult salmon returns. This would reduce the potential for recovery of PS Chinook salmon that would likely lead to nutritional stress for SRKW resulting in reduced body size and condition which can also lower reproductive and survival rates. Therefore, poor nutrition from the reduction of prey as a PBF could contribute to additional mortality in this population, and affect reproduction and immune function. This would be a significant reduction in the conservation role of this PBF for SRKWs.

2.4.5 Effects on Listed Species

Effects on listed species is a function of (1) the numbers of animals exposed to habitat changes or effects of an action; (2) the duration, intensity, and frequency of exposure to those effects; and (3) the lifestage at exposure. This section presents an analysis of exposure and response.

As noted above in the effects to critical habitat, the projects have temporary, episodic, and enduring effects. Our exposure and response analysis identifies the multiple life stages of listed species that use the action area, and whether they would encounter these effects, as different life-stages of a species may not be exposed to all effects, and when exposed, can respond in different ways to the same habitat perturbations.

Period of Exposure to Temporary Effects

As described in Section 1.3 (Proposed Action), all in-water work would occur only between July 16 and February 15 in any year the permit is valid.

Juvenile Puget Sound Chinook salmon generally emigrate from freshwater natal areas to estuarine and nearshore habitats from January to April as fry, and from April through early July as larger sub-yearlings. However, juveniles have been found in PS neritic waters between April and November (Rice et al. 2011). The work window avoids peak juvenile Chinook salmon presence from mid-February through mid-July, but does not fully avoid exposure in January through the first half of February. Additionally, a substantial percentage of Chinook salmon rear in Puget Sound without migrating to ocean areas (O'Neill and West 2009).

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 (Goetz et al. 2015). However, steelhead smolts have been found in low abundances in the marine nearshore, outside of their natal estuary, between May and August (Brennan et al. 2004), which overlaps with the in-water work window. Juvenile steelhead will therefore be present in Puget Sound during the early part of the work window, July 15 through August, however, because they enter the Sound after a longer freshwater residency, they are larger and less dependent on nearshore locations where work is going to occur. The proposed work window would minimize overlap of temporary construction effects with the presence in nearshore habitat of juvenile PS steelhead in the action area, but will not avoid all exposure.

Larval and Juvenile Rockfish. Larval rockfish presence peaks twice in the spawning period, once in spring and once in late summer. The in-water work window (July 15 to February 15) that is adhered to for salmon species makes it likely that during the fall spawning period large numbers of larval rockfish, both PS/GB bocaccio and yelloweye, will be exposed to construction effects, and thus exposed to sound and high turbidity and any associated contaminants or low DO.

Juvenile Hood Canal Summer run chum salmon. In late winter, juvenile chum salmon can spend up to one month in estuarine shallow waters (all salinity zones) before moving to the ocean. After leaving estuaries, juveniles may exhibit extended residency within Puget Sound before migrating, and may even overwinter in the sound (Salo 1991, Johnson et al. 1997). Wait et al (2018) show widespread use of nearshore habitat by summer run chum salmon, even at sites that are distant from natal streams. Migration rates of chum salmon in nearshore areas are variable and depend upon fish size, foraging success, and environmental conditions (currents and prevailing winds). Small chum salmon fry (< 50-60 mm) appear to migrate primarily along the shoreline in shallow water less than 2 meters in depth. Use of shallow water habitats relates to predator avoidance and prey availability. When present in shallow water habitats, juvenile chum salmon less than 60 mm consume primarily epibenthic invertebrates, particularly harpacticoid copepods and gammarid amphipods. These epibenthic prey are primarily associated with protected, fine-grained substrates, and often eelgrass, and are especially abundant early in the year in some locations. This suggests that these habitat types are especially important to small, early migrating chum salmon, some of which are presumably summer chum salmon. Exposure is likely among Hood Canal Summer run chum salmon (Fresh 2006).

Juvenile Summary. Because exposure cannot be fully excluded by in-water work timing for juvenile salmonids, juvenile bocaccio, or larval bocaccio and yelloweye, we evaluate other factors influencing potential presence of these fish, and if present, the potential duration of their exposure. Of these species, juvenile Chinook salmon have the longest period of nearshore association (Fresh 2006) and thus, although numbers are expected to be low at any given time, individual salmon are more likely per individual to encounter the short-term construction and enduring structure effects in the intertidal and nearshore area.

Adult salmonids. The presence of adult PS Chinook salmon and PS steelhead in PS overlaps with the proposed in-water construction window. Like adult PS Chinook salmon, adult PS steelhead occupy deep water, generally deeper than the location where the structures are proposed. Thus, we expect the direct habitat effects from the structures to create little exposure or response among adult PS Chinook salmon and PS steelhead as they do not rely on the nearshore. However, some data suggests that up to 70 percent of PS Chinook salmon spend their adult period in Puget Sound without migrating to the ocean (Kagley et al. 2016), suggesting that most adult PS Chinook salmon will experience far reaching effects such as sound from pile driving, vessel noise, some water quality diminishments and reduced prey.

Adult Rockfish. The presence of adult PS/GB bocaccio and yelloweye in the action area is extremely low. Suitable habitat for this lifestage is extremely limited based on preferred habitat depths and features such as rugosity. However, given the ability of this species to move throughout the marine environment, we cannot conclude that they would not ever occur within the action area or during a construction action.

Southern Resident Killer Whales. Between the three pods that comprise this DPS, identified as J, K, and L, some members of the DPS are present in Puget Sound at any time of the year though data on observations since 1976 generally shown that all three pods are in Puget Sound June through September, which means that all are likely present in the designated work window that begins on July 16. 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 Puget Sound from spring through fall. Late arrivals and fewer days present in Puget Sound have been observed in recent years. The likelihood of exposure to the temporary effects of construction are high (Olson et al. 2018).

Species Response to Temporary Effects

Water Quality

In-water work and nearshore work (bulkhead removal, excavation, and construction) would cause short-term and localized increases in turbidity and total suspended solids (TSS), potential declines in DO, and temporary increases in pollutants such as PAHs. For 12 projects, the area of elevated turbidity and TSS levels during construction could extend up to 200 feet radially from each non-dredging project location (12 projects at ~1.4 acre[31] per project equals ~20.8 acres total) during construction, and would return to background levels shortly after the end of construction (hours to days). Three dredging projects could have elevated turbidity and TSS levels during construction that extend up to 300 feet radially from each project location (~3.25 acres/project and ~6.5 acres total).

Fish Species Response

The effects of suspended sediment on fish increase in severity with sediment concentration and exposure time and can progressively include behavioral avoidance and/or disorientation, physiological stress (e.g., coughing), gill abrasion, and death—at extremely high concentrations. Newcombe and Jensen (1996) analyzed numerous reports on documented fish responses to suspended sediment in streams and estuaries, and identified a scale of ill effects based on sediment concentration and duration of exposure, or dose. Exposure to concentrations of suspended sediments expected during the proposed in-water construction activities could elicit sublethal effects such as a short-term reduction in feeding rate or success, or minor physiological stress such as coughing or increased respiration. Studies show that salmonids have an ability to detect and distinguish turbidity and other water quality gradients (Quinn 2005; Simenstad 1988), and that larger juvenile salmonids are more tolerant to suspended sediment than smaller juveniles (Servizi and Martens 1991; Newcombe and Jensen 1996).

Despite being present during a portion of the work window, juvenile PS steelhead are not nearshore dependent and so are not expected to be in the shallow water in large numbers. Those present are expected to be only briefly in the area where elevated suspended sediment would occur (within a 200-foot radius to account for the point of compliance for aquatic life turbidity criteria) and to have strong capacity as larger juveniles to avoid areas of high turbidity. To the degree that there is a contemporary decrease in DO within the same footprint, because steelhead

[31] Because the projects are near the shoreline, only half of an impact circle is in the water and would experience elevated turbidity. We used an area of a semi circle with a 200-foot radius for non-dredging projects and 300-foot radius for dredging projects to determine impacts associated with elevated tubidity and TSS levels.

are expected to have only brief exposure to the affected area, we do not anticipate a significant response to reduced DO. We accordingly consider their exposure to the temporary effects will not be sufficient to cause any injury or harmful behavioral response to juvenile PS steelhead.

Juvenile PS Chinook salmon are likely to be present during in-water construction activities and likely to be exposed to the temporary construction effects, most notably elevated levels of suspended sediment. The proposed minimization measures (i.e. only working in the dry) indicate that TSS levels will be only slightly elevated near the construction area and only during tidal inundations of the site during the project and during the first tidal inundation after completion of the project. Turbidity and TSS levels would return to background levels quickly and be localized to the in-water construction areas (200-foot radius turbidity mixing zone and 300-foot radius for dredging projects). Again, decreased DO is expected to be contemporaneous with and in the same footprint of the suspended sediment. While juvenile PS Chinook salmon are likely to encounter these areas, they can detect and avoid areas of high turbidity, and exposure is expected to be brief. Thus, duration and intensity of exposure of juvenile PS Chinook salmon is also unlikely to cause injury or a harmful response.

While there is little information regarding the habitat requirements of rockfish larvae, other marine fish larvae biologically similar to rockfish larvae are vulnerable to low dissolved oxygen levels and elevated suspended sediment levels that can alter feeding rates and cause abrasion to gills (Boehlert 1984; Boehlert and Morgan 1985; Morgan and Levings 1989). Because the work window will overlap with one peak in larval presence, which is a several month pelagic stage without significant capacity for avoidance behavior (larval rockfish can swim at a rate of roughly 2 cm per second (Kashef et al. 2014) but are likely passively distributed with prevailing currents (Kendall and Picquelle 2003)), we can assume that 15 sites will have areas of high turbidity, and that larvae can be present in significant numbers (PS/GB bocaccio) that will be adversely affected.

Benthic conditions/forage communities

<u>Fish Species Response</u>

For non-dredging projects, the area (~19.2 acres total) in which benthic forage base is temporarily diminished by disturbed substrate is very small, and because benthic prey recruits from adjacent areas via tides and currents, the prey base can re-establish in a matter of weeks. We expect only the cohorts of PS Chinook salmon and PS steelhead that are present in the action area to be exposed to this temporary reduction of prey, and we expect that because prey is abundant in close proximity, feeding, growth, development and fitness of the individuals that are present during this brief habitat disruption from construction would not be affected. Therefore, we consider the temporary effects on any juvenile PS Chinook salmon and PS steelhead in the action area to be unlikely to cause injury at the individual scale.

For dredging projects, the area (~6.5 acres) disruption of normal feeding behaviors in this area is expected to occur for up to two years which is the amount of time expected for the benthic community to recover.

On the other hand, juvenile PS/GB bocaccio feed on the young of other rockfish, surfperch, and jack mackerel in nearshore areas (Love et al. 1991; Leet et al. 1992). Juveniles also eat all life stages of copepods and euphausiids (MacCall et al. 1999). Because juvenile rockfish are less able to access adjacent areas compared with salmon species, reductions in benthic prey communities, and in SAV from disturbance in work areas will reduce available forage for PS/GB bocaccio in their nearshore settlements, reducing growth and fitness of affected individuals at each location.

<u>SRKW Response</u>

The reduction in prey (PS Chinook salmon) from the temporary construction effects of the proposed action is extremely small even when considered across the action area, due to the application of work windows to avoid peak presence of this species at the juvenile life stage and the other reasons discussed above. As mentioned above, diet data suggest that SRKWs are consuming mostly larger (i.e., generally age 3 and up) Chinook salmon (Ford and Ellis 2006). Given the total quantity of prey available to SRKWs throughout their range, this short-term reduction in prey that results from the temporary construction effects is extremely small. It is also likely that only a small percent of impacted juvenile salmon would survive to the age that they would be prey for SRKW. Because the annual reduction is so small, there is also a low probability that any of the Chinook salmon killed from implementation of the proposed action would be intercepted by the killer whales across their vast range in the absence of the proposed action. Therefore, the NMFS anticipates that the short-term reduction of Chinook salmon during construction would have little effect on SRKWs. 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).

Construction Noise

<u>Fish Species Response</u>

A total of six projects (Table 23) include pile driving activities. Only those that have impact pile driving will generate sound loud enough to directly injure or kill fish. Vibratory pile driving can generate noise levels that fish detect and respond to, including above the 150 Db behavioral threshold but well below the thresholds for physical injury (Erbe and McPherson 2017). Fish may exhibit behavioral responses to vibratory driving.

Where piles are to be replaced, the piles may be installed either a vibratory or an impact hammer or a combination of both. When impact driving or proofing steel piles, a bubble curtain or other sound attenuation method will be used to absorb and reduce the energy. Some projects may exclusively use a vibratory hammer to drive the piles. However, in order to ensure that the pile will be able to support the weight of construction equipment or to overcome difficult substrates, applicants may finish driving each pile with an impact hammer.

Pile driving can cause high levels of underwater sound. This noise from impact pile driving can injure or kill fish and alter behavior (Turnpenny et al. 1994; Turnpenny and Nedwell 1994; Popper 2003; Hastings and Popper 2005). Death from barotrauma can be instantaneous or delayed up to several days after exposure. Even when not enough to kill fish, high sound levels can cause sublethal injuries. Fish suffering damage to hearing organs may suffer equilibrium problems, and may have a reduced ability to detect predators and prey (Turnpenny et al. 1994; Hastings et al. 1996). Hastings (2007) determined that a cumulative Sound Exposure Level (cSEL) as low as 183 dB (re: 1 µPa2-sec) was sufficient to injure the non-auditory tissues of juvenile spot and pinfish with an estimated mass of 0.5 grams.

Cumulative SEL is a measure of the sound energy integrated across all of the pile strikes. The Equal Energy Hypothesis, described by the NMFS (2007b), is used as a basis for calculating cumulative SEL. The number of pile strikes is estimated per continuous work period. This approach defines a work period as all the pile driving between 12-hour breaks. NMFS uses the practical spreading model to calculate transmission loss (NMFS 2020h). In 2008, the Fisheries Hydroacoustic Working Group (FHWG) developed interim criteria to minimize potential impacts to fishes (FHWG 2008). The interim criteria identify the following thresholds for the onset of physical injury using peak sound pressure level (SPL) and cSEL:

- Peak SPL: levels at or above 206 dB from any hammer strike; and
- cSEL: levels at or above 187 dB for fish sizes of 2 grams or greater, or 183 dB for fish smaller than 2 grams.

Adverse effects on survival and fitness can occur even in the absence of overt injury. Exposure to elevated noise levels can cause a temporary shift in hearing sensitivity (referred to as a temporary threshold shift), decreasing sensory capability for periods lasting from hours to days (Turnpenny et al. 1994; Hastings et al. 1996). Popper et al. (2005) found temporary threshold shifts in hearing sensitivity after exposure to cSELs as low as 184 dB. Temporary threshold shifts reduce the survival, growth, and reproduction of the affected fish by increasing the risk of predation and reducing foraging or spawning success.

We cannot predict the 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 will experience sublethal effects, such as temporary threshold shifts, or behavior responses to underwater noise for each of the projects that includes pile driving.

The above-discussed criteria specifically address fish exposure to impulsive sound. Stadler and Woodbury (2009) make it clear that the thresholds likely overestimate the potential for impacts on fish from non-impulsive sounds (e.g., vibratory pile driving). Non-impulsive sounds have less potential to cause adverse effects in fish than impulsive sounds. Impulsive sources cause short bursts of sound with very fast rise times and the majority of the energy in the first fractions of a second. Whereas, non-impulsive sources cause noise with slower rise times and sound energy that is spread across an extended period of time; ranging from several seconds to many minutes in duration. Regarding noise from boat motors, 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).

With regard to vibratory driving and noise from construction vessels, the behavioral effects from anthropogenic sound exposure remains poorly understood for fishes, especially in the wild. NMFS applies a conservative threshold of 150 dB rms (re 1 μPa) to assess potential behavioral responses of fishes from acoustic stimuli. Fewtrell (2003) observed fish exposed to air gun noise exhibited alarm responses from sound levels of 158 to 163 dB (re 1 μPa). More recently, Fewtrell and McCauley (2012) exposed fishes to air gun sound between 147-151 dB SEL and observed alarm responses in fishes.

Work windows are generally designed to prevent work from occurring during peak presence of salmonids, but do not guarantee that exposure will not occur. Juvenile Chinook salmon will have the most exposure due to their extensive use of nearshore habitats. Juvenile chum salmon also depend on estuarine and nearshore habitats, but they migrate more rapidly out of Puget Sound. Adult Chinook salmon, adult and juvenile steelhead, and adult chum salmon make little use of nearshore habitats, and will be exposed to injurious levels of underwater sound in very small numbers. Larval yelloweye rockfish and larval and juvenile PS/GB bocaccio will also be exposed in uncertain numbers. During the in-water work window (July 16 to February 15), all exposed PS Chinook salmon, PS steelhead, and adult HCSR chum salmon individuals will be at least two grams, which reduces the likelihood of lethal response. Larval rockfish, younger juvenile PS/GB bocaccio, and younger chum salmon will be less than two grams, making them more vulnerable to lethal response.

We cannot estimate the number of individuals from any species that will experience adverse effects from underwater sound, nor predict the specific responses among the fish exposed. Not all exposed individuals will experience adverse effects, some will experience sublethal effects, such as temporary threshold shifts, some merely behavior responses such as startle. Physical injury from barotrauma, and death are also possible. However, because the projects will occur across a variety of locations in Puget Sound, we anticipate that multiple individual fish from multiple populations of the various species will be adversely affected, up to and including death of some individuals.

SRKW Response

SRKWs could be injured or disturbed by sound pressure generated by pile driving. NMFS uses conservative thresholds of sound pressure levels from broad band sounds that cause behavioral disturbance (160dBrms re: 1μPa for impulse sound and 120 dBrms re: 1μPa for continuous sound) and injury (for impulsive: peak SPL flat weighted 230 dB, weighted cumulative SEL 185 dB; for non-impulsive: weighted cumulative SEL 198 dB) (NMFS 2018). However, criteria for monitoring and stop-work on sighting of SRKW is intended to ensure that SRKW will not experience duration or intensity of pile driving, either impact or vibratory, that would result in disturbance or harm to any individual of this species. Per the best management practices listed in Section 1.3 the following permits are assumed to have a Marine Mammal Monitoring Plan

(MMMP) that would detect listed marine mammals before they would come into a zone on behavioral impact: NWS-2020-54-WRD, NWS-2018-1183, NWS-2019-962, NWS-2019-897, NWS-2019-1032, and NWS-2019-682. SRKW response to vessel noise (whether it be barges, personal power boats, or shipping freights) are discussed in more detail below.

Species Response to Intermittent and Enduring Effects

As was described in the effects to critical habitat section above, the proposed structures would cause an array of negative impacts to intertidal and nearshore habitat availability and function, along with more system-wide detriments associated with the use of the structures. Once repaired, replaced, or newly constructed, the structures would be expected to remain in the aquatic environment for a 40- to 50-year useful life period. Thus, multiple cohorts of the multiple populations of PS Chinook salmon, PS steelhead, Hood Canal Summer run chum salmon, PS/GB bocaccio rockfish, PS/GB Yelloweye rockfish, and SRKW would experience the long-term habitat modifications associated with the presence of the structures.

Effects on listed species is a function of: (1) the numbers of fish exposed to habitat changes or direct effects of an action; (2) the duration, intensity, and frequency of exposure to those effects; and (3) the life stage at exposure. This section presents an analysis of exposure and response both to habitat effects, and some effects that occur directly on species.

Response to Water Quality Reductions—Suspended Sediments

Fish Species Response

A total of 6 (Table 5) projects will support vessel transit to and from ports, marinas, docks and piers. On-going and chronic increases in turbidity and TSS levels associated with propwash can occur at any time, in multiple PS locations, and are not constrained to periods when species presence or vulnerable life stages are low. For this reason, individual juvenile and adult salmonids, larval rockfish, and juvenile PS/GB bocaccio are all likely to be exposed at any time, and multiple exposures at individual and population scales are reasonably expected.

The effects of suspended sediment on fish increase in severity with sediment concentration and exposure time and can progressively include behavioral avoidance and/or disorientation, physiological stress (e.g., coughing), gill abrasion, and death (at extremely high concentrations). Newcombe and Jensen (1996) analyzed numerous reports on documented fish responses to suspended sediment in streams and estuaries, and identified a scale of ill effects based on sediment concentration and duration of exposure, or dose. Exposure to concentrations of suspended sediments expected during the proposed in-water construction activities could elicit sublethal effects such as a short-term reduction in feeding rate or success, or minor physiological stress such as coughing or increased respiration. Studies show that salmonids have an ability to detect and distinguish turbidity and other water quality gradients (Quinn 2005; Simenstad 1988), and that larger juvenile salmonids are more tolerant to suspended sediment than smaller juveniles (Servizi and Martens 1991; Newcombe and Jensen 1996).

We cannot estimate the number of individuals that will experience adverse effects from suspended sediment with any meaningful level of accuracy. We cannot predict the number or duration of each pulse of sediment, nor the number of individual fish that will be exposed to each pulse. Furthermore, not all exposed individuals will experience direct adverse effects. We expect that some individuals of listed fish species will experience sublethal effects such as stress and reduced prey consumption, some may respond with avoidance behaviors, and some may be injured. Those that engage in avoidance behaviors or with raised cortisol levels may have decreased predator detection and avoidance. Consistent with our analytical approach in this Opinion, these impacts are considered coextensive with the effects of the repaired, replaced or new OWS themselves (see *Response to Habitat Disruptions from In-Water and Overwater Structures* below).

Because the distribution of projects occurs across Puget Sound, and the nature of sediment delivery is episodic and chronic, we expect sediment impacts would adversely affect all listed fish species at multiple life stages, with the exception of adult PS/GB bocaccio, and juvenile and adult PS/GB yelloweye rockfish.

Response to Water Quality Reduction—Reduced Dissolved Oxygen

At stated above, increases of TSS can also produce localized reductions in DO. Sub-lethal effects of DO levels below saturation can include metabolic, feeding, growth, behavioral, and productivity effects. Behavior responses can include avoidance and migration disruption (NOAA Fisheries 2005). These effects are likely to occur contemporaneously with a subset of the events described above. As such it is expected that low DO exposure will occur in multiple locations each year, and will adversely affect multiple listed fish species at multiple life stages with the exception of adult PS/GB bocaccio, and juvenile and adult PS/GB yelloweye rockfish.

Response to Water Quality Reduction—Contaminants

<u>Fish Species Response</u>

Increased stormwater discharge. For two projects (Table 19), polluted stormwater will be discharged to the Puget Sound (~ 7,587 acres (Table 31) of pollution generating impervious surface (PGIS) that would not occur but for the proposed permit). Stormwater can discharge at any time of year, with the potential to expose individual PS Chinook salmon (juvenile and adult), and PS/GB bocaccio and yelloweye (larval, juvenile, and adult) within this action area. All stormwater discharge is expected to contain concentration levels of constituents and chemical mixtures that are toxic to fish and aquatic life (NMFS 2012, or "Oregon Toxics Opinion"). The Oregon Toxics Opinion concluded that for chronic saltwater criteria for metal compounds, fish exposed to multiple compounds, versus a single compound exposure, are likely to suffer toxicity greater than the assessment effects (e.g., 50 percent mortality) including mortality, reduced growth, impairment of essential behaviors related to successful rearing and migration, cellular trauma, physiological trauma, and reproductive failure.

The highest concentration levels are expected to occur at the point of discharge and will begin to dilute as the stormwater discharges into the Puget Sound. The effects of the dilution will be such that individual copper, lead and zinc levels and the chemical mixtures in the discharge will be indistinguishable from background levels.

Concentration levels and toxicity of chemical mixtures will also be seasonally affected. First-flush rain events after long antecedent dry periods (periods of no rain) that most typically occur in September are also expected to have extremely high levels of copper, lead, zinc, and tire particles. Higher concentrations are also expected to occur between March and October in any given year—as there will be longer dry periods between storm events. However, the occurrence of these events will occur with less frequency. Most discharge will occur between October and March, concurrent with when the region will receive the most rain.

Low levels of copper have been shown to cause olfactory impairment in juvenile coho salmon, affecting their predator avoidance and survivial (McIntyre et al. 2012). In an examination of effects on juvenile salmon, McIntyre et al. (2015) exposed sub yearling coho salmon to urban stormwater. One hundred percent of the juveniles exposed to untreated highway runoff died within 12 hours of exposure. McIntyre et al. (2018) later examined the prespawn mortality rate of coho salmon exposed to urban stormwater runoff. In their experiments, one hundred percent of coho salmon exposed to stormwater mixtures expressed abnormal behavior (lethargy, surface respiration, loss of equilibrium, and immobility) within 2 to 6 hours after exposure. Recent studies have shown that coho salmon show high rates of pre-spawn mortality when exposed to chemicals that leach from tires (McIntyre et al. 2015). Researchers have recently identified a tire rubber-derived chemical, 6PPD-quinone, as the cause (Tian et al. 2020). Coho salmon are extremely sensitive to 6PPD-quinone, more so than most other known contaminants in stormwater (Scholz 2011; Chow 2019; Tian et al. 2020). Although Chinook salmon 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, polycyclic aromatic hydrocarbons (PAHs), fire retardants, and emissions that have been linked to deformities, injury and/or death of salmonids and other fish (Trudeau 2017; Young et al. 2018).

We cannot estimate the number of individuals that will experience adverse effects from exposure to stormwater effects of this action with any meaningful level of accuracy. We cannot predict the number or duration of each pulse of discharge events, nor the number of individual fish that will be exposed during those events. Furthermore, not all exposed individuals will experience immediate adverse effects. We expect that every year some individual PS Chinook salmon (juvenile and adult), PS steelhead (juvenile and adult), and PS/GB bocaccio and yelloweye (larval, juvenile, and adult) will experience sublethal effects such as stress and reduced prey consumption, some may respond with avoidance behaviors that disrupt feeding and migratory behavior, and some may experience reduced growth, impairment of essential behaviors related to successful rearing and migration, cellular trauma, physiological trauma, reproductive failure, and mortality.

Creosote. A total of 8 proposed projects (Table 21) will remove creosote-treated piles and other creosote-treated timber. Creosote-treated piles contaminate the surrounding sediment up to two meters away with PAHs (Evans et al. 2009). The removal of the creosote-treated piles mobilizes these PAHs into the surrounding water and sediments (Smith et al. 2008; Parametrix 2011).

Projects can also release PAHs directly from creosote-treated timber during the demolition of overwater timber and if any of the piles break during removal (Parametrix 2011). The concentration of PAHs released into surface water rapidly dilutes. Smith et al. (2008) reported concentrations of total PAHs of 101.8 μg/l 30 seconds after creosote-pile removal and 22.7 μg/l 60 seconds after. However, 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.

Because they are shoreline-oriented and spend a greater amount of time within the action area, juvenile Chinook salmon will have the highest probability of exposure to PAHs. Juvenile chum salmon also depend on estuarine and nearshore habitats, but they migrate more rapidly out of Puget Sound. We cannot discount the probability of adult and juvenile steelhead and adult Chinook and chum salmon exposure. Larval and juvenile PS/GB bocaccio and larval yelloweye rockfish could also be exposed. We cannot predict the number of fish that will be exposed to PAHs. The numbers of each species within the action area varies year to year. NMFS also cannot, with any meaningful level of accuracy, estimate the proportion of fish each year that will enter the impact zones. The magnitude of the exposure among some fish will greatly increase during the removal of these structures. We expect increased PAHs in the water column and sediments will remain within the area of increased suspended sediment caused by the project within 200 feet of creosote pile removal and structure demolition, and we do not expect fish to engage in avoidance behaviors within this area once suspended sediment from construction effects have dropped to baseline levels. Within three years after construction, the removal of the creosote-treated timber will begin to reduce PAH levels (Romberg 2005) and thus exposure of listed-fish, and exposure to PAHs at these sites would continue to decline over the long-term.

Vessels. Species will also be exposed to contaminants in oils and fuels, and PAHs from vessel operations, whether commercial or recreational, that transit to and from marinas, piers, wharfs, docks, floats, or boat ramps. These exposures are likely to be highest in the areas where use is concentrated, and more dilute throughout the remainder of the Sound where the vessels transit. Many individuals within each cohort of each species will be exposed annually via exhaust and incidental introduction of fuels and oils from vessels. These impacts are considered coextensive with the presence of the OWS themselves (see *Response to Habitat Disruptions from In-Water and Overwater Structures* below).

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). Fish rapidly uptake PAHs through their gills and food but also efficiently remove them from their body tissues (Lee and Dobbs 1972; Neff et al. 1976). Juvenile Chinook salmon prey, including amphipods and copepods, uptake PAHs from contaminated sediments (Landrum and Scavia 1983; Landrum et al. 1984; Neff 1982). Varanasi et al. (1993) found high levels of PAHs in the stomach contents of juvenile Chinook salmon in the Duwamish estuary. The primary response of exposed 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 (*O. 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. Of the listed fish exposed to PAHs and other contaminants, all are likely to have some degree of immunosuppression and reduced growth, which, generally, increases the risk of death.

SRKW Response

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. Water quality impaired by contaminants can inhibit reproduction, impair immune function, result in mortalities, or otherwise impede the growth and the species' recovery. The proposed action exposes SRKW to contaminants.

SRKW can be exposed to contaminants directly (e.g., oil spills), or indirectly when their prey are contaminated through exposure to reduced water quality. For example, Chinook salmon contain higher levels of some persistent pollutants than other salmon species comparingthe limited information available for pollutant levels in Chinook salmon (Krahn et al. 2007; O'Neill and West 2009; Veldhoen et al. 2010; Mongillo et al. 2016). These harmful pollutants, through consumption of prey species that contain these pollutants, are stored in the killer whale's blubber and can later be released; when the pollutants are released, they are redistributed to other tissues when the whales metabolize the blubber in response to food shortages or reduced acquisition of food energy that could occur for a variety of other reasons. The release of pollutants can also occur during gestation or lactation. Once the pollutants mobilize 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 Southern Residents and result in adverse health effects.

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). Southern Residents are exposed to a mixture of pollutants, some of which may interact synergistically and enhance toxicity, influencing their health. High levels of these pollutants have been measured in blubber biopsy samples from Southern Residents (Ross et al. 2000; Krahn et al. 2007; Krahn et al. 2009), and more recently, these pollutants were measured in fecal samples collected from Southern Residents (Lundin et al. 2016a; Lundin et al. 2016b).

It is expected that SRKW prey species in the action area (i.e., PS Chinook salmon) will be exposed to and bio-accumulate contaminants through TSS, creosote pile removal and storm water discharge (a pathway for exposure of persistent pollutants such as PCBs). The majority of SRKWs have high levels of PCBs (Ross et al. 2000; Krahn et al. 2007, 2009) that exceed a health-effects threshold (17,000 ng/g lipid) derived by Kannan et al. (2000) and Ross et al. (1996) for PCBs in marine mammal blubber. The PCB health-effects threshold is associated with reduced immune function and reproductive failure in harbor seals (Reijnders 1986; de Swart et al. 1996; Ross et al. 1996; Kannan et al. 2000). Moreover, juvenile SRKWs have blubber concentrations that are currently 2 to 3.6 times higher than the established health-effects threshold (Krahn et al. 2009).

Since the contaminant exposure is considered to be chronic and on-going, it is also expected SRKWs will consume at least some of the exposed and contaminated fish, adversely impacting SRKW health and fitness. The proposed action reduces the time until persistent pollutants (e.g., PCBs from stormwater) will surpass a health-effects threshold (i.e., PCB accumulation over the lifetime of a killer whale will occur more rapidly with the action than without it). Increasing persistent pollutant levels in the whales further exacerbates their current susceptibility to adverse health effects.

Response to Water Quality Reduction—Vessel Noise

Over the last 150+ years, 4.5 million people have settled in the Puget Sound region. With the level of infrastructure development associated with this population growth in the Puget Sound, the number of personal watercraft is on the rise (Washington Coast Economist Recreational Boat Fleet Website, https://sites.google.com/uw.edu/wacoasteconomist/dashboards/recreational-boat-fleet; Puget Sound Partnership 2021, https://vitalsigns.pugetsoundinfo.wa.gov/VitalSignIndicator/Detail/42) while the number of commercial vessels transiting in Puget Sound has remained consistent overall (WDOE 2021). A concomitant increase in underwater noise has been reported in several regions around the globe. Given the important role sound plays in the life functions of marine mammals, research on the potential effects of vessel noise has grown—in particular since the year 2000. Studies have been patchy in terms of their coverage of species, habitats, vessel types, and types of impact investigated. The documented effects include behavioral and acoustic responses, auditory masking, and stress (Erbe et al. 2019). Small crafts with high-speed engines and propellers generally produce higher frequency sound than large vessels (Erbe 2002, Erbe et al. 2013). Large vessels, including the cruise ships and tour vessels, generate substantial low frequency noise (Arveson and Vendittis 2000). Studies have shown that underwater-radiated noise from commercial ships may have both short and long-term negative consequences on marine life, especially marine mammals.

Fish Species Response

The increase in noise related to commercial vessel traffic and recreational boating caused by the proposed action is likely to adversely affect Chinook salmon, HCSR chum salmon, steelhead, and rockfish. 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 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 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).

We expect juvenile and adult life history stages of Chinook salmon, HCSR chum salmon, steelhead, will be exposed; larval and juvenile PS/GB bocaccio will be exposed to noise from vessels. Each species at each of these life stages will experience sublethal physiological stress. Adult PS/GB bocaccio, and all lifestages of yelloweye are not expected to experience stressful levels of noise from vessels because these species/lifestages occur along the sea floor in deep water, where we expect noise to attenuate to lower sound pressure levels.

Some fish that encounter boating 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 following that response.

Taken together, it can be assumed that juvenile salmonids are likely to respond to episodes of motor boat noise with a stress and startle reaction that can diminish both predator and prey detection for a short period of time with each episode. Because of the intermittent nature of the disturbance and the ability for fish to recuperate when it occurs, we do not expect this effect to be meaningful to survival in adult or juvenile fish in every location where they encounter noise from recreational boating, though growth and fitness could be slightly diminished if they encounter frequent episodes of boat noise, such as at marinas, public boat launches, or commercial piers or wharfs.

As described in the baseline section, commercial and recreational vessel traffic occurs throughout Puget Sound. We expect all life history stages of Chinook salmon, HCSR chum salmon, steelhead, and juvenile PS/GB bocaccio will be exposed to vessel traffic and will experience sublethal physiological stress. Given that adult yelloweye rockfish occur along the sea floor in deep water, we do not expect adult PS/GB bocaccio and yelloweye rockfish to be affected by noise from vessel traffic.

SRKW Response

The proposed action will result in vessel use and noise as described in the Environmental Baseline Section 2.3. While larger tanker-type industrial vessels can generate sound that is detectable within the range of the SRKW, and the co-occurrence of SRKW and transiting ships is expected to be short-term and transitory, such that we do not expect to be able to meaningfully detect a measurable impact from large vessel traffic.

Vessels used for a variety of purposes (commercial shipping, military, recreation, fishing, whale watching and public transportation) occur in inland waters of the SRKW's range. 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)). These studies concluded that vessel traffic may affect foraging efficiency, communication, and/or energy expenditure through the physical presence of the vessels, underwater sound created by the vessels, or both. Collisions of killer whales with vessels are rare, but remain a potential source of serious injury and mortality, although the true effect of vessel collisions on mortality is unknown.

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

Recently, there have been several studies that have characterized sound from ships and vessels as well as ambient noise levels in the inland waters (Bassett et al. 2012; McKenna et al. 2013; Houghton et al. 2015; Veirs et al. 2016; Holt et al. 2017, Joy et al. 2019). Bassett et al. (2012) assessed ambient noise levels in northern Admiralty Inlet (a waterway dominated by larger vessels). They found that vessel activity contributed most to the variability measured in the ambient noise and cargo ships contributed to the majority of the vessel noise budget. However, noise from smaller vessels may affect mid- and high-frequency cetaceans because their energy is concentrated at higher frequencies than commercial ships (Erbe 2002). Veirs et al. (2016) estimated sound pressure levels for larger ships that transited through the Haro Strait, and found that the received levels were above background levels, and that underwater noise from ships extends up to high frequencies similar to noise from smaller boats. Commercial shipping was also identified as a significant source of low frequency ambient noise in the ocean, which has long-range propagation and therefore can be heard over long distances. Additionally, over the past few decades the contribution of shipping to ambient noise has increased by as much as 12dB (Hildebrand 2009). Ship noise was identified as a concern because of its potential to interfere with SRKWs communication, foraging, and navigation (Veirs et al. 2016). In a study that measured ambient sound in a natural setting, SRKWs increased their call amplitude in a 1:1 dB ratio with louder background noise, which corresponded to increased vessel counts (Holt et al. 2009) (Holt et al. 2009). It should be noted that vessel speed also strongly predicts received sound levels by the whales (Holt et al. 2017). Holt et al. (2021a) found that the probability of capturing prey for SRKW increased as salmon abundance increased, but decreased as vessel speed increased. SRKW made longer dives to capture prey and descended more slowly during these foraging dives while vessels emitted navigational sonar, Whales descended more quickly when noise levels were higher and vessel approaches were closer. Further, Holt et al. (2021b) found a sex and vessel distance effect on these foraging dives, suggesting that females and males respond differently to nearby vessels with female killer whales at greater risk to close approaches by vessels. These studies provide evidence of behavioral responses by SRKW resulting from vessels and noise in the Puget Sound. Although there are several vessel characteristics that influence noise levels, vessel speed appears to be the most important predictor in source levels (McKenna et al. 2013; Houghton et al. 2015; Veirs et al. 2016; Holt et al. 2017), and reducing vessel speed would likely reduce these documented acoustic exposure effects to SRKWs.

In 2017, the Vancouver Fraser Port Authority conducted a voluntary slow-down trial through Haro Strait (Joy et al. 2019). They determined that a speed limit of 11 knots would achieve positive noise reduction results without compromising navigational safety through the Strait. Hydrophones were deployed at sites adjacent to the northbound and southbound shipping lanes to measure noise levels through the trial period from August to October. During that period, 61 percent of piloted vessels, including bulk carriers, tugs, passenger vessels, container ships, and tankers, participated in the trial by slowing to 11 knots through the Strait. When compared to the pre-trial control period, the acoustic intensity of ambient noise in important SRKW foraging habitat off the west coast of San Juan Island was reduced by as much as 44% (corresponding to a 2.5 dB reduction in median sound pressure level) when vessels slowed down through Haro Strait (Joy et al. 2019). The results of this in situ trial show that vessel speed can be an effective target for the management of vessel impacts.

Recent evidence indicates there is a higher energetic cost of surface-active behaviors and vocal effort resulting from vessel disturbance in the Salish Sea (Williams 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 British Columbia's inland waters in the presence of vessels resulted in an approximate 3% increase in energy expenditure compared to when vessels are not present. Other studies measuring metabolic rates in captive dolphins have shown these rates can increase during the more energetically costly surface behaviors (Noren et al. 2012) that are observed in killer whales in the wild, as well as during vocalizations and the increased vocal effort associated with vessels and noise (Noren et al. 2013; Holt et al. 2015). These studies that show an increase in energy expenditure during surface active behaviors and changes in vocal effort may negatively impact the energy budget of an individual, particularly when cumulative impacts of exposure to multiple vessels throughout the day are considered.

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). SRKWs spent 17 to 21 percent less time foraging in inland waters in the presence of vessels for 12 hours, depending on vessel distance (see Ferrara et al. 2017). Although the impacts of short-term behavioral changes on population dynamics is unknown, it is likely that because SRKWs are exposed to vessels the majority of daylight hours they are in inland waters, and that the whales in general spend less time foraging in the presence of vessels, there may be biologically relevant effects at the individual or population-level (Ferrara et al. 2017).

The Be Whale Wise viewing guidelines and the 2011 federal vessel regulations (www.bewhalewise.org) were designed to reduce behavioral impacts, acoustic masking, and risk of vessel strike to SRKWs in inland waters of Washington State. Since the regulations were codified, there is some evidence that the average distance between vessels and the whales has increased (Houghton 2014; Ferrara et al. 2017). The majority of vessels in close proximity to the whales are commercial and recreational whale watching vessels and the average number of boats accompanying whales can be high during the summer months (i.e., from 2013 to 2017 an average of 12 to 17 boats;(Seely 2016)). The average number of vessels with the whales decreased 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). In 2019, the annual maximum number of total vessels observed in a ½ mile radius of the whales was 29, which was the lowest maximum number of vessels recorded by Soundwatch (Frayne 2021), the maximum in 2020 was 39 (Frayne 2021). However, fishing vessels are also found in close proximity to the whales and vessels that were actively fishing were responsible for 7% of the incidents inconsistent with the Be Whale Wise Guidelines and federal regulations in 2020 (Frayne 2021). In 2020, 92% 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% private sailing vessels, 3% U.S. commercial vessels, <1% commercial kayaks, <1% Canadian commercial vessels (possibly related to closures due to COVID-19 orders) and <1% by commercial fishing vessels (Frayne 2021). An overall decrease in incidents was recorded in 2020, but incidents by private recreational vessels increased as the season progressed possibly in response to reductions in COVID-19 restrictions. These incidents 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 by a variety of partners to further reduce vessel disturbance (Ferrara et al. 2017).

Anthropogenic (human-generated) sound in inland waters is generated by other sources beside vessels, including construction activities, and military operations. For example, Kuehne et al. (2020) reported measurements of underwater noise associated with military aircraft using a hydrophone deployed near a runway off Naval Air Station (NAS) Whidbey Island, WA. The average of the underwater received levels detected was 134 ± 3dB re 1µPa. The frequency of the sound from these overflights ranged from 20 Hz to 30 kHz, with a peak between 200 Hz and 1 kHz. However, these peak levels are well below the best hearing sensitivity of the whales reported by Branstetter et al. (2017) to be between 20 and 60 kHz. Natural sounds in the marine environment include wind, waves, surf noise, precipitation, thunder, and biological noise from other marine species. The intensity and persistence of certain sounds (both natural and anthropogenic) in the vicinity of marine mammals vary by time and location and have the potential to interfere with important biological functions (e.g., hearing, echolocation, communication), that may impact ability to access prey.

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

The proposed action has one true residential project and seven commercial, emergency vessel, or marina type projects that will support the continued use of mooring facilities throughout the Salish Sea. Based on recent satellite imagery and project plans submitted to NMFS, the total number of slips/moorages associated with the proposed action is approximately 495. The lengths of vessels currently moored at project locations range from 16 to 114 ft, with an average vessel length of approximately 38 ft. The largest project will repair and replace structures associated with the mooring of 360 vessels. We expect that the size of vessels using these facilities will remain constant following project completion.

Smaller fishing, recreational and commercial vessels 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 (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- to 400-yard approach limits, 7 knots or less speed within ½ nautical mile of the whales). Additionally, NMFS and other partners have outreach programs in place to educate vessel operators on how to avoid impacts to whales. As a result, we expect that any vessels in the vicinity of SRKWs are not likely to disrupt normal behavioral patterns nor have the potential to disturb by causing disruption of behavioral patterns.[32]

Response to Habitat Disruptions from In-Water and Overwater Structures

<u>Fish Species Response</u>

Migration Disruption. In and overwater structures cause delays in migration for PS Chinook salmon from disorientation, fish school dispersal (resulting in a loss of refugia), and altered migration routes (Simenstad 1999). Juvenile salmonids stop at the edge of the structures and avoid swimming into their shadow or underneath them (Heiser and Finn 1970; Able et al. 1998; Simenstad 1988; Southard et al. 2006; Toft et al. 2013). Swimming around structures lengthens the migration distance and is correlated with increased mortality. Anderson et al. (2005) found migratory travel distance rather than travel time or migration velocity has the greatest influence on the survival of juvenile spring Chinook salmon migrating through the Snake River 2005.

Juvenile salmon, in both the marine nearshore and in freshwater, migrate along the edge of shadows rather than through them (Nightingale and Simenstad 2001b; Southard et al. 2006; Celedonia et al. 2008a; Celedonia et al. 2008b; Moore et al. 2013; Munsch et al. 2014). In

[32] No 'take' as defined in the ESA or MMPA, of SRKWs, is expected to result from vessel-related impacts.

freshwater, about three-quarters of migrating Columbia River fall Chinook salmon smolts avoided a covered channel and selected an uncovered channel when presented with a choice in an experimental flume setup (Kemp et al. 2005). 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 the marine nearshore, there is also substantial evidence that OWS impede the nearshore movements of juvenile salmonids (Heiser and Finn 1970; Able et al. 1998; Simenstad 1999; Southard et al. 2006; Toft et al. 2007). In the Puget Sound nearshore, 35-millimeter to 45-millimeter juvenile chum and pink salmon were reluctant to pass under docks (Heiser and Finn 1970). Southard et al. (2006) snorkeled underneath ferry terminals and found that juvenile salmon were not underneath the terminals at high tides when the water was closer to the structure, but only moved underneath the terminals at low tides when there was more light penetrating the edges. These findings show that overwater-structures disrupt juvenile migration in the Puget Sound nearshore. Juvenile Chinook and juvenile HCSR chum salmon migrate along shallow nearshore habitats, and OWSs willdisrupt their migration and increase their predation risk. Every juvenile Chinook and juvenile HCSR chum salmon will encounter OWSs during their out-migration, and because the projects in this consultation are across Puget Sound, these structures ill continue to be part of that migration disruption for fish in every year that they are present in the marine environment. Adult Chinook salmon, adult and juvenile steelhead, adult chum salmon, and juvenile PS/GB bocaccio do not migrate along shallow nearshore habitats. Therefore, OWS will not obstruct their movements.

Increased Predation Risk. An implication of juvenile salmon avoiding OWS is that some of them will swim around the structure (Nightingale and Simenstad 2001b). This behavioral modification will cause them to temporarily utilize deeper habitat, thereby exposing them to increased piscivorous predation. Hesitating upon first encountering the structure, as discussed, also exposes salmonids to avian predators that may use the floating structures as perches. Typical piscivorous juvenile salmonid predators, such as flatfish, sculpin, and larger juvenile salmonids, being larger than their prey, generally avoid the shallowest nearshore waters that outmigrant juvenile salmonids prefer—especially in the earliest periods of their marine residency. When juvenile salmonids temporarily leave the relative safety of the shallow water, their risk to being preyed upon by other fish increases. This has been shown in the marine environment where juvenile salmonid consumption by piscivorous predators increased fivefold when juvenile pink salmon were forced to leave the shallow nearshore (Willette 2001).

Further, swimming around OWS lengthens the salmonid migration route, which has been shown to be correlated to increased mortality. Migratory travel distance rather than travel time or migration velocity has been shown to have the greatest influence on survival of juvenile spring Chinook salmon migrating through the Snake River (Anderson et al. 2005). In summary, NMFS assumes that the increase in migratory path length from swimming around OWS as well as the increased exposure to piscivorous predators in deeper water likely will result in proportionally increased juvenile PS Chinook and HCSR chum salmon mortality.

Habitat modifications resulting from anthropogenic infrastructure, including over water structures (dams, bridges, locks), have been shown to inhibit movement of migrating salmon and cause unnaturally large aggregations. The aggregation of salmon has shown an increase in mortalities due to predation by marine mammals (Jeffries and Scordino 1997, Keefer et al. 2012, Moore et al. 2013).

Decreased Prey and Cover. OWS and associated boat use adversely affects SAV, if present. SAV is important in providing cover and a food base for juvenile PS Chinook salmon, HCSR chum salmon, PS steelhead, and juvenile PS/GB bocaccio. Bax et al. (1978) determined the abundance of chum salmon fry was positively correlated with the size of shallow nearshore zones, and sublittoral eelgrass beds have been considered to be the principal habitat utilized by the smaller. Overwater structures shade SAV (Kelty and Bliven 2003). Additionally, the turbidity from boat propeller wash decreases light levels (Eriksson et al. 2004). 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.

Fresh et al. (2006a) researched the effects of grating in residential floats on eelgrass, a substrate for herring spawning, and a Chinook salmon forage species. They reported a statistically significant decline in eelgrass shoot density underneath six of the 11 studied floats in northern Puget Sound. However, the physiological pathways that result in the reduction in shoot density and biomass from shading applies to all SAV. Thus, it is reasonable to assume that shading from OWS adversely affects all SAV. A reduction to the primary production of SAV beds is likely to incrementally reduce the food sources and cover for juvenile PS Chinook salmon, HCSR chum salmon, PS steelhead, and juvenile PS/GB bocaccio. The reduction in food source includes epibenthos (Haas et al. 2002) as well as forage fish. This reduction occurs in areas where smoltified salmonids have entered salt water and require abundant prey for growth, maturation and fitness for their marine life history stage.

The incremental reduction in epibenthic prey associated with the OWS projects will continue to reduce forage for listed fish production at each site for the new 40-year useful life period. When salmonids from multiple cohorts from all populations have reduced prey availability and increased competition, it is reasonable to assume that the carrying capacity is constrained and abundance of these listed species will be curtailed or reduced. For these species, particularly because Chinook salmon as returning adults are prey of SRKW, this reduction constrains the prey availability for SRKW as well.

When PS/GB bocaccio rockfish reach sizes of 1 to 3.5 in (3 to 9 cm) or 3 to 6 months old, they settle into shallow, intertidal, nearshore waters in rocky, cobble and sand substrates with or without kelp (Love et al. 1991; Love et al. 2002). This habitat feature offers a beneficial mix of warmer temperatures, food, and refuge from predators (Love et al. 1991). Areas with floating and submerged kelp species support the highest densities of juvenile PS/GB bocaccio rockfish. OWS, then, by reducing prey communities and impairing SAV growth, diminish both values for PS/GB bocaccio, impairing their survival, growth, and fitness.

As described in the baseline section, there are approximately 503,106 acres of overwater structure in the nearshore of Puget Sound (Schlenger et al. 2011). The authorization for a new

40-year useful life period of the overwater structures considered in this Opinion contributes to stasis in that number. While this could be interpreted to not exert a change in the area of overwater cover, we do interpret that the stasis in the amount of overwater coverage means that overwater coverage will not meaningfully decrease for the foreseeable future, areas of diminished habitat in an around each structure will not improve for the foreseeable future, carrying capacity near these structures will not improve for the foreseeable future, and overall abundance and productivity for the populations listed species that rely on these areas at juvenile lifestages will also not improve for the foreseeable future. This would be particularly true of juvenile Puget Sound Chinook salmon from all populations, annually for 40 years (new useful life period), and larval and juvenile PS/GB bocaccio for the same time frame. Impacts to SAV and epibenthic forage at these structures will affect both adult and juvenile Chinook salmon, chum salmon, steelhead, and juvenile PS/GB bocaccio by reducing forage at each site.

Species Response to Shoreline Armoring

<u>Fish Species Response</u>

Juvenile Chinook and juvenile HCSR chum salmon migrate along shallow nearshore habitats, and bulkheads will degrade nearshore habitats and increase their predation risk. Every juvenile Chinook and juvenile HCSR chum salmon will encounter armored beaches during their out-migration. As described in the effects on critical habitat, shoreline armoring reduces several nearshore habitat values, including reduced feeding opportunity, increased predation risk, and lack of shallow habitat areas particularly during high tides. We cannot estimate the number of individuals that will experience these effects from the shoreline armoring projects covered in this consultation.

Given that out-migrating juvenile salmonids (particularly Chinook salmon) use shallow-water habitats for rearing, foraging, and migration, bulkheads may potentially reduce growth and fitness of juvenile salmonid during this phase of their life history. In turn, the aggregate impact of this disruption among individuals over each year that these structures are in their habitat for the new 50-year useful life period) and will amount to an overall reduction in survival rate because forcing juveniles into deeper water (when shore processes steepen beaches and truncate access to shallows during high tides), potentially affects their survival by exposing them to greater risk of predation while simultaneously limiting their prey resource availability along the shoreline (shallow littoral zone), thereby decreasing their feeding success and growth rate.

In addition, the alignment of some bulkheads will create or continue shading along the face of the wall, which further camouflages predators holding there from prey moving along the wall in waters lit by the sun. Such shaded areas create hiding areas for predators and prey that conceal them from fish in the lighted zone outside of the area impacted by the shaded area. Such behavior by fish creates a temporal and spatial overlap of predators and prey in the shaded zone, as well as enhancing the success of predator ambush attacks on prey outside of the shaded zone (Kahler et al. 2000, Carrasquero 2001).

Adult Chinook salmon, adult and juvenile steelhead, adult chum salmon, and juvenile PS/GB bocaccio do not migrate along shallow nearshore habitats. Therefore, bulkheads will not directly affect them. Impacts to SAV and epibenthic communities from shore steepening, and sediment coarsening will affect adult and juvenile Chinook salmon, chum salmon, steelhead, and juvenile PS/GB bocaccio by reducing available forage. To the degree that rockfish spawn depends on SAV, their survival will also be reduced.

Species Response to Forage Reduction

<u>Fish Species Response</u>

Temporary, episodic, and enduring reductions in forage base, whether benthic prey communities or forage fish, will occur as a chronic additional reduction over the baseline condition from the proposed repairs, replacements, expansions, or new construction of in and overwater structures and shoreline armoring. When the reductions are widespread throughout Puget Sound, it increases the likelihood that many individual fish from most populations, from all future cohorts of all species, with the exception of yelloweye rockfish and adult PS/GB bocaccio, will experience increased competition with a decrease in carrying capacity of the action area. This would result in slight but chronic reductions in abundance from each cohort of each population, but at levels impossible to predict or measure. The long-term effect of downward abundance would be an overall reduction in productivity, spatial structure, and diversity of the various fish species.

<u>SRKW Response</u>

When prey is scarce, as stated in Section 2.2.1, SRKW likely spend more time foraging than when prey is plentiful. Increased energy expenditure and prey limitation can cause poor body condition and nutritional stress. Nutritional stress is the condition of being unable to acquire adequate energy and nutrients from prey resources and as a chronic condition, can lead to reduced body size of individuals and to lower reproductive 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). This individual stress and diminished body condition of individuals would lead to an overall decline in the fitness of the species, while accounting for age and sex (Stewart et al. 2021). NMFS qualitatively evaluated long-term effects on the SRKW from the anticipated reduction in PS Chinook salmon. We assessed the likelihood for localized depletions, and long-term implications for SRKW survival and recovery, resulting from the proposed action presenting risks to the continued existence of PS Chinook salmon and reducing the ability for the ESU to expand and increase in abundance. In this way, NMFS can determine whether the reduced likelihood for survival and recovery of prey species is also likely to appreciably reduce the likelihood of survival and recovery of Southern Residents. Viability at the population level is a foundational necessity for PS Chinook salmon persistence and recovery.

Hatchery programs, which account for a large portion of the production of this ESU, may provide a short-term buffer, but it is unlikely that hatchery-only stocks could be sustained indefinitely. The loss of an individual Chinook salmon population could preclude the potential for the ESU level future recovery to healthy, more substantial numbers. The weakened ESU demographic structure, with declines in abundance, spatial structure, and diversity, will result in a long-term suppression, if not decline, in the total prey available to Southern Residents. In this consultation, the long-term effects are specifically: fewer populations contributing to Southern Residents' prey base, reduced diversity in life histories, spatial structure, resiliency of prey base, greater ESU level risk relative to stochastic events, and diminished redundancy that is otherwise necessary to ensure there a margin of safety for the salmon and Southern Residents to withstand catastrophic events.

Differences in adult salmon life histories and locations of their natal streams likely affect the distribution of salmon across the Southern Residents' geographic range. The continued decline and reduced potential for recovery of the PS Chinook salmon, and consequent interruption in the geographic continuity of salmon-bearing watersheds in the Southern Residents' critical habitat, is likely to alter the distribution of migrating salmon and increase the likelihood of localized depletions in prey, with adverse effects on the Southern Residents' ability to meet their energy needs. A fundamental change in the prey base within critical habitat is likely to result in Southern Residents abandoning areas in search of more abundant prey or expending substantial effort searching for prey in areas of depleted prey resources. This potential increase in energy demands should have the same effect on an animal's energy budget as reductions in available energy, such as one would expect from reductions in prey.

Lastly, the long-term reduction of PS Chinook salmon is likely to lead to nutritional stress in the SRKW. Nutritional stress can lead to reduced body size and condition of individuals and can also lower reproductive and survival rates. Prey sharing would distribute more evenly the effects of prey limitation across individuals of the population that would otherwise be the case. Therefore, poor nutrition from the reduction of prey could contribute to additional mortality in this population. Food scarcity could also cause whales to draw on fat stores, mobilizing contaminants stored in their fat and affecting reproduction and immune function.

Because SRKWs are already stressed due to the cumulative effects of multiple stressors, and the stressors can interact additively or synergistically, any additional stress such as reduced Chinook salmon abundance likely have a greater physiological effect than they would for a healthy population, which may have negative implications for SRKW vital rates (mortality and fecundity) and population viability (e.g., NAS 2017). Intuitively, at some low Chinook salmon abundance level, the prey available to the whales may not be sufficient to allow for successful foraging, leading to adverse effects (such as reduced body condition and growth and/or poor reproductive success). This could affect SRKW survival and fecundity. For example, food scarcity could cause whales to draw on fat stores, mobilizing the relatively high levels of contaminants stored in their fat and potentially affecting reproduction and immune function (Mongillo et al. 2016). Increasing time spent searching for prey during periods of reduced prey availability may decrease the time spent socializing; potentially reducing reproductive opportunities. Also, low abundance across multiple years may have even greater effect because SRKWs likely require more food consumption during certain life stages, female body condition and energy reserves potentially affect reproduction and/or result in reproductive failure at multiple stages of reproduction (e.g., failure to ovulate, failure to conceive, or miscarriage, successfully nurse calves, etc), and effects of prey availability on reproduction should be combined across consecutive years. Additionally, females exhibit reduced foraging behaviors in the presence of vessels (within 400 yards), and as suggested by the author, this may have impacts on reproduction if they are unable to forage to meet energetic requirements for reproduction (Holt et al. 2021b). Good fitness and body condition coupled with stable group cohesion and reproductive opportunities are important for reproductive success.

Effects on Population Viability

<u>Fish Species Response</u>

We assess the importance of effects in the action area to the ESUs/ DPS by examining the relevance of those effects to the characteristics of Viable Salmon Populations (VSPs). The characteristics of VSPs are sufficient abundance, population growth rate (productivity), spatial structure, and diversity. While these characteristics are described as unique components of population dynamics, each characteristic exerts significant influence on the others. For example, declining abundance can reduce spatial structure of a population when habitats are less varied diversity among the population declines. We expect a persistent, chronic, negative effect from the proposed action, especially on the survival of juvenile PS Chinook salmon and larval and juvenile PS/GB bocaccio. The adaptive ability of these threatened and endangered species is depressed due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. Without these natural sources of resilience, systematic changes in local and regional climatic conditions due to anthropogenic global climate change will likely reduce long-term viability and sustainability of populations in many of these ESUs (NWFSC 2015). These conditions will possibly intensify the climate change stressors inhibiting recovery of ESA-listed species in the future. The impacts expected from climate change are addressed in Section 2.2 (Rangewide Status of the Species and Critical Habitat).

Abundance. While numbers cannot be ascertained, it is certain that at each site, there would be temporary, episodic and enduring effects that diminish water quality, forage base, and safe migration, as habitat effects, as well as sound that can cause direct injury and mortality. Because these effects at each location, for each year they are in place, have the potential to reduce fitness and survival among individuals from the listed fish species that use the action area, we find it likely that there will be reduced survival and thus abundance from each cohort of each population of the listed species. This effect will be most influential on the abundance of PS Chinook salmon and PS/GB bocaccio given their greater reliance on nearshore areas during juvenile life stages. Because of the chronic nature of these reductions in survival, we expect that over time, productivity will also be diminished.

Productivity. We cannot quantify the effects of degraded habitat on the listed rockfish because these effects are poorly understood. However, there is sufficient evidence to indicate that ESA-listed rockfish productivity may be negatively impacted by the habitat structure and water quality stressors discussed above (Drake et al. 2010). While it is impossible to attribute the decline in returning cohorts to specific causes of death at marine life stages, it is likely that declines in abundance of juvenile salmonids while in Puget Sound allows fewer fish, and less fit fish, to reach an ocean life stage. Typical sources of mortality while in their ocean life stage then work against smaller entering cohorts, and further reduce the numbers of fish that ultimately return to spawn, which we recognize as decreased productivity.

Spatial structure. As abundance and productivity decline, the spatial extent of habitat utilized for spawning may also decline.

Diversity. Once juvenile Chinook salmon leave estuarine/delta habitats and enter Puget Sound, they distribute widely and probably can be found along all stretches of shoreline at some point during the year. Data from coded wire tag recoveries of hatchery juvenile Chinook salmon suggest that some fish from each population may distribute broadly within Puget Sound before leaving, thus we anticipate that over the life of the structures, every population of PS Chinook salmon will have multiple members from each cohort exposed to the habitat effects in the nearshore, irrespective of proximity to natal streams (Fresh 2006).

Salmonids have complex life histories and changes in the nearshore environment have a greater effect on specific life-history traits that make prolonged use of the nearshore. The proposed in-water construction would occur when most juvenile PS Chinook salmon and PS steelhead have moved away from the nearshore, utilizing deeper water. However, annually many juvenile PS Chinook salmon and some PS steelhead would be exposed to long-term impacts of the enduring structures on habitat conditions. The impacts are expected to be greatest on juvenile PS Chinook salmon because they spend a longer period of time in nearshore environments (i.e., rearing) and on PS/GB bocaccio because their larval and juvenile life stages rely on nearshore features. Over time, selective pressure on one component of a life-history strategy tends to eliminate that divergent element from the population, reducing diversity in successive generations and the ability of the population to adapt to new environmental changes (McElhany et al. 2000). Any specific populations that experience increased mortality or survival from the proposed action would have their life-history strategy selected against or for, respectively. The long-term effects of the proposed enduring structures would likely result in a slight decline in PS Chinook salmon diversity, proportional to the limited habitat alteration, by differentially affecting specific populations that encounter the armored shorelines (e.g., with bulkheads) within and adjacent to the action area, with greater frequency during their early marine life-history. We are unable to determine which specific populations of PS Chinook salmon most frequently utilizes resources within the action area and will be impacted.

<u>SRKW Response</u>

We review the population level effects on SRKW using the same parameters for viability, namely abundance, productivity, spatial structure, and distribution. This distinct population segment comprises three groups, J, K, and L pods. Abundance is low, (J pod = 24, K pod = 17, L pod =33) as of November, 2021. Productivity is likely to be impaired by the relatively high number of males to females. Spatial distribution has high inter-annual variability, and diversity is at risk because of the low abundance.

These threats were reviewed by Murray et al. (2021), who found a "cumulative effects" model was better at determining population impacts compared to individual threats. The "cumulative effects" model indicated that Chinook salmon abundance was the most sensitive model parameter, however they highlighted the importance of considering threats collectively. Lacy et al. (2017) developed a PVA developed a model that attempts to quantify and compare the three primary threats affecting the whales (e.g. prey availability, vessel noise and disturbance, and high levels of contaminants). The Lacy et al. (2017) model also found that Chinook salmon abundance was the most important threat to SRKW population growth; however, they also emphasized that prey increases alone would likely not be sufficient to recover the whales and that the other threats would need to be addressed as well.

The most recent effort to review the relationships of SRKW vital rates and Chinook salmon abundance was conducted by an Ad Hoc Workgroup through the PFMC (PFMC 2020). However, the Workgroup did not assess the cumulative threats, and found that the small population size limited their ability to detect a quantitative relationship between Chinook salmon abundance and SRKW demographic metrics (e.g. fecundity and survival) to input into their PVA and the relationship is likely not linear or not constant over time (PFMC 2020). Although there are challenges to detecting quantitative relationships and others have cautioned against overreliance on correlative studies (see Hilborn et al. 2012), given the status of the species (endangered with low abundance and productivity), and their strong preference for Chinook salmon prey, the continued existence and potential for recovery of the species is highly dependent on healthy numbers of Chinook salmon throughout its range.

Short-term reduction of Chinook salmon abundance associated with the temporary effects of the proposed action would result in an insignificant reduction in adult equivalent prey resources for SRKW. However, the intermittent and long-term effects of the action include the suppression of productivity among (i.e., reduced survival of juvenile) PS Chinook salmon populations during a 40- to 50-year time period, and spatial and temporal depletions in Chinook salmon presence. This in turn limits the number of adult PS Chinook salmon available as prey for SRKW over the long-term, as well as causing SRKW to expend energy to seek prey in other locations due to spatial and temporal depletions. These effects of the proposed action are likely to be experienced by all members of this species.

As mentioned previously, there are several factors identified in the final recovery plan for SRKWs that may be limiting recovery: quantity and quality of prey, toxic chemicals that accumulate in top predators, and disturbance from sound and vessels. It is likely that multiple threats are acting together, and while it is not clear which threat or threats are most significant to the survival and recovery of Southern Residents, all of the threats are important to address. Effects of the proposed action on Southern Residents would be due to the project's adverse effects on Chinook salmon, the whales preferred prey. Given the status of the species (endangered with low abundance and productivity), and their strong preference for Chinook salmon prey, the continued existence and potential for recovery of the species is highly dependent on healthy numbers of Chinook salmon throughout its range.

The reduction in the number of adult PS Chinook salmon available as prey for SRKW over the long-term would likely result in additional stress and a lower likelihood of survival and reproduction for individual whales in response to decreased prey availability, the Southern Residents would likely increase foraging effort or abandon areas in search of more abundant prey. Reductions in prey or a resulting requirement of increased foraging efficiency would increase the likelihood of physiological effects. The Southern Residents would likely experience nutritional, reproductive, or other health effects (e.g., reduced immune function from drawing on fat stores and mobilizing contaminants in the blubber) from this reduced prey availability. These effects would lead to reduced body size and condition of individuals and can also lower reproductive and survival rates. In particular, the reduction in available prey is likely to put further stress on SRKW juveniles, pregnant females, and nursing females, with likely mortality (decrease in abundance) and decreased fecundity (decreased productivity).

Because of this population's small size, it is susceptible to rapid decline due to demographic stochasticity, and genetic deterioration. Small populations are inherently at risk because of the unequal reproductive success of individuals within the population. The more individuals added to a population in any generation, the more chances of adding a reproductively successful individual. Random chance can also affect the sex ratio and genetic diversity of a small population, leading to lowered reproductive success of the population as a whole. For these reasons, the failure to add even a few individuals to a small population in the near term can have long-term consequences for that population's ability to survive and recover into the future. A delisting criterion for the SRKW DPS is an average growth rate of 2.3 percent for 28 years (NMFS 2008). In light of the current average annual growth rate of 0.1 percent, this recovery criterion and the risk of stochastic events and genetic issues described above underscore the importance for the population to grow quickly.

Particularly in light of the small population size and the associated risks, the enduring effects of the proposed action could limit survival and impede the recovery of the PS Chinook salmon ESU by reducing the potential for population growth and increasing the likelihood of additional loss of individual whales. Further reductions in Southern Resident prey quantity, or spatial or temporal depletions would reduce the representation of diversity in SRKW life histories, resiliency in withstanding stochastic events, and redundancy to ensure there is a margin of safety for the salmon and Southern Residents to withstand catastrophic events. Long-term prey reductions affect the fitness of individual whales and their ability to both survive and reproduce. Reduced fitness of individuals increases the mortality and extinction risk of Southern Residents and reduces the likelihood of recovery of the DPS.

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 action area, all waters of Puget Sound from Olympia, Washington at its southern end, to north of Bellingham, Washington and to, but not including, the Strait of Juan de Fuca, is influenced by actions in the nearshore, along the shoreline, and also in tributary watersheds of which effects extend into the action area. Future actions in the nearshore and along the shoreline of Puget Sound are reasonably certain to include port and ferry terminal expansions, residential and commercial development, shoreline modifications, road and railroad construction and maintenance, and agricultural development. The repair, replacement, construction and removal of bulkheads above the High Tide Line[33] (HTL) that may not require federal authorization will continue. Based on current trends, there could continue to be a net reduction in the total amount of shoreline armoring in Puget Sound (PSP 2018). Changes in tributary watersheds that are reasonably certain to affect the action area include reductions in water quality, water quantity, and sediment transport. Future actions in the tributary watersheds whose effects are reasonably certain to extend into the action area include operation of hydropower facilities, flow regulations, timber harvest, land conversions, disconnection of floodplain by maintaining flood-protection levees, effects of transportation infrastructure, and growth-related commercial and residential development. Some of these developments will occur without a federal nexus, however, activities that occur waterward of the OHWM or HTL require a USACE permit and therefore involve federal activities.

All such future non-federal actions, in the nearshore as well as in tributary watersheds, will cause long-lasting environmental changes and will continue to harm ESA-listed species and their critical habitats. Especially relevant effects include the loss or degradation of nearshore habitats, pocket estuaries, estuarine rearing habitats, wetlands, floodplains, riparian areas, and water quality. We consider human population growth to be the main driver for most of the future negative effects on salmon and steelhead and their habitat.

When we consider a generic design life of structures in the proposed action, we can anticipate that docks, piers, ramps, and bulkheads, when maintained, are reasonably certain to remain in the environment for roughly 50 years. Thus, to gauge the cumulative effects accurately, we consider the non-federal effects that will occur in the action area within that same timeframe. As mentioned above, human populations are expected to increase within the Puget Sound region, and if population growth trends remain relatively consistent with recent trends, we can anticipate future growth at approximately 1.5 percent per year.[34]

The human population in the PS 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 the date of this Biological Opinion, the human population in the Puget Sound Region is 4.2 million, slightly exceeding projections. Thus, future private and public development actions are reasonably certain to continue in and around PS. As the human population continues to grow, demand for agricultural, commercial, and residential development and supporting public infrastructure is also reasonably certain to grow. We believe the majority of environmental effects related to future growth will be linked to these activities, in particular land clearing, associated land-use changes (i.e., from forest to impervious, lawn or pasture), increased impervious surface, and related contributions of contaminants to area waters. Land use changes and development of the built environment that are detrimental to salmonid habitats are reasonably certain to continue under existing regulations. Though the existing regulations minimize future potential adverse effects on salmon habitat, as currently constructed and implemented, they still allow systemic, incremental, additive degradation to occur.

[33] The definitions and processes in USACE regulations, including the “high tide line” (HTL) definition at 33 C.F.R. § 328.3, apply to future permitting and other contexts in which jurisdictional determinations are made.
[34] https://www.psrc.org/whats-happening/blog/region-adding-188-people-day

In June 2005, the Shared Strategy presented its recovery plan for PS Chinook salmon and the Hood Canal Coordinating Council presented its recovery plan for Hood Canal summer-run chum salmon to NMFS who adopted and expanded the recovery plans to meet its obligations under the ESA. Together, the joint plans comprise the 2007 PS Chinook and Hood Canal summer-run chum Salmon Recovery Plan. Several not-for-profit organizations, tribes, and local, state and federal agencies are implementing recovery actions identified in these recovery plans.

Multiple non-federal activities are reasonably certain to occur that impact SRKW interactions with vessels in the Salish Sea. These additional actions are designed to further reduce impacts from vessels on SRKW by limiting the potential for interactions including:

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 new 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 nose 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.

2. Continued implementation and enforcement of the 2019 restrictions on speed and buffer distance around SRKW for all vessels.

3. Increased effort dedicated to outreach and education programs. 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. On-site efforts include materials distributed at pumpout and re-fueling stations along Puget Sound, during Enforcement orca patrols, and signage at WA State Parks and WDFW water access sites. Additionally, 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.

4. Promotion of the Whale Report Alert System (WRAS) in Puget Sound, developed by the Ocean Wise Research Institute, which uses on-the-water reporting to alert large ships when whales are nearby. Reporting SRKW to WRAS is required for commercial whale watching license holders, and on-the-water staff are also being trained to report their sightings.

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, WA State Ferries, and the Puget Sound Partnership in collaboration with the Ports, NOAA, and others. Funding is anticipated to be secured in the 2021 state legislative session.

6. Continued promotion of the voluntary "No-Go" Whale Protection Zone along the western side of San Juan Island in R-MA and C-MA7 for all recreational boats—fishing and non-fishing—and commercial fishing vessels (with the exception of the Fraser Panel sockeye and pink fisheries[35]) (Figure 21). The geographic extent of this area will stretch from Mitchell Bay in the north to Cattle Point in the south, and extend offshore ¼ mile between these locations. The voluntary "No-Go" Zone extends further offshore—out to ½ mile—from a point centered on Lime Kiln Lighthouse. This area reflects the San Juan County Marine Stewardship Area[36] extended in 2018 and the full protected area recognized by the Pacific Whale Watch Association[37] and is consistent with that proposed by NOAA Fisheries as Alternative 4 in the 2009 Environmental Assessment on New Regulations to Protect SRKWs from Vessel Effects in Inland Waters of Washington and represents the area most frequently utilized for foraging and socialization in the San Juan Islands. WDFW will continue to work with San Juan County and will plan to adjust their outreach on a voluntary No Go zone to be consistent with any outcomes of current marine spatial planning processes.

[35] Non-treaty Fraser River Panel commercial fisheries utilize purse seine gear within ¼ mile of San Juan Island and are required to release non-target species (Chinook and coho); (Cunningham 2021).
[36] https://www.sjcmrc.org/projects/southern-resident-killer-whales/
[37] https://www.pacificwhalewatchassociation.com/guidelines/

Figure 21. An approximation of the Voluntary "No-Go" Whale Protection Zone, from Mitchell Bay to Cattle Point (Shaw 2018). See https://wdfw.wa.gov/fishing/locations/marine-areas/san-juan-islands

7) 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 areas of northern Puget Sound, particularly MA 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 MA7 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.

On March 14, 2018, WA Governor's Executive Order 18-02 was signed and 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.[38] In 2019, a new state law was signed that 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. 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[39] 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 the Washington State Department of Transportation to complete fish barrier corrections. Although these measures won't improve prey availability in 2020/2021, they are designed to improve conditions in the long-term.

Notwithstanding the beneficial effects of ongoing habitat restoration actions, the cumulative effects associated with continued development are reasonably certain to have ongoing adverse effects on all the listed species populations addressed in this Opinion. Only improved, low-impact development actions together with increased numbers of restoration actions, watershed planning, and recovery plan implementation would 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 probably not be completely avoided.

2.6 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. 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

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[38] Available at: https://www.governor.wa.gov/sites/default/files/OrcaTaskForce_reportandrecommendations_11.16.18.pdf, last visited May 26, 2019.

[39] Available at: https://www.governor.wa.gov/sites/default/files/OrcaTaskForce_FinalReportandRecommendations_11.07.19.pdf, last visited May 26, 2019.

likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

2.6.1 Integration for Critical Habitat

At the ESU designation scale, the quality of PS Chinook salmon critical habitat is generally poor with only a small amount of freshwater and nearshore habitat remaining in good condition. Most critical habitat for this species is degraded but nonetheless maintains of high value for conservation of the species, based largely on its restoration potential. Loss of freshwater and nearshore critical habitat quality is a limiting factor for this species. Development of shoreline and estuary areas of Puget Sound is expected to continue to adversely impact the quality of critical habitat PBFs for PS Chinook salmon.

The quality of PS steelhead critical habitat also varies, with a small amount of habitat remaining in good condition. Unlike PS Chinook salmon, PS steelhead critical habitat is only designated in freshwater rivers and streams. Nearshore marine areas are not designated because juvenile steelhead do not use nearshore areas extensively. Poor quality of freshwater critical habitat quality is a limiting factor for PS steelhead.

Critical habitat for HCSR chum salmon is designated in stream, rivers, and nearshore areas of the Hood Canal basin. Although some critical habitat for this species is degraded, several nearshore areas of critical habitat remain in good condition. Implementation of recovery plan actions for HCSR chum salmon, including development of an in-lieu fee program for projects that impact critical habitat for this species, represent positive steps toward addressing habitat limiting factors for this species.

Critical habitat for PS/GB bocaccio and yelloweye rockfish includes hundreds of square miles of deep-water areas in Puget Sound. Large areas of nearshore habitat are also designated, but only for juvenile bocaccio. Juvenile bocaccio use shallow nearshore areas extensively during life history while yelloweye rockfish do not. The quality of nearshore critical habitat for PS/GB bocaccio has been degraded by nearshore development and in-water construction, dredging and disposal of dredged material, pollution and runoff.

Critical habitat for SRKWs is designated in Puget Sound and will be affected by the proposed action. Within Puget Sound, the quality of critical habitat for SRKWs has been negatively affected by degradation of water quality, vessel noise, and a 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, is a concern for this consultation.

PS steelhead critical habitat is not designated in nearshore areas and will not be meaningfully affected by the proposed actions. Similarly, critical habitat for yelloweye rockfish is designated only in deep water areas of Puget Sound and will not be significantly affected by the proposed actions. We can therefore conclude that the proposed actions will not diminish the value of critical habitat for the conservation of the PS steelhead and yelloweye rockfish.

The effects of the proposed action would primarily impact nearshore areas of the critical habitats for PS Chinook salmon, HCSR chum salmon, and PS/GB bocaccio. For SRKWs, the impact of the proposed action is primarily on the prey PBF. This impact is caused by the loss of nearshore habitat quality that results in a reduction in the abundance of PS Chinook salmon. The remainder of our integration and synthesis for critical habitat will focus on how the effects of the proposed actions, when added to environmental baseline and cumulative effects, impact the ability of PBFs to support conservation of PS Chinook salmon, HCSR chum salmon, PS/GB bocaccio, and SRKWs.

Modification of nearshore habitat in Puget Sound has resulted in a substantial decrease in critical habitat quality for PS Chinook salmon and PS/GB bocaccio. The effect on critical habitat for HCSR chum salmon is similar, but some areas, including Port Gamble Bay, Port Ludlow, and Kilisut Harbor, remain in good condition (Daubenberger et al. 2017, Garono and Robinson. 2002). As noted in Section 2.3, shoreline development is the primary cause of this decline in habitat quality. Development includes shoreline armoring, filling of estuaries and tidal wetlands, and construction of overwater structures. Currently, 27 percent of Puget Sound's shorelines are armored (Simenstad et al. 2011).

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 piers, ramps, floats (PRFs), 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 cause adverse impacts 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 PS Chinook salmon. Degradation of sand lance and herring spawning habitat has reduced the quality of the forage PBF. Construction of overwater structures throughout Puget Sound has degraded PS Chinook salmon critical habitat by creating artificial obstructions to free passage in the nearshore marine area. Habitat modification that have occurred in Puget Sound to date have reduced juvenile survival and in some cases, eliminated PS Chinook salmon life history strategies that rely on rearing in nearshore areas during early life history.

These impacts on the survival of individual juvenile PS Chinook salmon translate to reduction of adult PS Chinook salmon, the prey PBF for SRKW critical habitat. The SRKW's population has declined in recent years. Under the current environmental baseline and proposed action, critical habitat for SRKWs would be unable to support the conservation of this species. In particular, critical habitat would be unable to produce enough Chinook salmon to ensure survival and recovery of SRKWs.

Changes to nearshore areas in Puget Sound have also reduced the ability of critical habitat to support juvenile life stages of PS/GB bocaccio. Loss of submerged aquatic vegetation has reduced cover available for larval and juvenile rockfish. Changes in the physical character of nearshore areas and loss of water quality reduce the amount of prey available for juvenile rockfish. Although loss of nearshore habitat quality is a threat to bocaccio, the recovery plan for this species lists the severity of this threat as low (NMFS 2017a) relative to other factors, such as overfishing, which is a more significant threat to PS/GB bocaccio.

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 result in some positive as well as a number of adverse effects on the quality of Puget Sound nearshore habitat critical habitat for PS Chinook salmon, bocaccio, and SRKWs including:

- Removal of creosote treated piles and bulkheads would improve water quality by removing these chronic sources of contaminants (Table 21).
- Planting, rubble removal, and beach nourishment will improve habitat.
- Two projects would have some negative impact on water quality because they would result in some stormwater discharges.
- Conversion of solid wood decking to grated decking on replacement structures would reduce the amount of shade under overwater structures, compared to current conditions.
- In the short-term, the proposed construction activities can kill, injure, or disturb normal behavior patterns of fish close to the project site.
- Construction of new or replacement overwater structures would create shade, suppress submerged aquatic vegetation, interrupt migration of juvenile PS Chinook salmon, and provide cover for predatory fish that eat juvenile salmon.
- Replacement of shoreline armoring would prevent development of shoreline vegetation, and impede sediment and organic material supply to beaches.
- In some locations, replacement of shoreline armoring would cause beach erosion waterward of the armoring, which, in turn, would lower beaches, coarsen substrate, increase sediment temperature, and reduce invertebrate density.

- Replacement of shoreline armoring would prevent development of suitable habitat for forage fish spawning and likely reduce abundance and productivity of these important salmon prey items.
- Replacement of vessel-related overwater structures would ensure current or greater levels of vessel use in Puget Sound.

On balance, the positive and negative effects of the proposed action result in a net decrease in critical habitat quality over time. As explained in Section 2.4, *Effects of the Action*, authorization of the construction of new structures degrades the quality of PBFs. The proposed authorization of replacement structures would ameliorate some effects as compared to the baseline condition (through early removal and changes to design that result in more environmentally friendly structures). At the same time, the future consequences of the proposed action include adverse effects caused by the replacement structures to the extent they are extending the life of that structure. Those adverse effects include the impacts listed above. These effects prevent the development of critical habitat PBFs for PS Chinook salmon, salmon, HCSR chum salmon, PS/GB bocaccio, and SRKWs. Additionally, the proposed actions, would result in a net increase in the amount of shoreline armoring, with 1,033 feet of bulkhead proposed for removal and 1,323 feet proposed for installation.

For PS/GB bocaccio critical habitat, the proposed action would degrade the quality of PBFs in the nearshore. This would likely reduce juvenile survival in some areas of affected critical habitat. However, given the low severity of this threat, in context with other limiting factors for this species, we do not expect the adverse effects of the proposed action to be significant enough to reduce the conservation value of critical habitat for this species.

Critical habitat for HCSR chum salmon has been degraded by development but some areas of nearshore habitat remain in good condition. For this batched consultation, there are two projects that occur in areas that would affect critical habitat for this species. Although these projects result in some loss of critical habitat quality, the aggregate impacts of these projects is small. We expect, given the current status of critical habitat and the implementation of recovery actions that address habitat limiting factors, that this impact is not significant enough to reduce the conservation value of critical habitat for HCSR chum salmon.

The adverse effects of the proposed action would exacerbate limiting factors identified in the recovery plans for PS Chinook salmon and SRKWs. For SRKWs, loss of prey is one of three major threats identified in this species' recovery plan. The proposed actions would degrade the quality of the prey PBF of critical habitat, further reducing available prey (Chinook salmon). Stormwater from PGIS will deliver a wide variety of pollutants to aquatic ecosystems, including nutrients, metals, petroleum-related compounds, and sediment washed off the impervious surfaces. Stormwater inputs will result in short-term reduction of water quality and an increase in water quantity due to concentrated flows derived from impervious surfaces, which are reasonably certain to cause injury to fish depending on the level of exposure. Additionally, by supporting boating and vessel traffic into the future, the proposed actions would also modestly exacerbate the other two major limiting factors, toxic chemicals that accumulate in top predators and impacts from sound and vessels. For PS Chinook salmon, degraded nearshore conditions are listed as a limiting factor. The proposed actions will exacerbate this factor by degrading or impeding the development of nearshore critical habitat PBFs essential for the conservation of this species.

The proposed action is also inconsistent with recovery actions identified in the PS Chinook salmon recovery plan. The following recommend actions from the PS Chinook salmon recovery plan speak to the need to protect or restore nearshore habitat:

- 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;
- Aggressive protect areas, especially shallow water/low gradient habitats and pocket estuaries, within five miles of river deltas;
- Protect the forage fish spawning areas;
- 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 functions;
- 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;

Numerous factors have led to the decline of PS Chinook salmon including overharvest, freshwater and marine habitat loss, hydropower development, and hatchery practices. 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, future effects of climate change on habitat quality throughout Puget Sound are expected to be negative. NMFS's jeopardy opinions (WCRO-2020-1361 and WCRO-2021-1620) took a step towards our ultimate goal to curb habitat loss, but only enough to slightly slow the decline.

In summary, the status of critical habitat for PS Chinook salmon is poor and current quality of PBFs in nearshore areas cannot support conservation of this species. The prey quality and quantity PBF of critical habitat for SRKWs is at a fraction of historical levels. Under the current environmental baseline, the PBFs of critical habitat cannot support the biological requirements of PS Chinook salmon. This is evidenced by low survival of PS Chinook salmon juveniles in the nearshore of Puget Sound. The condition of the environmental baseline is such that additional long term and chronic negative impacts on the quality of critical habitat PBFs (nearshore habitat for PS Chinook salmon and prey availability for SRKWs) is likely to impair the ability of critical habitat to support conservation of these species. The net result of the proposed actions would further reduce the quality and further perpetuate poor conditions of nearshore PBFs for PS Chinook salmon and prey availability for SRKWs. The proposed actions would also exacerbate habitat limiting factors identified by the PS Chinook salmon and SRKW recovery plans and are inconsistent with recovery action listed in these plans. Due to demand for future human development, cumulative effects on critical habitat quality are expected to be mostly negative. When the net effects of the proposed action is added to the environmental baseline and cumulative effects, the proposed action is likely to appreciably diminish the value of critical habitat as a whole for the conservation of PS Chinook salmon and SRKWs.

For the reasons described earlier, the proposed actions will not appreciably diminish the value of critical habitat for PS steelhead, PS/GB yelloweye rockfish, PS/GB bocaccio, or HCSR chum salmon.

Another possible approach to this analysis would include giving greater consideration to the quality of critical habitat at each project site. At first glance, one might conclude that if nearshore habitat quality were high at a particular project site, this could lead to a finding that the particular project would not diminish the value of critical habitat for PS Chinook salmon or SRKWs. The basis of this analysis would be that any high-quality critical habitat at a project site would be able to absorb the impact of the adverse effects caused by the proposed project. Or, stated differently, a relatively small increment of adverse effect on high quality critical habitat is not as detrimental as the same increment of adverse effect on critical habitat that is already impaired.

However, there are several flaws with this approach, making it inconsistent with the evaluation required by ESA section 7. When completing our analysis, we add the effects of the action and cumulative effects to the environmental baseline, and, *in light of the status of the critical habitat,* determine if the proposed action is likely to adversely modify critical habitat. The status of critical habitat for both PS Chinook salmon and SRKWs is poor and continuing to decline. As noted previously, the loss of nearshore habitat quality is a factor for decline for PS Chinook salmon. Given the negative trend in the quality of nearshore critical habitat for PS Chinook salmon and the risk that poses for SRWKs, protection of currently high-functioning habitat is critically important. The need to protect quality habitat is expressed in the recovery plan for PS Chinook salmon (SSPS 2005).

Additionally, the quality of nearshore critical habitat is expected to change in the future as a result of climate change. For example, increasing sea surface temperatures are expected to negatively affect salmon population viability (Mauger et al. 2015). This means that even if human development in nearshore areas ceased completely, currently well-functioning critical habitat is likely to decline in quality over time. For these reasons, even if we considered the presence of high quality nearshore critical habitat at a project site in a more isolated manner, it would not be sufficient to lead us to a different conclusion in this consultation.[40]

2.6.2 Integration for Species

PS Chinook salmon are currently listed as threatened with generally negative recent trends in status. Widespread negative trends in natural-origin spawner abundance across the ESU have been observed since 1980. Productivity remains low in most populations, and hatchery-origin spawners are present in high fractions in most populations outside of the Skagit watershed. Available data now shows that most populations have declined in abundance over the last evaluation period (NWFSC 2015). Most populations are consistently below the spawner-recruit levels identified by the recovery plan for this ESU. 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.

HCSR chum salmon have made substantive gains towards meeting this species' recovery plan viability criteria. The most recent 5-year review for this ESU notes improvements in abundance and productivity for both populations that make up this ESU. However, the ESU still does not meet all of the recovery criteria for population viability at this time. Implementation of recovery plan actions for HCSR chum salmon, including development of an in-lieu fee program for projects that impact critical habitat for this species, represent positive steps toward addressing habitat limiting factors for this species.

The most recent 5-year review for PS steelhead notes some signs of modest improvement in productivity since the previous review, at least for some populations, especially in the Hood Canal and Strait of Juan de Fuca MPG. However, these modest changes must be sustained for a longer period (at least two generations) to lend sufficient confidence to any conclusion that productivity is improving over larger scales across the DPS. Moreover, several populations are still showing dismal productivity, especially those in the Central and South Puget Sound MPG (NWFSC 2015). Trends in abundance of natural spawners remain predominantly negative. Particular aspects of diversity and spatial structure, including natural spawning by hatchery fish and limited use of suitable habitat, are still likely to be limiting viability of most PS steelhead populations. In the near term, the outlook for conditions affecting PS steelhead is not optimistic. While harvest and hatchery production of steelhead in Puget Sound are currently at low levels and are not likely to increase substantially in the foreseeable future, some recent environmental trends not favorable to PS steelhead survival and production are expected to continue.

SRKWs are at risk of extinction in the foreseeable future. NMFS considers SRKWs to be currently among nine of the most at-risk species as part of the Species in the Spotlight initiative because of their endangered status, declining population trend, and 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

[40] For similar reasons, even if we were to consider a proposed project through an individual consultation instead of together in this batched consultation, and the project's impacts were limited to affecting local, high-functioning habitat, we do not anticipate a different result for critical habitat or species. *See also* Section 1.4, Action Area, describing the area affected directly or indirectly by the action.

killer whale populations that have generally been increasing since the 1970s (Carretta et al. 2021). Reduced prey availability is a major limiting factor for this species.

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. 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.

PS steelhead complete much of their early life history in freshwater and do not rely on nearshore areas of Puget Sound for rearing as Chinook and chum salmon do. Since the proposed actions primarily affect the quality of nearshore habitat, PS steelhead are spared from many of the adverse effects, especially the long-term effects. Short-term construction- related impacts such as elevated noise and turbidity would likely injure or kill a small number of PS steelhead but not enough to result in any population-level effects. Considering both short-term and potential long-term impacts, the proposed actions would not have any meaningful effects on PS steelhead population abundance, productivity, spatial structure, or diversity.

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 proposed actions would only result in short-term impacts to larval rockfish and only a few cohorts of larval rockfish would be affected during the limited years of proposed construction. 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.

The effects of the proposed action would primarily impact nearshore areas of Puget Sound. This reduces survival of early life-stages of PS Chinook salmon, HCSR chum salmon, and PS/GB bocaccio. For SRKWs, the impact of the proposed action is primarily on their primary prey, Chinook salmon. The remainder of the integration and synthesis for our jeopardy determination will focus on how the effects of the proposed actions, when added to environmental baseline and cumulative effects, affect the likelihood of both the survival and recovery of PS Chinook salmon, HCSR chum salmon, PS/GB bocaccio, and SRKWs.

Modification of nearshore habitat in Puget Sound has resulted in a substantial decrease in habitat quality for PS Chinook salmon. This has coincided in decreased survival at early life history stages and lower population abundance and productivity (Magnusson and Hilborn 2003, Meador 2013. The effect on nearshore habitat used by HCSR chum salmon is similar, but most of the available habitat for this species remains in good condition. 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 this species.

As noted in Section 2.3, shoreline development is the primary cause of this decline in nearshore habitat quality. Development includes shoreline armoring, filling of estuaries and tidal wetlands, and construction of overwater structures.

As explained above in Section 2.6.1, once developed, shoreline areas tend to remain developed due to 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 PRFs, 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 cause 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 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 feature of habitat for PS Chinook salmon. Degradation of sand lance and herring spawning habitat has reduced the quantity of the forage for PS Chinook salmon. Construction of overwater structures throughout Puget Sound has degraded PS Chinook salmon habitat by creating artificial obstructions to free passage in the nearshore marine area. Habitat modification that have occurred in Puget Sound to date have reduced juvenile survival, and in some cases, have eliminated PS Chinook salmon life history strategies that rely on rearing in nearshore areas during early life history.

As described in the section on Effects to the Species, the anticipated short-term (or annual) reduction of PS Chinook salmon, their primary prey, associated with the proposed action would result in a potentially minor reduction in prey resources for SRKWs. Over the long-term, however, the proposed action will inhibit recovery of PS Chinook salmon and would result in a greater reduction in prey quantity and affect availability in other ways (i.e., spatially and temporally). Fewer populations contributing to SRKW's prey base will reduce the representation of diversity of life histories, resiliency in withstanding stochastic events, and redundancy to ensure there is a margin of safety for the salmon and SRKWs to withstand catastrophic events. These reductions increase the risk of extinction to SRKWs.

The chronic long-term impacts to PS Chinook salmon would reduce prey availability and increase the likelihood for local depletions of prey in particular locations and times. In response, the SRKWs would increase foraging effort or abandon areas in search of more abundant prey. Reductions in prey or a resulting requirement of increased foraging efficiency increase the likelihood of physiological effects. The SRKWs would likely experience nutritional, reproductive, or health effects (e.g. reduced immune function from drawing on fat stores and mobilizing contaminants in the blubber) from this reduced prey availability. These effects would lead to reduced body size and condition of individuals and can also lower reproductive and survival rates and thereby diminish the potential for SRKWs to recover.

Changes to nearshore areas in Puget Sound have also 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 larval and juvenile rockfish. Changes in physical character of nearshore areas and loss of water quality reduce the amount of prey available for juvenile rockfish. Although loss of nearshore habitat quality is a threat to bocaccio, the recovery plan for this species lists the severity of this threat as low (NMFS 2017a). Other factors, such as overfishing, are more significant threats to PS/GB bocaccio.

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 actions would result in some positive as well as a number of adverse effects on the quality of Puget Sound nearshore habitat including:

- Removal of creosote treated piles and bulkheads would improve water quality by removing these chronic sources of contaminants.
- Two projects would have some negative impact on water quality because they would result in some stormwater discharges.
- Conversion of solid wood decking to grated decking on replacement structures would reduce the amount of shade under overwater structures, compared to current conditions.
- Set back of bulkheads would reduce negative effects of structures by decreasing the structure’s impact on nearshore habitat-forming processes.
- In the short term, the proposed construction activities can kill, injure, or disturb normal behavior patterns of fish close to the project site.
- Construction of new or replacement overwater structures would create shade, suppress submerged aquatic vegetation, interrupt migration of juvenile PS Chinook salmon, and provide cover for predatory fish that eat juvenile salmon.
- Replacement of shoreline armoring would prevent development of shoreline vegetation, and impede sediment and organic material supply to beaches.
- In some locations, replacement of shoreline armoring would cause beach erosion waterward of the armoring, which, in turn, would lower beaches, coarsen substrate, increase sediment temperature, and reduce invertebrate density.
- Replacement of shoreline armoring would prevent development of suitable habitat for forage fish spawning and likely reduce abundance and productivity of these important salmon prey items.
- Replacement of vessel-related overwater structures would ensure current or greater levels of vessel use in Puget Sound.

On balance, the positive and negative effects of the proposed actions result in a net decrease in nearshore habitat quality over time. As explained in Section 2.4 *Effects of the Action*, authorization of the construction of new structures degrades the quality of nearshore habitat as described above. The future consequences of the proposed actions include adverse effects caused by the replacement structures that extend the useful life of existing structures. Those adverse effects include the impacts listed above. These effects prevent the development of habitat PBFs of PS Chinook salmon, HCSR chum salmon, PS/GB bocaccio, and SRKWs.

As was discussed above for PS steelhead and yelloweye rockfish, the proposed actions would have short-term adverse effects on PS Chinook salmon, HCSR chum salmon, and PS/GB bocaccio. These construction-related effects would include elevated turbidity, resuspended contaminants, incidental discharge, increased noise, and reduced dissolved oxygen. A small number of these fish species would be exposed to these effects at each project site. Although some fish could be injured or killed, the total fish affected is too small to result in any meaningful impact on abundance or productivity of any of the affected species. SRKWs may be in project areas during construction, but Marine Mammal Monitoring plans will be implemented to avoid exposure of these short-term effects.

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. However, given the low severity of this threat, in context with other limiting factors for this species, we do not expect the adverse effects of the proposed action to be significant enough to reduce the conservation value of critical habitat for this species.

Habitat for HCSR chum salmon has been degraded by development but some areas of nearshore habitat remain in good condition. For this batched consultation, there are two projects that occur in areas that would affect this species' habitat, NWS-2020-365 and NWS-2018-1183 in the Hood Canal. Although these projects result in some loss of nearshore habitat quality, the aggregate impacts of these projects is small. 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.

The adverse effects of the proposed actions would exacerbate limiting factors identified in the recovery plans for PS Chinook salmon and SRKWs. For SRKWs, loss of prey is one of three major threats identified in this species' recovery plan. The proposed actions would degrade the quality nearshore habitat, further reducing available prey (Chinook salmon). By supporting boating and vessel traffic into the future, the proposed actions would also modestly exacerbate the other two major limiting factors, toxic chemicals that accumulate in top predators and impacts from sound and vessels. For PS Chinook salmon, degraded nearshore conditions are listed as a limiting factor. The proposed actions exacerbate this factor by degrading or impeding the development of nearshore habitat features essential for the conservation of this species.

The proposed actions are also inconsistent with recovery actions identified in the PS Chinook salmon recovery plan. The following recommend actions from the PS Chinook salmon recovery plan speak to the need to protect or restore nearshore habitat:

- 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;
- Aggressive protect areas, especially shallow water/low gradient habitats and pocket estuaries, within five miles of river deltas;
- Protect the forage fish spawning areas;
- 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 functions;
- 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;

Numerous factors have led to the decline of PS Chinook salmon including overharvest, freshwater and marine habitat loss, hydropower development, and hatchery practices. Adjustments can be made in the short term to ameliorate some of the factors for decline. Harvest can be adjusted on yearly or even in-season basis. Likewise, hatchery management can be adjusted relatively quickly if 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, loss of habitat quality and resulting impacts on population abundance, productivity, spatial structure and diversity are much more difficult to address in the short term. Once human development causes loss of habitat quality, that loss tends to persist for decades or longer. The condition of habitat will improve only through active restoration or natural recovery following the removal of human infrastructure. As noted throughout this Opinion, future effects of climate change on habitat quality throughout Puget Sound are expected to be negative.

In summary, PS Chinook salmon populations are far from meeting recovery goals and trends in abundance and productivity are mostly negative. Nearshore habitat quality is insufficient to support conservation of this ESU. SRKW prey is at a fraction of historical levels. Under the current environmental baseline, nearshore habitat in Puget Sound cannot support the biological requirements of PS Chinook salmon. This is evidenced by low survival of PS Chinook salmon juveniles in the nearshore of Puget Sound. Fewer populations contributing to SRKW's prey base will reduce the representation of diversity of life histories, resiliency in withstanding stochastic events, and redundancy to ensure there is a margin of safety for the salmon and SRKWs to withstand catastrophic events. The condition of the environmental baseline is such that additional impacts on the quality of nearshore habitat is likely to impair the ability of that habitat to support conservation of these species. The proposed actions would further reduce the quality of nearshore habitat in Puget Sound. The proposed actions would also exacerbate habitat limiting factors identified by the PS Chinook salmon and SRKW recovery plans and are inconsistent with recovery action listed in these plans. Due to demand for future human development cumulative effects on nearshore habitat quality are expected to be mostly negative. When the effects of the proposed action are added to the environmental baseline and cumulative effects, the proposed action would appreciably reduce the likelihood of both the survival and recovery of PS Chinook salmon and SRKWs in the wild by reducing their numbers and reproduction.

Another possible approach to this analysis would include giving greater consideration to the quality of habitat at each project site. At first glance, one might conclude that if nearshore habitat quality were high at a particular project site, this could lead to a finding that the particular project would not appreciably reduce the likelihood of both the survival and recovery of PS Chinook salmon or SRKWs. The basis of this analysis would be that any high-quality habitat at a project site would be able to absorb the impact of the adverse effects caused by the proposed project. Or stated differently, a relatively small increment of adverse effect on high quality habitat is not as detrimental as the same increment of adverse effect on habitat that is already impaired.

However, there are several flaws with this approach, making it inconsistent with the evaluation required by ESA section 7. When completing our analysis, we add the effects of the action and cumulative effects to the environmental baseline, and, *in light of the status of the species,* determine if the proposed action is likely to jeopardize the continued existence of listed species. The status of both PS Chinook salmon and SRKWs is poor and continuing to decline. As noted previously, the loss of nearshore habitat quality is a factor for decline for PS Chinook salmon. Given the negative trend in status for PS Chinook salmon and the risk that poses for SRKWs, protection of currently high-functioning habitat is critically important. The need to protect quality habitat is expressed in the recovery plan for PS Chinook salmon (NMFS 2007).

Additionally, the quality of nearshore habitat is expected to decline in the future as a result of climate change. For example, increasing sea surface temperatures are expected to negatively affect salmon population viability (Mauger et al. 2015). This means that even if human development in nearshore areas ceased completely, currently well-functioning habitat is likely to decline in quality over time. For these reasons, even if we considered the presence of high-quality nearshore habitat at a project site in a more isolated manner, it would not be sufficient to lead us to a different conclusion in this consultation.

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, the effects of other activities caused by the proposed action, and cumulative effects, it is NMFS's biological opinion that the proposed action is likely to jeopardize the continued existence of Puget Sound Chinook salmon and SRKW, and adversely modify the designated critical habitats of these species. However, the proposed action is not likely to jeopardize the continued existence of PS/GB yelloweye rockfish, PS/GB bocaccio rockfish, HCSR chum salmon, and PS steelhead or to adversely modify designated critical habitat for these species.

2.8 Reasonable and Prudent Alternative

"Reasonable and prudent alternatives" (RPA) refer to alternative actions identified during formal consultation that can be implemented in a manner consistent with the intended purpose of the action, that can be implemented consistent with the scope of the federal agency's legal authority and jurisdiction, that are economically and technologically feasible, and that would avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat (50 CFR 402.02).

At the foundation of the jeopardy and adverse modification finding is the loss of nearshore habitat such that survival of juvenile Puget Sound Chinook salmon is reduced to a level that will in turn limit this vital prey resource for SRKW. The RPA offered here utilizes the project calculator outputs (discussed in Section 2.8.2), employing the Habitat Equivalency Analysis methodology and the Nearshore Habitat Values Model, to establish an RPA target of no-net-loss of critical habitat functions. NMFS has determined that this proposed action would result in habitat loss equivalent to -1755 debits (Table 26). The RPA is designed to achieve, at a minimum, a reduction of these debits to zero (0) and provides a range of options for achieving this.

NMFS determined that four of the proposed projects (Table 25) batched in this consultation have provided sufficient conservation offsets either through the terms of their original or modified proposed action—per the NHVM result in credits—such that no additional action is needed to achieve the RPA's goal of avoiding jeopardy by offsetting the loss of nearshore habitat quality and quantity caused by the proposed action. Therefore, the projects listed in Table 25 are not subject to the requirements of this RPA. We reached this conclusion based on the expectation that those projects will complete their action and proposed offsets as documented.

Table 25. USACE projects not subject to the RPA

NWS#	Credits
NWS-2020-365	0
NWS-2020-54-WRD	20
NWS-2020-277	0
NW-2019-682	840

The remaining 11 projects considered under this consultation, as currently designed, have a combined total of -1755 debits (Table 26). NMFS determined that those remaining 11 projects are subject to the RPA to avoid jeopardizing the continued existence of PS Chinook salmon and SRKW, and destroying or adversely modifying those species' designated critical habitat.

Table 26. Projects Subject to the RPA

NWS#	Debits
NWS-2020-430	-3
NWS-2019-799	-202
NWS-2019-759	-500
NWS-2020-382	-13
NWS-2019-812	-325
NWS-2018-1183	-11
NWS-2018-263	-33
NWS-2019-962	-43
NWS-2019-725	-359
NWS-2019-897	-29
NWS-2019-1032	-237
Total	-1755

The RPA is reasonable and prudent. It is consistent with the USACE's legal authority and jurisdiction and allows the USACE to authorize the proposed projects such that the structures involved can serve their intended purpose. The range of options offered in the RPA could allow the USACE to finalize a project permit as currently proposed (i.e., RPA 1.3 and 1.4), while others options would result in project amendments that may also require amendments to the current USACE permit proposals (i.e., RPA 1.1, 1.2 and 1.5). Regardless of which option a project applicant chooses, compliance with this RPA is expected to achieve no-net-loss for ESA species and critical habitat, while allowing the project to achieve its intended purpose[41].

The RPA is economically and technologically feasible. NMFS determined that significant opportunities exist for project proponents to obtain conservation credits through on or off-site restoration and/or the purchase of conservation credits through collaborating with various stakeholders consistent with the RPA options listed below. For example, conservation credits can be obtained Puget Sound-wide through the Puget Sound Partnership. Some or all (subject to NMFS approval) mitigation credits obtained through the Hood Canal Coordinating Council's In-Lieu-Fee program for projects in Hood Canal (this option would be relevant to NWS-2018-1183) may also be able to be used as conservation credits to fulfil the requirements of this RPA. The Blue Heron Slough Conservation Bank has conservation credits available for proposed projects in their currently approved service area that includes the estuary of the Snohomish River expanding into the marine waters around Vashon Island and south to approximately the city of Des Moines (applicants will need to contact that bank for exact locations).

If any of the applicants fail to implement the portion of the RPA applicable to their individual project, that project will be subject to reinitiation (see Section 2.12 below) and will not be

[41] Based on the best available information at this time, our effects analysis and compliance with the RPA offsets is pro rata to the part of the structure being repaired/replaced; however, future analysis of an action may consider whether an action extends the life of all or a greater portion of the structure, including additional effects that would not occur but for the action and are reasonably certain to occur.

covered by the take exemption described in the Incidental Take Statement (ITS) for this Opinion, and could become subject to the "take" prohibitions under Section 9 of the ESA.

2.8.1 RPA 1. Compensatory Conservation Actions

This RPA requires projects in Table 26 to offset project debits with an equal (or greater) amount of conservation credits by taking one or more actions consistent with RPA 1.1-1.5. RPA parts 1.1, 1.2, 1.3, 1.4, and 1.5 may be used in any combination with each other to achieve the necessary conservation offsets so long as each project results in net zero conservation debits.

1. Implement on-site habitat improvements (at or in the immediate vicinity of the project site) that would result in conservation credits. On-site habitat improvements are those that would occur within the boundaries of the applicant's property and that can be implemented with the full discretion and control of the applicant. Improvements that could result in credits include, but are not limited to:

    - Removal of existing over-water structures or piles;
    - Removal of derelict structures;
    - Removal of shoreline armoring;
    - Planting or relocation of submerged aquatic vegetation (SAV);
    - Shoreline planting of native (non-submerged) vegetation; and
    - Beach nourishment or other kinds of enhancement of forage fish habitat.

    The removal of pilings or overwater structures, or any removal of shoreline armoring that is already included as part of the proposed action has already been accounted for when NMFS calculated project debits and credits and thus would not be considered again as an action that would meet the terms of this RPA.

    For applicants choosing RPA 1.1 to meet required conservation offsets in whole or in part, the following is required:

    a. A Habitat Improvement Plan. The plan must include a description of the type(s) of on-site habitat improvements, including:
        i. A quantitative description of habitat improvements relative to the NHVM/calculator inputs (e.g., square foot (sq ft) of overwater structure removed, linear foot (lf) shoreline armoring removed, cubic yards of gravel placement);
        ii. Where the improvements would occur;
        iii. How the improvements would occur (e.g., any construction type actions); and
        iv. When the improvements would occur.
    b. A NHVM/calculator output documenting expected credit generation.
    c. On-site habitat improvement projects must be completed within three years of the project's construction start date.

2. Implement off-site habitat improvements that would result in conservation credits through one or more of the following.

   - Removal of pilings or overwater structures that would reduce the loss of nearshore habitat; and/or
   - Remove shoreline armoring to reduce the loss of nearshore habitat.

   The removal of pilings or overwater structures, or any removal of shoreline armoring that is already included as part of the proposed action has already been accounted for when NMFS calculated project debits and credits and thus would not be considered again as an action that would meet the terms of this RPA.

   Off-site habitat improvements proposed by the applicants must be stand-alone projects (e.g., discrete actions such as the removal of a specific number of piles). Projects may not be split between and/or applied to multiple applicants under RPA 1.2.

   For applicants choosing RPA 1.2 to meet required conservation offsets in whole or in part, the following is required:

   a. A Habitat Improvement Plan. The plan must include a description of the type(s) of off-site habitat improvements, including:
      i. Quantitative description of habitat improvements relative to the NHVM/calculator inputs (e.g., sq ft of overwater structure removed, lf shoreline armoring removed);
      ii. Where the improvements would occur;
      iii. How the improvements would occur (e.g., any construction type actions); and
      iv. When the improvements would occur;
   b. A NHVM/calculator output documenting expected credit generation; and
   c. A written agreement with offsite landowner(s) (if improvements are not occurring on applicant-owned or controlled land) that documents the landowner(s)'s consent to the Habitat Improvement Plan.
   d. Off-site habitat improvement projects must be completed within three years of the project's construction start date.

3. Provide funding to a habitat restoration "sponsor" (i.e., a state agency, Regional Organization, designated Lead Entity, Conservation District or Regional Fisheries Enhancement Group) to support a restoration project that will improve nearshore or estuarine habitat.

   For applicants choosing RPA 1.3 to meet required conservation offsets in whole or in part, the following is required:

   a. A Habitat Improvement Plan. The plan must include a description of the type(s) of off-site habitat improvements, including:

i. Quantitative description of habitat improvements relative to the NHVM/calculator inputs (e.g., sq ft of overwater structure removed, lf shoreline armoring removed, cubic yards of gravel placement);
ii. Where the improvements would occur;
iii. How the improvements would occur (e.g., any construction type actions); and
iv. When the improvements would occur

b. A NHVM/calculator output documenting expected credit generation;
c. Documentation of a presale (or equivalent) agreement between restoration project sponsor and the applicant; and
d. Written assurances from the restoration project sponsor that the identified restoration project would occur within three years of the pre-sale (or equivalent) agreement date.
e. Funds must be paid to the habitat restoration partner within one year of the associated USACE permit issuance date.

4. Purchase conservation credits from a NMFS-approved conservation bank, in-lieu fee program, and/or crediting provider.

   For applicants choosing RPA 1.4 to meet required conservation offsets in whole or in part, the following is required:

   a. Documentation of a presale (or equivalent) agreement between credit provider and applicant that identifies the number of credits the applicant intends to purchase.
   b. Purchase of all credits must occur within one year of the associated USACE permit issuance date or as otherwise specified in NMFS-approved agreement (e.g. third party responsible, in-lieu fee, banking instrument).

5. Project modifications that reduce impacts to habitat function. Project modification that could result in reduced debit or increased credits include, but are not limited to:

   - Setback of bulkheads/shoreline armoring landward/above above the Highest Astronomical Tide (HAT)
   - "Soft-shore" bank armoring design
   - Reduced overwater footprint (e.g., less overwater structure (sq ft), fewer piles)
   - Increased grating in decking
   - Calculator input error

   For applicants choosing RPA 1.5 to meet required conservation offsets in whole or in part, the following is required:

   a. A Project Update. The plan must include a description of the type(s) of project updates compared to previous proposed action, including:
      i. Quantitative description of project changes relative to the NHVM/calculator inputs (e.g., new vs. previously proposed location of

shoreline armoring, new vs. previously proposed grating, calculator input error correction);

   ii. Where the improvements would occur;
   iii. How the improvements would occur (e.g., any construction type actions); and
   iv. When the improvements would occur;

b. A NHVM/calculator output documenting expected credit/debit output;
c. Project modifications would be implemented as part of the associated USACE permit.

6. Applicant-proposed plans to comply with the requirements of this RPA shall be submitted to the USACE. The USACE must verify that proposed responses meet requirements listed above. After verification, the USACE shall then submit the proposed plans to NMFS for review. Within 30 calendar days of receipt of a proposed plan, NMFS will reply to the USACE and applicant as to whether the proposed plan meets the requirements of the RPA.

7. RPA Monitoring and Reporting. The following reports are required to document compliance with the terms of this RPA. All reports shall contain the WCRO Tracking number and be sent by electronic copy to NOAA's reporting system email address at: projectreports.wcr@noaa.gov:

   a. For applicants using RPA 1.1 to meet all or part of their RPA requirements, applicants shall, within three years from the project's construction start date do the following:
      i. Provide verification, via the RPA Report sheet (Appendix 2) turned in through projectreports.wcr@noaa.gov, that on-site habitat improvement projects were implemented as proposed. At a minimum this verification should include:
         A. A description of the final design, and
         B. Before and after photographs.
   b. For applicants using RPA 1.2 to meet all or part of their RPA requirements, applicants shall, within three years from the project's construction start date do the following:
      i. Provide verification, via the RPA Report sheet (Appendix 2) turned in through projectreports.wcr@noaa.gov, that off-site habitat improvement projects were implemented as proposed. At a minimum this verification should include:
         A. A description of the final design, and
         B. Before and after photographs.
   c. For applicants using RPA 1.3 to meet all or part of their RPA requirements, applicants shall, within one year from the date of the USACE permit issuance, provide proof of the proposed partnership and verification of the final sales agreement purchasing credits.
   d. For applicants using RPA 1.4 to meet all or part of their RPA requirements, applicants shall, within one year from the date of the USACE permit issuance date, provide verification of the final sales agreement purchasing credits

e. For applicants using RPA 1.5 to meet all or part of their RPA requirements, applicants shall implement any project modifications consistent with the specifications of the USACE permit.
f. For projects subject to this RPA, within 30 days of the Corp issuing the final permit, the USACE shall provide NMFS notice and a final copy of the USACE permit.

General Provisions

For any part of this RPA that requires updated NHVM calculator outputs, NMFS will respond to a request for technical assistance within 25 days of any such request.

The implementation of RPAs 1.1-1.2 must meet the design, best management practices, and conservation measure requirements established in the Fish Passage and Restoration Action Programmatic Biological Opinion ("FPRP III" WCR-2014-1857). Conservation projects administered through RPA 1.3 and 1.4 are expected to be covered by a separate existing (NWR-2006-5601[42] and NWR-2007-8287[43]), or future, ESA consultation. Modifications made per RPA 1.5, are not expected to result in effects not considered in this Opinion and are expected to result in a reduction in debits and therefore a reduction of impacts.

If the proposed project is located within five miles of a major river estuary, any offsite conservation offsets actions pursuant to RPA 1.2, 1.3, or 1.4 must take place within the marine basin or the estuary where the proposed project will take place (Figure 22). If there is no appropriate mitigation available in the marine basin where the project is proposed, the service area may be extended into an adjacent marine basin where impacted stocks would still benefit from the offsets. An additional debit ratio may need to be applied to ensure adequate offsets for the impacted stock. Another exception is for projects that occur in the Blue Heron Slough Conservation Bank currently designated service area, which occurs in two contiguously overlapping adjacent marine basins (Whidbey and South Central); projects within the Blue Heron Slough Conservation Bank's currently designated service area may elect to purchase credits from the Blue Heron Slough.

Any time after signature of the final Opinon, NOAA staff (biologist and/or accompanied by NOAA enforcement) may do periodic compliance checks on randomly selected projects in the nearshore program.

[42] NWR-2006-5601, NMFS consultation on qualification of the Washington State Habitat Restoration programs under limit 8 of the 4(d) protective rule for listed salmon and steelhead (56 FR 42422).
[43] NWR 2007/08287, NMFS Endangered Species Act Section 7 formal consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Blue Heron Slough Conservation Bank Construction, Snohomish County, Washington.

Figure 22. Marine basins of Puget Sound

2.8.1 The USACE's Implementation Decision

Because this Biological Opinion has found jeopardy to PS Chinook salmon and SRKW, and destruction or adverse modification of PS Chinook salmon and SRKW designated critical habitat, and offers a reasonable and prudent alternative to avoid jeopardy and adverse modification of critical habitat, the USACE is required to notify NMFS of its final decision on whether it will implement the RPA (50 CFR 402.15(b)).

2.8.2 Analysis of the Effects of the Proposed Action As Modified by the RPAs

In this section we explain how implementing this RPA would ensure that the proposed action would avoid the likelihood of jeopardizing the continued existence of PS Chinook salmon and SRKW, as well as avoid the likelihood of destruction or adverse modification of their critical habitats. For PS/GB yelloweye rockfish, PS/GB bocaccio rockfish, HCSR chum salmon, PS steelhead and their designated critical habitat, the RPA and its no-net loss approach to near-shore habitat will have similar positive results on the effects of the action as described below. As a result, the effects of the RPA do not change the "no jeopardy" and "no adverse modification" conclusions reached in Section 2.7, or the "Not Likely to Adversely Affect" for the southern DPS of green sturgeon and the Mexico DPS and Central America DPS of Humpback whale made in Section 2.11.

Effects of Conservation Offset Activities Required by the RPA on PS Chinook salmon and SRKW and their Critical Habitats

As described above, proposed conservation offsets associated with RPA 1.1 and 1.2 must be implemented consistent with requirements established in the Fish Passage and Restoration Action Programmatic opinion ("FPRP III" WCR-2014-1857). Conservation projects administered through RPA 1.3 or 1.4 have undergone (NMFS consultations: NWR-2006-5601 and NWR-2007-8287), or will undergo, a separate ESA consultation. Conservation projects administered through RPA 1.4 would have undergone their own separate consultation or are subject to the limitation on take prohibitions for actions conducted under Limit 8 of the 4(d) Rule for salmon and steelhead promulgated under the ESA (65 FR 42421; July 10, 2000).[44]

The precise restoration activities associated with RPA 1.1 and 1.2 have yet to be determined. However, we can anticipate the effects of restoration projects are consistent with the requirements of FPRP III. For RPA 1.3 and 1.4, although subject to separate ESA consultation, we anticipate the restoration projects associated with those RPAs will meet requirements similar to those set forth in FPRP III and will have effects consistent with those described in FPRP III. Those expected effects for the RPA elements are described in Sections 2.4, 2.4.1, and summarized in Section 2.6, respectively, in the FPRP III Opinion, which NMFS incorporates here by reference. In FPRP III (WCR-2014-1857 Section 2.6), NMFS concluded that restoration projects will have short-term impacts due to construction (i.e., suspended sediment, noise from pile driving and removal, and re-suspended contaminants). We expect the RPA-related restoration activities to cause similar short-term impacts here. To better define those short-term impacts related to this RPA for purposes of the incidental take statement, we are providing an estimate of the duration of the restoration-related construction. NMFS anticipates that the duration of the restoration construction required by this RPA will be proportionally linked to the amount of conservation credits restored (the greater the amount of credits required the longer it will take to achieve) and assumes the following:

[44] NMFS issued a biological opinion resulting in an intragency consultation on the establishment of this 4(d) limit. NMFS 2006/0560, February 28 2007.

Table 27. Estimated days associated with construction of RPA conservation offset projects relative to conservation credits. This table shows the more construction days (Table 28), the more conservation credits owed (Table 25)

Conservation Credits	Days to Construct Conservation Offset Projects
1 to 200	10 days
201 to 500	20 days
501 +	30 days

The projects analyzed in FPRP III would be expected to have similar durational estimates. In FPRP III, NMFS concluded that restoration projects will have short-term impacts due to construction but long-term will contribute to reducing many of the factors limiting the recovery of these species. NMFS reaches the same conclusion for this batch Opinion.

As to RPA 1.5, some projects could be modified (e.g., relocation of a bulkhead above HAT, relocation away from a pocket estuary, reduction in size of structure) in a way that reduces effects of the structure, reduces impacts on habitat functions and therefore result in a smaller output of NHVM debits. In some cases, a redesign could result in a conservation debits equaling zero or even a positive credit output. However, we expect the most common use of RPA 1.5 to be in conjunction with components of RPA 1.1 to 1.4. In general, for those projects that use RPA 1.5, we would expect the temporary construction effects as described above in Section 2.4.1 of FPRP III, and a smaller increment of intermittent and enduring impacts described above in Section 2.4.3 of FPRP III that would be offset with a smaller number of conservation credits gained through 1.1 to 1.4. In all these cases, we would still expect a no-net loss result.

The conservation offsets in the nearshore required by this RPA are expected to achieve a no-net-loss of habitat function in the Puget Sound nearshore as a result of this proposed action, which are needed to help ensure that PS Chinook salmon do not continue to drop below the existing juvenile survival rates (Kilduff et al. 2014, Campbell et al. 2017) and in turn will not further reduce available SRKW prey. As detailed above in the Section 2.3 above, PS Chinook salmon juvenile survival is directly linked to the quality and quantity of nearshore habitat. Campbell et al. 2016 has most recently added to the evidence and correlation of higher juvenile survival in areas where there is a greater abundance and quality of intact and restored estuary and nearshore habitat. Relatedly, there is emerging evidence that without sufficient estuary and nearshore habitat, significant life history traits within major population groups are being lost. And specific to this action area, there appear to be higher rates of mortality in the fry life stage in the more urbanized watersheds. By contrast, in watersheds where the estuaries are at least 50 percent functioning, fry out-migrants made up at least 30 percent of the returning adults, compared to the 3 percent in watersheds like the Puyallup and the Green Rivers, where 95 percent of the estuary has been lost. This also means that for projects that occur in less developed areas and within stretches of functioning habitats, no net loss is even more crucial. It has been long understood that protection and conservation of existing unimpaired systems is more effective and efficient than full restoration of impaired systems (Cereghino et al. 2012, Goetz et al. 2004, Greiner 2010). Here, the RPA-required conservation offsets will not result in *adding* to the needed nearshore restoration, but they will ensure that the proposed action does not cause nearshore habitat conditions to get worse.

We expect conservation offsets implemented under RPA 1.1 to 1.5 to be in place within one to seven years[45] of Corp permit issuance, and expect that the offsetting effects of the restoration would begin to occur as soon as one year of restoration project completion. This expected time delay in achieving a conservation offset is acceptable for two reasons. First, 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). Second, as discussed in our effects analysis, most of the projects included in this consultation relate to existing structures that would continue to exist on the landscape for several years into the future even without the proposed modifications or upgrades. Our analysis assumed those projects would continue to exist for at least 10 years. However, within a span of just one to at most seven years, the conservation offsets of the RPA will begin to provide their conservation benefits offsetting the adverse effects of the existing structures. Additionally, the HEA methodology and NHVM calculator can adjust debit/credits to account for delayed implementation and or shorter periods of projected habitat benefits.

Additionally, there have been recent increases in production at conservation hatcheries and agreements to reduce harvest levels that are aimed at stemming the near-term population decline of Chinook salmon and help ensure an immediate prey supply for SRKW. The conservation hatchery efforts for PS Chinook salmon and reduced harvest levels will continue to help maintain current population levels of Chinook salmon and SRKW while conservation offsets are implemented and conservation benefits realized.

Effects of the Proposed Action as Modified by the RPA on PS Chinook salmon and their Critical Habitat

The proposed action, as modified by the RPA, avoids jeopardy and adverse modification of critical habitat, despite climate change effects, because it requires the USACE and applicants to fully offset the long-term adverse effects of the proposed projects on the quality of Puget Sound

[45] In general, NMFS agreements expect that conservation projects will be implemented within three years of conservation credits being purchased. However, in-case of in-lieu-fee type programs, additional time could be necessary for situations such as when credit demand is lower than expected, and the in-lieu fee program has not been able to collect enough funds to secure an in-lieu fee project site and plan and implement the compensatory offsets within the three years.

nearshore habitat (as described in Section 2.1). Applying a "no-net loss" approach to the nearshore habitat affected by the projects will ensure that this limiting factor for the production of PS Chinook salmon and the PBFs of PS Chinook salmon critical habitat will not continue to worsen as a result of these projects. In addition, stabilizing this limiting factor in the context of this consultation will help allow the expected benefits from other efforts such as modified harvest management, hatchery reform, improved fish passage at dams, and freshwater habitat restoration to have meaningful, positive impacts on PS Chinook salmon abundance, productivity, spatial structure, and diversity and their related critical habitat. Loss of Puget Sound nearshore habitat quality is among a subset of limiting factors for PS Chinook salmon that have yet to be addressed in a meaningful manner.

Effects of the Proposed Action as Modified by the RPA on SRKW and their Critical Habitat

The proposed action, as modified by the RPA, avoids jeopardy and adverse modification of critical habitat for SRKWs by applying a "no-net loss" approach to nearshore habitat affected by the projects. This habitat is important to the production of PS Chinook salmon. As explained above, applying a "no-net loss" approach to nearshore habitat (as also described in Section 2.1) will ensure that this limiting factor for the production of PS Chinook salmon will not continue to worsen as a result of these projects. Stabilizing this limiting factor in the context of this consultation will help allow the expected benefits from other efforts such as modified harvest management, hatchery reform and production from conservation hatcheries, improved fish passage at dams, and freshwater habitat restoration to have a meaningful, positive impact on PS Chinook salmon abundance, productivity, spatial structure, and diversity. In turn, this addresses SRKW's critical habitat requirement for prey species of sufficient quantity, quality and availability to support individual growth, reproduction and development, as well as overall population growth. The RPA avoids further reductions in prey that would otherwise be caused by the proposed action.

2.9 Incidental Take Statement

NMFS has developed the following Incidental Take Statement (ITS) based on the proposed action as modified by the RPA. Section 9 of the ESA and federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

2.9.1 Amount or Extent of Take Anticipated

In this Opinion, including actions associated with implementation of the RPA 1.1, 1.2 and 1.5, NMFS determined that incidental take is reasonably certain to occur as:

- Harm of PS Chinook salmon (juvenile and adult), PS steelhead (juvenile and adult), HCSR chum salmon (juvenile and adult), PS/Georgia Basin DPSs of yelloweye rockfish and bocaccio (egg, larvae, juvenile, and adult) from temporary construction related actions[46]; and
- Harm of individual PS Chinook salmon (juvenile and adult), PS steelhead (juvenile and adult), HCSR chum salmon (juvenile and adult), PS/Georgia Basin DPSs of yelloweye rockfish and bocaccio (egg, larvae, juvenile, and adult) and SRKWs from intermittent and enduring impacts resulting from the repair or replacement of existing structures and the construction of new structures.

For this Opinion, even using the best available science, NMFS cannot predict with meaningful accuracy the number of listed species that are reasonably certain to be injured or killed annually by exposure to these stressors. The distribution and abundance of the fish that occur within the action area are affected by habitat quality, competition, predation, and the interaction of processes that influence genetic, population, and environmental characteristics. These biotic and environmental processes interact in ways that may be random or directional, and may operate across far broader temporal and spatial scales than are affected by a proposed action. Thus, the distribution and abundance of fish within the action area cannot be attributed entirely to habitat conditions, nor can NMFS precisely predict the number of fish that are reasonably certain to be injured or killed if their habitat is modified or degraded by the proposed action. Additionally, NMFS knows of no device or practicable technique that would yield reliable counts of individuals that may experience these impacts. Similarly, NMFS is unable to reliably quantify and monitor the number of individual SRKWs that may be harmed by the incidental take identified here. In such circumstances, NMFS uses the causal link established between the activity and the likely extent of timing, duration and area of changes in habitat conditions to describe the extent of take as a numerical level. Many of the take surrogates identified below could be construed as partially coextensive with the proposed action; however, they also function as effective re-initiation triggers. If any of the take surrogates established here and summarized in Tables 28, 29, 30, and 31 are exceeded, they are considered meaningful reinitiation triggers because the USACE has authority to conduct compliance inspections and to take actions to address non-compliance, including post-construction (33 CFR 326.4), and exceeding any of the surrogates would suggest a greater level of effect than was considered by NMFS in its analysis.

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[46] The temporary nature of the construction related effect on SRKW prey resources are not expected to be detectable at the individual SRKW level, and therefore, as described in the effects analysis, we do not anticipate harm to SRKW from these activities.

Take from Construction-Related and Temporary Effects

Construction Timing and Duration Surrogates

The timing (in-water work window) and duration (days) of in-water work is applicable to construction related stressors described below because the in-water work windows for specific geographic regions are designed to avoid the expected peak presence of listed species in the action area. Construction outside of the in-water work window could increase the number of fish that would be exposed to construction related stressors, as would working for longer than planned. Therefore, for all stressors below that identify a timing and duration take surrogate, they will be synonymous with the defined in-water work window and number of in-water workdays identified in Table 28. The only exception to this is the days associated with pile installation and removal listed in Table 29. These surrogate measures of incidental take can be reasonably and reliably monitored by the applicants. Due to the nature of construction in the marine environment, there is the potential for a project to exceed these identified time frames.

We include construction-related impacts for RPA 1.1 and 1.2 where relevant and consistent with the estimated duration of construction operations described above. Construction-related impacts from RPA 1.5 would have the same surrogates, however the magnitude will be the same or less than those specified for the proposed action in Tables 28 and 29. For RPA 1.3 and 1.4, as discussed above, the construction impacts of the restoration actions associated with those RPAs will be covered by separate existing or future ESA consultations. Consistent with 50 CFR 402.16(i)(6), we are not including any amount or extent of take associated with those actions since any incidental take will be addressed in the consultations associated with those conservation offset mechanisms (project funding or credits).

Harm from Pile Driving Activities - Noise

PS Chinook salmon (juvenile and adult), PS steelhead (juvenile and adult), HCSR chum salmon (juvenile and adult), PS/Georgia Basin DPSs of yelloweye rockfish and bocaccio (egg, larvae, juvenile, and adult) will be exposed to construction-related noise resulting from pile installation and removal activities and construction vessels at the work sites. Disruption of normal feeding and migration, and injury and death can occur from this exposure. Additionally, implementation of the RPA 1.1 and 1.2 may result in additional removal of piles. The amount and extent of short-term take resulting from the proposed action, including actions taken to implement RPA 1.1 and 1.2, are accounted for and exempted in this take statement as reflected below in Tables 28 and 29.

The maximum number of individual pile strikes per day, and time of vibratory pile driving per day (minutes) are the best available surrogates for the extent of take from exposure to pile removal and installation -related noise (see below Table 29).

The surrogates for take caused by underwater sound generated by pile driving and vessel use are proportional to the anticipated amount of take. These surrogates are also the most practical and feasible indicators to measure. In particular, the number of pile strikes with an impact hammer is directly correlated to the potential for harm due to hydroacoustic impacts, and thus the number of individuals harmed due to pile driving. Each pile strike creates underwater sound and a pressure wave that can kill, injure, or significantly impair behavior of listed species addressed by this Opinion. Numerous strikes occurring in temporal proximity also increase the likelihood of injury, death, or behavior modification due to cumulative exposure to underwater sound. Thus, the number of pile strikes is closely related to the amount of incidental take that would be caused by the proposed action. In some cases, persistent noise can make an affected area inhospitable for normal behaviors such as migrating and foraging. The duration of this disturbance is related to the number of animals potentially affected as well as the intensity of the disturbance. As the duration of noise increases, a larger number of animals migrating or traveling through the affected area are likely to be exposed. Likewise, the longer the noise persists, the longer the affected area may remain incapable of supporting the normal behaviors of salmon, steelhead, and HCSR chum salmon.

Harm from Suspended Sediments and Contaminants

PS Chinook salmon (juvenile and adult), PS steelhead (juvenile and adult), HCSR chum salmon (juvenile and adult), PS/Georgia Basin DPSs of yelloweye rockfish and bocaccio (egg, larvae, juvenile, and adult), will be exposed to increased suspended sediments (turbidity) and corollary decrease in DO, re-suspended contaminants, and contaminants from incidental discharge which are expected to persist during the in-water work period of each project associated with pile removal, removal of debris in the nearshore, nearshore construction activities during removal and replacement of shoreline armoring, and dredging. Impairment of normal patterns of behavior including rearing and migrating, potential injury such as gill abrasion, cough, PAH bioaccumulation or other transitory health effects can occur from this exposure (described in Section 2.4.1). Additionally, implementation of the RPA 1.1, 1.2, and 1.5 may result in additional removal of piles, nearshore debris, shoreline armoring, and SAV relocation. The amount and extent of short-term take resulting from the proposed action, including actions taken to implement RPA 1.1 and 1.2, are accounted for and exempted in this take statement as reflected in Table 28.

The exposure to suspended sediments and contaminants will occur contemporaneously—these actions are triggered by the same stressor, will occur in the same time and place and can be measured and monitored in the same manner. The best available indicator for the extent of take from suspended sediments and contaminants are described below.

<u>For non-dredging activities</u>

The levels of suspended sediments and contaminants are expected to be proportional to the amount of injury that the proposed action is likely to cause through physiological stress from elevated suspended sediments and contaminants throughout the duration of the projects' in-water activities. In estuaries, state water quality regulations (WAC173-201A-400) establish a mixing zone of 200 feet plus the depth of water over the discharge port(s) as measured during mean lower low water. As such, NMFS expects that for projects with sediment disturbing activities, that elevated levels of suspended sediment and contaminants resulting from construction actions will reach background levels within a 200-foot buffer from the point of suspended sediment generation. Listed fish and their prey resources can be harmed from a wide range of elevated sediment levels and expect that at the point where sediment levels return to background levels that the harm will cease. Thus, the maximum extent of take is defined as within the 200-foot buffer around the outer boundaries of each of the project footprints, where construction will increase suspended sediments (turbidity) and a cause a commensurate decrease in DO, re-suspend contaminants, and increase contaminants from incidental discharge. Elevated suspended sediment levels beyond 200-foot buffer would indicate exceedance of take. The 200-foot buffer extent of take surrogate also applies to projects that implement RPA 1.1, 1.2, and 1.5.

<u>For dredging activities</u>

The levels and amounts of suspended sediments and contaminants are expected to be proportional to the amount of injury that the proposed action is likely to cause through physiological stress from elevated suspended sediments and contaminants throughout the duration of the projects' in-water activities. For dredging activities that occur in estuary environments, Washington state water quality regulations (WAC173-201A-400) establish mixing zones not to extend to a downstream direction for a distance from the discharge port(s) greater than three hundred feet plus the depth of water over the discharge port(s), or extend upstream for a distance of over one hundred feet. As such, NMFS expects that for projects with dredging, that elevated levels of suspended sediment and contaminants resulting from dredging actions will reach background levels within a 300-foot buffer from the point of suspended sediment generation. Listed fish and their prey resources can be harmed from a wide range of elevated sediment levels and expect that at the point where sediment levels return to background levels that the harm will cease. Thus, the maximum extent of take for dredging activities is defined as within the 300-foot buffer around the outer boundaries of each of the project footprints, where construction will increase suspended sediments (turbidity) and a corollary decrease in DO, re-suspend contaminants, and increase contaminants from incidental discharge. Elevated suspended sediment levels beyond 300-foot buffer would indicate exceedance of take.

The dredging material is typically disposed of at designated multi-user open-water disposal sites (open-water disposal sites) that are managed under the Dredge Material Management Program (DMMP) https://www.nws.usace.army.mil/Missions/Civil-Works/Dredging/. The effects of sediment disposal at DMMP open-water disposal sites have already been considered in the programmatic formal consultation for their continued use through 2040 (NMFS 2015a). Therefore, the use of DMMP open-water disposal sites for disposal of sediments dredged in accordance with this proposed action and the resulting effects of that disposal have already been consulted on and will be accounted for in the monitoring and reporting of the DMMP Opinion.

The surrogate measures of incidental take identified in this section can be reasonably and reliably measured and monitored by applicants.

Harm from Entrainment from dredging operations (only applies to NWS-2018-263 and NWS-2019-725)

We expect PS Chinook salmon (juvenile), PS steelhead (juvenile), HCSR chum salmon (juvenile), and PS/Georgia Basin DPSs of yelloweye rockfish and bocaccio (egg, larvae, juvenile, and adult) to be captured by entrainment during the proposed dredging operations (clam shell or suction). Most listed species that are entrained will be injured or killed.

The exact number of listed species that would be entrained cannot be determined due to extensive variables. The best available indicator of take is the amount of dredge material (cubic yards). The amount of dredge material is appropriate for this proposed action because it is directly related to the quantitative magnitude of take caused by entrainment during dredging. The applicant can measure and monitor the volume of material dredged. The amount and extent of take resulting from dredging associated with this proposed action is accounted for and exempted in this take statement as reflected in Table 27. Due to the nature of dredging in the marine environment, there is the potential for a project to exceed these identified indicators.

Table 28. Amount of take expressed by take surrogates: construction timing (fish window) and duration (in-water work days, area of suspended sediments from project site, re-suspended contaminants in tons of creosote removed and entrainment that would occur during dredging actions. Where appropriate, RPA 1.1 and 1.2 actions that result in take are explicitly delineated from take resulting from the Proposed Action (PA).

	Timing and Duration for all Surrogates			**Suspended Sediments and Contaminants**			**Entrainment From Dredging**
NWS#	**Work Window**	**# of Work Windows**	**Days (PA/RPA)**	**Non-Dredge**	**PAH**	**Dredge**	**Cubic Yards**
				Square Foot (PA/RPA)	**Minimum Ton Removal**	**Square Foot**	
NWS-2020-430	July 16 - February 15	1	1/10	200/200	NA	NA	NA
NWS-2019-799	July 16 - February 15	1	30/20	200/200	14.3	NA	NA
NWS-2019-759	July 16 - February 15	1	56/30	200/200	NA	NA	NA
NWS-2020-382	July 16 - February 15	1	30/10	200/200	3.6	NA	NA
NWS-2019-812	July 16 - February 15	1	30/30	200/200	NA	NA	NA
NWS-2020-365	July 16 - January 14	1	7/NA	200/200	0.3	NA	NA
NWS-2020-54-WRD	August 16 - February 15	1	180/10	200/200	3.1	NA	NA
NWS-2020-277	August 1 - February 15	1	30/10	200/200	NA	NA	NA

	Timing and Duration for all Surrogates			Suspended Sediments and Contaminants			Entrainment From Dredging
NWS#	Work Window	# of Work Windows	Days (PA/RPA)	Non-Dredge	PAH	Dredge	Cubic Yards
				Square Foot (PA/RPA)	Minimum Ton Removal	Square Foot	
NWS-2018-1183	July 16 - January 14	1	2/10	200/200	2.6	NA	NA
NWS-2018-263	July 16 - February 15	1	30/10	NA	NA	300	4,813.3
NWS-2019-962	July 16 - January 14	1	5/10	200/200	18.2	NA	NA
NWS-2019-725	July 16 - February 15	1	30/20	NA	NA	300	46,004
NWS-2019-897	July 16 - February 15	1	30/10	200/200	1.3	NA	NA
NWS-2019-1032	July 16 - February 15	1	30/20	200/200	NA	NA	NA
NWS-2019-682	July 16 - February 15	1	120/NA	200/200	387.0	NA	NA

Table 29. Amount of take expressed by take surrogate, by projects resulting from Temporary and Construction Effects for elevated construction noise associated with pile installation and removal.

NWS#	Number of Days of Pile Removal/Install Work	Number of Work Windows	Max Impact Strikes/Day	Max Minutes Vibratory Hammer /Day
NWS-2020-430	1	1	NA	30
NWS-2020-54-WRD	2	1	400	240
NWS-2018-1183	1	1	180	NA
NWS-2019-962	3	1	225	NA
NWS-2019-897	3.5	1	NA	200
NWS-2019-1032	3	1	520	120
NW-2019-682	7	1	520	300

Take from Intermittent and Enduring Effects

Harm due to habitat-related effects

PS Chinook salmon (juvenile and adult), PS steelhead (juvenile and adult), HCSR chum salmon (juvenile and adult), PS/Georgia Basin DPSs of yelloweye rockfish and bocaccio (egg, larvae, juvenile, and adult) and SRKW will be exposed to reduction in the quantity and quality of nearshore habitat resulting from the replacement or repair (rebuilding) of existing structures and the placement of new structures. For SRKWs, the impact of the habitat-related effects is primarily on the reduction in prey. This impact is caused by the loss of nearshore habitat quality that results in a reduction in the abundance of PS Chinook salmon. Specifically addressed here are the reduction in habitat quality and quantity—including prey resources for PS Chinook salmon and SRKW—that will result from in- and over-water structures and vessels using these structures, and shoreline stabilization and bank armoring. The take associated with these impacts is summarized below in Table 30.

<u>For In-Water and Over-Water Structures, Including Mooring Buoys</u>
The physical size (sq feet) of an in- or over-water structure is the best available surrogate for the extent of take from exposure to the structure itself and also the accompanying vessel noise accommodated by the structure. This is because the likelihood of avoidance and the distance required to swim around the structure 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 (effects further described in Section 2.4.3). The extent of these impacts would increase and decrease depending directly on structure size.

Also, as the size of a structure increases, the number of individual boats that could moor there increases; mooring buoys only allow for one boat to moor at a time and structure and slip sizes within marina would dictate the number of individual boats that could use these facilities. As the number of mooring buoys increases the number of boats using it will be expected to increase. As size and slip number increase the number of boats using a marina would also increase. As the number of boats increase, boating activity would likely increase, and the potential for ESA-listed species to be exposed to the related noise effects (as described in Sections 2.3, 2.4.1 and 2.4.2) also increases.

For Shoreline Armoring and Bulkheads

The physical extent (length and width) of shoreline armoring and bulkheads, and placement on the shore below the HAT is the best available indicator for the extent of take from decreased habitat function caused by shoreline armoring and bulkhead structures (including stairs). Shoreline armoring restricts natural beach forming processes (natural erosive processes) by disrupting the supply and replenishment of sediment sources that are the base of forage fish spawning habitat (effects described in Section 2.4.3). As forage fish reproduction is restricted or reduced, so is the availability of food for listed fish (salmon and bocaccio), limiting and reducing the numbers of listed fish that the action area can support. In turn, this limits the number of juvenile PS Chinook salmon that will survive and return to the Puget Sound as adults that supply prey for SRKW. The loss of natural sediment deposition along the shoreline north and south of a structure that supports forage fish and other intertidal and nearshore habitat function are directly proportional to the physical area, length and width of shoreline armoring and bulkheads, and placement on the shore below the HAT. As the length and width of a bulkhead increases so does impact to sediment inputs. Structures that are placed below the HAT directly eliminate forage fish habitat and feeding habitat for listed species. The further a structure is placed below HAT, the greater the loss of this habitat and thus impacts. Further, due to the variability of the marine environment and nature of project implementation, the potential exists for a project to exceed the structure's identified physical extent.

The surrogate measures of incidental take identified in this section can be reasonably and reliably measured and monitored and all serve as meaningful reinitiation triggers.

Table 30. Amount of take expressed by take surrogate, by projects resulting from Intermittent and Enduring Effects

	In-water and Over-water Structure	Bulkhead and Shoreline Armoring	
USACE Project #	**Square Feet (sqft)**	**Length (linear feet)**	**Average Elevation of Substrate at Toe of Armoring**
NWS-2020-430	3	NA	NA
NWS-2019-799	NA	214	2.3 ft below MHHW
NWS-2019-759	NA	453	2.17 ft below MHHW
NWS-2020-382	NA	70	1.5 ft below MHHW
NWS-2019-812	NA	481	1.15 ft below MHHW
NWS-2020-365	1	NA	NA
NWS-2020-54-WRD	2,466	NA	NA
NWS-2020-277	NA	NA	NA
NWS-2018-1183	400	NA	NA
NWS-2018-263	NA	NA	NA
NWS-2019-962	2,548	NA	NA
NWS-2019-725	NA	NA	NA
NWS-2019-897	2,215	NA	NA
NWS-2019-1032	2,703	105	5.5 ft above MLLW (average)
NW-2019-682	74,238	NA	NA

Harm from Stormwater Runoff

PS Chinook salmon (juvenile and adult), PS steelhead (juvenile and adult), HCSR chum salmon (juvenile and adult), PS/Georgia Basin DPSs of yelloweye rockfish and bocaccio (egg, larvae, juvenile, and adult) will be exposed to intermittent stormwater runoff associated with two projects. The take associated with these impacts is summarized below in Table 31.

For this consultation, the best available indicator for the extent of take expected due to storm water runoff is the physical extent (sq. ft.) of pollution generating impervious surface (PGIS) associated with the permitted structure (i.e., access roads and parking lots). Stormwater from PGIS will result in delivering a wide variety of pollutants to aquatic ecosystems, such as nutrients, metals, petroleum-related compounds, and sediment washed off the impervious surfaces. Stormwater inputs will result in short-term reduction of water quality and an increase in water quantity due to concentrated flows derived from impervious surfaces, which are reasonably certain to cause injury to fish depending on the level of exposure. Stormwater contaminants cause a variety of lethal and sublethal effects on fish, including disrupted behavior, reduced olfactory function, immune suppression, reduced growth, disrupted smoltification, hormone disruption, disrupted reproduction, cellular damage, and physical and developmental abnormalities (Fresh et al. 2006; Hecht et al. 2007; Lower Columbia River Estuary Partnership 2007). The amount of stormwater resulting from the project and pollutants in the stormwater are directly proportional to the amount of PGIS. As PGIS increases so would the amount of pollutants being discharged.

The surrogate measure of incidental take identified in this section can be reasonably and reliably measured and monitored and serves as a meaningful reinitiation trigger.

Table 31. Pollutions Generating Surface from projects involving stormwater

NWS#	Stormwater Runoff Pollutions Generating Surface (sqft)
NWS-2019-799	2,777
NWS-2019-812	4,810
Total	**7,587**

2.9.2 Effect of the Take

In the Opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action as modified by the RPA, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.9.3 Reasonable and Prudent Measures

The "reasonable and prudent measures" (RPMs) described below are non-discretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

1. The USACE shall minimize incidental take of listed species from construction related noise resulting from exposure to pile driving activities.

2. The USACE shall minimize incidental take of listed species resulting from dredging operations.

3. The USACE shall minimize incidental take of listed species resulting from suspended sediment and re-suspended contaminants during construction.

4. The applicant shall minimize incidental take of listed species resulting from stormwater.

5. The USACE and applicants shall ensure compliance with the requirements of this Opinion, including the RPA and ITS, and shall implement monitoring and reporting programs to confirm that the RPA and RPMs are implemented as required and take exemption for the proposed action is not exceeded, and that the terms and conditions are effective in minimizing incidental take.

2.9.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the USACE or any applicant must comply with them in order to implement the RPMs (50 CFR 402.14). The 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 these Terms and Conditions (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 likely would lapse.

1. The following terms and conditions implement RPM 1 (pile driving activities). To minimize incidental take from pile installation and removal for the relevant projects, the USACE shall require the applicant to:
   a. Adhere to the applicable in-water work window (as specified in Table 28)
   b. Utilize vibratory pile driving whenever sediment conditions allow.
   c. Utilize sound attenuation measure(s) (double walled piles, wooden block, bubble curtain, etc.) for all steel impact pile driving.

2. The following terms and conditions implement RPM 2 (dredging). To minimize incidental take from dredging operation, the USACE shall require the applicant to:
   a. Adhere to the applicable in-water work window (as specified in Table 28)
   b. Comply with Washington State water quality standards by conducting water quality monitoring during dredging activities. At point of compliance (per state permit), turbidity levels shall not exceed 5 nephelometric turbidity units (NTUs) more than background turbidity when the background turbidity is 50 NTUs or less, or there shall not be more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTUs.
   c. Dredge in a manner that minimizes spillage of excess sediments from the bucket and minimizes the potential entrainment of fish. This includes, but is not limited to:
      i. Using effective materials such as hay bales or filter fabric on the barge to avoid contaminated sediment and water from being deposited back into the water.
      ii. Avoiding the practice of washing contaminated material off the barge and back into the water. This can be accomplished by the use of hay bale and/or filter fabric.
      iii. Using filter fabric or some other device (hay bales, eco-blocks, etc.) to minimize spillage of material into the water during the unloading of the barge to the upland facility.
   d. Ensure dredging contractor utilizes the most current, accurate Global Positioning System (GPS) dredge positioning to control the horizontal and vertical extent of the dredge. A horizontal and vertical control plan will be prepared, submitted to the contractor, and adhered to by the dredge contractor to ensure dredging does not occur outside the limits of the dredge prism.
   e. Ensure that an emergency cleanup plan is in place in the event the barge, truck, or railcar has an incident where contaminated material is spilled. This plan will be on-board the vehicle at all times.

3. The following terms and conditions implement RPM 3 (suspended sediment):
   a. Adhere to the applicable in-water work window (as specified in Table 28)
   b. To minimize incidental take from increased suspended sediments (turbidity) and corollary decrease in DO, re-suspended contaminants, and contaminants from incidental discharge during structure removal and construction, the USACE shall require the applicant to:
      i. Implement the best management practices and conservation measures to ensure compliance with Washington State water quality standards by conducting water quality monitoring during structure removal and construction activities. At point of compliance (per state permit), turbidity levels shall not exceed 5 nephelometric turbidity units (NTUs) more than background turbidity when the background turbidity is 50 NTUs or less, or there shall not be more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTUs
      ii. Removed creosote structures should be disposed of at approved facilities. (https://ecology.wa.gov/Regulations-Permits/Guidance-technical-assistance/Dangerous-waste-guidance/Dispose-recycle-or-treat/Hiring-a-contractor)

4. The following terms and condition implement RPM 4 (stormwater discharge).
   a. To minimized incidental take from discharge of stormwater the applicant shall:
      i. Provide treatment for stormwater from pollution generating surfaces (e.g., parking lots, roads, support vehicle traffic, landscape areas subject to chemical maintenance) that will ensure that discharge meets Washington state water quality standards for pollution generating surfaces (https://ecology.wa.gov/Water-Shorelines/Water-quality/Runoff-pollution/Stormwater).
      ii. Within 60 days of a project being completed, the applicant shall prepare and send to NMFS a project completion report that contains the following:
         (1) Stormwater treatment plan
         (2) Final square feet of actual replaced, repaired, or new impervious surface

5. The following terms and conditions implement RPM 5 (Monitoring and Reporting). The USACE shall require the applicant to comply with the terms of this Opinion, including the RPA and ITS, as a condition of its permit. In addition, the USACE shall require the applicant to:
   a. Before work begins, all contractors working on site must receive a complete list of the USACE permit special conditions, the USACE best management practices listed above in the Proposed Federal Action section of this document, this Biological Opinion's RPA and the ITS, including the RPMs and terms and conditions intended to minimize the amount and extent of take resulting from in-water work.
   b. On the start date of the construction, the applicant (or designated agent) shall notify NMFS, via projectreports.wcr@noaa.gov, that construction has commenced and include:
      i. Email subject line: "NOTIFICATION OF START DATE **WCRO-2021-03047"**
      ii. Date project construction began
      iii. USACE NWS project number
      iv. A written verification that all USACE-required best management practices (including implementation of a MMMP) are being implemented.

c. Within 60 days of a project being completed, the USACE shall require the applicant to prepare and send to NMFS a project completion report that contains the following:
   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. USACE contact person(s);
   v. Timing and Duration of Project Work:
      (1) Starting and ending dates for work completed;
      (2) Number of days of in-water work for proposed action and when RPA 1.1 and 1.2 apply
   vi. Evidence of Construction-Related Noise
      (1) For Piles Installed, the final report must identify:
         (a) Number days that pile installation activities occurred
         (b) Number of Pile(s)
         (c) Pile type(s)
         (d) Pile size(s)
         (e) Method(s) used for installation
         (f) Daily records of impact hammer strikes
         (g) Daily record of time that vibratory hammer was used
      (2) For Piles Removed—for both the proposed action and when RPA 1.1 and 1.2 apply, the final report must identify:
         (a) Number days that pile removal activities occurred
         (b) Number of Pile(s)
         (c) Pile type(s)
         (d) Pile size(s)
         (e) Method(s) used for removal
         (f) Daily record of time that vibratory hammer was used
      (3) Suspended Sediment and Contaminant Monitoring
         (a) Report of BMPs used
         (b) Monitoring data collected, or use of BMPs that demonstrate that 200 ft buffers (for non-dredging actions) and 300 ft (for dredging) buffers were not exceeded
         (c) For projects with creosote removal – copy of disposal receipt verifying tons of creosote disposed.
      (4) For Dredging Projects:
         (a) Final amount of cubic yards dredged
      (5) For In-water and Overwater Structures:
         (a) Final square feet (replaced/repaired/new)
      (6) For Shoreline Armoring/Bank Stabilization:
         (a) Final length in lf (replaced/repaired/new)
         (b) Final width in sq ft (replaced/repaired/new)
         (c) Placement of structure on the shoreline relative to HAT
      (7) Photo documentation.
         (a) Photos of habitat conditions at the project site before, during and after project completion

(b) Include general views and close-ups showing details of the project and project site, including pre- and post-construction.
(c) Label each photo with date, time, project name, photographer's name, and the subject and project number.

(8) A description of how the USACE successfully met the terms and conditions contained in this Opinion

Submit Reports. All reports shall contain the NMFS Number WCRO-2021-03047 and be sent by electronic copy to NOAA's reporting system email address at: projectreports.wcr@noaa.gov.

2.10 Conservation Recommendations

Section 7(a)(1) of the ESA directs federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

NMFS recommends that the USACE, per requirements in Section 7(a)(1) and (2), develop a program and complete a programmatic consultation with NMFS that will ensure nearshore projects contain adequate conservation offsets to avoid future jeopardy and adverse modification determinations.

2.11 "Not Likely to Adversely Affect" Determinations

2.11.1 Green Sturgeon and their Designated Critical Habitat

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 this DPS of green sturgeon, however Puget Sound is excluded from the designation for economic reasons. Observations of green sturgeon in Puget Sound are much less common compared to the other estuaries in Washington. Although two confirmed Southern DPS fish were detected there in 2006, the extent to which Southern DPS green sturgeon use Puget Sound remains uncertain. Puget Sound has a long history of commercial and recreational fishing and fishery-independent monitoring of other species that use habitats similar to those of green sturgeon, but very few green sturgeon have been observed there. In addition, Puget Sound does not appear to be part of the coastal migratory corridor that Southern DPS fish use to reach overwintering grounds north of Vancouver Island thus corroborating the assertion that Southern DPS do not use Puget Sound extensively. Because critical habitat is not designated in the action area, effects of the 15 projects on critical habitat are discountable.

As for any potential effect on the species, even if green sturgeon are present in the action area of Puget Sound, they rely on deep bottom areas for feeding and rearing, indicating that the effects of the 15 actions will be attenuated to the degree that exposure to effects will be at low enough levels that response will be insignificant. It is very unlikely that green sturgeon will occur in the action area or be exposed to stressors from the proposed action. Therefore, we conclude that the effects to the southern DPS green sturgeon are likely to be fully discountable, but if any exposure to project effects did occur, response would be insignificant.

2.11.2 Humpback Whales 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). Humpbacks 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).

Critical habitat was designated for humpback whale DPSs 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. Critical habitat encompasses off shore areas up to 1200 meters with the shoreward boundary at 50 meters. The action area for this consultation does not overlap with critical habitat for Central America DPS and Mexico DPS of the humpback whales. The physical and biological feature of humpback critical habitat is prey availability. While the action is expected to affect forage fish in Puget Sound, the proposed action will not affect prey resources within critical habitat for the two humpback whale DPSs. Any potential imapcts of reduced forage fish prey on individual humpback whales are discussed below.

Data has not been collected on the proportion of DPSs 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 Puget Sound proper, we have presented our humpback whale text outside of the scope of DPS. With current limited data, any individual humpback in the Puget Sound proper 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. 2020; 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 Puget Sound proper 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, which overlaps with project construction windows. Despite increases in sightings of humpback whales in the Puget Sound, scientific survey data indicate that the highest densities of humpback whales occur within the Strait of Juan de Fuca up to Port Angeles with only intermittent use of the Puget Sound (pers. comm., John

Calambokidis, Cascadia Research Collective, February 26, 2020 cited in 86 FR 21082). The likelihood of exposure of humpbacks to the temporary effects associated with the actions is low due to low whale density outside the Strait. Criteria for monitoring and stop-work on sighting as well as BMPs in Section 1.3 as described above for SRKW apply to all marine mammals, including humpback whales. They are intended to ensure that humpbacks will not experience duration or intensity of pile driving. Because the likelihood of exposure of any individual humpback whale to project work is low, and MMMPs will be in place for projects with pile driving, effects to this species are discountable.

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). Coinciding with possible long-term effect pathways from the proposed group of projects in this Opinion, we have examined possible effects related to recreational vessel strikes, marine noise associated with vessel use, decreased forage availability, and contamination from pollutants. Effects from entanglement were discounted because few commercial fishing vessels are associated with structures in the proposed actions.

Decreased Forage Availability

Humpback whales are generalist feeders, and may show regional prey preferences. The whales are known to shift prey between krill and fish along the US West Coast and these shifts seem to match the relative abundance of prey and are reflected in changes in stable isotope concentrations from skin samples taken in biopsies of whales (Fleming et al. 2015). No studies have yet been conducted on the feeding preferences of humpback whales within the Salish Sea. Humpbacks forage and switch between target prey depending on what is most abundant or of highest quality in the system (Fleming et al. 2016) and it is possible that humpbacks enter the Salish Sea in search of dense congregations of prey such as krill and other forage fish like sand lance, and herring. 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 actions is not likely to adversely affect their overall food supply. 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. We expect that the whales will proportionally shift food sources in response to any decrease in forage fish, but the decrease in forage fish at project locations is also not expected to have a detectible effect on humpback food availability. Therefore, effects on humpbacks due to a decrease in forage fish are expected to be insignificant.

Contamination from Pollutants

Humpback whales can bioaccumulate lipophilic compounds (e.g., halogenated hydrocarbons) and pesticides (e.g., DDT) in their blubber, by feeding on contaminated prey (bioaccumulation) or inhalation in areas of high contaminant concentrations (Barrie et al. 1992; Wania and Mackay 1993).

Herring in the Puget Sound and Georgia Basin, a known humpback food source, have elevated pollutant levels in their bodies. And PCBs in herring in two Central/South Puget Sound locations were significantly greater than three northern locations (O'neill et al. 2001).

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 currently 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.

Vessel Noise

The proposed action either authorizes new or extends the life of marine structures. As a result, vessel traffic associated with the authorized structures is a consequence of the proposed action. As noted in the description of the action area for this consultation, these vessels are expected to operate primarily in Puget Sound proper.

Baleen whales rely on their acoustic sensory system for communicating with other individuals. Significant levels of anthropogenic sound can therefore interfere with communication by masking vocalizations (Erbe et al. 2016). Vessel noise is a broadband signal which overlaps with the frequency band of many baleen whale vocal sounds (Richardson et al. 1995). Noise from vessel traffic has shown to cause variation in Humpback whale behavior from changes in surface, foraging, and vocal behavior, displace animals from occupied areas, and produce temporary or permanent hearing damage and physiological stress. Nevertheless, responses by whales can vary depending on localized circumstances, sometimes with no observable reactions recorded. Where sound-related impacts are severe, reproduction and survival of animals may be affected (Clark et al. 2009).

In response to noise, humpback whales have been found to move away from noise sources (Dunlop et al. 2016), reduce male singing activity (ssps and Clark 2008, Risch et al. 2012), reduce feeding activity (Siyle et al. 2016), and alter their migration path and speed (Dunlop et al. 2015, 2016). Williams et al. (2014) found coastal marine noise levels high enough to potentially cause significant communication problems for humpback whales at several locations in British Columbia, including Haro Strait in the Salish Sea adjacent to Washington. Schuler et al. (2019) found that feeding and traveling humpback whales were likely to maintain their behavioral state regardless of vessel presence, while surface active humpback whales were likely to transition to traveling in the presence of vessels. These short-term changes in movement and behavior in response to whale-watching vessels could lead to cumulative, long-term consequences, negatively impacting the health. Sprogis et al. (2020) showed vessel noise as a driver of significant behavioral response in humpback whales while simulating whale watching scenarios. During high noise playbacks on mother/calf pairs, the mother’s proportion of time resting decreased by 30 percent, respiration rate doubled, and swim speed increased by 37 percent.

Small crafts with high-speed engines and propellers generally produce higher frequency noise than large vessels (Erbe 2002, Erbe et al. 2013). Large vessels, including the cruise ships and tour vessels, generate substantial low frequency noise (Arveson & Vendittis 2000). Because of their low frequency, large vessels have more potential to cause noise-related effects to humpback whales.

Based on data available in 2015, the threat of anthropogenic noise received a "low" rating for all DPSs of humpback whales in the recent NMFS Status Review (out of possible ratings of unknown, low, medium, high, and very high; Bettridge et al. 2015).

NOAA whale viewing guidelines suggest all vessels remain at least 100 yards away from large whales. 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. 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 vessels associated with the actions within the vicinity of humpback whales would follow NOAA guidelines and federal mandates and would not likely disrupt normal behavioral patterns of humpback whales. Therefore, humpback whale response to vessel noise associated with the action is considered insignificant.

Vessel Strikes

Members of the Mexico and Central America DPSs are expected to face increasing vessel traffic in the Puget Sound proper due to increasing population and coinciding vessel use. Ship strike risk may expand in these areas as vessel traffic intensifies in the future and humpback numbers increase. The proposed actions would maintain and expand existing vessel (less than 75ft) traffic in the Puget Sound proper.

Six of the projects included in this Opinion are either residential, commercial, or industrial structures that support motorized boating with the potential to extend throughout Puget Sound (Table 5). The vessels associated with this opinion are mostly recreational boat, but also include Coast Guard vessels, emergency vessels, and commercial vessels. For larger vessels, Coastal studies of vessel strikes show that humpback whales are particularly vulnerable due to their feeding methods near the surface and mother/calf pairs that stay near the surface. Of 292 recorded strikes contained in the Jensen and Silber (2003) West Coast database, 44 were of humpback whales, second only to fin whales. According to a NMFS West Coast Region whale collision database, there have been 31 documented humpback whale strikes by vessels in the state of Washington since 1995. However, for smaller vessels, there are no known cases of a recreational vessel strike of a humpback in Puget Sound (Pers. comm., Hanna Miller, NMFS, 5/17/2021). Currently there is not a reliable dataset documenting smaller recreational vessels striking humpback whales in the Salish Sea, though numbers are likely very low due to low densities of the species and the high mobility of the vessels. In the past several years, documented humpback whale strikes have occurred in association with large vessels, such as the Bainbridge Island ferry in May 2019 (NWPB 2019), and the Whidbey Island ferry in July 2020

(Cascadia Research Collective, 2020). These collisions have resulted in the assumed fatality of the individual. While there is a risk of stikes caused by larger vessels, the volume of large vessel traffic caused by the proposed action is very low.

Areas with high boat traffic pose a higher collision risk for humpback whales. These include the mouths of the Strait of Juan de Fuca and Columbia River, the north-south shipping lane leading to California, and the Strait of Juan de Fuca and other parts of the Salish Sea (Williams and O'Hara 2010, Nichol et al. 2017, Rockwood et al. 2017).

The volume of vessel traffic caused by the proposed action is relatively small. The vessels are primarily recreational and no documentation of recreational vessel strikes to humpback whales exists in Washington., These factors combined with the the whales' relative low density in the Puget Sound proper, make exposure to vessel strikes discountable.

2.12 Reinitiation of Consultation

This concludes formal consultation for the USACE's proposal to authorize 15 in-water, overwater, or nearshore activities in Puget Sound.

If any of the applicants fail to implement the portion of the terms and conditions of the ITS applicable to their individual project, that project will not be covered by the take exemption described in the ITS for this Opinion, and could become subject to the "take" prohibitions under Section 9 of the ESA. This circumstance would not automatically trigger re-initiation requirements.

As 50 CFR 402.16 states, re-initiation of consultation is required and shall be requested by the federal agency or by the Service 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 identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the Biological Opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

This consultation represents a combined review of 15 individual requests for consultation on proposed projects that may affect listed species and critical habitat in Puget Sound. If any of the re-initiation triggers identified above are reached, and the USACE retains discretionary involvement or control over the action, the USACE can request re-initiation on a project-by-project basis. In such a case, NMFS does not expect that reinitiation on a single project would trigger a need to reinitiate consultation on all of the projects addressed by this Opinion. Other projects may still meet the no net loss requirements of the RPA and be consistent with the analysis in this Opinion even if a single project does not.

Any request for re-initiation of consultation should be made to the West Coast Region NMFS Regional Office, Oregon Washington Coastal Office, at owco.wa.consultationrequest@noaa.gov

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION

Section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) directs federal agencies to consult with the Secretary of Commerce on all actions or proposed actions that may adversely affect essential fish habitat (EFH). This EFH consultation is specific to the effects of the proposed action on the EFH for MSA managed species. This batch consultation is being used broadly to consider as many adverse effects as possible through EFH Conservation Recommendations (CRs). It should be noted; the managed species of the MSA have different life cycles, migration patterns, forage species and foraging techniques than the ESA protected species discussed in the ESA section of this document. Therefore, it is important to reiterate this consultation is specific to the effects of the proposed action on the EFH for MSA managed species and not the RPA for ESA species.

The permits for this batch consultation will be administered by the United States Army Corps of Engineers (USACE), Regulatory Branch. The USACE relies on the Rivers and Harbors Act of 1899 (Section 10) and the Clean Water Act (Section 404) authorities, as described in Section 1.3 above. The Seattle District of the USACE routinely permits a variety of projects that occur in estuarine and nearshore waters designated as EFH. Included in these projects are the construction, maintenance, replacement and expansion of such structures as piers, wharves, bulkheads, dolphins, marinas, ramps, and floats. All of the projects within the batch consultation fall within the nearshore of the same waterbody (Salish Sea).

EFH guidelines (50 CFR 600.05 – 600.930) outline the process for federal agencies, including NMFS and the Fishery Management Councils, to satisfy the EFH consultation requirement under section 305(b)(2)-(4) of the MSA. EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity" (16 U.S.C. 1802(10)).

Waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate.

Substrate includes sediment, hard bottom, and structures underlying the water, and associated biological communities.

Necessary means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem.

Adverse effect refers to any impact that reduces the quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations 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 and/or quantity of EFH. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810 (a)).

Additionally, Section 305(b) of the MSA requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

Unlike ESA regulations, in which the Action Agency operates under the determinations of "no effect," "likely to adversely affect," or "not likely to adversely affect" on project actions within the action area, the appropriate EFH regulation determinations used by the Action Agency are "**may adversely affect**" or "**would not adversely affect.**"[47] In this Batch of 15 projects, two of the projects had no EFH determination, three projects were determined to "likely adversely affect," and 10 projects were determined "not likely adversely affect" (Table 32). We assume this incorrect wording is a misunderstanding of the regulatory standard, or an accidental carryover from the ESA.

Table 32. EFH Determination by project

USACE Number	USACE Determination	NMFS Determination
NWS-2020-430	No determination provided	Would adversely affect
NWS-2019-799	NLAA*	Would adversely affect
NWS-2019-759	NLAA	Would adversely affect
NWS-2020-382	NLAA	Would adversely affect
NWS-2019-812	NLAA	Would adversely affect
NWS-2020-365	NLAA	Would adversely affect
NWS-2020-54-WRD	NLAA	Would adversely affect
NWS-2020-277	NLAA	Would adversely affect
NWS-2018-1183	NLAA	Would adversely affect
NWS-2018-263	LAA**	Would adversely affect
NWS-2019-962	NLAA	Would adversely affect
NWS-2019-725	NLAA	Would adversely affect
NWS-2019-897	No determination provided	Would adversely affect
NWS-2019-1032	LAA	Would adversely affect
NW-2019-682	LAA	Would adversely affect

*NLAA = Not likely to adversely affect ** LAA= Likely to adversely affect

NOAA Fisheries, in collaboration with its partners and stakeholders, has begun the process of implementing Ecosystem-Based Fisheries Management (EBFM),[48] through the recognition of the need for ecosystem considerations in a number of actions including, the identification and conservation of EFH and habitat areas of particular concern (HAPC) upon which commercial fisheries are dependent. One way NOAA Fisheries is supporting the Fisheries Management Council in considering EFH at a system level is by identifying HAPCs that are known to support important ecological functions for multiple species or species groups or may be especially vulnerable or provide essential functions in a changing climate. This EFH assessment was based on the description of effects provided by the USACE for the projects listed, NMFS review and analysis of effects, and on descriptions of EFH for Pacific coast groundfish (PFMC 2005),

[47] MSA §305(b)(2) states federal agencies must consult with NMFS on any action they authorize, fund, or undertake that *may adversely affect EFH*. MSA §305(b)(4)(A) states NMFS shall provide conservation recommendations to State and Federal agencies for any action they authorize, fund, or undertake that *would adversely affect EFH*.
[48] EBFM Policy (NOAA Fisheries Policy 01-120): https://www.fisheries.noaa.gov/resource/document/ecosystem-based-fisheries-management-policy and EBFM Road Map (NOAA Fisheries Procedure 01-120-01) : https://www.fisheries.noaa.gov/resource/document/ecosystem-based-fisheries-management-road-map

coastal pelagic species (PFMC 1998), Pacific coast salmon (PFMC 2014) contained in the fishery management plans (FMP) developed by the Pacific Fishery Management Council and approved by the Secretary of Commerce.

In this section, we identify the potentially impacted EFH, HAPCs, and species designated by the Fisheries Management Plans in Puget Sound and describe the potential impact the proposed action may have on them. It is NMFS' determination that the proposed action may adversely affect EFH and may result in substantial impacts to other aquatic resources of national importance.

3.1 Essential Fish Habitat Affected by the Project

The entire action area of the Salish Sea fully overlaps with identified EFH for Pacific Coast groundfish, coastal pelagic species, and Pacific Coast salmon.

The role of nearshore habitats in providing EFH for MSA species

A wide variety of MSA taxa use nearshore habitats within Puget Sound, including groundfish, coastal pelagic, and salmonid species. Routine surveys of fish communities conducted by NOAA's NWFSC scientists have observed MSA species throughout the five basins in the Puget Sound using beach seine, near surface townet, diving, and angling survey methods. Appendix 3 lists the MSA species and the habitat type in which they have been observed in the Puget Sound marine nearshore and highlights which species are likely to be most affected by structures in the nearshore. These diverse fish communities include year-round residents (e.g., some rockfishes and flatfishes) as well as those that are more transient, occurring in the nearshore during a migratory phase of the life cycle (e.g., juvenile salmon) or for breeding purposes (e.g., adult lingcod). Several species covered under the MSA use the nearshore habitat year-round and are consequently exposed to impacts for a longer duration, and potentially for multiple life stages, than transient species. These impacts are not discountable and can have a lasting adverse impact to the productivity of the species.

No matter the duration or timing of occurrence of MSA species in nearshore habitats, these areas play a critical role in fish population dynamics. Nearshore habitats provide areas that are suitable for species of interest because they contain prey resources, afford shelter from predators (e.g., within submerged aquatic vegetation such as eelgrass and kelp), and have other characteristics that allow for positive population growth. The trophic interactions that are set up in nearshore habitats are especially important for MSA species. Retention of nutrients, attenuation of currents, and availability of shelter from predators can attract species that form a forage base (e.g., phytoplankton and zooplankton), allowing the development of productive food webs that support multiple life stages of many MSA species.

For MSA species with spatially disjunct juvenile and adult habitats (e.g., many rockfishes), certain nearshore areas can serve as nursery habitats that produce more individuals that recruit to adult populations per unit area than others. Any combination of four factors can cause a subset of juvenile habitats to act as nurseries by contributing disproportionately to the individuals that recruit to adult populations. These factors include greater: (1) density, (2) survival, (3) growth, and (4) movement to adult habitats (Beck et al. 2001).

Pacific Coast Groundfish FMP

Designated EFH for Pacific Coast groundfish encompasses all waters along the coasts of Washington, Oregon, and California that are seaward from the mean high water line. This also includes 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, though this consultation is limited to Puget Sound (PFMC 2005, Figure 23). Based on research and habitat modeling developed for the Pacific Coast Groundfish Fishery Mnagement Plan (FMP), forty-six species in the groundfish FMP have been documented to occur within Puget Sound. Habitat in Puget Sound supports one or more necessary life history stages (spawning, breeding, feeding or growth to maturity) of those forty-six species.

Figure 23. Pacific Coast Groundfish EFH in Puget Sound

Table 33 provides the list of the aforementioned groundfish species that have been identified as potentially affected by the projects in this consultation. For detailed life history descriptions for each species, please see Appendix B Part 2 of the Pacific Coast Groundfish FMP (PFMC 2005).

Table 33. Pacific Coast Groundfish Species in the Action Area

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 elongates*
curlfin sole	*Pleuronichthys decurrens*	longnose skate	*Raja rhina*
darkblotch rockfish	*Sebastes crameri*	Pacific cod	*Gadus microcephalus*
Dover sole	*Microstomus pacificus*	Pacific ocean perch	*Sebastes alutus*
Pacific sanddab	*Ctlharichthys sordidus*	shortspine thornyhead	*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*

Pacific Coast Groundfish Habitat Areas of Particular Concern

Five Habitat Areas of Particular Concern (HAPC) types for groundfish have been identified: estuaries, seagrass, canopy kelp, rocky reefs, and "areas of interest." HAPCs are described in the regulations as subsets of EFH which are rare, particularly susceptible to human-induced degradation, especially ecologically important, or located in an environmentally stressed area (50 CFR 600.815(a)(8)). Designated HAPCs are not afforded any additional regulatory protection under MSA; however, federally permitted projects with potential adverse impacts to HAPCs will be more carefully scrutinized during the consultation process. Most of the Pacific Coast Groundfish HAPCs are based on habitat type and may vary spatially and/or temporally depending upon environmental conditions. For this reason, the mapped extent of these areas offers only a first approximation of their location. Defining criteria are provided in the following descriptions of HAPCs, which can be used in conjunction with maps to determine if a specific location is within a HAPCs.

Estuaries

Estuaries are protected nearshore areas, such as bays, sounds, inlets, and river mouths, influenced by both the ocean and freshwater. Because of tidal cycles and freshwater runoff, salinity varies within estuaries and results in great diversity, offering freshwater, brackish, and marine habitats within close proximity (Haertel and Osterberg 1967). Estuaries tend to be shallow, protected, nutrient rich, and biologically productive, providing important habitat for marine organisms. The inland extent of the estuary HAPC is defined as Mean Higher High Water (MHHW), or the upriver extent of saltwater intrusion, defined as upstream and landward to where ocean-derived salts measure less than 0.5 parts per thousand during the period of average annual low flow. The seaward extent is an imaginary line closing the mouth of a river, bay, or sound; and to the seaward limit of wetland emergent plants, shrubs, or trees occurring beyond the lines closing rivers, bays, or sounds. This HAPC also includes those estuary-influenced offshore areas of continuously diluted seawater. This definition is based on Cowardin, et al. (1979). In Puget Sound, a diversity of habitats are included within the estuary HAPC. These habitats include shallow subtidal, intertidal flats (sand and mud), tidal creeks and channels, and salt marsh.

Subtidal habitats include harbors and sheltered bays with open water. These habitats are inundated throughout the tidal cycle and have less variable physical environments than intertidal areas (Desmond 1996). Seagrass beds are a marine wetland habitat that is frequently found within shallow subtidal areas. The majority of overwater development occurs in subtidal habitats where a variety of fish species that inhabit open-ocean, intertidal flats, tidal creeks, and salt marshes are supported; these are discussed in further detail below.

Intertidal sand and mudflats are generally lacking in vascular plant assemblages, but may contain significant amounts of microphytes. Microphytobenthos (MPB) is a matrix of unicellular eukaryotic algae and cyanobacteria that exist in the upper portion of aquatic substrates. It is distributed across a multitude of environments, but governed on a local scale by factors including irradiance, depth, topography, wave action and benthic fauna (Swanberg 1991). Because light is absorbed quickly in sediment, the depth limit of MPB may be only a few millimeters. Across those few millimeters, strong chemical gradients exist because MPB acts as a transport for nutrients between the water column and sediments. The matrix serves as a sink for silica, because diatoms use it to construct their shells. MPB also absorbs inorganic phosphates and nitrates because they are nutrients that aid in growth (Bartoli et al. 2003). Because of MPB’s role as a primary producer, there is a net flux of oxygen into the water column. However, phytoplankton produces more oxygen in subtidal areas while MPB is more productive in intertidal zones (MacIntyre et al. 1996). The additional oxygen in the sediment increases the denitrification rate, though not enough to become a source (Webster et al. 2002). These fluxes potentially limit the growth of macrophytes (Sundbäck 2002) and have ramifications throughout the food web. When estuaries become hypoxic, either through natural or anthropogenic causes, MPB is resilient and recovers rapidly. Therefore, MPB can provide oxygen and form the base of a food web for incoming colonists in the recovering area (Larson and Sundbäck 2008).

In addition to its chemical role, MPB also physically and biologically influences ecosystems. The primary physical function is substrate stabilization. MPB grows in high energy areas where sediments can be eroded. Not only does this erosion have harmful effects to coastal systems, it also increases turbidity, potentially causing hypoxia, benthic invertebrate burial and possible mortality in vertebrates unable to avoid it. The MPB mat is primarily composed of diatoms and spreads across the bottom forming a net against erosion (Miller et al. 1996, Stal 2010). MPB also forms the base of an aquatic food web. Deposit feeders such as snails, polychaete worms, crustaceans and others are a major consumer of MPB. When strong currents lift MPB into the water column, suspension feeders like clams and polychaete worms consume it. Meiofauna, the organisms including nematodes and oligochates that live within the sediments and microfauna, ciliate protozoans, also consume MPB. Despite all these consumers, it is unlikely MPB is controlled by top-down processes, rather, light is the primary limiting factor affecting growth (MacIntyre et al. 1996, Miller et al. 1996). Over water structures limiting light to water bottoms limit healthy MPB communities. Pilings may also decrease light levels by casting shade on sediments around the structure (Burdick and Short, 1999; Pagliosa et al., 2012). All of these changes in environmental conditions have the potential to interfere with important functions of soft bottom ecosystems such as benthic community respiration, primary productivity, and sediment-water nutrient cycling.

Mudflats provide habitat for the most diverse invertebrate assemblages of the coastal wetlands, which include gastropods and bivalves, polychaetes, amphipods, and crabs (Levin et al. 1998). Although most fish can only use these habitats when they are flooded, burrowing gobiids can reside in the mudflats through the tidal cycle. During high tides these habitats are utilized by a variety of fish that migrate daily from subtidal habitats. These subtidal to intertidal movements are primarily related to feeding and in some cases predator avoidance (Ruiz et al. 1993).

Animal assemblages within salt marshes are quite diverse and include both resident and transient species. The epifaunal assemblages are dominated by gastropod and bivalve mollusks, insects, amphipods, isopods, and crabs (Scatolini and Zedler 1996).

Tidal creeks and channels connect marshes to subtidal basins and to the ocean, these serve as corridors for animals and energy. They provide access to the marshes, are migratory pathways, and represent vital links to a variety of habitats used by various species. Additionally, these channels serve as habitat and transition areas for commercially important larval and juvenile fishes (Nordby 1982).

Seagrasses

Seagrass species found on the West Coast of the U.S. include eelgrass species (*Zostera* spp.), widgeongrass (*Ruppia maritima*), and surfgrass (*Phyllospadix* spp.). These grasses are vascular plants, not seaweeds, forming dense beds of leafy shoots year-round in the lower intertidal and subtidal areas. Eelgrass is found on soft-bottom substrates in intertidal and shallow subtidal areas of estuaries and occasionally in other nearshore areas. Surfgrass is found on hard-bottom substrates along higher energy coasts.

Studies have shown seagrass beds to be among the areas of highest primary productivity in the world (Herke and Rogers 1993, Hoss and Thayer 1993). In general, eelgrass beds provide a wide array of ecological functions important in maintaining a healthy estuarine and coastal ecosystem (Anderson 1989, Peterson and Lipcius 2003). Eelgrass habitat functions as an important structural environment for resident bay and estuarine species, offering refuge from predation and high current velocity (Orth 1977, Peterson and Quammen 1982), along with serving as a food source. Eelgrass functions as a nursery area for many commercially and recreational important finfish and shellfish species, including those that are resident within bays and estuaries, as well as oceanic species that enter estuaries to breed or spawn (Hoffman 1986, Heck et al. 1989, Dean et al. 2000, Semmens 2008). Eelgrass also provides a unique habitat that supports a high diversity of non-commercially important species whose ecological roles are less well understood (Peterson et al. 1984, Murphy et al. 2000, Malavasi et al. 2007).

As the basis for a nearshore detrital-based food web, eelgrass provides a large proportion of the total primary production for some nearshore ecosystems. Eelgrass is also a source of secondary production, providing a substratum for supporting epiphytic plants (Penhale 1977), animals (Orth 1973), and microbial organisms (Pedersen et al. 1999) that in turn are grazed upon by other invertebrates (Orth et al. 1984, Nelson 1997), larval and juvenile fish (Thom 1989), and birds (Bayer 1980). Thus, eelgrass contributes functions to the ecosystem at multiple trophic levels (Phillips and Watson 1984, Thayer et al. 1984). In addition to habitat and resource attributes, eelgrass serves beneficial physical and chemical roles in bays and estuaries. Eelgrass beds dampen wave and current action (Fonseca and Fisher 1986, Fonseca et al. 1983, Fonseca and Cahalan 1992), trap suspended particulates, and reduce erosion by stabilizing the sediment (Thayer et al. 1984). They also improve water clarity, cycle nutrients (Kenworthy et al. 1982, Kenworthy and Thayer 1984, Penhale and Smith 1977), and generate oxygen during daylight hours (Murray and Wetzel 1987).

Many of the biological and physical functions of eelgrass discussed above, result in ecosystem services with significant economic value (Costanza et al. 1997). Erosion control provided by eelgrass through soil stabilization can protect shoreline property and infrastructure. Nursery functions and nutrient cycling contribute to income from commercial and recreational fisheries. Constanza et al. (1997) estimated the economic value of ecosystem services of several marine and terrestrial habitat types; eelgrass per hectare dollar value was second only to coastal estuaries among the marine habitat types and was higher than all terrestrial habitat types with the exception of floodplains. It is estimated that seagrasses provide services in excess of 1.9 trillion dollars in the form of nutrient cycling (Waycott et al. 2009). Seagrass beds are also a promising habitat for carbon sequestration that, if restored on a large enough scale, may reduce carbon from the atmosphere and could affect climate change (Mateo et al. 1997, Williams 1999).

The dynamic nature of eelgrass growth and distribution, have made it quite challenging to map and evaluate expansions and contractions. In many cases, eelgrass may have been present in an area for consecutive years, but due to a variety of factors, it may be absent from that same area for multiple years. As a result, management of eelgrass has become particularly challenging where coastal development continues to impact habitats considered suitable for eelgrass, but when the resource was absent at the time of a project-specific survey.

Kelp Canopy

Kelp forests are in decline across much of their range due to place-specific combinations of local and global stressors, including in the area designated as EFH for Pacific coast groundfish. The Salish Sea is a hotspot of kelp diversity, with 21 species of kelp identified, where many species of kelp provide critical habitat and EFH for commercially, ecologically, and culturally important fish and invertebrate species, including rockfish, forage fish, abalone, and Pacific salmon (Hollarsmith et al. 2022; NMFS 2014c; NMFS 2005c). The bull kelp (*Nereocystis luetkeana*) is the primary floating canopy-forming species, while the majority of species lie within a few meters of the bottom. Most kelps in this region grow as small forests along a narrow depth band near the shore where they are exposed to large seasonal swings in temperature and salinity. Kelp stands provide nurseries, feeding grounds, and shelter to a variety of managed species and their prey (Ebeling, et al. 1980, Feder et al. 1974).

Rocky Reefs

Rocky habitats are generally categorized as either nearshore or offshore in reference to the proximity of the habitat to the coastline. Rocky habitat may be composed of bedrock, boulders, or smaller rocks, such as cobble and gravel. Hard substrates are one of the least abundant benthic habitats, yet they are among the most important habitats for groundfish species. Rocky reefs provide the appropriate substratum for colonization of diverse algal and invertebrate assemblages creating a complex physical and biogenic habitat that provides important shelter and foraging opportunities for many species of groundfish. In Puget Sound, most of the shallow rocky habitat is on the eastern shore, which is also more urbanized and impacted. However, there is a "rind" of deeper rocky reef that forms a bathtub ring around much of the Central Basin, South Sound, and Hood Canal. NMFS expects very few overwater structures will adversely affect natural rocky reef communities given the reefs predominant distribution. Therefore, a detailed description of rocky reefs does not seem warranted for this consultation.

Areas of Interest

Areas of interest can include a variety of submarine features, such as banks, seamounts, and canyons. They can also include other types of spatially delineated areas such as all Washington State waters and the Cowcod East Conservation Area off Southern California.

Coastal Pelagic Species FMP

Designated EFH for coastal pelagic species encompasses all coastal marine, estuarine, and offshore waters to the EEZ and water above the thermocline where sea surface temperature is 10 degrees Celsius to 26 degrees Celsius. The attributes that define EFH for CPS change in time and space, making the EFH dynamic (PFMC 1998). The habitat and trophic requirements of the following pelagic species is adapted from the CPS FMP (1998, Figure 24).

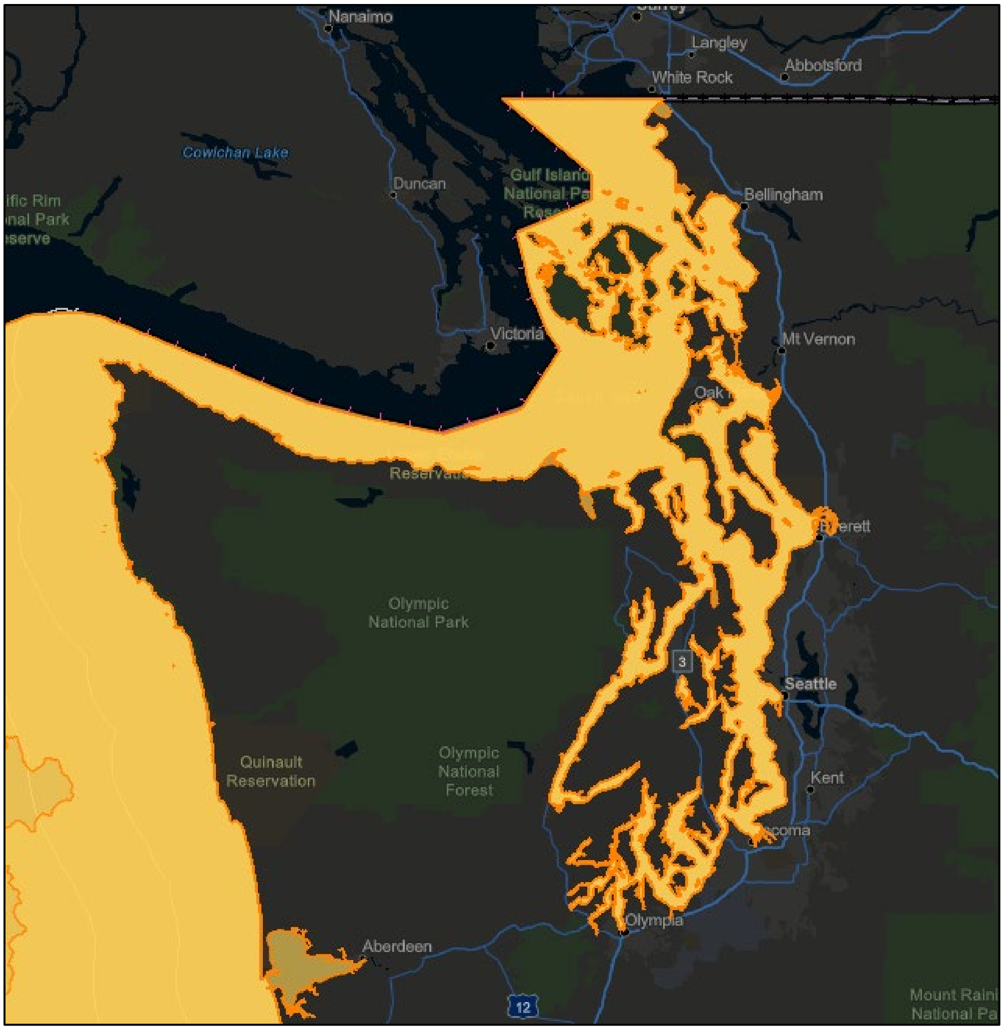

Figure 24. Coastal Pelagic Species EFH in Puget Sound, EFH Mapper

The Coastal Pelagic Species FMP includes five species, all of which have been identified as within the boundary of, and potentially affected by the activities in this batch consultation (Table 34). The Pacific sardine and northern anchovy are two commercially and ecologically important Coastal Pelagic Species with higher affinity for nearshore and embayment habitats in the Puget Sound. The Coastal Pelagic FMP does not have any HAPCs.

Table 34. Coastal Pelagic EFH Species in the Action Area

Coastal Pelagic	
Common Name	**Scientific Name**
market squid	*Loligo opalescens*
northern anchovy	*Engraulis mordax*
jack mackerel	*Trachurus symmetricus*
Pacific mackerel	*Scomber japonicus*
Pacific sardine	*Sardinops sagax*

Pacific Salmon FMP

Designated EFH for salmonid species 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 2014, Figures 25, 26, and 27).

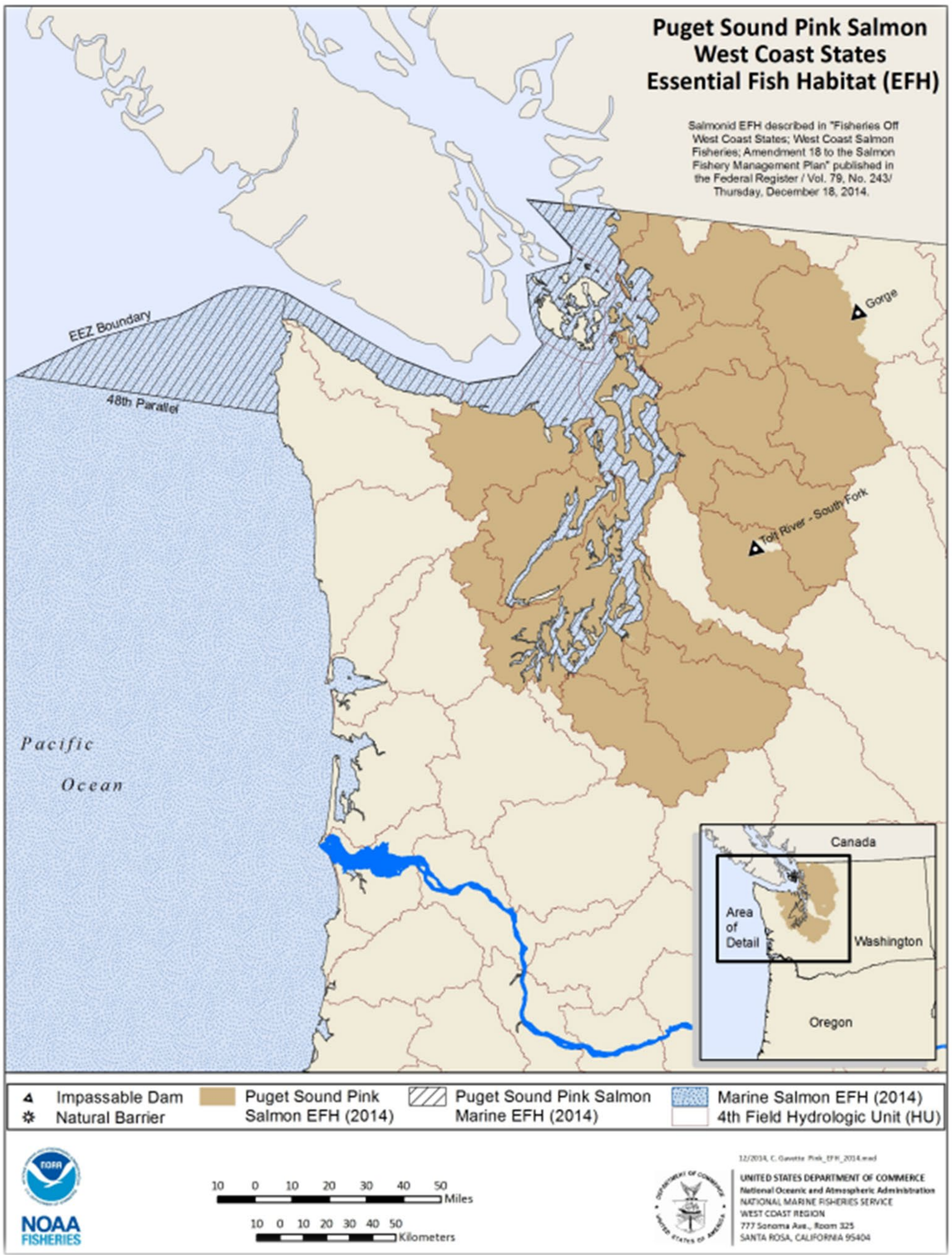

Figure 25. Pink salmon EFH (PFMC 2014)

Figure 26. Chinook salmon EFH (PFMC 2014)

Figure 27. Coho salmon EFH, (PMFC 2014)

The Pacific Salmon FMP includes three species, all of which have been identified as within the boundary of, and potentially affected by, the activities in this batch consultation (Table 35). The coho and pink salmon have a high affinity for nearshore and embayment habitats, much like the Chinook salmon, steelhead, and HCSR chum discussed in Sections 1 and 2 of the ESA portion of this document.

Table 35. Salmon EFH Species in Action Area

Salmonid Species	
Common Name	**Scientific Name**
Chinook salmon	*Oncorhynchus tshawytscha*
coho salmon	*Oncorhynchus kisutch*
pink salmon	*Oncorhynchus gorbuscha*

Pacific Salmon Habitat Areas of Particular Concern

The following describes components of the salmon HAPCs. For a more detailed description of these HAPCs, see Appendix A to the Pacific Coast Salmon FMP (PFMC 2014).

The complex channels and floodplains, thermal refugia, and spawning habitat HAPC components apply to freshwater habitats and are outside of the action area.

Estuaries

Estuaries include nearshore areas, such as bays, sounds, inlets, river mouths and deltas, pocket estuaries, and lagoons, influenced by ocean and freshwater. Because of tidal cycles and freshwater runoff, salinity varies within estuaries and results in great diversity, offering freshwater, brackish, and marine habitats within close proximity. Such areas tend to be shallow, protected, nutrient rich, and biologically productive, providing important habitat for marine organisms, including salmon.

Marine and Estuarine Submerged Aquatic Vegetation

Submerged aquatic vegetation includes the canopy kelps and eelgrass, as well as a broad variety of non-canopy kelps and turf algaes. These habitats have been shown to have some of the highest primary productivity in the marine environment and provide a significant contribution to the marine and estuarine food webs.

Kelps are brown macroalgae and include those that float to form canopies and those that do not, such as *Laminaria* spp. Canopy-forming kelps of the Pacific Coast are dominated by two species, giant kelp (*Macrocystis pyrifera*) and bull kelp (*Nereocystis leutkeana*). Kelp plants, besides requiring moderate to high water movement and energy levels, are most likely limited by the availability of suitable substrate. Native eelgrass (*Zostera marina*) forms dense beds of leafy shoots year-round in the soft sediments of the lower intertidal and shallow subtidal zone. Eelgrass forms a three-dimensional structure in an otherwise two-dimensional (sand or mud) environment. Turf algaes, including green or red (*Ulva spp.*) or Sargasaum (*Gracilaria spp.*), occupy much of Puget Sounds shorelines (http://mva-test.apphb.com/index.html). Turf algae are multispecies assemblages of small, mostly filamentous algae that attain a height of only 1 mm to 2 cm and provide a nutritious food source for various herbivorous fish and invertibrates.

3.2 Adverse Effects on Essential Fish Habitat

Alterations to the nearshore light, wave energy, and substrate regimes affect the nature of EFH and nearshore food webs that are important to a wide variety of marine finfish and shellfish (Armstrong et al.1987, Beal 2000; Burdick and Short 1995, Cardwell and Koons 1981, Fresh and Williams 1995, Kenworthy and Haunert 1991, Olson et al. 1996, Parametrix and Battelle 1996, Penttila and Doty 1990, Shafer 1999; Simenstad et al. 1979, 1980, 1998, Thom and Shreffler 1996, Weitkamp 1991).

The effects of the proposed action on ESA-listed species are described in Section 2.4 of the ESA analysis above. The same mechanisms of effect are likely to affect all Pacific Coast groundfish, coastal pelagic species, and Pacific Coast salmon to varying degrees. Some additional adverse effects include:

Water quality – Both temporary (during construction) and permanent (during project operations) impacts likely will occur. Examples include sound, turbidity, enduring PAHs and other contaminants, low dissolved oxygen, and stormwater pollutants. Additionally, copper-based paints are frequently used on boat hulls in marine environments as an antifouling agent. These pesticidal paints slowly leach copper from the hull in order to deter attachment of fouling species, which may slow boats and increase fuel consumption. Copper that is leached into the marine environment does not break down and may accumulate in aquatic organisms, particularly in systems with poor tidal flushing. At low concentrations, metals such as copper may inhibit development and reproduction of marine organisms, and at high concentrations they can directly contaminate and kill fish and invertebrates. In coho salmon, low levels of copper have been shown to cause olfactory impairment, affecting their predator avoidance and survivial (McIntyre 2012). These metals have been found to adversely impact phytoplankton (NEFMC 1998), larval development in haddock, and reduced hatch rates in winter flounder (Bodammer 1981, Klein-MacPhee et al. 1984). Other animals can acquire elevated levels of copper indirectly through trophic transfer, and may exhibit toxic effects at the cellular level (DNA damage), tissue level (pathology), organism level (reduced growth, altered behavior and mortality), and community level (reduced abundance, reduced species richness, and reduced diversity) (Weis et al. 1998, Weis and Weis 2004, Eisler 2000).

Forage reduction – Disturbance and shading of SAV can result in reduction in SAV density and abundance, and related primary production. Designated EFH in the action area will experience temporary, episodic, and enduring declines for MSA managed species' forage or prey communities.

Whitney and Darley (1983) found that microalgal communities in shaded areas are generally less productive than unshaded areas, with productivity positively correlated with ambient irradiance. Stutes et al. (2006) found a significant effect of shading on both sediment primary production and metabolism (i.e. sediment respiration). Intertidal salt marsh plants are also impacted by shading: the density of Spartina alterniflora was significantly lower under docks than adjacent to docks in South Carolina estuaries, with stem densities decreased by 71 percent (Sanger et al. 2004). Kearny et al. (1983) found the *S. alterniflora* was completely shaded out under docks that were less than 40 cm high and that the elimination of the macrophytic communities under the docks ultimately led to increased sediment erosion. Thom et al. (2008) evaluated the effects of short- and long-term reductions in submarine light reaching eelgrass in the Pacific Northwest, especially related to turbidity and overwater structures. They found that lower light levels may result in larger and less dense plants and provided light requirements for the protection and restoration of eelgrass.

Reductions in benthic primary productivity may in turn adversely affect invertebrate distribution patterns. For example, Struck et al. (2004) observed invertebrate densities under bridges at 25-52 percent of those observed at adjacent unshaded sites. These results were found to be correlated with diminished macrophyte biomass, a direct result of increased shading. Overwater structures that attenuate light may adversely affect estuarine marsh food webs by reducing macrophyte growth, soil organic carbon, and altering the density and diversity of benthic invertebrates (Whitcraft and Levin 2007). Reductions in primary and invertebrate productivity may additionally limit available prey resources to federally managed fish species and other important commercial and recreational species. Prey resource limitations likely impact movement patterns and the survival of many juvenile fish species. Adverse impacts to estuarine productivity may, therefore, have effects that cascade through the nearshore food web.

Fishes rely on visual cues for spatial orientation, prey capture, schooling, predator avoidance, and migration. Juvenile and larval fish are primarily visual feeders with starvation being the major cause of larval mortality in marine fish populations. Survival at early life history stages is often critical in determining recruitment and survival at subsequent life stages, with survival linked to the ability to locate and capture prey and to avoid predation (Britt 2001). The reduced-light conditions found under overwater structures limit the ability of fishes, especially juveniles and larvae, to perform these essential activities. For example, Able et al. (1999) found that caged fish under piers had growth rates similar to those held in a laboratory setting without food. In contrast, growth rates of fish caged in pile fields and open water were significantly higher. Able et al. (1998) also demonstrated that juvenile fish abundance and species richness was significantly lower under piers in an urban estuary. Although some visual predators may use alternative modes of perception, feeding rates sufficient for growth in dark areas usually demand high prey concentrations and encounter rates (Grecay and Targett 1996). As coastal development and overwater structure expansion continues, the underwater light environment will continue to degrade, resulting in adverse effects to EFH and nearshore ecosystems.

1. Migration and passage - Designated salmon EFH (Chinook, coho and Puget Sound pink) will experience enduring incremental diminishment of safe migration. As mentioned in Section 2.4 above, in the marine nearshore, there is substantial evidence that OWS impede the nearshore movements of juvenile salmonids.

2. Shoreline armoring projects will reduce available nearshore habitat - Reduction in quality of nearshore habitat through removal of riparian vegetation and resulting reduction of allochthonous input to the nearshore. Armoring also degrades sediment conditions, forage base, and access to shallow water waterward of the structures. Furthermore, access to forage and shallow water habitat upland of the structures is prevented during high tides.

3. Non-indigenous Species Associations with Overwater Structures - Non-indigenous species (NIS) are a significant environmental threat to biological diversity (Vitousek et al. 1996, Simberloff et al. 2005). The cost of NIS to the U. S. economy was estimated to be in excess of $137 billion in 2005 (Pimentel et al. 2005). With the expansion of worldwide shipping, the transport of marine NIS via ballast water tanks on ships is now the most significant pathway of introduction of aquatic invasive species into marine ecosystems.

In a 2008 study to evaluate NIS arriving in ballast water, zooplankton was sampled in 380 ballast tanks of ships after they entered Puget Sound. Taxa were classified into a higher risk group of coastal organisms (including known NIS), and a lower risk group of largely oceanic species. Most ships reported conducting mid-ocean ballast water exchange (BWE). However, despite state regulations requiring BWE, and apparent compliance by ship operators, most sampled tanks from both transpacific and coastal routes had coastal zooplankton densities exceeding internationally proposed discharge standards. BWE efficiency models and controlled before-and-after BWE experiments indicate that BWE consistently removes most coastal zooplankton. However, this study found that although the empty-refill method of BWE significantly reduced coastal plankton compared with un-exchanged tanks, the flow-through method did not, and in either case remaining coastal plankton densities presented appreciable risks of introducing NIS. Densities of high-risk taxa were consistently and significantly higher from US domestic trips dominated by tank ships carrying ballast water from California, and lower in samples from trans-Pacific trips dominated by container ships and bulk carriers with ballast from Asia. These findings are probably a result of the dense and diverse NIS assemblages present in California and other US west coast estuaries, and the comparatively short transit times between them and Puget Sound.

Although not the cause of direct introductions, artificial overwater structures and associated substrate provide increased opportunity for NIS colonization and exacerbate the increase in abundance and distribution of NIS (Bulleri and Chapman 2010). "It is clear that artificial structures can pave the way and act as stepping stones or even corridors for some marine aliens" (Mineur et al. 2012). In a survey of NIS within sheltered waters of CA, the largest numbers of exotic species were found on floating piers and associated structures (Cohen et al. 2002).

Glasby et al. (2007) argue that artificial structures, such as floating docks and pilings, provide entry points for invasion and increase the spread and establishment of NIS in estuaries. Within Elkhorn Slough, Wasson et al. (2005) found that hard substrate harbored significantly more exotic species than soft substrate. In Maine, Tyrell and Byers (2007) found that exotic tunicates were disproportionately enhanced on artificial surfaces. Dafforn et al. (2009) found that, overall, native species were disproportionally less numerous than NIS on shallow moving surfaces. These results would implicate floating structures, such as floating docks, pontoons, mooring balls, and vessel hulls as potential "hotspots" for NIS. Dafforn et al. (2009) also found NIS were more abundant on artificial substrates exposed to copper and/or anti-fouling paints, indicating that artificial structures associated with overwater structures such as vessel hulls may also promote NIS. Given the relative lack of natural hard bottom habitat in estuaries, the addition of artificial hard structures within this type of habitat may provide an invasion opportunity for non-indigenous hard substratum species (Glasby et al. 2007, Wasson et al. 2005, Tyrell and Byers, 2007). Therefore, NMFS believes that artificial substrate in estuaries may contribute to further proliferation of NIS. Some researchers have recommended that coastal managers should consider limiting the amount of artificial hard substrates in estuarine environments (Wasson et al. 2005, Tyrell and Byers 2007).

Long-term impacts of NIS can change the natural community structure and dynamics, lower the overall fitness and genetic diversity of natural stocks, and pass and/or introduce exotic lethal disease. Overall, exotic species introductions create five types of negative impacts to EFH and associated federally management fish species: 1) habitat alteration, 2) trophic alteration, 3) gene pool alteration, 4) spatial alteration, and 5) introduction of diseases/pests.

Non-native plants and algae can degrade coastal and marine habitats by changing natural habitat qualities. Habitat alteration includes the excessive colonization of exotic species (e.g., *Caulerpa taxifola*) which preclude the growth of native organisms (e.g., eelgrass). *Caulerpa taxifolia* is a green alga native to tropical waters that typically grows in limited patches. A particularly cold tolerant clone (tolerant of temperatures at least as low as 10 °C for a period of three months) of this species has already proven to be highly invasive in the Mediterranean Sea and efforts to control its spread have been unsuccessful. In areas where the species has become well established, it has caused ecological and economic devastation by overgrowing and eliminating native seaweeds, seagrasses, reefs, and other communities. In the Mediterranean, it is reported to have harmed tourism and pleasure boating, devastated recreational diving, and had a significant impact on commercial fishing both by altering the distribution of fish as well as creating a considerable impediment to net fisheries.

The introduction of NIS may also alter community structure by predation on native species or by population explosions of the introduced species (Byers 1999). Introduced NIS increases competition with indigenous species, or forage on indigenous species, which can reduce fish and shellfish populations. Although hybridization is rare, it may occur between native and introduced species and can result in gene pool deterioration (Currant et al. 2008). Spatial alteration occurs when territorial introduced species compete with and displace native species (Blossey and Notzold 1995). The introduction of bacteria, viruses, and parasites is another threat to EFH as it may reduce habitat quality. New pathogens or higher concentrations of disease can be spread throughout the environment resulting in deleterious habitat conditions, reduced species survival and overall fitness.

The chronic, episodic, and enduring diminishments of EFH created by nearshore, in-water and overwater structures to water quality, migration areas, shallow water habitat, forage base, and SAV has and will continue to incrementally degrade the function of EFH. The effects further constrain the carrying capacity for some life stages (larval and juvenile) for multiple species within the action area.

EFH Adverse Effects Determination

Based upon the above effects analysis, NMFS has determined that the activities covered under this consultation would adversely affect EFH for various federally managed fish species under the Pacific Coast groundfish species, coastal pelagic species, and Pacific Coast salmon species

FMPs. Moreover, extending the useful life and increases in over-, in-, and near-water structures will adversely affect estuary and seagrass HAPCs for Pacific Coast salmon and Pacific Coast groundfish. Given the significant alteration of existing shoreline habitat, NMFS believes additional impacts to EFH associated with extending the useful life or expanding over-, in-, and near-water coverage would be substantial.

3.3 Essential Fish Habitat Conservation Recommendations

Pursuant to Section 305(b)(4)(A) of the MSA, NMFS is required to provide EFH Conservation Recommendations to federal agencies regarding actions that would adversely affect EFH. To mitigate for the adverse effects of the project described above, the NMFS recommends that the USACE use its authority at 33 CFR 320.4(r)[49] to require compensatory mitigation for adverse effects to EFH resulting from the construction, maintenance, replacement and expansion of such structures as piers, wharves, bulkheads, dolphins, marinas, ramps and floats. In addition to this recommendation, the NMFS makes further recommendations below to address the adverse effects described in the sections above. Fully implementing these EFH Conservation Recommendations (CRs) would protect, by using the mitigation hierarchy to first avoid impacts, and then minimize impact, and finally to otherwise offset the adverse effects described in Sections 3.2 and 2.4 above.

General Recommendations

1. All overwater structure construction (including in-kind replacement) should be required to follow eelgrass monitoring requirements put forth in the Washington Department of Fish and Wildlife “Eelgrass/Macroalgae Habitat Interim Survey Guidelines”[50]. Exceptions may be granted for areas that the USACE and the NMFS believe are highly unlikely to support eelgrass habitat.

2. Given the significant alteration of existing shoreline and shallow water habitats in Puget Sound, all overwater structures should be water dependent. Proposed projects should clearly explain their water dependency and why the project is in the public’s best interest.

3. As part of the project permit, the applicants should describe how their proposal addresses the specific conservation recommendations identified below. NMFS recognizes that not all conservation recommendations will be relevant in all situations. Therefore, the proponent should clearly articulate when a particular recommendation is not applicable to

[49] (r) Mitigation.1 (1) Mitigation is an important aspect of the review and balancing process on many Department of the Army permit applications. Consideration of mitigation will occur throughout the permit application review process and includes avoiding, minimizing, rectifying, reducing, or compensating for resource losses. Losses will be avoided to the extent practicable. Compensation may occur on-site or at an off-site location.
(2) All compensatory mitigation will be for significant resource losses which are specifically identifiable, reasonably likely to occur, and of importance to the human or aquatic environment. Also, all mitigation will be directly related to the impacts of the proposal, appropriate to the scope and degree of those impacts, and reasonably enforceable. District engineers will require all forms of mitigation, including compensatory mitigation, only as provided in paragraphs (r)(1) (i) through (iii) of this section. Additional mitigation may be added at the applicants' request.

[50] https://wdfw.wa.gov/sites/default/files/publications/00714/wdfw00714.pdf

the proposed project. Based upon the project application, the Corps should determine if the project implements appropriate conservation recommendations.

Pile Removal and Installation

Minimization:

1. Encircle the pile with a silt curtain that extends from the surface of the water to the substrate, where appropriate and feasible.

2. If contaminated sediment occurs in the footprint of the proposed project, cap all holes left by the piles with clean native sediments.

3. Drive piles during low tide periods when substrates are exposed in intertidal areas. This minimizes the direct impacts to fish from sound waves and minimizing the amount of sediments re-suspended in the water column.

4. Use a vibratory hammer to install piles, when possible. Under those conditions where impact hammers are required (i.e., substrate type and seismic stability) the pile should be driven as deep as possible with a vibratory hammer prior to the use of the impact hammer. This will minimize noise impacts.

Over- and in- water Structures

For all projects, the project proponent should strive to implement avoidance measures to the extent feasible. When avoidance measures are not feasible, minimization measures should be implemented.

Avoidance:

1. To the maximum extent practicable, site overwater structures in areas not occupied by or determined to be suitable for sensitive habitat (e.g., SAV, intertidal flats, etc.).

2. Any cross or transverse bracing should be placed above the MHHW to avoid impacts to water flow and circulation.

Minimization:

1. Minimize, to the maximum extent practicable, the footprint of the overwater structure. The overwater structure should be the minimum size necessary to meet the water dependent purpose of the project.

2. Design structures in a north-south orientation, to the maximum extent practicable, to minimize persistent shading over the course of a diurnal cycle.

3. For residential dock and pier structures, the height of the structure above water should be a minimum of 5 feet above MHHW.

4. Extend the structure's terminal platform into nearest adjacent deep water to minimize the need for dredging and to minimize the likelihood of boat grounding, propeller scar/scour in shallow water habitat.

5. Use the fewest number of piles as practicable for necessary support of the structure to minimize pile shading, substrate impacts, and impacts to water circulation. Pilings should be spaced a minimum of 10 feet apart on center.

6. The use of floating dock structures should be minimized to the extent practicable and should be restricted to terminal platforms placed in the deepest water available at the project site.

7. Use floating breakwaters whenever possible and remove them during periods of low dock use. Encourage only seasonal use of docks and off-season haul-out of boats and structures.

Nearshore Structures

Minimization

1. Use soft approaches (e.g., beach nourishment, soft or hybrid armoring, vegetative plantings, and placement of LWD) in lieu of "hard" shoreline stabilization and modifications (such as concrete bulkheads and seawalls, concrete or rock revetments).

2. Use manmade structures in combination with ecosystem-based methods (e.g., oyster domes) to promote both shoreline protection and ecological benefits (Gedan et al. 2011).

3. If planting in the riparian zone, use an adaptive management plan with ecological indicators and performance standards to oversee monitoring and ensure mitigation objectives are met. Take corrective action as needed.

3.4 Statutory Response Requirement

This consultation is specific to the effects of the proposed action on the EFH for MSA managed species. NMFS has determined the action(s) would adversely affect EFH for MSA managed species that are not listed under ESA, and has provided EFH Conservation Recommendations necessary for those species' EFH.

As required by section 305(b)(4)(B) of the MSA, the USACE must provide a detailed response in writing to NMFS within 30 days after receiving these EFH CRs. Such a response must be provided at least 10 days prior to final approval of the individual project action if the response is inconsistent with any of NMFS' EFH CRs unless NMFS and the federal agency have agreed to use alternative timeframes for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the CRs, 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 CRs 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 CRs accepted, per project.

3.5 Supplemental Consultation

The USACE 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 CRs (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 Opinion addresses these DQA components, documents compliance with the DQA, and certifies that this Opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this Opinion is the USACE. Other interested users could include permit applicants, citizens of affected areas, and other parties interested in the conservation of the affected ESUs/DPS. Individual copies of this Opinion were provided to the USACE. The document will be available within two weeks 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 and the 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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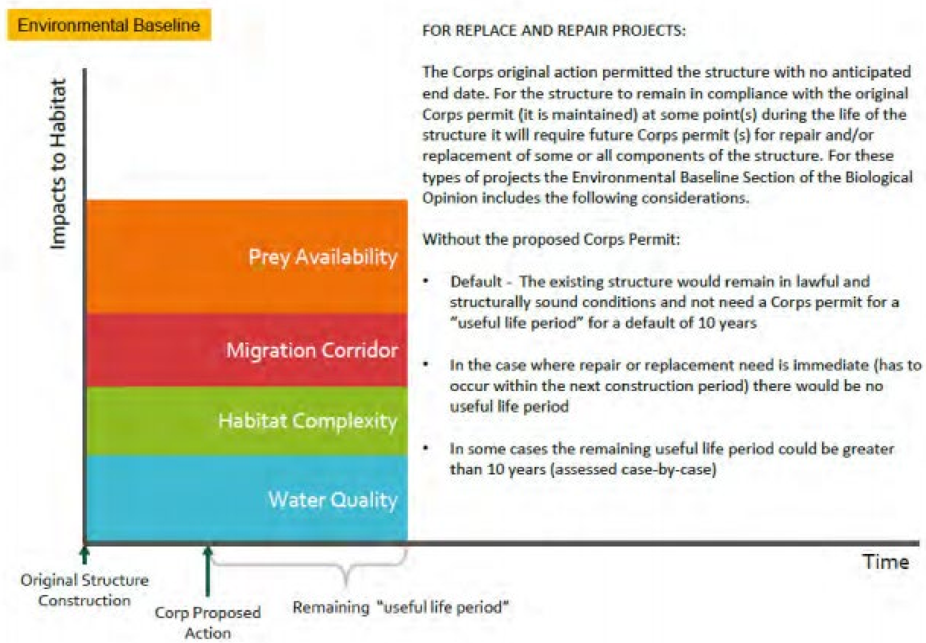
APPENDIX 1

DISTINGUISHING BASELINE FROM EFFECTS OF THE ACTION



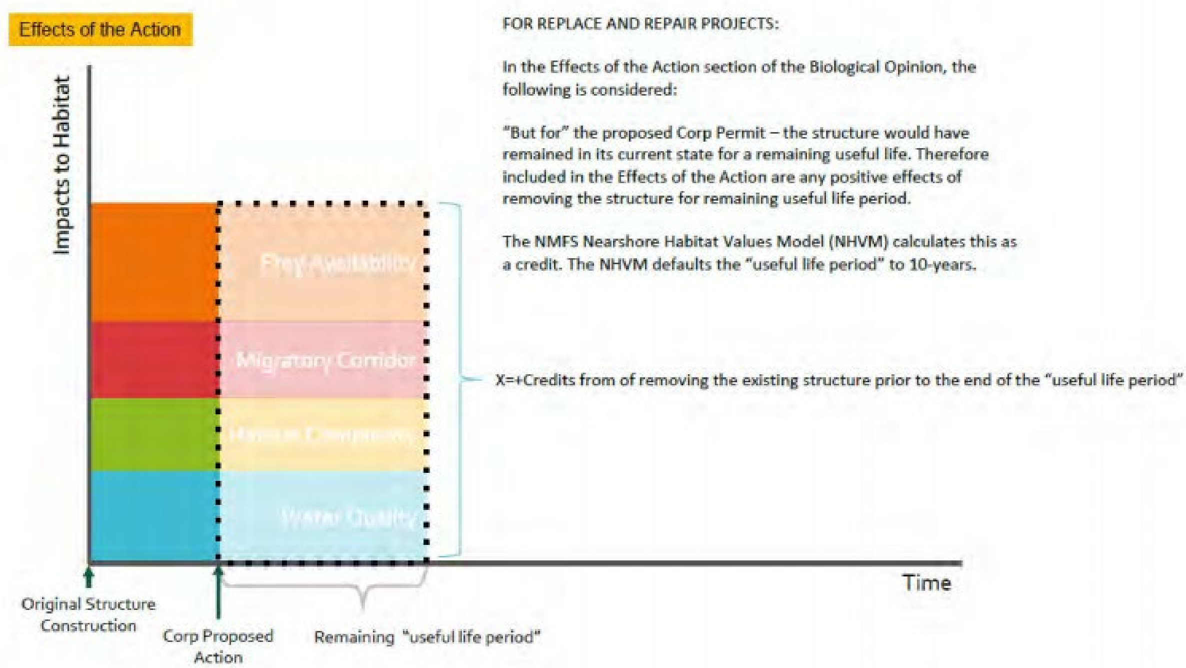
FOR REPLACE AND REPAIR PROJECTS:

The Corps original action permitted the structure with no anticipated end date. For the structure to remain in compliance with the original Corps permit (it is maintained) at some point(s) during the life of the structure it will require future Corps permit (s) for repair and/or replacement of some or all components of the structure. For these types of projects the Environmental Baseline Section of the Biological Opinion includes the following considerations.

Without the proposed Corps Permit:

- Default - The existing structure would remain in lawful and structurally sound conditions and not need a Corps permit for a "useful life period" for a default of 10 years
- In the case where repair or replacement need is immediate (has to occur within the next construction period) there would be no useful life period
- In some cases the remaining useful life period could be greater than 10 years (assessed case-by-case)

Note: This scenario is applied when a structure has not undergone previous ESA Section 7 consultation (consultation). In the event that the structure has a previous consultation, the Corps will need to asses whether the proposed repair or replacement would constitute the need for re-initiation of the previous consultation.

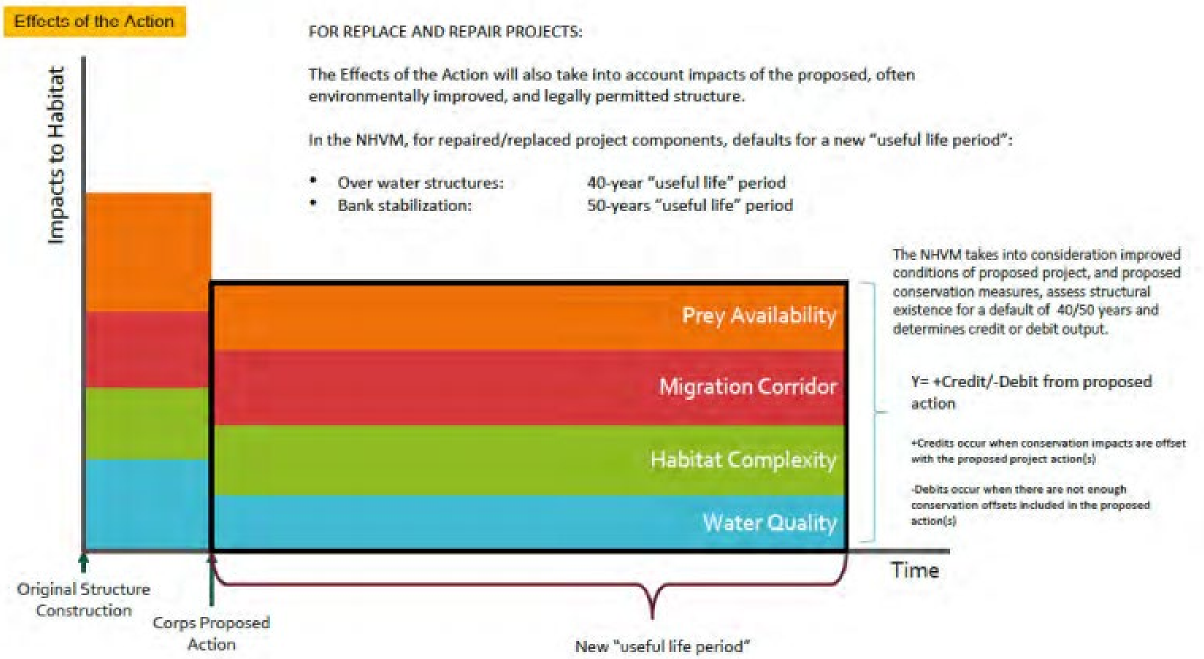


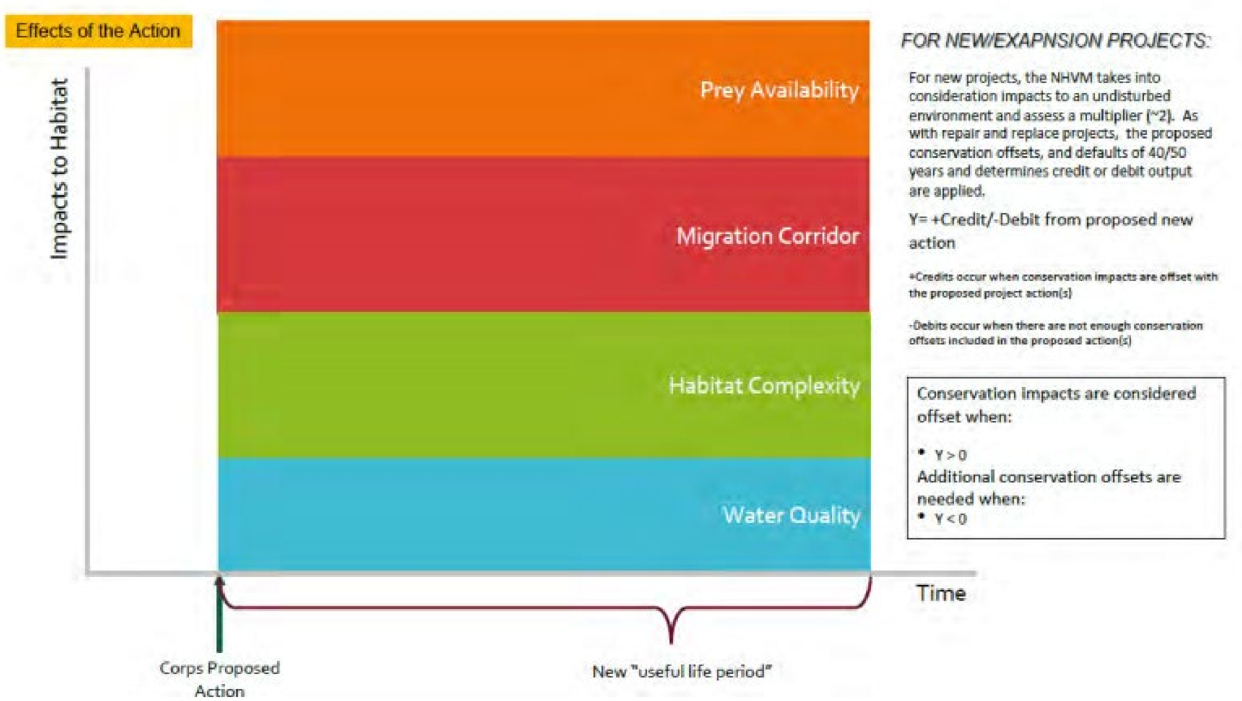
FOR REPLACE AND REPAIR PROJECTS:

In the Effects of the Action section of the Biological Opinion, the following is considered:

"But for" the proposed Corp Permit – the structure would have remained in its current state for a remaining useful life. Therefore included in the Effects of the Action are any positive effects of removing the structure for remaining useful life period.

The NMFS Nearshore Habitat Values Model (NHVM) calculates this as a credit. The NHVM defaults the "useful life period" to 10-years.


Effects of the Action
FOR REPLACE AND REPAIR PROJECTS:
The Effects of the Action will also take into account impacts of the proposed, often environmentally improved, and legally permitted structure.
In the NHVM, for repaired/replaced project components, defaults for a new "useful life period":
• Over water structures: 40-year "useful life" period
• Bank stabilization: 50-years "useful life" period
Impacts to Habitat
Prey Availability
Migration Corridor
Habitat Complexity
Water Quality
The NHVM takes into consideration improved conditions of proposed project, and proposed conservation measures, assess structural existence for a default of 40/50 years and determines credit or debit output.
Y= +Credit/-Debit from proposed action
+Credits occur when conservation impacts are offset with the proposed project action(s)
-Debits occur when there are not enough conservation offsets included in the proposed action(s)
Time
Original Structure Construction
Corps Proposed Action
New "useful life period"


Effects of the Action
Impacts to Habitat
Prey Availability
Migration Corridor
Habitat Complexity
Water Quality
FOR NEW/EXAPNSION PROJECTS:
For new projects, the NHVM takes into consideration impacts to an undisturbed environment and assess a multiplier (~2). As with repair and replace projects, the proposed conservation offsets, and defaults of 40/50 years and determines credit or debit output are applied.
Y= +Credit/-Debit from proposed new action
+Credits occur when conservation impacts are offset with the proposed project action(s)
-Debits occur when there are not enough conservation offsets included in the proposed action(s)
Conservation impacts are considered offset when:
• Y > 0
Additional conservation offsets are needed when:
• Y < 0
Time
Corps Proposed Action
New "useful life period"

APPENDIX 2

NMFS RPA Report

Project Name:

USACE Number:

NMFS Number: **WCRO-2021-03047**

Report whether the action was taken on-site or off site, which type of action was taken, how much of each action was implemented, and corresponding conservation credits as listed in your final Conservation Calculator or RPA verification letter. You may use the table below to report.

Enter RPA 1.1 and 1.2 Report if on-site or off-site	Type of structure removed or action taken	Enter Metric in ft, sqft, cubic feet, or tons	Notes	Conservation Credits
	Creosote removal			
	Bulkhead removal			
	Boat Ramp removal			
	Jetty removal			
	Overwater structure removal: pier		% grating	
	Overwater structure removal: ramp		% grating	
	Overwater structure removal: float		% grating	
	Removal of rubble			
	Addition of forage fish spawning gravel			
	Riparian plantings: native trees			
	Riparian plantings: native shrubs			
	Riparian plantings: native herbaceous			

APPENDIX 3

Observed Fish Species with Essential Fish Habitat in the Puget Sound Marine Nearshore

This appendix lists fish species included in fishery management plans under the Magnuson-Stevens Fishery Conservation and Management Act that were encountered during various routine surveys conducted throughout the 5 basins in the Puget Sound by scientists at NOAA's Northwest Fisheries Science Center (Samhouri, Andrews, Greene, Kagley, and Tolimieri, pers. comm). An 'X' indicates the species was observed in that specific Essential Fish Habitat/Habitat Areas of Particular Concern habitat type in the Puget Sound nearshore marine environment. **Bolded** common names indicate the species most likely to be affected by changes in the nearshore habitat. Ecosystem component species are stocks that are included in a Fishery Ecosystem Plan to achieve ecosystem management objectives, but do not require conservation and management. The Fishery Management Plans (FMP) each contain ecosystem component species specific to each FMP, as well as a group of ecosystem component species shared between all of the FMPs.

Common name	Scientific name	Fishery management plan	Rocky nearshore habitat	Mud or sand nearshore habitat	Eelgrass nearshore habitat	Kelp nearshore habitat	Water column nearshore habitat	Demersal (bottom trawls)
Arrowtooth flounder	*Atheresthes stomias*	Pacific Coast Groundfish						X (historically)
Big skate	*Raja binoculata*	Pacific Coast Groundfish		X				X
Black rockfish	*Sebastes melanops*	Pacific Coast Groundfish	X		X	X	X	Not consistently observed
Bocaccio	*Sebastes paucispinis*	Pacific Coast Groundfish	X			X		Not consistently observed
Brown rockfish	*Sebastes auriculatus*	Pacific Coast Groundfish	X	X		X		Not consistently observed
Butter sole	*Isopsetta isolepis*	Pacific Coast Groundfish						X
Cabezon	*Scorpaenichthys marmoratus*	Pacific Coast Groundfish	X		X	X		Not consistently observed
California skate	*Raja inornata*	Pacific Coast Groundfish		X				Not consistently observed

Common name	Scientific name	Fishery management plan	Rocky nearshore habitat	Mud or sand nearshore habitat	Eelgrass nearshore habitat	Kelp nearshore habitat	Water column nearshore habitat	Demersal (bottom trawls)
Canary rockfish	*Sebastes pinniger*	Pacific Coast Groundfish	X			X	X	Not consistently observed
China rockfish	*Sebastes nebulosus*	Pacific Coast Groundfish						Not consistently observed
Copper rockfish	*Sebastes caurinus*	Pacific Coast Groundfish	X		X	X		X
Curlfin sole	*Pleuronichthys decurrens*	Pacific Coast Groundfish						Not consistently observed
Darkblotch rockfish	*Sebastes crameri*	Pacific Coast Groundfish						Not consistently observed
Dover sole	*Microstomus pacificus*	Pacific Coast Groundfish						X
Pacific sanddab	*Ctlharichthys sordidus*	Pacific Coast Groundfish		X	X	X		X
Petrale sole	*E opsetta jordani*	Pacific Coast Groundfish						Not consistently observed
Quillback rockfish	*Sebastes maliger*	Pacific Coast Groundfish	X	X	X	X		X
Ratfish	*Hydrolagus colliei*	Pacific Coast Groundfish	X	X	X	X		X
Redbanded rockfish	*Sebastes babcocki*	Pacific Coast Groundfish						Not consistently observed
Redstripe rockfish	*Sebastes proriger*	Pacific Coast Groundfish	X	X				Not consistently observed
Rex sole	*Glyptocephalus zachirus*	Pacific Coast Groundfish						X
Rock sole	*Lepidopsetta bilineata*	Pacific Coast Groundfish	X	X	X	X		X
Rosethorn rockfish	*Sebastes helvomaculatus*	Pacific Coast Groundfish						Not consistently observed

Common name	Scientific name	Fishery management plan	Rocky nearshore habitat	Mud or sand nearshore habitat	Eelgrass nearshore habitat	Kelp nearshore habitat	Water column nearshore habitat	Demersal (bottom trawls)
Rosy rockfish	*Sebastes rosaceus*	Pacific Coast Groundfish						Not consistently observed
Rougheye rockfish	*Sebastes aleutianus*	Pacific Coast Groundfish						Not consistently observed
Sablefish	*Anoplopoma fimbria*	Pacific Coast Groundfish						X (historically)
Sand sole	*Psettichthys melanostictus*	Pacific Coast Groundfish	X	X	X	X		X
Sharpchin rockfish	*Sebastes zacentrus*	Pacific Coast Groundfish						Not consistently observed
English sole	*Parophrys vetulus*	Pacific Coast Groundfish	X	X	X	X		X
Flathead sole	*Hippoglossoides elassodon*	Pacific Coast Groundfish						X
Greenstriped rockfish	*Sebastes elongatus*	Pacific Coast Groundfish						Not consistently observed
Hake	*Merluccius productus*	Pacific Coast Groundfish						X
Kelp greenling	*Hexagrammos decagrammus*	Pacific Coast Groundfish	X		X	X		Not consistently observed
Lingcod	*Ophiodon elongatus*	Pacific Coast Groundfish	X		X	X		Not consistently observed
Longnose skate	*Raja rhina*	Pacific Coast Groundfish		X				X
Pacific cod	*Gadus macrocephalus*	Pacific Coast Groundfish	X	X	X	X		X
Pacific ocean perch	*Sebastes alutus*	Pacific Coast Groundfish						Not consistently observed
Shortspine thornyhead	*Sebastolobus alascanus*	Pacific Coast Groundfish						Not consistently observed

Common name	Scientific name	Fishery management plan	Rocky nearshore habitat	Mud or sand nearshore habitat	Eelgrass nearshore habitat	Kelp nearshore habitat	Water column nearshore habitat	Demersal (bottom trawls)
Spiny dogfish	*Squalus acanthias*	Pacific Coast Groundfish	X	X	X	X	X	X
Splitnose rockfish	*Sebastes diploproa*	Pacific Coast Groundfish						Not consistently observed
Starry flounder	*Platichthys stellatus*	Pacific Coast Groundfish		X	X	X		X
Stripetail rockfish	*Sebastes saxicola*	Pacific Coast Groundfish						Not consistently observed
Tiger rockfish	*Sebastes nigrocinctus*	Pacific Coast Groundfish						Not consistently observed
Vermilion rockfish	*Sebastes miniatus*	Pacific Coast Groundfish	X			X	X	Not consistently observed
Yelloweye rockfish	*Sebastes ruberrimus*	Pacific Coast Groundfish	X			X		Not consistently observed
Yellowtail rockfish	*Sebastes llavidus*	Pacific Coast Groundfish	X			X	X	Not consistently observed
Market squid	*Loligo opalescens*	Coastal Pelagic Species					X	Not consistently observed
Northern anchovy	*Engraulis mordax*	Coastal Pelagic Species				X	X	Not consistently observed
Jack mackerel	*Trachurus symmetricus*	Coastal Pelagic Species						Not consistently observed
Pacific mackerel	*Scomber japonicus*	Coastal Pelagic Species						Not consistently observed
Pacific sardine	*Sardinops sagax*	Coastal Pelagic Species				X	X	Not consistently observed
Chinook salmon	*Oncorhynchus tshawytscha*	Pacific Coast Salmon	X	X	X	X	X	Not consistently observed
Coho salmon	*Oncorhynchus kisutch*	Pacific Coast Salmon	X	X	X	X	X	Not consistently observed

Common name	Scientific name	Fishery management plan	Rocky nearshore habitat	Mud or sand nearshore habitat	Eelgrass nearshore habitat	Kelp nearshore habitat	Water column nearshore habitat	Demersal (bottom trawls)
Pink salmon	*Oncorhynchus gorbuscha*	Pacific Coast Salmon	X	X	X	X	X	Not consistently observed
Pacific sand lance	*Ammodytes hexapterus*	Ecosystem Component Species	X	X	X	X	X	Not consistently observed
Surf smelt	*Hypomesus pretiosus*	Ecosystem Component Species	X	X	X	X	X	Not consistently observed
Pacific Herring	*Clupea pallasii*	Ecosystem Component Species	X	X	X	X	X	X

ATTACHMENTS 1-15

Project Attachments for USACE Administrative Ease for Each Project

Puget Sound Nearshore Batch Opinion **WCRO-2021-03047**

Project Attachment for USACE Administrative Ease for: **NWS-2018-263**

Summary of current status of **NWS-2018-263** (at date of final signing of **WCRO-2021-03047**)

- Subject to the Reasonable and Prudent Alternative (RPA):**Yes**

- Current Nearshore Habitat Values Model Output: **-33 (- debits/+ credits)**

NOTE – This output includes conservation offsets that the applicant has not yet committed to implement; in this case without these assumed conservation offsets the currently reflected in NMHV results the amount of resulting debits could be larger (or smaller) and result in the need of additional (or fewer) credits needed for RPA fulfillment.

- Work window for this project: **July 16 - February 15**
- Number of days of in-water work/number of work windows: **30/1**
- Number of days that pile driving will occur/ number of work windows: **0**
- Impact pile driving activities - maximum number of pile strikes per day: **NA**
- Vibratory pile driving activities – minutes of vibratory driving per day: **NA**
- Creosote removal – minimum tons removed (can remove more): **NA**
- Dredging projects - maximum cubic yards dredge: **36000**
- In and overwater structure – maximum square foot of structure: **NA**
- Bulkhead/bank armoring – maximum linear foot of structure: **NA**
- Bulkhead/bank armoring – structure placement should not extend below: **NA**
- Stormwater discharge – square foot of impervious surface generating stormwater: **NA**

The RPM(s) that are applicable to this project are:
RPM 1 - **NA**
RPM 2 - **Required**
RPM 3 - **Required**
RPM 4 - **NA**
RPM 5 - **Required**

The T&C(s) that are applicable to this project are:
T&C 1 - **NA**
T&C 2 - **Required**
T&C 3 - **Required**
T&C 4 - **NA**
T&C 5 - **Required**

Puget Sound Nearshore Batch Opinion **WCRO-2021-03047**

Project Attachment for USACE Administrative Ease for: **NWS-2018-1183**

Summary of current status of **NWS-2018-1183** (at date of final signing of **WCRO-2021-03047**)

- Subject to the Reasonable and Prudent Alternative (RPA):**Yes**

- Current Nearshore Habitat Values Model Output: **-11 (- debits/+ credits)**

NOTE – This output includes conservation offsets that the applicant has not yet committed to implement; in this case without these assumed conservation offsets the currently reflected in NMHV results the amount of resulting debits could be larger (or smaller) and result in the need of additional (or fewer) credits needed for RPA fulfillment.

- Work window for this project: **July 16 - January 14**
- Number of days of in-water work/number of work windows: **2/1**
- Number of days that pile driving will occur/ number of work windows: **1**
- Impact pile driving activities - maximum number of pile strikes per day: **180**
- Vibratory pile driving activities – minutes of vibratory driving per day: **NA**
- Creosote removal – minimum tons removed (can remove more): **2.6**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of structure: **400**
- Bulkhead/bank armoring – maximum linear foot of structure: **NA**
- Bulkhead/bank armoring – structure placement should not extend below: **NA**
- Stormwater discharge – square foot of impervious surface generating stormwater: **NA**

The RPM(s) that are applicable to this project are:
RPM 1 - **Required**
RPM 2 - **NA**
RPM 3 - **Required**
RPM 4 - **NA**
RPM 5 - **Required**

Puget Sound Nearshore Batch Opinion **WCRO-2021-03047**

Project Attachment for USACE Administrative Ease for: **NWS-2019-682**

Summary of current status of **NWS-2019-682** (at date of final signing of **WCRO-2021-03047**)

- Subject to the Reasonable and Prudent Alternative (RPA):**No**

- Current Nearshore Habitat Values Model Output: **840 (- debits/+ credits)**

NOTE – This output includes conservation offsets that the applicant has not yet committed to implement; in this case without these assumed conservation offsets the currently reflected in NMHV results the amount of resulting debits could be larger (or smaller) and result in the need of additional (or fewer) credits needed for RPA fulfillment.

- Work window for this project: **July 16 - February 15**
- Number of days of in-water work/number of work windows: **120/1**
- Number of days that pile driving will occur/ number of work windows: **7**
- Impact pile driving activities - maximum number of pile strikes per day: **520**
- Vibratory pile driving activities – minutes of vibratory driving per day: **300**
- Creosote removal – minimum tons removed (can remove more): **387.0**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of structure: **74,238**
- Bulkhead/bank armoring – maximum linear foot of structure: **NA**
- Bulkhead/bank armoring – structure placement should not extend below: **NA**
- Stormwater discharge – square foot of impervious surface generating stormwater: **NA**

The RPM(s) that are applicable to this project are:
RPM 1 - **Required**
RPM 2 - **NA**
RPM 3 - **Required**
RPM 4 - **NA**
RPM 5 - **Required**

The T&C(s) that are applicable to this project are:
T&C 1 - **Required**
T&C 2 - **NA**
T&C 3 - **Required**
T&C 4 - **NA**
T&C 5 - **Required**

Puget Sound Nearshore Batch Opinion **WCRO-2021-03047**

Project Attachment for USACE Administrative Ease for: **NWS-2019-725**

Summary of current status of **NWS-2019-725** (at date of final signing of **WCRO-2021-03047**)

- Subject to the Reasonable and Prudent Alternative (RPA):**Yes**
- Current Nearshore Habitat Values Model Output: **-359 (- debits/+ credits)**

NOTE – This output includes conservation offsets that the applicant has not yet committed to implement; in this case without these assumed conservation offsets the currently reflected in NMHV results the amount of resulting debits could be larger (or smaller) and result in the need of additional (or fewer) credits needed for RPA fulfillment.

- Work window for this project: **July 16 - February 15**
- Number of days of in-water work/number of work windows: **30/2**
- Number of days that pile driving will occur/ number of work windows: **0**
- Impact pile driving activities - maximum number of pile strikes per day: **NA**
- Vibratory pile driving activities – minutes of vibratory driving per day: **NA**
- Creosote removal – minimum tons removed (can remove more): **NA**
- Dredging projects - maximum cubic yards dredge: **248422**
- In and overwater structure – maximum square foot of structure: **NA**
- Bulkhead/bank armoring – maximum linear foot of structure: **NA**
- Bulkhead/bank armoring – structure placement should not extend below: **NA**
- Stormwater discharge – square foot of impervious surface generating stormwater: **NA**

The RPM(s) that are applicable to this project are:
RPM 1 - **NA**
RPM 2 - **Required**
RPM 3 - **Required**
RPM 4 - **NA**
RPM 5 - **Required**

Puget Sound Nearshore Batch Opinion **WCRO-2021-03047**

Project Attachment for USACE Administrative Ease for: **NWS-2019-759**

Summary of current status of **NWS-2019-759** (at date of final signing of **WCRO-2021-03047**)

- Subject to the Reasonable and Prudent Alternative (RPA):**Yes**

- Current Nearshore Habitat Values Model Output: **-500 (- debits/+ credits)**

NOTE – This output includes conservation offsets that the applicant has not yet committed to implement; in this case without these assumed conservation offsets the currently reflected in NMHV results the amount of resulting debits could be larger (or smaller) and result in the need of additional (or fewer) credits needed for RPA fulfillment.

- Work window for this project: **July 16 - February 15**
- Number of days of in-water work/number of work windows: **56/1**
- Number of days that pile driving will occur/ number of work windows: **0**
- Impact pile driving activities - maximum number of pile strikes per day: **NA**
- Vibratory pile driving activities – minutes of vibratory driving per day: **NA**
- Creosote removal – minimum tons removed (can remove more): **NA**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of structure: **NA**
- Bulkhead/bank armoring – maximum linear foot of structure: **453**
- Bulkhead/bank armoring – structure placement should not extend below: **2.17 ft below MHHW**
- Stormwater discharge – square foot of impervious surface generating stormwater: **NA**

The RPM(s) that are applicable to this project are:
RPM 1 - **NA**
RPM 2 - **NA**
RPM 3 - **Required**
RPM 4 - **NA**
RPM 5 - **Required**

The T&C(s) that are applicable to this project are:
T&C 1 - **NA**
T&C 2 - **NA**
T&C 3 - **Required**
T&C 4 - **NA**
T&C 5 - **Required**

Puget Sound Nearshore Batch Opinion **WCRO-2021-03047**

Project Attachment for USACE Administrative Ease for: **NWS-2019-799**

Summary of current status of **NWS-2019-799** (at date of final signing of **WCRO-2021-03047**)

- Subject to the Reasonable and Prudent Alternative (RPA):**Yes**

- Current Nearshore Habitat Values Model Output: **-202 (- debits/+ credits)**

NOTE – This output includes conservation offsets that the applicant has not yet committed to implement; in this case without these assumed conservation offsets the currently reflected in NMHV results the amount of resulting debits could be larger (or smaller) and result in the need of additional (or fewer) credits needed for RPA fulfillment.

- Work window for this project: **July 16 - February 15**
- Number of days of in-water work/number of work windows: **30/1**
- Number of days that pile driving will occur/ number of work windows: **0**
- Impact pile driving activities - maximum number of pile strikes per day: **NA**
- Vibratory pile driving activities – minutes of vibratory driving per day: **NA**
- Creosote removal – minimum tons removed (can remove more): **14.3**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of structure: **NA**
- Bulkhead/bank armoring – maximum linear foot of structure: **214**
- Bulkhead/bank armoring – structure placement should not extend below: **2.3 ft below MHHW**
- Stormwater discharge – square foot of impervious surface generating stormwater: **2777**

The RPM(s) that are applicable to this project are:
RPM 1 - **NA**
RPM 2 - **NA**
RPM 3 - **Required**
RPM 4 - **Required**
RPM 5 - **Required**

The T&C(s) that are applicable to this project are:
T&C 1 - **NA**
T&C 2 - **NA**
T&C 3 - **Required**
T&C 4 - **Required**
T&C 5 - **Required**

Puget Sound Nearshore Batch Opinion **WCRO-2021-03047**

Project Attachment for USACE Administrative Ease for: **NWS-2019-812**

Summary of current status of **NWS-2019-812** (at date of final signing of **WCRO-2021-03047**)

- Subject to the Reasonable and Prudent Alternative (RPA):**Yes**

- Current Nearshore Habitat Values Model Output: **-325 (- debits/+ credits)**

NOTE – This output includes conservation offsets that the applicant has not yet committed to implement; in this case without these assumed conservation offsets the currently reflected in NMHV results the amount of resulting debits could be larger (or smaller) and result in the need of additional (or fewer) credits needed for RPA fulfillment.

- Work window for this project: **July 16 - February 15**
- Number of days of in-water work/number of work windows: **30/1**
- Number of days that pile driving will occur/ number of work windows: **0**
- Impact pile driving activities - maximum number of pile strikes per day: **NA**
- Vibratory pile driving activities – minutes of vibratory driving per day: **NA**
- Creosote removal – minimum tons removed (can remove more): **NA**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of structure: **NA**
- Bulkhead/bank armoring – maximum linear foot of structure: **481**
- Bulkhead/bank armoring – structure placement should not extend below: **1.15 ft below MHHW**
- Stormwater discharge – square foot of impervious surface generating stormwater: **4810**

The RPM(s) that are applicable to this project are:
RPM 1 - **NA**
RPM 2 - **NA**
RPM 3 - **Required**
RPM 4 - **Required**
RPM 5 - **Required**

The T&C(s) that are applicable to this project are:
T&C 1 - **NA**
T&C 2 - **NA**
T&C 3 - **Required**
T&C 4 - **Required**
T&C 5 - **Required**

Puget Sound Nearshore Batch Opinion **WCRO-2021-03047**

Project Attachment for USACE Administrative Ease for: **NWS-2019-897**

Summary of current status of **NWS-2019-897** (at date of final signing of **WCRO-2021-03047**)

- Subject to the Reasonable and Prudent Alternative (RPA):**Yes**

- Current Nearshore Habitat Values Model Output: **-29 (- debits/+ credits)**

NOTE – This output includes conservation offsets that the applicant has not yet committed to implement; in this case without these assumed conservation offsets the currently reflected in NMHV results the amount of resulting debits could be larger (or smaller) and result in the need of additional (or fewer) credits needed for RPA fulfillment.

- Work window for this project: **July 16 - February 15**
- Number of days of in-water work/number of work windows: **30/1**
- Number of days that pile driving will occur/ number of work windows: **3.5**
- Impact pile driving activities - maximum number of pile strikes per day: **NA**
- Vibratory pile driving activities – minutes of vibratory driving per day: **200**
- Creosote removal – minimum tons removed (can remove more): **1.3**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of structure: **2,215**
- Bulkhead/bank armoring – maximum linear foot of structure: **NA**
- Bulkhead/bank armoring – structure placement should not extend below: **NA**
- Stormwater discharge – square foot of impervious surface generating stormwater: **NA**

The RPM(s) that are applicable to this project are:
RPM 1 - **Required**
RPM 2 - **NA**
RPM 3 - **Required**
RPM 4 - **NA**
RPM 5 - **Required**

The T&C(s) that are applicable to this project are:
T&C 1 - **Required**
T&C 2 - **NA**
T&C 3 - **Required**
T&C 4 - **NA**
T&C 5 - **Required**

Puget Sound Nearshore Batch Opinion **WCRO-2021-03047**

Project Attachment for USACE Administrative Ease for: **NWS-2019-962**

Summary of current status of **NWS-2019-962** (at date of final signing of **WCRO-2021-03047**)

- Subject to the Reasonable and Prudent Alternative (RPA):**Yes**

- Current Nearshore Habitat Values Model Output: **-43 (- debits/+ credits)**

NOTE – This output includes conservation offsets that the applicant has not yet committed to implement; in this case without these assumed conservation offsets the currently reflected in NMHV results the amount of resulting debits could be larger (or smaller) and result in the need of additional (or fewer) credits needed for RPA fulfillment.

- Work window for this project: **July 16 - January 14**
- Number of days of in-water work/number of work windows: **5/1**
- Number of days that pile driving will occur/ number of work windows: **3**
- Impact pile driving activities - maximum number of pile strikes per day: **225**
- Vibratory pile driving activities – minutes of vibratory driving per day: **NA**
- Creosote removal – minimum tons removed (can remove more): **18.2**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of structure: **2,548**
- Bulkhead/bank armoring – maximum linear foot of structure: **NA**
- Bulkhead/bank armoring – structure placement should not extend below: **NA**
- Stormwater discharge – square foot of impervious surface generating stormwater: **NA**

The RPM(s) that are applicable to this project are:
RPM 1 - **Required**
RPM 2 - **NA**
RPM 3 - **Required**
RPM 4 - **NA**
RPM 5 - **Required**

The T&C(s) that are applicable to this project are:
T&C 1 - **Required**
T&C 2 - **NA**
T&C 3 - **Required**
T&C 4 - **NA**
T&C 5 - **Required**

Puget Sound Nearshore Batch Opinion **WCRO-2021-03047**

Project Attachment for USACE Administrative Ease for: **NWS-2019-1032**

Summary of current status of **NWS-2019-1032** (at date of final signing of **WCRO-2021-03047**)

- Subject to the Reasonable and Prudent Alternative (RPA):**Yes**

- Current Nearshore Habitat Values Model Output: **-237 (- debits/+ credits)**

NOTE – This output includes conservation offsets that the applicant has not yet committed to implement; in this case without these assumed conservation offsets the currently reflected in NMHV results the amount of resulting debits could be larger (or smaller) and result in the need of additional (or fewer) credits needed for RPA fulfillment.

- Work window for this project: **July 16 - February 15**
- Number of days of in-water work/number of work windows: **30/1**
- Number of days that pile driving will occur/ number of work windows: **3**
- Impact pile driving activities - maximum number of pile strikes per day: **520**
- Vibratory pile driving activities – minutes of vibratory driving per day: **120**
- Creosote removal – minimum tons removed (can remove more): **NA**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of structure: **2,703**
- Bulkhead/bank armoring – maximum linear foot of structure: **105**
- Bulkhead/bank armoring – structure placement should not extend below: **5.5 ft above MLLW (average)**
- Stormwater discharge – square foot of impervious surface generating stormwater: **NA**

The RPM(s) that are applicable to this project are:
RPM 1 - **Required**
RPM 2 - **NA**
RPM 3 - **Required**
RPM 4 - **NA**
RPM 5 - **Required**

The T&C(s) that are applicable to this project are:
T&C 1 - **Required**
T&C 2 - **NA**
T&C 3 - **Required**
T&C 4 - **NA**
T&C 5 - **Required**

Puget Sound Nearshore Batch Opinion **WCRO-2021-03047**

Project Attachment for USACE Administrative Ease for: **NWS-2020-54-WRD**

Summary of current status of **NWS-2020-54-WRD** (at date of final signing of **WCRO-2021-03047**)

- Subject to the Reasonable and Prudent Alternative (RPA):**No**

- Current Nearshore Habitat Values Model Output: **20 (- debits/+ credits)**

NOTE – This output includes conservation offsets that the applicant has not yet committed to implement; in this case without these assumed conservation offsets the currently reflected in NMHV results the amount of resulting debits could be larger (or smaller) and result in the need of additional (or fewer) credits needed for RPA fulfillment.

- Work window for this project: **August 16 - February 15**
- Number of days of in-water work/number of work windows: **180/1**
- Number of days that pile driving will occur/ number of work windows: **2**
- Impact pile driving activities - maximum number of pile strikes per day: **400**
- Vibratory pile driving activities – minutes of vibratory driving per day: **240**
- Creosote removal – minimum tons removed (can remove more): **3.1**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of structure: **2,466**
- Bulkhead/bank armoring – maximum linear foot of structure: **NA**
- Bulkhead/bank armoring – structure placement should not extend below: **NA**
- Stormwater discharge – square foot of impervious surface generating stormwater: **NA**

The RPM(s) that are applicable to this project are:
RPM 1 - **Required**
RPM 2 - **NA**
RPM 3 - **Required**
RPM 4 - **NA**
RPM 5 - **Required**

The T&C(s) that are applicable to this project are:
T&C 1 - **Required**
T&C 2 - **NA**
T&C 3 - **Required**
T&C 4 - **NA**
T&C 5 - **Required**

Puget Sound Nearshore Batch Opinion **WCRO-2021-03047**

Project Attachment for USACE Administrative Ease for: **NWS-2020-277**

Summary of current status of **NWS-2020-277** (at date of final signing of **WCRO-2021-03047**)

- Subject to the Reasonable and Prudent Alternative (RPA):**No**

- Current Nearshore Habitat Values Model Output: **0 (- debits/+ credits)**

NOTE – This output includes conservation offsets that the applicant has not yet committed to implement; in this case without these assumed conservation offsets the currently reflected in NMHV results the amount of resulting debits could be larger (or smaller) and result in the need of additional (or fewer) credits needed for RPA fulfillment.

- Work window for this project: **August 1 - February 15**
- Number of days of in-water work/number of work windows: **30/1**
- Number of days that pile driving will occur/ number of work windows: **0**
- Impact pile driving activities - maximum number of pile strikes per day: **NA**
- Vibratory pile driving activities – minutes of vibratory driving per day: **NA**
- Creosote removal – minimum tons removed (can remove more): **NA**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of structure: **NA**
- Bulkhead/bank armoring – maximum linear foot of structure: **NA**
- Bulkhead/bank armoring – structure placement should not extend below: **NA**
- Stormwater discharge – square foot of impervious surface generating stormwater: **NA**

The RPM(s) that are applicable to this project are:
RPM 1 - **NA**
RPM 2 - **NA**
RPM 3 - **Required**
RPM 4 - **NA**
RPM 5 - **Required**

The T&C(s) that are applicable to this project are:
T&C 1 - **NA**
T&C 2 - **NA**
T&C 3 - **Required**
T&C 4 - **NA**
T&C 5 - **Required**

Puget Sound Nearshore Batch Opinion **WCRO-2021-03047**

Project Attachment for USACE Administrative Ease for: **NWS-2020-365**

Summary of current status of **NWS-2020-365** (at date of final signing of **WCRO-2021-03047**)

- Subject to the Reasonable and Prudent Alternative (RPA):**No**

- Current Nearshore Habitat Values Model Output: **0 (- debits/+ credits)**

NOTE – This output includes conservation offsets that the applicant has not yet committed to implement; in this case without these assumed conservation offsets the currently reflected in NMHV results the amount of resulting debits could be larger (or smaller) and result in the need of additional (or fewer) credits needed for RPA fulfillment.

- Work window for this project: **July 16 - January 14**
- Number of days of in-water work/number of work windows: **7/1**
- Number of days that pile driving will occur/ number of work windows: **0**
- Impact pile driving activities - maximum number of pile strikes per day: **NA**
- Vibratory pile driving activities – minutes of vibratory driving per day: **NA**
- Creosote removal – minimum tons removed (can remove more): **0.3**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of structure: **1**
- Bulkhead/bank armoring – maximum linear foot of structure: **NA**
- Bulkhead/bank armoring – structure placement should not extend below: **NA**
- Stormwater discharge – square foot of impervious surface generating stormwater: **NA**

The RPM(s) that are applicable to this project are:
RPM 1 - **NA**
RPM 2 - **NA**
RPM 3 - **Required**
RPM 4 - **NA**
RPM 5 - **Required**

The T&C(s) that are applicable to this project are:
T&C 1 - **NA**
T&C 2 - **NA**
T&C 3 - **Required**
T&C 4 - **NA**
T&C 5 - **Required**

Puget Sound Nearshore Batch Opinion **WCRO-2021-03047**

Project Attachment for USACE Administrative Ease for: **NWS-2020-382**

Summary of current status of **NWS-2020-382** (at date of final signing of **WCRO-2021-03047**)

- Subject to the Reasonable and Prudent Alternative (RPA):**Yes**

- Current Nearshore Habitat Values Model Output: **-13 (- debits/+ credits)**

NOTE – This output includes conservation offsets that the applicant has not yet committed to implement; in this case without these assumed conservation offsets the currently reflected in NMHV results the amount of resulting debits could be larger (or smaller) and result in the need of additional (or fewer) credits needed for RPA fulfillment.

- Work window for this project: **July 16 - February 15**
- Number of days of in-water work/number of work windows: **30/1**
- Number of days that pile driving will occur/ number of work windows: **0**
- Impact pile driving activities - maximum number of pile strikes per day: **NA**
- Vibratory pile driving activities – minutes of vibratory driving per day: **NA**
- Creosote removal – minimum tons removed (can remove more): **3.6**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of structure: **NA**
- Bulkhead/bank armoring – maximum linear foot of structure: **70**
- Bulkhead/bank armoring – structure placement should not extend below: **1.5 ft below MHHW**
- Stormwater discharge – square foot of impervious surface generating stormwater: **NA**

The RPM(s) that are applicable to this project are:
RPM 1 - **NA**
RPM 2 - **NA**
RPM 3 - **Required**
RPM 4 - **NA**
RPM 5 - **Required**

The T&C(s) that are applicable to this project are:
T&C 1 - **NA**
T&C 2 - **NA**
T&C 3 - **Required**
T&C 4 - **NA**
T&C 5 - **Required**

Puget Sound Nearshore Batch Opinion **WCRO-2021-03047**

Project Attachment for USACE Administrative Ease for: **NWS-2020-430**

Summary of current status of **NWS-2020-430** (at date of final signing of **WCRO-2021-03047**)

- Subject to the Reasonable and Prudent Alternative (RPA):**Yes**

- Current Nearshore Habitat Values Model Output: **-3 (- debits/+ credits)**

NOTE – This output includes conservation offsets that the applicant has not yet committed to implement; in this case without these assumed conservation offsets the currently reflected in NMHV results the amount of resulting debits could be larger (or smaller) and result in the need of additional (or fewer) credits needed for RPA fulfillment.

- Work window for this project: **July 16 - February 15**
- Number of days of in-water work/number of work windows: **1/1**
- Number of days that pile driving will occur/ number of work windows: **1**
- Impact pile driving activities - maximum number of pile strikes per day: **NA**
- Vibratory pile driving activities – minutes of vibratory driving per day: **30**
- Creosote removal – minimum tons removed (can remove more): **NA**
- Dredging projects - maximum cubic yards dredge: **NA**
- In and overwater structure – maximum square foot of structure: **3**
- Bulkhead/bank armoring – maximum linear foot of structure: **NA**
- Bulkhead/bank armoring – structure placement should not extend below: **NA**
- Stormwater discharge – square foot of impervious surface generating stormwater: **NA**

The RPM(s) that are applicable to this project are:
RPM 1 - **Required**
RPM 2 - **NA**
RPM 3 - **Required**
RPM 4 - **NA**
RPM 5 - **Required**

The T&C(s) that are applicable to this project are:
T&C 1 - **Required**
T&C 2 - **NA**
T&C 3 - **Required**
T&C 4 - **NA**
T&C 5 - **Required**